EXPERIMENTAL INVESTIGATION OF CREEP IN CONCRETE SUBJECTED TO MULTIAXIAL COMPRESSIVE STRESSES AND ELEVATED TEMPERATURES

By Guy P. York, Thomas W. Kennedy,
and Ervin S. Perry

RESEARCH REPORT 2864-2

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operated by
UNION CARBIDE CORPORATION
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U. S. ATOMIC ENERGY COMMISSION

DEPARTMENT OF CIVIL ENGINEERING
THE UNIVERSITY OF TEXAS AT AUSTIN

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An Investigation of the Time-Dependent Deformation
of Concrete Under Triaxial Stress Conditions
in Prestressed Reactor Vessels

Union Carbide Subcontract No. 2864

conducted for

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operated by
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PREFACE

This is the second in a series of reports dealing with the findings of a research project concerned with the evaluation of the creep behavior of concrete subjected to triaxial compressive stresses and elevated temperature. This report summarizes the findings of a preliminary evaluation of the data obtained in the investigation. The effects of curing history, temperature during loading, stress condition, and time after loading on creep strain were evaluated along with the effects of the interactions between these factors. The findings concerning elastic behavior, Poisson's creep effects, and creep recovery behavior are also included and discussed. The data were analyzed by analysis of variance techniques, and several equations for predicting creep behavior were developed through regression analyses.

The investigation was conducted and financed under Union Carbide Subcontract 2864 for the Oak Ridge National Laboratory, which is operated by the Union Carbide Corporation for the United States Atomic Energy Commission. The planning, conducting, and analyzing of data for this experiment required the assistance and cooperation of many individuals and organizations; the authors would like to acknowledge the cooperation and assistance obtained from the Concrete Division of the Waterways Experiment Station, Jackson, Mississippi, and the Department of Civil Engineering of The University of California at Berkeley. In addition, special thanks are extended to Mr. G. D. Whitman, Coordinator, Pressure Vessel Technology Program, whose active participation and support allowed this investigation to be successfully conducted and to Dr. J. P. Callahan, Mr. J. G. Stradley, and Dr. J. M. Corum of the Oak Ridge National Laboratory. Appreciation is also extended to Professor Clyde E. Kesler, Department of Civil Engineering, University of Illinois, who served as a consultant to the project. Special thanks are also extended to Dr. Gerald R. Wagner and Mr. Joseph A. Kozuh for their suggestions and assistance in preparing the statistical analysis. Special appreciation is due Mr. Victor N. Toth, Dr. Nabil Jundi, and Dr. John W. Chuang for their aid in the planning of the experiment, the preparation of the specimens, and the analysis of the data. And finally, the aid extended by personnel of the Center for Highway Research, The University of Texas at Austin, is acknowledged.

Future reports will be concerned with a method of predicting long-term triaxial creep behavior from short-term uniaxial creep data, detailed inspection and evaluation of the specimens used in this investigation, a more detailed investigation of certain aspects of the data, and an extension of this investigation to include the effect of time after loading on creep behavior.

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ABSTRACT

This report describes the preliminary findings from an experimental investigation performed to evaluate the effects of five major factors and their interactions on creep in plain concrete. The five factors investigated were (a) temperature during loading, at 75° and 150° F, (b) curing history described as air-dried and as-cast, (c) axial loads in combinations of five stress levels varying from 0 to 3600 psi, (d) radial loads in combinations of five stress levels varying from 0 to 3600 psi, and (e) time which consisted of a continuous observation period of 18 months after casting.

Essentially this experiment consisted of applying compressive loads along the three principal axes of cylinderical concrete specimens. Loads along the longitudinal axis were varied independently of loads applied along the radial axes, permitting triaxial, biaxial, and uniaxial states of stress to be evaluated. The loads were applied by means of a hydraulic loading system and strains were measured by vibrating wire strain gages cast in the concrete along the axial and radial axes.

The creep strains were analyzed statistically through two factorial designs within the experiment. Analysis of variance was used to evaluate all main effects, two and three-factor interaction effects, and the nonlinear effects of stress and time. The highly significant effects are discussed in detail and the less significant effects are identified. Also included in this report is a discussion of the effects of factors on creep Poisson's ratio and creep recovery. Several equations which predict creep strains were developed through regression analysis, employing all factors investigated.

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CHAPTER 1. INTRODUCTION

One of the more important considerations in the design and safety evaluation of a prestressed concrete nuclear reactor vessel is the time-dependent behavior of the concrete in the presence of varying temperature, moisture, and loading conditions. Creep and shrinkage, two forms of time-dependent deformation, can have serious effects because of (1) the loss of initial prestress; (2) large deformations of the vessel, which might result in misalignment of the control-rod passages; and (3) possible residual stresses introduced as the loading conditions change. In the last case, the residual stresses could conceivably be tensile stresses, which might result in serious damage to the vessel.

At the request of the United States Atomic Energy Commission a basic research program was formulated and initiated by the Oak Ridge National Laboratory for the purpose of developing and improving the technology of prestressed concrete reactor vessels. As part of this program, an extensive experimental investigation was begun at The University of Texas at Austin for the purpose of studying the creep behavior of concrete under multiaxial states of stress and elevated temperature. The experiment consisted of measuring strains in cylindrical specimens subjected to 50 test conditions involving a variety of multiaxial loading conditions (stresses ranging from zero to 3600 psi), two curing histories (air-dried and as-cast), and at two temperatures (75 and 150° F). All creep strain observations were made on cylindrical concrete specimens which had a nominal 28-day compressive strength of 6000 psi and were placed in a controlled environment for 90 days. After curing the specimens were subjected to a prescribed loading condition and temperature for 12 months, followed by a three-month unloading period during which creep recovery was observed.

The purpose of this report is to summarize and discuss the findings from a preliminary evaluation of the data obtained during the investigation and to provide a framework for further detailed study of certain aspects of creep behavior.

The report contains six chapters and appendices. Chapter 2 provides a summary of the current status of knowledge concerning creep behavior in concrete. Chapter 3 describes the experimental program, including equipment, instrumentation, test procedures, and experimental design. Chapter 4 is devoted to the summarization and discussion of all data and pertinent information except that concerned directly with creep, which is discussed in detail in Chapter 5. Conclusions and recommendations are contained in Chapter 6 and the supporting data and information are contained in the appendices.

CHAPTER 2. THE NATURE OF CREEP

This chapter summarizes the current status of knowledge concerning the general nature of the creep phenomenon, its effect on structural members, the major factors which affect creep behavior, and the experimental means normally used to estimate its magnitude.

CREEP PHENOMENON

Concrete exhibits two forms of time-dependent deformation: creep and shrinkage. Creep deformation is that portion of the time-dependent deformation attributed to applied load, and shrinkage is the deformation due to physical or chemical causes other than applied load. According to Ali and Kesler (Ref 1), creep deformation is usually defined as the algebraic difference between the total deformation under load and the sum of the elastic and shrinkage deformations. A typical time-deformation relationship illustrating these forms of deformation for concrete subjected to a load which is sustained for a period of time and then released is shown in Fig 1.

When concrete is loaded, there is an immediate deformation, termed instantaneous elastic deformation, which is generally attributed to the elastic properties of the concrete. If the load is maintained, the concrete continues to deform, at a decreasing rate as shown by the total deformation curve in Fig 1. This figure also shows the time-dependent deformations resulting from the sustained load and from shrinkage of the material. Upon release of the load, there is an immediate deformation in the opposite direction, which is instantaneous recovery. This instantaneous recovery deformation is approximately equal to the instantaneous elastic deformation but decreases in magnitude as the time under load increases. This difference is attributed generally to an increase in the modulus of elasticity with age and to a time-dependent plastic set in the concrete (Ref 1). After the load is released, the concrete continues to recover, at a decreasing rate, so that deformation generally becomes constant after a period of time. This gradual recover is called creep recovery and its curve is essentially the reverse of that of

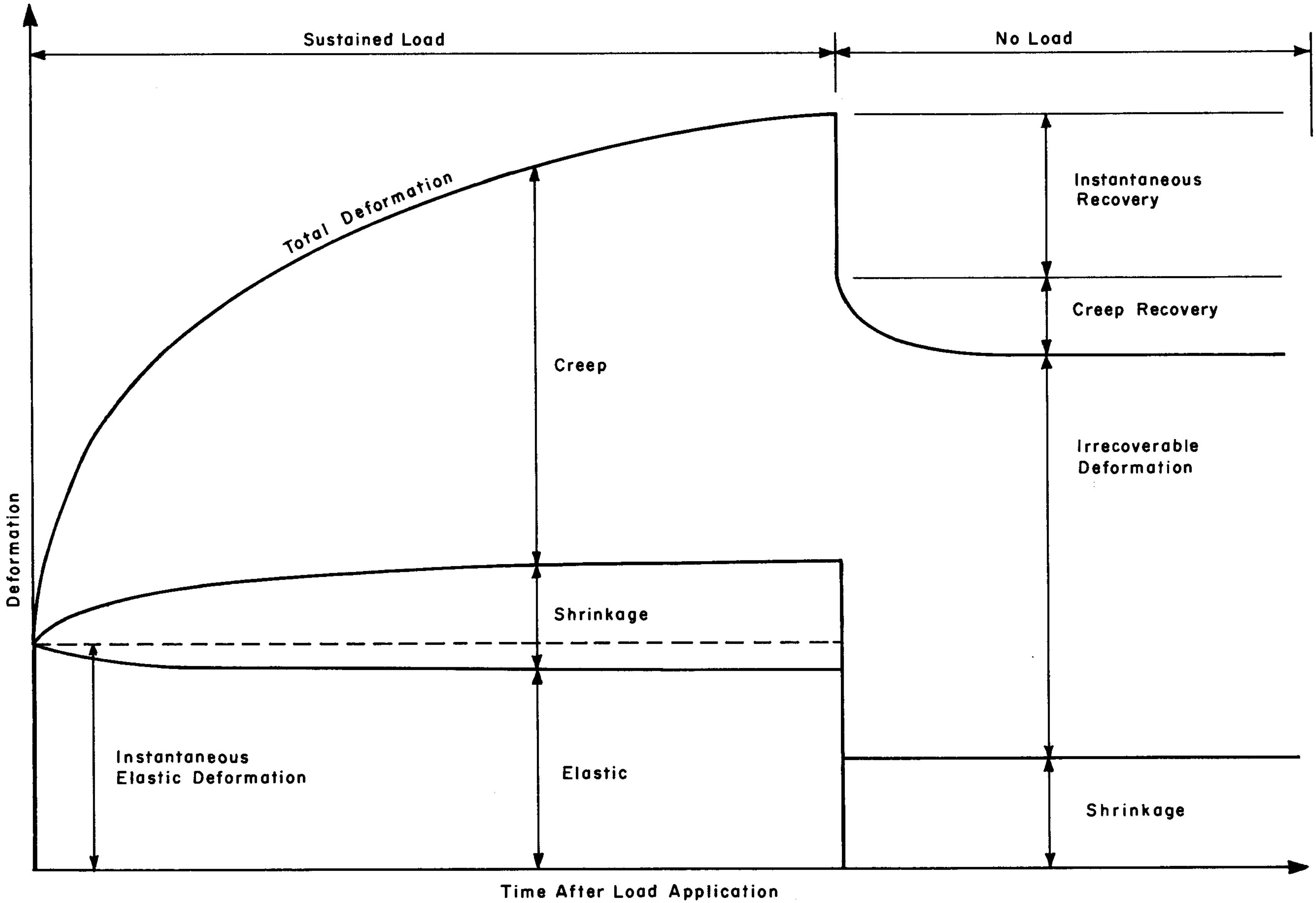

Fig 1. Typical deformation versus time curve for concrete under a sustained load which is later removed.

creep deformation. The difference between the shrinkage deformation and the total deformation remaining after the creep recovery reaches a limiting value is an irrecoverable deformation or permanent set.

Experimental Determination of Creep Strain

Creep strain at any particular time is usually computed as the algebraic difference between the total strain and the sum of shrinkage strain and the instantaneous elastic strain. It should be noted that this computation does not yield the actual creep strain, because the modulus of elasticity usually increases slightly with time, thus decreasing the deformation attributable to elastic strain as time progresses. The assumption that elastic strain is constant after loading usually results, therefore, in computed creep strains which are slightly smaller than the actual creep strains. Practically, this deficiency is not serious, however, because the above computation determines the apparent additional strain attributable to sustained load that occurs with time, and it is this additional time-dependent strain that is normally desired by the engineer.

In addition, the above method of computation assumes that shrinkage and creep strains are independent and additive effects. In reality there is probably an interaction between creep and shrinkage (Refs 26 and 50), making it difficult to isolate the actual strain attributable to shrinkage from that to creep. Nevertheless, shrinkage and creep strains are normally considered to be mutually independent (Ref 50), since an effect due to shrinkage alone can be easily determined experimentally. Creep is therefore considered to be that portion of the time-dependent strain in excess of shrinkage.

Magnitude of Creep Strain

The rate of creep deformation is largest immediately after loading and decreases with time, as shown in Fig 1. Troxell et al (Ref 61) conducted tests with uniaxially loaded specimens and found that approximately 18 to 38 percent of the total creep deformation which accumulated during 20 years of loading occurred in the first two weeks, 40 to 70 percent in the first three months, and 64 to 84 percent within the first year.

The ultimate magnitude of creep strain was found to vary from approximately 0.2×10^{-6} to 2×10^{-6} units per unit stress in psi (Ref 1). Troxell and Davis (Ref 60) found the ultimate magnitude to average about one micro-unit per unit stress, or approximately three times the instantaneous elastic deformation for concrete that has a modulus of elasticity of three million psi.

IMPORTANCE OF CREEP

The importance of creep depends largely on the kind of structure that is constructed. Creep strains exist in all concrete structures under load, but the effects differ according to the kind of structure and the conditions under which it is loaded. Creep is often undesirable since it causes the loss of prestress in prestressed members and results in excessive deflections in reinforced concrete beams and slabs, but by relieving highly stressed parts it can be desirable, e.g., in statically indeterminate structures.

To date there is no valid quantitative analysis method for estimating creep strain, although a number of investigators have attempted to derive mathematical relationships for predicting creep behavior, and the engineer must rely, therefore, on a qualitative evaluation of what occurs in order to allow for the effects of creep.

FACTORS AFFECTING CREEP

Practically, any variable that affects another property of concrete also influences creep. The more important of these variables are:

(1) water and cement;
(2) aggregate type and size;
(3) admixtures;
(4) age when loaded;
(5) temperature during loading;
(6) moisture condition during curing and loading;
(7) size and shape of concrete member;
(8) steel reinforcement;
(9) concrete strength; and
(10) magnitude, duration, type, and variation of stress.

The current status of knowledge concerning the creep effects produced by these major factors is summarized below. The factors and their effects are discussed qualitatively rather than quantitatively, since results and opinions from many experimenters operating under varying degrees of quality control are involved. In addition, since mix constituents are the main variables and it is impossible to alter one constituent of concrete without altering at least one other, it is difficult to ascertain the actual cause and effect relationships. Unless otherwise stated, the conclusions in this section are based on the results of uniaxial tests at stress levels below 50 percent of the ultimate strength of concrete.

Effect of Water and Cement

Quantity and Quality of Paste. Troxell et al (Ref 61) and Polivka et al (Ref 51) found that creep is proportional to the amount of paste in the concrete. In addition, Troxell et al (Ref 61) and Neville and Meyers (Ref 49) have shown that an increase in the water-cement ratio increases creep. In other words, an increase in the quantity of the paste or a decrease in the quality of the paste (i.e., an increase in the water-cement ratio) will result in a larger creep strain.

Cement Type. Troxell and Davis (Ref 60) and Davis et al (Ref 11) investigated the effect of cement type on creep. They found that concrete prepared with low-heat portland cement exhibited greater total creep strains and higher creep rates at all ages than concrete prepared with normal portland cement when the concrete was loaded at the usual times after placement. The influence of cement type on creep is apparently associated with the degree of hydration of the cement at the time the concrete is loaded, with a higher degree of hydration resulting in less creep strain. It was also found (Ref 11) that fine-ground low-heat cement generally produced less creep than coarse-ground low-heat cement, whereas fineness of normal cement had no appreciable effect on creep. Neville (Ref 46) believes that fineness itself has no effect on creep, but that grinding to a finer state reduces the gypsum content below an optimum amount and results in increased creep.

Little information is available on the creep effects of cement components, but Ali and Kesler (Ref 1) state that shrinkage is low for concrete containing cement with high tricalcium silicate (C_3S) and low alkali contents. A high alkali content requires a greater percentage of gypsum to keep shrinkage low, and thus gypsum appears to have a great effect on shrinkage, with the minimum shrinkage occurring with an optimum amount of gypsum. Davis and Troxell (Ref 13) have indicated that factors which affect shrinkage usually affect creep in the same manner. Therefore, because there is a lack of experimental data with regard to creep effects produced by various cement components, it is assumed that the above effects are probably true for creep.

Effect of Aggregate

Proportion of Aggregate. It would be expected that an increase in the proportion of aggregate in a mix would reduce creep, since concrete aggregates are usually considered to be essentially inert and therefore volumetrically stable. Neville (Ref 48) found this to be true by comparing creep of cement paste alone with creep of a concrete containing the same quantity of paste. Troxell et al (Ref 61) found that for constant water-cement ratios, higher aggregate-cement ratios produced less creep. For concrete subjected to stress levels above $0.7f'_c$, however, creep increased with increased aggregate-cement ratios up to a critical aggregate content and then decreased (Ref 58).

Type of Aggregate. The petrological characteristics of the aggregate appear to affect creep significantly. From tests in which the concrete was loaded for five years, Davis et al (Ref 12) found that concretes prepared with aggregates of limestone, quartz, granite, gravel, basalt, or sandstone exhibited increased creep strains in the order listed. Other investigators (Ref 58) have suggested that these aggregate effects are associated with the modulus of elasticity and porosity of the aggregate. A hard dense aggregate with a high modulus of elasticity produces concrete with a low creep potential. Although agregates with high porosity tend to lower the creep potential because they remove water from the paste, this effect is generally offset by the lower modulus of elasticity of the aggregate.

Size of Aggregate. A number of investigators have suggested that the gradation, maximum size, and shape of aggregate particles affect creep behavior. Davis et al (Ref 12) found that for concretes prepared with uniformly graded aggregates a larger maximum aggregate size resulted in less creep. They also discovered that an increase in the fineness modulus of the aggregate increased creep. It is the opinion of researchers at the Waterways Experiment Station, however (Ref 7), that aggregate size per se has little effect on creep behavior, except that for the same workability, smaller aggregates require more paste, which in turn increases creep strain.

Effect of Admixtures

Very little information is available on the influence of admixtures on the creep behavior of concrete. Tests at the Waterways Experiment Station (Ref 7) indicated that an increase in air content increased creep strain.

The use of pozzolans and blast furnace slag to replace part of the portland cement has been reported to increase the creep potential; however, the use of certain types of fly ash has been found to reduce creep (Refs 58 and 61). A reference (Ref 58) to research at Queen's University indicated that creep strain increased substantially with the use of calcium chloride, and that triethanolamine used simultaneously with lignosulphonic acid increased creep at the early ages after loading, but not at the later ages. Most evidence has indicated that generally admixtures tend to increase the creep potential; therefore, before an admixture is used in a structure in which creep strain is of concern, creep tests should be conducted.

Effect of Concrete Age When Loaded

Many investigators, beginning with R. E. Davis et al (Refs 12, 21, and 61), have found that creep is greater when concrete is loaded at an early age. For concrete samples moist cured at 70° F until loaded, the total creep strain in concrete loaded seven days after casting was approximately three times that in concrete loaded at three months, while creep strain in concrete loaded at 28 days was nearly twice that in concrete loaded at three months (Refs 12 and 60). This reemphasizes the point that the greater the degree of hydration at time of loading, the smaller the creep strain. Nasser and Neville (Ref 45) found, however, that even 50-year-old concrete, cored out of a bridge footing, could creep substantially, especially when subjected to higher than normal temperatures. In addition, the higher the level of stress, the more pronounced was the effect of the age of the concrete when it was loaded (Ref 1).

Nevertheless, it is assumed that at later ages creep behavior becomes relatively independent of age at loading. Hannant (Ref 26) reported that an investigation by Brown (Ref 4) showed that creep decreased with an increase in concrete age at loading for specimens at 60° F but that a similar decrease was not observed for specimens at 104° F, 150° F, and 200° F.

Effect of Temperature After Loading

Until 1960, when Hansen (Ref 28) reported testing beams in flexure, almost no research had been reported on creep of concrete subjected to variations in temperature. By 1965 several researchers began investigating creep at relatively high temperatures to meet a need for this knowledge caused by the development of prestressed concrete reactor vessels.

Temperatures Below 300° F. For sealed concrete beams cured six months under water at 92° F prior to loading, Hansen (Ref 28) found that creep deformations in flexure approximately doubled when the temperature was increased from 68° F to 104° F and nearly tripled for a change from 68° F to 140° F. These conclusions generally agreed with those of England and Ross (Ref 16) for sealed concrete cylinders loaded for periods of up to 80 days. They found that creep strains at 176° F and 284° F were approximately 3.5 and 4.2 times the creep at 68° F, and that the influence of temperature was not as great beyond 212° F as in the 68° F to 140° F range.

Recent research by Hannant (Ref 26) and Arthanari and Yu (Ref 2) showed that creep increased markedly with increased temperature and that regardless of whether the specimens were sealed or unsealed the relationship was essentially linear between 80° F and 170° F and between 68° F and 176° F, respectively. From 170° F to 200° F, which was the maximum temperature in his tests, Hannant found that the creep strain-time relationships were nonlinear and that the rate of creep increased with temperature. Hannant also found that creep strains at 170° F were between 4 and 4.8 times the strains at 80° F. Arthanari and Yu also discovered that creep strain was greater when the temperature was increased in stages rather than being set at the maximum and kept constant throughout the loading period.

It was reported (Ref 58) that Hickey (Ref 31) found similar temperature effects in unsealed concrete specimens subjected to a uniaxial compressive stress of 800 psi for six months. He found that creep at 290° F in a near zero relative humidity was approximately five times that at 73° F and 50 percent relative humidity and that creep had a linear variation between 73° F and 180° F and a curvilinear variation between 180° F and 240° F.

Temperatures Above 300° F. Cruz (Ref 8) conducted an investigation in which he subjected concrete specimens to a uniaxial compressive stress of 1800 psi for five hours at temperatures ranging up to 1200° F. He found that creep in concrete maintained in a dry air environment at 1200° F, 900° F, 600° F, and 300° F was approximately 33, 15, 6, and 3 times that under identical conditions at 75° F.

Effect of Moisture Condition

Of the many factors that affect creep behavior, the moisture environment to which the concrete is subjected during curing and while under load is probably one of the most important, and yet it is probably the least understood and most difficult to control. It is generally concluded that less creep occurs when the humidity of the environment during loading is high.

Troxell et al (Ref 61) reported that at the end of 20 years, creep in unsealed specimens stored at 50 percent relative humidity during the loading period was three times that in specimens stored at 100 percent relative humidity. Mitzel and Klapoc (Ref 44) found that the creep strain in sealed specimens was approximately 20 percent less than in identical unsealed specimens.

Glucklick and Ishai (Ref 23) have indicated, however, that a well-cured concrete with a low moisture content at time of loading exhibits less creep than the same concrete with a high moisture content. In addition, Hannant (Ref 26) found that when all the vaporable water in the concrete was removed before loading, little creep occurred at the end of 200 days when compared to saturated concrete, even at a stress of 2000 psi and temperature of 158° F.

Effect of Size and Shape

It has been generally observed that large concrete members exhibit less creep strain than small ones. Troxell et al (Ref 61) tested 6, 8, and 10-inch-diameter specimens stored in 100 percent relative humidity and found that at the end of 9-1/2 years creep strains in the 8 and 10-inch specimens were 85 and 70 percent respectively, of the creep strains in the 6-inch specimens. Hansen and Mattock (Ref 29) found that with time, creep in large members approached that in the corresponding sealed specimens. They also discovered that size and shape seemed to affect the creep rate of only those specimens loaded during the first three months after casting. For specimens loaded beyond that time, size and shape appeared to have little effect, since the creep in these members approached that of the sealed specimens under identical temperature and humidity conditions.

Some investigators, however (Refs 12 and 60), believe that the effect of size and shape on creep is important primarily in the way it affects moisture movement in the concrete mass as a whole, i.e., the longer the seepage paths to the free surface, the less the total creep strain. This belief is compatible with recent tests in Russia. Hannant (Ref 26) reported that Karapetrin (Ref 36) concluded from tests of 4, 5.5, and 9.8-inch-diameter specimens that size actually had no influence on creep if there were no moisture movement.

Effect of Concrete Strength

The effect of strength on creep in many cases is actually the cumulation of the interactions of all the previous factors. It can be generally concluded (Refs 10 and 18) that the stronger the concrete at time of loading, the less the creep. Furthermore, Nasser and Neville (Ref 45) stated that the increase in strength of concrete with age influences the magnitude of creep by helping to restrain creep as the concrete becomes stronger.

Effect of Steel Reinforcement

The presence of steel in concrete tends to reduce the apparent creep strain. As the concrete deforms under sustained load more and more of this load is transferred from the concrete to the steel. Tests by Troxell et al (Ref 61) on reinforced concrete columns showed that for 1.9 percent reinforcement the stress in the steel increased more than fivefold in 5-1/2 years. Thus less creep should occur in specimens containing reinforcement.

Effect of Stress

Magnitude and Duration. It is well established that higher stresses and longer load times increase creep strain. If the stress level is below approximately 75 percent of the ultimate strength, the rate of creep in concrete decreases progressively with time until it approaches zero or some small constant (Ref 1). For the stresses common in normal structural members, it is generally assumed that the creep rate approaches zero and that creep strain reaches a constant value (Ref 58), although Troxell et al (Ref 61) found that creep strains were still increasing after 30 years under a sustained load.

If the stress level is above approximately 75 percent of the ultimate strength, the concrete will continue to creep and eventually will fail (Refs 18 and 56). The creep rate in this case increases very rapidly when the load is applied and then begins to decrease. After a few days or weeks, however, the creep rate again increases, until failure occurs. Rüsch (Ref 56) performed uniaxial load tests at stress levels of up to 90 percent of the ultimate strength of concrete with a 56-day compressive strength of 5000 psi. He found that specimens loaded at 90 and 80 percent of ultimate compressive strength failed after approximately 20 minutes and 7 days, respectively. Likewise, Freudenthal and Roll (Ref 18) found that specimens loaded at 80 percent of ultimate strength failed after approximately 10 days.

<u>Proportionality of Stress to Creep</u>. Many investigators (Refs 1, 10, 18, 21, 35, and 46) have shown that creep is proportional to stress up to stress levels of from 20 to 50 percent of the ultimate compressive strength. It is well established that for stresses above 50 percent of the ultimate strength, the relationship between creep strain and stress is nonlinear and that large strains result, the magnitudes of which increase significantly with increased stress (Ref 33). It is believed that this nonlinearity starts when microcracking begins in the concrete. Hsu et al (Ref 32) found that bond cracks between the aggregates and mortar began at stresses approximately 25 to 33 percent of the ultimate strength.

<u>Repeated Loads</u>. Very little information is available relating repeated loads and creep behavior. Nevertheless, the effect of repeated loads on creep is extremely important since concrete structures are normally subjected to variable stress rather than sustained stress. Ali and Kesler (Ref 1) reported that Probst (Ref 52) found that the creep strains decreased as the frequency of load applications of a given stress duration increased. He also discovered that uniform stress fluctuations resulted in less creep than irregular fluctuations did. L'Hermite (Ref 43) found that concrete exhibited less creep when subjected to a rapidly fluctuating stress than when subjected to a comparable stress sustained over the total time period.

<u>Type of Stress</u>. The conclusions from the preceding discussion have been formulated primarily on results from uniaxial compression tests with strains measured along the axis of the applied load. Unfortunately, little information is available concerning strains measured along other axes and the effects of other states of stress and this limited information is often somewhat contradictory.

<u>Uniaxial Compression Stresses</u>. Although numerous investigators have conducted uniaxial creep tests, few have measured strains in directions normal to the applied load. Tests conducted by Glanville and Thomas (Ref 22) and reported in 1939 showed that lateral creep strains were approximately 3 percent of the axial creep strains in one case and negligible in another. Likewise, L'Hermite (Ref 43) in 1957 observed that lateral deformation was approximately the same for loaded and unloaded specimens, indicating a creep Poisson's ratio*

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*Creep Poisson's ratio was defined as the ratio of creep in the direction perpendicular to the applied load to creep along the axis of the applied load.

of zero. Polvika, Pirtz, and Adams, however, (Ref 51) tested 16 and 30-inch-diameter cylindrical specimens and showed that the creep ratio was constant, indicating that creep Poisson's ratio was proportional to the elastic Poisson's ratio. Duke and Davis (Ref 15) also found that creep strain occurred in both the radial and axial directions under uniaxial loads; they found a creep Poisson's ratio of approximately 0.17.

Biaxial Compression Stresses. Ross (Ref 55) investigated creep under biaxial stresses using small concrete prisms under relative low compressive stresses. He found that creep strains in the principal directions were essentially equal to creep strains under corresponding uniaxial stresses. Likewise, Furr (Ref 19) in 1967 reported that creep strains in two-way prestressed slabs, indicated that creep Poisson's ratio was zero and that volumetric creep occurred. In contrast biaxial tests by Arthanari and Yu (Ref 2) in 1967 indicated that creep Poisson's ratio was 0.2. These tests, which were similar to those conducted by Ross, were performed on 12 × 12 × 4-inch concrete prisms subjected to a stress of 1000 psi for 60 days.

Triaxial Compression Stresses. The earliest triaxial creep tests were reported by Davis et al (Ref 12) in 1934 and used cylindrical concrete specimens. These tests were actually more of a relaxation than a normal creep test since the radial dimensions were kept unchanged by varying the radial pressure. It was found that creep strains in the axial direction were essentially equal to that in similar specimens not under radial restraint.

Duke and Davis (Ref 15) tested 8-inch-diameter cylindrical specimens using different ratios of axial to radial stress, which ranged up to 500 and 250 psi, respectively. They reported that the lateral stresses caused a marked decrease in longitudinal strains as compared to comparable uniaxially loaded specimens because of the Poisson's ratio effect. The validity of their results, however, was questionable, since hydraulic fluid leaked into the specimens during the test.

No other creep results from triaxial test conditions of consequence were reported until those of Hannant in 1969 (Refs 26 and 27) and those of Gopalakrishnan et al in 1970 (Refs 24 and 25). Hannant conducted tests on 4 × 12-inch concrete cylinders subjected to combinations of three radial and axial stress levels ranging from 0 to 2000 psi and to two levels of temperature. Load was applied six months after casting and was maintained for two years. Throughout the test period, the specimens were sealed against moisture loss. Each specimen contained one vibrating wire strain gage cast in the longitudinal direction. From these tests Hannant found that (1) the application of a radial stress significantly reduced the creep strains in the direction of the axial load relative to axial creep strains in comparable uniaxially loaded specimens; (2) considerable creep strain occurred under a hydrostatic state of stress even after two years under load, indicating that volumetric creep occurred; and (3) creep Poisson's ratio averaged 0.18 and was virtually constant over the entire test period. It should be noted, however, that the creep Poisson's ratio was estimated from a uniaxial and biaxial test specimen because no radial strains were actually measured. This means that the creep Poisson's ratio as determined by Hannant was, in effect, a uniaxial and not a triaxial creep ratio.

Gopalakrishnan et al (Refs 24 and 25) reported creep strains in all three principal directions from tests on 10-inch concrete cubes that were loaded independently in each of the principal directions at various combinations of stress ranging up to 2015 psi. The specimens were maintained in a near constant environment at 100 percent relative humidity and 78° F throughout the test. The loads were applied eight days after casting and usually were sustained for 28 days, but were sustained for 98 days in one case. It was found that (1) creep strains under multiaxial stress conditions could not be predicted simply by superposition methods from creep measurement of uniaxial tests; (2) multiaxial compression reduced the creep strain relative to that occurring under uniaxial compression of the same magnitude in a given direction, substantiating Hannant's results; (3) creep Poisson's ratio was apparently unaffected by time and was approximately equal to the elastic Poisson's ratio under the uniaxial state of stress; and (4) in the case of multiaxial compression, the effective creep Poisson's ratio was less than in the uniaxial case, varied between 0.09 and 0.17 depending on the relative magnitudes of the principal stresses, and was greater in the direction of the smallest load.

Uniaxial Tensile Stresses. The creep behavior of concrete in tension appears to be qualitatively similar to that of concrete in compression, although there is some disagreement among researchers. This may be explained by the fact that the applied tensile stresses were small, therefore resulting in small observed creep strains. Thus, errors associated with strain measurements were much more significant than those for compression tests, which would be expected to have higher strains. Several investigators (Refs 11 and 61) have found that for equal stresses the initial rate of creep was higher in tension than in compression, but that the rates eventually tended to approach the same magnitude. Illston (Ref 33) likewise found that initially the rate of creep was higher in tension than in compression but that later the reverse was true. Ross (Ref 55) and Glanville (Ref 21), respectively, found, however, that in three and six months the creep strains were almost the same for equal stresses under both tension and compression.

Flexure Stresses. Here again very little information is available on plain concrete despite the simplicity of the test. Tests have indicated that creep strain of the tensile fibers exceeds the creep strain in the corresponding compressive fibers (Ref 11) and that creep is much higher in flexure than would be expected from the results of uniaxial tests (Refs 6 and 62).

SUMMARY OF CURRENT STATUS OF KNOWLEDGE

From the literature, it appears that creep in concrete is a complex phenomenon which depends primarily on the physio-chemical behavior of the internal structure of the hardened cement paste. Most of the factors which influence creep are interdependent, as the effect of one factor cannot be adequately described without discussing its relationship with or dependence on the other factors. Nevertheless, an overriding influence on the magnitude of creep appears to be the degree of hydration of the cement in the concrete at time of loading with a higher degree of hydration resulting in a lower creep potential. Many of the factors discussed above either directly or indirectly influence the degree of hydration.

In general the literature shows that creep in concrete subjected to working stress levels decreases with the following:

(1) reduction in water-cement ratio and paste content,
(2) use of higher heat portland cements,
(3) increase in aggregate-cement ratio,
(4) use of hard dense aggregates with high modulus of elasticity and low porosity,
(5) reduction in the use of most admixtures,
(6) increased curing time prior to loading the concrete,
(7) decrease in the temperature during loading,

(8) increase in relative humidity of the environment during loading,

(9) better retention of moisture during curing period,

(10) removal of all evaporable water before loading and maintaining this condition under load,

(11) increase in size of concrete member,

(12) increase in concrete strength,

(13) increase in steel reinforcement,

(14) decrease in the magnitude and duration of load, and

(15) application of a load normal to a previously applied load.

Unfortunately, most of the above findings were formulated from uniaxial compression tests with strains measured only along the axis of the applied stress. Available information on creep in concrete under multiaxial stresses is very limited and in many cases contradictory. Few, if any, studies have been conducted on the long-term interrelated effects of moisture condition and temperature on creep in concrete under various combinations of multiaxial stress. In addition, the previous studies have not evaluated as many major factors simultaneously as investigated in this study for strains measured along the principal axes. Thus, no estimate is available on the interactions of factors which may significantly affect the magnitude of creep in plain concrete.

CHAPTER 3. EXPERIMENTAL PROGRAM

This chapter presents a discussion and description of the factors investigated, the design of the experiment, the techniques used to prepare specimens, the various equipment components used, and, briefly, the test procedures employed; a detailed description of these procedures is contained in Ref 42.

The tests consisted of applying compressive loads along the three principal axes of cylindrical concrete specimens (Fig 2) and measuring the axial and radial strains throughout the test period. The axial and radial loads were varied independently to achieve triaxial, biaxial, and uniaxial states of stress. The loads were applied by means of a hydraulic loading system and the resulting strains were measured by vibrating wire strain gages cast in the concrete along the axes of the axial and radial loads.

TEST CONDITIONS

Although numerous factors affect the creep behavior of concrete, this study investigated the interrelationship of only five of the more important variables, i.e., temperature during loading, curing history prior to loading, axial loading, radial loading, and time.

Temperature During Loading

Two temperature levels during loading were selected, representative of the limits of the range of concrete temperature in a nuclear reactor containment vessel. The low level was set at 75° F, which could be expected at the outer surface of a reactor, and the high level at 150° F, which is representative of the temperature occurring at the inner surface.

Environmental control provided temperatures which were within $\pm 2^{\circ}$ F of the desired temperature, and they were recorded continuously. Relative humidity of the 75° F environment was maintained at 60 percent $\pm$ 5 percent and was checked periodically.

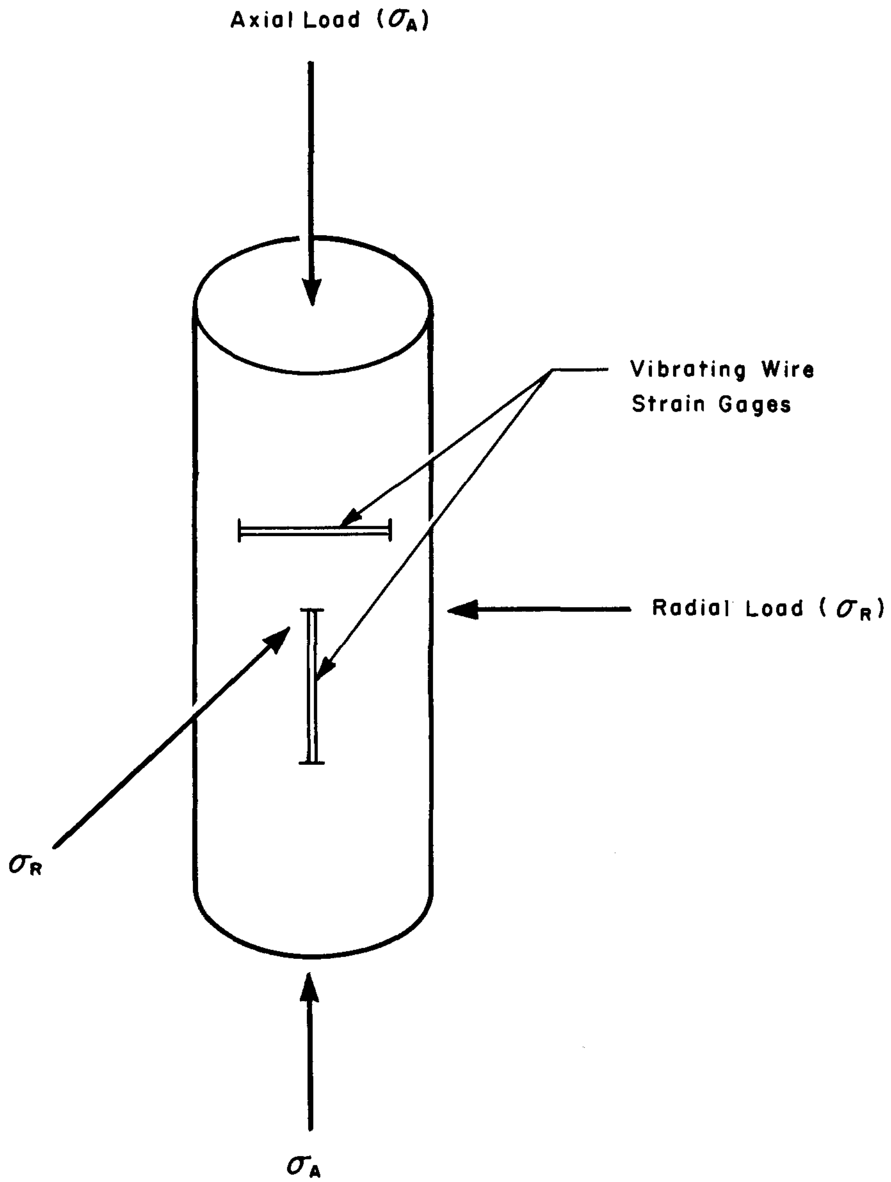


Fig 2. State of stress on experimental specimen.

Curing History

Two curing histories were selected for study and were designated as "as-cast " and "air-dried." These two histories were supposed to be representative of the range of curing histories to which concrete in a prestressed concrete reactor would be subjected during curing and as such would be closely associated with the moisture conditions in the concrete during curing and during loading. However, since it was difficult to determine the actual moisture conditions which resulted from the two types of curing and because it was impossible to assign the cause of an observed effect to anything but the curing procedure, this variable was designated as curing history.

As-cast specimens were removed from the molds 24 hours after casting and placed in a curing room for an additional 24 hours. Then, 48 hours after casting, the specimens were sealed in copper and allowed to cure at 75° F for an additional 81 days (a total of 83 days of curing) at which time they were placed in the test temperature environment. Air-dried specimens were also removed from the mold 24 hours after casting and placed in the curing room for an additional 24 hours. However, rather than being sealed 48 hours after casting, the air-dried specimens were submerged in lime-saturated water for the next five days, for a total of seven days of curing. At seven days, the specimens were removed from the lime-saturated water and placed in the laboratory at 75° F and 60 percent relative humidity and allowed to air-dry for 76 days, for a total of 83 days of curing, at which time they were sealed in copper and placed in the test temperature environment. These curing procedures are presented in more detail in the section entitled "Curing and Sealing."

The air-dried condition is representative of the curing history of the concrete at the outer surface of a reactor or other mass-concrete structure or of concrete in relatively thin members. The as-cast condition is representative of the curing history of concrete at the inner face of a reactor or of concrete in any massive structure except for that near a free air surface.

Load

In this study test specimens were loaded triaxially at five stress levels, ranging from 0 to 3600 psi for both axial stress σ_a and radial confining stress σ_r . Since the combination of stresses involved some zero stress levels, the loading conditions can be classified as uniaxial $\sigma_r = 0$, biaxial $\sigma_a = 0$, and triaxial. The five stress levels involved were 0, 600, 1200, 2400, and 3600 psi nominal pressures. The radial stress was estimated to be accurate within ± 5 percent. The actual stress in the axial direction was somewhat less than indicated and averaged approximately 0, 545, 1080, 2185, and 3460 psi, respectively. These reduced pressures were due to friction in the hydraulic-mechanical system used to load the specimens axially. This system is described in more detail in the section on equipment.

Time

Time, and its relationship to creep strain, is a major factor in any creep investigation; in this study time consisted of a continuous observation period of 18 months after casting and included 3 months of curing, 12 months under load, and 3 months of recovery after the load was removed. Concrete strain and internal temperature measurements were recorded periodically, according to a preestablished time schedule, which had no more than 28 days between readings (Ref 42).

TEST SPECIMENS

Description of Specimens

A total of 337 concrete specimens were cast, in nine batches designated A through I, using the same mix design. Three types of specimens were prepared, creep, shrinkage, and strength. These specimens were of two sizes. All creep and shrinkage specimens were cast in steel molds 16 inches long by 6 inches in diameter that were designed specifically for this project (Fig 3). The strength specimens were cast in standard 6 × 12-inch molds.

The 6 × 16-inch specimens were cast against 3-inch-high end slugs through which the axial load was applied. The 6 × 16-inch molds were open on one side (Fig 3) because of the end slugs and to facilitate placing the strain gages. All creep and shrinkage specimens, therefore, were cast horizontally while the strength specimens were cast vertically.

Creep Specimens. The creep specimens were the primary test specimens in the design and were used to measure the total strains experienced by the concrete under the various combinations of the five test variables. The experimental design contained 50 such specimens.

Shrinkage Specimens. For each environmental test condition and for each batch of concrete there was a shrinkage specimen that remained unloaded in a test environment identical to that of its companion loaded specimen. Thirty-two specimens for estimating shrinkage strains were cast in order to estimate

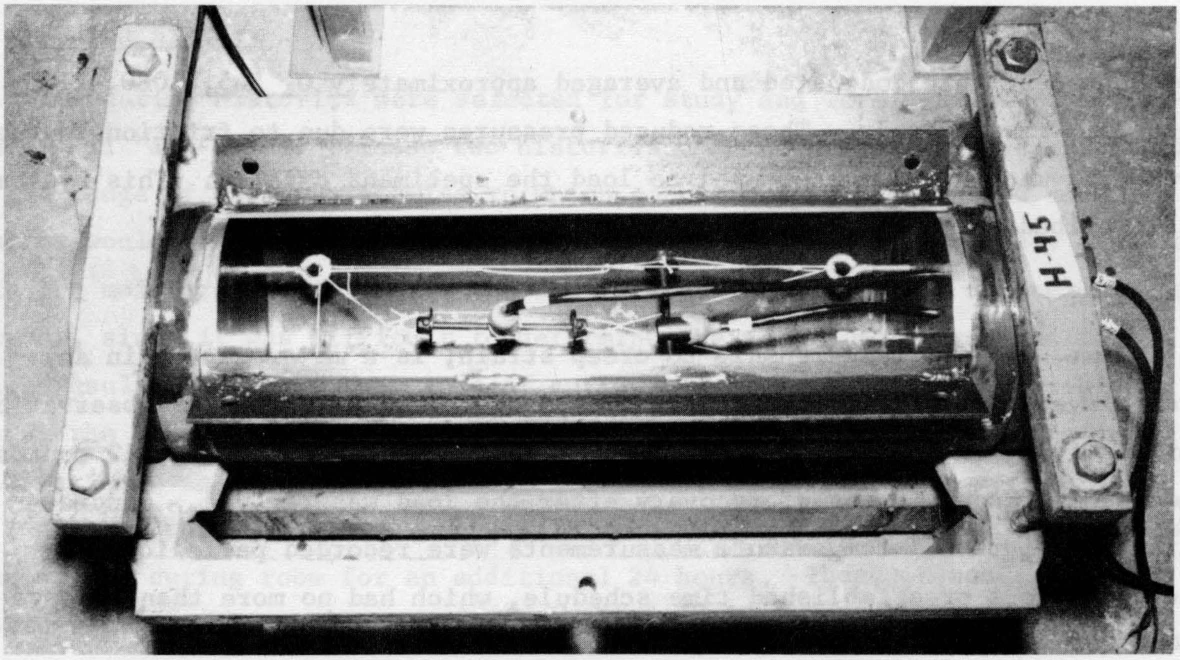


Fig 3. Steel mold assembly for 6 × 16-inch specimen.

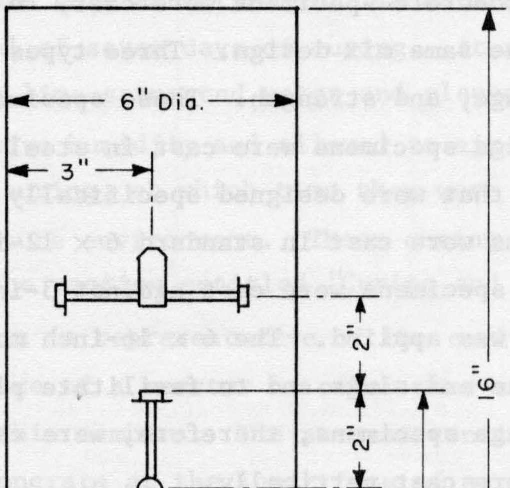


Fig 4. Location of strain gages in 6 × 16-inch specimens.

the time-dependent strains due to load and to provide an estimate of batch-to-batch variations.

Strength Specimens. A total of 255 concrete strength specimens were cast. They were distributed among the nine batches and consisted of as-cast and air-dried specimens as well as standard cured specimens. The as-cast and air-dried strength specimens were subjected to the same environmental conditions as the creep and shrinkage specimens. These specimens were prepared to evaluate the compressive and tensile strengths of the concrete for the various conditions at various times throughout the test period. In addition, they provided a means of measuring batch-to-batch variation. The standard strength specimens, which were cured by submerging in lime-saturated water, were cast to compare the as-cast and air-dried concrete with concrete cured in accordance with ASTM Specification C-192 and to establish the strength according to an established procedure.

Casting and Compaction

The concrete test specimens for the various test conditions were prepared in accordance with the detailed instructions presented in Ref 42. A brief summary of the casting and compaction operations follows:

(1) The various molds were assembled in numerical order and the strain gages were positioned in the 6 × 16-inch molds (Fig 4) by use of a wooden template and held in place with a steel wire and nylon string (Fig 3). The 6 × 12-inch specimens were cast in standard molds except that those for the as-cast specimens contained 0.008-inch thick copper inserts (Fig 5) which were used for sealing.

(2) The concrete was mixed in accordance with an established procedure (Ref 42), in a Gilson mixer (Model 11S-CRT).

(3) Consistency tests were performed and the concrete was poured into the molds. The 6 × 12-inch specimens were cast and compacted as prescribed by ASTM Specification C-192 and then vibrated 3 seconds at a frequency of 3600 cycles per minute. The 6 × 16-inch specimens, which were cast horizontally, were compacted by approximately 200 strokes of a one-quarter-inch-diameter rod. A specially constructed curved trowel was used to finish the exposed longitudinal surface of the 6 × 16-inch specimens (Fig 6), and they were then vibrated 5 seconds on a vibrating table at a frequency of 3600 cycles per minute. The entire casting and compaction operation to this point took approximately 45 minutes. Figure 7 shows the specimens of one batch immediately after casting.

(4) Four hours after casting, each 6 X 12-inch specimen was capped with neat cement and a glass plate was pressed and worked to form a smooth flat surface (Fig 8). The exposed side of each 6 X 16-inch specimen

Fig 5. The 6 x 12-inch molds ready for casting. Copper inserts in some molds are for as-cast specimens.

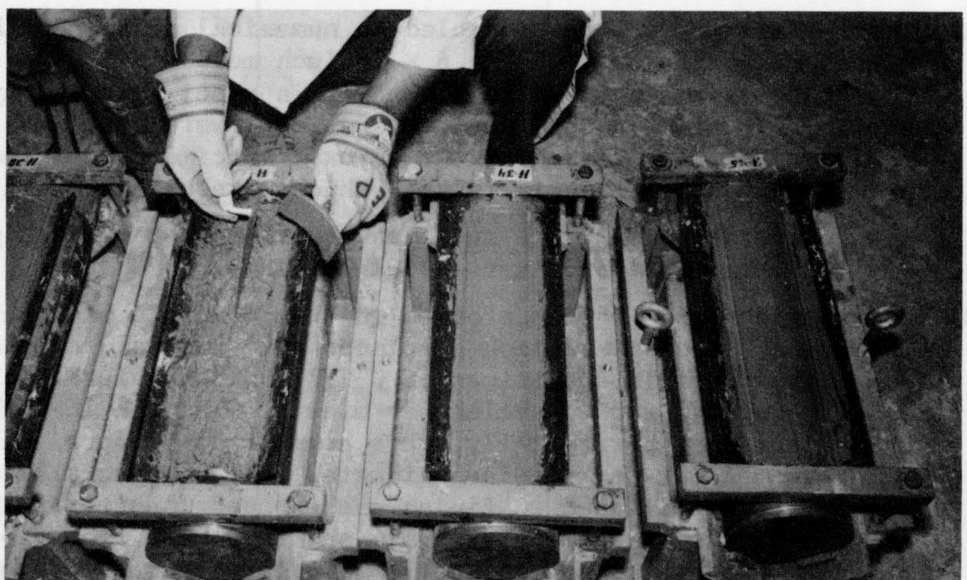


Fig 6. Finishing operation on 6 x 16-inch specimens.

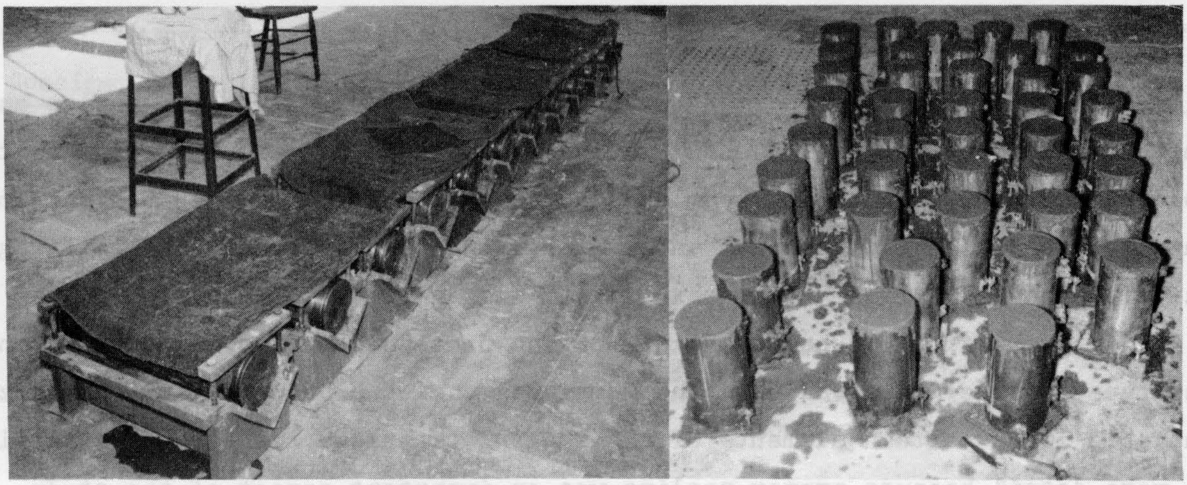


Fig 7. View of 6 × 16 and 6 × 12-inch specimens immediately after casting.

Fig 8. Capping operation on 6 × 12-inch specimens.

also received a final finishing with neat cement, applied with the curved trowel.

Curing and Sealing

After casting, all specimens were completely covered with wet burlap and left in the laboratory for 24 hours. Then the specimens were removed from the molds and placed in a curing room and the surfaces of the 6 × 16-inch specimens were scrubbed with a wire brush and pumice stone to remove any surface irregularities and all surface voids were filled with a neat cement paste.

After the first 48 hours of curing, the procedures followed depended on the type of specimen involved. The remaining curing procedures are summarized in Table 1 but certain elements of the sealing technique are described herein in more detail because proper sealing was an important aspect of the study.

The sealing method used in this investigation was developed after months of experimental tests (Ref 38). The effectiveness of a method was determined by whether or not specimens subjected to high temperature lost weight with time. In the sealing method selected, two coats of epoxy were applied to the surface of the specimens, 24 hours apart. While the second coat was still wet, a 0.008-inch-thick copper jacket was wrapped around the specimen and soldered to the steel end slugs and to itself along the longitudinal seam. The jacket was also crimped, at the interface between the end slugs and the concrete, to allow for possible expansion. These operations are shown in Fig 9.

Just prior to assembling the specimens in the test units, the specimens were placed in a 6-inch-diameter 0.12-inch-thick neoprene sleeve which was slipped over the copper jacket as added protection against penetration of hydraulic oil. The end of the neoprene jacket was then sealed with a liquid neoprene glue and clamped with a 1/4-inch stainless steel clamp.

CONCRETE MIX DESIGN

The concrete mix design and all materials except water employed in this investigation were furnished by the Waterways Experiment Station, Vicksburg, Mississippi. Prior to shipping, the materials were proportioned in thirteen 12-cubic-foot batch quantities and placed in sealed containers in order to keep the mix design variables constant, since several other laboratories were involved in the overall research effort.

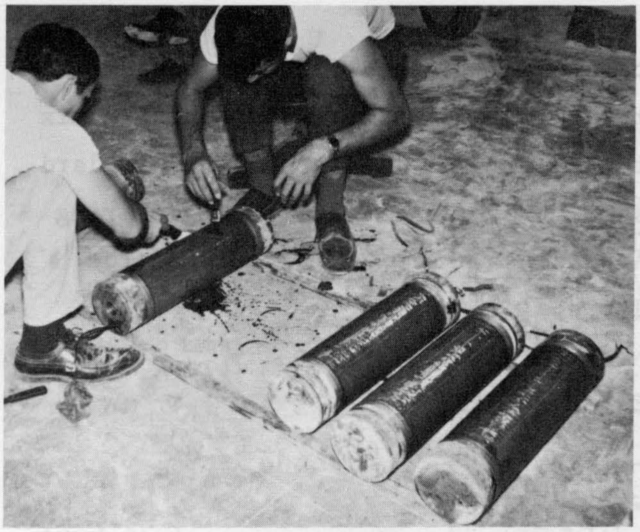
TABLE 1. CURING HISTORY OF SPECIMENS BEYOND 24-HOUR CONCRETE AGE

Specimen Type	Age	Curing/Sealing Operation	Figure Number
6 × 16-inch As-Cast	24 hours	First coat of epoxy applied	
		Specimens placed in concrete laboratory fog room	
	48 hours	Second coat of epoxy applied	9a
		Specimens sealed in copper	9b
		Specimens placed in test laboratory and cured at 73.4 ±3° F	
	83 days	Specimens sealed in neoprene jacket	9d
		Specimens assembled and placed in loading rig which was at the environmental test temperature of 75 or 150° F	
	90 days	Creep specimens loaded for 12 months	10
		Shrinkage specimens remain unloaded in test environment	11
6 × 16-inch Air-Dried	24 hours	Specimens placed in concrete laboratory fog room	
	48 hours	Specimens submerged and cured in lime-saturated water at 73.4 ±3° F	
	7 days	Specimens removed from lime water and placed in test laboratory at 73.4±3° F and 60% relative humidity	
	81 days	First coat of epoxy applied	9a
	82 days	Second coat of epoxy applied; specimens sealed in copper	9b
	83 days	Same as 6 × 16-inch as-cast	9d
	90 days	Same as 6 × 16-inch as-cast	

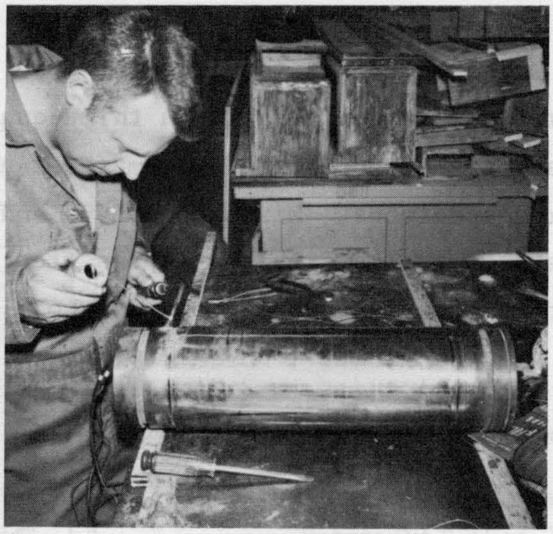
(Continued)

TABLE 1. (CONTINUED)

Specimen Type	Age	Curing/Sealing Operation	Figure Number
6 × 12-inch As-Cast	24 hours	Specimens placed in concrete laboratory fog room	
	48 hours	Specimens sealed in copper Specimens placed in test laboratory and cured at 73.4 ±3° F	9c
	83 days	Specimens to be tested at 183 days or beyond placed in the applicable temperature test environment (75 or 150° F)	
	28, 90, 183, 365 days	Compressive and tensile strengths determined; 24 hours prior to strength test, copper seal removed and specimen placed in 73.4±3° F environment	
6 × 12-inch Air-Dried	24 hours	Specimens placed in concrete laboratory fog room	
	48 hours	Specimens submerged and cured in lime-saturated water at 73.4±3° F	
	7 days	Specimens removed from lime water and placed in test laboratory at 73.4±3° F and 60% relative humidity	
	83 days	Specimens to be tested at 183 days or beyond sealed in copper and placed in applicable test temperature (75 or 150° F)	9c
	28, 90 183, 365 days	Same as 6 × 12-inch as-cast	
6 × 12-inch Standard	24 hours	Specimens placed in concrete laboratory fog room	
	48 hours	Same as 6 × 12-inch air-dried	
	28, 90 days	Specimens removed from lime-saturated water, compressive strength determined	

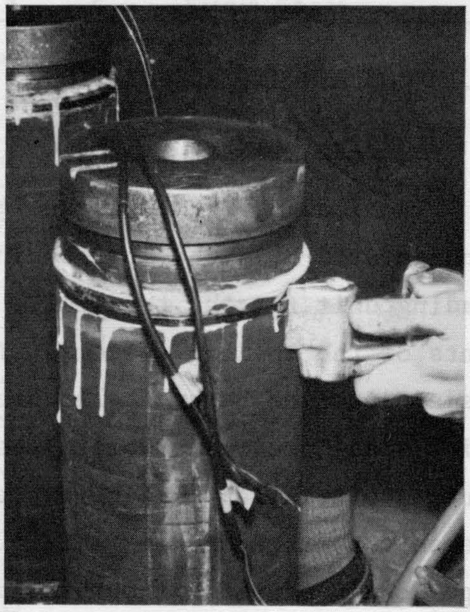


a. Application of epoxy.



b. Soldering copper to end slugs.

c. 6 X 12-inch concrete specimens after completion of soldering copper jackets.



d. Installation of neoprene sleeve over copper jacket.

Fig 9. Steps in sealing operation.

The materials consisted of Type II cement and crushed fine and coarse limestone aggregates with a three-quarter-inch maximum size. The concrete mix was designed for a 28-day compressive strength of 6000 ± 600 psi, for standard cured specimens. Mix proportions and a summary of the results of engineering tests on the materials are presented in Appendix A. A brief summary of the concrete design proportions is shown in Table 2.

TABLE 2. MIX DESIGN SUMMARY

Water-cement ratio	0.425, by weight
Cement content	7.25 bags/cubic yard
Slump	2 inches

Aggregate	Percent of total mix, by weight		Size Range
Fine		33.4	Sand
Coarse A	12.9	43.1	No. 4
Coarse B	15.1		3/8-inch
Coarse C	15.1		1/2-inch

EQUIPMENT AND INSTRUMENTATION

Loading Unit

The loading frame was designed specifically for this project and was manufactured by Wight Engineering Company, Austin, Texas. A schematic of the loading unit for the triaxially loaded case (Fig 10) illustrates all components of the loading systems. The radial load was applied directly to the sealed specimen by hydraulic pressure through oil contained by a one-inch-thick steel pressure jacket; the axial load was applied by a hydraulic ram. Thus, the triaxial loading system was made up of both an axial and a radial pressure system which permitted each to be varied independently. The same type loading frame without the pressure jackets was used for the uniaxial case. Triaxial and uniaxial specimens are shown in Fig 11. The pressure jacket system without the loading frames was used for the biaxial case; biaxially loaded specimens are shown in Fig 11.

Each loading frame contained two specimens from the same batch, one as-cast and one air-dried, which were simultaneously subjected to the same temper-

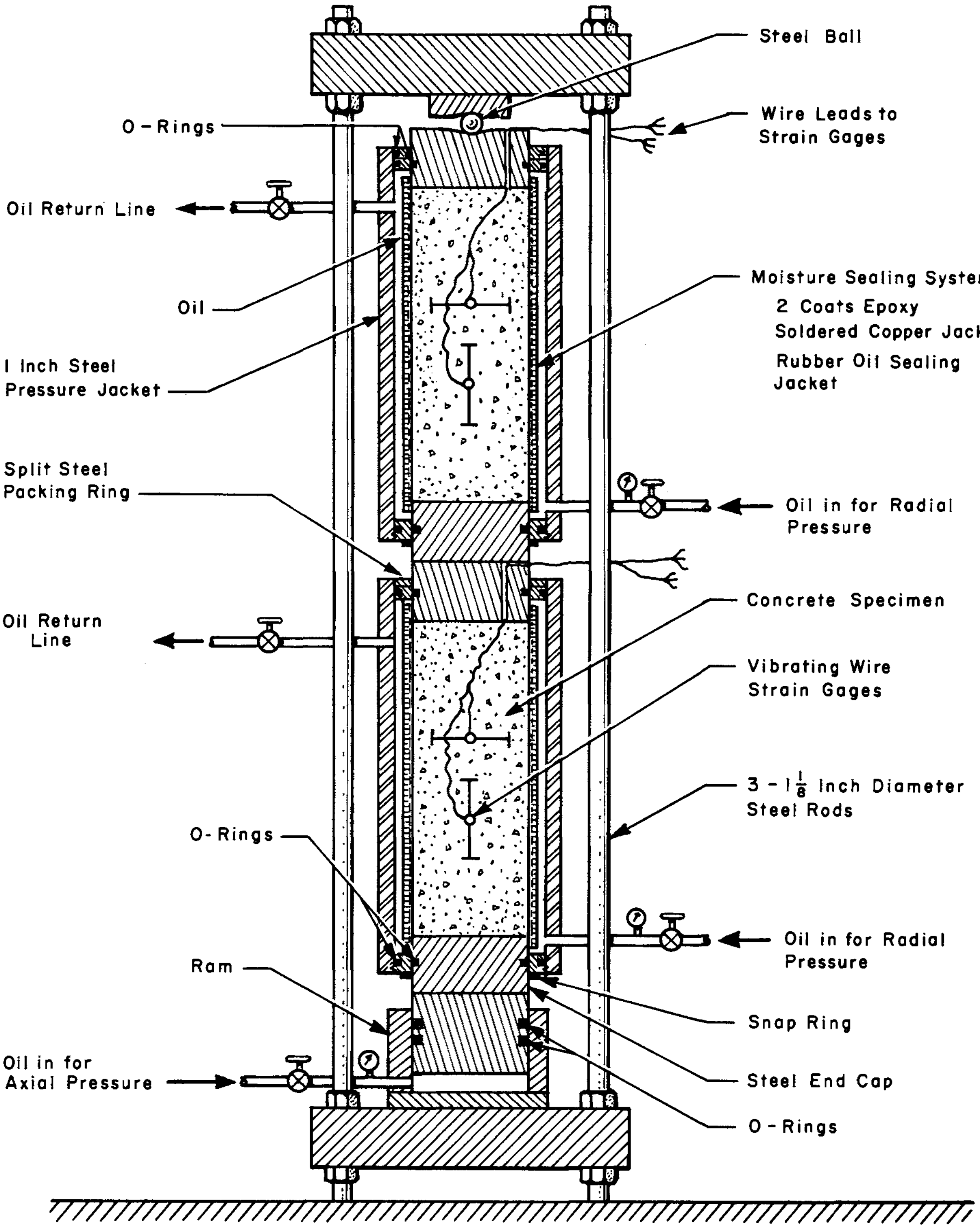
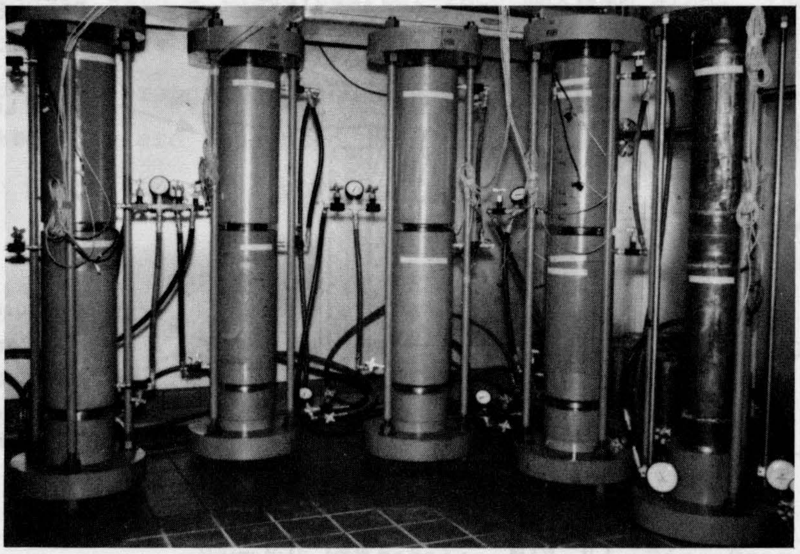
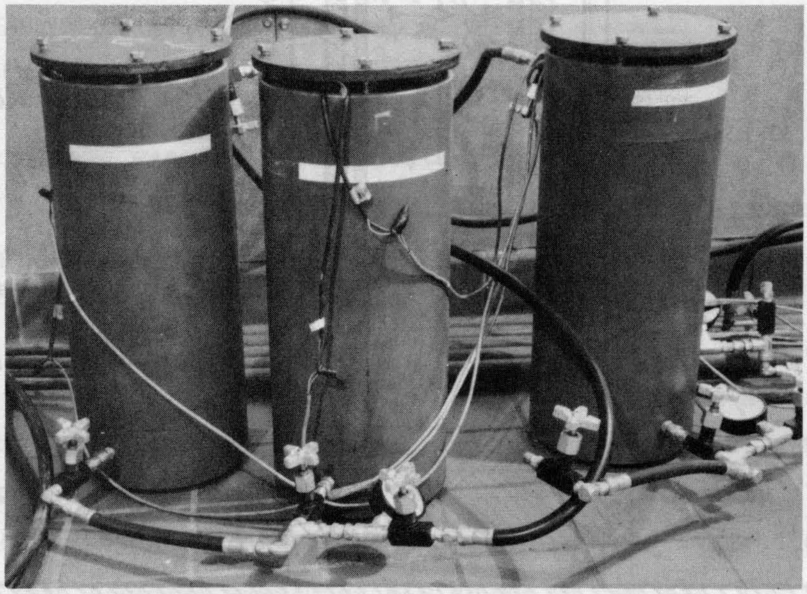


Fig 10. Schematic of triaxial test unit.



a. Specimens under triaxial and biaxial stress conditions.



b. Specimens under the biaxial stress condition.

Fig 11. Creep specimens under load in 150° F control room.

ature and loading conditions. The locations of the as-cast and air-dried specimens within the frame were determined by a random selection process in order to minimize bias in the results from specimen location. Likewise, the biaxial specimens were simultaneously loaded in pairs under identical conditions.

To evaluate shrinkage strains, unloaded specimens were placed in the same test environment as the loaded specimens. Shrinkage specimens in the 150° F temperature room are shown in Fig 12.

The loading system developed for this investigation was generally satisfactory, but there were two problems that should be noted. First, the axial pressures transmitted to the specimens were significantly less than the pressure input into the system, due to the friction between the piston o-rings and the hydraulic cylinder. Machine tolerances between the moving parts were close in order to prevent oil leakage at the high pressures involved, and slight misalignment caused friction which along with normal friction reduced the pressures actually applied to the specimens from 3 to 10 percent below the desired pressure. The second problem involved the radial pressure system. Extreme care was required during sealing of the creep specimens; when a weak point developed in the seal, the hydraulic oil, under high radial pressure, broke through the sealing jacket and penetrated the specimen, causing either a structural failure in the specimen or contamination of the specimen and rendering it useless for further investigation. The weakest point was usually at the interface between the end slug and the concrete. Extreme care in sealing and construction of an expansion bellows in the copper jacket at this interface (Fig 9c) apparently solved the problem.

Hydraulic System

Hydraulic pressure was supplied to the loading units by using the 100 psi air pressure available in the laboratory to drive oil pressure intensifiers. This was adequate for creep testing since only a very small quantity of oil was necessary once the system was pressurized. A flow diagram of the hydraulic system is shown in Fig 13.

The hydraulic system consisted of a pressure control console (Fig 14) and eight pressure manifolds to the loading units plus return lines. The pressure control console housed the pressure control valves, pressure intensifiers, air reservoir, auxiliary air compressor, and pressure gages for the four different pressures.

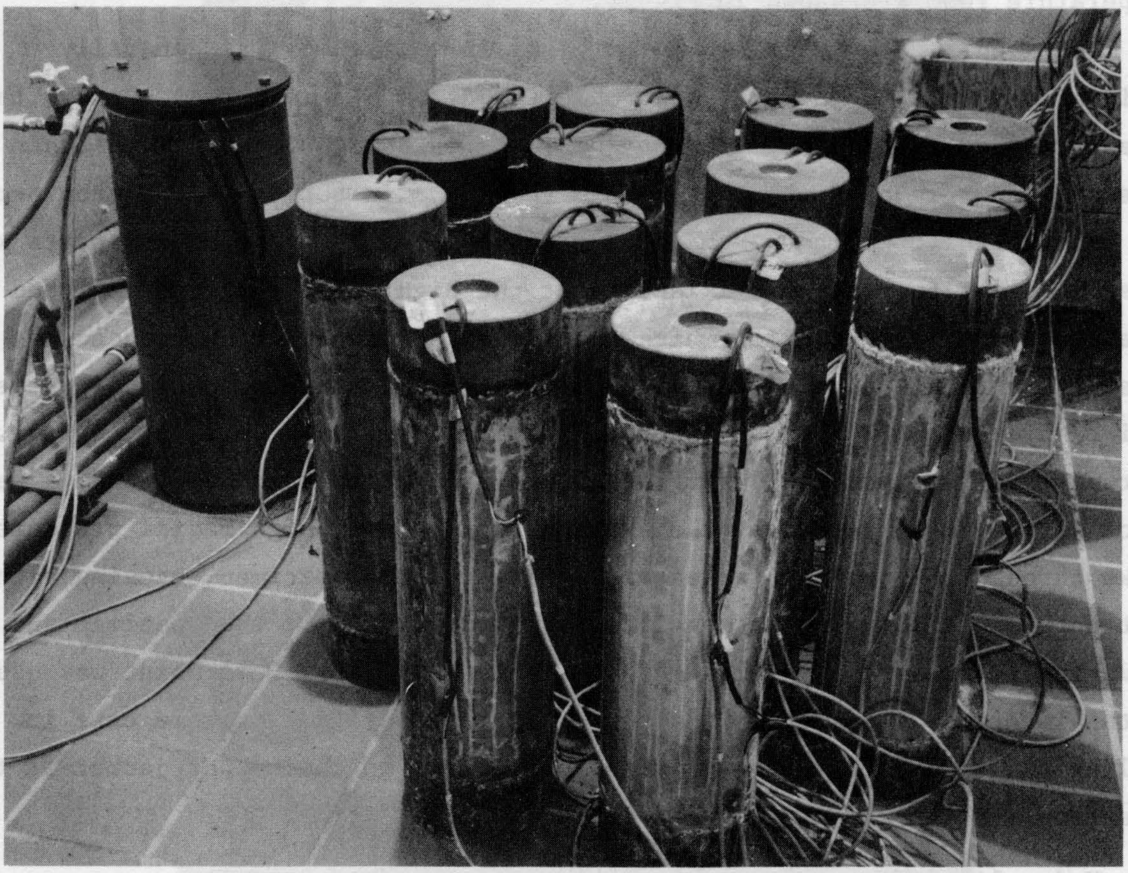


Fig 12. Shrinkage specimens under test adjacent to a biaxially loaded specimen.

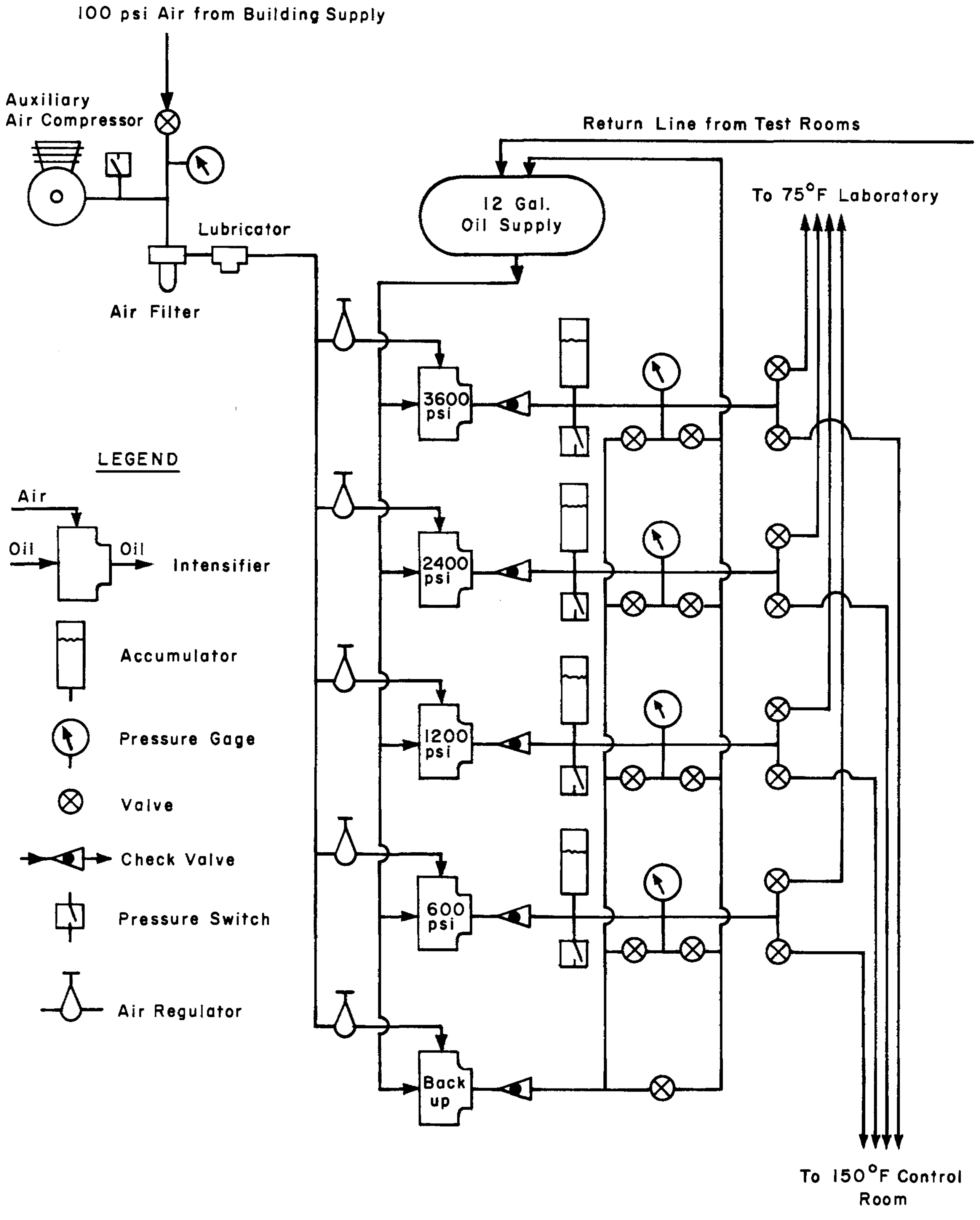


Fig 13. Flow diagram of hydraulic system.

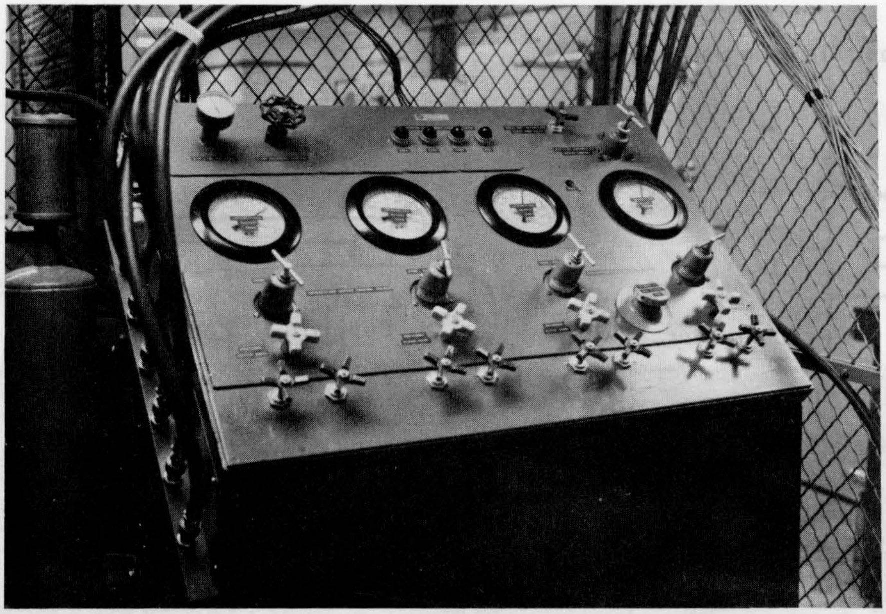


Fig 14. Hydraulic pressure control console.

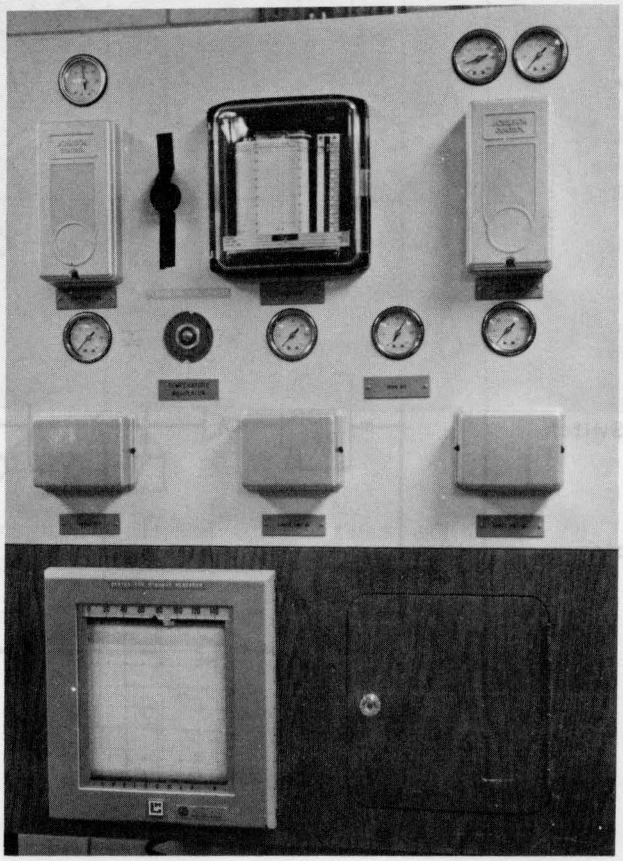


Fig 15. Laboratory environmental control system.

The pressure system was designed for 5000 psi pressure and consisted of hydraulic pressure pipes with flexible pressure hoses to the test units. A dual system was employed for each of the four pressures (600, 1200, 2400, and 3600 psi). One manifold system supplied pressure to the 75° F laboratory and the other to the 150° F control room. Each manifold system contained a return line which was connected to each test unit and allowed oil to circulate to the oil reservoir in the console. The primary purpose of this arrangement was to provide a way to remove air from the hydraulic system and to circulate oil in order to keep the valves from sticking.

The hydraulic system was designed with two back-up subsystems: an auxiliary pressure intensifier which could be used to replace any of the four intensifiers that failed or required maintenance and an auxiliary air compressor which would turn on automatically if the laboratory air pressure dropped significantly.

The control system automatically regulated the pressure to within $\pm$ 5 percent of the assigned gage pressure. Any of the eight pressure manifolds could be independently controlled and each individual test unit and specimen had independent controls. However, there were several drawbacks to the overall system. In the event of a complete electric power failure, there was no auxiliary means to maintain the oil pressure; and, in case of a major oil leak in the system, the pressures in the entire system could drop unless the failure was discovered before all the oil was pumped out of the reservoir.

Environmental Control

To make effective creep comparisons, a constant environment had to be maintained over a long period of time. Temperature and humidity conditions were effectively controlled by the systems used on the project.

The tests performed under the nominal 75° F test condition were conducted in an environmental control laboratory, while the tests performed under the nominal 150° F test condition were conducted in a special, controlled-temperature room, which was approximately 14 $\times$ 20 $\times$ 7 feet and was designed to maintain a constant temperature in the range from -20° F to 150° F. The temperatures in both the temperature vault and the laboratory were controlled by Johnson Control Systems (Fig 15).

The excellent reliability of this environmental control is evidenced by the constant temperatures recorded for each specimen over a period of almost 21 months (Appendix G). The curing phase of this investigation was also conducted in this environmental control laboratory.

Instrumentation and Recording

A major problem was finding a strain measuring system that would maintain its stability and sensitivity over a long time period. Until the last few years, these conditions could be satisfied only by a mechanical demountable fulcrum-plate type gage such as the Whittemore gage. This type of gage is not practical for measuring strains in specimens that are triaxially loaded, however, and it is slow and cumbersome. For specimens that are to be loaded triaxially or otherwise confined by a sealing process, a strain gage system that can be cast in the specimen and still satisfy stability and sensitivity requirements appeared to be the best approach. After extensive study, a vibrating wire strain gage (PC 641, manufactured in England by Perivale Control Company) was selected.

Principle of the Vibrating Wire Strain Gage. The principle involved is that the frequency of a vibrating wire changes as the strain in the wire changes. The gage measures the frequency and when it changes, the change in the strain is determined through calculations involving Mersonnes' and Hooke's Laws. These two physical laws are combined as follows to derive a gage factor (Ref 5):

Mersonnes Law: $$F = \frac{1}{2\ell}\sqrt{\frac{T}{M}}$$

Hooke's Law: $$E = \frac{\sigma}{\epsilon}$$

where

F = vibration frequency,

ℓ = effective wire length,

T = tension in wire,

M = mass/unit length of wire,

σ = stress,

ϵ = strain.

since $\sigma = \frac{T}{a}$

then $T = Ea\epsilon$

and $F = \frac{1}{2\ell} \frac{aE\epsilon}{M}$

Letting $C = \frac{1}{2\ell}\sqrt{\frac{aE}{M}}$

then $F = C\sqrt{\epsilon}$

$F^2 = C^2\epsilon$

and $\epsilon = \frac{F^2}{C^2}$

The gage factor is

$$K = \frac{1}{C^2} = \frac{\epsilon}{F^2} \qquad (3.1)$$

where

a = cross-sectional area of wire,

E = Young's modulus of wire,

C = wire properties constant,

K = gage factor.

The change in strain $\triangle\epsilon$ can be determined as follows:

$$\triangle\epsilon = \epsilon_i - \epsilon_f = K\left(F_i^2 - F_f^2\right) \qquad (3.2)$$

where

F_i = the initial (or reference) frequency,

F_f = the frequency at the strain point desired,

ϵ_i = the initial (or reference) strain,

ϵ_f = the strain point desired.

Perivale Strain Gage. The Perivale gage was designed primarily for measuring strains in concrete and when cast in concrete had a gage factor of 1.24×10^{-3}, which was determined experimentally by the manufacturer. The gage used had a range of $\pm$ 1000 micro-units of strain and could be read to less than one micro-unit of strain.

A cross section of the Perivale gage is shown in Fig 16. The gage was 4 inches long with a 3 1/2-inch gage length and basically consisted of a hollow brass tube with an aluminum cap at each end and a steel wire tensioned between them. The frequency of the wire was measured by an electronic comparator (Fig 17) which, when activated, plucked the wire by use of an electromagnet in the gage. The magnetic coil was used to measure the vibration of the wire and the frequency was compared with a standard frequency generated in the comparator. From this comparison the frequency of the gage wire could be measured and used to calculate the change in strain (Eq 3.2).

The gage was supplied with a preset initial frequency or wire tension. In this project a mid-range frequency was selected for all gages, to allow measurement of a strain ranging from 285 micro-units in tension to 1050 micro-units in compression. Even with this selection, the range of the gage was often exceeded at the higher stress levels.

All the gages were tested in 150° F water for 24 hours prior to installation, and approximately 16 percent became inoperative. However, they became operative again after drying, which indicated that there was moisture leakage. Therefore, all the gages were waterproofed with liquid neoprene at the junction of the electrical leads and the gage housing.

Temperature Measurements. Temperatures in the creep and shrinkage specimens were measured throughout the test period by a Wheatstone bridge system in the comparator which measured the change in resistance of the electromagnetic coil in each gage. Thus, two internal temperature readings

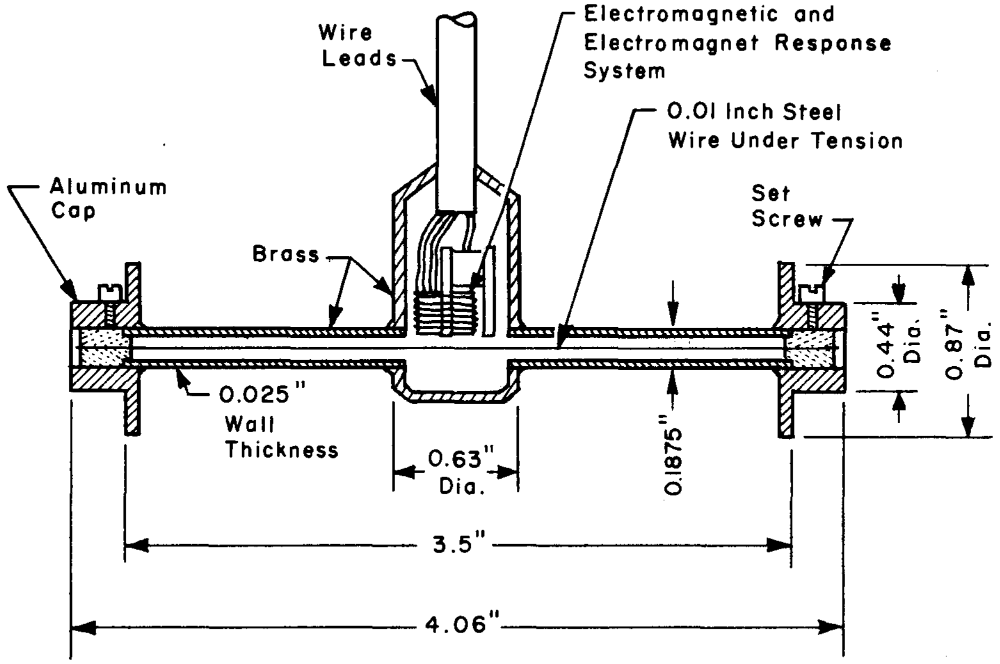
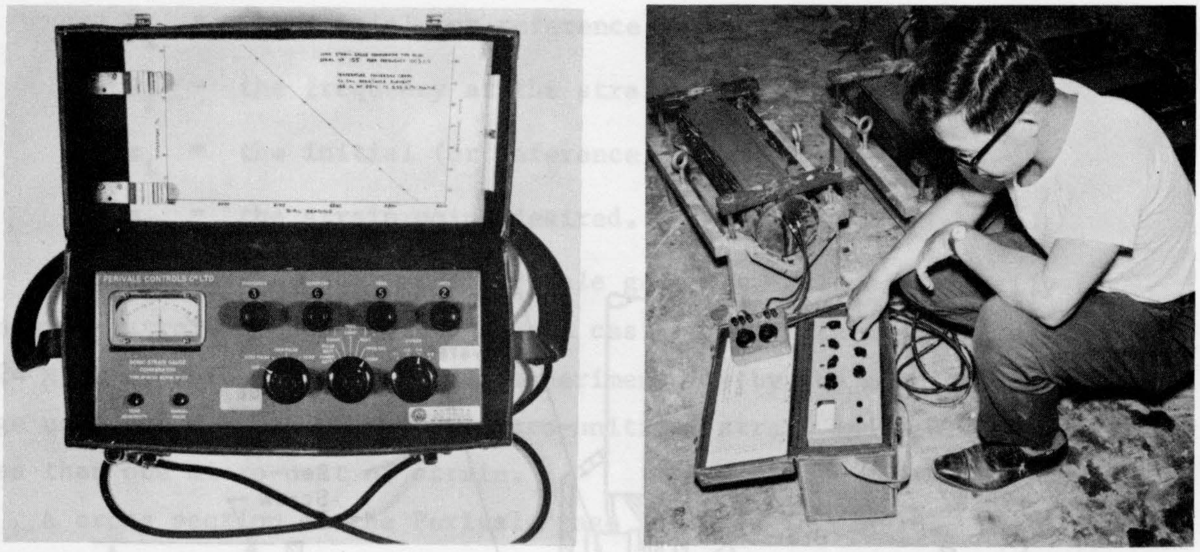


Fig 16. Cross section of Perivale Vibrating Wire Strain Gage.



a. Perivale comparator.

b. Comparator used with specimens immediately after casting.

Fig 17. Perivale comparator used in measuring strain gage frequency and temperature.

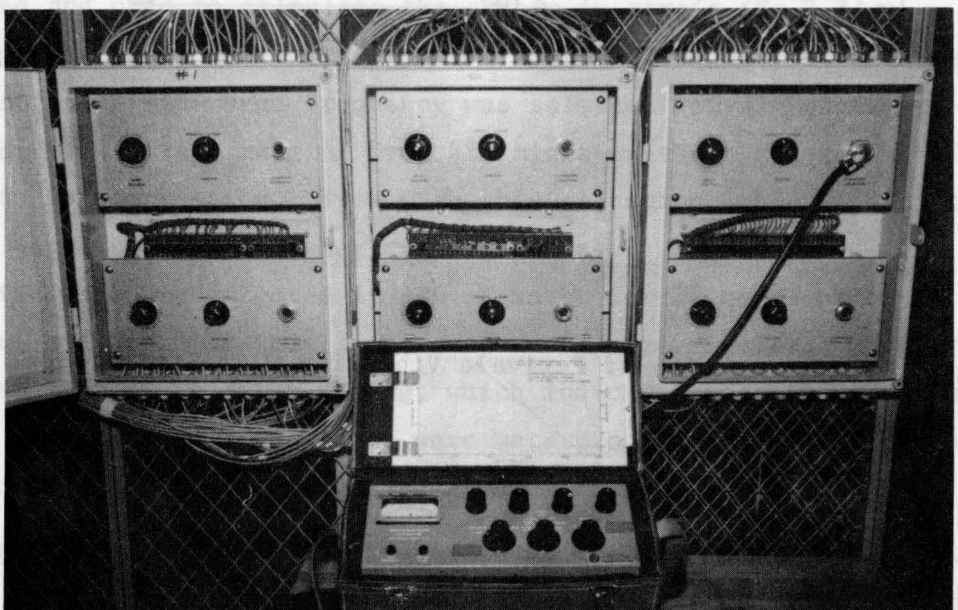


Fig 18. Switchboard configuration used with comparator for measurements in loaded specimens.

could be recorded for each specimen. A coil resistance versus temperature curve was provided by the strain gage manufacturer.

Switchboard System. For recording strain and temperature data, the comparator was connected to a switchboard with a capacity of 180 gages (Fig 18). Each gage was independently connected by separate cables to the switchboard, and the strain or temperature in any one of the 164 gages (82 specimens) could be measured from a central location.

Gage Effectiveness. The vibrating wire strain gage was considered generally satisfactory. It appeared to remain stable throughout the 18-month test period, although 36 of the 164 gages became inoperative before the end of the test period; 13 stopped because the range of the gage was exceeded, three exceeded the range of the comparator, and 20 simply failed, probably due to water leakage. The gage failure ratio was much higher for the 150° F than the 75° F test condition. These strain gages were not thermally compatible with the concrete, a fact which is discussed in detail in the following chapter.

EXPERIMENTAL PROCEDURE

Preparation for Casting

For approximately nine months prior to casting the actual test specimens used in this investigation, a number of preliminary experiments were conducted with the actual test equipment and materials since much of the equipment and materials used in this study were new and had been designed specifically for this project. The purpose of these preliminary tests was to evaluate the equipment and instrumentation and to establish techniques and procedures prior to the beginning of the actual test program.

Mixing and Casting Test. Numerous concrete specimens were prepared to develop the techniques required for mixing the concrete and casting the specimens. Compressive strength and consistency tests were also performed to insure that the design requirements for strength and consistency would be satisfied.

Sealing Tests. One of the most difficult problems encountered was developing a way to seal the specimens to prevent any moisture loss over an 18-month test period (Ref 38). Preventing moisture loss at 150° F was particularly difficult. Several different sealing techniques were tried, and the method which was finally developed for this project appeared to be successful (see section on Curing and Sealing, p 26).

Loading System Tests. A number of problems were also discovered within the loading system. One of the major problems occurred with radially loaded test specimens, several of which developed oil leaks that penetrated the concrete. The affected specimens are denoted in Table 3. This problem was not solved until the actual loading program was approximately 50 percent completed. Great care during sealing and a slight modification to the sealing technique were required to correct this situation.

Hydrostatic Load Tests. Preliminary tests conducted with specimens loaded hydrostatically ($\sigma_a = \sigma_r$) showed elastic strains in the radial direction to be significantly higher than in the axial direction. A series of subsequent tests revealed that the axial stresses were less than those indicated by the pressure gage due to friction losses in the hydraulic-mechanical pressure system (Ref 39). A number of modifications to the system were tried, but none produced any significant improvement over the original system, and therefore, it was decided to calibrate each of the loading rigs with a load cell and use this value in the investigation (Ref 41).

It should also be noted that further preliminary tests showed that this loss in axial load did not account for all the strain differences recorded (Ref 40). It was suspected that the remaining differences were due to the fact that there was variation in the size and shape of the specimens, that the radial gage was large relative to the diameter of the specimen, or that the ends of the specimens were restrained under load.

General Test Procedure

The casting of the specimens for the actual test program began with Batch A, on October 29, 1968, and batches were cast in alphabetical order through G. Batches H and I, which were used in part to replace specimens that failed in Batches A through G, were not cast until approximately six months after the casting of Batch G. The casting and testing procedures were identical for all batches.

The major events for each batch are summarized in Fig 19. The test specimens were cured for 90 days prior to loading for 12 months; then the specimens were unloaded and observations of strain and temperature were

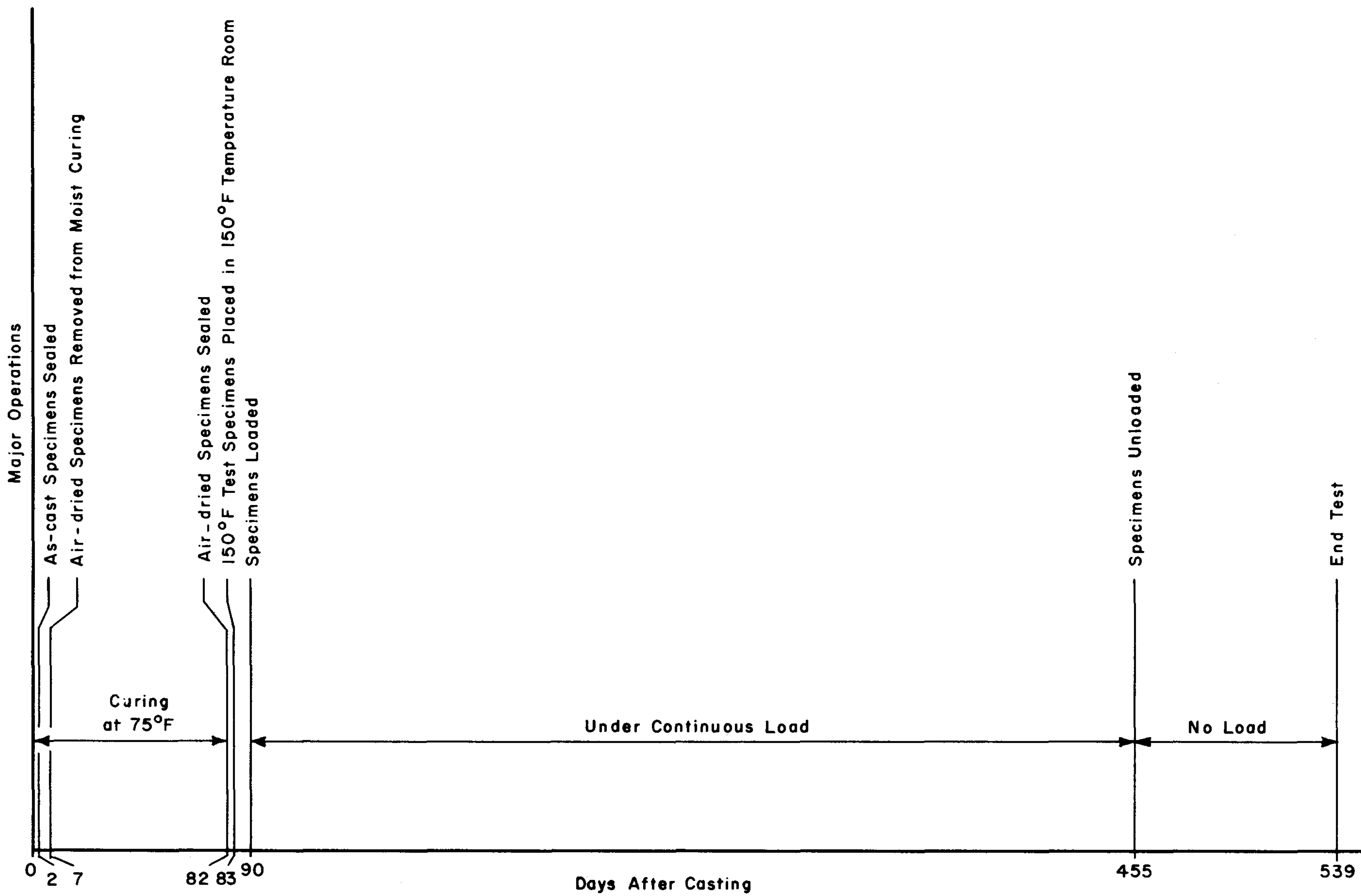


Fig 19. Experimental program time sequence.

TABLE 3. EXPERIMENTAL DESIGN FOR LOADED CREEP SPECIMENS

Temperature °F	Axial Load psi	Radial Load psi	Curing History*	
			As-Cast	Air-Dried
75	0	600	F-13	F-42
75	0	3600	H-22r	H-14r
75	600	0	E-39	E-40
75	600	600	E-5	E-13
75	600	3600	G-35	G-30
75	1200	1200	C-16x	C-17
75	1200	2400	B-41	B-42
75	2400	0	B-7	B-19
75	2400	600	C-23	C-11
75	2400	2400	F-9	F-30
75	3600	1200	D-26	D-44
75	3600	3600	D-31	D-40
150	0	600	A-35	I-13rf
150	0	1200	I-27r	D-3
150	0	2400	E-43	E-1
150	0	3600	I-16r	I-30rf
150	600	0	B-4	B-1
150	1200	0	D-15	D-22
150	1200	1200	C-12	C-46x
150	1200	2400	D-2x	D-41
150	2400	0	F-33	F-34
150	2400	600	E-18	E-4
150	2400	2400	G-9	G-19
150	3600	0	B-16	B-5
150	3600	3600	F-20	F-6

* - Specimen designation: The letter indicates the batch and the numeral the specimen within the batch.
r - Replacement specimens.
x - Radial pressure zero ($\sigma_r = 0$) due to oil leak in specimen.
f - Specimen failed shortly after loading.

continued for an additional three months.

The loading operation for each batch followed the same order as the casting. Each as-cast specimen was loaded simultaneously with its companion air-dried specimen. The four gages (two axial and two radial) could not be read simultaneously. The larger stress was applied at a rate of 35 psi per second. The ratio of the axial and radial loads during loading was maintained and was equal to the ratio of the final axial and radial loads on the specimens; therefore, the lower stress was applied at a slower rate.

In addition, the unconfined compressive and tensile strengths of specimens which had been subjected to the various environmental conditions were determined. The compressive strengths were determined at 28, 90, 183, and 365 days after casting. Generally, three specimens for each curing history and age were tested for each batch. The tensile strengths were determined by the indirect tensile test at 28 and 90 days; however, only two specimens for each curing history and age were tested, and these specimens were all from Batches B through F. The compressive and tensile strength specimens were tested in accordance with ASTM specifications C39-66 and C496-69, respectively.

EXPERIMENTAL DESIGN

The various test conditions investigated in this experiment were randomly assigned to each batch, except that Batches H and I were used for replacement specimens. This randomization was restricted only to the condition that each batch contain specimens at both test temperatures and an equal number of specimens for each curing history. Each batch contained approximately 48 specimens; each specimen was prepared and tested in a numerical sequence that had been randomly assigned. This randomization was used to minimize experimental bias from the casting and testing operations.

The various combinations of test variables assigned to the creep and shrinkage specimens are shown in the experimental design charts in Tables 3 and 4, respectively. It should be noted that each batch contained one shrinkage specimen for each temperature and curing history. The purpose of duplicating the shrinkage specimens for each batch was to provide a means of measuring batch-to-batch variation and a basis for comparing creep results if the variations were significant.

TABLE 4. EXPERIMENTAL DESIGN FOR SHRINKAGE SPECIMENS

Temperature °F	Load psi	Curing History*	
		As-Cast	Air-Dried
75	0	A-8	A-38
75	0	B-29	B-23
75	0	C-39	C-6
75	0	D-20	D-33
75	0	E-28	E-23
75	0	F-23	F-17
75	0	G-18	G-10
75	0	H-28	H-1
150	0	A-22	A-32
150	0	B-13	B-26
150	0	C-41	C-36
150	0	D-12	D-23
150	0	E-10	E-42
150	0	F-15	F-21
150	0	G-1	G-21
150	0	I-21	I-1

*Specimen designation: The letter indicates the batch and the numeral the specimen number within the batch.

CHAPTER 4. EXPERIMENTAL RESULTS

This chapter summarizes and discusses compressive and tensile strengths, Poisson's ratio, modulus of elasticity, shrinkage strains, coefficient of thermal expansion, elastic recovery strains, and total strains of the concrete under the various environmental conditions. Creep behavior is discussed in Chapter 5. Shrinkage strains, one of the major factors evaluated in this study, are presented for time periods before and after the creep specimens were loaded. A detailed discussion of the physical characteristics of the vibrating wire strain gage in the concrete is also included in this chapter.

STRENGTH

Strength is one of the more important properties of concrete and is generally the basis for evaluating concrete quality. The concrete used in this investigation was designed to have a compressive strength of 6000 ± 600 psi at 28 days under standard ASTM curing conditions for specimens stored in lime-saturated water.

The average compressive strengths for each batch of the concrete are shown in Table 5 for the various curing conditions and at various curing times. The average 28-day compressive strength of the standard cured specimens was 6420 psi, which was within the 6000 ± 600 psi range established for this experiment and was used as the standard concrete strength for calculations in this report. The individual compressive strengths of all 211 specimens tested are contained in Appendix B.

The average tensile strength, as determined by the indirect tensile test, was 590 psi, which is shown in Table 6 with the averages of the 28 and 90-day tensile strengths for the various curing conditions and batches. The individual tensile strengths of the 44 specimens tested are shown in Appendix C.

For specimens cured 90 days or less, the apparent compressive strengths of the as-cast specimens were significantly lower at 28 and 90 days than

TABLE 5. AVERAGE COMPRESSIVE STRENGTHS[1]

		Average Strengths at Following Ages in Days					
		28	90	183		365	
Batch	Curing Condition	psi	psi	75° F psi	150° F psi	75° F psi	150° F psi
A	Standard	6760	8550	--	--	--	--
B	Standard	6650	8690	--	--	--	--
C	Standard	6140	8290*	--	--	--	--
D	Standard	6200	8540	--	--	--	--
E	Standard	6520	8200	--	--	--	--
F	Standard	6510	8090	--	--	--	--
G	Standard	6440	7730	--	--	--	--
H	Standard	6340	8110	--	--	--	--
I	Standard	6260	7870	--	--	--	--
Average		6420	8220				
A	As-Cast	6580	6880	8260	8120	8840	7600
B	As-Cast	4710	6110	--	--	--	--
C	As-Cast	5700	6430*	--	--	--	--
D	As-Cast	5980	6500	--	--	--	--
E	As-Cast	5410	7290	--	--	--	--
F	As-Cast	5650	7410	--	--	--	--
G	As-Cast	5940	6460	7620	8280	8190	8310
H	As-Cast	5650	6330	7660	--	--	--
I	As-Cast	5790	6160	--	7730	--	--
Average		5710	6640	7850	8040	8510	7960
A	Air-Dried	7060	6960	7030	7760	7480	7010
B	Air-Dried	6200	7790	--	--	--	--
C	Air-Dried	6520	7370*	--	--	--	--
D	Air-Dried	6640	7790	--	--	--	--
E	Air-Dried	6540	7420	--	--	--	--
F	Air-Dried	6680	7870	--	--	--	--
G	Air-Dried	6570	7460	7310	7100	7810	7860
H	Air-Dried	6320	7280	7470	--	--	--
I	Air-Dried	6440	7060	7200	6960	--	--
Average		6550	7450	7250	7270	7640	7440

[1]Table consists of the average compressive strengths of 211 6 x 12-inch specimens.

*Batch C tested at 83 days.

TABLE 6. AVERAGE TENSILE STRENGTHS[1]

Batch	Average Strengths for Different Ages and Curing Conditions					
	28 Days			90 Days		
	Standard psi	As-Cast psi	Air-Dried psi	Standard psi	As-Cast psi	Air-Dried psi
B	630	---	560*	540	550	540
C	580	---	---	680	610	580
D	620	520	530	510	530	550
E	570	---	---	710	590	550
F	550	---	---	690	590	580
Average	590	---	---	630	570	560

[1]Table consists of the average strengths of 44 6 x 12-inch specimens as determined by the indirect tensile test (ASTM C496-69).

*Only one sample

those of the air-dried specimens, the reverse of what might have been expected. However, it is thought that the air-dried concrete exhibited apparently higher strengths because of end cap conditions and the moisture contents of the specimens at the time of testing.

The neat-cement cap on the as-cast specimens was usually disturbed when the copper jackets were removed prior to loading. In many cases, only 75 percent of the cap on an as-cast specimen was effective, whereas usually 95 to 100 percent of the cap on an air-dried specimen was effective, since these specimens were not sealed in copper prior to testing at 28 and 90 days after casting. The poor bearing caps on the as-cast specimens undoubtedly caused lower ultimate strengths, because stress was concentrated over a smaller area.

Secondly, if two concrete specimens which are comparable except for moisture content are tested, the dry specimen will exhibit a higher compressive strength than the one with the higher moisture content (Ref 59). In this investigation, the air-dried specimens were relatively dry at the time of testing in comparison to the as-cast specimens, and the increase in strength associated with the dry condition at the time of testing could have more than offset the decrease in strength due to air-dry curing. It should also be remembered that the air-dried specimens were cured in lime-saturated water for five days immediately after casting.

The tensile strengths of the as-cast specimens at 90 days were generally, although not significantly, higher than those of the air-dried specimens (Table 6). Since the condition of the cap is not a factor when the indirect tensile test is used, it could be reasoned that the compressive strengths of the as-cast specimens would have also been larger than the compressive strengths of the air-dried specimens if the end caps had not been a factor.

Another aspect of strength for specimens cured 90 days or less is that the ultimate compressive and tensile strengths of the standard cured specimens were generally higher than those of either the as-cast or air-dried specimens. This would be expected since the standard cured specimens were allowed to absorb additional water while they were curing, thereby improving the hydration process (Ref 17).

Beyond 90 days the compressive strengths of the as-cast specimens were significantly higher than those of the air-dried. Both as-cast and air-dried specimens were sealed in copper by this time, and therefore both were subjected to the same capping conditions; and in addition, the as-cast specimens had more favorable curing conditions, which would give a substantially higher gain in strength. It might have been expected that the specimens sealed and stored at 150° F 90 days after casting would have had a slightly higher strength than those stored at 75° F, but no significant difference in compressive strength was observed.

MODULUS OF ELASTICITY AND POISSON'S RATIO

The modulus of elasticity and Poisson's ratio were considered together since the same procedure was used to estimate both values. The stress-strain results at the instant the creep specimens were fully loaded were used in the following expressions, which are based on elastic theory:

$$\nu = \frac{\sigma_a \epsilon_r - \sigma_r \epsilon_a}{2\sigma_r \epsilon_r - \epsilon_a(\sigma_r + \sigma_a)} \tag{4.1}$$

$$E = \frac{\sigma_r - \nu(\sigma_r + \sigma_a)}{\epsilon_r} \tag{4.2}$$

where

ν = Poisson's ratio;

E = modulus of elasticity, psi;

σ_a = axial stress, psi;

σ_r = radial stress, psi;

ϵ_a = strain in axial direction immediately after loads were applied;

ϵ_r = strain in radial direction immediately after loads were applied.

The value of Poisson's ratio in Eq 4.2 was determined by Eq 4.1.

The strain measurements for the 6 X 16-inch specimens were determined immediately before and after loading. The strain values associated with loading are presented in Appendix G; however, the strain quantity actually used in Eqs 4.1 and 4.2 is denoted as the "elastic strain." In some cases the elastic strain is a slightly smaller absolute quantity than the measured strain. Since as-cast and air-dried specimens tested under identical stress conditions were always loaded simultaneously, only one of the four strain gages could be read at a time; as a result, there was a time lag in reading the other three gages which averaged approximately one minute between measurements. The elastic strains at the instant the specimens were fully loaded were determined by developing the polynomial relationship that best fit the first six strain measurements after loading and extrapolating to the theoretical time "zero." In most cases, the value determined for the elastic strain was the same as the strain measured immediately after loading; however, a difference of approximately 5 micro-units occurred in the specimens subjected to higher stresses because of the rapid initial creep rate in these specimens.

Poisson's ratios and the secant moduli of elasticity for all creep specimens are presented in Table 7. These values appear to be reasonable except possibly for some of the specimens loaded hydrostatically. Excluding the hydrostatic test conditions, Poisson's ratio ranged from 0.21 to 0.28 and averaged 0.25; the modulus of elasticity ranged from 4.0×10^6 to 7.1×10^6 psi and averaged 5.5×10^6 psi.

Poisson's ratio values for some of the specimens loaded hydrostatically were negative or near zero while for others they were higher than the normal range. Likewise, some of the moduli were too large, with values of ten to twelve million. These were thought to be primarily due to the sensitivity of Eqs 4.1 and 4.2 as the stresses approach a hydrostatic condition, under which a small change in either stress or strain results in substantial change in Poisson's ratio and modulus of elasticity. Also, any error resulting from the assumption that concrete is an isotropic and homogeneous material, becomes far more critical as the equations become sensitive to slight changes.

Of more importance is the comparison of the properties under the various test conditions, shown in Table 8. From this table, it can be generally stated that (1) the air-dried specimens had slightly lower moduli of elasticity than the as-cast specimens; (2) the specimens at a test temperature of 150° F had slightly lower moduli than the specimens at 75° F; and (3) Poisson's ratio was not significantly affected by variations in curing history or moisture but was somewhat smaller at 150° F than at 75° F.

TABLE 7. MODULUS OF ELASTICITY AND POISSON'S RATIO

	Specimen	Stress, psi Axial	Stress, psi Radial	Strain ($\times 10^{-6}$) Axial	Strain ($\times 10^{-6}$) Radial	Poisson's Ratio	Modulus of Elasticity, psi ($\times 10^6$)
75° F As-Cast	B-7	2179	0	385	-94	0.243	5.66
	B-41	1092	2400	-8	219	.239	7.14
	C-16	1100	1200	58	127	.409	2.04
	C-23	2139	600	283	-10	.244	6.54
	D-26	3449	1200	473	-12	.273	5.91
	D-31	3472	3600	286	342	.358	3.11
	E-5	562	600	38	57	.381	2.78
	E-39	527	0	87	-26	.293	6.04
	F-9	2147	2400	178	197	-.017	12.55
	F-13	0	600	-52	72	.264	6.13
	G-35	536	3600	-255	524	.248	4.91
	H-22	0	3600	-333	631	.209	4.51
75° F Air-Dried	B-19	2179	0	379	-104	.274	5.76
	B-42	1092	2400	-4	262	.233	6.05
	C-11	2139	600	331	-21	.259	5.51
	C-17	1101	1200	75	101	.306	4.92
	D-40	3472	3600	298	357	.359	2.97
	D-44	3449	1200	533	-16	.276	5.23
	E-13	562	600	32	51	.392	2.84
	E-40	527	0	93	-26	.279	5.64
	F-30	2147	2400	171	220	.226	6.23
	F-42	0	600	-52	74	.258	5.98
	G-30	536	3600	-240	522	.241	4.99
	H-14	0	3600	-340	572	.229	4.85
150° F As-Cast	A-35	0	600	-48	71	.253	6.35
	B-4	561	0	94	-22	.235	5.94
	B-16	3450	0	538	-150	.280	6.42
	C-12	1032	1200	77	95	.096	10.36
	D-2	1086	2400	-54	266	.284	5.28
	D-15	1102	0	203	-53	.259	5.44
	E-18	2259	600	322	-4	.219	6.19
	E-43	0	2400	-221	321	.256	5.56
	F-20	3474	3600	309	423	.416	1.56
	F-33	2123	0	412	-109	.265	5.15
	G-9	2268	2400	181	239	.355	3.12
	I-16	0	3600	-351	550	.242	4.97
	I-27	0	1200	-101	147	.256	6.08
150° F Air-Dried	B-1	561	0	102	-25	.249	5.49
	B-5	3450	0	759	-174	.229	4.54
	C-46	1032	1200	101	117	-.003	10.28
	D-3	0	1200	-86	160	.211	5.91
	D-22	1102	0	255	-54	.210	4.32
	D-41	1086	2400	-23	382	.246	4.04
	E-1	0	2400	-233	369	.240	4.94
	E-4	2259	600	378	-15	.237	5.23
	F-6	3474	3600	387	429	.278	3.80
	F-34	2123	0	469	-123	.262	4.53
	G-19	2268	2400	190	253	.361	2.82
	I-13	0	600	-53	87	.235	5.28
	I-30	0	3600	-377	629	.230	4.40

TABLE 8. COMPARATIVE MODULUS OF ELASTICITY AND POISSON'S RATIO RESULTS

Stress, psi		75° F As-Cast			75° F Air-Dried		
Axial*	Radial	Specimen	Poisson's Ratio	Modulus of Elasticity psi (x 10^6)	Specimen	Poisson's Ratio	Modulus of Elasticity psi (x 10^6)
600	0	E-39	0.293	6.04	E-40	0.279	5.64
2400	0	B-7	.243	5.66	B-19	0.274	5.76
2400	600	C-23	.244	6.54	C-11	0.259	5.51
0	600	F-13	.264	6.13	F-42	0.258	5.98
0	3600	H-22	.209	4.51	H-14	0.229	4.85
Average			0.251	5.78		0.260	5.55
		150° F As-Cast			150° F Air-Dried		
600	0	B-4	0.235	5.94	B-1	0.249	5.49
2400	0	F-33	.265	5.15	F-34	.262	4.53
2400	600	E-18	.219	6.19	E-4	.237	5.23
0	600	A-35	.253	6.35	I-13	.235	5.28
0	3600	I-16	.242	4.97	I-30	.230	4.40
Average			0.243	5.72		0.243	4.99

*Nominal axial stress.

SHRINKAGE

Shrinkage, deformation of concrete due to any physical or chemical cause other than applied load and temperature change (Ref 53), was determined by measuring strains in unloaded specimens which were comparable to the loaded specimens.

The average axial and radial shrinkage strain-time relationships for the four combinations of temperature and curing history are shown in Fig 20. These strains are relative to the strains seven days after casting. The seven-day strains were considered to be the zero point of reference because this was the earliest time at which the various environmental test conditions could be considered comparable and stable. Prior to seven days, the physical handling, sealing, lack of total temperature control, and different curing procedures prevented establishing an adequate base for calculating shrinkage strains. Moreover, the strains observed immediately before casting and later indicated that the strains stabilized into a continuous pattern from two to seven days after casting.

The curves for the first 90 days after casting include all 6 × 16-inch shrinkage and creep specimens, since the shrinkage and creep specimens were treated identically during the period prior to loading. The shrinkage strain-time relationships for the loading period are the averages of the strains that occurred in the shrinkage specimens after the creep specimens were loaded. However, not all strains from the shrinkage specimens could be used in the averages, so the average shrinkage strain relationships after loading were determined as shown in Appendix D. The strain and temperature data recorded during the period before and after loading are shown in Appendices F and G, respectively.

Shrinkage from Casting to Time of Loading

The shrinkage strain that occurred after the creep specimens were loaded is of primary importance to the study of creep deformations, but in order to understand these later shrinkage strains, the shrinkage history during the 90-day curing period prior to loading must be studied.

As-Cast Specimens. The magnitude of both the axial and the radial shrinkage strains for the as-cast specimens remained essentially constant throughout

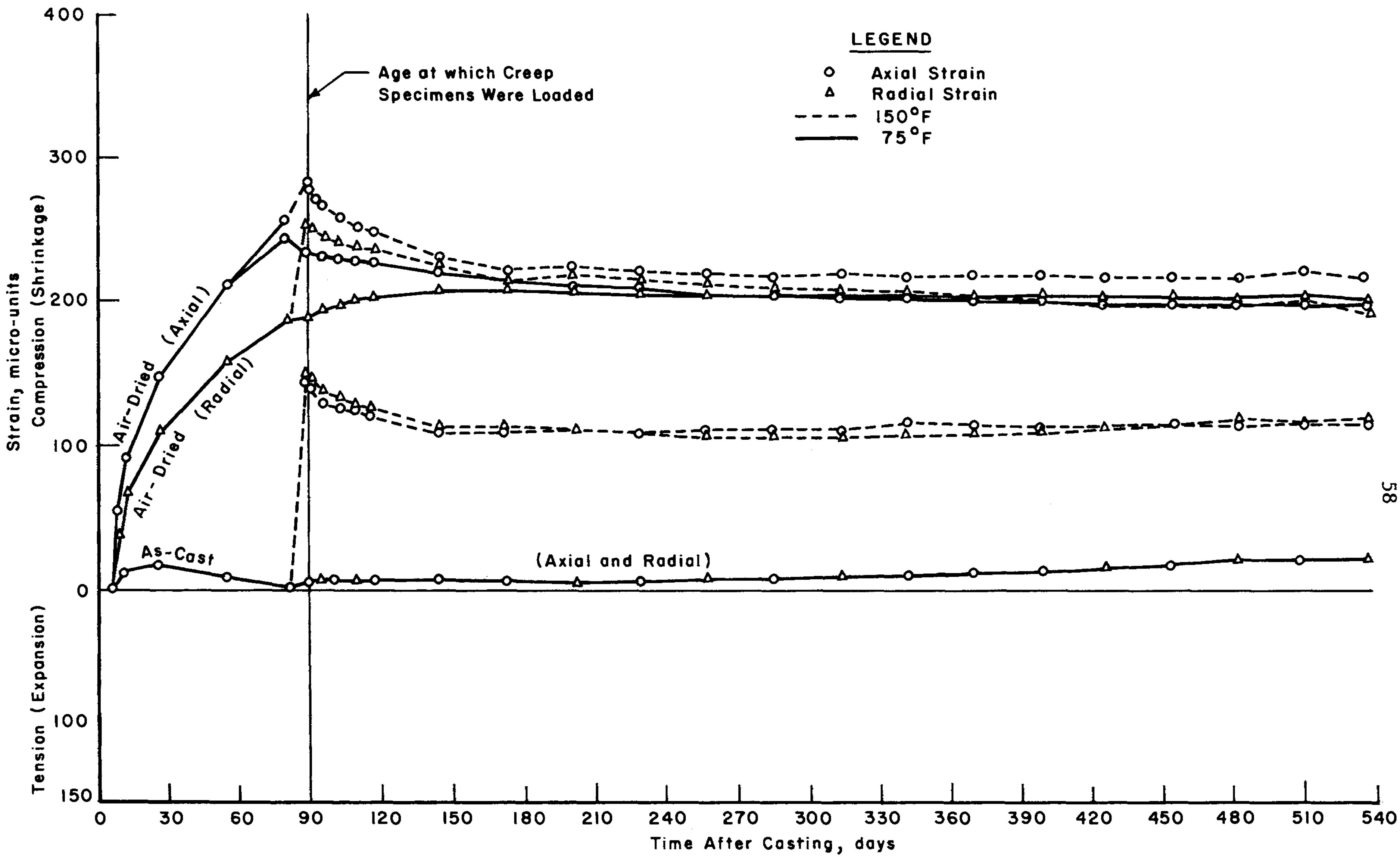


Fig 20. Apparent average shrinkage strains as indicated by gages in unloaded specimens.

the curing period (Fig 20), since the specimens were sealed shortly after casting and no moisture loss occurred. In the specimens under the 75° F test conditions, the shrinkage strains stabilized near the point of zero strain, suggesting that the decision to use the strain value recorded seven days after casting as the zero strain reference was a good one. In addition, as shown in Fig 20, the as-cast specimens exhibited shrinkage strains when subjected to 150° F, even though normally if the temperature were increased, the concrete would expand. The cause of this apparent behavior is discussed later.

Air-Dried Specimens. The shrinkage deformation patterns exhibited by the air-dried specimens were considerably different from those of the as-cast (Fig 20). During the first 83 days after casting, shrinkage in the air-dried concrete averaged approximately 220 micro-units. However, the shrinkage strain in the axial direction was approximately 60 micro-units more than in the radial direction. According to Jain and Kesler (Ref 34), the reverse should have been true, because the average internal humidity around the radial gage should have been less than that adjacent to the axial gage since the radial gage was physically located nearer the drying surface. Thus, more shrinkage should have occurred in the direction of the radial gage than in the direction of the axial gage. It may also be noted that the shrinkage strains in the air-dried specimens increased when the specimens were subjected to a temperature of 150° F.

Shrinkage After Loading

The average strain-time relationships that occurred in the shrinkage specimens after the creep specimens were loaded are shown in Fig 21. These curves are the same as the portion of those shown in Fig 20 which depict the period after the creep specimens were loaded, except that the strains were referenced to the strain values at the time of loading. These eight shrinkage curves were used as a basis for estimating all the creep strains for the various test conditions.

In the original experiment design, each creep specimen was to have an unloaded companion specimen within that batch for measuring its individual shrinkage deformations. As the experiment progressed, however, it became evident that this system was not practical, particularly under the 150° F test conditions, because (1) a number of strain gages were no longer functioning

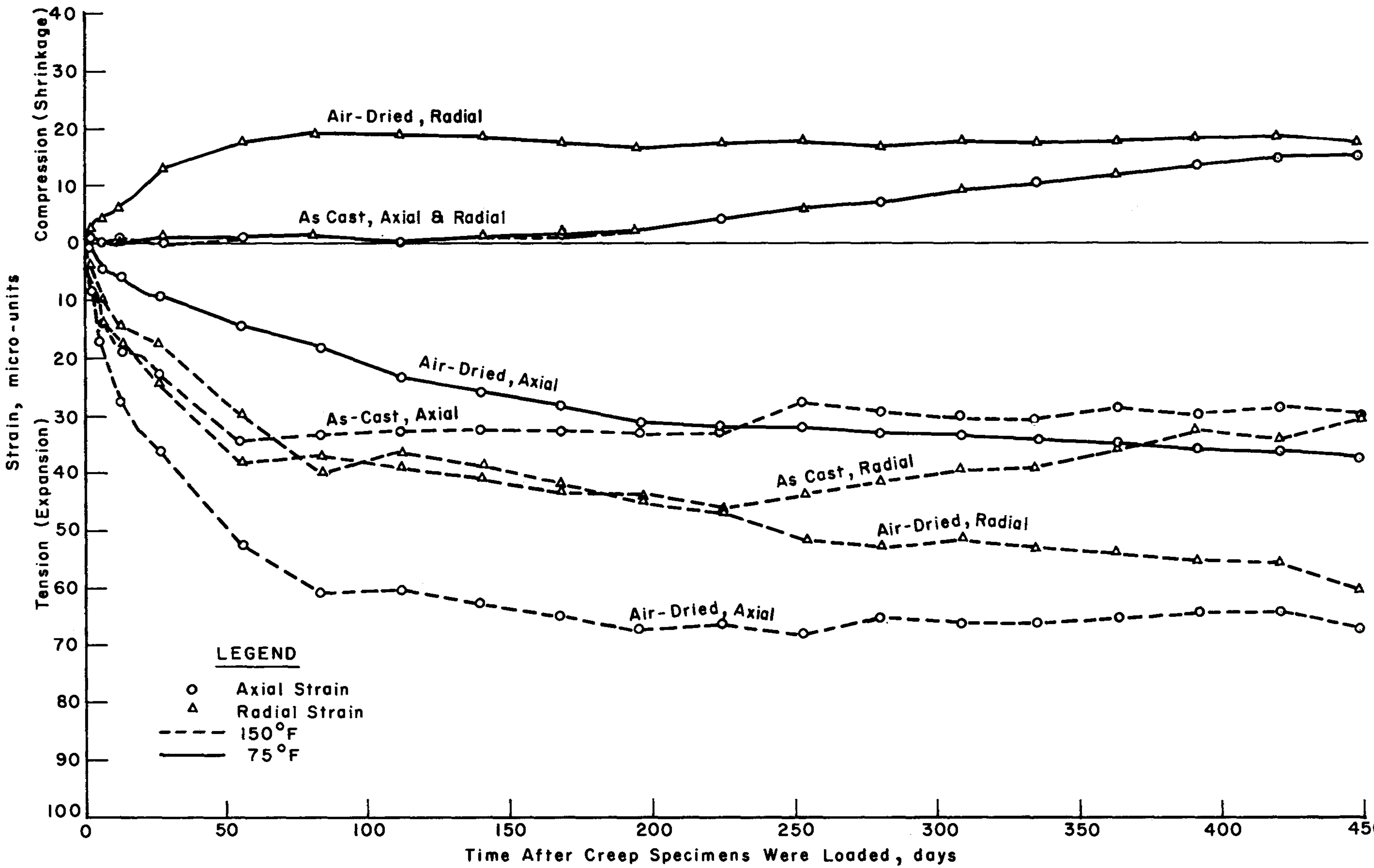


Fig 21. Average shrinkage strains from shrinkage specimens after creep specimens were loaded.

and (2) it was suspected from the strains recorded that some of the specimens were losing moisture. Therefore, average shrinkage-time relationships (Fig 21) for each environmental test condition were developed, assuming that there was no significant batch-to-batch variation, a necessary assumption if the effects of the test variables in this investigation were to be effectively analyzed. Shrinkage strains which were excluded from the averages were (1) those from specimens which showed at least a 1-ounce loss in weight during the first 90 days after loading, indicating a loss of moisture; and (2) those from specimens containing improperly functioning strain gages. The shrinkage calculations used are shown in Appendix D.

Under all test conditions, except in the 75° F as-cast case, a rapid change in strain occurred immediately after the specimens were sealed or subjected to the temperature change (Fig 21), but generally stabilized approximately 90 days after sealing or after the temperature change.

As-Cast Specimens. Under the 75° F test condition, the shrinkage strains remained practically unchanged for 200 days, at which time a gradual shrinkage began, probably due to a slight moisture loss.

In the case of the 150° F test condition, in which the concrete was subjected to a 75° F rise in temperature just prior to loading of the creep specimens, the concrete apparently expanded approximately 35 micro-units during the first 100 days. Beyond this time, both axial and radial strains remained essentially constant. The apparent expansion during the first 100 days of the loading period is attributed to the fact that the coefficient of thermal expansion of the gage assembly was approximately three times that of the concrete. Thus, when the temperature was increased, the gage attempted to expand more than the concrete causing stresses to develop in the concrete at the interface with the gage. These stresses caused localized creep in the concrete around the gage, allowing it to expand slightly with time. Such an expansion would subject the vibrating wire to tension and cause an apparent expansion of the concrete to be recorded.

Air-Dried Specimens. In the case of the 75° F test condition, the air-dried concrete shrank in the radial direction and expanded in the axial direction until approximately 100 days after the specimens were sealed

(Fig 21). If, however, the entire shrinkage history is considered (Fig 20), it can be seen that the average axial and radial shrinkage-time relationship began to converge shortly after sealing, with the strains being essentially equal 100 days after sealing, suggesting that the time required for the moisture movement and internal vapor pressure in the concrete to stabilize was 100 days. According to Helmuth and Turk (Ref 30), coalescence of shrinkage strains in specimens this small will ultimately occur as the moisture content is equalized, but sealing at 83 days after casting caused it to occur sooner in these specimens.

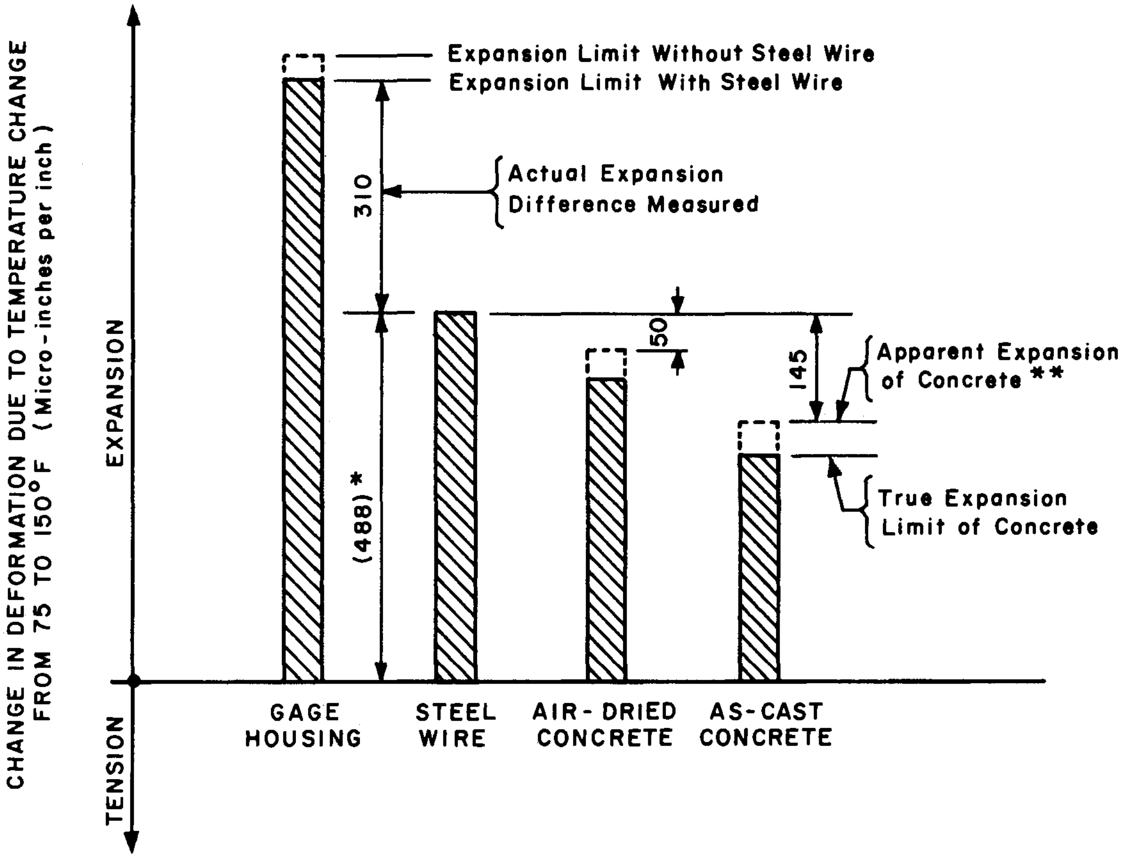
For the 150° F air-dried test condition, the concrete expanded in both axial and radial directions at a decreasing rate until the strain essentially stabilized at about 55 micro-units, although the two curves continued to slowly converge. In terms of the total strain history, both strains stabilized at approximately the same magnitude approximately 100 days after sealing (Fig 20). This behavior was similar to that for the 150° F as-cast condition and its causes are thought to be the same.

Gage-in-Concrete System

As previously noted, large apparent shrinkage strains, rather than expansions, occurred for the 150° F test specimens between 83 and 90 days after casting (Fig 20), when the temperature environment was changed from 75° F to 150° F. This apparent shrinkage, which averaged approximately 145 micro-units for the as-cast specimen and approximately 50 for the air-dried specimens, was attributed to the fact that the gage was not thermally compatible with the concrete. Therefore, this behavior was a characteristic of the gage-in-concrete system, rather than of the concrete.

Basically, the gage-in-concrete system consisted of three materials, the concrete, the brass gage housing, and the pretensioned steel wire in the gage, each with different thermal expansion characteristics (see Fig 22).

To determine the effect of temperature on the gage measurements, several tests were conducted with the gage suspended in air unconstrained. The results revealed that rising temperatures caused the measured tension in the steel



* Coefficient of thermal expansion of the steel wire is assumed to 6.5 micro-inches/inch/$^{\circ}$F; therefore, a 75°F increase in temperature causes a change in strain of

$$\Delta\epsilon_w = (6.5)\ (75) = 488 \text{ micro-inches/inch}$$

** Apparent expansion of concrete at interface with gage due to the greater expansion characteristics of gage housing.

Fig 22. Expansion characteristics of gage-in-concrete system.

wire to increase relative to the gage housing; the gage housing expanded 4.12 micro-units per degree Fahrenheit relative to the wire. This is shown in Fig 22 as the 310 micro-unit strain difference experienced by raising the gage temperature from 75° F and 150° F.

When the gage was encased in concrete, deformation of the gage housing was generally restricted by the concrete, and the pretensioned steel wire acted as though it were cast in an air pocket with only its ends fixed in the concrete. Consequently, if a rise in temperature caused apparent shrinkage in the concrete, the steel wire must have expanded more than the concrete, causing the reduced tension in the wire and the gage to register compressive strains or apparent shrinkage. This means that the coefficient of thermal expansion of the concrete was less than that of the steel wire, and therefore, the gages indicated shrinkage when the concrete actually expanded.

Apparent Coefficient of Thermal Expansion. Since the thermal expansion of the gage assembly was greater than that of the concrete, stresses developed at the gage-concrete interface when the system experienced a change in temperature, thereby apparently increasing the deformation of the concrete relative to the gage. This apparent additional strain is shown in Fig 22 by the dotted lines above the true expansion limits of the concretes.

The apparent coefficient of thermal expansion of the materials can be calculated from the recorded strain relationships if the thermal coefficient of one of the materials is known. None of the thermal coefficients for the materials considered was known; therefore, a coefficient was assumed for the steel wire since the thermal coefficient for steel varies less than for the other materials. Assuming the coefficient of thermal expansion of the steel wire to be 6.5 micro-units per degree Fahrenheit, the apparent coefficients of thermal expansion for the air-dried and as-cast concretes were 5.8×10^{-6} and 4.6×10^{-6}, respectively. The true thermal coefficients of the concretes were probably slightly less than the apparent thermal coefficients calculated, due to the stress concentration caused by the gage. In any event, the thermal coefficient for the air-dried concrete was larger than that for the as-cast concrete.

This is compatible with the thermal expansion results published by Bonnell and Harper (Ref 3), who found that the thermal coefficients of air-dried and water-cured concretes (1:6 mix) made with limestone aggregates were 4.1 and 3.4 x 10^{-6}, respectively. Since these results were smaller than the thermal coefficient of steel, a rise in temperature would cause an increase in the apparent shrinkage strains.

ELASTIC RECOVERY STRAINS

The elastic recovery strains, which occurred immediately after the creep specimens were unloaded and which were assumed to be the change in strains immediately before and after the creep specimens were unloaded, are summarized in Table 9. In addition, Table 9 contains modulus of elasticity and Poisson's ratio values for elastic recovery which were calculated using Eqs 4.1 and 4.2 in a manner similar to that used for calculating the elastic values.

The average recovery strains after one year under sustained load ranged from 89 to 111 percent of the initial elastic strains, depending on test condition. The recovery strains were generally larger than the initial elastic strains and the moduli of elasticity during recovery were generally smaller than the moduli upon loading, except for air-dried specimens loaded at 150° F and most hydrostatically loaded specimens in the other test environments, while Poisson's ratios were generally smaller than the elastic values except for some hydrostatically loaded specimens.

The percentage of instantaneous elastic strain was the average percentage of absolute change in strain between the loading and unloading elastic strains for each of the test conditions involved. Even though there were slight differences, the modulus and Poisson's ratio values for elastic recovery were essentially of the same magnitude as these quantities at the time of loading 12 months earlier. This indicates that the gages remained relatively stable throughout the test period. Also, one specimen loaded hydrostatically, which calculations showed to have a near negative Poisson's ratio and a modulus of about twelve million, had the same values upon unloading. Another specimen (C-46) also had a negative Poisson's ratio and large modulus upon loading, but due to an oil leak shortly after loading, the radial pressure was reduced to zero. When the specimen was unloaded from a uniaxial state of stress 12 months

TABLE 9. ELASTIC RECOVERY STRAIN CHARACTERISTICS

	Specimen*	Released Stress, psi		Recovery Characteristics				Percent of Instantaneous Elastic Strain	
				Strain (x 10^{-6})		Poisson's Ratio	Modulus of Elasticity, psi (x 10^6)		
		Axial	Radial	Axial	Radial			Axial	Radial
75° F As-Cast	B-7	2179	0	401	-94	.236	5.43		
	C-16x	1100	0	166	-43	.258	6.61		
	C-23	2139	600	298	-18	.260	6.14		
	D-26	3449	1200	495	1	.257	5.72		
	D-31	3472	3600	275	322	.342	3.67	102.8	97.1
	E-5	562	600	39	53	.355	3.53		
	E-39	527	0	85	-23	.268	6.18		
	F-9	2147	2400	181	199	-.058	13.38		
	F-13	0	600	-55	74	.269	5.89		
75° F Air-Dried	B-19	2179	0	433	-103	.239	5.03		
	C-11	2139	600	385	-15	.245	4.79		
	C-17	1101	1200	70	95	.303	5.31		
	D-40	3472	3600	315	382	.367	2.63		
	D-44	3449	1200	-	13	-	-	111.2	104.6
	E-13	562	600	51	55	.093	8.86		
	E-40	527	0	100	-27	.266	5.28		
	F-30	2147	2400	184	241	.235	5.52		
	F-42	0	600	-53	81	.246	5.56		

(Continued)

TABLE 9. (CONTINUED)

	Specimen*	Released Stress, psi		Recovery Characteristics				Percent of Instantaneous Elastic Strain	
				Strain ($\times 10^{-6}$)		Poisson's Ratio	Modulus of Elasticity, psi ($\times 10^6$)		
		Axial	Radial	Axial	Radial			Axial	Radial
150° F As-Cast	A-35	0	600	-	65	-	-		
	B-4	561	0	-	-22	-	-		
	D-2x	1086	0	200	-51	.256	5.44	106.7	108.4
	D-15	1102	0	211	-	-	-		
	G-9	2268	2400	199	272	.370	2.47		
150° F Air-Dried	B-1	561	0	96	-21	.217	5.87		
	C-46x	1032	0	227	-53	.231	4.54		
	D-3	0	1200	99	-	-	-		
	D-22	1102	0	234	-47	.202	4.72	89.3	95.9
	D-41	1086	2400	-3	368	.229	4.35		
	E-4	2259	600	243	-	-	-		
	F-6	3474	3600	295	-	-	-		
	F-34	2123	0	431	-	-	-		
	G-19	2268	2400	188	249	.357	2.96		
							Weighted Average	100.6	100.7

* Only specimens in which at least one gage was functioning properly after one year under sustained load are included in this table.

x Radial pressure reduced to zero shortly after initial loading due to oil leak and these values were not used in percent calculations.

later, Poisson's ratio and modulus of elastic recovery were 0.23 and 4.5×10^6 psi, respectively, which is in the range expected for this concrete.

For concrete cubes subjected to multiaxial stresses and unloaded from 22 to 98 days after loading, Gopalakrishnan et al (Ref 25) found in all cases that the elastic recovery strains were less than the elastic strains upon loading. However, in this experiment, which subjected the specimens to load for a period of 12 months, it was found that the elastic recovery strains were generally larger than the elastic strains at loading.

TOTAL STRAINS IN LOADED SPECIMENS

The total strain in a concrete structure after loading is very important because it is this strain which ultimately must be determined by the designer; however, in this study, the primary purpose for obtaining total strain values was for estimating creep strains.

The total strain-time data recorded for the axial and radial strains for all the loaded specimens are presented in Appendix G. Curves for the total axial and radial strains for each specimen are shown in Appendix E. The total strain curves include the elastic strains upon application of load and the time-dependent shrinkage and creep strains. Briefly, a qualitative review of these curves indicates that

(1) An increase in stress in one direction produced larger total strains and strain rates in that direction.

(2) Specimens loaded triaxially at a stress ratio approximately equal to Poisson's ratio experienced little or no strain in the minor stress direction.

(3) In triaxially loaded specimens, for a given principal stress, an increase in stress in a plane perpendicular to the principal stress reduced the strain along the axis of the principal stress.

(4) Under a hydrostatic state of stress considerable compressive strain in all three principal directions occurred with time, indicating the existence of volumetric creep.

(5) The total strain and strain rate for air-dried specimens were significantly greater than for as-cast specimens.

(6) The total strain and strain rate were higher for specimens at 150° F than for specimens at 75° F.

(7) For comparable states of stress, within the test limits of this experiment the order of increased total strain with time was 75° F, as-cast; 75° F, air-dried; 150° F, as-cast; and 150° F, air-dried.

CHAPTER 5. ANALYSIS OF CREEP DATA

The purpose of this chapter is to analyze the creep strains obtained from the test results and to determine the effects produced by the various factors investigated. This analysis will include the determination of those factors and their interactions which significantly affect creep behavior, the development of predictive equations for estimating creep strains in terms of all factors in the experiment, and the evaluation and discussion of Poisson's ratio for creep and creep recovery. This chapter is designed to provide a qualitative understanding of the factors that affect creep behavior and to develop a framework for more detailed evaluation of specific aspects of creep behavior.

As discussed in Chapter 2, creep strain at a given time and in a given direction is the total measured strain in a load specimen, less the instantaneous elastic strain at the time of loading and the average strain measured in unloaded specimens under identical environmental conditions (Fig 1). The creep strains for each specimen are presented in Appendix F.

STATISTICAL EVALUATION OF CREEP DATA

Analysis of variance techniques were used to evaluate the effects of the various factors in this experiment. Although all factors would be expected to be significant as main effects, the statistical analysis provides a means to determine which factors or combination of factors affect the response surface and to what probable extent. Furthermore, statistics offers the only means to identify interactions and to measure quantitatively their effect within a certain confidence or probability level. Techniques used in this analysis are described in Refs 9, 14, and 57.

The overall experimental design consisted of 50 independent test conditions. However, not all combinations of factors and levels could be investigated in one complete model because of limitations imposed by the design (Table 3) and because after 84 days under load the gages in only 32 specimens or test conditions were considered to be functioning properly. Therefore, two smaller models, each consisting of a "full factorial arrangement of treatments," were used to analyze the effects of these variables. These models are discussed in the following sections as "Model A" and "Model B."

Model A

Model A was a full factorial arrangement of four of the five test variables involving 12 test conditions as summarized in Table 10. As noted, axial stress was maintained constant at a nominal level of 2400 psi while the other four factors were varied.

Assumptions. The data analysis using Model A was based on certain assumptions which are summarized below.

(1) There was no significant batch-to-batch variation. This assumption was reasonably valid since identical mix designs and procedures were employed in the preparation of all batches and since an analysis of the compressive and tensile strengths for the various moisture conditions on a batch-to-batch basis indicates no significant differences.

(2) All axial loads applied to the specimens from the same hydraulic pressure header were equal. This assumption was not completely valid, as discussed in Chapter 3, due to the slight differences in friction losses in the hydraulic piston system between loading units; however, these differences were small and were assumed to be negligible.

(3) There were no significant four-factor interactions or significant time factors beyond the third-order terms. Statistically, this is generally a safe assumption.

Model Considered. A number of models were investigated; the multilinear model finally selected to express the creep strain relative to the four factors in Table 10 was as follows:

$$Y = \mu + A + B + AB + C + C_q + AC + AC_q + BC + BC_q + ABC$$

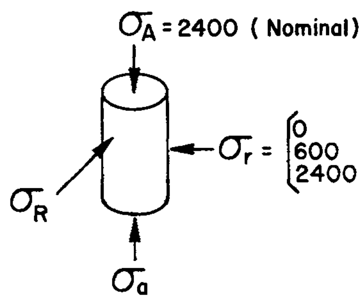
$$+ ABC_q + E + E_q + E_c + AE + AE_q + AE_c + BE + BE_q$$

$$+ BE_c + ABE + ABE_q + ABE_c + CE + CE_q + CE_c + C_qW$$

$$+ C_qE_q + C_qE_c + ACE + ACE_q + ACE_c + AC_cE + AC_qE_q$$

TABLE 10. FACTORS AND LEVELS SELECTED FOR MODEL A*

Factor	Number	Levels: Low	Mid	High
A - Temperature, °F	2	75 - - - - - -	- - - - - - -	150
B - Curing history	2	As-cast - - - -	- - - - -	Air-dried
C - Radial stress, psi	3	0 - - - - - -	600 - - - - -	2400
D - Axial stress	1		Constant at 2400 psi	
E - Time, days	12	56 84 112 140 168 196 224 252 280 308 336 364		



* The following specimens incorporated these test conditions for Model A: B-7, B-19, C-11, C-23, E-4, E-18, F-9, F-30, F-33, F-34, G-9, and G-19.

$$+ AC_qE_c + BCE + BCE_q + BCE_c + BC_qE + BC_qE_q$$

$$+ BC_qE_c + \epsilon_e$$

where

Y = an individual creep strain observation,

μ = overall mean,

ϵ_e = experimental error,

A = effect of temperature,

B = effect of curing history,

C = effect of radial stress,

E = effect of time after loading,

q = effect of quadradic variation of variable,

c = effect of cubic variation of variable.

This model involves both levels of temperature and curing history, three of the five radial stress levels in the overall experimental design, and 12 levels of time. Furthermore, this model allows the evaluation of all main effects except axial stress, all two and three-factor interaction effects, all second degree nonlinear and second degree interaction effects involving radial stress, and all second and third degree nonlinear and second and third degree interaction effects involving time. The low level of time was set at 56 days because the rate of change of creep was considerably smaller for all test conditions beyond this time, allowing a more precise prediction equation for strains, which are of primary interest.

The orthogonal coding for this statistical design is tabulated in Table 11. The coding for the unequally spaced levels of radial stress was constructed by a method described by Robson (Ref 54). The orthogonal coding for the equally spaced levels of the remaining factors is after Fisher and Yates (Ref 17).

TABLE 11. CODED TREATMENT COMBINATIONS FOR MODEL A

Specimen	Level of Factor						
	A	B	C	C_q	E	E_q	E_c
B-7	-1	-1	-5	3	-11	55	-33
	-1	-1	-5	3	- 9	25	3
	-1	-1	-5	3	- 7	1	21
	-1	-1	-5	3	- 5	-17	25
	-1	-1	-5	3	- 3	-29	19
	-1	-1	-5	3	- 1	-35	7
	-1	-1	-5	3	1	-35	- 7
	-1	-1	-5	3	3	-29	-19
	-1	-1	-5	3	5	-17	-25
	-1	-1	-5	3	7	1	-21
	-1	-1	-5	3	9	25	- 3
	-1	-1	-5	3	11	55	33
B-13	-1	1	-5	3	-11	55	-33
	-1	1	-5	3	- 9	25	3
	-1	1	-5	3	- 7	1	21
	-1	1	-5	3	- 5	-17	25
	-1	1	-5	3	- 3	-29	19
	-1	1	-5	3	- 1	-35	7
	-1	1	-5	3	1	-35	- 7
	-1	1	-5	3	3	-29	-19
	-1	1	-5	3	5	-17	-25
	-1	1	-5	3	7	1	-21
	-1	1	-5	3	9	25	- 3
	-1	1	-5	3	11	55	33
C-11	-1	1	-2	-4	-11	55	-33
	-1	1	-2	-4	- 9	25	3
	-1	1	-2	-4	- 7	1	21
	-1	1	-2	-4	- 5	-17	25
	-1	1	-2	-4	- 3	-29	19
	-1	1	-2	-4	- 1	-35	7
	-1	1	-2	-4	1	-35	- 7
	-1	1	-2	-4	3	-29	-19
	-1	1	-2	-4	5	-17	-25
	-1	1	-2	-4	7	1	-21
	-1	1	-2	-4	9	25	- 3
	-1	1	-2	-4	11	55	33

(Continued)

TABLE 11. (CONTINUED)

Specimen	Level of Factor						
	A	B	C	C_q	E	E_q	E_c
C-23	-1	-1	-2	-4	-11	55	-33
	-1	-1	-2	-4	- 9	25	3
	-1	-1	-2	-4	- 7	1	21
	-1	-1	-2	-4	- 5	-17	25
	-1	-1	-2	-4	- 3	-29	19
	-1	-1	-2	-4	- 1	-35	7
	-1	-1	-2	-4	1	-35	- 7
	-1	-1	-2	-4	3	-29	-19
	-1	-1	-2	-4	5	-17	-25
	-1	-1	-2	-4	7	1	-21
	-1	-1	-2	-4	9	25	- 3
	-1	-1	-2	-4	11	55	33
E-4	1	1	-2	-4	-11	55	-33
	1	1	-2	-4	- 9	25	3
	1	1	-2	-4	- 7	1	21
	1	1	-2	-4	- 5	-17	25
	1	1	-2	-4	- 3	-29	19
	1	1	-2	-4	- 1	-35	7
	1	1	-2	-4	1	-35	- 7
	1	1	-2	-4	3	-29	-19
	1	1	-2	-4	5	-17	-25
	1	1	-2	-4	7	1	-21
	1	1	-2	-4	9	25	- 3
	1	1	-2	-4	11	55	33
E-18	1	-1	-2	-4	-11	55	-33
	1	-1	-2	-4	- 9	25	3
	1	-1	-2	-4	- 7	1	21
	1	-1	-2	-4	- 5	-17	25
	1	-1	-2	-4	- 3	-29	19
	1	-1	-2	-4	- 1	-35	7
	1	-1	-2	-4	1	-35	- 7
	1	-1	-2	-4	3	-29	-19
	1	-1	-2	-4	5	-17	-25
	1	-1	-2	-4	7	1	-21
	1	-1	-2	-4	9	25	- 3
	1	-1	-2	-4	11	55	33

(Continued)

TABLE 11. (CONTINUED)

Specimen	Level of Factor						
	A	B	C	C_q	E	E_q	E_c
F-9	-1	-1	7	1	-11	55	-33
	-1	-1	7	1	- 9	25	3
	-1	-1	7	1	- 7	1	21
	-1	-1	7	1	- 5	-17	25
	-1	-1	7	1	- 3	-29	19
	-1	-1	7	1	- 1	-35	7
	-1	-1	7	1	1	-35	- 7
	-1	-1	7	1	3	-29	-19
	-1	-1	7	1	5	-17	-25
	-1	-1	7	1	7	1	-21
	-1	-1	7	1	9	25	- 3
	-1	-1	7	1	11	55	33
F-30	-1	1	7	1	-11	55	-33
	-1	1	7	1	- 9	25	3
	-1	1	7	1	- 7	1	21
	-1	1	7	1	- 5	-17	25
	-1	1	7	1	- 3	-29	19
	-1	1	7	1	- 1	-35	7
	-1	1	7	1	1	-35	- 7
	-1	1	7	1	3	-29	-19
	-1	1	7	1	5	-17	-25
	-1	1	7	1	7	1	-21
	-1	1	7	1	9	25	- 3
	-1	1	7	1	11	55	33
F-33	1	-1	-5	3	-11	55	-33
	1	-1	-5	3	- 9	25	3
	1	-1	-5	3	- 7	1	21
	1	-1	-5	3	- 5	-17	25
	1	-1	-5	3	- 3	-29	19
	1	-1	-5	3	- 1	-35	7
	1	-1	-5	3	1	-35	- 7
	1	-1	-5	3	3	-29	-19
	1	-1	-5	3	5	-17	-25
	1	-1	-5	3	7	1	-21
	1	-1	-5	3	9	25	- 3
	1	-1	-5	3	11	55	33

(Continued)

TABLE 11. (CONTINUED)

Specimen	Level of Factor						
	A	B	C	C_q	E	E_q	E_c
F-34	1	1	-5	3	-11	55	-33
	1	1	-5	3	- 9	25	3
	1	1	-5	3	- 7	1	21
	1	1	-5	3	- 5	-17	25
	1	1	-5	3	- 3	-29	19
	1	1	-5	3	- 1	-35	7
	1	1	-5	3	1	-35	- 7
	1	1	-5	3	3	-29	-19
	1	1	-5	3	5	-17	-25
	1	1	-5	3	7	1	-21
	1	1	-5	3	9	25	- 3
	1	1	-5	3	11	55	33
G-9	1	-1	7	1	-11	55	-33
	1	-1	7	1	- 9	25	3
	1	-1	7	1	- 7	1	21
	1	-1	7	1	- 5	-17	25
	1	-1	7	1	- 3	-29	19
	1	-1	7	1	- 1	-35	7
	1	-1	7	1	1	-35	- 7
	1	-1	7	1	3	-29	-19
	1	-1	7	1	5	-17	-25
	1	-1	7	1	7	1	-21
	1	-1	7	1	9	25	- 3
	1	-1	7	1	11	55	33
G-19	1	1	7	1	-11	55	-33
	1	1	7	1	- 9	25	3
	1	1	7	1	- 7	1	21
	1	1	7	1	- 5	-17	25
	1	1	7	1	- 3	-29	19
	1	1	7	1	- 1	-35	7
	1	1	7	1	1	-35	- 7
	1	1	7	1	3	-29	-19
	1	1	7	1	5	-17	-25
	1	1	7	1	7	1	-21
	1	1	7	1	9	25	- 3
	1	1	7	1	11	55	33

Model B

Model B was a complete factorial arrangement of three of the five test variables involving four test conditions, as summarized in Table 12. In this model, temperature during loading and curing history remained constant while axial stress, radial stress, and time were varied. The effects of axial and radial stress were each evaluated at two levels while their relationships with time were evaluated at the same 12 levels used in Model A. The purpose of this model was to assist in interrelating the effects of all five test variables.

The assumptions for Model A also apply to Model B. In addition, it was assumed that all radial loads applied to the specimens from the same hydraulic pressure manifold were equal.

The multilinear model selected to express the creep strain relative to the three factors in Table 12 is as follows:

$$Y = \mu + C + D + CD + E + E_q + E_c + CE + CE_q + CE_c + DE$$

$$+ DE_q + DE_c + CDE + CDE_q + CDE_c + \epsilon_e$$

where

Y = an individual creep strain observation,

μ = overall mean,

ϵ_e = experimental error,

C = effect of radial stress,

D = effect of axial stress,

E = effect of time after loading,

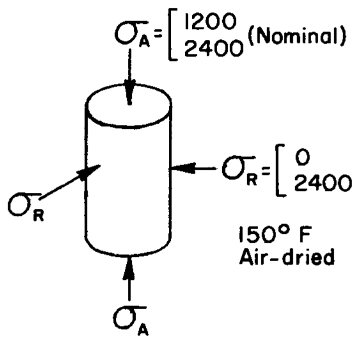
q = effect of quadratic variation of variable,

c = effect of cubic variation of variable.

This model allowed the evaluation of all main effects, all two and three-factor interaction effects, and all second and third degree nonlinear and interaction effects involving time. The orthogonal coding used to evaluate this

TABLE 12. FACTORS AND LEVELS SELECTED FOR MODEL B*

Factor	Number	Levels: Low	Mid	High
A-Temperature	1	Constant at 150° F		
B-Curing History	1	Constant at air-dried		
C-Radial stress, psi	2	0	- - - - - - - - - - - -	2400
D-Axial stress, psi	2	1200	- - - - - - - - - - -	2400
E-Time, days	12	56	84 112 140 168 196 224 252 280 308 336	364



* The following specimens incorporated these test conditions for Model B: D-22, D-41, F-34, and G-19.

model is tabulated in Table 13. Since all levels of the factors were equally spaced, the coding scheme described by Fisher and Yates was used.

Analysis of Variance

The analyses of variance (AOV) for Model A are presented in Tables 14 and 15 for creep strains calculated in the axial and radial directions, respectively; similarly, the analyses of variance for Model B are shown in Tables 16 and 17. The factors or interactions found to significantly affect creep strains at probability levels of 0.005 and 0.05 are indicated.*

F-Test. The relative significance of a test variable is determined by a statistical "F-test." The F-test is the ratio of the mean square of the particular test variable to the "error mean square" of the experiment. The error mean square represents an estimate of the true experimental error. The more accurate the estimate of true experimental error, the greater the confidence placed in the results of the F-test. The best estimate of true experimental error is the within error mean square calculated from duplicate specimens, which are specimens treated alike in all respects. In this experiment, however, there were no duplicate specimens, so the pooled mean square of all four-factor interactions and time variables beyond the third-order terms were used as an estimate of the true experimental error. This estimate of the error mean square was relatively small and it is believed that the true error term was somewhat larger than this value due to the nature of this experiment. In cases where the estimate of the experimental error is less than the true error, the F-test is oversensitive and more variables would be found to be significant at a given probability level.

Discussion of AOV Tables. The percent of total variation column in Tables 14 through 17 represents the percent of the total creep strain variation that was attributed to the specific factor investigated within the range of the variables tested in the model. This is, in effect, the relative influence of each factor. Missing data also occurred in the experiment near the end of the loading period when five of the strain gages failed. To keep the model orthogonal for purposes of evaluating the factors, the missing data points were estimated by extrapolation methods. The number of degrees of freedom in the

*A probability level of 0.005 means that the probability is less than one-half percent that this factor does not affect creep.

TABLE 13. CODED TREATMENT COMBINATIONS FOR MODEL B

Specimen	Level of Factor				
	C	D	E	E_q	E_c
D-22	-1	-1	-11	55	-33
	-1	-1	- 9	25	3
	-1	-1	- 7	1	21
	-1	-1	- 5	-17	25
	-1	-1	- 3	-29	19
	-1	-1	- 1	-35	7
	-1	-1	1	-35	- 7
	-1	-1	3	-29	-19
	-1	-1	5	-17	-25
	-1	-1	7	1	-21
	-1	-1	9	25	- 3
	-1	-1	11	55	33
D-41	-1	1	-11	55	-33
	-1	1	- 9	25	3
	-1	1	- 7	1	21
	-1	1	- 5	-17	25
	-1	1	- 3	-29	19
	-1	1	- 1	-35	7
	-1	1	1	-35	- 7
	-1	1	3	-29	-19
	-1	1	5	-17	-25
	-1	1	7	1	-21
	-1	1	9	25	- 3
	-1	1	11	55	33
F-34	1	-1	-11	55	-33
	1	-1	- 9	25	3
	1	-1	- 7	1	21
	1	-1	- 5	-17	25
	1	-1	- 3	-29	19
	1	-1	- 1	-35	7
	1	-1	1	-35	- 7
	1	-1	3	-29	-19
	1	-1	5	-17	-25
	1	-1	7	1	-21
	1	-1	9	25	- 3
	1	-1	11	55	33

(Continued)

TABLE 13. (CONTINUED)

Specimen	Level of Factor				
	C	D	E	E_q	E_c
G-19	1	1	-11	55	-33
	1	1	- 9	25	3
	1	1	- 7	1	21
	1	1	- 5	-17	25
	1	1	- 3	-29	19
	1	1	- 1	-35	7
	1	1	1	-35	- 7
	1	1	3	-29	-19
	1	1	5	-17	-25
	1	1	7	1	-21
	1	1	9	25	- 3
	1	1	11	55	33

TABLE 14. ANALYSIS OF VARIANCE FOR AXIAL CREEP, MODEL A

Source of Variation	Degrees of Freedom		Mean Square	F Value	Significance Level, %	Percent of Total Variation
A	1		334535	11779	0.5	19.40
B	1		251068	8840	0.5	14.56
AB	1		7309	257	0.5	.42
C	2					
C_ℓ		1	650654	22910	0.5	37.73
C_q		1	91082	3207	0.5	5.28
AC	2					
$A_\ell C_\ell$		1	76709	2701	0.5	4.45
$A_\ell C_q$		1	69936	2463	0.5	4.06
BC	2					
$B_\ell C_\ell$		1	11024	388	0.5	.64
$B_\ell C_q$		1	8434	297	0.5	.45
ABC	2					
$A_\ell B_\ell C_\ell$		1	4198	148	0.5	.24
$A_\ell B_\ell C_q$		1	9850	347	0.5	.57
E	11					
E_ℓ		1	164794	5803	0.5	9.56
E_q		1	6988	246	0.5	.41
E_c		1	1624	57	0.5	.09
AE	11					
$A_\ell E_\ell$		1	4147	146	0.5	.24
$A_\ell E_q$		1	65	2.3	-	0
$A_\ell E_c$		1	6	-	-	0
BE	11					
$B_\ell E_\ell$		1	21	-	-	0
$B_\ell E_q$		1	440	15	0.5	.03
$B_\ell E_c$		1	6	-	-	0

(Continued)

TABLE 14. (CONTINUED)

Source of Variation	Degrees of Freedom	Mean Square	F Value	Significance Level, %	Percent of Total Variation
ABE	11				
$A_\ell B_\ell E_\ell$	1	964	34	0.5	.06
$A_\ell B_\ell E_q$	1	72	2.5	-	0
$A_\ell B_\ell E_c$	1	0	-	-	0
CE	22				
$C_\ell E_\ell$	1	17644	621	0.5	1.02
$C_\ell E_q$	1	105	3.7	-	.01
$C_\ell E_c$	1	37	1.3	-	0
$C_q E_\ell$	1	3610	127	0.5	.21
$C_q E_q$	1	40	1.4	-	0
$C_\ell E_c$	1	38	1.3	-	0
ACE	22				
$A_\ell C_\ell E_\ell$	1	1338	47	0.5	0.08
$A_\ell C_\ell E_q$	1	229	8	5.0	.01
$A_\ell C_\ell E_c$	1	21	-	-	0
$A_\ell C_q E_\ell$	1	3555	125	0.5	.21
$A_\ell C_q E_q$	1	9	-	-	0
$A_\ell C_q E_c$	1	4	-	-	0
BCE	22				
$B_\ell C_\ell E_\ell$	1	35	-	-	0
$B_\ell C_\ell E_q$	1	85	3	-	.01
$B_\ell C_\ell E_c$	1	5	-	-	0
$B_\ell C_q E_\ell$	1	882	31	0.5	.05
$B_\ell C_q E_q$	1	193	6.8	5.0	.01
$B_\ell C_q E_c$	1	10	-	-	0
ABCE	22				
Total	143				

(Continued)

TABLE 14. (CONTINUED)

Source of Variation	Degrees of Freedom	Mean Square	F Value	Significance Level, %	Percent of Total Variation
Residual*	95**	28.4			

* Includes all four-factor interactions, time, and time interaction beyond the third-order terms.

** Seven degrees of freedom were removed from residual due to seven missing data points.

Legend

A - Temperature during loading

B - Curing history

C - Radial stress

E - Time after loading

ℓ - Linear variation of factor

q - Quadratic variation of factor

c - Cubic variation of factor

TABLE 15. ANALYSIS OF VARIANCE FOR RADIAL CREEP, MODEL A

Source of Variation	Degrees of Freedom		Mean Square	F Value	Significance Level, %	Percent of Total Variation
A	1		12860	464	0.5	.35
B	1			2720	0.5	2.06
AB	1		8320	300	0.5	.23
C	2					
C_ℓ		1	3326338	120084	0.5	91.10
C_q		1	12246	442	0.5	.34
AC	2					
$A_\ell C_\ell$		1	2773	100	0.5	.08
$A_\ell C_q$		1	29192	1054	0.5	.80
BC	2					
$B_\ell C_\ell$		1	70446	2543	0.5	1.93
$B_\ell C_q$		1	1459	53	0.5	.04
ABC	2					
$A_\ell B_\ell C_\ell$		1	40729	1470	0.5	1.12
$A_\ell B_\ell C_q$		1	2849	103	0.5	.08
E	11					
E_ℓ		1	21779	786	0.5	.60
E_q		1	1168	42	0.5	.03
E_c		1	32	-	-	0
AE	11					
$A_\ell E_\ell$		1	5698	206	0.5	.16
$A_\ell E_q$		1	98	3.5	-	0
$A_\ell E_c$		1	7	-	-	0
BE	11					
$B_\ell E_\ell$		1	477	17	0.5	.01
$B_\ell E_q$		1	42	-	-	0
$B_\ell E_c$		1	23	-	-	0

(Continued)

TABLE 15. (CONTINUED)

Source of Variation	Degrees of Freedom	Mean Square	F Value	Significance Level, %	Percent of Total Variation
ABE	11				
$A_\ell B_\ell E_\ell$	1	93	3.4	-	0
$A_\ell B_\ell E_q$	1	5	-	-	0
$A_\ell B_\ell E_c$	1	6	-	-	0
CE	22				
$C_\ell E_\ell$	1	34377	1241	0.5	.94
$C_\ell E_q$	1	1179	43	0.5	.03
$C_\ell E_c$	1	204	7.4	5.0	.01
$C_q E_\ell$	1	346	12.5	0.5	.01
$C_q E_q$	1	18	-	-	0
$C_q E_c$	1	1	-	-	0
ACE	22				
$A_\ell C_\ell E_\ell$	1	0	-	-	0
$A_\ell C_\ell E_q$	1	63	-	-	0
$A_\ell C_\ell E_c$	1	29	-	-	0
$A_\ell C_q E_\ell$	1	713	25.7	0.5	.02
$A_\ell C_q E_q$	1	59	-	-	0
$A_\ell C_q E_c$	1	3	-	-	0
BCE	22				
$B_\ell C_\ell E_\ell$	1	2	-	-	0
$B_\ell C_\ell E_q$	1	72	2.6	-	0
$B_\ell C_\ell E_c$	1	5	-	-	0
$B_\ell C_q E_\ell$	1	1	-	-	0
$B_\ell C_q E_q$	1	3	-	-	0
$B_\ell C_q E_c$	1	4	-	-	0
ABCE	22				
Total	143				

(Continued)

TABLE 15. (CONTINUED)

Source of Variation	Degrees of Freedom	Mean Square	F Value	Significance Level, %	Percent of Total Variation
Residual*	75 **	27.7			

* Includes all four-factor interactions, time, and time interactions beyond the third-order terms.

** Twenty-seven degrees of freedom were removed from residual due to 27 missing data points.

Legend

A - Temperature during loading

B - Curing history

C - Radial stress

E - Time after loading

ℓ - Linear variation

q - Quadratic variation

c - Cubic variation

TABLE 16. ANALYSIS OF VARIANCE FOR AXIAL CREEP, MODEL B

Source of Variation	Degrees of Freedom		Mean Square	F Value	Significance Level, %	Percent of Total Variation
C	1		329884	16831	0.5	23.67
D	1		857715	43761	0.5	61.54
CD	1		151829	7746	0.5	10.89
E	11					
E_ℓ		1	36214	1848	0.5	2.60
E_q		1	2025	103	0.5	.15
E_c		1	405	21	0.5	.13
CE	11					
$C_\ell E_\ell$		1	7554	385	0.5	.54
$C_\ell E_q$		1	108	5.5	5.0	.01
$C_\ell E_c$		1	1	-	-	0
DE	11					
$D_\ell E_\ell$		1	5827	297	0.5	.42
$D_\ell E_q$		1	406	21	0.5	.03
$D_\ell E_c$		1	54	-	-	0
CDE	11					
$C_\ell D_\ell E_\ell$		1	1058	54	0.5	.08
$C_\ell D_\ell E_q$		1	8	-	-	0
C D E		1	23	-	-	0
Total	47					
Residual*	32		19.2			

* Includes all time and time interactions beyond the third-order terms.

Legend

C - Radial stress

D - Axial stress

E - Time after loading

ℓ - Linear variation

q - Quadratic variation

c - Cubic variation

TABLE 17. ANALYSIS OF VARIANCE FOR RADIAL CREEP, MODEL B

Source of Variation	Degrees of Freedom		Mean Square	F Value	Significance Level, %	Percent of Total Variation
C	1		2069652	67196	0.5	94.74
D	1		55301	1795	0.5	2.53
CD	1		11197	364	0.5	.51
E	11					
E_ℓ		1	28686	931	0.5	1.31
E_q		1	1110	36	0.5	.05
E_c		1	77	2.5	-	0
CE	11					
$C_\ell E_\ell$		1	16039	521	0.5	.73
$C_\ell E_q$		1	974	32	0.5	.05
$C_\ell E_c$		1	188	6.1	5.0	.01
DE	11					
$D_\ell E_\ell$		1	164	5.3	5.0	.01
$D_\ell E_q$		1	7	-	-	0
$D_\ell E_c$		1	1	-	-	0
CDE	11					
$C_\ell D_\ell E_\ell$		1	271	8.8	5.0	.01
$C_\ell D_\ell E_q$		1	58	-	-	0
$C_\ell D_\ell E_c$		1	3	-	-	0
Total	47					
Residual*	25**		30.8			

* Includes all time and time interactions beyond the third-order terms.

**Seven degrees of freedom removed from residual due to seven missing data points.

Legend

C - Radial stress

D - Axial stress

E - Time after loading

ℓ - Linear variation

q - Quadratic variation

c - Cubic variation

residual was then reduced by the number of degrees of freedom lost due to missing points. This caused no noticeable error since the factors found to be significant before any of the gages failed were also significant over the entire period at approximately the same percent of the total variations.

A review of the AOV (Tables 14 through 17) showed that the test variables found to significantly affect axial creep were usually found to significantly affect radial creep also. In addition, the same variables found significant in Model A were likewise significant in Model B. All of this adds credence to the analysis and the selection of those factors and their interactions believed to significantly affect creep.

Most interaction effects involving axial stress could not be evaluated due to the factorial limitations of the two models. It is believed, however, that those interaction effects involving radial stress which were found significant will also be found significant in axial stress interactions. This theory is demonstrated graphically in the next section.

A summary of the significant factors and their interactions for both models is presented in Table 18. This table is divided into three categories, those variables having practical significance, those variables found to be highly significant, and those termed as statistically significant. Variables of practical significance were generally considered to be those variables that contributed at least 0.25 percent to the total variation. Highly significant is defined as a probability level less than 0.005, while statistically significant is defined as a probability level between 0.005 and 0.01. Only those factors shown to be of practical significance will be discussed because (1) the less significant factors have little actual effect on the total variation; (2) the error mean square used in the F-test probably was too small causing more factors to appear significant, and (3) which is of primary interest, these are the effects of practical value to the engineer. The less significant factors are mentioned because (1) under controlled test conditions their effects could be measured; (2) they appear to have some effect on creep; and (3) in later creep investigations these variables may be shown to be more important, particularly for concrete under load for time periods exceeding one year.

TABLE 18. SUMMARY OF SIGNIFICANT FACTORS

Significance Level	Axial Creep*		Radial Creep*	
Practical Significance	$C + C_q$		$C + C_q$	
	D	(D_q)	D	(D_q)
	A		B	
	B		BC	(BD)
	CD		$ABC + ABC_q$	$(ABD + ABD_q)$
	$E + E_q$		CE	
	$AC + AC_q$	$(AD + AD_q)$	$AC + AC_q$	$(AD + AD_q)$
	$CE + C_qE$		E	
	$BC + BC_q$	$(BD + BD_q)$	CD	
	$ABC + ABC_q$	$(ABD + ABD_q)$	A	
	DE	(DE_q)		
Highly Significant $\alpha = .005$	AB		AB	
	AE		AE	
	AC_qE		CE_q	
	E_c		BC_q	
	ACE		E_q	
	ABE		AC_qE	
	$BC_qE + BC_qE_q$		BE	
	CDE			
Statistically Significant $\alpha = .05$	ACE_q		CE_c	
	BE_q		DE	
	CE_q		CDE	

<u>Legend</u>

A - Temperature during loading
B - Curing history
C - Radial stress
c - Cubic variation
D - Axial stress
E - Time after loading
q - Quadratic variation

* Axial stress variables or interactions in parentheses could not be evaluated by the models, but are expected to be as significant as those for radial stress.

FACTORS AFFECTING CREEP

Excluding nonlinear terms, 11 effects were found to have practical significance. They included all five main effects, 5 two-factor interactions, and 1 three-factor interaction.

As expected, all main effects were found to significantly affect creep behavior and it was observed that both compressive and tensile creep strains were larger for

(1) a test temperature of 150° F than for 75° F,
(2) air-dried specimens than for as-cast specimens,
(3) increased time under load, and
(4) higher stress levels for uniaxial and biaxial states of stress.

These main effects are consistent with previous findings and are not of particular importance except as an indication of an average trend and the relative importance of each. The actual effect for any given set of conditions is dependent on the other factors as evidenced by the large number of two and three-factor interactions which were found to be significant. Thus, main effects should not be considered without first evaluating the interactions among factors.

These significant interaction effects have been graphically illustrated by plotting the creep strain results for specific specimens, or test conditions, which involve the factors being considered and for which the creep strain behavior is typical of the interaction effect being considered. Where possible, specimens outside of the statistical models were used to demonstrate that the inferences found in the model applied to the entire experiment. These graphical relationships were often constructed by connecting points with a straight line, but this is not meant to imply that a linear relationship exists. In reality the relationships could be either linear or nonlinear.

Three-Factor Interaction

Temperature × Curing History × Radial Stress (Interactions A×B×C and $A \times B \times C_q$. The interaction effect involving temperature during loading, curing history, and radial stress was highly significant for both a linear and a nonlinear stress term. The three-factor interaction effects for axial and radial creep strains are shown in Figs 23 and 24, respectively, by the three-dimensional response surfaces derived from the creep results of 12 specimens.

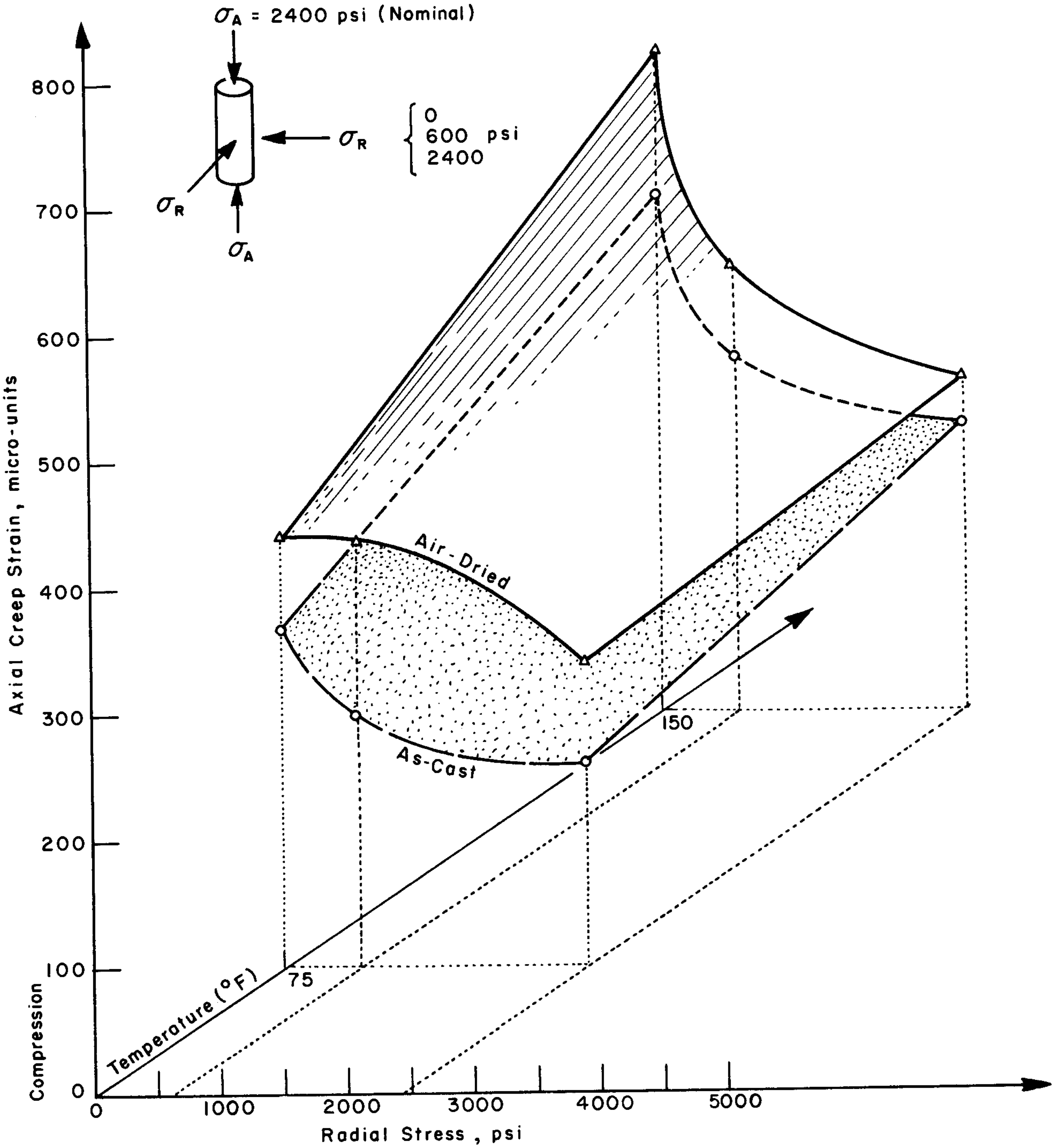


Fig 23. Effect of interaction between temperature, curing history, and radial stress on axial creep strain 140 days after loading (Interaction A×B×C and A×B×C_q).

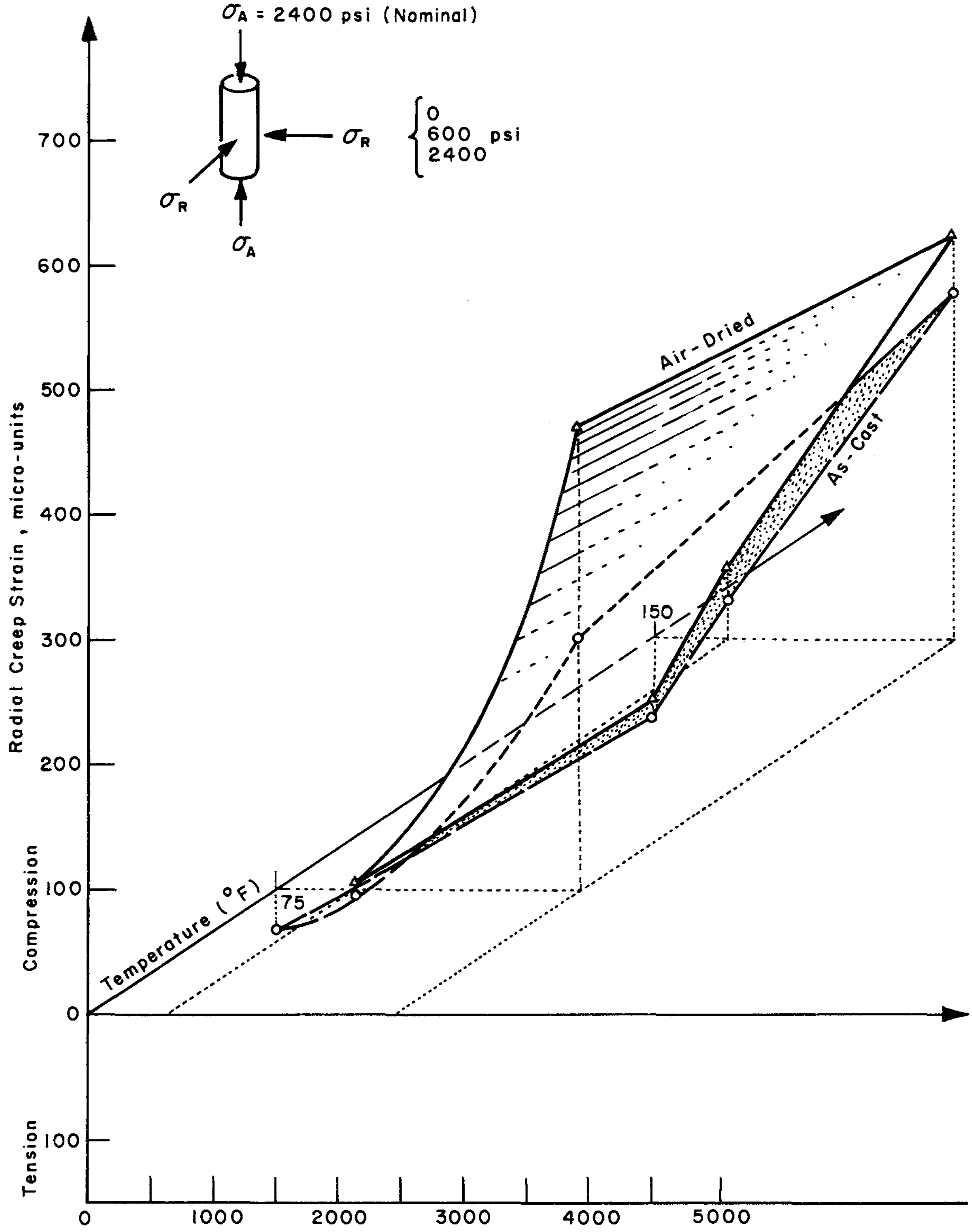


Fig 24. Effect of interaction between temperature, curing history, and radial stress on radial creep strain 140 days after loading (Interaction A×B×C and A×B×C_q).

Generally, these figures show that air-dried specimens exhibited more compressive creep strain than as-cast specimens and that specimens loaded at 150° F exhibited greater compressive and tensile creep strains than specimens loaded at 75° F. As radial stress increased under a high axial stress, the axial creep strains decreased, while the radial creep strains changed from tensile to compressive strain. The nonlinear effect was estimated by the quadratic radial stress factor in the term $A \times B \times C_q$. For both axial and radial creep strains, it was noted that the air-dried and as-cast response surfaces generally sloped upward toward the point of highest radial stress and highest temperature. In the case of axial creep strain, the increase was greater for the as-cast specimens than for the air-dried. This suggests that under a high state of stress at elevated temperatures, axial creep strains in the as-cast and air-dried concrete approach the same magnitude. In the case of radial creep strain, the increase was larger for air-dried specimens, and in addition the strains changed from compression to tension as the response surface sloped toward the point of lowest temperature and radial stress.

<u>Temperature × Curing History × Axial Stress (Interaction A×B×D)</u>. Although not contained in the models, this interaction is similar to the previously discussed interaction. The A×B×D interaction is shown graphically in Figs 25 and 26. It may be noted that the interaction effect for axial creep strain (Fig 25) is similar to that for radial creep (Fig 24) and that the interaction for radial creep strain (Fig 20) is similar to that for axial creep (Fig 23). One important exception is that the air-dried specimens exhibited larger tensile creep strains than the as-cast, particularly at the highest stress level. The test results seem to indicate that an as-cast concrete will exhibit more tensile creep strain than an air-dried concrete, except under very high stress levels when very high tensile strains are produced. The experimental design does not allow the nonlinearity of axial stress with curing history and temperature to be evaluated; however, the A×B×D interaction is expected to be curvilinear, as was the A×B×C interaction.

<u>Two-Factor Interactions</u>

From a total of 21 two-factor interactions evaluated, including nonlinear terms, eight were found to be of practical significance. These interactions are discussed in the following sections.

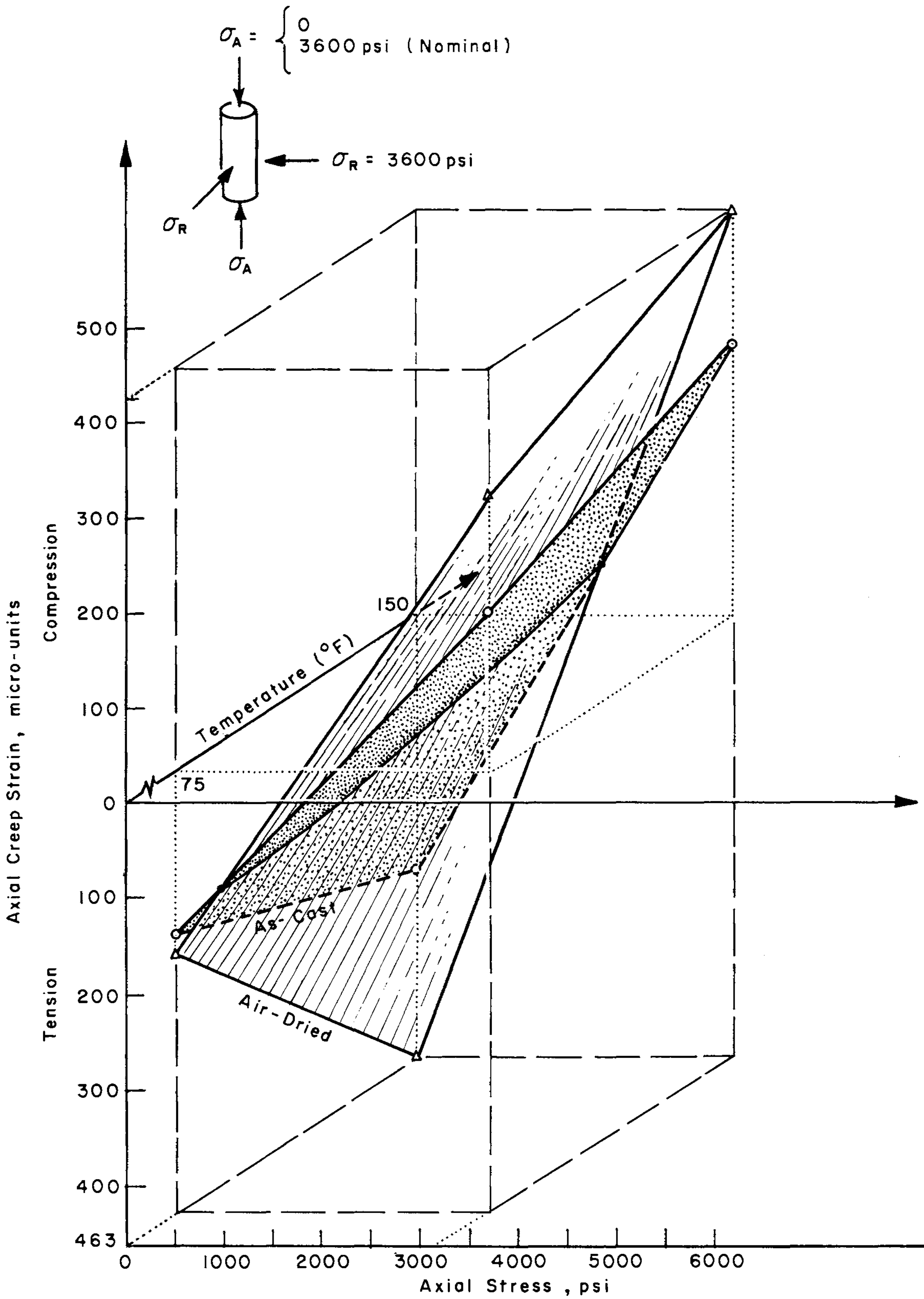


Fig 25. Effect of interaction between temperature, curing history, and axial stress on axial creep strain 21 days after loading (Interaction AxBxD).

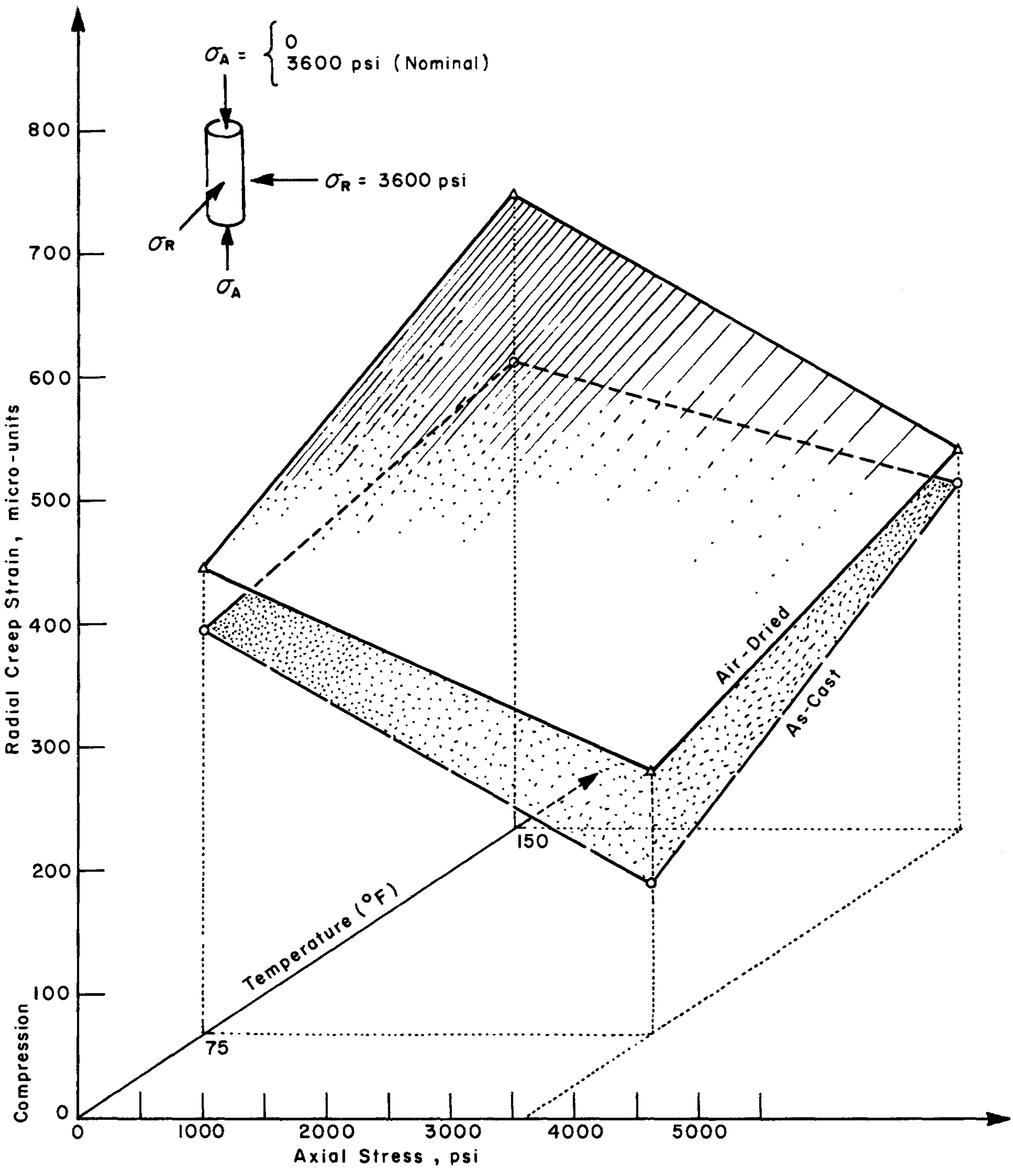


Fig 26. Effect of interaction between temperature, curing history, and axial stress on radial creep strain 21 days after loading (Interaction A×B×D).

Temperature During Loading × Radial Stress (Interactions A×C and A×C_q). Temperature during loading and radial stress combined to produce a pronounced interaction effect, as shown in Fig 27, for two different states of stress. It can be seen that as the radial stress increased, the absolute magnitude of the axial and radial creep strains generally increased, but that the increase was greater in specimens at 150° F, resulting in an interaction effect. Under a relatively high axial stress, however, as shown in Fig 27b, increasing the radial stress from zero decreased the creep strain in the axial direction. In this case, the decrease in axial creep was greater at 150° F than at 75° F. This suggests that if an increase in radial stress increases creep strains in a given direction, the increase is greater for specimens at the higher temperature, and if, on the other hand, an increase in radial stress decreases creep strains in a given direction, the decrease in creep strains is greater for the higher temperature. Figure 27b also illustrates the significant nonlinear effect of radial stress with temperature.

This interaction might be expected, since a rise in temperature significantly decreases the apparent strength of concrete (Refs 37 and 59), therefore increasing the creep potential. This does not mean to imply that the difference in strength is the total explanation, since strength itself is a response to more complex intermolecular activity and physiochemical behavior of the internal structure of the concrete.

Temperature During Loading × Axial Stress (Interaction A×D). Again this effect could not be evaluated by the models; however, a similar interaction effect appeared to exist between temperature and axial stress as illustrated by Fig 28. As in Fig 27, if an increase in axial stress produced an increase or a decrease in the axial or radial creep strain, the magnitude of the effect was greater for specimens at 150° F than for specimens at 75° F. The one exception was for radial creep strains (Fig 28a) in which the effect, reduced compressive strains, was greater at 75° F, and it is believed to be due to experimental error rather than a characteristic of creep.

Curing History × Radial Stress (Interactions B×C and B×C_q). The interaction effect involving curing history and radial stress (Fig 29) was similar to that of the temperature × radial stress interaction for compressive creep strains. If the stress conditions produced greater compressive creep strains in a given direction with an increase in stress, then the increase was much

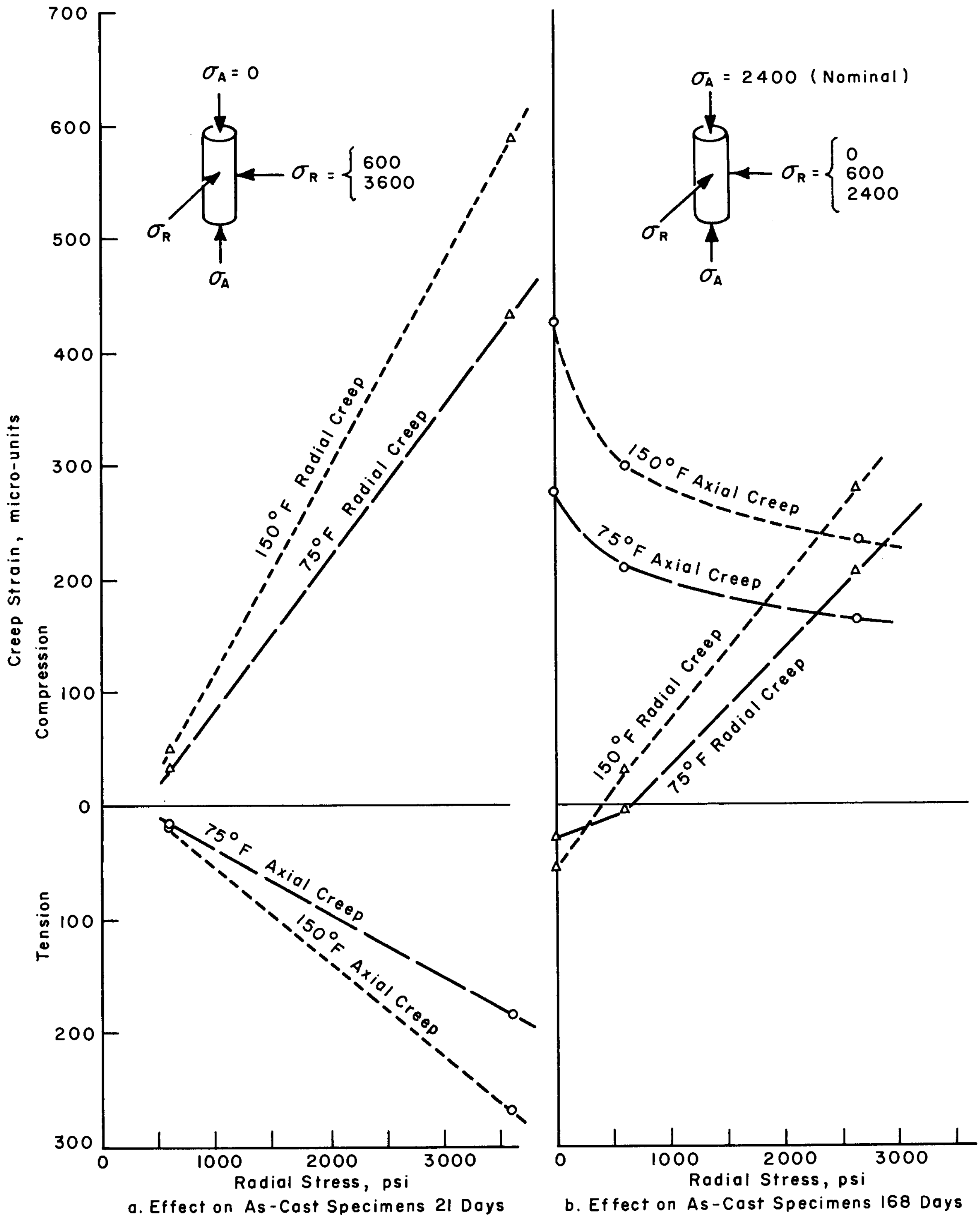


Fig 27. Effect of interaction between temperature and radial stress on axial and radial creep strain (Interaction AXC and AXC_q).

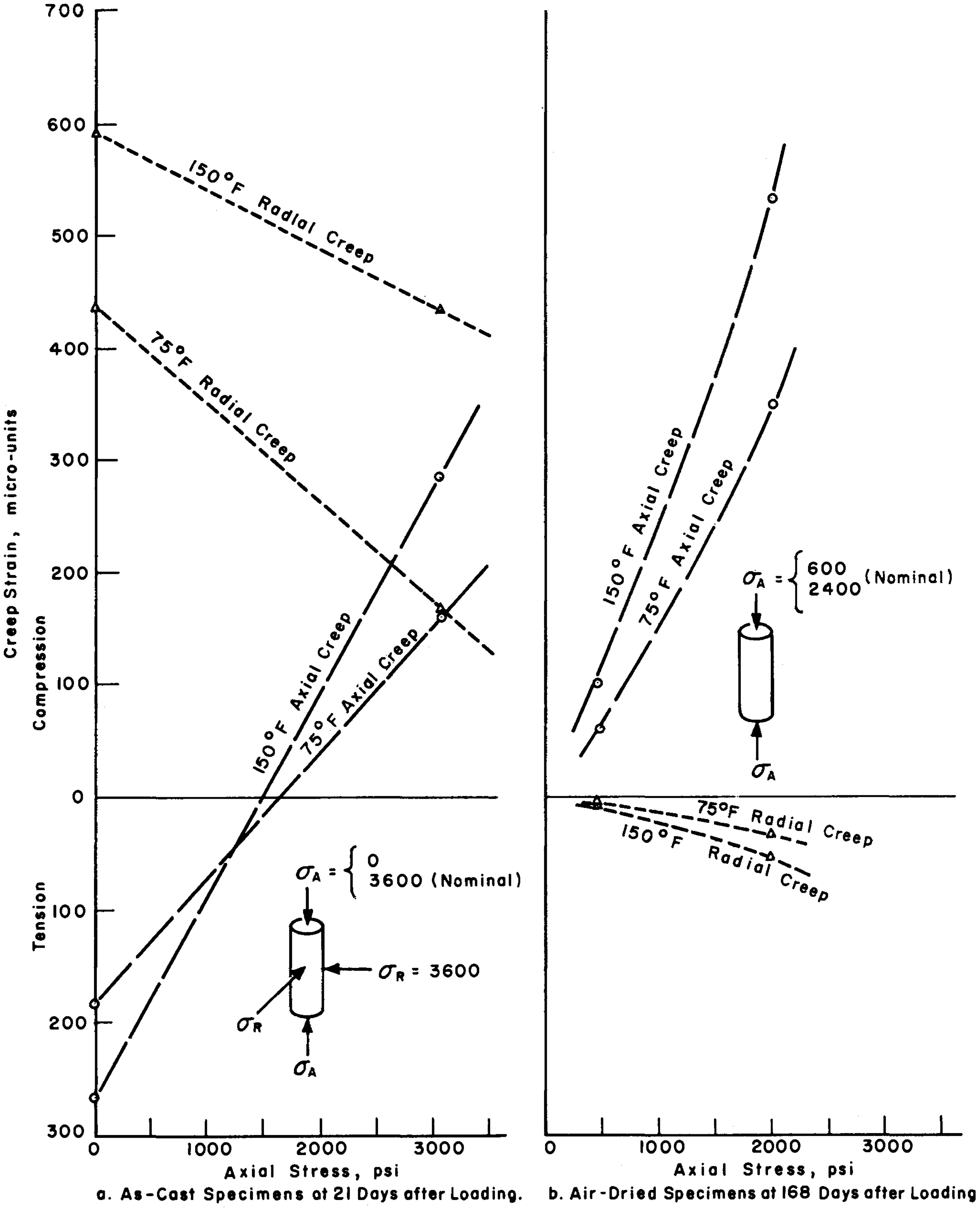


Fig 28. Effect of interaction between temperature and axial stress on axial and radial creep strain (Interaction AXD).

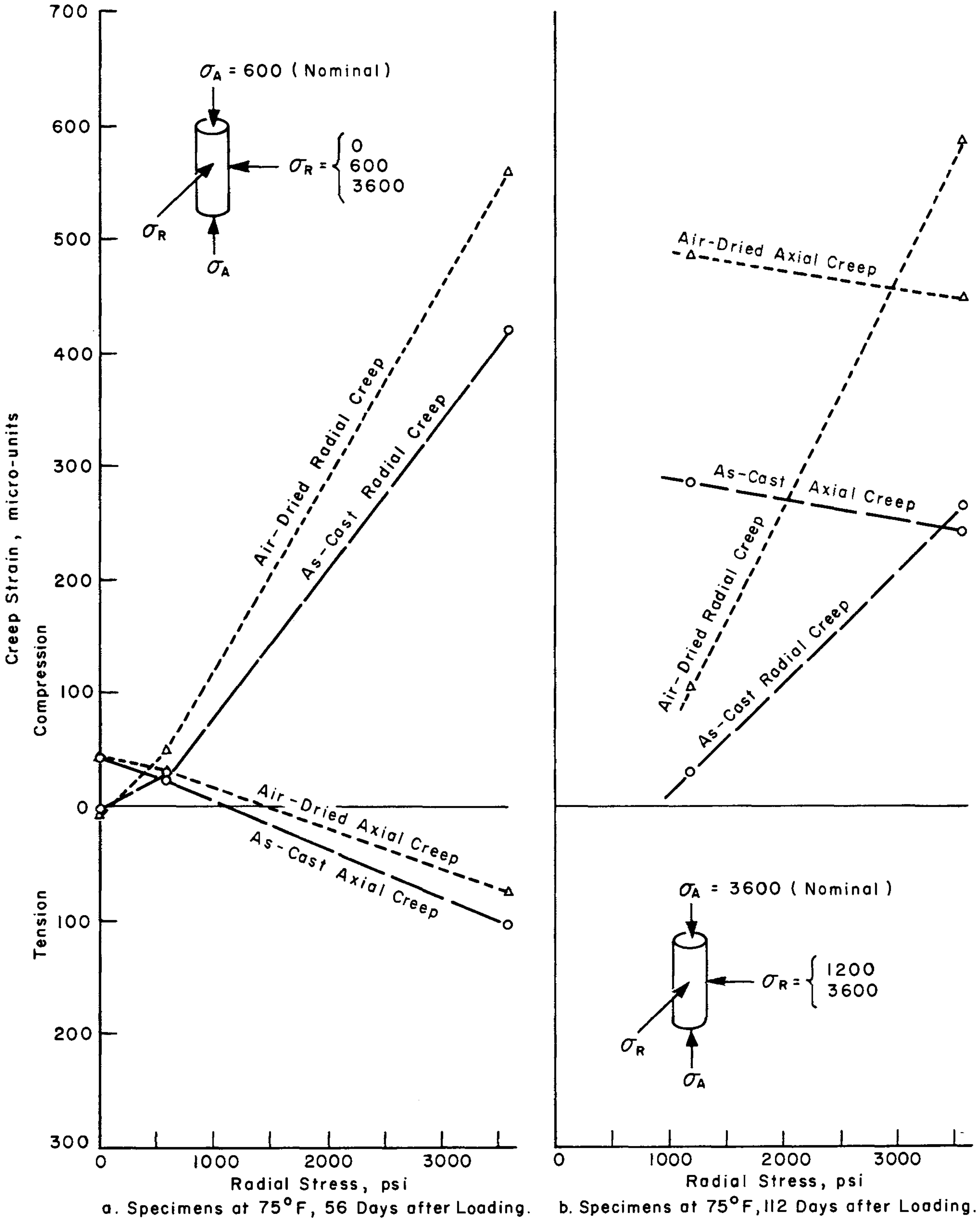


Fig 29. Effect of interaction between curing history and radial stress (Interaction B×C and B×C_q).

greater for air-dried than for as-cast specimens. If, however, the stress conditions produced less creep in a given direction with an increase in stress, then the decrease or absolute magnitude of the effect was slightly greater for as-cast specimens. The cause of this interaction is believed to be similar to that suggested for the interaction effect involving temperature and stress, since the air-dried specimens exhibited considerably less strength than the as-cast specimens (Chapter 3). This means that the air-dried specimens had a higher creep potential than the as-cast specimens, and when creep increased with increase in stress, creep strains in the more creep susceptible concrete increased at a higher rate. The nonlinear effect of stress is also shown in Fig 29a and the curvature is similar to that associated with the temperature × radial stress interaction.

It also appears that the air-dried specimens exhibited more creep strain than the as-cast specimens except when the creep strains were tensile. Thus, it appears that air-dried concrete exhibits less tensile creep strain than as-cast concrete at relatively low tensile strains. Gopalakrishnan et al (Ref 25) found from uniaxial tests at moisture conditions comparable to those used in this study that the tensile creep strains of dry concrete were lower than those of concrete specimens maintained at 98 percent relative humidity. It is believed, however, that this is not true under stress conditions that produce relatively large tensile strains at high temperatures.

Curing History × Axial Stress (Interaction B×D). This effect, also, could not be evaluated by the models; however, an interaction appeared to exist between curing history and axial stress similar to that between curing history and radial stress. This effect is illustrated in Fig 30 by specimens under two different states of stress. It can be seen that the interaction effect is very similar to the interaction involving curing history and radial stress, which was discussed above and illustrated in Fig 29.

Radial Stress × Axial Stress (Interaction C×D). The interaction effect between axial and radial stress is shown in Fig 31 for various states of stress. Figure 31a indicates that increased radial stress either caused a decrease in the axial compressive strains for high axial stresses or produced an increase in axial tensile strains when the axial stress was relatively low. In any event the effect was much greater for lower axial stress levels. Similarly (Fig 31b), an increased radial stress increased the radial compressive

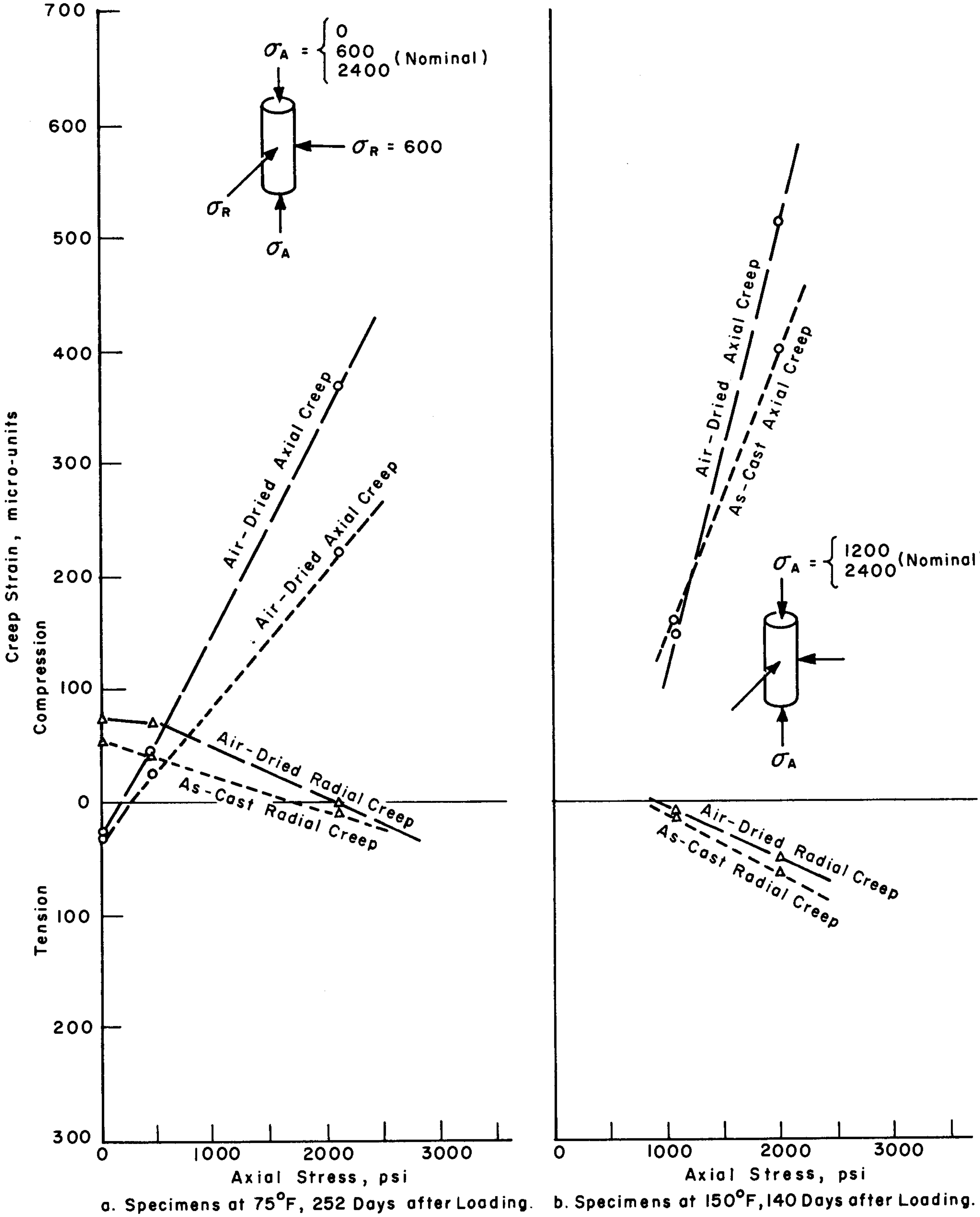


Fig 30. Effect of interaction between curing history and axial stress on axial and radial creep strain (Interaction B×D).

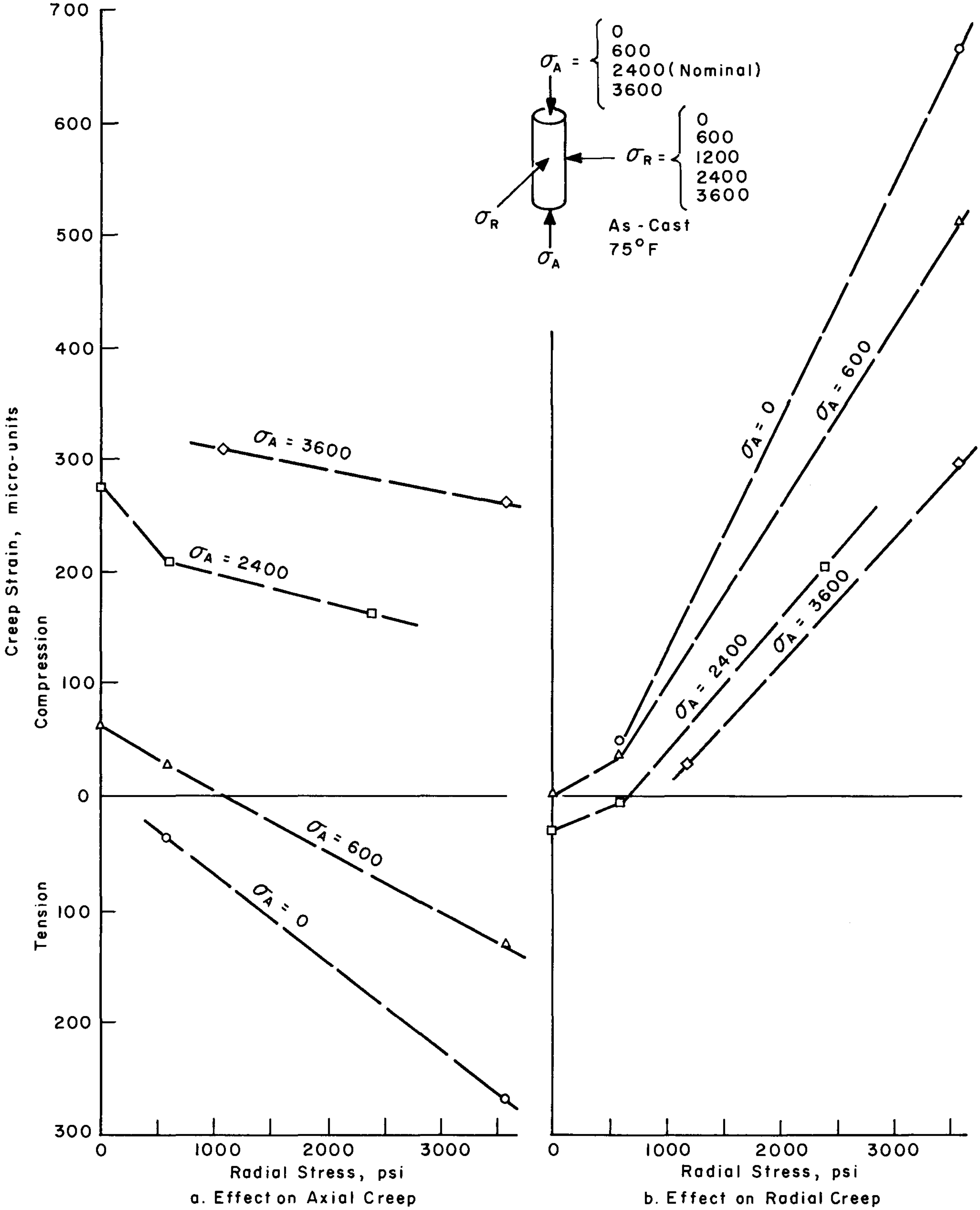


Fig 31. Effect of interaction between radial and axial stress 168 days after loading (Interaction C×D).

strains and the rate of the increase was greater at the low axial stresses. Moreover, Fig 31 indicates that increasing the confining pressure in all principle stress directions reduced the rate of increase, or decrease, in creep strain. This suggests that concrete under a hydrostatic state of stress has a greater apparent strength and a lower apparent modulus of elasticity, and, thus, less creep occurs than for a concrete under an equivalent uniaxial state of stress. In a recent experimental study on the mechanical properties of concrete under triaxial loading, Gardner (Ref 20) stated that failure strength increases with an increase in confining pressure. Since the concrete is apparently stronger under triaxial states of stress, the increase in rate of creep with increasing confining pressure is less, resulting in the interaction effect.

There also appears to be a curvilinear interaction between axial and radial stress, although the nonlinear effects could not be evaluated by the models.

Radial Stress × Time After Loading (Interaction C×E). Typical examples of this interaction effect are shown in Fig 32 for two different states of stress, moisture conditions, and temperatures. It can be seen that compressive and tensile creep strains generally increased with increased radial stress. If the increase in radial stress increased the creep strain in a given direction, then the rate of increase was greater the longer the specimens were under load. Conversely, if an increase in radial stress produced less creep strain in a given direction, then the rate of decrease in creep strain was greater the longer the specimens were under load. Generally, these effects have been recognized for some time, although not termed as interaction effects.

These curves also show curvilinear effects of both stress and time. The analysis of variance tables show that the nonlinear factors of time and stress were significant, although not as significant as the linear terms between 56 and 364 days after loading used in the models.

Axial Stress × Time After Loading (Interaction D×E). In a similar manner, there was a highly significant interaction between axial stress and time after loading (Fig 33). Here again the curvilinear effects of both time and stress were evident.

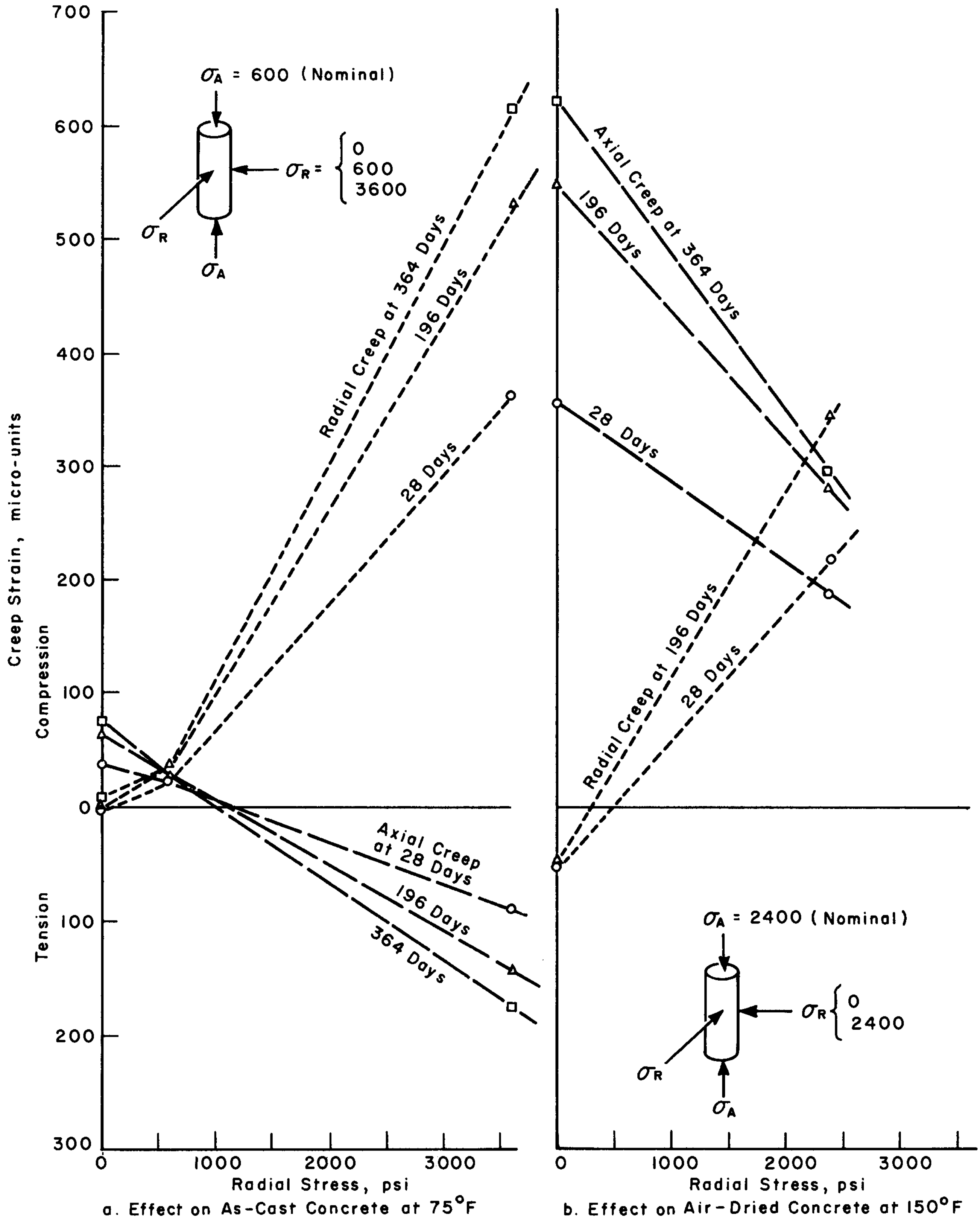


Fig 32. Effect of interaction between time after loading and radial stress on axial and radial creep strain (Interaction C×E).

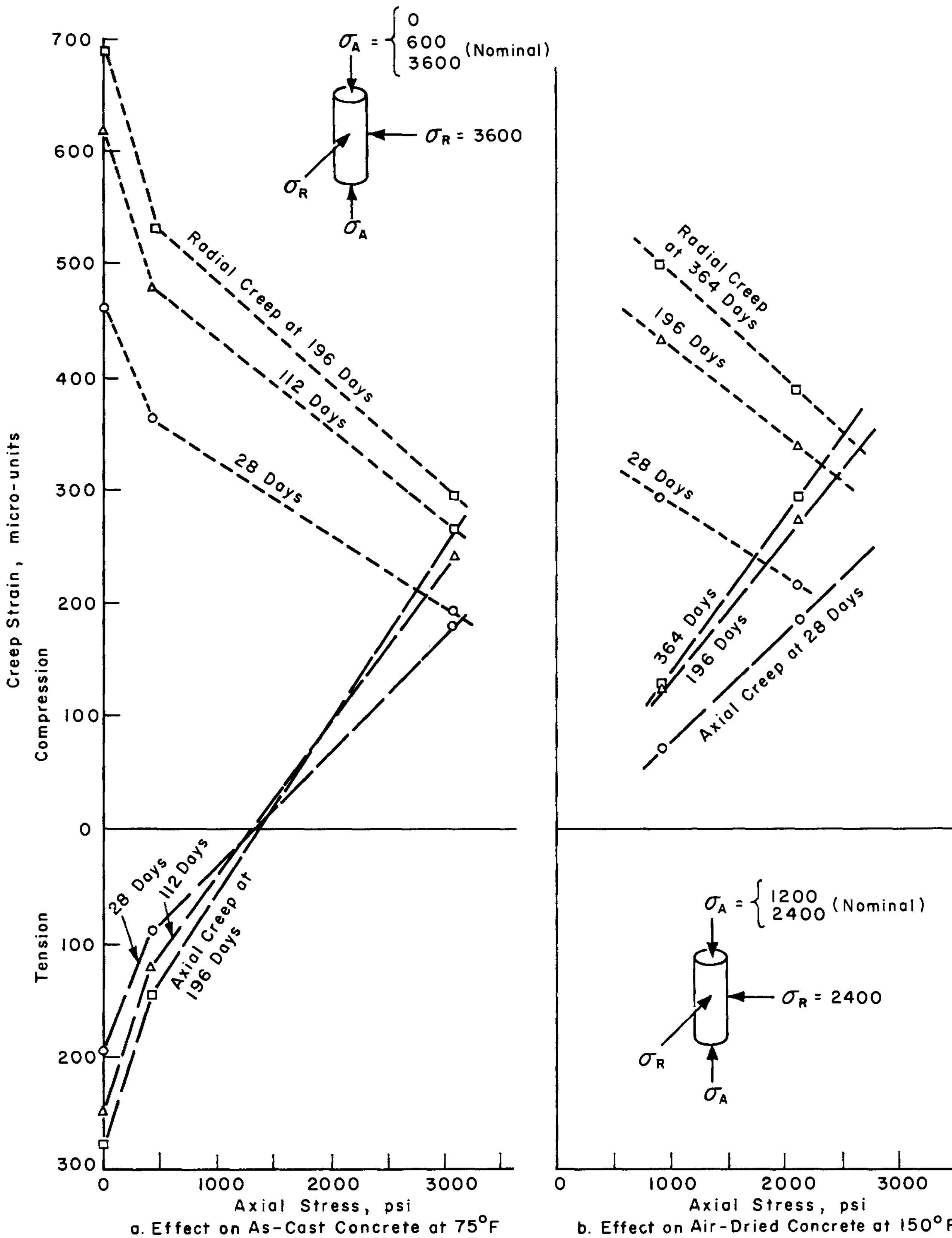


Fig 33. Effect of interaction between time after loading and axial stress on axial and radial creep strain (Interaction D×E).

Main Effects

All five main effects were found to be very highly significant, including the nonlinear terms of radial stress and time after loading. This was expected since all five main variables have been shown in the literature to affect creep. The effects produced by these factors are illustrated in Figs 34 through 50 for a variety of loading and test conditions. These figures are in effect summary illustrations of the results shown by the previous interaction curves and as such are not classical main effects.

Temperature During Loading (Factor A). The general effects of temperature on axial and radial creep strains for a variety of stress conditions are shown in Fig 34. In all cases compressive and tensile creep strains were increased by increasing the temperature from 75 to 150° F; however, the increase associated with increased temperature was greater under high stress conditions. These interactions are similar to those previously discussed and shown in Figs 27 and 28.

Curing History (Factor B). The general effects of curing history on axial and radial creep strains for a variety of stress conditions are shown in Fig 35. The air-dried specimens exhibited more compressive creep strain than the as-cast specimens for stress conditions that produced compressive creep, but for conditions which produced relatively low tensile creep strains the air-dried specimens exhibited less tensile creep strain than the as-cast specimens. It should be noted that the increase in strain associated with air-drying was larger for higher stress conditions.

Radial Stress (Factors C and C_q). Figure 36 shows the general effects of radial stress on axial and radial creep strains for a variety of axial stresses. For high axial stresses, the effect was to reduce axial creep strain and to change radial creep strain from a state of tension to a greatly increased rate of compression. For low axial stresses, increasing radial stress changed axial creep strain from a state of compression to an increasing tension and changed radial creep strain from tension to increasing compression. Of considerable importance is the apparent curvilinear relationship between stress and creep strain, particularly for multiaxial states of stress. It is believed that the direction of curvature changes as the creep strain changes from tension to compression.

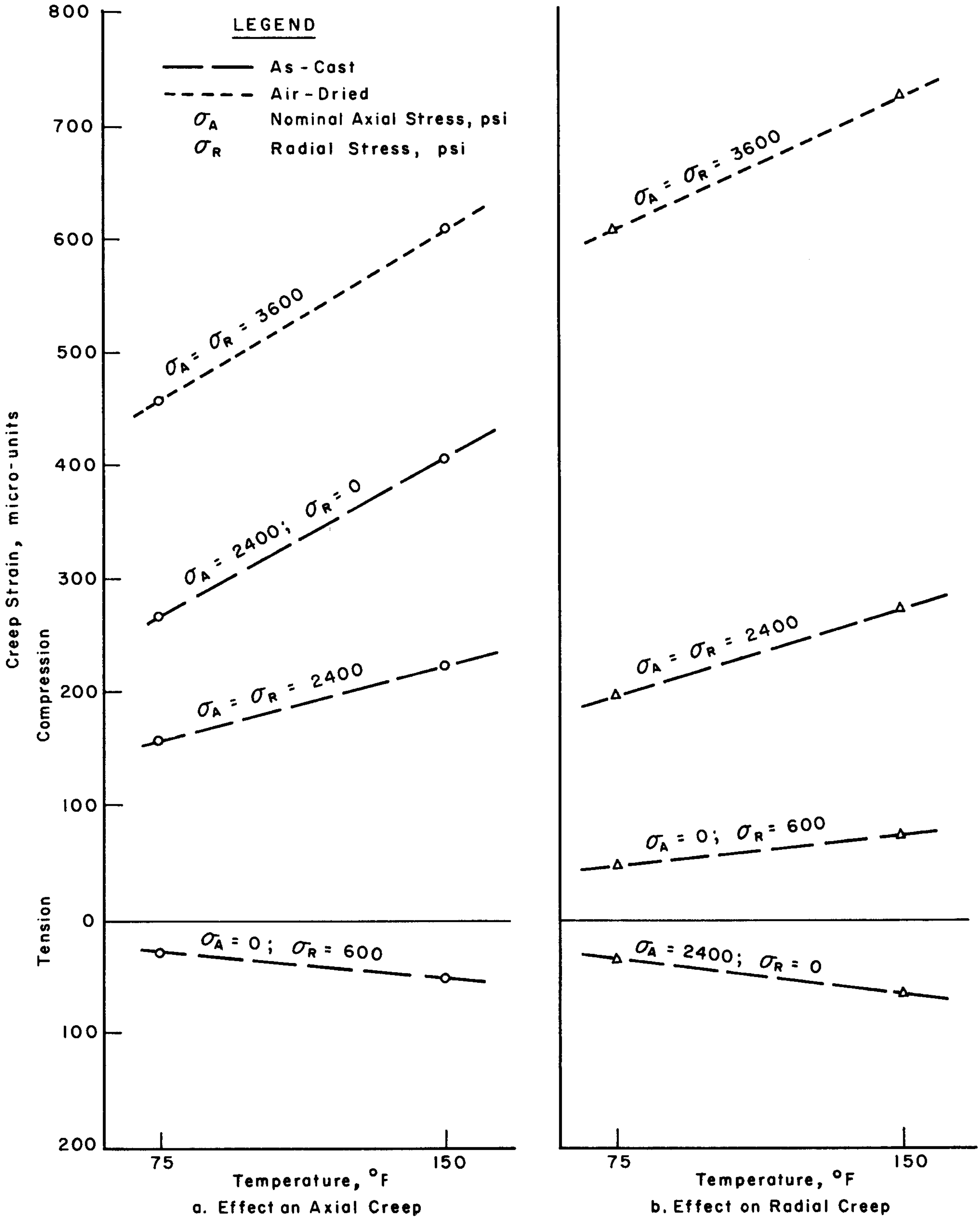


Fig 34. Effect of temperature on axial and radial creep strain 140 days after loading for a variety of stress conditions.

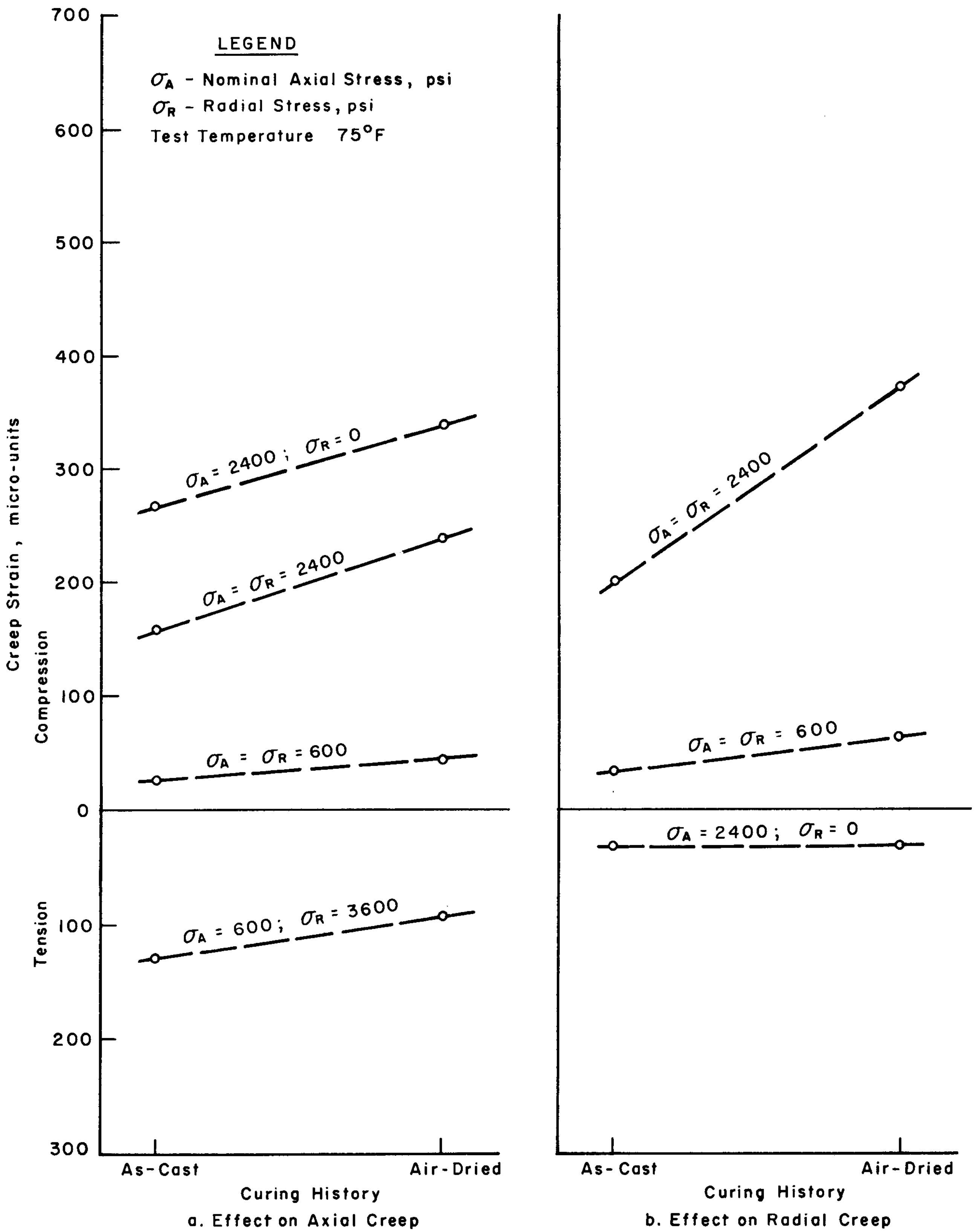


Fig 35. Effect of curing history on axial and radial creep strain 140 days after loading for a variety of stress conditions.

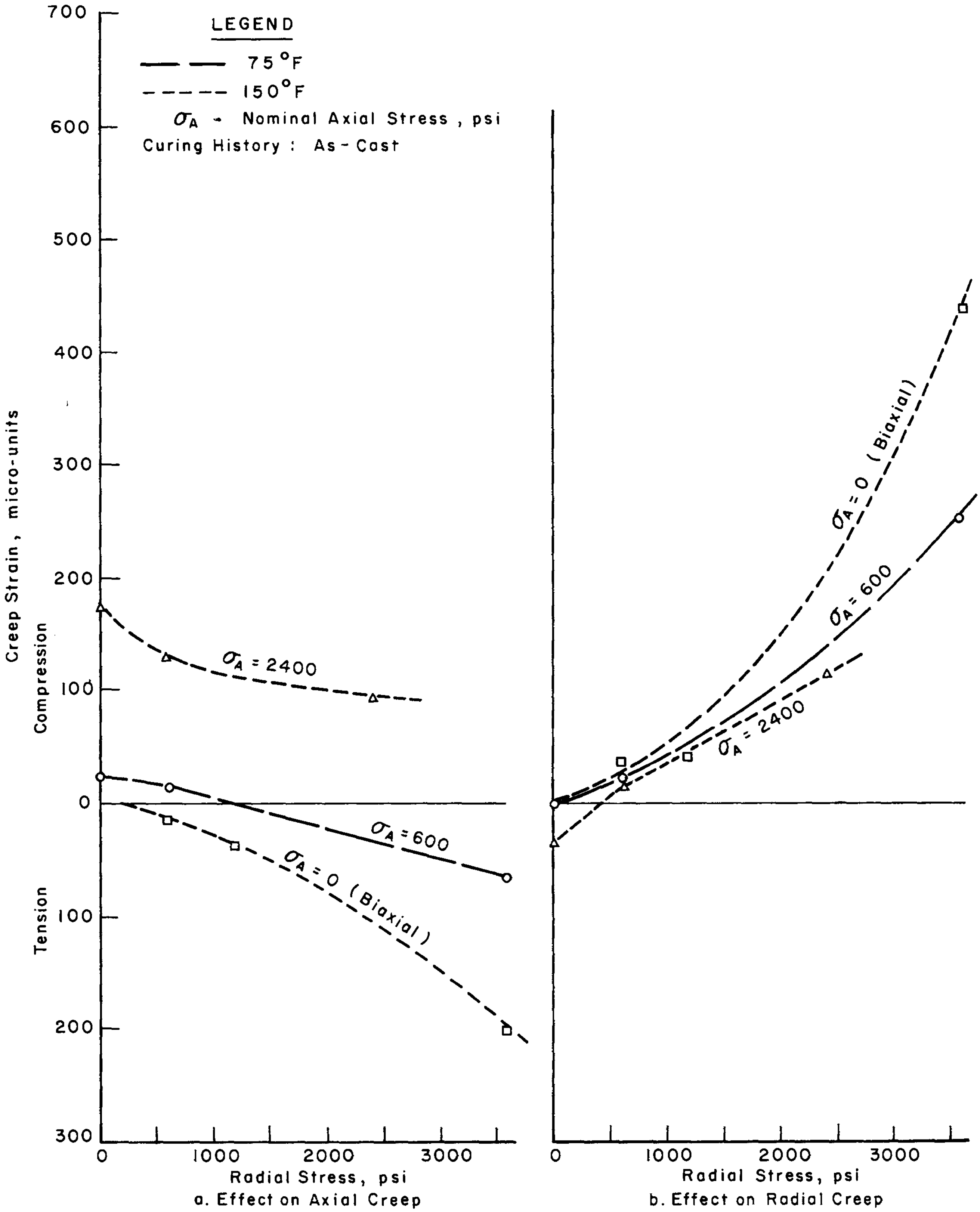


Fig 36. Effect of radial stress on axial and radial creep strain 21 days after loading for a variety of stress conditions.

Axial Stress (Factors D and D_q). The general effects of varying axial stress on axial and radial creep strains for a variety of radial stresses are shown in Fig 37. The observations associated with axial stress are similar in nature to those indicated for radial stress. It should be noted, however, that there was not as much curvature associated with the uniaxial states of stress as with the triaxial.

Time After Loading (Factors E and E_q). Typical time versus creep strain relationships are shown in Figs 38 through 50, arranged to illustrate the effects of time after loading with each of the main variables for a variety of loading conditions. As expected, compressive and tensile creep strains increased with time after loading and at a decreasing rate, and, also, the greater the initial elastic strain in a given direction was, the larger the total creep strain and creep rate.

Time-creep strain curves illustrating the influence of temperature during loading and time on axial and radial creep strains are shown in Figs 38 and 39, respectively, and the influence of curing history in Figs 40 and 41, respectively. These figures indicate that creep strains for the curing histories and temperatures used in this experiment were generally unaffected by time at the later ages after loading, which means that there were no significant interactions between time and temperature during loading or between time and curing history.

Time-creep strain relationships demonstrating the time effects of varying radial stress on axial and radial creep strains for both a high and a low axial stress are shown in Figs 42 through 45. Curves exemplifying the time effect of varying axial stress on creep strain for a high and low radial stress are shown in Figs 46 through 49. As seen in these figures, increasing the stress at right angles to an applied uniaxial or biaxial stress field reduced the creep strain in the direction of these applied stresses while increasing the compressive creep strain in the direction of the increasing stress field. It is obvious that considerable creep strain occurred under hydrostatic states of stress and was still continuing after one year under load. Similar observations were recently reported by Hannant (Ref 27) and Gopalakrishnan et al (Ref 24)

In addition and for the sake of comparison, the time-creep strain relationships depicting the time effects on creep of varying axial stress for

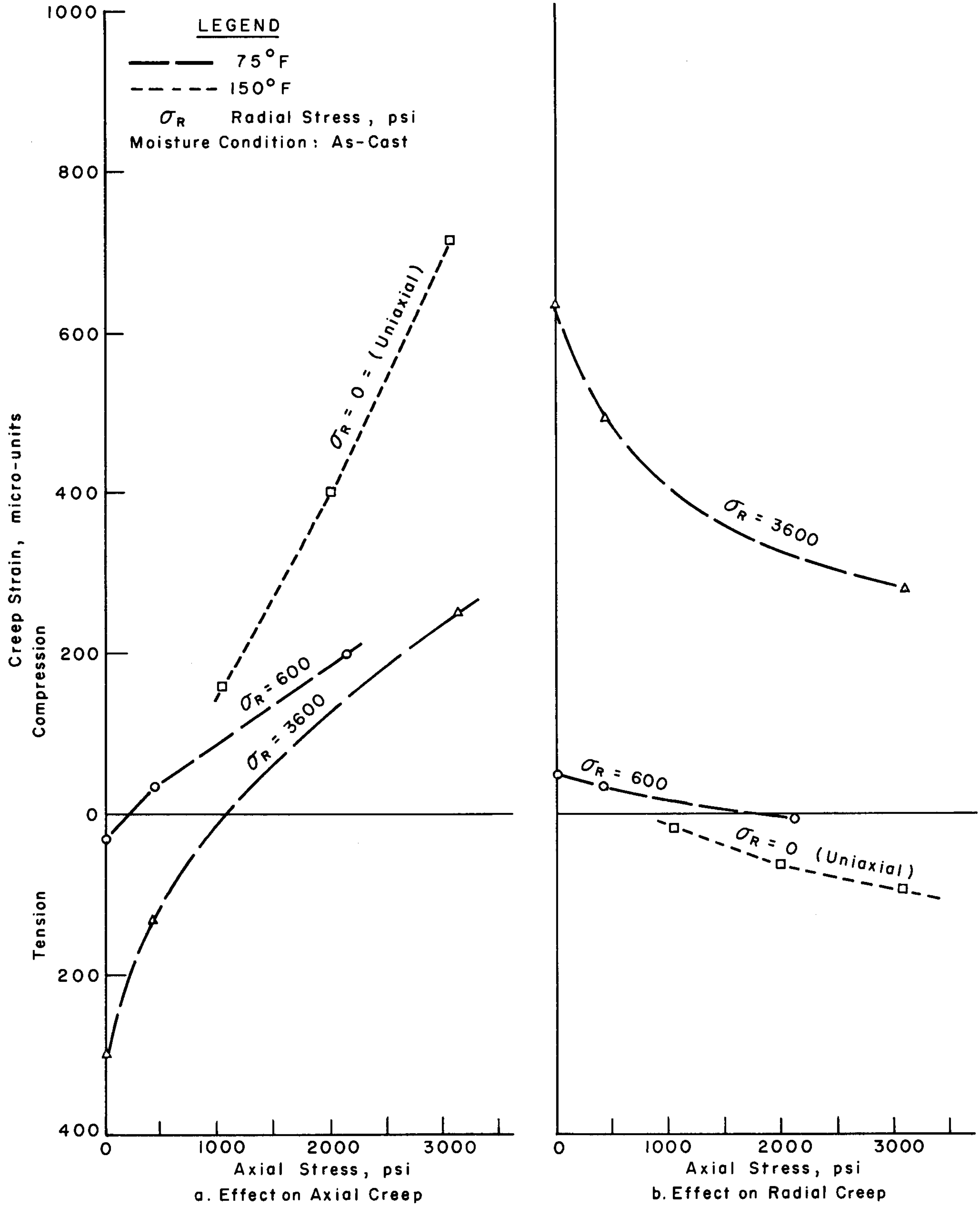


Fig 37. Effect of axial stress on axial and radial creep strain 140 days after loading for a variety of stress conditions.

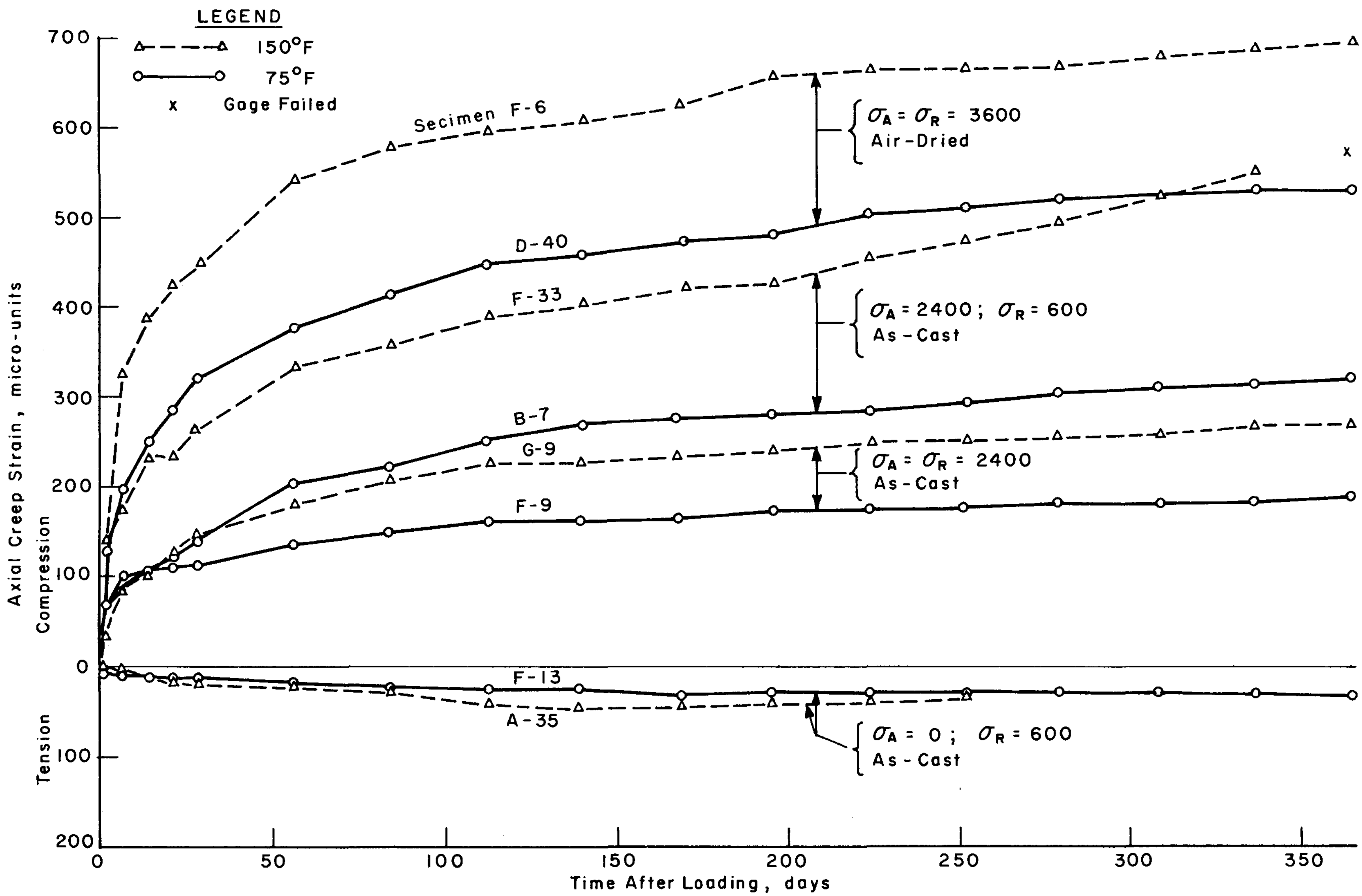


Fig 38. Effect of time after loading and temperature on axial creep strain for a variety of stress conditions.

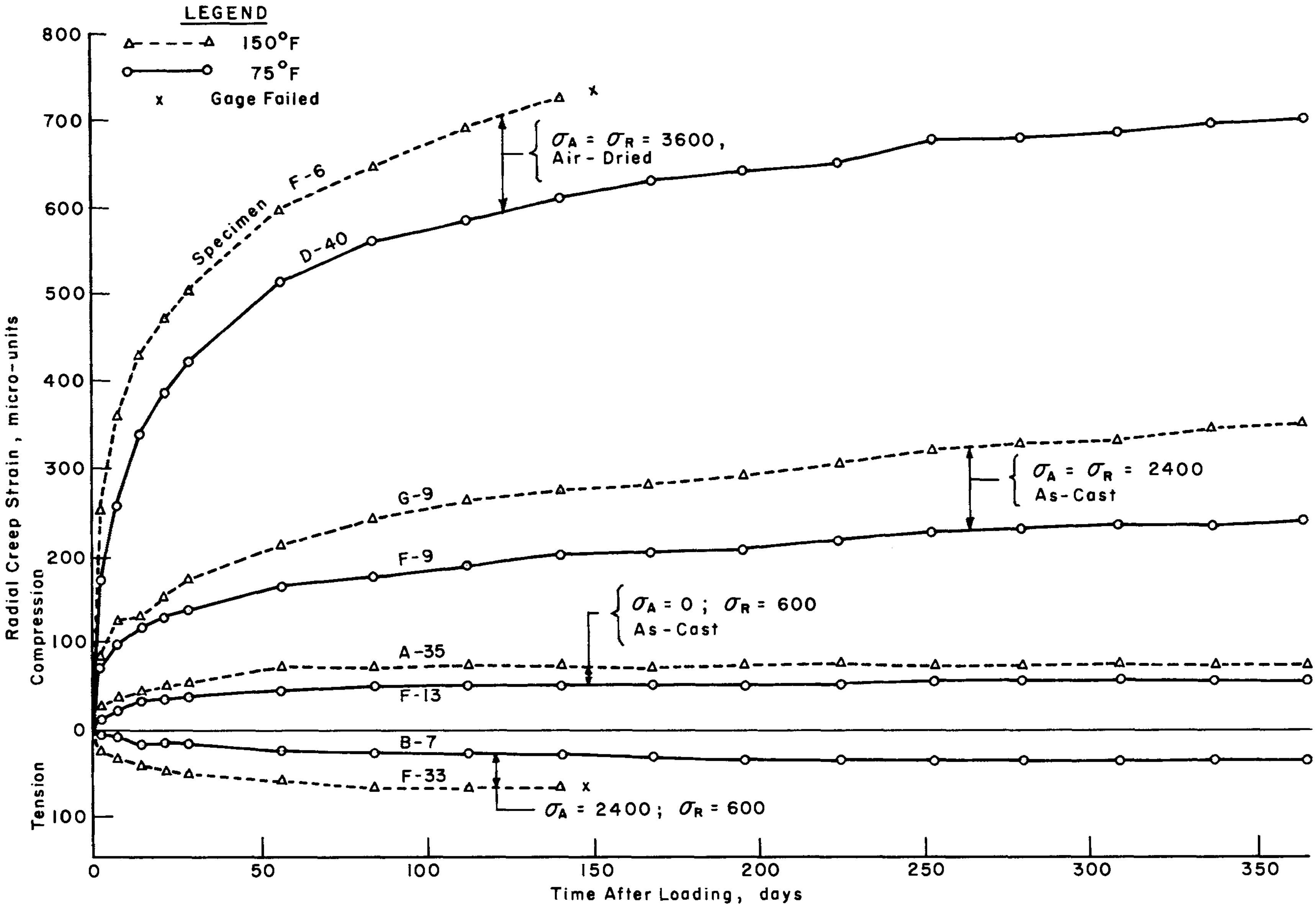


Fig 39. Effect of time after loading and temperature on radial creep strain for a variety of stress conditions.

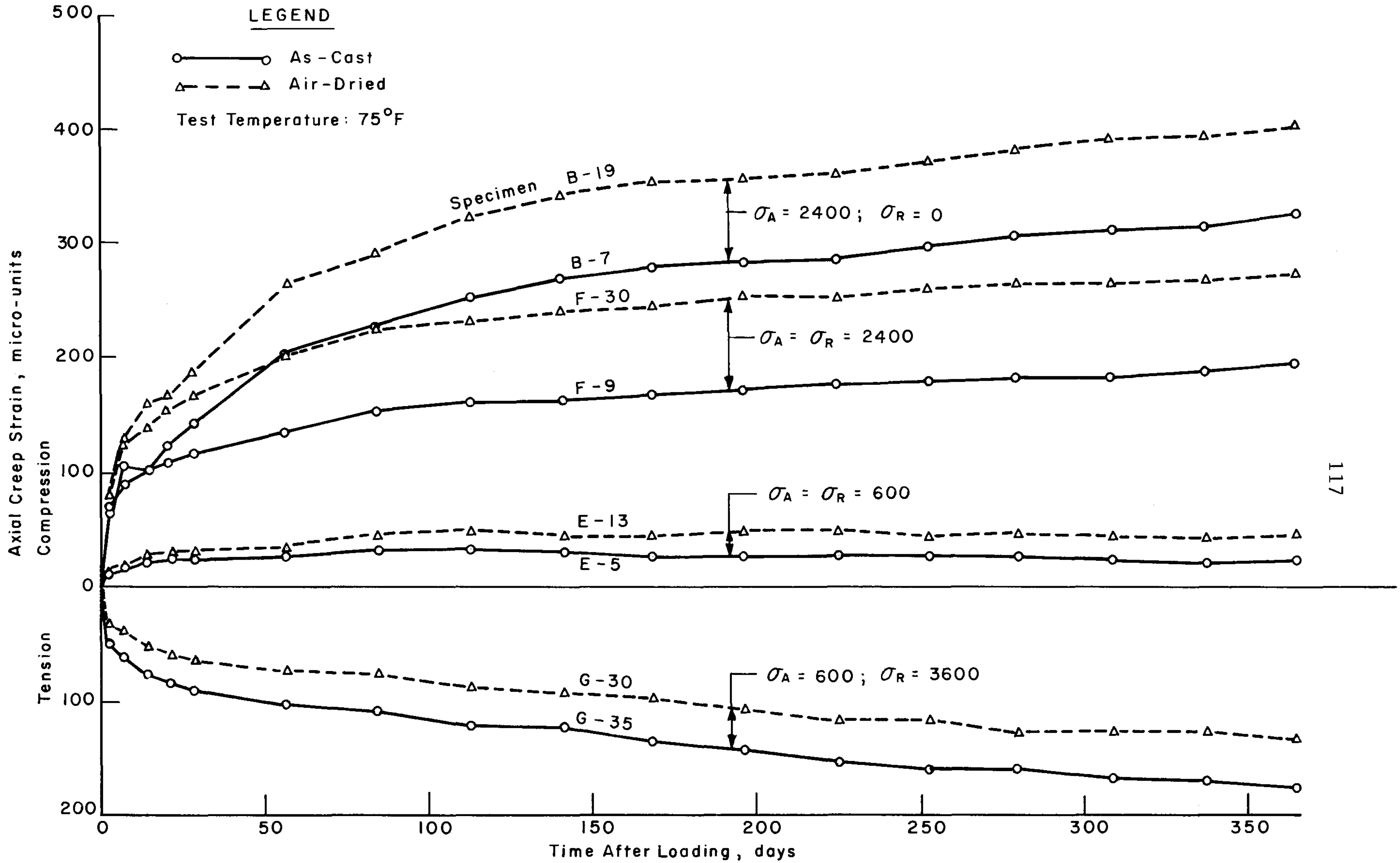


Fig 40. Effect of time after loading and curing history on axial creep strain for a variety of stress conditions.

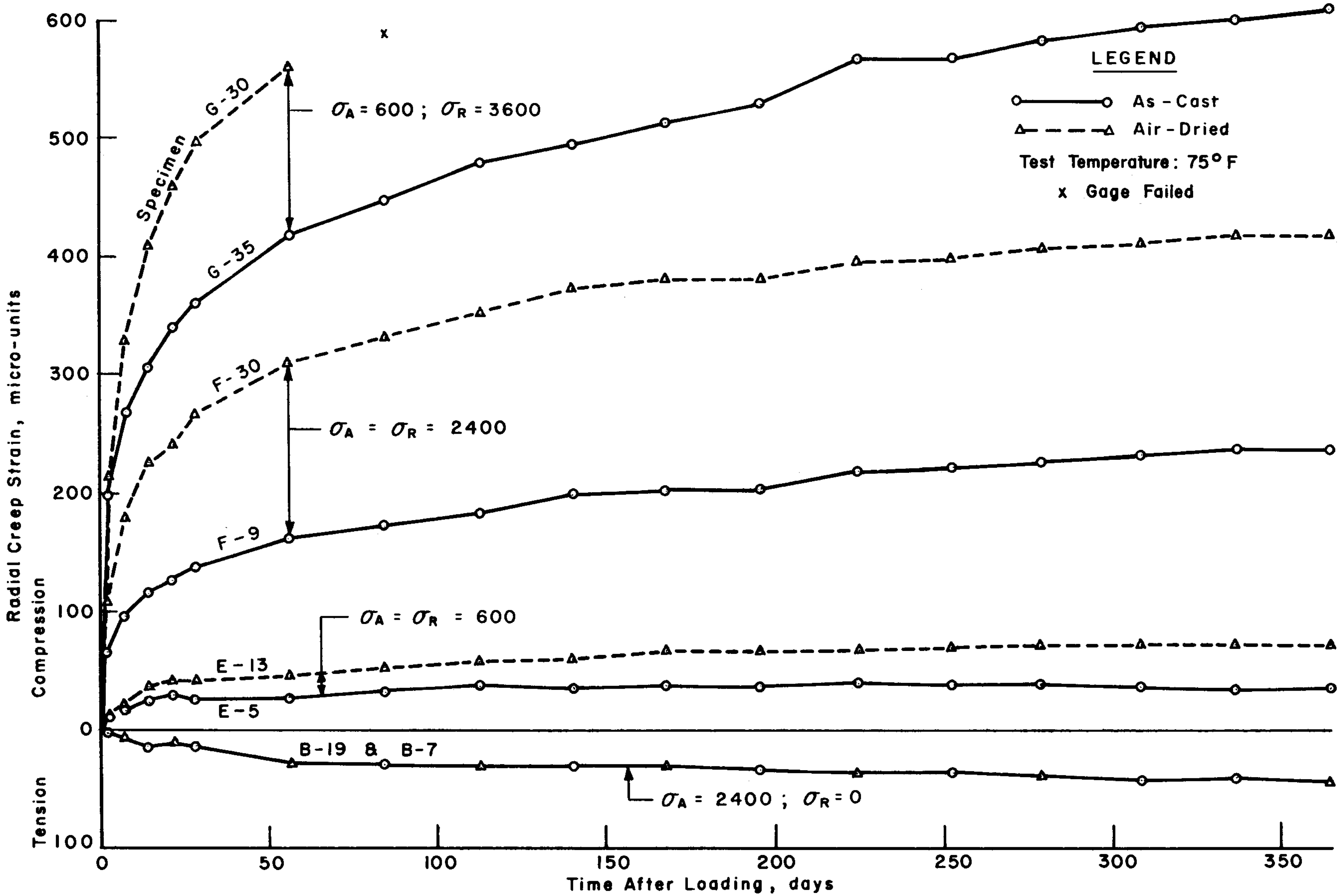


Fig 41. Effect of time after loading and curing history on radial creep strain for a variety of stress conditions.

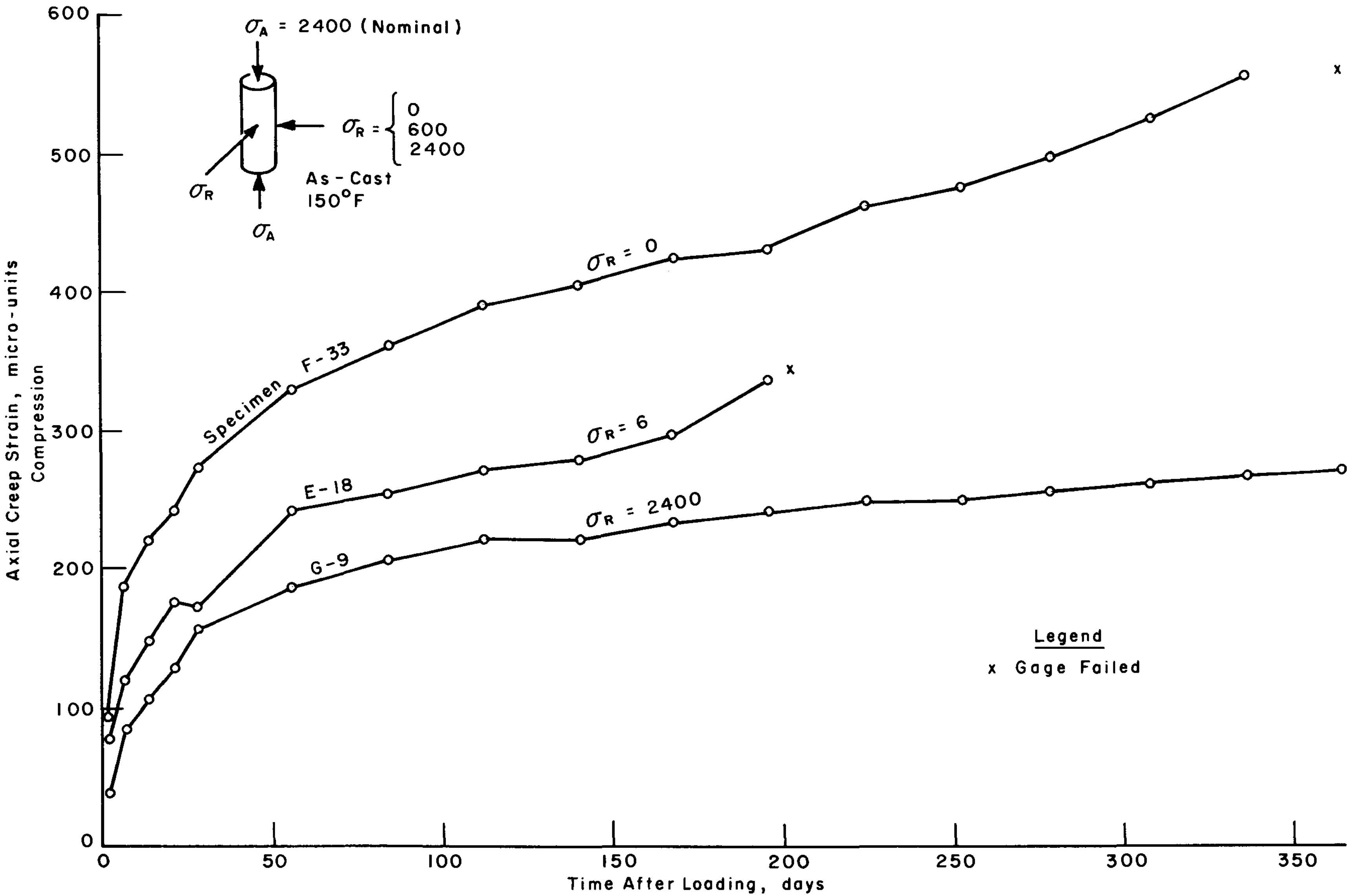


Fig 42. Effect of time after loading and radial stress on axial creep strain for a high axial stress.

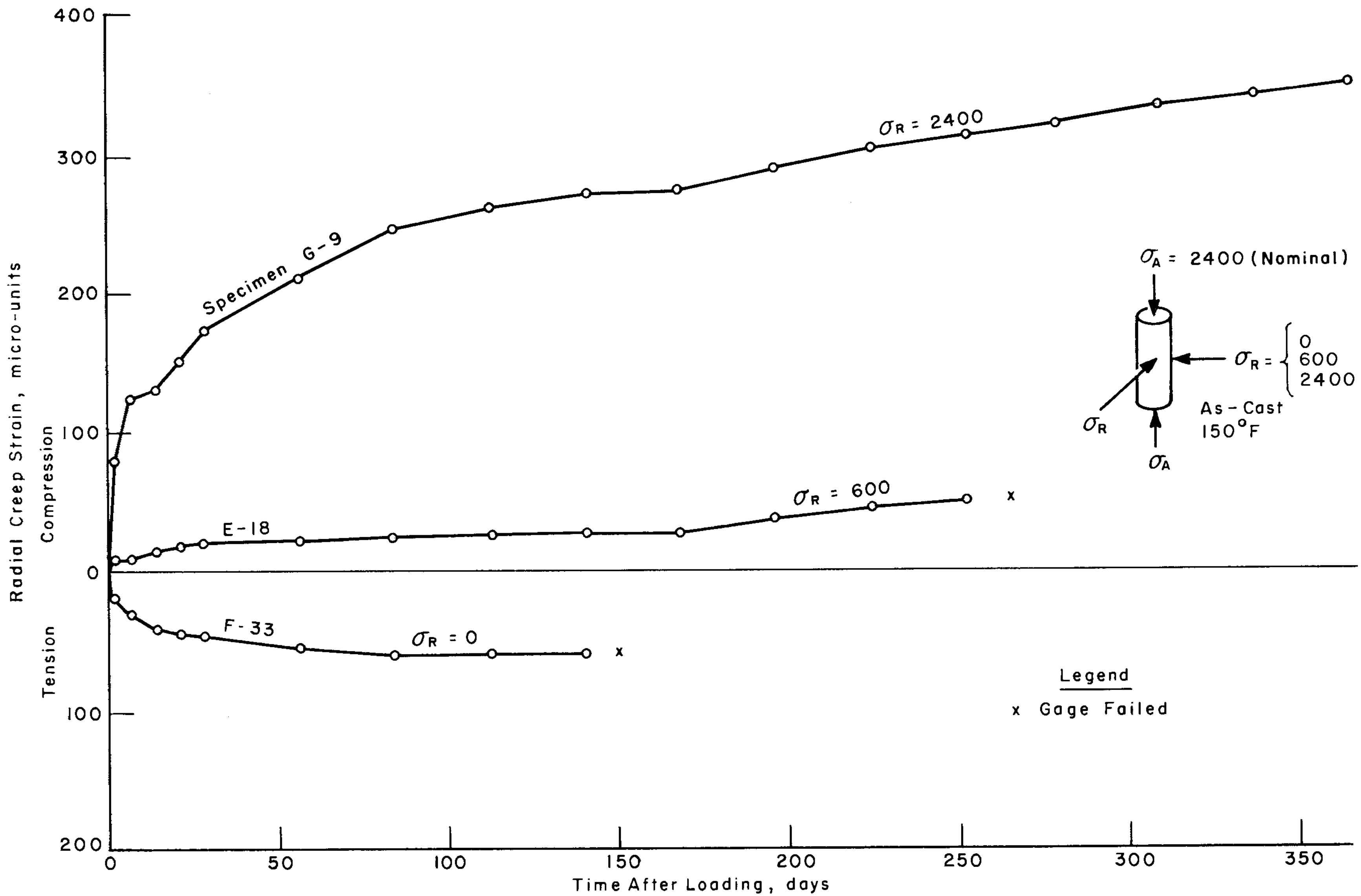


Fig 43. Effect of time after loading and radial stress on radial creep strain for a high axial stress.

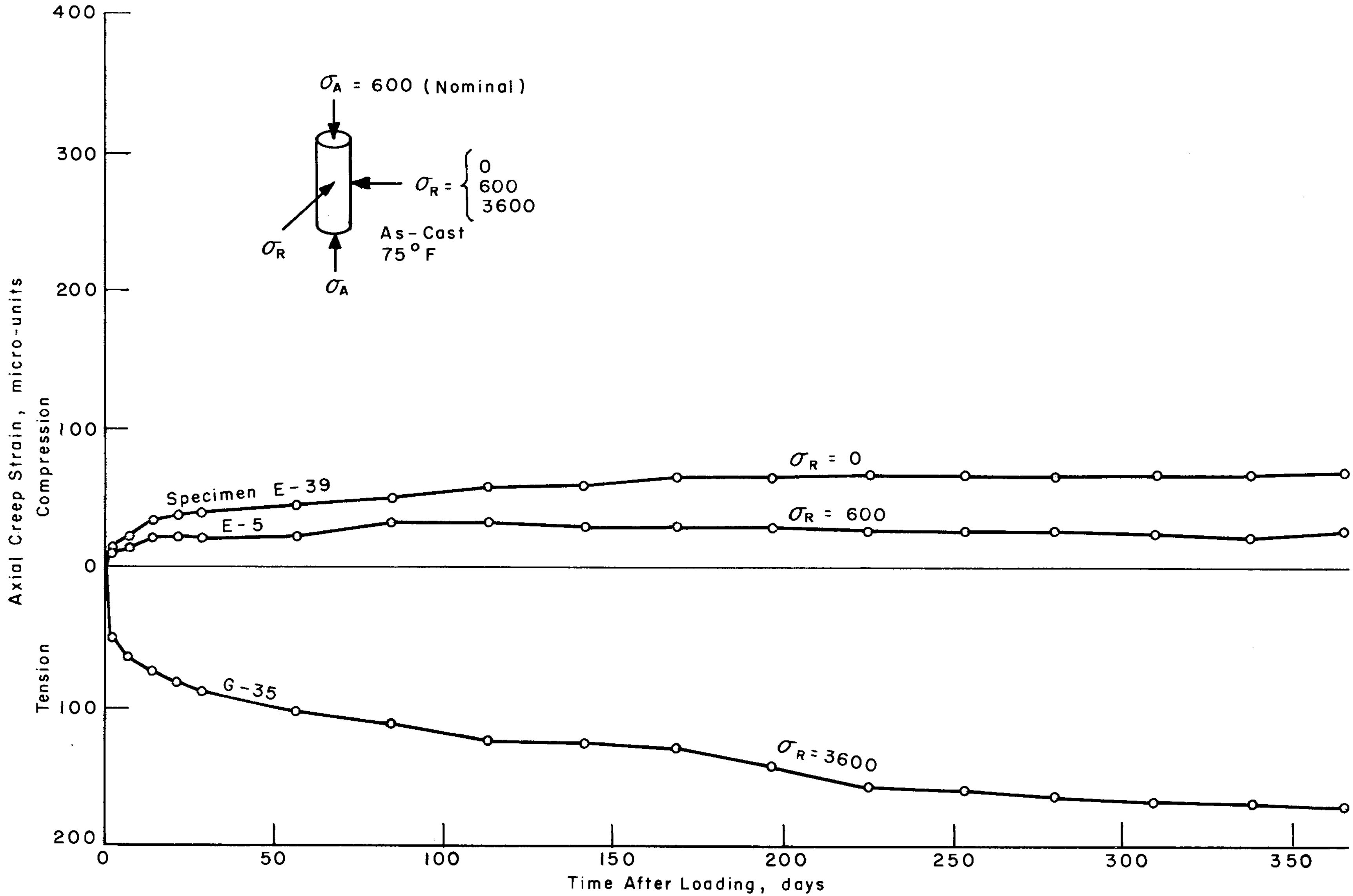


Fig 44. Effect of time after loading and radial stress on axial creep strain for a low axial stress.

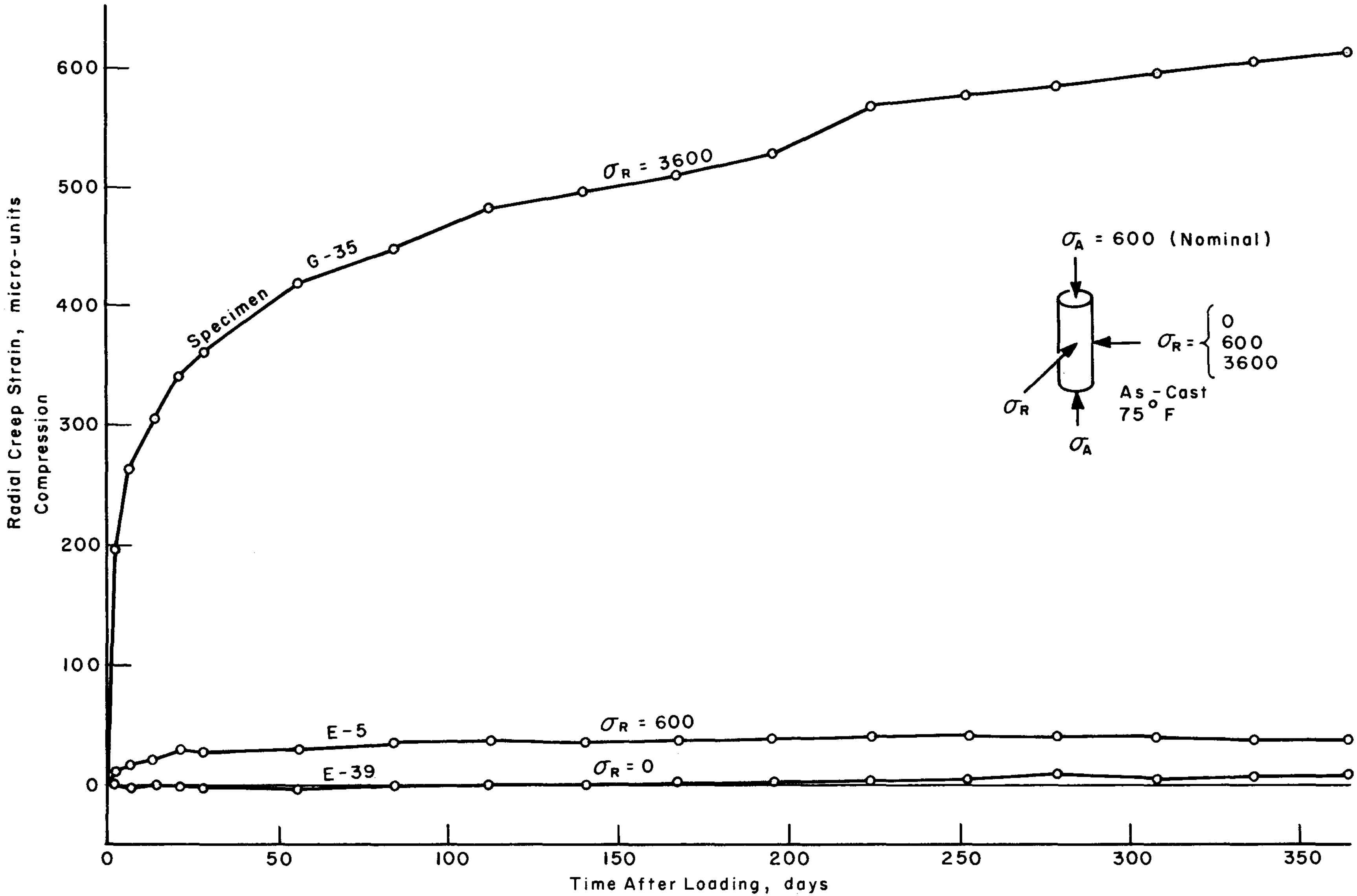


Fig 45. Effect of time after loading and radial stress on radial creep strain for a low axial stress.

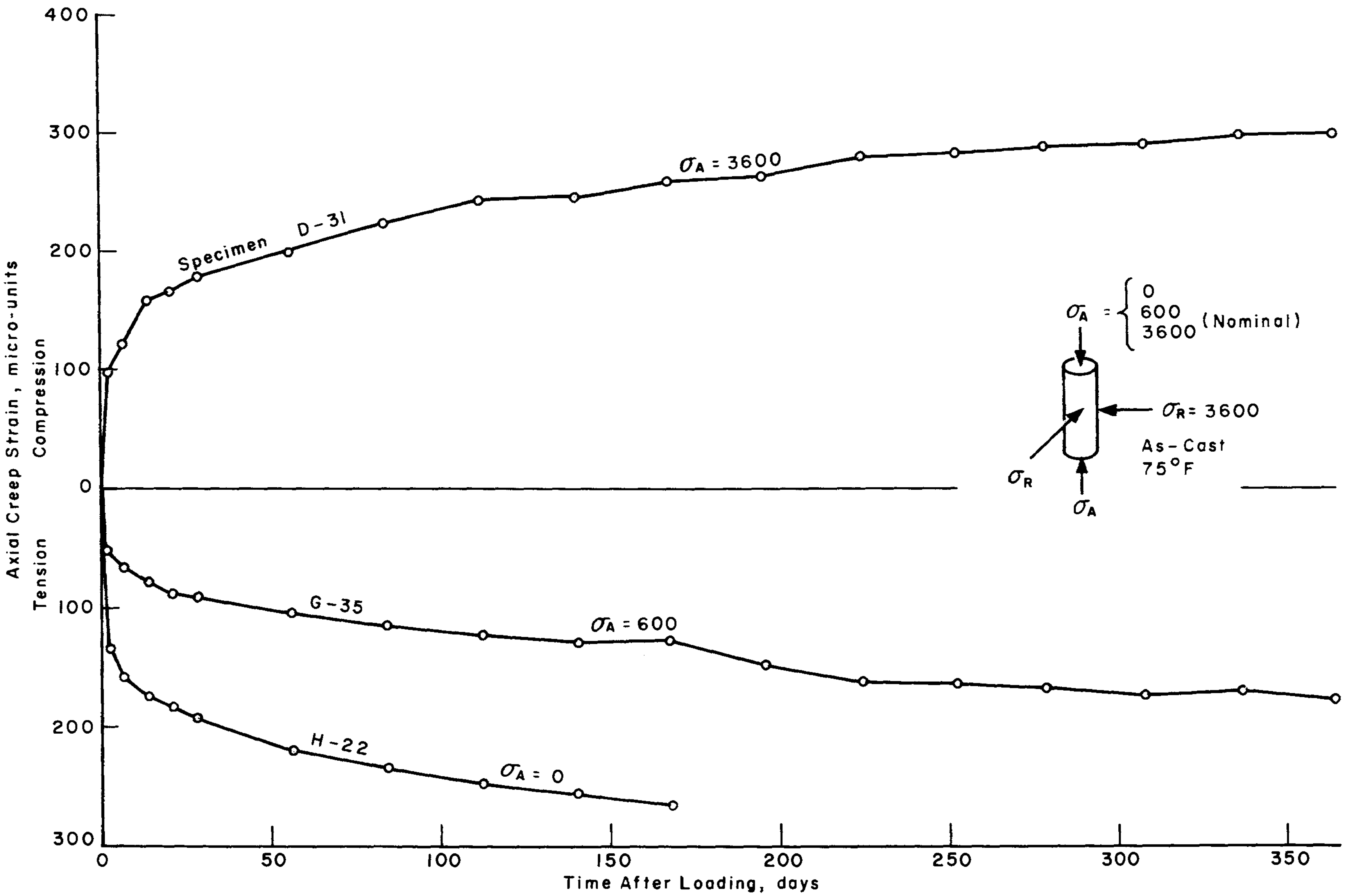


Fig 46. Effect of time after loading and axial stress on axial creep strain for a high radial stress.

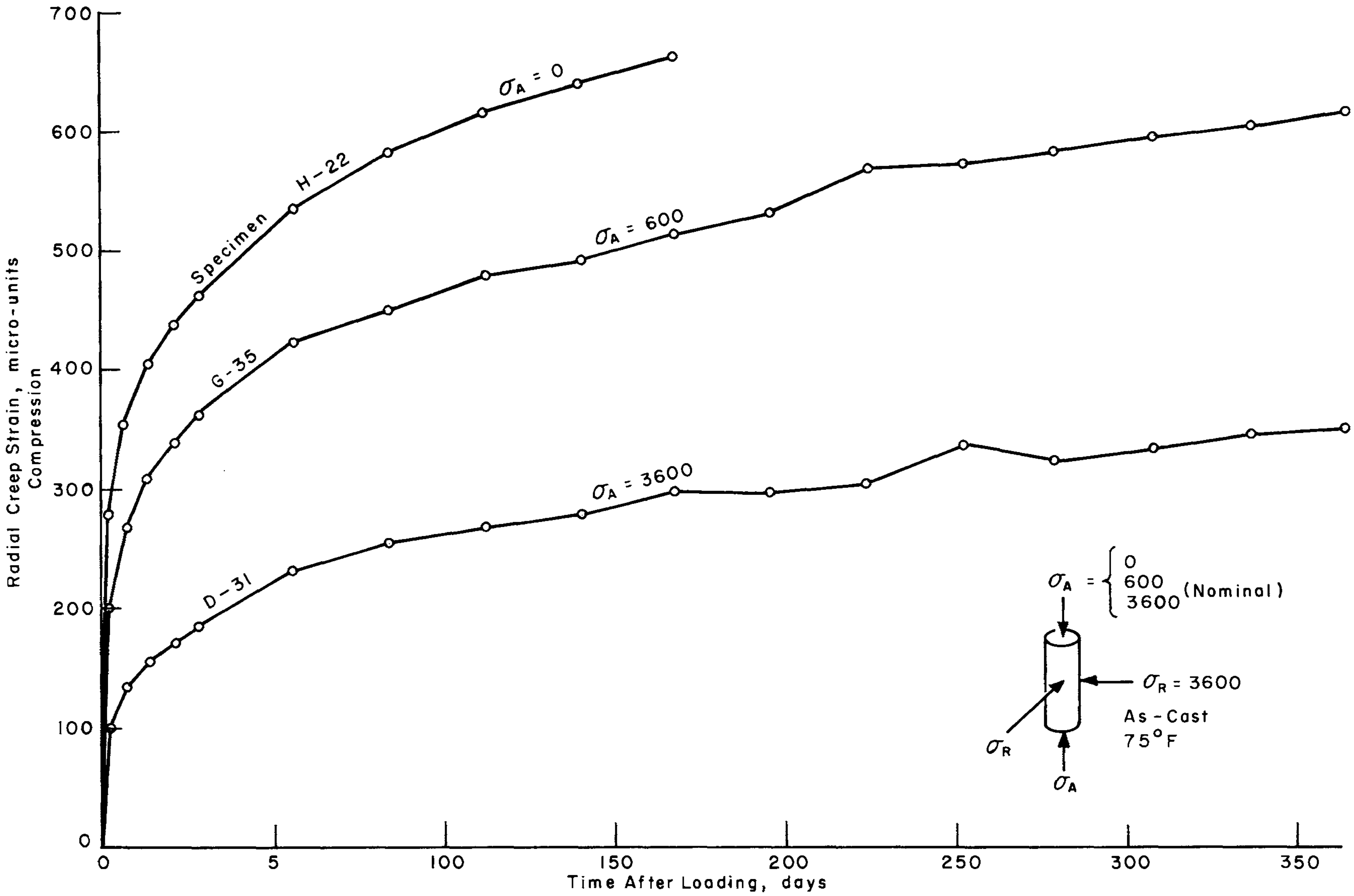


Fig 47. Effect of time after loading and axial stress on radial creep strain for a high radial stress.

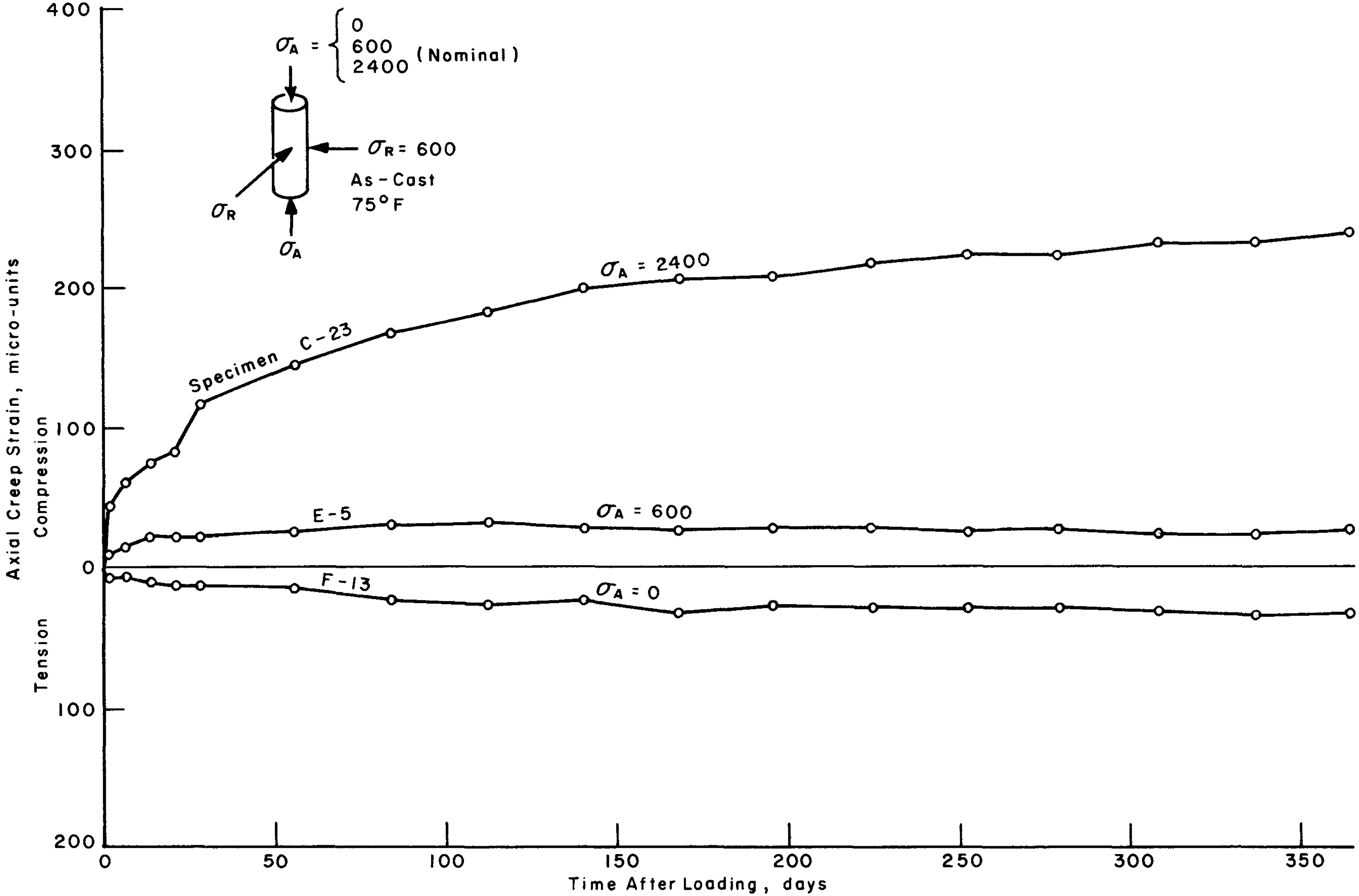


Fig 48. Effect of time after loading and axial stress on axial creep strain for a low radial stress.

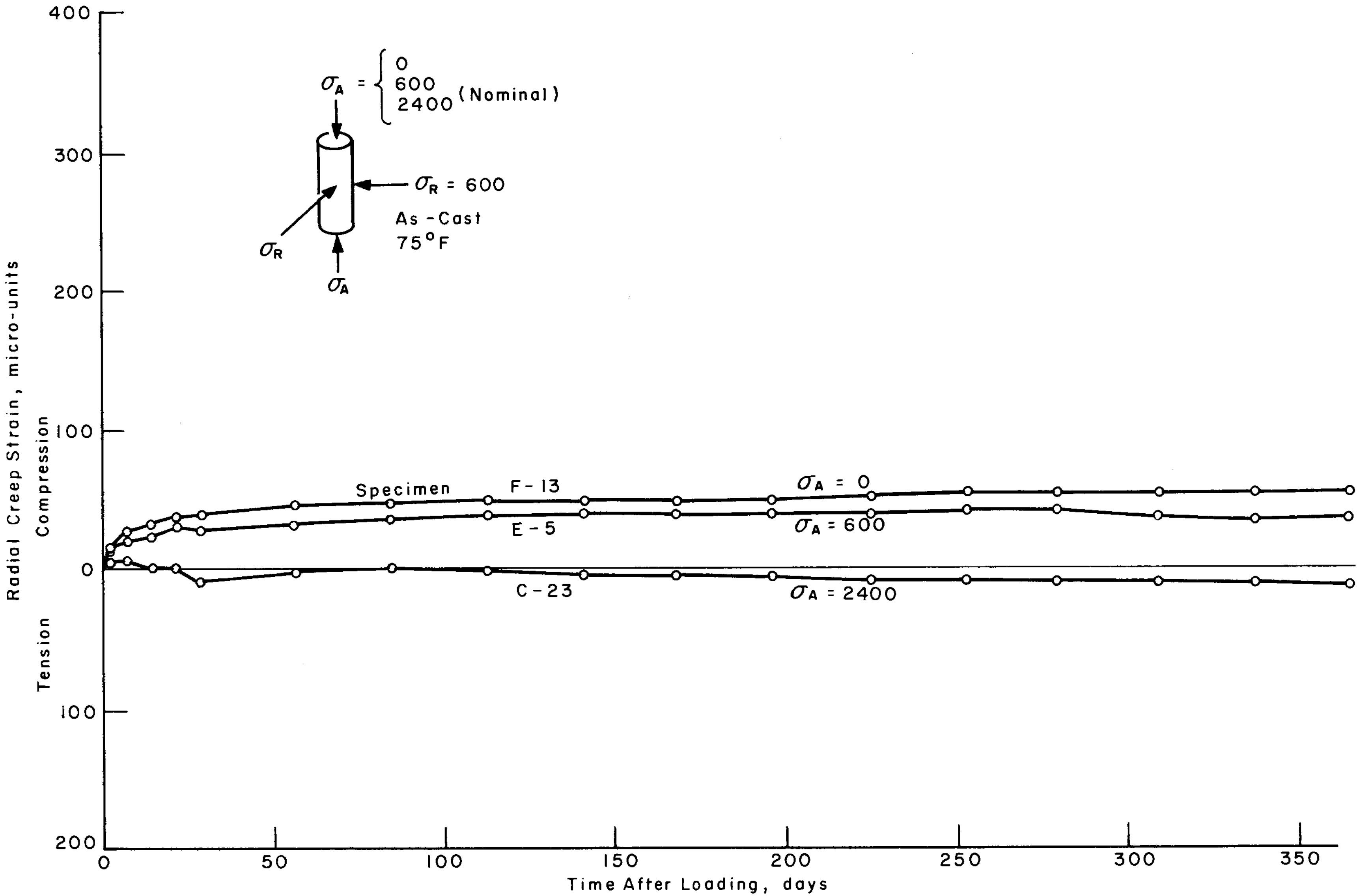


Fig 49. Effect of time after loading and axial stress on radial creep strain under a low radial stress.

uniaxial states of stress are shown in Fig 50. The comparison again indicates that a greater degree of nonlinearity exists between stress and creep strain for triaxial than for uniaxial states of stress.

Summary Evaluation

This report was designed to investigate the effects produced by all five factors and their interactions; however, it was not necessarily intended to explain their causes or advance another theory on creep mechanisms. Nevertheless, it is desirable where practical to advance a logical explanation or to hypothesize concerning the cause of the observed behavior.

From the analyses of variance and a review of the previous discussion and illustrations, it is obvious that the applied stress, particularly radial stress, was by far the most important factor affecting creep within the range of this experiment. Stress was not only highly significant in itself, it also produced highly significant interactions with each of the other factors investigated. This is not surprising since creep strain is usually considered to be proportional to stress at the lower stress levels and is nonlinear at higher stresses, resulting in progressively larger creep strains as stress increases. Radial stress was generally more significant than axial stress since it involved two, rather than one, principal stresses. In addition, larger creep strains generally occurred in specimens which exhibited large initial elastic strains.

All of the five main factors investigated very significantly affected creep. It was shown that compressive and tensile creep strains were generally larger for

(1) a test temperature of 150° F than for 75° F,

(2) an air-dried concrete than an as-cast concrete (except in the case of low tensile creep where the reverse was true),

(3) increased time after loading, and

(4) higher stresses for uniaxial and biaxial states of stress.

For triaxial states of stress, creep strain increased or decreased depending on the magnitude of the changing stress and the stress direction. For a high constant stress in the axial direction, increasing the stress from zero in the radial direction decreased the compressive creep strain in the axial direction and changed the creep strain from tension to increasing compression in the radial direction. Likewise, for a high constant stress in the

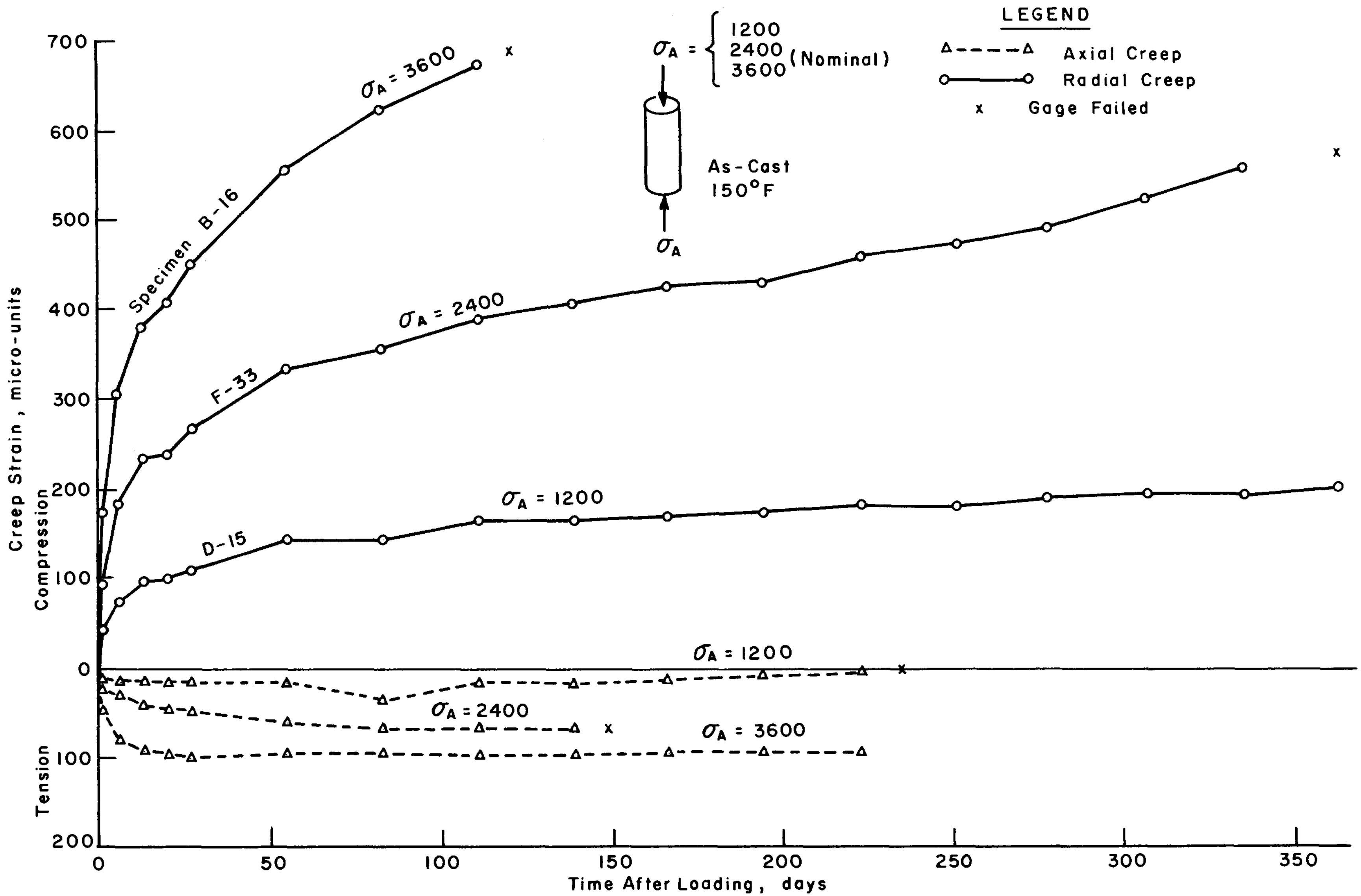


Fig 50. Effect of time after loading and uniaxial stress on axial and radial creep strains.

radial direction, increasing axial stress reduced the radial compressive creep strain and changed axial creep strain from tension to compression. When the constant stress in the above cases was relatively low, an increase in stress in the direction perpendicular to the constant stress changed the creep strain in the direction of the constant stress from compression to tension and in the direction of the changing stress from tension to increasing compression. Thus, a definite creep Poisson's effect was evident.

The effects of the major interactions indicated generally that increasing the level of stress increased the creep strains but that the increase was larger for specimens at the higher temperature relative to the lower temperature and for the air-dried specimens relative to the as-cast specimens, except for specimens exhibiting small tensile creep strains. In addition, the increase was larger after longer periods under load. Increasing the confining pressure, however, tended to reduce the overall creep strains. In all but the time-stress interaction case, it can be reasoned that the interactions were related to the effective strength of the concrete during loading since concretes with a low effective strength generally exhibit larger creep strains under a given stress. High temperatures during loading and air-dried curing tended to reduce effective strength, while confining concrete tended to increase its effective strength. The interaction with time, on the other hand, is more complicated and will not be discussed in this report.

PREDICTION EQUATIONS

The complexity of the creep behavior of concrete, as evidenced by the large number of interactions found to significantly affect creep strain, makes it extremely difficult to estimate the creep behavior of concrete except in terms of regression equations. Thus, in order to be able to predict quantitatively creep strains in terms of the factors evaluated in the experimental investigation, predictive equations were developed by regression techniques.

Two types of equations for predicting creep strains in plain concrete were developed by stepwise regression analyses. These are denoted as the Model A and Model C equations. The Model A equations were developed from an orthogonal coding of a full factorial arrangement of treatments while Model C was not.

Model A Equations

These equations were developed from the Model A used in the analysis of variance (AOV) except that the time variable (Factor E) was changed from an arithmetic to a logarithmic scale. The advantage of this modification was generally to eliminate the significance of the nonlinear time terms and, thus, to reduce the total number of terms in the prediction equation. This modification also produced equations which fit the test data slightly better than those produced using an arithmetic time term. This indicates that creep varied more nearly with the $\log_{10}$ of time than with the combined linear, quadratic, and cubic effects of time.

Since Model A was orthogonal, the terms in the derived equations were identical in form and in relative influence to those factors and interactions found to significantly affect creep in the analysis of variance. However, in order to make the equation more usable, the coefficients which were based on coded levels were decoded so that the actual values could be input in the equation. The resulting prediction equations are shown below.

$$\begin{aligned} Y_a = {} & -135.9 - 0.4312A + 75.7024B - 14.2707C + 0.1365C^2 \\ & + 92.6104E + 0.1357AC - 0.0012AC^2 + 3.2829CE + 15.2833BC \\ & - 0.1258BC^2 - 0.1184ABC + 0.0009ABC^2 + 0.8910AB \\ & + 0.0005AC^2E - 0.0363C^2E + 0.9800AE \end{aligned} \tag{5.1}$$

$$\begin{aligned} Y_r = {} & 228.5 - 2.2103A - 90.2720B - 9.7774C - 0.0470C^2 \\ & - 85.5198E + 5.9747BC + 1.3665CE - 0.0363ABC \\ & - 0.0003AC^2 + 0.8176AB + 0.6582AE \end{aligned} \tag{5.2}$$

where

Y_a = predicted value of axial creep strain, micro-units;

Y_r = predicted value of radial creep strain, micro-units;

A = the temperature during loading, ^{o} F;

B = curing history prior to loading (use values of 0.5 for as-cast and 1.0 for air-dried);

C = axial stress/radial stress, percent;

E = $\log_{10}$ time after loading, days.

The multiple correlation coefficient for both equations was 0.99 and the respective standard errors of estimate for axial and radial strains were ±7 and ±9 micro-units. The first nine terms of each equation, however, were sufficient to produce adequate creep estimates for most practical uses. These first nine terms have multiple correlation coefficients of 0.98 and 0.99, and standard errors of estimate of ±20 and ±15 micro-units. The remaining terms in the above equations primarily add more precision for fitting the equations to the experimental data.

The use of these equations should be limited to the range of the test conditions defined by Model A:

(1) Concrete loaded approximately 90 days after casting;

(2) 28-day, standard cured, unconfined compressive strength of approximately 6000 psi;

(3) loading temperatures in the range of 75^{o} F to 150^{o} F;

(4) concrete cured by procedures similar to those defined as as-cast or air-dried, and sealed during loading period;

(5) time after loading in excess of approximately 50 days;

(6) radial pressures that do not exceed the axial stress by more than approximately 25 percent; and

(7) axial stresses of about 2185 psi, except when a correction factor is used as noted in the discussion below.

It should be possible to estimate creep strains for a range beyond 364 days with reasonable reliance; however, less confidence can be placed in the results since the inference space is exceeded. Creep strains predicted for time periods beyond 364 days will probably be somewhat larger than the actual strains experienced.

The axial stress in Model A was constant at an average value of 2185 psi. However, rough estimates of creep strains for axial stresses up to approximately 3200 psi may be calculated with Eqs 5.1 and 5.2 by multiplying the results by the axial stress divided by 2185 psi. This, of course, assumes that creep is proportional to stress below $0.5f'_c$. Temperatures of 75° F and 150° F and curing histories coded as 0.5 and 1.0 for as-cast and air-dried concrete were used in these equations. In evaluating creep strains for the intermediate values of temperature and curing history, it must be assumed that linear relationships exist between the high and low values used in this experiment. For curing histories that cannot be described as either as-cast or air-dried, some estimate ranging from 0.5 to 1.0 should be used in the regression equations. Such a procedure for estimating creep strains for intermediate values of these variables should produce little error.

Model C Equations

Model C was used to develop a more general set of equations to predict creep strains involving all test conditions in the experiment. The selected multilinear regression model for expressing creep strain in relation to all five test variables was as follows:

$$
\begin{aligned}
Y = {} & K + A + B + C + D + E + AB + C^2 + AC + AC^2 + BC + BC^2 \\
& + ABC + ABC^2 + D^2 + AD + AD^2 + BD + BD^2 + ABD + ABD^2 \\
& + CD + CD^2 + C^2D + C^2D^2 + ACD + ACD^2 + AC^2D + AC^2D^2 \\
& + BCD + BCD^2 + BC^2D + BC^2D^2 + ABCD + E^2 + AE + BE \\
& + ABE + CE + C^2E + CE^2 + ACE + AC^2E + BCE + BC^2E \\
& + DE + D^2E + DE^2 + ADE + AD^2E + BDE + BD^2E + CDE
\end{aligned}
$$

$$+ CD^2E + C^2DE + C^2D^2E + Log_{10}E + ALog_{10}E + ACLog_{10}E$$

$$+ ADLog_{10}E + CLog_{10}E + Log_{10}E + BLog_{10}E$$

$$+ CDLog_{10}E + R$$

where

Y = an individual creep strain observation,

K = equation constant,

A = influence of temperature,

B = influence of curing history,

C = influence of radial stress,

D = influence of axial stress,

E = influence of time,

R = residual lack of fit.

Model C involved the results from all specimens, or test conditions, in the experiment which had gages that were considered to be functioning 140 days after loading. The regression analysis incorporated the available creep strain results from 37 specimens (Table 19) and thus used all available factors and levels of factors to develop the prediction equation. As with the previous models, the low level of time was set at 56 days after loading. Since these test conditions (Table 19) could not be factorially arranged, an orthogonal coding of the data was not possible. This means that no specific quantitative measure of significance can be attached to any term in the derived equations, since these terms are highly correlated with each other. Thus, the prediction equations developed from Model C are a collection of terms that provided the best estimate of the creep strains; however, the individual terms taken separately have no significant meaning.

Two sets of prediction equations were developed from Model C: one for stress conditions in which axial stress was larger than or approximately equal

TABLE 19. MODEL C TEST CONDITIONS

Stress, psi Axial	Stress, psi Radial	Temperature, °F	Curing History	Specimen	Number of Data Points Axial Creep	Number of Data Points Radial Creep
527	0	75	As-Cast	E-39	12	12
527	0	75	Air-Dried	E-40	12	12
561	0	150	Air-Dried	B-1	12	11
1102	0	150	As-Cast	D-15	12	7
1102	0	150	Air-Dried	D-22	12	12
2179	0	75	As-Cast	B-7	12	12
2179	0	75	Air-Dried	B-19	12	12
2123	0	150	As-Cast	F-33	10	4
2123	0	150	Air-Dried	F-34	12	5
3450	0	150	As-Cast	B-16	-	7
562	600	75	As-Cast	E-5	12	12
562	600	75	Air-Dried	E-13	12	12
2139	600	75	As-Cast	C-23	12	12
2139	600	75	Air-Dried	C-11	12	12
2259	600	150	As-Cast	E-18	5	6
2259	600	150	Air-Dried	E-4	12	6
2147	2400	75	As-Cast	F-9	12	12
2147	2400	75	Air-Dried	F-30	12	12
2268	2400	150	As-Cast	G-9	12	12
2268	2400	150	Air-Dried	G-19	12	12
3449	1200	75	As-Cast	D-26	12	12
3449	1200	75	Air-Dried	D-44	-	12
3472	3600	75	As-Cast	D-31	12	12
3472	3600	75	Air-Dried	D-40	12	12
3474	3600	150	As-Cast	F-20	-	7
3474	3600	150	Air-Dried	F-6	12	4
0	600	75	As-Cast	F-13	12	12
0	600	75	Air-Dried	F-42	12	12
0	600	150	As-Cast	A-35	7	12
0	1200	150	As-Cast	I-27	5	5
0	1200	150	Air-Dried	D-3	10	7
0	2400	150	As-Cast	E-43	-	6
0	3600	75	As-Cast	H-22	5	5
0	3600	75	Air-Dried	H-14	5	-
536	3600	75	As-Cast	G-35	12	12
536	3600	75	Air-Dried	G-30	12	-
1086	2400	150	Air-Dried	D-41	12	12
Total data points used					359	344

to the radial stress and a second set for stress conditions in which the radial stress was much larger than the axial stress.

The prediction equations obtained for estimating creep strains when the axial stress was larger than or approximately equal to the radial stress are as follows:

$$Y_a = 13.30 + 27.78AC^2 - 0.6549ABC - 5.677AD + 17.43AD^2$$
$$+ 462.2BD^2 - 1075C^2D^2 - 29.55ACD - 1.971AC\text{Log}_{10}E$$
$$+ 2.591AD\text{Log}_{10}E + 224.4D\text{Log}_{10}E \quad (5.3)$$

$$Y_r = 17.97 - 602.8C + 3467C^2 - 24.58AC^2 + 117.1BC$$
$$+ 800.6BC^2 - 6.334ABC^2 - 8239C^2D^2 + 19.32ACD^2$$
$$+ 56.21AC^2D^2 + 2.23AC\text{Log}_{10}E + 241.9C\text{Log}_{10}E$$
$$- 88.45D\text{Log}_{10}E \quad (5.4)$$

where

Y_a = predicted value of axial creep, micro-units;

Y_r = predicted value of radial creep, micro-units;

A = temperature during loading, $^{\circ}$ F;

B = curing history prior to loading (use values of -1 for as-cast and +1 for air-dried concrete);

C = ratio of radial load to the 28-day, unconfined compressive strength of standard cured specimens;

D = ratio of axial load to the 28-day, unconfined compressive strength of standard cured and tested concrete specimen;

E = time after loading, days.

The multiple correlation coefficients for predicting axial and radial creep strains by Eqs 5.3 and 5.4 were both 0.99, and the respective standard errors of estimate were ±21 and ±12 micro-units.

Likewise, the equations obtained for cases when the radial stress was much larger than the axial stress are

$$Y_a = 9.358 - 381.8C + 30.57ABD^2 + 4547C^2D$$
$$- 1.673C^2E + 12.28C^2DE \quad (5.5)$$

$$Y_r = -115.5 + 0.6940A + 4929BC^2D + 0.2439BCE$$
$$- 2.998ACLog_{10}E + 824.1CLog_{10}E \quad (5.6)$$

where the terms are identical to those for Eqs 5.3 and 5.4.

The multiple correlation coefficients for Eqs 5.5 and 5.6 were both 0.99, and the respective standard errors of estimate were ±10 and ±12 micro-units.

Equations 5.3 and 5.4 predict axial and radial creep, respectively, for states of stress in which the axial stress is larger than or approximately equal to the radial stress. These equations are more versatile prediction equations than the equations developed from Model A because all test variables in the experiment were used to arrive at a predicted value of creep strain. However, the first six limiting conditions that are applicable to the Model A equations also apply to these equations. In addition, the stress levels used in the equations should not exceed approximately $0.6f'_c$.

Equations 5.5 and 5.6 are very limited because of the small number of test conditions available to develop general prediction equations. These equations estimate axial and radial creep strains for stress conditions in which radial stress is much larger than the axial stress; however, the use of these equations is restricted to the first five limiting conditions applicable to the Model A equation and to a triaxial state of stress in which the axial stress does not exceed the radial stress by more than about 20 percent.

CREEP POISSON'S RATIO

The existence and magnitude of a creep Poisson's ratio (CPR) has not been completely resolved due to somewhat conflicting reports. Some investigators, e.g., Ross (Ref 55) and Furr (Ref 19), found that there is no creep Poisson's effect or that CPR is approximately zero; L'Hermite (Ref 43) and Glanville and Thomas (Ref 22) indicated that the magnitude of CPR was approximately 0.05, while Polivka et al (Ref 51), Duke and Davis (Ref 15), Hannant (Ref 27), and Gopalakrishnan et al (Ref 24) claimed that creep Poisson's ratio was approximately equal to the elastic Poisson's ratio. Part of this discrepancy was probably due to the different test conditions and part to the different methods used to determine the magnitude of creep Poisson's ratio.

Several investigators (Refs 24 and 27) have recently reported values for creep Poisson's ratio under multiaxial states of stress, but each used different methods to determine its value. The magnitude of CPR under multiaxial stresses depends on the investigator's definition of CPR or the method used to calculate its magnitude. This fact should be considered when evaluating the CPR results of different researchers. The methods used by most investigators to determine CPR under uniaxial stresses, however, have been essentially the same.

In this report creep Poisson's ratios for all states of stress were calculated by Eq 4.1, which was derived from theory of elasticity by substituting the appropriate creep strains for elastic strains. This equation is another method for calculating creep Poisson's ratio for multiaxial states of stress.

Creep Poisson's ratios for all specimens at various times during the loading period are presented in Table 20. Excluding specimens subjected to hydrostatic stress conditions and specimens into which oil penetrated, creep Poisson's ratio averaged about 0.10. Values 84 days after loading ranged from 0.16 to 0.28, averaging 0.17. It was found that the CPR values and elastic Poisson's ratios for most hydrostatic stress conditions were generally substantially larger than for the other stress conditions.

Included in Table 20 are the average creep Poisson's ratios for the various environmental test conditions at various times after loading. Although these averages are slightly biased due to differences in loading conditions, the averages do offer a general indication as to the effect of

TABLE 20. CREEP POISSON'S RATIO*

75° F, As-Cast

Specimen	Stress, psi Axial	Radial	Creep Poisson's Ratio at following days after loading 28	84	140	224	364	Avg**
B-7	2179	0	.10	.13	.12	.13	.13	
C-16 x	1100	0	.22	.23	.29	.34	.41	
C-23	2139	600	.28	.23	.24	.25	.26	
D-26	3449	1200	.18	.19	.21	.21	.22	
D-31	3472	3600	-.36	.31	.31	.22	.33	.19
E-5	562	600	.29	.08	.33	.38	.39	
F-9	2147	2400	.15	.09	.20	.20	.19	
F-13	0	600	.15	.21	.21	.23	.24	
G-35	536	3600	.18	.18	.18	.18	.19	
H-22	0	3600	.17	.17	.17			
Average***			.18	.18	.19	.20	.21	

75° F, Air-Dried

Specimen	Axial	Radial	28	84	140	224	364	Avg**
B-19	2179	0	.08	.10	.09	.10	.11	
C-11	2139	600	.17	.19	.21	.22	.23	
D-40	3472	3600	.40	.41	.41	.40	.40	
D-44	3449	1200	.11	.11				
E-13	562	600	.37	.35	.38	.37	.41	0.14
E-40	527	0	.10	.10	.13	.16	.24	
F-30	2147	2400	.33	.31	.32	.32	.32	
F-42	0	600	.10	.14	.13	.14	.17	
G-30	536	3600	.13					
H-14	0	3600	.14					
Average***			.12	.13	.14	.16	.19	

150° F, As-Cast

Specimen	Axial	Radial	28	84	140	224	364	Avg**
A-35	0	600	.16	.18	.25	.20		
B-16	3450	0	.21	.18				
D-2 x	1086	0	.12	.40	.30	.38	.53	
D-15	1102	0	.15	.23	.08	.02		
E-18	2259	600	.12	.14	.14			.18
E-43	0	2400	.20	.15				
F-20	3474	3600	.44					
F-33	2123	0	.19	.18	.15			
G-9	2268	2400	.29	.28	.31	.31	.35	
I-27	0	1200	.29	.28	.26			
Average***			.19	.19	.18	.11		

(Continued)

TABLE 20. (CONTINUED)

150° F, Air-Dried

Specimen	Stress, psi Axial	Radial	Creep Poisson's Ratio at following days after loading 28	84	140	224	364	Avg**
B-1	561	0	.10	.20	.11	.09	0	
C-46x	1032	0	.28	.18	.24	.27	.28	
D-3	0	1200	.17	.22	.19	.18		
D-22	1102	0	.15	.18	.06	.05	-.01	
D-41	1086	2400	.13	.12	.11	.12	.12	.12
E-1	0	2400	.16					
E-4	2259	600	.14	.11	.10	.05		
F-6	3474	3600	.30	.30	.36			
F-34	2123	0	.15	.10	.10			
G-19	2268	2400	.26	.31	.32	.32	.36	
Average***			.14	.16	.11	.10	.04	

* Specimens which failed or had improperly functioning gages at time considered are excluded from table.

** Average over the entire test period for all environmental test conditions except those loaded hydrostatically and those which oil penetrated.

*** Averages for all specimens except those loaded hydrostatically and those which oil penetrated.

x Radial pressure reduced to zero shortly after loading due to oil leak into specimen.

the various test factors on CPR. Generally, it appears that CPR was larger for as-cast than for air-dried specimens, was approximately 65 percent of the elastic Poisson's ratio, and was different for different states of stress.

Effect of Curing History

The effect of curing history is shown in Fig 51 for both 75° F and 150° F and for comparable stress conditions. In all cases the air-dried specimens exhibited a lower CPR than the comparable as-cast specimens. Since it was shown earlier in the chapter that air-dried specimens exhibited smaller tensile creep strains than comparable as-cast specimens, it would be expected that CPR would be less for air-dried concrete. In the case of the 75° F test conditions, CPR for as-cast and air-dried specimens averaged 0.19 and 0.14, respectively.

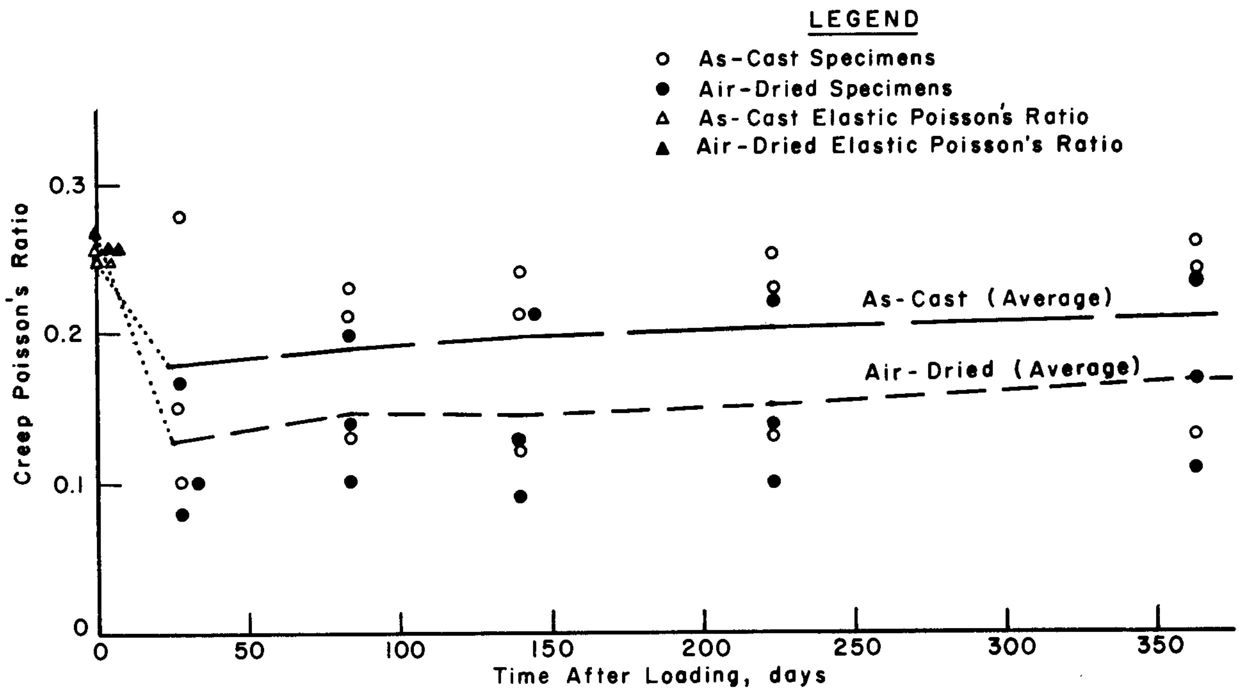
The elastic Poisson's ratios at the instant of loading are also shown in Fig 51, at zero days after loading for the respective specimens. In most cases the CPR was smaller than the elastic Poisson's ratio with CPR ranging from 39 to 84 percent of the elastic Poisson's ratio. The greatest deviation between elastic Poisson's ratio and CPR was for the 150° F air-dried condition.

Effect of Temperature During Loading

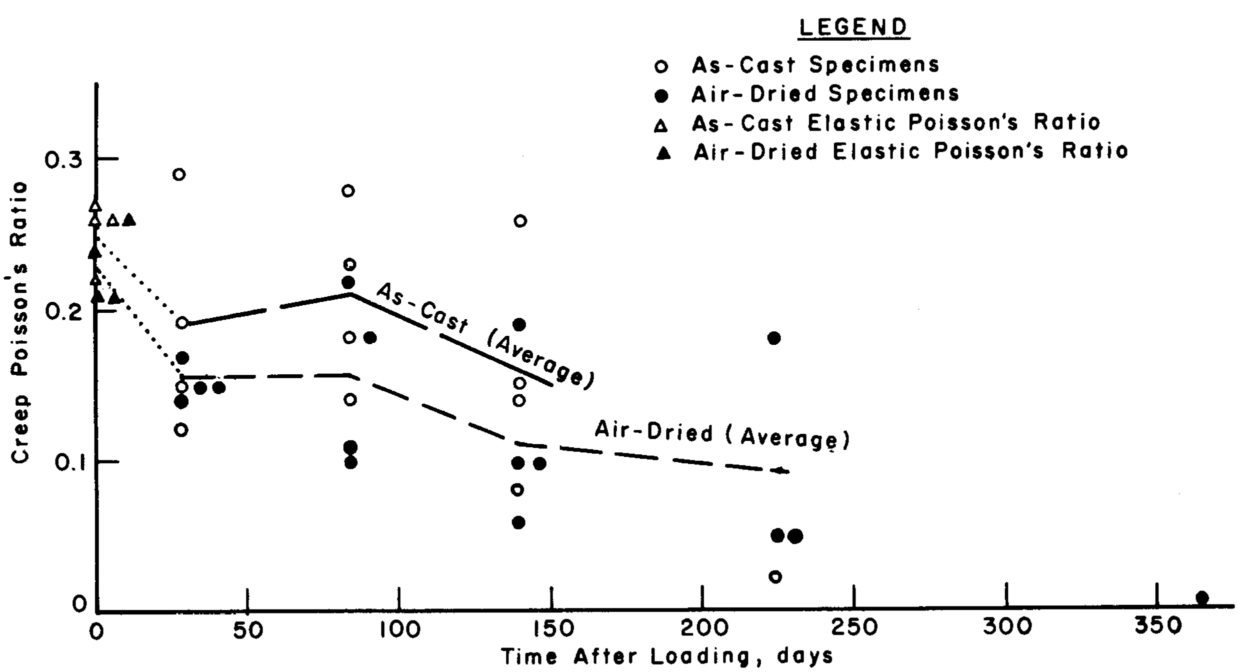
The effect of temperature on CPR throughout the loading period is shown in Fig 52 for both moisture conditions under comparable stress conditions. It appears that the creep Poisson's ratios for specimens loaded at 150° F were slightly less than those loaded at 75° F; however, due to the limited amount of data and the scatter of the data, no definite conclusions could be made. Nevertheless, Hannant's results (Refs 26 and 27) were similar and showed that the average CPR for sealed specimens at 164° F was slightly less than that at 81° F, but Hannant did not state that this difference was significant. Once again it can be seen that the creep Poisson's ratios were smaller than the elastic values.

Effect of Stress

Various states of stress appeared to influence the magnitude of CPR (Fig 53). For specimens subjected to the 75° F test temperature, CPR was lower for uniaxial and higher for triaxial states of stress, while for



(a) 75° F specimens subjected to comparable stress conditions.



(b) 150° F specimens subjected to comparable stress conditions.

Fig 51. Effect of curing history and time after loading on creep Poisson's ratio.

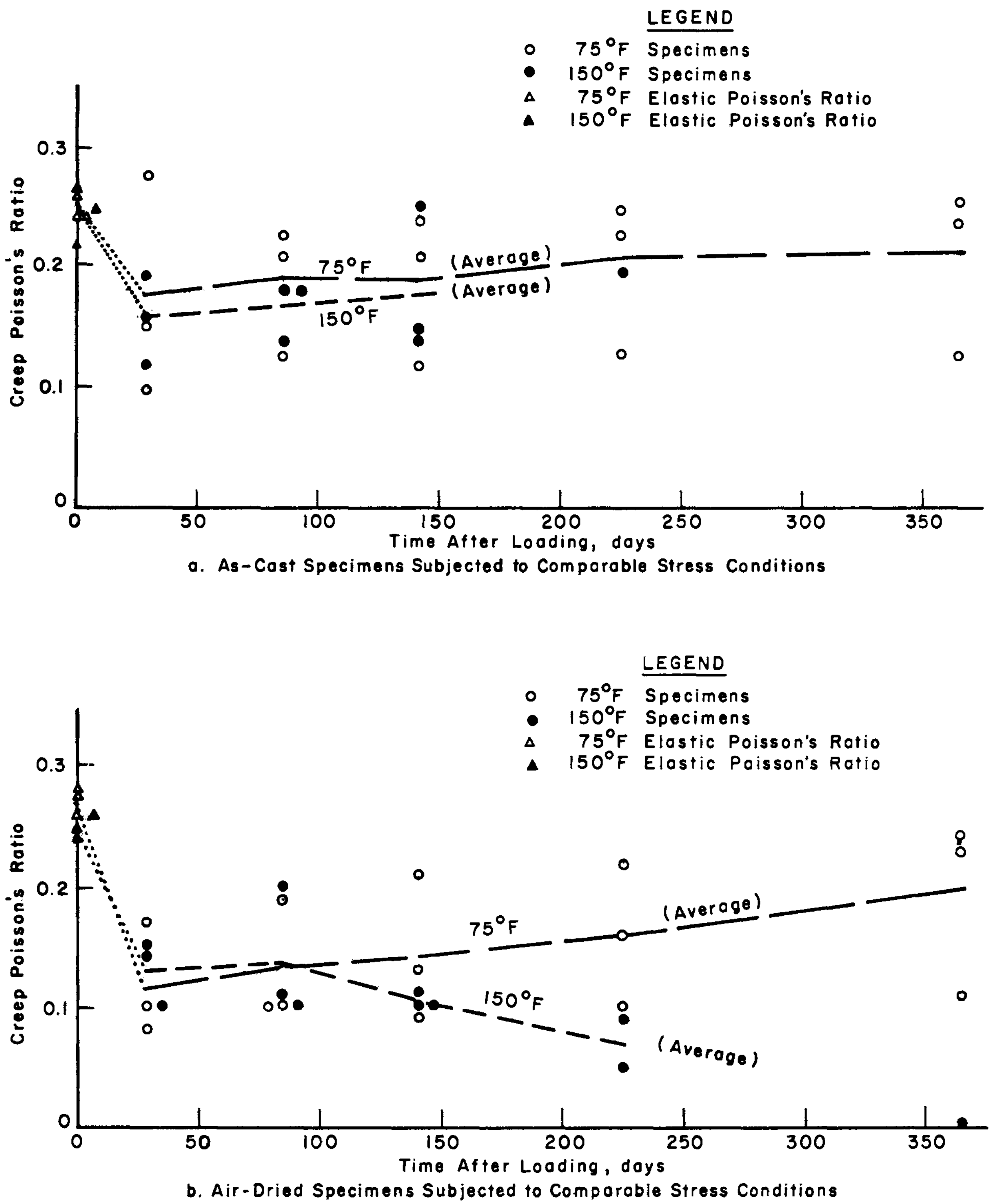


Fig 52. Effect of temperature and time after loading on creep Poisson's ratio.

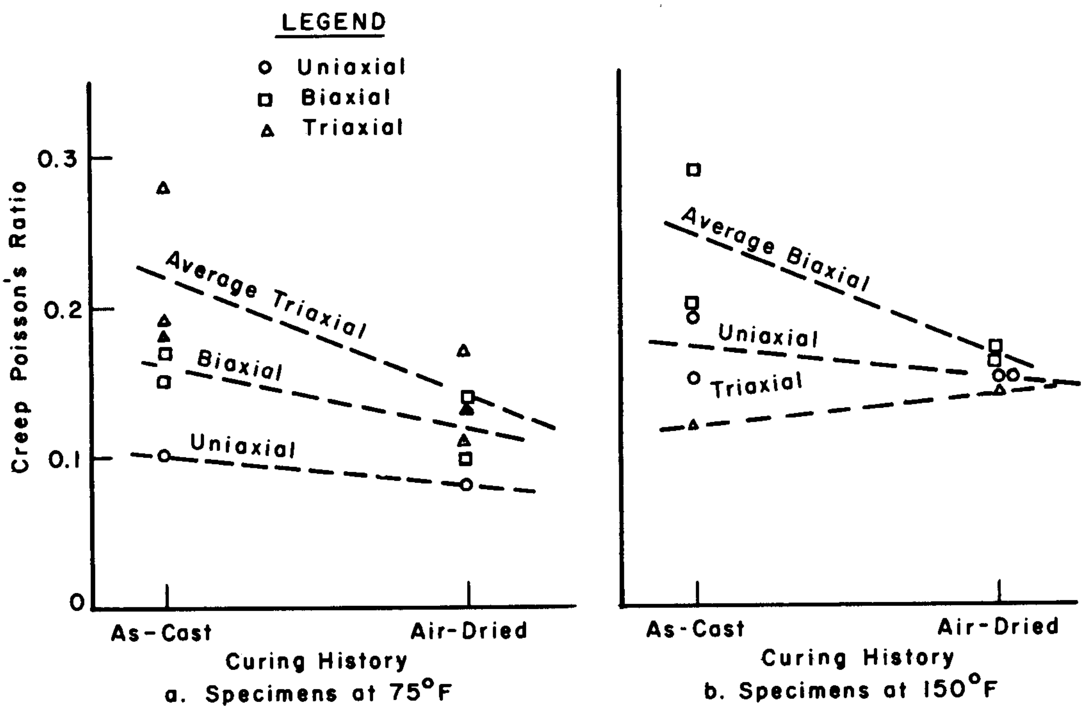


Fig 53. Effect of state of stress on creep Poisson's ratio 28 days after loading.

specimens subjected to the 150° F temperature, the differences were not as large, with CPR higher for the biaxial and lower for the triaxial case. Gopalakrishnan et al (Ref 24) found, however, from tests comparable to the 75° F as-cast case, that CPR under multiaxial compression was less than that under uniaxial compression. This may be due to the differences in the method of calculation.

The results (Table 19) generally showed that as the difference between the axial and radial stress became larger, for a given state of stress, creep Poisson's ratio became larger. The results at 75° F also indicated that CPR was higher for triaxial stress combinations in which the axial stress was much larger than the radial stress. This substantiates Hannant's tests (Ref 26), which showed this to be true not only at 81° F but also at 164° F. Hannant indicated that a small radial stress had more effect on creep strain than a large radial stress for conditions of high axial stress. This effect was also shown earlier in this report by the significant non-linear effects of increasing radial or axial stresses for relatively high constant axial or radial stresses.

In addition, it appeared that the influence of states of stress on CPR was less for air-dried concrete than for as-cast concrete.

It should be noted, however, that the above observations can be considered only as a possible trend since the data were insufficient to be conclusive.

Effect of Time

The effect of time is also shown in Figs 51 and 52. It appeared that CPR remained relatively constant throughout the test period, except, possibly, for the 150° F air-dried test environment. In this case, however, CPR decreased with time and this trend could have been caused by a gradual moisture loss from the specimens. In any event, there were not sufficient data for the later portion of the loading period to draw a satisfactory conclusion, but it is believed that time does not significantly affect CPR. Hannant (Ref 27) found that CPR remained essentially constant throughout two years of loading and Gopalakrishnan et al (Ref 24) stated that there was no systematic variation of CPR with time. In the latter case, however, the specimens were normally loaded for only 28 days, and the maximum was three months.

Summary

Within the ranges of the test conditions investigated in this experiment, the following appeared to be true:

(1) A creep Poisson's effect occurred and creep Poisson's ratio values ranged from approximately 39 percent to 84 percent of the elastic Poisson's ratio. The actual magnitude depended primarily on curing history prior to loading and the state of stress. The average creep Poisson's ratio throughout the test period was 0.16, which was approximately 65 percent of the average elastic Poisson's ratio.

(2) The creep Poisson's ratio for air-dried concrete was approximately 30 percent less than that for as-cast concrete.

(3) The magnitude of stress and the state of stress influenced creep Poisson's ratio although this influence was less at the higher temperature and for the air-dried concrete.

(4) The effects of time and temperature were inconclusive due to the limited amount of data during the later portion of the loading period; however, it appears that creep Poisson's ratio was not time-dependent and that it was slightly smaller at the higher temperature.

CREEP RECOVERY

A summary of the creep recovery data is shown in Table 21. From one to 46 percent of the creep strain at time of unloading, an average of 17 percent, was recovered 84 days after the loads were released. The percentage of the creep recovered appeared to depend primarily on the curing history of the specimen. The percentage of creep recovered for the as-cast specimens was 18 to 46 percent greater than that for the air-dried specimens under all stress conditions, although the total creep strains recovered were generally greater for air-dried than as-cast specimens. The results of this research generally substantiated the results reported by Gopalakrishnan et al (Ref 25) for uniaxially loaded specimens in which they found that the percentage of axial creep strain recovered was slightly higher for wet-stored than dry-stored cylindrical specimens.

Neither temperature during loading, elastic strain recovery, magnitude of stress, nor the type of stress applied appeared to be significantly related to the percentage of creep recovered, as there was no systematic variation of creep recovery with these factors. Gopalakrishnan et al (Ref 24) found, however, that the percentage of creep strain recovered was approximately 20 percent higher for multiaxial than uniaxial states of stress.

TABLE 21. CREEP RECOVERY SUMMARY*

	Specimen	Stress, psi Axial	Stress, psi Radial	Creep 364 days After Loading ($\times 10^{-6}$) Axial	Creep 364 days After Loading ($\times 10^{-6}$) Radial	Creep Strain Recovered After 84 Days: Axial ($\times 10^{-6}$)	Radial ($\times 10^{-6}$)	Axial %**	Radial %**
75° F As-Cast	B-7	2179	0	322	-42	62	-20	19	46
	C-16x	1100	0	100	-41	30	-13	30	31
	C-23	2139	600	242	-15	54	- 6	22	
	D-26	3449	1200	373	26	89	- 6	24	--
	D-31	3472	3600	300	348	40	57	14	16
	E-5	562	600	24	37	12	11	48	29
	E-39	527	0	75	10	15	- 7	19	--
	F-9	2147	2400	191	238	51	50	27	21
	F-13	0	600	- 37	57	- 7	19	20	33
	G-35	536	3600	-176	614	-38	107	22	17
Average (absolute)								24	29
75° F Air-Dried	B-19	2179	0	398	-43	78		20	39
	C-11	2139	600	397	- 8	76	10	19	--
	D-40	3472	3600	532	705	82	101	15	14
	D-44	3449	1200	--	114	116	20	--	17
	E-13	562	600	45	77	13	13	28	17
	E-40	527	0	69	-17	21	- 2	30	13
	F-30	2147	2400	271	423	60	73	21	17
	F-42	0	600	- 33	81	- 1	19	1	24
	G-30	536	3600	-134	-	-31	104	23	--
Average								20	20

(Continued)

TABLE 21. (CONTINUED)

	Specimen	Stress, psi Axial	Stress, psi Radial	Creep 364 days After Loading ($\times 10^{-6}$) Axial	Creep 364 days After Loading ($\times 10^{-6}$) Radial	Creep Strain Recovered After 84 Days: Axial ($\times 10^{-6}$)	Radial ($\times 10^{-6}$)	Axial %**	Radial %**
150° F As-Cast	A-35	0	600	--	70	--	33	--	47
	D-2x	1086	0	132	-70	48	2	36	2
	D-15	1102	0	195	--	56	--	29	--
	G-9	2268	2400	273	353	89	116	33	33
	Average							31	40
150° F Air-Dried	B-1	561	0	114	0	13	-13	11	--
	C-46x	1032	0	207	-58	72	-12	35	21
	D-22	1102	0	202	2	35	-10	17	--
	D-41	1086	2400	131	500	6	97	4	19
	E-4	2259	600	417	--	112	--	27	--
	F-6	3474	3600	700	--	146	--	21	--
	F-34	2123	0	623	--	107	--	17	--
	G-19	2268	2400	295	390	67	97	23	25
	Average							17	22

x Radial pressure reduced to zero shortly after loading due to oil leak into specimen; values not included in averages.

* Includes all specimens except those in which both gages had failed or the gages had been confirmed to be functioning improperly.

** Percentage of total creep at 364 days after loading that was recovered 84 days after unloading.

The magnitude of creep recovered was not proportional to stress nor to the magnitude of the creep strain prior to unloading. The magnitude of the creep recovery strain generally increased as temperature, stress, and magnitude of creep strain prior to unloading increased and was greater for air-dried specimens. It is also suspected that creep recovery was less the longer the duration of loading.

Creep recovery was generally in the direction opposite to the direction of creep strains; however, in some triaxially loaded cases in which the creep strain in one direction was very small relative to the other direction, creep recovery was in the same direction as the creep strain. It should be noted also that creep recovery was still continuing 84 days after the specimens were unloaded.

In conclusion, curing history appeared to be the only factor that could be shown to significantly affect the percentage of creep strain recovered. The as-cast specimens exhibited approximately 25 percent more creep recovery than the air-dried specimens under comparable test conditions. In addition, the factors shown to cause greater creep strains resulted generally in greater recovery strains, although not necessarily a greater percentage of the creep recovered.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

This report describes the preliminary results of an experimental investigation performed to evaluate the effects of five major factors and their interactions on the creep behavior of plain concrete and to develop preliminary information on creep recovery behavior and Poisson's creep effects.

CONCLUSIONS

The conclusions, except those involving strength, are based on data from 6 × 16-inch concrete cylindrical specimens, and, undoubtedly, this size and shape had some influence on the relative magnitudes of the axial and radial creep strains. These creep specimens were loaded 90 days after casting, were prepared from a crushed limestone aggregate, and had a nominal 28-day compressive strength of 6000 psi. Specimens which were sealed in copper 48 hours after casting are termed "as-cast." Those which were cured at 75° F and 60 percent relative humidity for 82 days before sealing in copper are termed "air-dried."

All conclusions are limited to the actual test conditions included in the investigation. It is felt that these conclusions should be fairly reliable within the inference space encompassed by the test condition and, in most cases, the conclusions can probably be extended beyond this inference space; however, caution should be used when extending these conclusions.

Within the above qualifications, the following conclusions can be drawn.

General

(1) After 90 or more days of curing, the unconfined compressive and indirect tensile strengths of as-cast concrete were greater than of air-dried concrete. Concrete cured in lime-saturated water (standard ASTM curing) until tested, however, exhibited greater compressive and tensile strengths than as-cast and air-dried specimens.

(2) The secant modulus of elasticity was greater for as-cast concrete than for air-dried concrete.

(3) An increase in temperature at time of loading decreased the modulus of elasticity.

(4) The elastic Poisson's ratio did not appear to be significantly affected by curing history, temperature, or stress conditions.

(5) The thermal expansion of air-dried concrete was greater than that of as-cast concrete, and the thermal expansion of the concrete used in this study was less than that of steel.

(6) Little or no shrinkage strain occurred in sealed specimens.

(7) During the first 84 days after casting, the air-dried specimens exhibited shrinkage strains of approximately 220 micro-units, with shrinkage strains approximately 60 micro-units greater in the axial than radial direction. Beyond this time the axial and radial strains began to converge. At approximately 100 days after casting, the radial and axial strains became essentially equal and remained essentially constant through the remainder of the test period. Thus, little or no shrinkage occurred after 84 days, at which time these specimens were sealed.

Creep Behavior

The results of this study show that creep in plain concrete under multiaxial compressive stress is a very complex phenomenon involving many interaction effects.

(1) The following factors and interactions of factors produced highly significant effects on creep strain in plain concrete:

Main Effects

(a) stress and nonlinear effect of stress,

(b) temperature during loading,

(c) curing history, and

(d) time after loading and nonlinear effect of time.

Interaction Effects

(e) temperature during loading × stress and temperature × nonlinear effect of stress,

(f) curing history × stress and curing history × nonlinear effect of stress,

(g) time after loading x stress,

(h) axial stress x radial stress, and

(i) temperature during loading x type of curing x stress and temperature during loading x type of curing x nonlinear effect of stress.

(2) Applied stress was the most important factor affecting creep strain. It was not only the most significant main effect, but it also produced highly significant interaction effects with each of the other main factors in this experiment. Radial stress was generally more significant than axial stress since it involved two principal stresses.

(3) Compressive and tensile creep strains were larger for

(a) a higher constant temperature during loading;

(b) air-dried concrete, except in the case when the stress conditions produced a low tensile creep strain;

(c) increased time after loading; and

(d) increased stress for uniaxial and biaxial states of stress.

(4) Under triaxial states of stress under comparable environmental conditions, creep strain increased or decreased depending on the magnitude of the changing stress and on the stress directions. For a relatively high constant stress in either the axial or radial direction, increasing the stress from zero in the direction perpendicular to the direction of the constant stress decreased the compressive creep strain in the direction of constant stress and changed the creep strain from tension to increasing compression in the direction of the changing stress. If the constant stress was relatively low, an increase in stress in the direction perpendicular to the constant stress changed the creep strain in the direction of the constant stress from compression to tension, and in the direction of the changing stress, from tension to increasing compression.

(5) As the level of stress increased, the creep strain increased but the increase was larger for concrete at a higher temperature relative to one at a lower temperature, for air-dried concrete relative to as-cast concrete, and as time after loading increased.

(6) Increasing the confining pressure reduced the overall creep strains, i.e., the sum of the absolute creep strains in all principal stress directions.

Creep Poisson's Ratio

(1) A creep Poisson's effect did occur and creep Poisson's ratio ranged from approximately 39 to 84 percent of the elastic Poisson's ratio, the magnitude of which depended primarily on curing history and on the state of stress. The average creep Poisson's ratio for the entire test period was 0.16, which was approximately 30 percent less than the average elastic Poisson's ratio.

(2) Creep Poisson's ratio for air-dried concrete was approximately 30 percent less than that for as-cast concrete.

(3) The magnitude of stress and the state of stress influenced creep Poisson's ratio, but this influence was less at higher temperatures and for air-dried concrete.

Elastic Recovery Strains

(1) The modulus of elasticity and Poisson's ratio for elastic recovery were essentially equal to the modulus of elasticity and Poisson's ratio at the time of loading.

(2) The elastic recovery strains were generally slightly higher than the initial elastic strains, except for the air-dried specimens loaded at 150° F and most hydrostatically loaded specimens.

Creep Recovery

(1) Curing history appeared to be the only factor studied that significantly affected the percentage of creep recovered. A larger percentage of the creep strain, which occured during one year under load, was recovered from the as-cast concrete than from the air-dried concrete.

(2) Factors that caused larger creep strains generally caused larger total recovery strains although they did not necessarily cause a larger percentage of the creep strains to be recovered.

RECOMMENDATIONS

The following recommendations are made for further research into the factors affecting creep in plain concrete:

(1) All specimens used in this investigation should be weighed and disassembled in order to determine if any moisture loss occurred after the specimens were sealed. These specimens also should be inspected thoroughly to determine if oil penetrated the concrete, if any structural flaws were present, and the general condition of the gages. If this investigation reveals that there was a significant loss in moisture or that test conditions existed other than those assumed, the conclusions presented in this report should be modified accordingly.

(2) This study should be expanded to correlate the effects of two very important variables that were maintained as constants in this experiment, i.e., time of loading and concrete strength. These additional tests should include the general ranges for most of the primary factors affecting creep in prestressed concrete construction. In addition, this experiment should be designed as a full factorial in order that more versatile prediction equations can be developed.

(3) This study investigated the interrelated effects of multiaxial stresses and a number of important variables that were known to affect creep behavior. This report describes the general nature and complexity of these effects, but does not attempt to explain the creep phenomenon in terms of the microstructure of concrete or advance a new theory on the creep mechanism. Certain aspects of this study should be investigated further, including a rigorous analysis of the effects of time and its interactions and the effect of multiaxial stress on creep behavior in terms of the basic structure of concrete. In addition, a study should be made to determine the reason air-dried concrete resists tensile creep strains, but not compressive creep strains, more than a comparable as-cast concrete, and the reason elastic recovery strains under certain conditions can be greater than initial elastic strains upon loading. It would also be desirable to be able to predict creep

strains under multiaxial compression from the results of uniaxial creep tests on the material.

(4) If a similar creep investigation is begun for which equipment systems must be manufactured, the following changes in the test equipment and experimental test design are suggested:

(a) Develop a near frictionless axial loading system to transfer hydraulic pressure to the specimen.

(b) Develop a radial loading technique which will eliminate the possibility of oil penetrating into the specimen.

(c) Design the experiment so all factors and levels of factors are within a factorial design. This will allow the most information for the effort expended regardless of whether the data are analyzed statistically.

(d) Test several duplicate test conditions within the design in order to estimate the experimental error involved.

(e) Avoid the use of low major principal stress levels within the experiment, if large differences exist between the indicated load and true load. For example in this investigation, the creep strains resulting from an axial stress of 600 psi were relatively small compared with the errors associated with loss of axial load and possible errors in strain measurement.

(f) Use test specimens that are approximately the same dimension in each of the principal directions. If cylindrical specimens are used, the diameter should be approximately equal to the height, e.g., 12 $\times$ 12-inch cylindrical specimens.

REFERENCES

1. Ali, I., and C. E. Kesler, "Rheology of Concrete: A Review of Research," Engineering Experiment Station, Bulletin 476, University of Illinois, 1965.

2. Arthanari, S., and C. W. Yu, "Creep of Concrete Under Uniaxial and Biaxial Stresses at Elevated Temperatures," Magazine of Concrete Research, Vol 19, No. 60, September 1967, pp 149-156.

3. Bonnell, D. G. R., and F. C. Harper, "The Thermal Expansion of Concrete," National Building Studies, Technical Paper No. 7, London, 1951.

4. Brown, R., "The Deformation Behavior of the Wylfa P. C. P. V. Concrete," Taylor Woodrow Construction Ltd., Report No. 13-65-1061, 1965.

5. Brown, W. E. F., personal communciation concerning the Perivale Strain Gage, Perivale Controls Company, Ltd., November 8, 1967, Union Carbide Subcontract 2864 research files.

6. Chang, T. S., and C. E. Kesler, "Correlation of Sonic Properties of Concrete with Creep and Relaxation," Proceedings, American Society for Testing Materials, Vol 56, 1956, pp 1257-1272.

7. "Creep in Mass Concrete," Miscellaneous Paper No. 6-132, Report Nos. 2 and 3, U. S. Waterways Experiment Station, January 1958.

8. Cruz, C. R., "Apparatus for Measuring Creep of Concrete at High Temperatures," Journal of PCA Research and Development Laboratories, Vol 10, No. 3, 1968.

9. Davies, O. L., Design and Analysis of Industrial Experiments, Hafner Publishing Company, New York, 1967.

10. Davis, R. E., and H. E. Davis, "Flow of Concrete Under Sustained Compressive Stress," American Society for Testing Materials, Proceedings, Vol 24, pt II, 1930, p 707.

11. Davis, R. E., H. E. Davis, and E. H. Brown, "Plastic Flow and Volume Change in Concrete," Proceedings, American Society for Testing Materials, Vol 37, pt II, 1937, pp 317-330.

12. Davis, R. E., H. E. Davis, and J. S. Hamilton, "Plastic Flow of Concrete Under Sustained Stress," Proceedings, American Society for Testing Materials, Vol 34, pt II, 1934, pp 354-386.

13. Davis, H. E., and G. E. Troxell, "Properties of Concrete and Their Influence on Prestress Design," Journal of the American Concrete Institute, Proceedings, Vol 50, 1954, pp 381-392.

14. Draper, N. R., and H. Smith, Applied Regression Analysis, John Wiley and Sons, Inc., New York, 1967.

15. Duke, C. M., and H. E. Davis, "Some Properties of Concrete Under Sustained Combined Stresses," Proceedings, American Society for Testing Materials, Vol 44, 1944, pp 888-896.

16. England, G. L., and A. D. Ross, "Reinforced Concrete Under Thermal Gradiends," Magazine of Concrete Research, Vol 14, No. 40, pp 5-12.

17. Fisher, R. A., and F. Yares, Statistical Tables for Biological Agricultural and Medical Research, Oliver and Boyd, 3rd Edition, London, 1948, p 62.

18. Freudenthal, A. M., and F. Roll, "Creep and Creep-Recovery of Concrete Under High Compressive Stresses," Journal of the American Concrete Institute, Proceedings, Vol 54, No. 12, June 1958, pp 1111-1142.

19. Furr, H. L., "Creep Tests of Two-Way Prestressed Concrete," Journal of the American Concrete Institute, Proceedings, June 1967, pp 288-294.

20. Gardner, N. J., "Triaxial Behavior of Concrete," Journal of the American Concrete Institute, Vol 66, No. 15, February 1969, pp 136-146.

21. Glanville, W. H., "The Creep or Flow of Concrete Under Load," Building Research Technical Paper, Department of Scientific and Industrial Research, No. 12, London, 1930.

22. Glanville, W. H., and F. G. Thomas, "Further Investigations on the Creep or Flow of Concrete Under Load," Building Research Technical Paper, Department Scientific and Industrial Research, No. 21, London, 1939.

23. Glucklick, J., and D. Ishai, "Creep Mechanism in Cement Mortar," Journal of the American Concrete Institute, Proceedings, Vol 63, No. 2, February 1966, pp 267-290.

24. Gopalakrishnan, K. S., A. M. Neville, and A. Ghali, "Creep Poisson's Ratio of Concrete Under Multiaxial Compression," Journal of the American Concrete Institute, Proceedings, December 1969, pp 1008-1019.

25. Gopalakrishnan, K. S., A. M. Neville, and A. Ghali, "A Hypothesis on Mechanism of Creep of Concrete With Reference to Multiaxial Compression," Journal of the American Concrete Institute, Proceedings, January 1970, pp 29-35.

26. Hannant, D. J., "The Strain Behavior of Concrete Under Compressive Stress at Elevated Temperatures," Central Electricity Research Laboratories Study, Survey, England, Job No. 30223, 30539, 1966.

27. Hannant, D. J., "Creep and Creep Recovery of Concrete Subjected to Multiaxial Compressive Stress," Journal of the American Concrete Institute, Proceedings, May 1969, pp 391-394.

28. Hansen, T. C., "Creep and Stress Relaxation of Concrete," Swedish Cement and Concrete Research Institute, Royal Institute of Technology, Proceedings No. 31, Stockholm, 1960.

29. Hansen, T. C., and A. H. Mattock, "Influence of Size and Shape of Member on Shrinkage and Creep of Concrete," Journal of the American Concrete Institute, Proceedings, Vol 63, No. 2, February 1966, pp 267-290.

30. Helmuth, R. A., and D. H. Turk, "The Reversible and Irreversible Drying Shrinkage of Hardened Portland Cement and Tricalcium Silicate Plates," Portland Cement Association Research and Development Laboratories Journal, No. 2, May 1967, pp 8-21.

31. Hickey, K. B., "Creep, Strength, and Elasticity of Concrete at Elevated Temperatures," U. S. Bureau of Reclamation Report C-1257.

32. Hsu, T. T. C., F. O. Slate, G. M. Stutman, and G. Winter, "Microcracking of Plain Concrete and the Shape of the Stress-Strain Curve," Journal of the American Concrete Institute, Proceedings, Vol 60, No. 2, February 1963, pp 209-224.

33. Illston, J. M., "Creep of Concrete Under Uniaxial Tension," Magazine of Concrete Research, Vol 17, No. 51, June 1965, pp 77-84.

34. Jain, K. K., and C. E. Kesler, "Moisture Exchange Behavior in Concrete and Mortar," Theoretical and Applied Mechanics Report, No. 646, University of Illinois, July 1964.

35. Jensen, R. S., and F. E. Richart, "Shorttime Creep Tests of Concrete in Compression," American Society for Testing Materials, Proceedings, Vol 38, pt II, 1938, p 410.

36. Karapetrin, K. S., Fiziko-Mathematicheskie Estestvenney, Proceedings, No. 1, Armenian Academy of Sciences, Soviet Union, 1956.

37. Kawahara, Y., and A. Haraguchi, "Dynamic Properties of Concrete Exposed to High Temperature," Concrete Journal, (Japan), Vol 7, No. 3, March 1969, pp 12-19. (English Translation by Scientific Translation Service, Ann Arbor).

38. Kennedy, Thomas W., "Sealing of Specimens to Prevent Moisture Loss," Union Carbide Subcontract 2864, unpublished research, Department of Civil Engineering, The University of Texas at Austin, June 18, 1968.

39. Kennedy, Thomas W., "Pilot Test 1," Union Carbide Subcontract 2864, unpublished research, Department of Civil Engineering, The University of Texas at Austin, July 21, 1968.

40. Kennedy, Thomas W., "Pilot Test 2," Union Carbide Subcontract 2864, unpublished research, Department of Civil Engineering, The University of Texas at Austin, August 2, 1968.

41. Kennedy, Thomas W., "Loss of Axial Load Due to Friction in the Loading Ram," Union Carbide Subcontract 2864, unpublished research, Department of Civil Engineering, The University of Texas at Austin, August 15, 1968.

42. Kennedy, Thomas W., and E. S. Perry, "An Experimental Approach to the Study of the Creep Behavior of Plain Concrete Subjected to Triaxial Stresses and Elevated Temperatures," Union Carbide Report No. 2864-1, Department of Civil Engineering, The University of Texas at Austin, June 1970.

43. L'Hermite, R., "What Do We Know About the Plastic Deformation and Flow of Concrete?," (Que Savon-nous Dela Deformation Plastique et du Floage du Beton?), Annalesde L'Institute Technique du Batiment et des Travaux Publics, Paris, No. 117, September 1957, pp 772-809.

44. Mirzel and Klapoc, "On the Superposition of Shrinkage and Creep Deformations," Building Science, Vol 7, No. 3, 1967.

45. Nasser, K. W., and A. M. Neville, "Creep of Old Concrete at Normal and Elevated Temperatures, Journal of the American Concrete Institute, Proceedings, Vol 64, No. 2, February 1967, pp 97-103.

46. Neville, A. M., "Role of Cement in the Creep of Mortar," Journal of the American Concrete Institute, Proceedings, Vol 55, March 1959, pp 963-984.

47. Neville, A. M., "Strength of Concrete," Properties of Concrete, John Wiley and Sons, Inc., New York, 1963, pp 241-243.

48. Neville, A. M., "Creep of Concrete as a Function of Cement Paste," Magazine of Concrete Research, Vol 16, No. 46, 1964.

49. Neville, A. M., and B. L. Meyers, "Creep of Concrete: Influencing Factors and Prediction," Symposium on Creep of Concrete, Journal of the American Concrete Institute, Publication SP-9, 1964.

50. Pickett, G., "The Effect of Change in Moisture-Content of the Creep of Concrete Under Sustained Load," Journal of the American Concrete Institute, Proceedings, Vol 38, 1942, pp 333-335.

51. Polivka, M., D. Pirtz, and R. F. Adams, "Symposium of Mass Concrete," Proceedings, Journal of the American Concrete Institute, Publication SP-6, Paper No. 12, 1963.

52. Probst, E., "The Influence of Rapidly Alternating Loading on Concrete and Reinforced Concrete," Structural Engineer, Vol 9, London, 1931, p 326.

53. "Recommended Concrete Creep and Shrinkage Values for Computing Prestressing Losses," Report on Project No. 67-535, Schupack and Associates, Consulting Engineers, Stamford, Connecticut, Appendix 5J, June 1968.

54. Robson, D. W., "A Simple Method for Constructing Orthogonal Polynominals When the Independent Variable is Unequally Spaced," Biometrics, June 1959, pp 187-191.

55. Ross, A. D., "Experiments on the Creep of Concrete Under Two-Dimensional Stressing," Magazine on Concrete Research, Vol 6, No. 16, June 1954, pp 3-10.

56. Rusch, H., "Researches Toward a General Flexural Theory for Structural Concrete," Journal of the American Concrete Institute, Proceedings, Vol 32, No. 1, July 1960, pp 1-28.

57. Snedecor, G. W., and W. G. Cochran, Statistical Methods, 6th Edition, The Iowa State University Press, Ames, Iowa, 1968.

58. The Effects of Concrete Constituents, Environment and Stress on the Creep and Shrinkage of Concrete, Presented at Annual Journal of the American Concrete Institute Convention, Subcommittee I, Journal of the American Concrete Institute Committee 209, New York, April 1970.

59. Troxell, G. E., and H. E. Davis, "Strength of Concrete," Composition and Properties of Concrete, McGraw-Hill, New York, 1956, pp 282-291.

60. Troxell, G. E., and H. E. Davis, "Volume Changes and Creep-Creep in Concrete," Composition and Properties of Concrete, McGraw-Hill, New York, 1956, pp 245-252.

61. Troxell, G. E., J. M. Raphael, and R. E. Davis, "Long-Time Creep and Shrinkage Tests of Plain and Reinforced Concrete," Proceedings, American Society for Testing Materials, Vol 58, 1958, pp 1101-1120.

62. Vaishnan, R. N., and C. E. Kesler, "Correlation of Creep of Concrete With Its Dynamic Properties," Theoretical and Applied Mechanics Report, No. 603, Urbana, University of Illinois, September 1961.

APPENDIX A

SUMMARY OF MIXTURE PROPORTIONS AND ENGINEERING CHARACTERISTICS OF AGGREGATE AND CEMENT

TABLE A1. SUMMARY FOR CONCRETE MIXTURE PROPORTIONS*

Materials:

Material	Type	Source
Portland cement, SS-C-192	II	Alpha Portland Cement Co.
Admixtures	None	
Fine aggregate	Limestone	Vulcan Materials Company
Coarse aggregate	3/4-inch limestone	Vulcan Materials Company

Material Properties:

Material	Size Range	Coarse Aggregate, % by weight	Bulk Specific Gravity, SSD	Absorption, % by weight
Portland cement			3.15	
Fine aggregate	-		2.67	1.3
Coarse aggregate (A)	No. 4	30	2.71	0.5
Coarse aggregate (B)	3/8-in.	35	2.71	0.5
Coarse aggregate (C)	1/2-in.	35	2.71	0.5

Mixture Data:

Material	Mixture Proportions, by weight	SSD Weights per cubic yard, lb	Solid Volume per one cubic yard, cubic feet
Portland cement	1.00	681.5	3.473
Fine aggregate	2.03	1381.5	8.305
Coarse aggregate (A)	0.79	535.4	3.171
Coarse aggregate (B)	0.92	624.5	3.699
Coarse aggregate (C)	0.92	624.5	3.697
Water	0.425	289.86	4.653

Water/cement ratio = 0.425, by weight
Slump = 2 inches
Cement factor = 7.25 bags/cu. yd.
Sand/aggregate ratio = 44%, by volume

Strength Data:

Age, days	Psi
28	5750
28	6190
28	6050
28	6200
28	5860
28	5890

Average for 6 × 12-inch cylinders = 5990 psi

* From test reports submitted and prepared by Waterways Experiment Station, Jackson, Mississippi, December 5, 1967.

TABLE A2. REPORT OF TEST ON PORTLAND CEMENT

General:

Specification:	SS-C-192, Type II, LA, HH
Company:	Alpha Portland Cement Co., Birmingham, Ala.
Dates Sampled:	June 17-18, 1967
Barrels Represented:	5000
Date of Report:	December 5, 1967

Cement Components:

Sample No.	Ign. Loss, %	Insol. Res., %	SO_3, %	M_gO, %	SiO_2, %	Al_2O_3, %	Fe_2O_8, %
1	1.1	0.22	2.0	3.4	21.9	4.4	4.4
2	1.1	0.22	1.9	3.5	21.8	4.4	4.8
3	1.1	0.22	2.0	3.4	21.9	4.4	4.4
5	1.1	0.24	1.9	3.4	21.7	4.5	4.4

Sample No.	C_3A, %	CaO, %	Total Alkali, %	Compressive Strength, psi 3-day	7-day	Entrained Air, %	Blaine Specific Surface, cm^2/gm
1	4.0	62.8	0.46	2000	2570	7.9	3150
2	4.1	62.7	0.45	1975	2480	8.1	3135
3	4.1	62.6	0.44	2095	2750	7.5	3135
5	4.3	62.7	0.44	2125	2760	8.1	3150

Time of Set:

Sample Series	Autoclave Expansion, %	Time of Set Initial hr:min	Final hr:min
1-2	0.10	3:25	6:55
3-4	0.09	3:10	7:00
5-6	0.10	3:10	7:00

Heat of Hydration:

7 days = 62 calories/gram
28 days = 72.5 calories/gram

TABLE A3. REPORT ON AGGREGATE

General

Type of Material:	Limestone
Location:	Lat. 36°10', Long. 86°35': off highway 70 north at Stone River on Central Pike near junction of Chandler Road, Tennessee
Producer:	Lambert Division, Vulcan Materials Company, Hermitage, Tennessee plant
Geological Formation and Age:	Carter Limestone - Ordovican
Date of Report:	November 16, 1967

Gradation

Sieve Size	Cumulative % Passing Coarse Agg.	Fine Agg.
1-in.	100	
3/4-in.	99	
1/2-in.	70	
3/8-in.	41	100
No. 4	0	98
No. 8		84
No. 16		64
No. 30		47
No. 50		24
No. 100		8
-200		4.2
Fineness Modulus		2.75

Test Results

	Coarse Agg.	Fine Agg.
Bulk Specific Gravity, SSD:	2.71	2.67
Absorption, %	0.5	1.3

TABLE A4. CONCRETE MIXTURE PROPORTIONS

General:

Cement Factor:	7.25 bags/cu. yd.
Water/Cement Ratio:	4.8 gals/bag or 0.425 by weight
Sand/Aggregate Ratio:	44% by volume
Slump:	2 inches
Date of Report:	November 16, 1967

Materials:

Material	Size Range	Bulk Sp. Gravity	Unit Wt. (solid), lb/cu.ft.	Absorp., %	Net Moisture, %
Cement		3.15	196.24		
Fine aggregate	Sand	2.67	166.34	1.3	-1.3
Coarse aggregate (A)	No. 4	2.71	168.83	0.5	-0.4
Coarse aggregate (B)	3/8-in.	2.71	168.83	0.5	-0.4
Coarse aggregate (C)	1/2-in.	2.71	168.83	0.5	-0.4

Mixture Proportions:

For 1 Cubic Yard

Material	Solid Volume, cu.ft./batch	SSD Batch Weight, lb
Cement	3.473	681.5
Fine aggregate	8.305	1381.5
Coarse aggregate (A)	3.171	535.4
Coarse aggregate (B)	3.699	624.5
Coarse aggregate (C)	3.699	624.5
Water	4.653	289.86

For 1.6 Cubic Feet

Material	SSD Batch Weight, lb	Water Correction, lb	Actual Batch Weight, lb
Cement	40.9		40.9
Fine aggregate	82.9	-1.1	81.8
Coarse aggregate (A)	32.1	-0.1	32.0
Coarse aggregate (B)	37.5	-0.1	37.4
Coarse aggregate (C)	37.5	-0.2	37.3
Water	17.4	+1.5	18.9

APPENDIX B

COMPRESSIVE STRENGTH DATA

TABLE B1. 28-DAY COMPRESSIVE STRENGTHS

Curing History: As-Cast

Specimen	Remarks	Load, lb	Strength, psi	Average Strength, psi
A-13	Good cap	188,400	6663	
A-14	Good cap	184,600	6529	6577
A-28	Good cap	184,900	6539	
B-21	Loading machine problems	--	--	
B-30	Good cap	152,800	5404	4713
B-33	Very poor cap	113,700	4021	
C-8	Good cap	163,200	5772	
C-19	Fair cap	161,400	5708	5704
C-40	Good cap	159,200	5630	
D-1	Good cap	177,270	6270	
D-6	Good cap	167,600	5928	5983
D-24	Good cap	162,540	5749	
E-17	Good cap	162,200	5737	
E-36	Good cap	148,000	5234	5411
E-37	Good cap	148,800	5263	
F-4	Fair cap	153,400	5425	
F-18	Good cap	170,800	6041	5652
F-38	Good cap	155,200	5489	
G-7	Good cap	162,000	5730	
G-29	Cap slightly cracked	165,000	5836	5942
G-40	Good cap	177,000	6260	
H-11	Fair cap	152,520	5394	
H-19	Fair cap	154,090	5450	5646
H-33	Good cap	172,280	6093	
I-12	Fair cap	163,650	5788	5788

(Continued)

TABLE B1. (CONTINUED)

Curing History: Air-Dried

Specimen	Remarks	Load, lb	Strength, psi	Average Strength, psi
A-18	Good cap	198,900	7034	
A-23	Good cap	200,000	7073	7060
A-43	Good cap	200,000	7073	
B-24	Poor cap	147,000	5199	
B-37	Good cap	188,600	6670	6199
B-46	Good cap	190,200	6727	
C-7	Good cap	183,200	6479	
C-27	Good cap	177,600	6281	6523
C-31	Good cap	192,500	6808	
D-16	Good cap	203,040	7181	
D-21	Good cap	186,240	6587	6645
D-30	Good cap	174,370	6167	
E-21	Good cap	183,200	6479	
E-29	Good cap	187,200	6621	6536
E-44	Good cap	184,000	6508	
F-8	Good cap	191,700	6780	
F-16	Good cap	190,500	6737	6675
F-35	Good cap	184,000	6508	
G-5	Good cap	190,200	6727	
G-28	Good cap	194,000	6862	6569
G-47	Good cap	173,000	6118	
H-7	Good cap	179,230	6339	
H-40	Lost specimen	--	--	6320
H-48	Good cap	178,170	6301	
I-9	Fair cap	169,700	6002	
I-15	Fair cap	186,190	6585	6436
I-18	Fair cap	190,080	6723	

(Continued)

TABLE B1. (CONTINUED)

Curing History: Standard

Specimen	Remarks	Load, lb	Strength, psi	Average Strength, psi
A-7	Good cap	184,300	6518	
A-25	Good cap	188,800	6677	6756
A-42	Good cap	200,000	7073	
B-12	Good cap	192,200	6798	
B-20	Good cap	199,500	7056	6646
B-22	Good cap	172,000	6083	
C-2	Good cap	170,000	6012	
C-15	Good cap	176,000	6225	
C-45	Good cap	186,200	6585	6136
C-47	Fair cap	172,200	6090	
C-49	Fair cap	163,100	5768	
D-7	Machine test specimen	--	--	
D-8	Very poor cap	129,600	4584	
D-25	Good cap	210,520	7445	6201
D-32	Good cap	199,210	7046	
D-45	No cap (poor)	150,470	5322	
D-49	Specimen cracked	--	--	
E-2	Good cap	183,000	6472	
E-14	Good cap	184,400	6522	6522
E-19	Good cap	185,800	6571	
E-47	Good cap	172,600	6099	
F-1	Good cap	180,600	6387	
F-19	Good cap	191,700	6780	
F-36	Good cap	186,300	6589	6511
F-47	Good cap	186,300	6607	
F-49	Good cap	175,100	6193	
G-11	Good cap	186,400	6592	
G-17	Good cap	182,400	6451	6442
G-48	Good cap	177,600	6281	
H-18	Good cap	175,480	6206	
H-13	Fair cap	186,350	6591	6344
H-32	Good cap	176,290	6235	
I-26	Fair cap	175,510	6207	
I-29	Fair cap	186,860	6609	6260
I-32	Fair cap	168,670	5965	

TABLE B2. 90-DAY COMPRESSIVE STRENGTHS

Curing History: As-Cast

Specimen	Remarks	Load, lb	Strength, psi	Average Strength, psi
A-5	Good cap	199,200	7045	6883
A-20	Good cap	190,000	6720	
B-18	Fair cap	169,000	5977	
B-44	Good cap	177,000	6260	6109
B-45	Good cap	172,200	6090	
C-1	Poor cap	181,500	6419	
C-29	Good cap	177,600	6282	6426*
C-35	Good cap	186,000	6578	
D-28	Fair cap	192,100	6794	
D-36	Fair cap	154,940	5480	6502
D-39	Good cap	204,450	7231	
E-9	Fair cap	213,730	7559	
E-11	Poor cap	197,680	6991	7290
E-33	Good cap	206,940	7319	
F-22		210,780	7455	
F-24		211,850	7493	7414
F-31		206,260	7295	
G-33	Cap 70% effective	174,800	6182	
G-45	Cap 70% effective	177,800	6288	6462
G-49	Cap 70% effective	195,500	6914	
H-25	Poor cap	191,490	6773	
H-37	Poor cap	158,210	5596	6333
H-46	Good cap	187,510	6632	
I-40	Fair cap	174,230	6162	6162

(Continued)

*C-Specimens tested at age 83 days

TABLE B2. (CONTINUED)

Curing History: Air-Dried

Specimen	Remarks	Load, lb	Strength, psi	Average Strength, psi
A-15	Good cap	206,420	7300	6963
A-47	Pitted cap - fair	187,340	6626	
B-11	Good cap	229,100	8103	
B-31	Fair cap	211,620	7484	7793
B-35	Good cap	220,300	7791	
C-5	Good cap	216,110	7643	
C-43	Good cap	219,260	7755	7372*
C-44	Very poor cap	190,000	6720	
D-4	Good cap	212,155	7503	
D-13	Good cap	229,330	8111	7787
D-35	Good cap	219,020	7746	
E-7	Good cap	223,270	7896	
E-24	Good cap	196,900	6964	7425
E-45	Fair cap	209,640	7414	
F-12		228,570	8084	
F-29		216,300	7650	7869
F-44		222,640	7874	
G-14	Cap 95% effective	207,300	7332	
G-20	Cap 95% effective	209,600	7413	7457
G-50	Cap 95% effective	215,600	7625	
H-6	Poor cap	215,540	7623	
H-30	Good cap	201,600	7130	7280
H-36	Good cap	200,360	7086	
I-4	Good cap	201,980	7144	
I-6	Good cap	197,510	6985	7059
I-28	Good cap	199,310	7049	

(Continued)

*C-Specimens tested at age 83 days

TABLE B2. (CONTINUED)

Curing History: Standard

Specimen	Remarks	Load, lb	Strength, psi	Average Strength, psi
A-29	Good cap	222,280	7861	
A-37	Good cap	252,320	8924	8547
A-48	Good cap	250,370	8855	
B-9		246,770	8728	
B-10		256,070	9056	8694
B-34		234,610	8297	
C-22	Good cap	229,540	8118	
C-25	Good cap	233,000	8241	8289*
C-28	Good cap	239,470	8469	
C-32	Good cap	235,520	8330	
D-5	Good cap	249,850	8836	
D-11	Good cap	248,420	8786	
D-14	Good cap	246,090	8703	8544
D-34	Good cap	211,200	7470	
D-42	Fair cap	252,390	8926	
E-16	Good cap	243,290	8604	
E-22	Good cap	246,230	8708	8195
E-32	Good cap	229,560	8119	
E-48	Fair cap	207,740	7347	
F-3		231,700	8195	
F-10		202,370	7157	8093
F-27		251,350	8889	
F-40		229,930	8132	
G-12	Good cap	230,500	8152	
G-25	Good cap	206,500	7303	7727
G-36	Cap 90% effective	218,400	7724	
H-15	Good cap	232,810	8234	8111
H-39	Fair cap	225,870	7989	
I-36	Good cap	222,570	7872	7872

*C-Specimens tested at age 83 days

TABLE B3. 183-DAY COMPRESSIVE STRENGTHS

Curing History: As-Cast

Specimen	Remarks	Temp., °F	Load, lb	Strength, psi	Average Strength, psi
A-16	Good cap	75	249,849	8836	8262
A-39	Fair cap	75	217,365	7688	
A-17	Good cap	150	256,670	9078	8117
A-36	Fair cap	150	202,345	7156	
G-15	Good cap	75	216,750	7666	7617
G-38	Good cap	75	214,000	7569	
G-16	Good cap	150	234,280	8286	8283
G-23	Good cap	150	234,120	8280	
H-9	Good cap	75	229,280	8109	7661
H-20	Good cap	75	204,200	7222	
H-23	Fair cap	75	216,330	7651	
I-25	Fair cap (cracks)	75	196,870	6963	6963
I-14	Good cap	150	206,500	7303	
I-11	Good cap	150	230,380	8148	7726

Curing History: Air-Dried

Specimen	Remarks	Temp., °F	Load, lb	Strength, psi	Average Strength, psi
A-1	Good cap	75	222,840	7881	7027
A-4	Fair cap	75	174,540	6173	
A-11	Good cap	150	215,355	7616	7757
A-41	Good cap	150	223,300	7897	
G-26	Good cap	75	201,600	7130	7314
G-37	Good cap	75	212,000	7498	
G-39	Chipped edges	150	202,000	7144	7096
G-43	Good cap	150	199,260	7047	
H-29	Good cap	75	210,040	7429	
H-47	Good cap	75	202,720	7172	7472
H-21	Fair cap	75	221,020	7817	
I-42	Good cap	75	198,330	7015	7200
I-34	Fair cap (90% effective)	75	208,830	7386	
I-22	Very poor cap (70% effect)	150	192,610	6812	6957
I-35	Fair cap	150	200,780	7101	

TABLE B4. 365-DAY COMPRESSIVE STRENGTHS

Curing History: As-Cast

Specimen	Remarks	Temp., °F	Load, lb	Strength, psi	Average Strength, psi
A-26	Good cap	75	248,970	8805	8836
A-45	Fair cap	75	250,720	8867	
A-6	Very poor cap	150	189,720	6710	7596
A-40	Fair cap	150	239,810	8481	
G-3	Fair cap	75	225,530	7977	8190
G-24	Good cap	75	237,620	8404	
G-8	Good cap	150	241,030	8525	8313
G-34	Good cap	150	229,040	8101	

Curing History: Air-Dried

Specimen	Remarks	Temp., °F	Load, lb	Strength, psi	Average Strength, psi
A-24	Good cap	75	207,820	7350	7480
A-34	Good cap	75	215,190	7611	
A-33	Very poor cap	150	198,350	7015	7009
A-44	Very poor cap	150	198,000	7003	
G-6	Fair cap (cracks)	75	222,340	7864	7809
G-46	Good cap	75	219,230	7754	
G-22	Good cap	150	225,350	7970	7863
G-31	Good cap	150	219,300	7756	

APPENDIX C

TENSILE STRENGTH DATA

TABLE C1. 28-DAY TENSILE STRENGTHS

Curing History: As-Cast

Specimen	Load, lb	Strength, psi	Average Strength, psi
D-27	64,400	569	516
D-29	52,200	462	

Curing History: Air-Dried

Specimen	Load, lb	Strength, psi	Average Strength, psi
B-36	63,500	561	561
D-9	56,400	499	530
D-19	63,300	560	

Curing History: Standard

Specimen	Load, lb	Strength, psi	Average Strength, psi
B-3	70,800	626	626
C-20	66,800	591	576
C-26	63,400	561	
D-18	65,700	581	622
D-40	75,000	663	
E-31	64,500	570	568
E-38	64,000	566	
F-5	68,100	602	554
F-39	57,300	506	

TABLE C2. 90-DAY TENSILE STRENGTHS

Curing History: As-Cast

Specimen	Load, lb	Strength, psi	Average Strength, psi
B-15	56,900	503	549
B-38	67,200	594	
C-10	77,100	682	609
C-30	60,500	535	
D-10	56,500	500	531
D-17	63,400	561	
E-3	68,600	607	587
E-25	64,050	566	
F-26	69,000	610	589
F-28	64,100	567	

Curing History: Air-Dried

Specimen	Load, lb	Strength, psi	Average Strength, psi
B-2	66,900	592	540
B-32	55,100	487	
C-18	60,000	531	575
C-21	70,000	619	
D-37	67,000	592	547
D-43	56,800	502	
E-35	67,000	592	554
E-15	58,200	515	
F-25	63,150	558	577
F-45	67,400	596	

(Continued)

TABLE C2. (CONTINUED)

Curing History: Standard

Specimen	Load, lb	Strength, psi	Average Strength, psi
B-6	66,000	584	542
B-14	56,500	500	
C-42	80,000	707	681
C-48	74,000	654	
D-38	60,850	538	508
D-50	53,900	477	
E-8	75,500	668	710
E-41	85,000	752	
F-43	78,400	693	691
F-48	77,800	688	

APPENDIX D

AVERAGE SHRINKAGE STRAINS AFTER LOADING

TABLE D1. AXIAL SHRINKAGE STRAINS FOR AS-CAST SPECIMENS AT 75° F

Days After Loading	Strain, (x 10^{-6}) In Following Specimens							Average Strain, (x 10^{-6})
	A-8*	B-29	C-39	D-20	E-28	F-23	G-18	
2		0	0	1.3	2.6	0	1.4	0.9
5		0	-1.3	1.3	1.3	2.7	2.7	1.1
7		-1.3	-2.5	-1.3	0	2.7	0	-0.4
14		-1.3	-3.8	0	1.3	0	-2.7	-1.1
21		-3.9	-1.3	1.3	4.0	0	-2.7	-0.4
28		-2.6	0	2.5	1.3	0	-2.7	-0.3
56		-1.3	3.7	3.8	0	0	-2.7	0.6
84		-5.2	7.4	3.8	0	0	-2.7	0.6
112		0	6.2	2.5	-1.3	-1.4	-5.5	0.1
140		0	7.4	2.5	-1.3	1.4	-5.5	0.8
168		-1.3	10.0	3.8	-1.3	-1.4	-6.9	0.5
196		0	10.0	3.8	0	2.7	-4.1	2.1
224		0	12.4	6.3	1.3	4.1	-1.4	3.8
252		1.3	14.9	10.1	4.0	6.8	-1.4	6.0
280		3.9	16.2	10.1	6.6	8.2	-2.7	7.0
308		7.7	18.0	8.8	6.6	10.9	1.4	8.9
336		7.7	21.1	13.9	9.3	10.9	1.4	10.7
364		9.0	21.9	13.9	11.9	13.6	1.4	11.8
366		10.3	21.7	13.9	10.6	13.6	2.8	12.1
371		9.0	22.4	15.2	10.6	13.6	2.8	12.2
378		10.3	24.2	15.2	10.6	13.6	2.8	12.8
385		12.9	24.2	15.2	11.9	15.0	4.1	13.9
392		12.9	23.	13.9	11.9	16.3	2.8	13.5
420								
448								

* Not used since there were no loaded specimens in Batch A for this test condition.

TABLE D2. RADIAL SHRINKAGE STRAINS FOR AS-CAST SPECIMENS AT 75° F

Days After Loading	Strain, (x 10^{-6}) In Following Specimens A-8*	B-29	C-39	D-20	E-28	F-23	G-18	Average Strain, (x 10^{-6})
2		0	0	0	3.8	1.3	1.3	1.1
5		-1.3	0	1.2	2.5	4.0	1.3	1.3
7		-1.3	-1.3	-1.2	2.5	2.7	1.3	0.5
14		-1.3	-3.9	0	5.1	2.7	0	0.4
21		-6.5	-2.6	0	6.4	1.3	0	-0.2
28		-3.9	-1.3	3.7	3.8	1.3	1.3	0.8
56		-3.9	0	3.7	0	2.7	1.3	0.6
84		-6.5	1.3	5.0	5.1	1.3	0	1.0
112		-3.9	-1.3	5.0	3.8	0	-1.3	.4
140		-3.9	-2.6	3.7	3.8	4.0	1.3	1.1
168		-5.2	0	6.2	5.1	1.3	1.3	1.5
196		-3.9	-2.6	6.8	5.1	5.4	1.3	2.0
224		-5.2	0	8.7	6.4	8.1	6.5	4.1
252		-3.9	0	12.4	8.9	9.4	6.5	5.6
280		-1.3	2.6	11.8	11.5	10.7	6.5	7.0
308		1.3	3.9	11.8	12.7	14.8	11.7	9.4
336		1.3	5.2	17.3	15.3	16.1	11.7	11.2
364		1.3	5.2	17.4	17.8	18.8	13.0	12.2
366		1.3	6.5	18.0	16.5	18.8	14.3	12.6
371		1.3	5.2	19.2	16.5	18.8	14.3	12.5
378		2.6	7.8	19.2	16.5	18.8	14.3	13.2
385		3.9	7.8	18.6	17.8	20.1	16.9	14.2
392		3.9	6.5	17.4	19.1	21.5	14.3	13.8
420		5.2						
448								

* Not used since there were no loaded specimens in Batch A for this test condition.

TABLE D3. AXIAL SHRINKAGE STRAINS FOR AIR-DRIED SPECIMENS AT 75° F

Days After Loading	Strain, (x 10^{-6}) In Following Specimens							Average Strain, (x 10^{-6})
	A-38*	B-23	C-6	D-33	E-23	F-17	G-10	
2		-1.2	0	0	1.3	-1.3	-1.3	0.4
5		-2.4	-3.5	-2.4	-2.5	0	-1.3	-2.0
7		-4.2	-5.9	-6.0	-2.5	-2.5	-5.2	-4.4
14		-2.4	-10.7	-7.2	-2.5	-5.1	-7.8	-5.9
21		-11.9	-10.7	-6.6	-3.8	-8.9	-9.1	-8.5
28		-11.9	-10.7	-7.9	-5.1	-10.2	-10.4	-9.4
56		-17.9	-14.8	-13.2	-12.8	-14.0	-15.6	-14.7
84		-22.7	-16.6	-17.4	-12.8	-21.8	-19.5	-18.5
112		-27.5	-23.20	-24.1	-16.6	-25.7	-26.1	-23.9
140		-31.7	-27.4	-28.3	-19.2	-25.7	-26.1	-26.4
168		-35.3	-27.4	-28.3	-20.5	-32.1	-30.0	-28.9
196		-37.7	-32.8	-	-23.0	-32.1	-31.3	-31.4
224		-42.0	-32.7	-33.2	-24.3	-32.1	-28.7	-32.2
252		-42.6	-32.2	-30.2	-23.0	-33.4	-31.3	-32.1
280		-43.2	-32.2	-35.0	-24.3	-34.7	-32.6	-33.7
308		-42.6	-32.2	-37.5	-25.6	-34.7	-30.0	-33.7
336		-44.4	-31.6	-35.6	-26.9	-37.3	-31.3	-34.5
364		-46.2	-32.8	-35.6	-25.6	-37.3	-32.7	-35.0
366		-45.6	-32.2	-35.6	-26.9	-37.3	-31.3	-34.8
371		-46.2	-32.2	-38.1	-26.9	-38.6	-31.3	-35.6
378		-45.6	-29.8	-39.9	-28.2	-39.9	-31.3	-35.8
385		-44.4	-30.4	-39.9	-28.2	-39.9	-30.0	-35.5
392		-45.6	-32.2	-39.9	-28.2	-37.3	-32.7	-36.0
420								
448								

* Not used since there were no loaded specimens in Batch A for this test condition.

TABLE D4. RADIAL SHRINKAGE STRAINS FOR AIR-DRIED SPECIMENS AT 75° F

Days After Loading	Strain, ($\times 10^{-6}$) In Following Specimens							Average Strain, ($\times 10^{-6}$)
	A-38*	B-23	C-6	D-33	E-23	F-17	G-10	
2		3.6	1.2	2.4	2.5	1.3	1.3	2.0
5		3.6	2.4	5.3	3.8	6.5	5.2	4.5
7		4.8	1.8	3.6	5.0	6.5	3.9	4.3
14		1.8	1.8	8.9	11.4	9.1	6.5	6.6
21		6.0	7.3	10.1	15.1	10.4	9.0	9.7
28		10.1	9.7	17.2	16.4	10.4	12.9	12.8
56		15.5	14.5	23.1	18.9	14.3	16.8	17.2
84		16.6	17.5	23.7	25.2	13.0	18.1	19.0
112		17.8	15.7	23.1	26.4	11.7	16.8	18.6
140		16.7	13.9	21.3	25.2	13.0	19.3	18.2
168		14.9	15.7	21.3	25.2	9.1	16.8	17.2
196		16.0	10.9	gf	25.2	11.7	18.0	16.4
224		13.7	13.9		25.2	11.7	20.6	17.0
252		14.3	14.5		26.4	11.7	19.3	17.3
280		14.9	13.9		25.2	10.4	18.1	16.5
308		16.0	13.9		25.2	11.7	21.9	17.8
336		14.9	16.3		25.2	10.5	20.6	17.5
364		14.9	16.3		26.4	10.5	20.6	17.7
366		16.1	16.3		25.2	10.5	20.6	17.7
371		14.9	16.9		25.2	9.1	20.6	17.3
378		14.9	18.1		23.9	9.1	21.9	17.6
385		15.5	18.1		25.2	10.5	21.9	18.2
392		16.1	16.9		25.2	11.8	20.6	18.1
420								
448								

* Not used since there were no loaded specimens in Batch A for this test condition.

gf Gage failed or began to function improperly.

TABLE D5. AXIAL SHRINKAGE STRAINS FOR AS-CAST SPECIMENS AT 150° F

Days After Loading	Strain, ($\times 10^{-6}$) In Following Specimens							Average Strain, ($\times 10^{-6}$)
	A-22*	B-13	C-41	D-12**	E-10	F-15**	G-1	
2		-7.3	-4.9		-7.7		-4.	-6.
5		-7.9	-7.4		-10.3		-10.6	-9.
7		-16.5	-16.0		-14.10		-10.6	-14.3
14		-22.6	-16.0		-18.0		-18.6	-18.8
21		-21.4	-16.0		-19.3		-22.6	-19.8
28		-23.2	-19.8		-19.8		-26.6	-22.5
56		-29.4	-23.5		-37.3		-52.0	-35.6
84		-41.8	-19.8		-32.2		-39.9	-33.4
112		gf	-23.5		-30.8		-47.6	-34.0
140			-22.2		-30.9		-44.0	-32.4
168			-23.5		-30.9		-42.6	-32.3
196			-26.0		-30.9		-41.3	-32.7
224			-33.4		-30.9		-33.2	-32.5
252			-29.7		-30.9		-26.6	-29.0
280			-29.7		-30.9		gf	-30.3
308			-30.9		-29.6			-30.3
336			-32.2		-29.6			-30.9
364			-32.2		-25.7			-28.9
366			-32.2		-25.7			-28.9
371			-32.2		-25.7			-28.9
378			-32.2		-25.7			-28.9
385			-33.4		-24.4			-28.9
392			-34.7		-24.4			-29.6
420								
448								

* Not used since there were no loaded specimens in Batch A for this test condition.

** Not used in average because specimens were losing moisture or gages were functioning improperly.

gf Gage failed or began to function improperly.

TABLE D6. RADIAL SHRINKAGE STRAINS FOR AS-CAST SPECIMENS AT 150° F

Days After Loading	Strain, (x 10^{-6}) In Following Specimens A-22*	B-13**	C-41	D-12**	E-10	F-15	G-1	Average Strain, (x 10^{-6})
2			-5.4		-8.4	-8.6	-5.2	-6.9
5			-7.8		-10.2	-9.9	-10.4	-9.6
7			-16.9		-14.4	-12.4	-13.0	-14.2
14			-16.9		-18.1	-15.5	-20.9	-17.8
21			-18.7		-19.2	-19.2	-26.20	-20.8
28			-24.8		-21.0	-21.7	-30.1	-24.4
56			-30.8		-36.8	-27.9	-56.6	-38.0
84			-30.2		gf	-34.2	-47.3	-37.2
112			-37.5			-34.2	-46.0	-39.2
140			-36.9			-37.9	-48.7	-41.2
168			-38.1			gf	-48.7	-43.4
196			-39.4				-48.7	-44.0
224			-45.5				-47.3	-46.4
252			-40.6				-47.3	-44.0
280			-40.0				-43.4	-41.7
308			-40.0				-40.7	-40.3
336			-39.4				-39.4	-39.4
364			-36.9				-35.4	-36.2
366			-36.3				-35.4	-35.9
371			-36.3				-32.8	-34.6
378			-36.3				-34.1	-35.2
385			-36.9				-31.4	-34.2
392			-36.9				-28.8	-32.9
420								
448								

* Not used since there were no loaded specimens in Batch A for this test condition.

** Not used in average because specimens were losing moisture or gages were functioning improperly.

gf Gage failed or began to function improperly.

TABLE D7. AXIAL SHRINKAGE STRAINS FOR AIR-DRIED SPECIMENS AT 150° F

Days After Loading	Strain, (x 10^{-6}) In Following Specimens							Average Strain, (x 10^{-6})
	A-32*	B-26	C-36**	D-23	E-42	F-21	G-21	
2		-3.4		-6.3	-10.0	-7.6	-6.4	-6.7
5		-11.5		-13.3	-15.8	-12.7	-13.9	-13.5
7		-21.3		-15.0	-19.4	-16.5	-16.3	-17.7
14		-31.1		-27.2	-29.4	-22.9	-27.5	-27.6
21		-31.7		-36.6	-35.4	-29.3	-33.3	-33.3
28		-33.4		-38.3	-41.3	-33.2	-35.7	-36.4
56		-42.7		-51.3	-62.9	-39.6	-67.2	-52.7
84		-60.9		-72.0	-62.9	-48.6	-61.2	-61.1
112		-59.7		-67.2	-62.9	-47.3	-64.2	-60.3
140		-61.5		-70.2	-65.3	-48.6	-69.0	-62.9
168		-65.0		-73.2	-67.1	-48.6	-70.8	-64.9
196		-66.8		-75.0	-67.1	-56.4	-72.6	-67.6
224		-66.8		-78.0	-66.5	-48.63	-72.6	-66.5
252		-67.4		-78.5	-77.3	-43.34	-73.2	-68.8
280		-63.8		-79.1	-65.9	-46.0	-72.6	-65.5
308		-69.7		-79.1	-64.7	-44.8	-72.0	-66.1
336		-70.3		-79.7	-65.3	-44.8	-72.6	-66.5
364		-71.5		-77.9	-64.7	-44.8	-70.2	-65.8
366		-70.9		-77.9	-64.7	-43.5	-69.6	-65.3
371		-72.1		-77.9	-64.7	-43.5	-70.8	-65.8
378		-72.7		-79.7	-64.1	-43.5	-70.2	-66.0
385		-71.5		-80.3	-63.5	-43.5	-69.	-65.6
392		-72.1		-79.7	-62.3	-42.2	-67.2	-64.7
420								
448								

* Not used since there were no loaded specimens in Batch A for this test condition.

** Not used in average because specimens were losing moisture or gages were functioning improperly.

TABLE D8. RADIAL SHRINKAGE STRAINS FOR AIR-DRIED SPECIMENS AT 150° F

Days After Loading	Strain, (x 10^{-6}) In Following Specimens A-32*	B-26	C-36**	D-23	E-42	F-21**	G-21	Average Strain, (x 10^{-6})
2		-2.4		-3.5	-8.1		-2.6	-4.1
5		-6.5		-5.3	-9.8		-6.4	-7.0
7		-14.3		-5.9	-12.1		-6.4	-9.7
14		-20.1		-11.2	-16.2		-11.6	-15.0
21		-19.1		-16.0	-17.4		-14.1	-16.6
28		-20.9		-16.5	-19.7		-14.1	-17.8
56		-26.9		-24.3	-37.8		-32.3	-30.3
84		-46.2		-44.0	-30.8		gf	-40.3
112		-41.4		-35.6	-32.5			-36.5
140		-40.8		-41.0	-35.5			-39.0
168		-42.6		-44.6	-39.6			-42.3
196		-45.6		-47.6	-42.5			-45.2
224		-46.8		-50.6	-44.3			-47.2
252		-48.0		-53.6	-54.3			-52.0
280		-55.9		-56.0	-47.2			-53.1
308		-49.3		-58.4	-47.8			-51.8
336		-49.3		-60.3	-50.2			-53.2
364		-49.3		-61.5	-52.			-54.2
366		-48.7		-61.5	-52.			-54.0
371		-49.3		-62.1	-52.5			-54.6
378		-50.5		-63.9	-52.6			-55.6
385		-48.1		-65.1	-52.			-55.0
392		-49.3		-65.1	-52.6			-55.6
420								
448								

* Not used since there were no loaded specimens in Batch A for this test condition.

** Not used in average because specimens were losing moisture or gages were functioning improperly.

gf Gage failed or began to function improperly.

APPENDIX E

TOTAL STRAIN CURVES AFTER LOADING

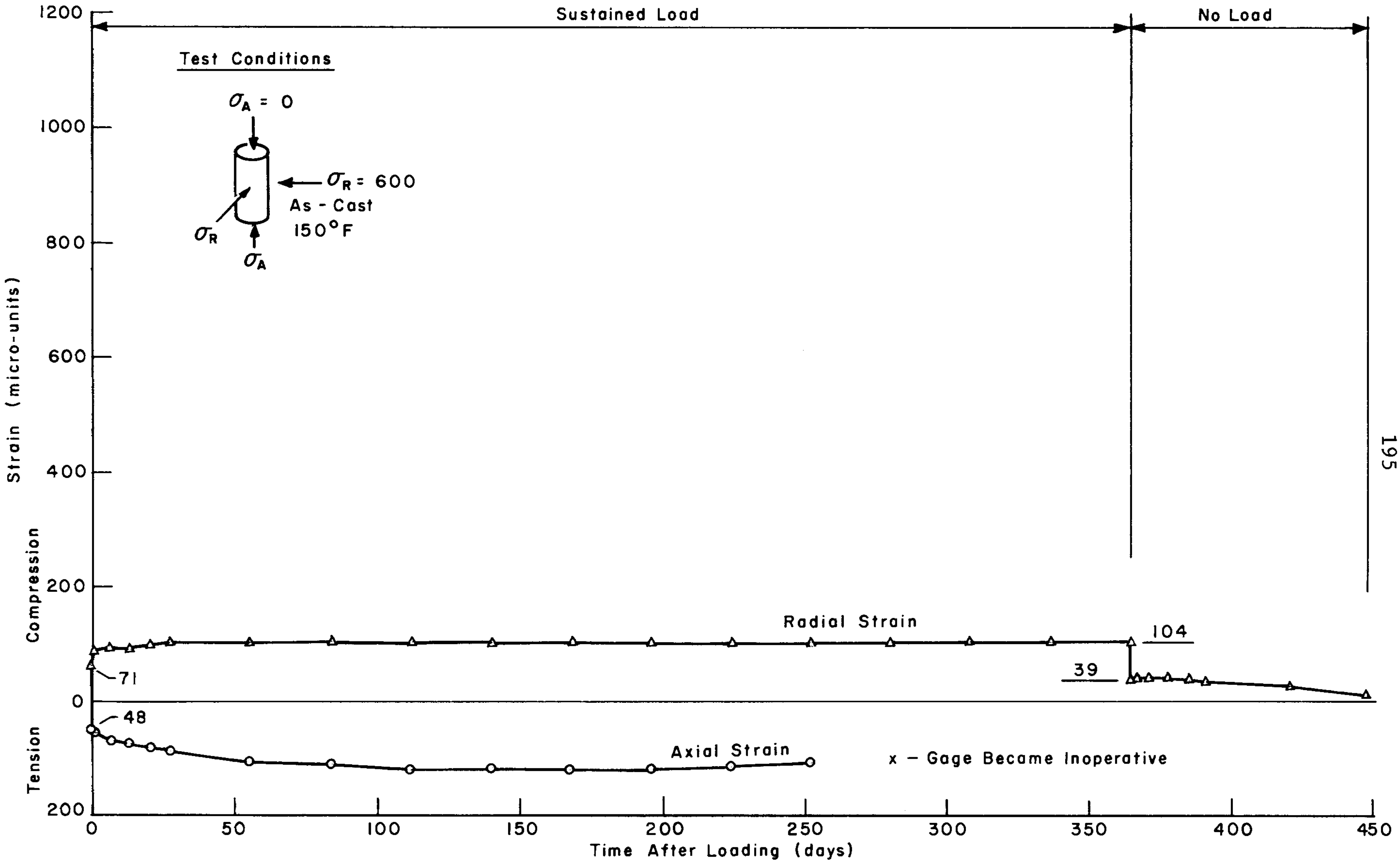


Fig E1. Total axial and radial strain curves for specimen A-35.

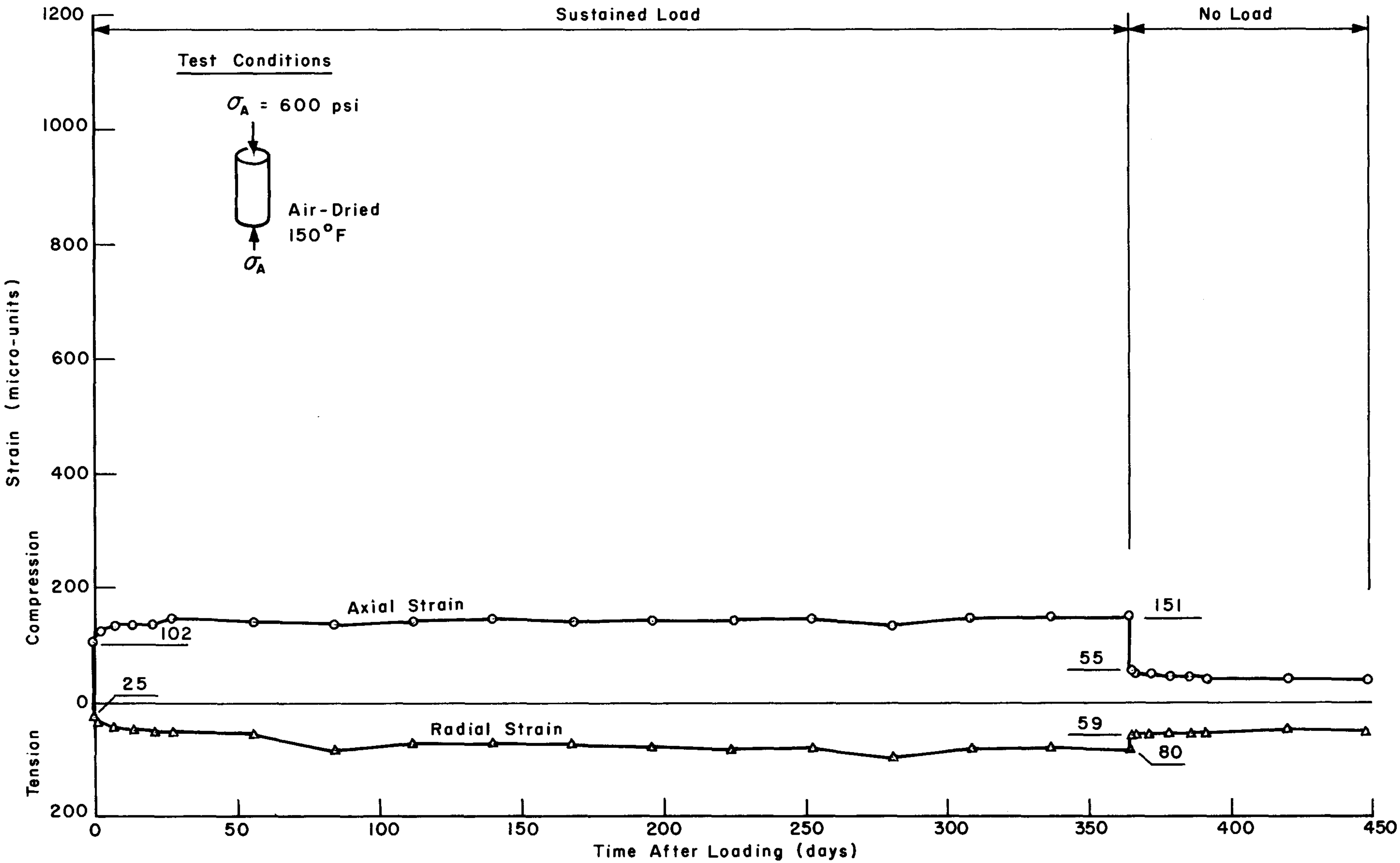


Fig E2. Total axial and radial strain curves for specimen B-1.

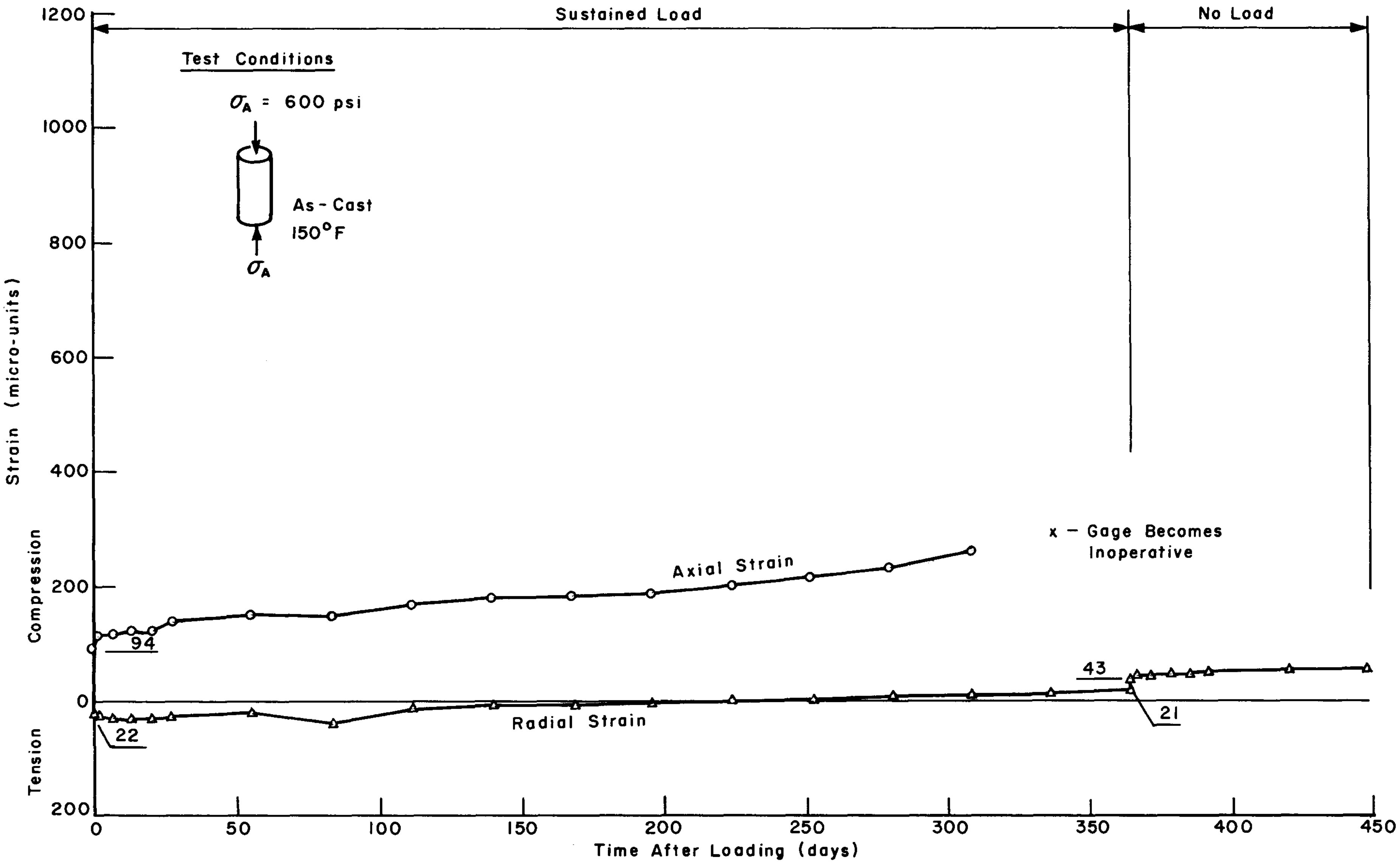


Fig E3. Total axial and radial strain curves for specimen B-4.

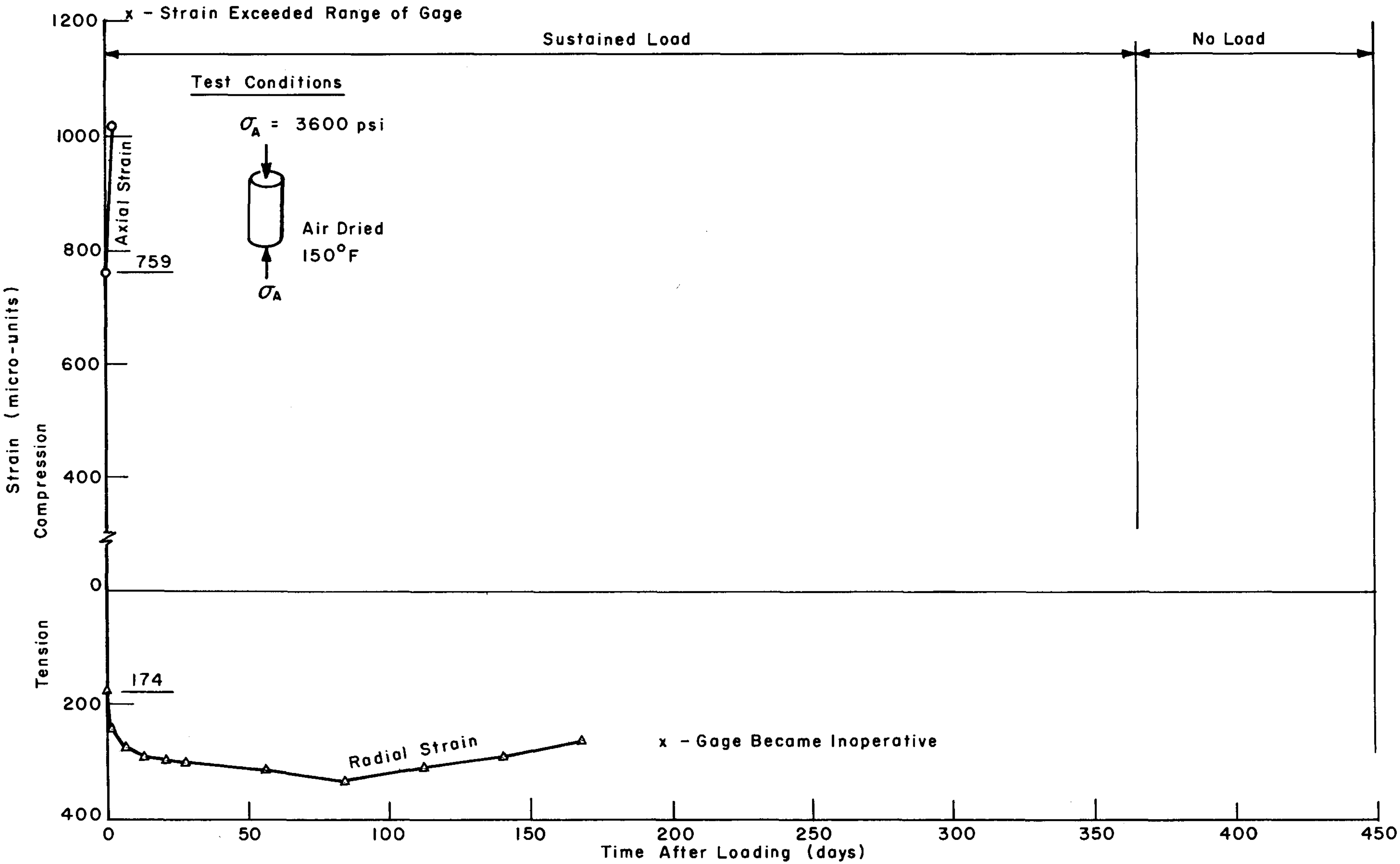


Fig E4. Total axial and radial strain curves for specimen B-5.

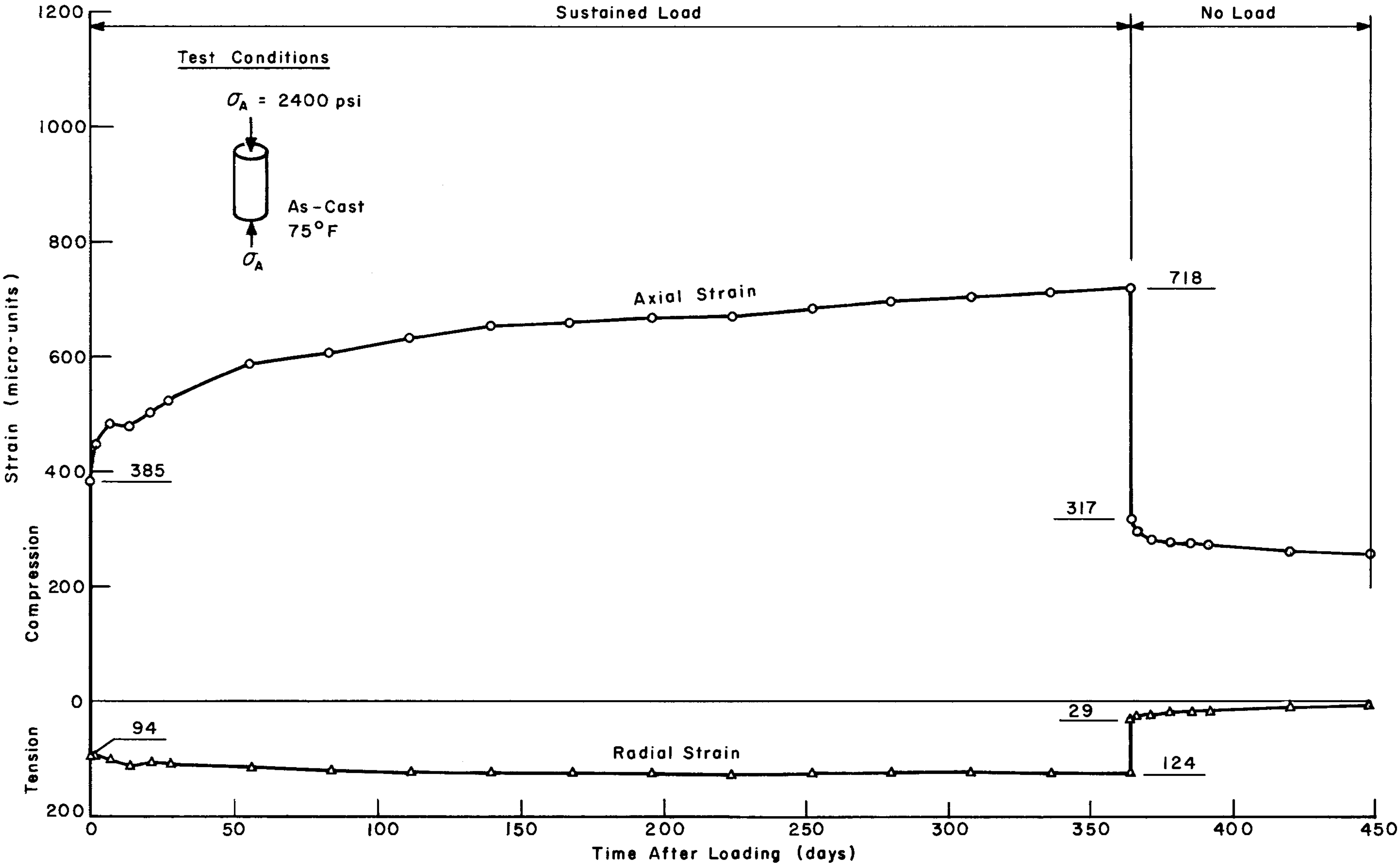


Fig E5. Total axial and radial strain curves for specimen B-7.

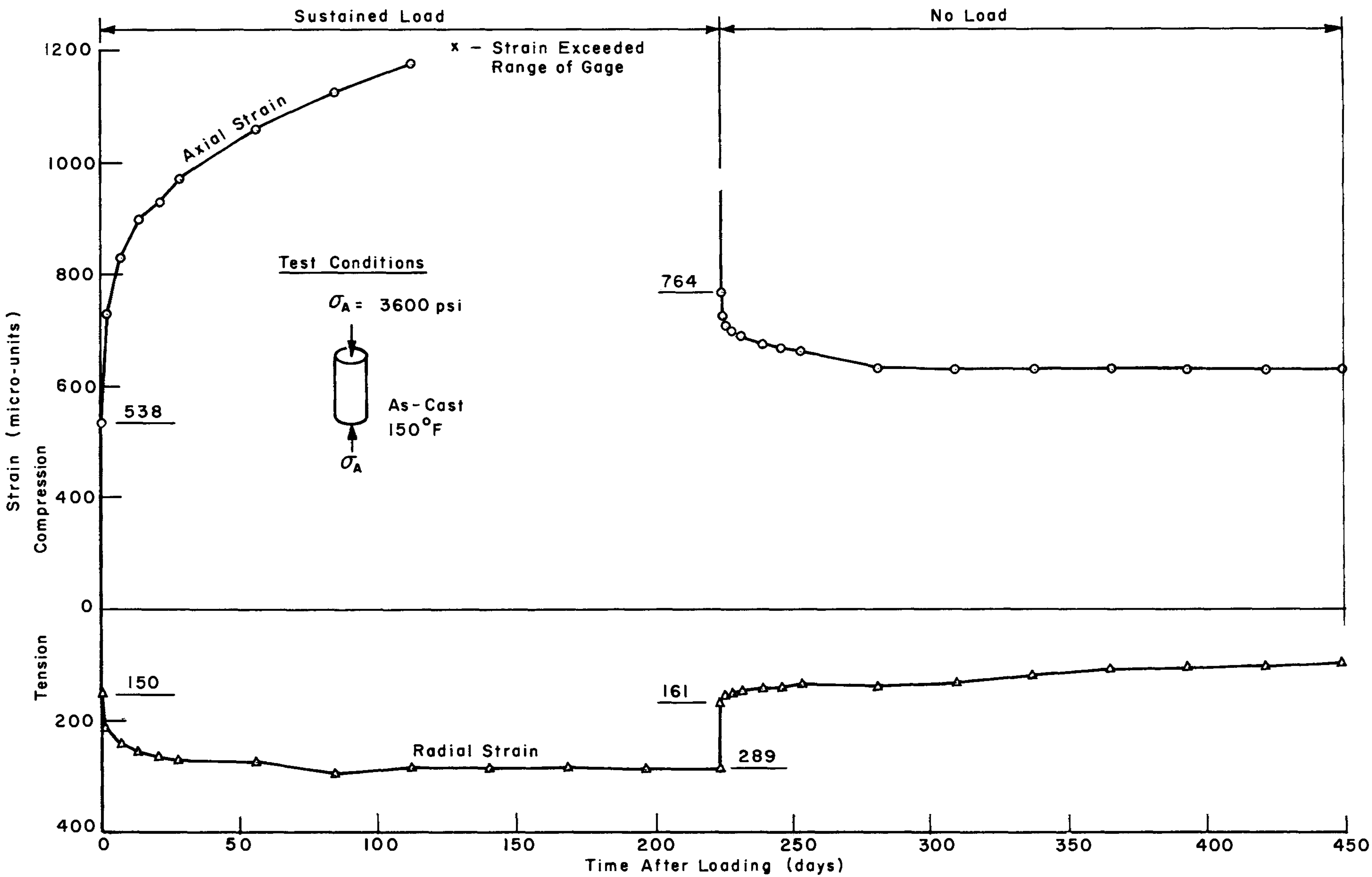


Fig E6. Total axial and radial strain curves for specimen B-16.

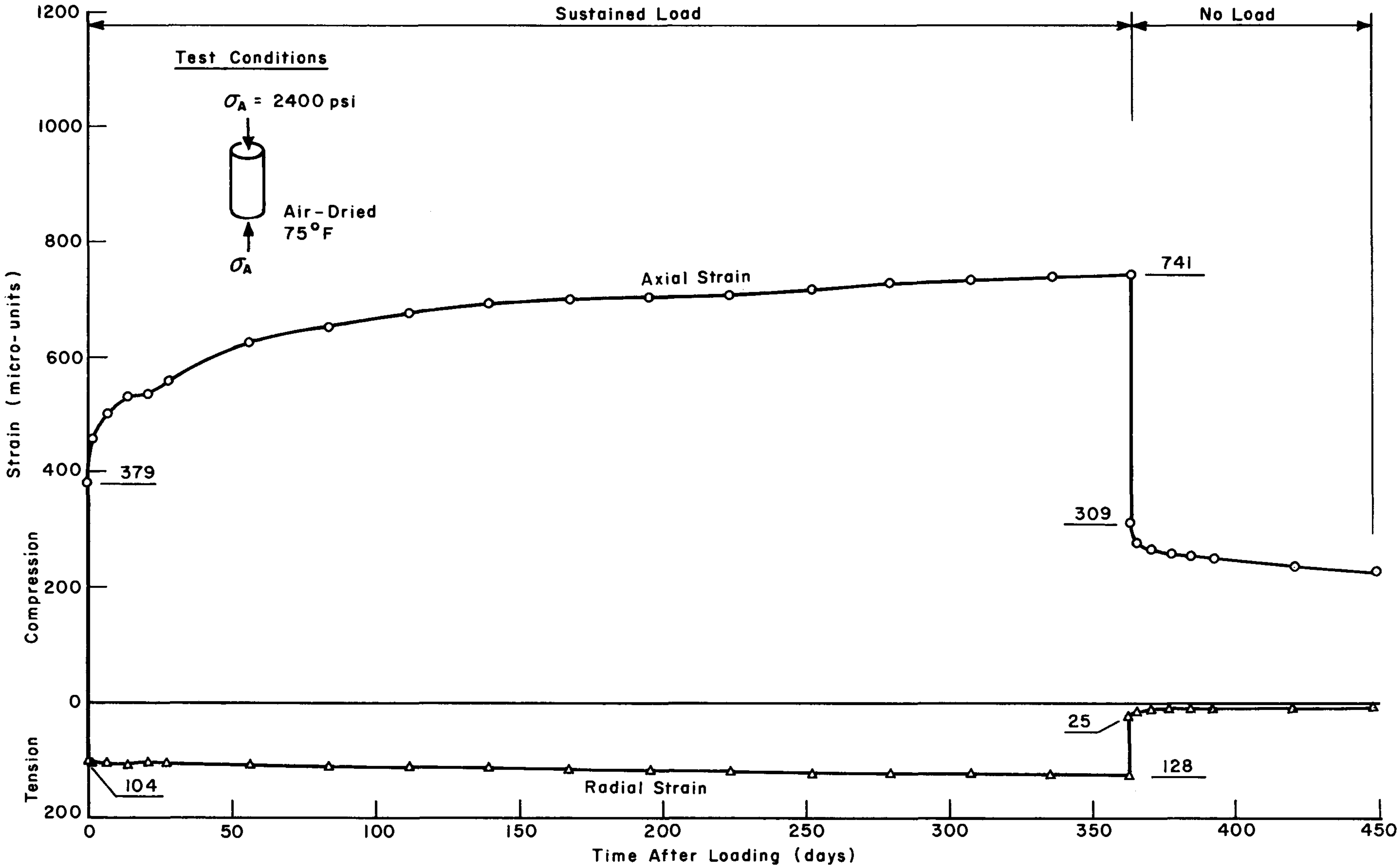


Fig E7. Total axial and radial strain curves for specimen B-19.

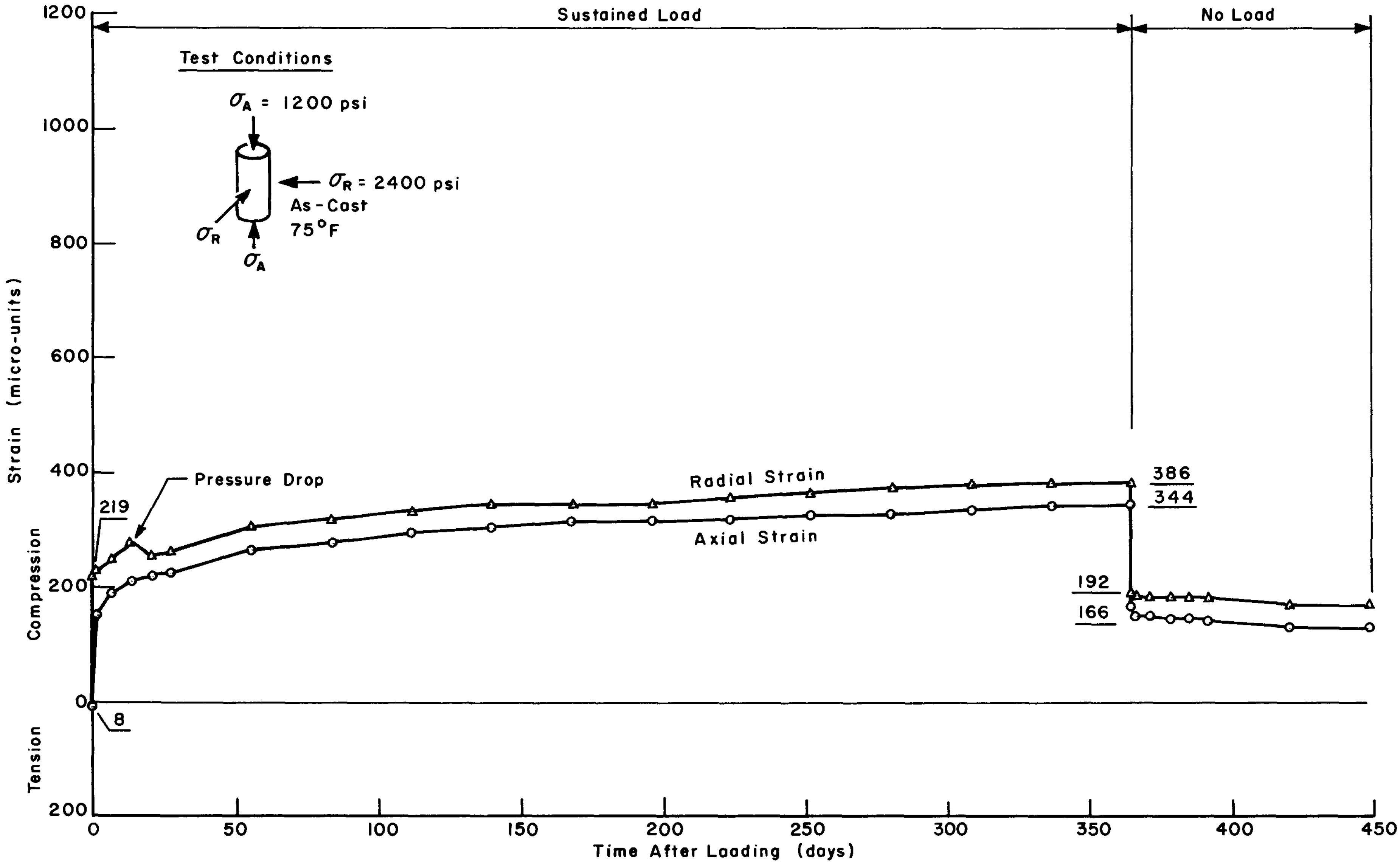


Fig E8. Total axial and radial strain curves for specimen B-41.

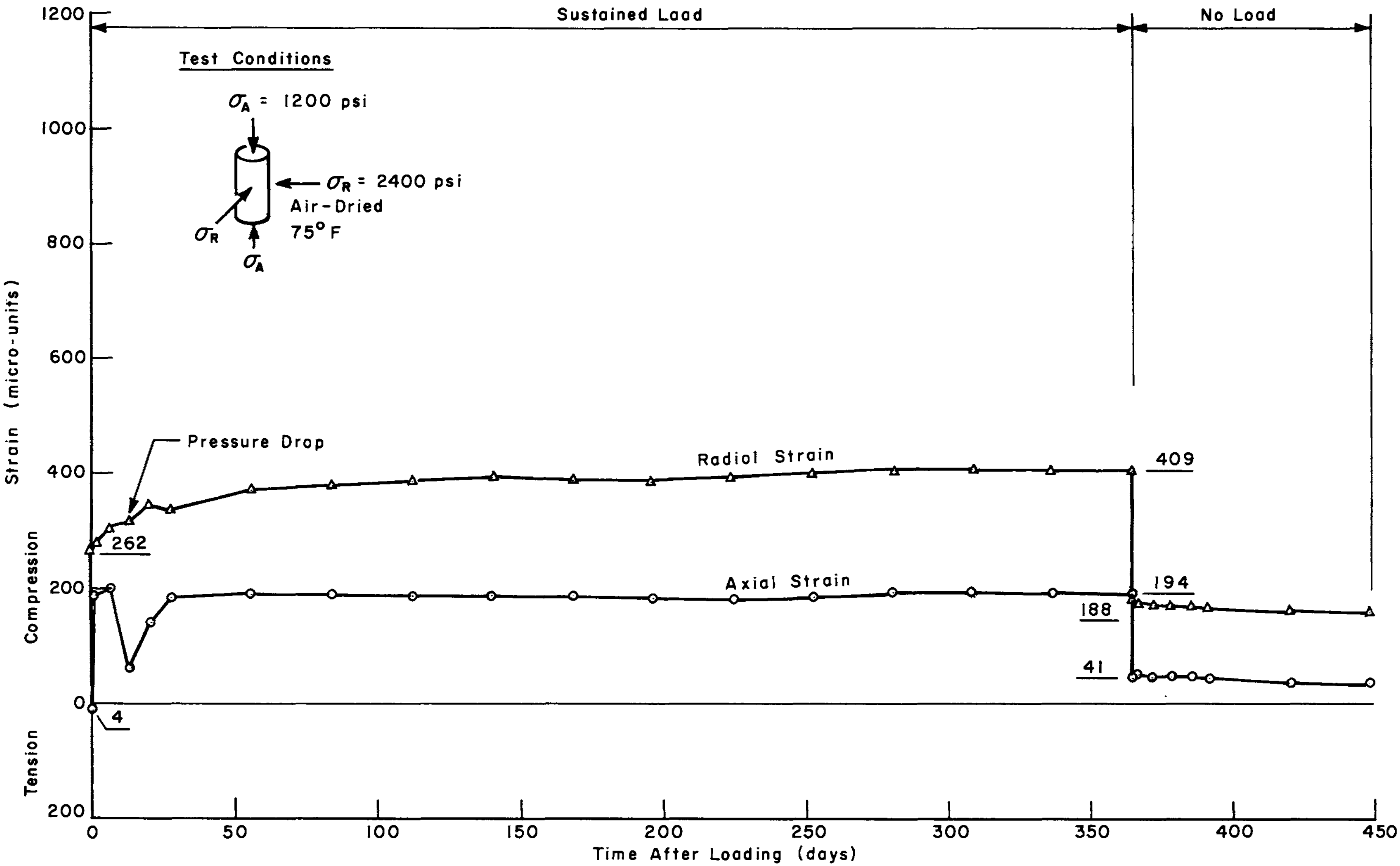


Fig E9. Total axial and radial strain curves for specimen B-42.

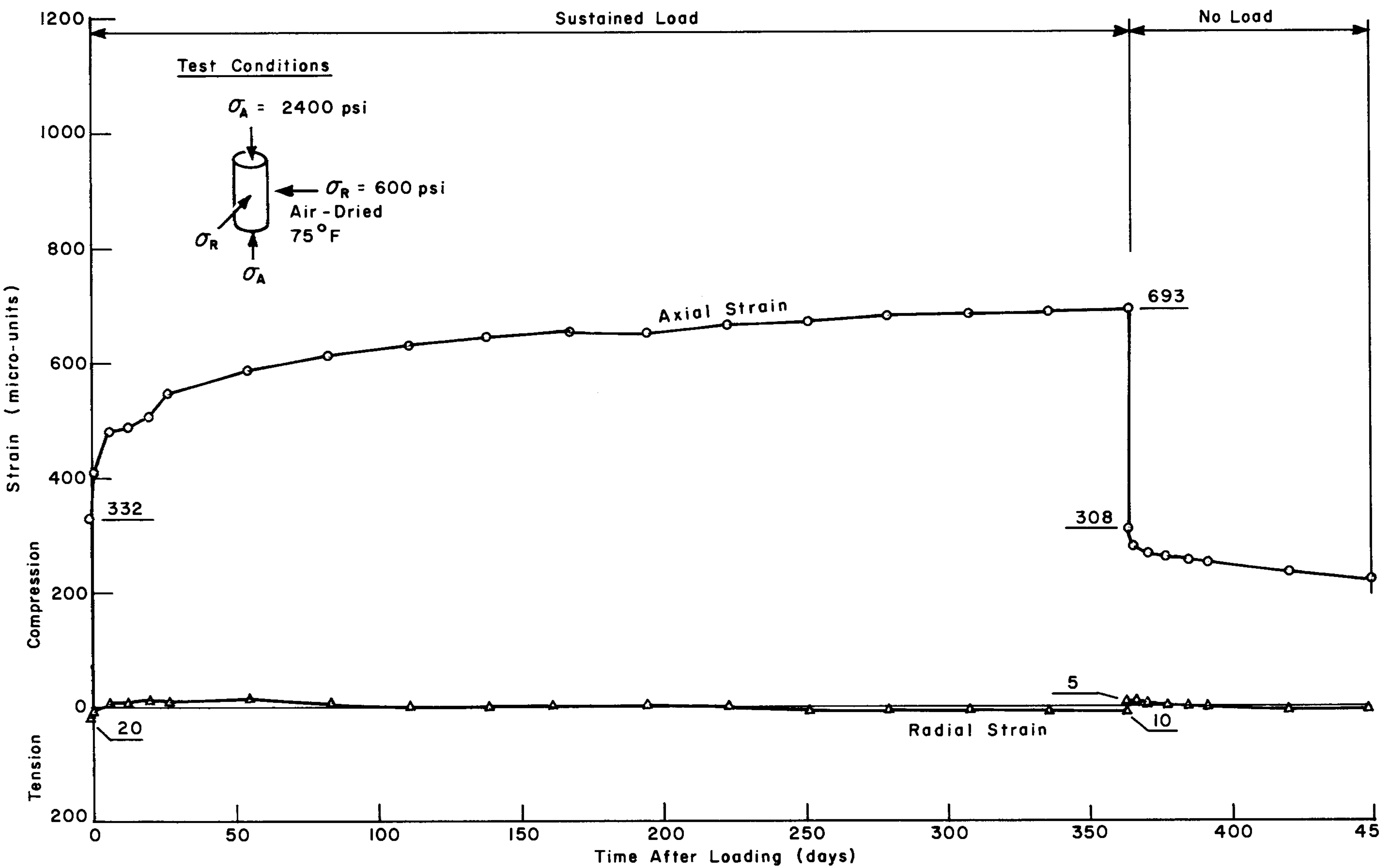


Fig E10. Total axial and radial strain curves for specimen C-11.

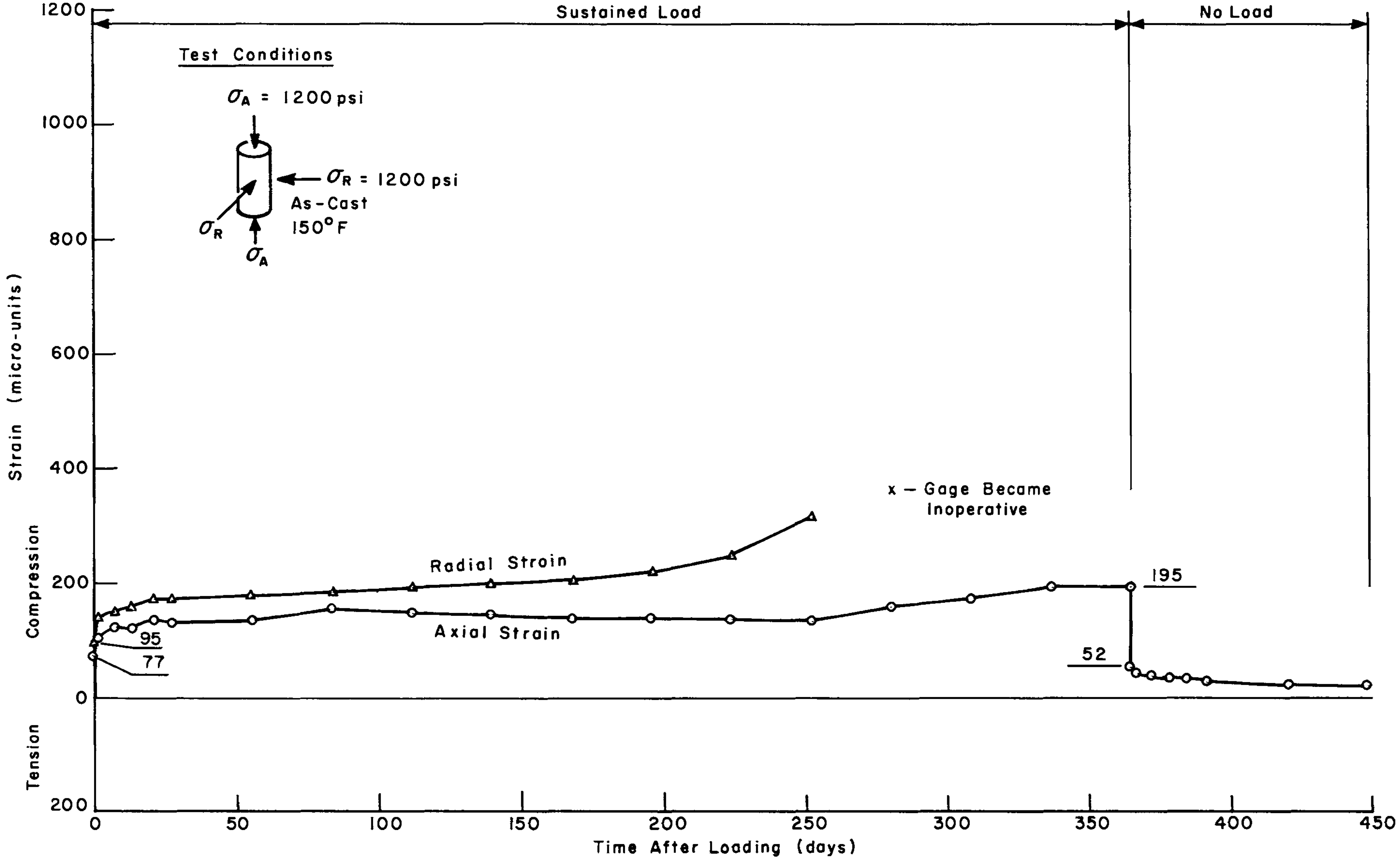


Fig E11. Total axial and radial strain curves for specimen C-12.

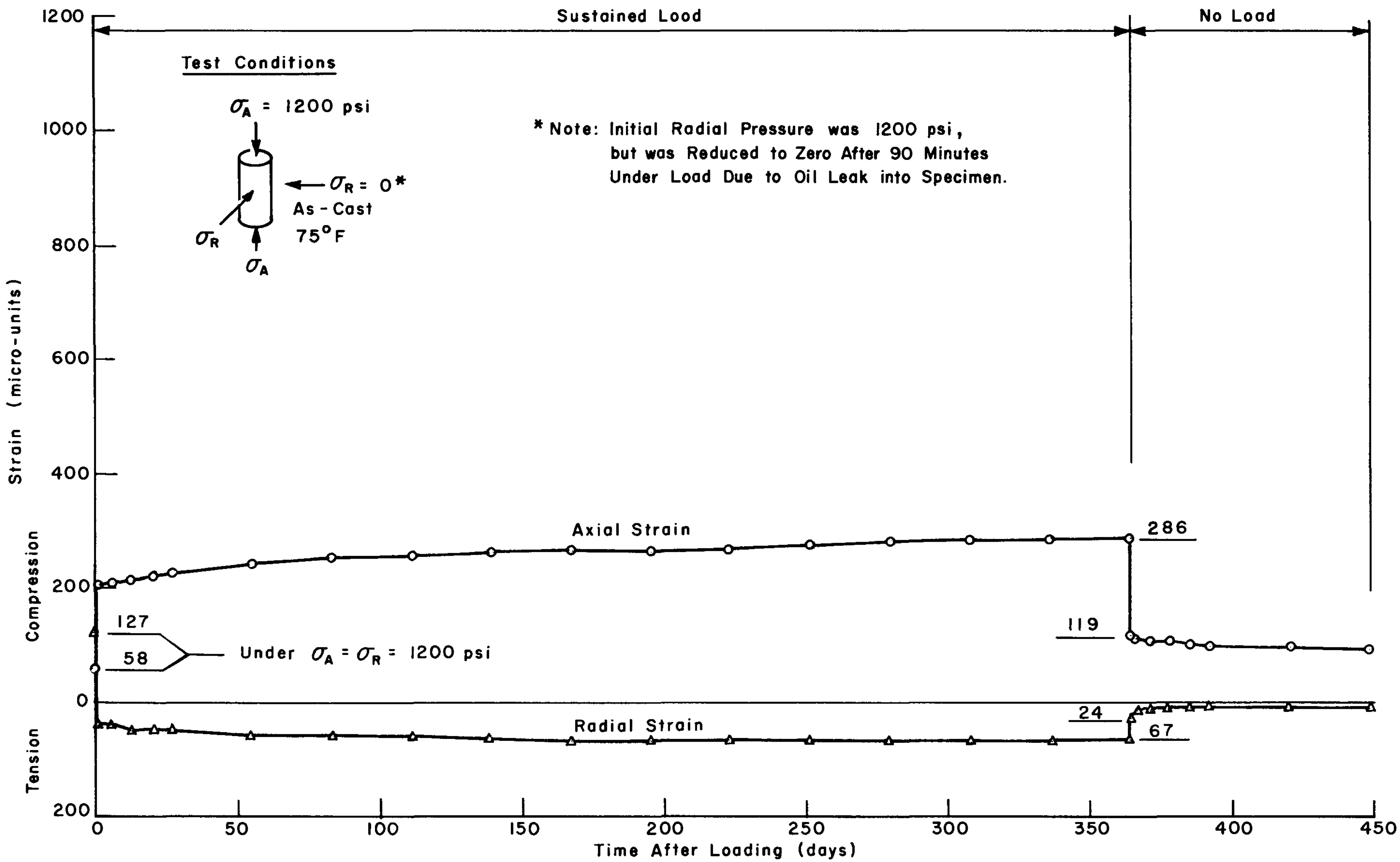


Fig E12. Total axial and radial strain curves for specimen C-16.

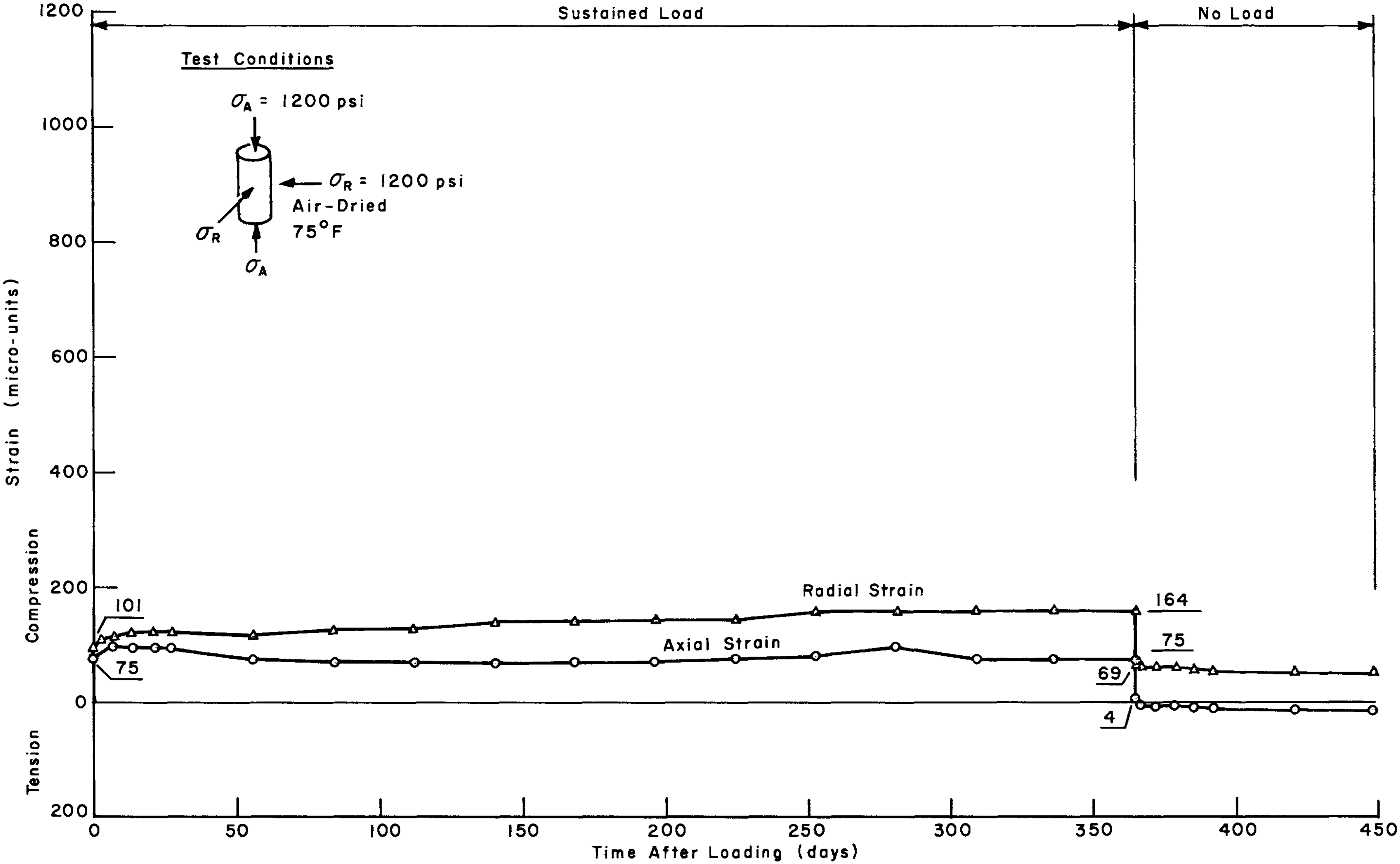


Fig E13. Total axial and radial strain curves for specimen C-17.

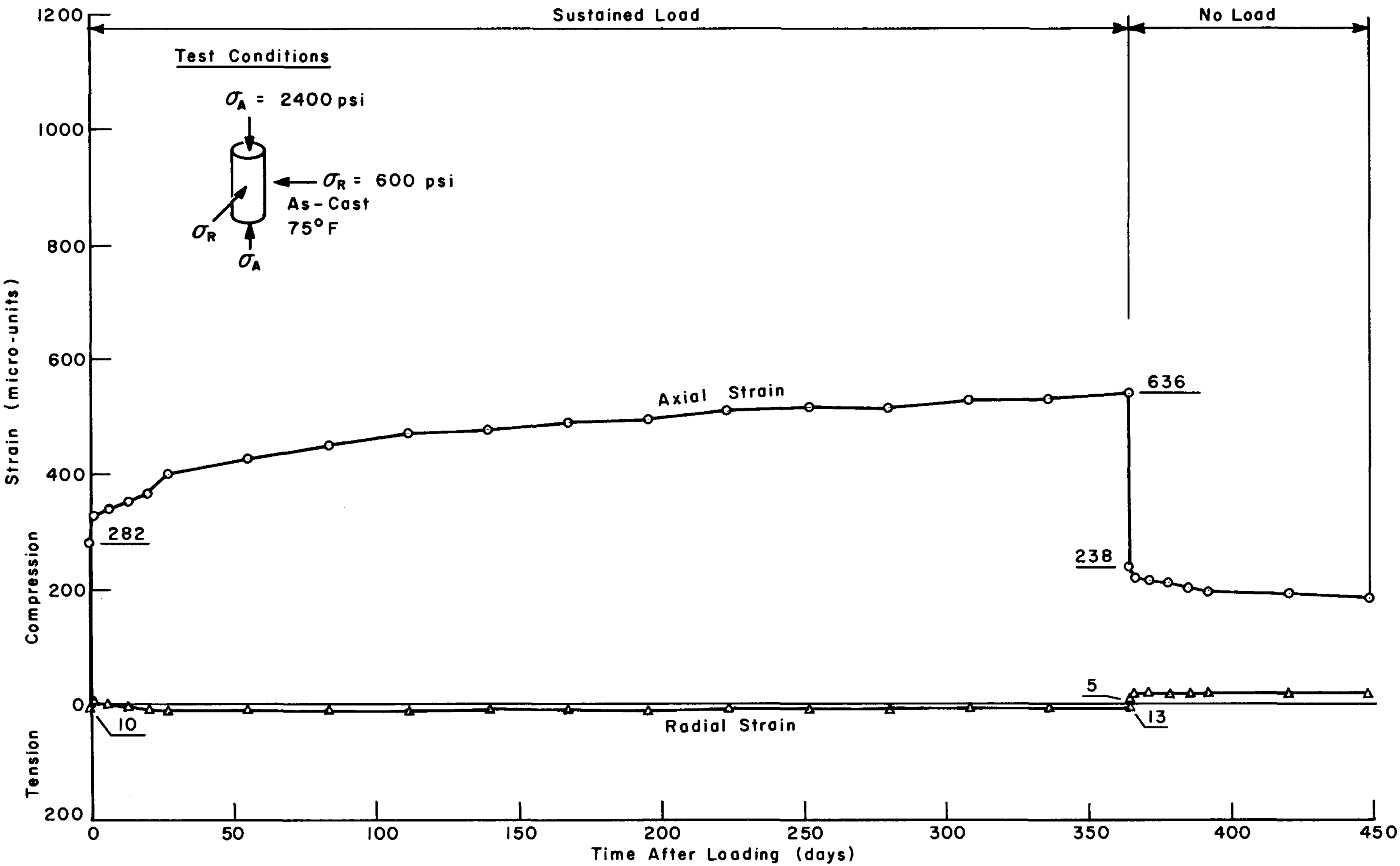


Fig E14. Total axial and radial strain curves for specimen C-23.

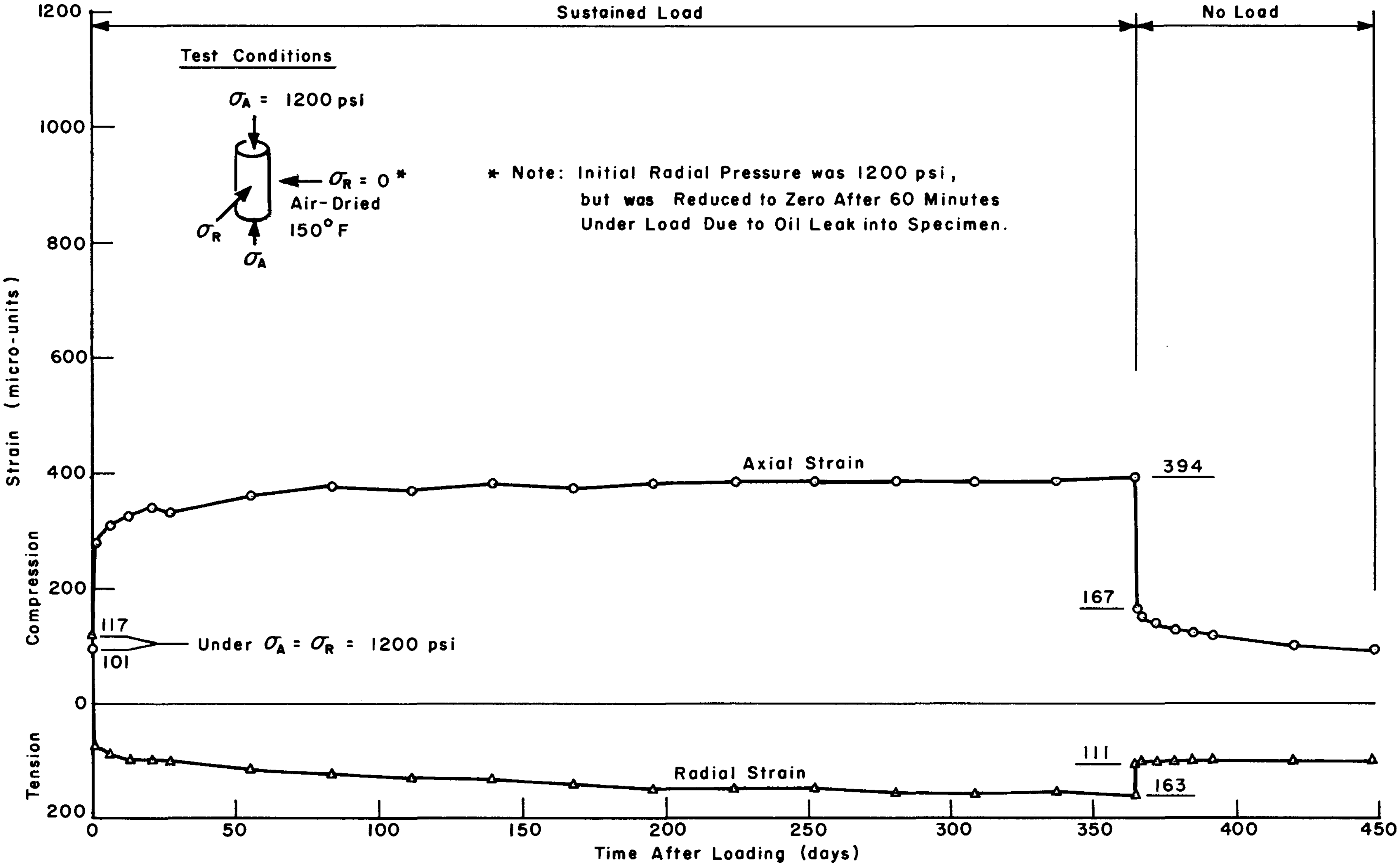


Fig E15. Total axial and radial strain curves for specimen C-46.

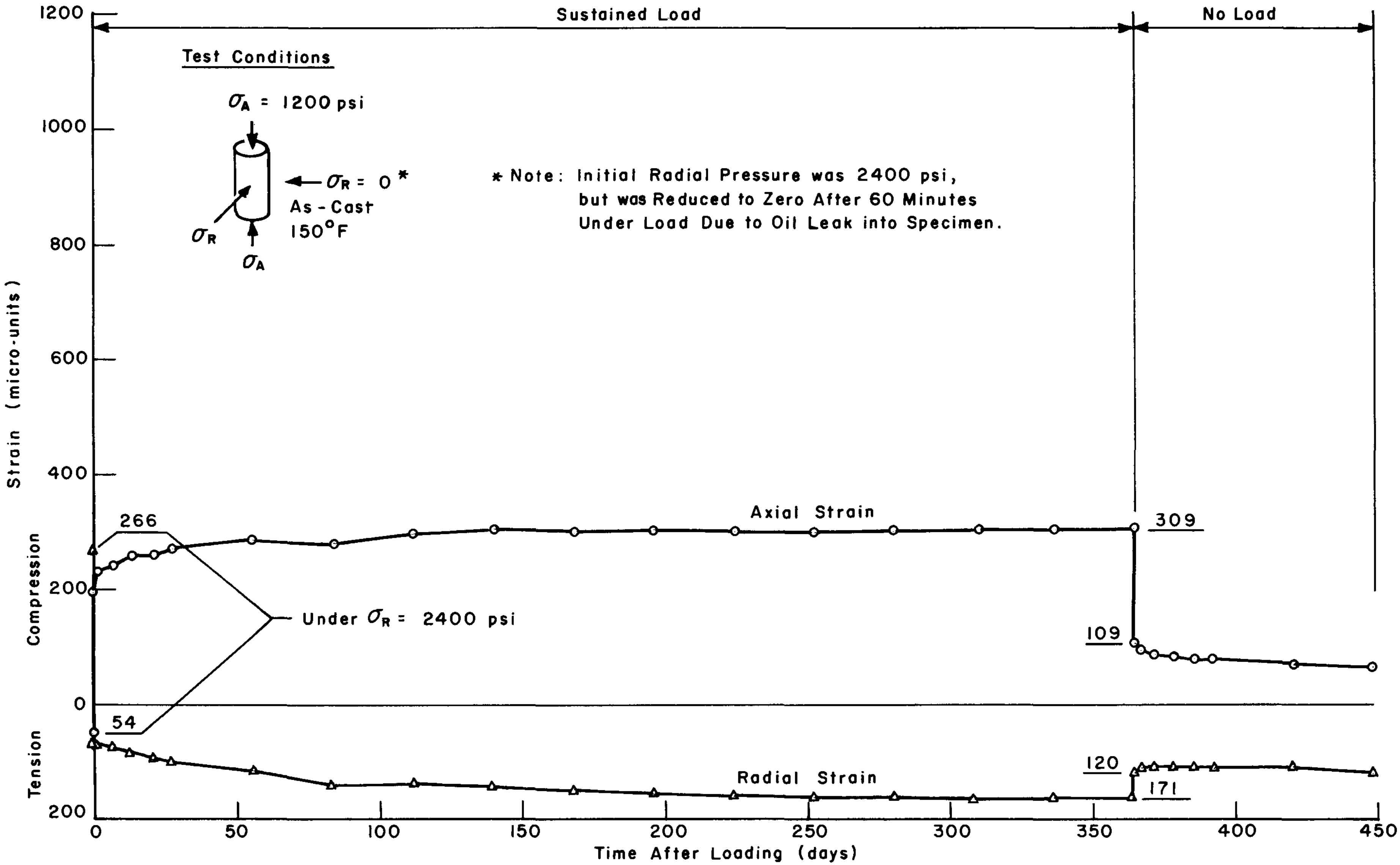


Fig E16. Total axial and radial strain curves for specimen D-2.

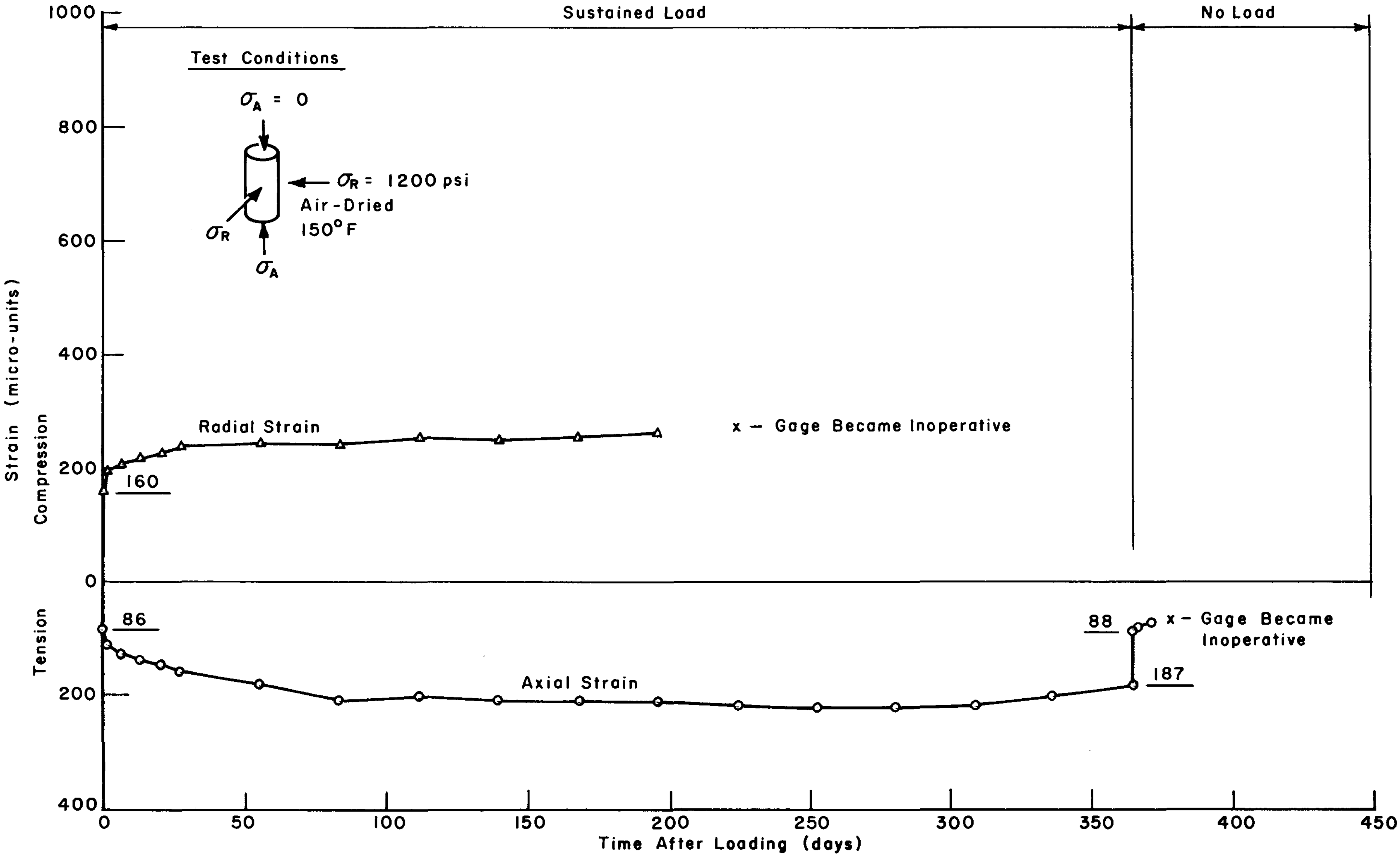


Fig E17. Total axial and radial strain curves for specimen D-3.

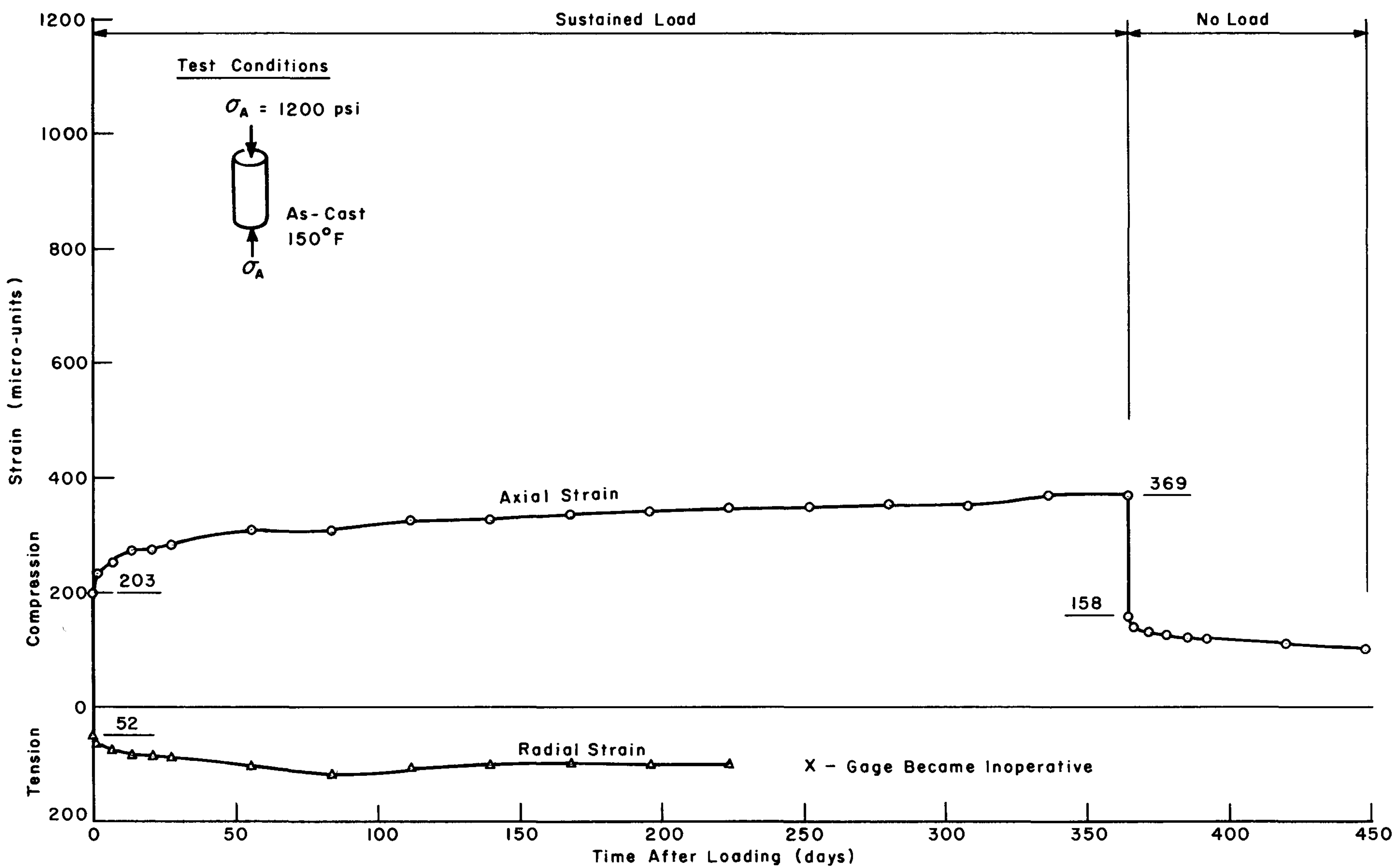


Fig E18. Total axial and radial strain curves for specimen D-15.

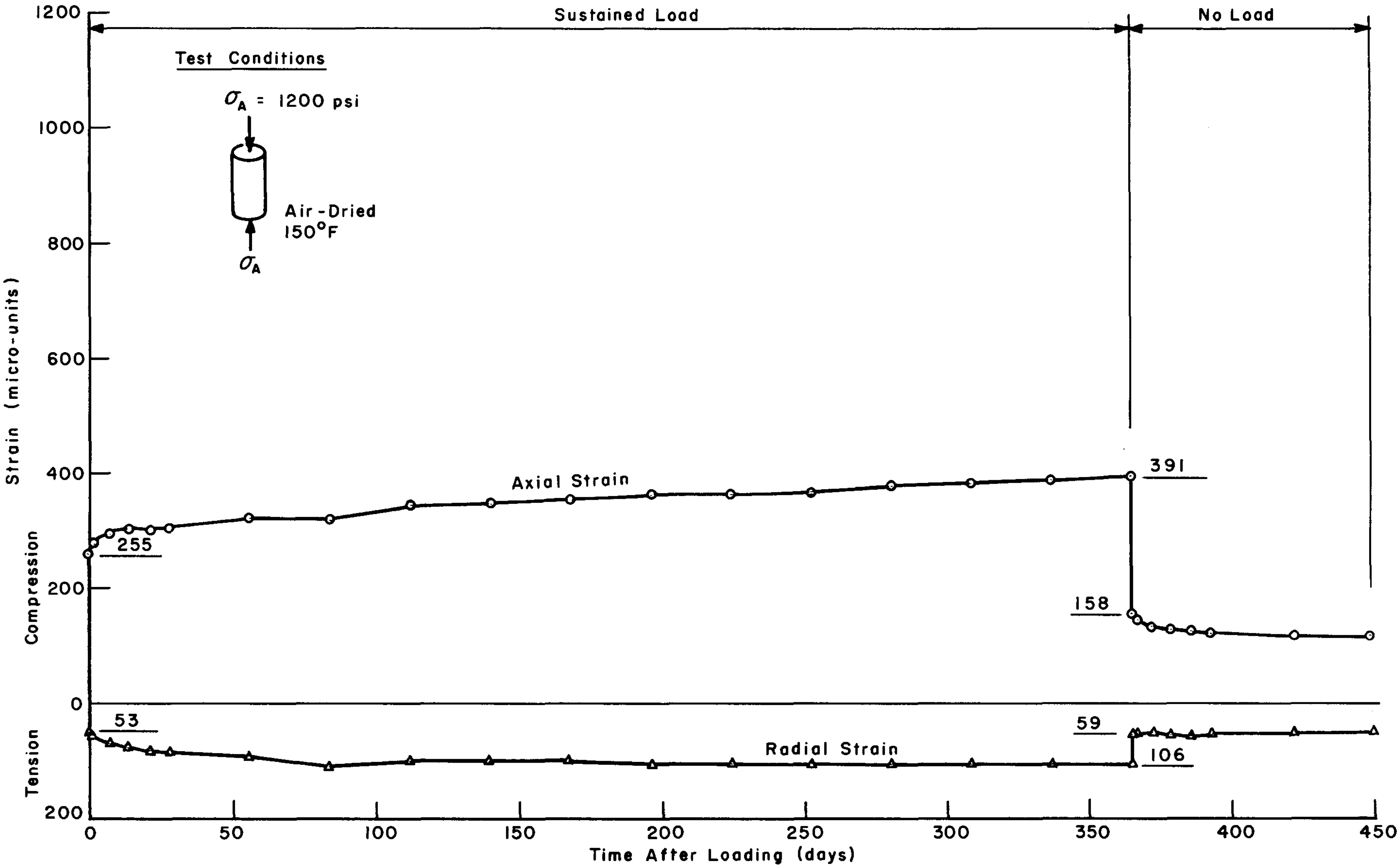


Fig E19. Total axial and radial strain curves for specimen D-22.

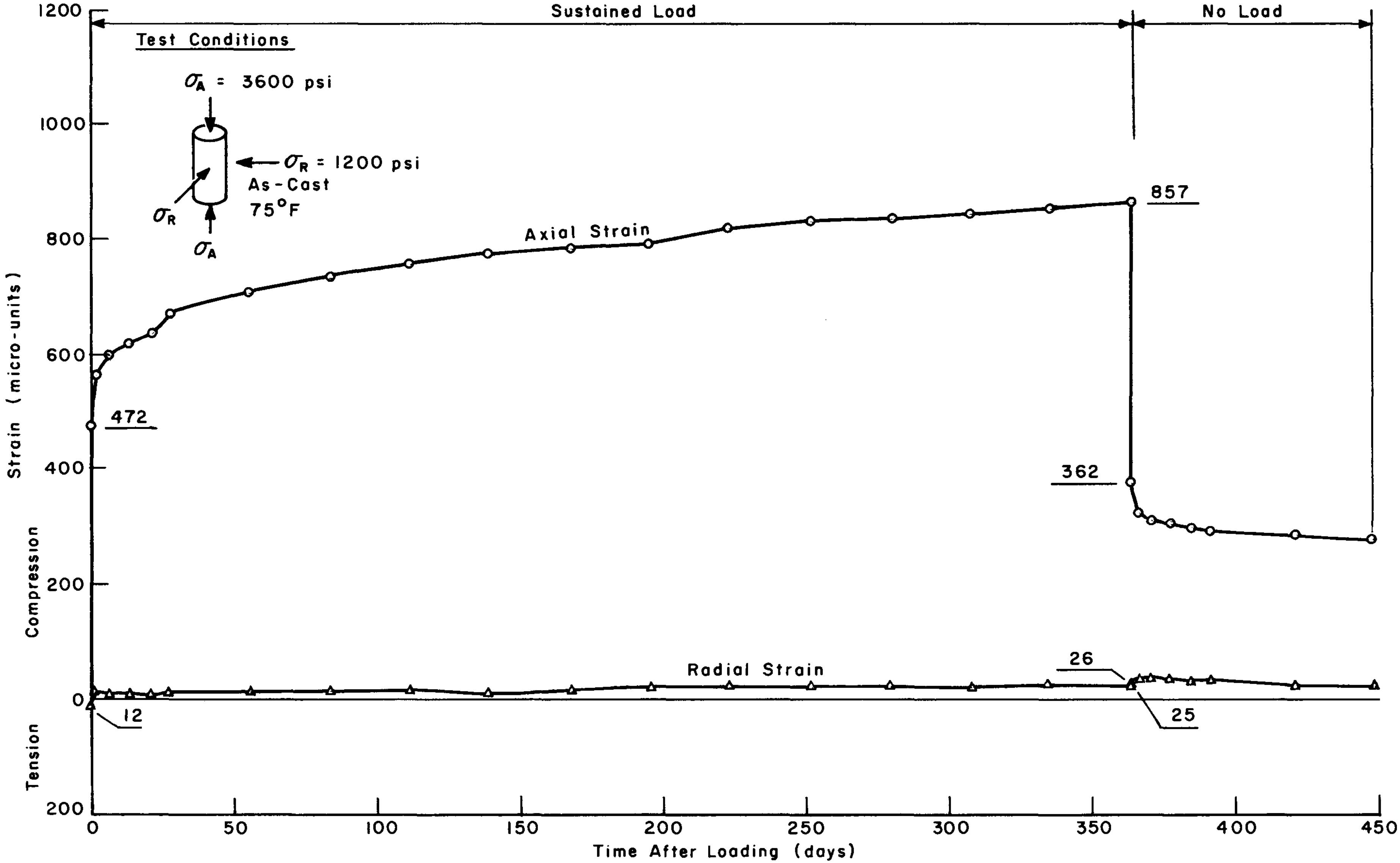


Fig E20. Total axial and radial strain curves for specimen D-26.

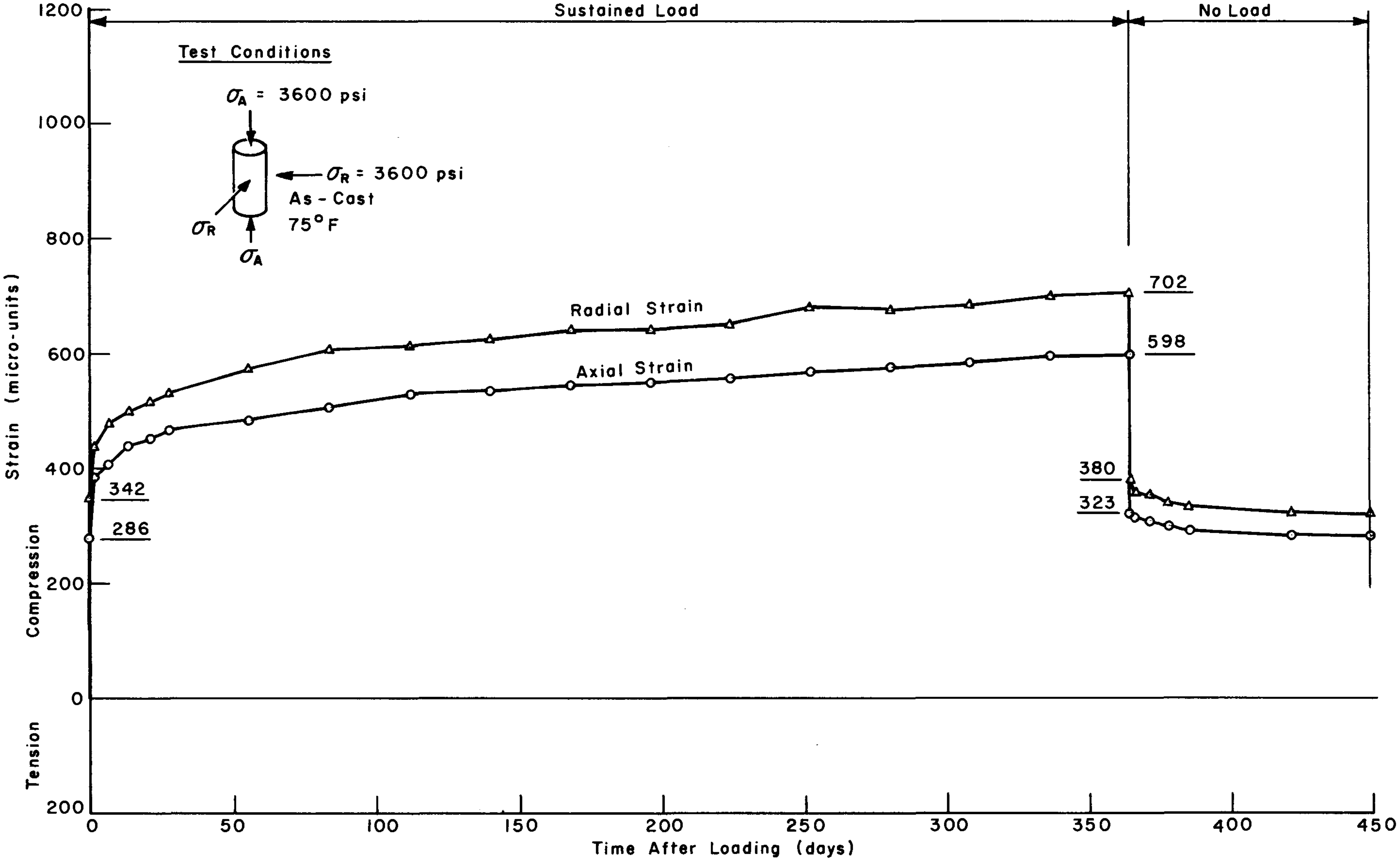


Fig E21. Total axial and radial strain curves for specimen D-31.

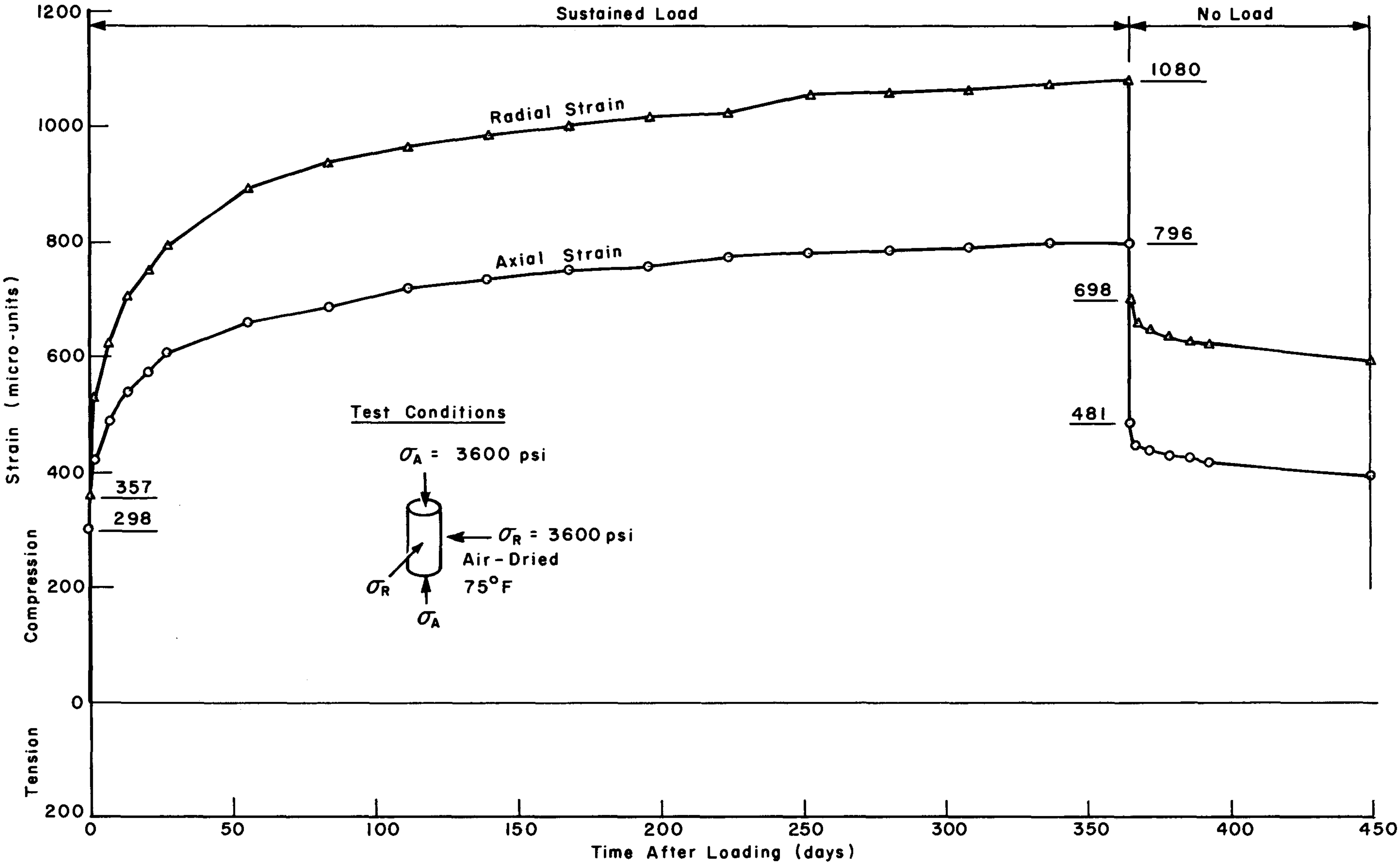


Fig E22. Total axial and radial strain curves for specimen D-40.

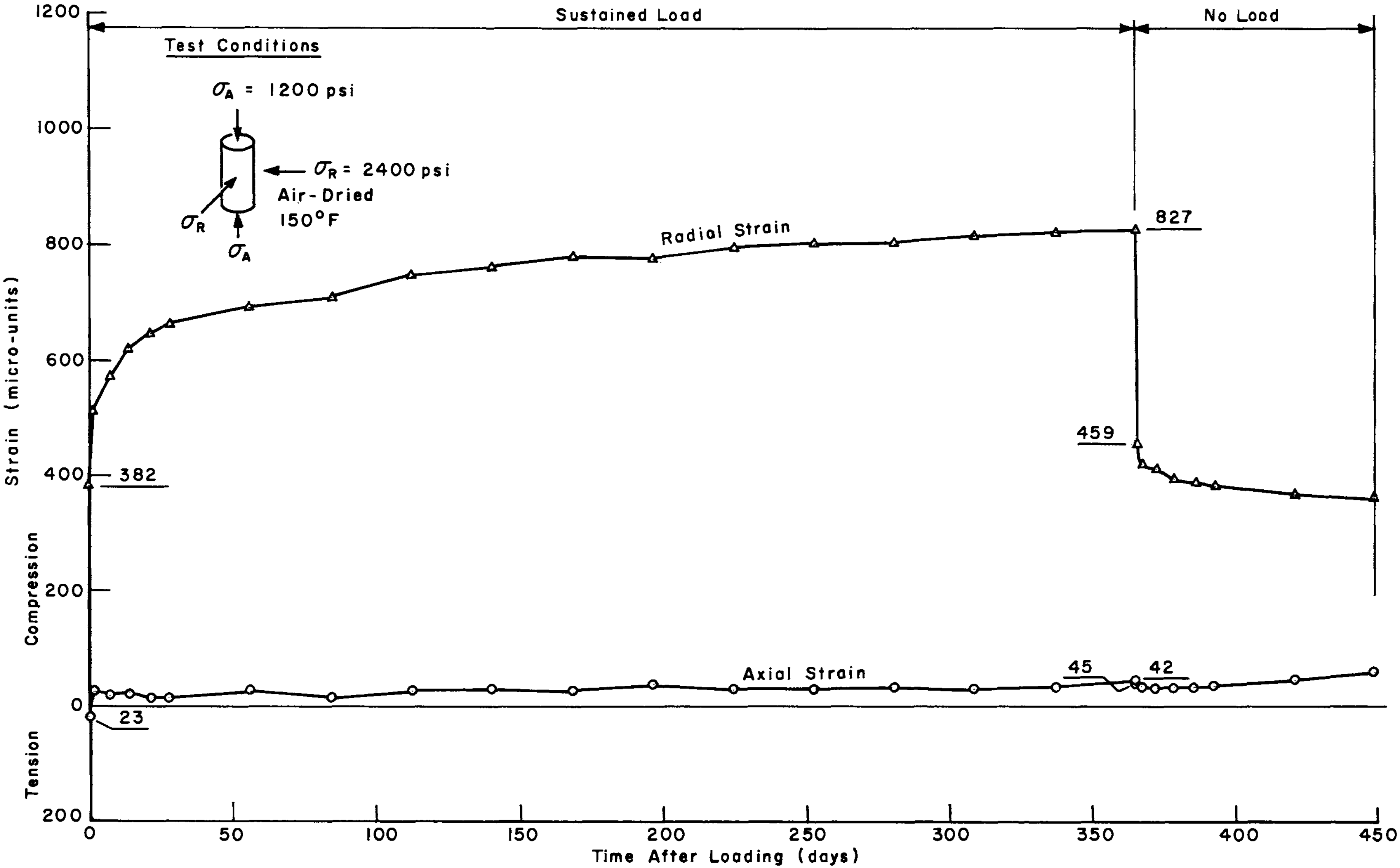


Fig E23. Total axial and radial strain curves for specimen D-41.

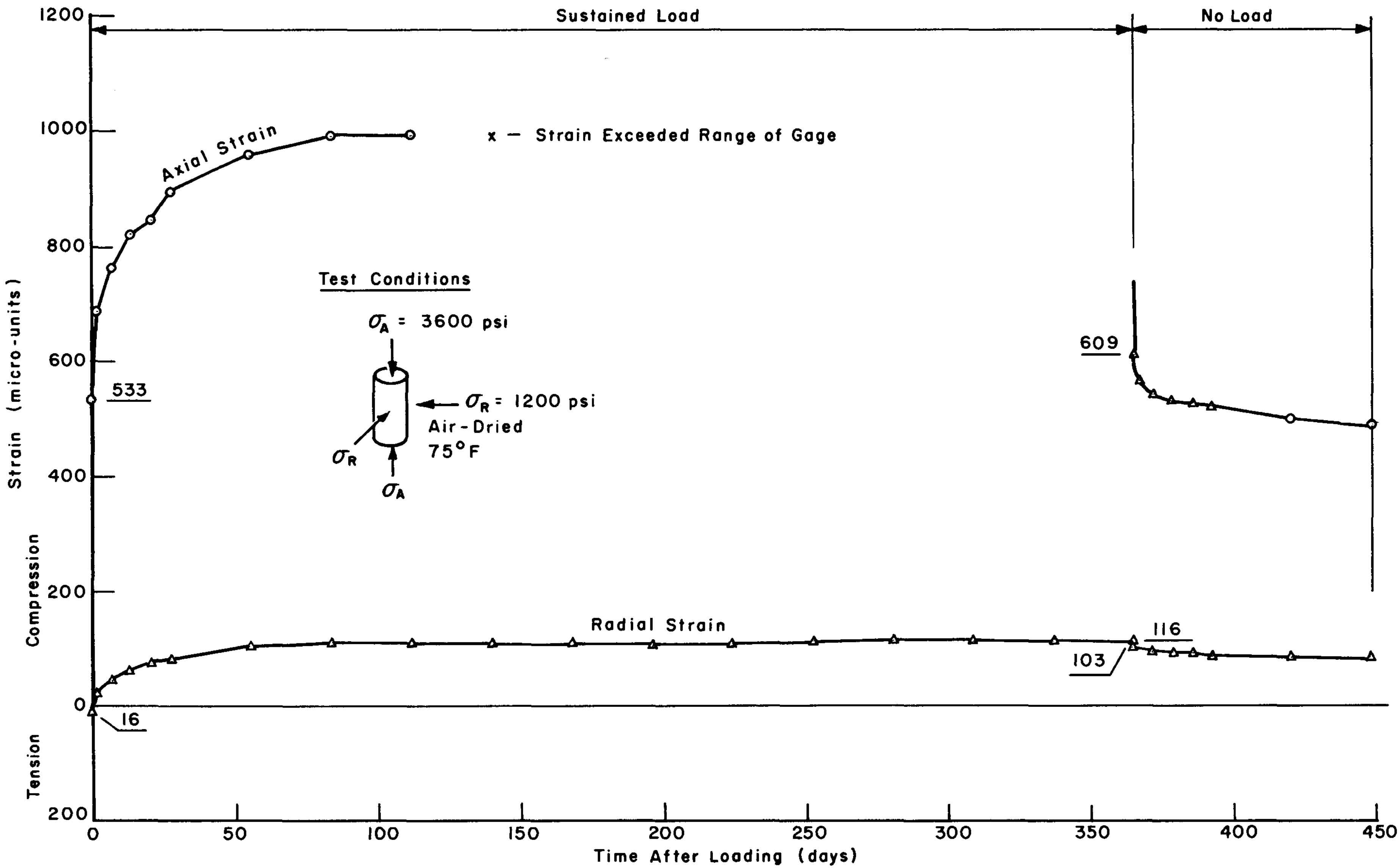


Fig E24. Total axial and radial strain curves for specimen D-44.

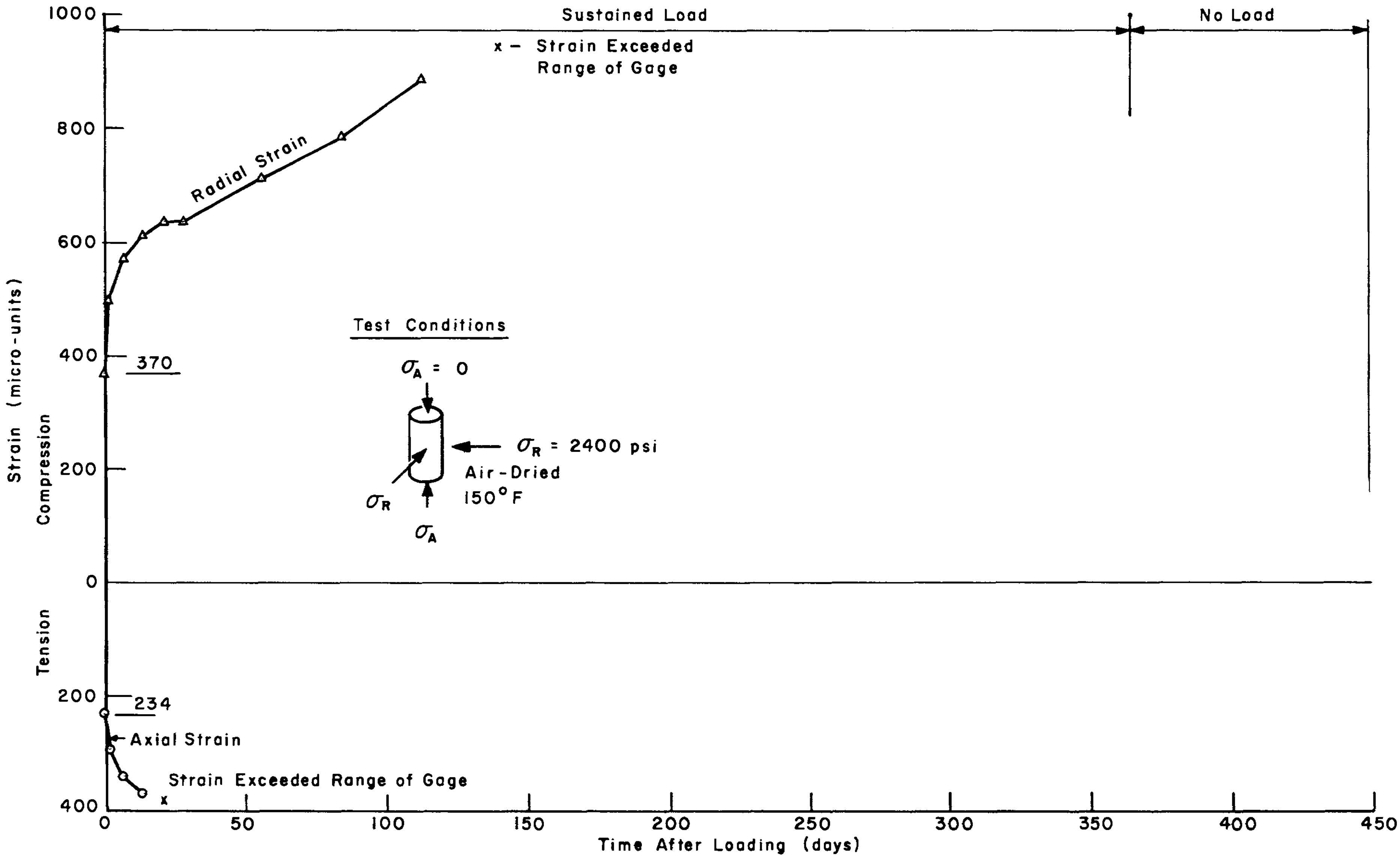


Fig E25. Total axial and radial strain curves for specimen E 1.

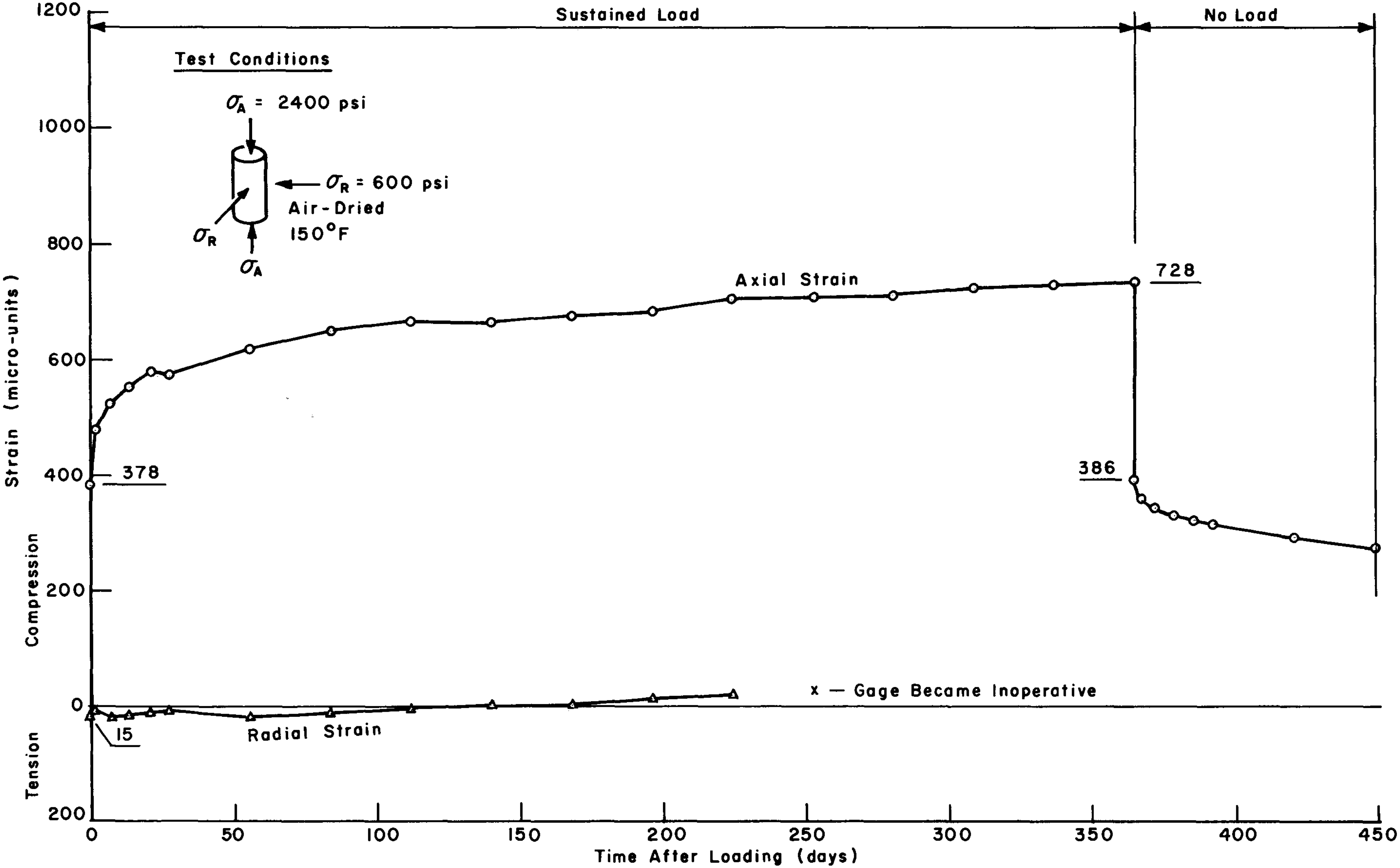


Fig E26. Total axial and radial strain curves for specimen E-4.

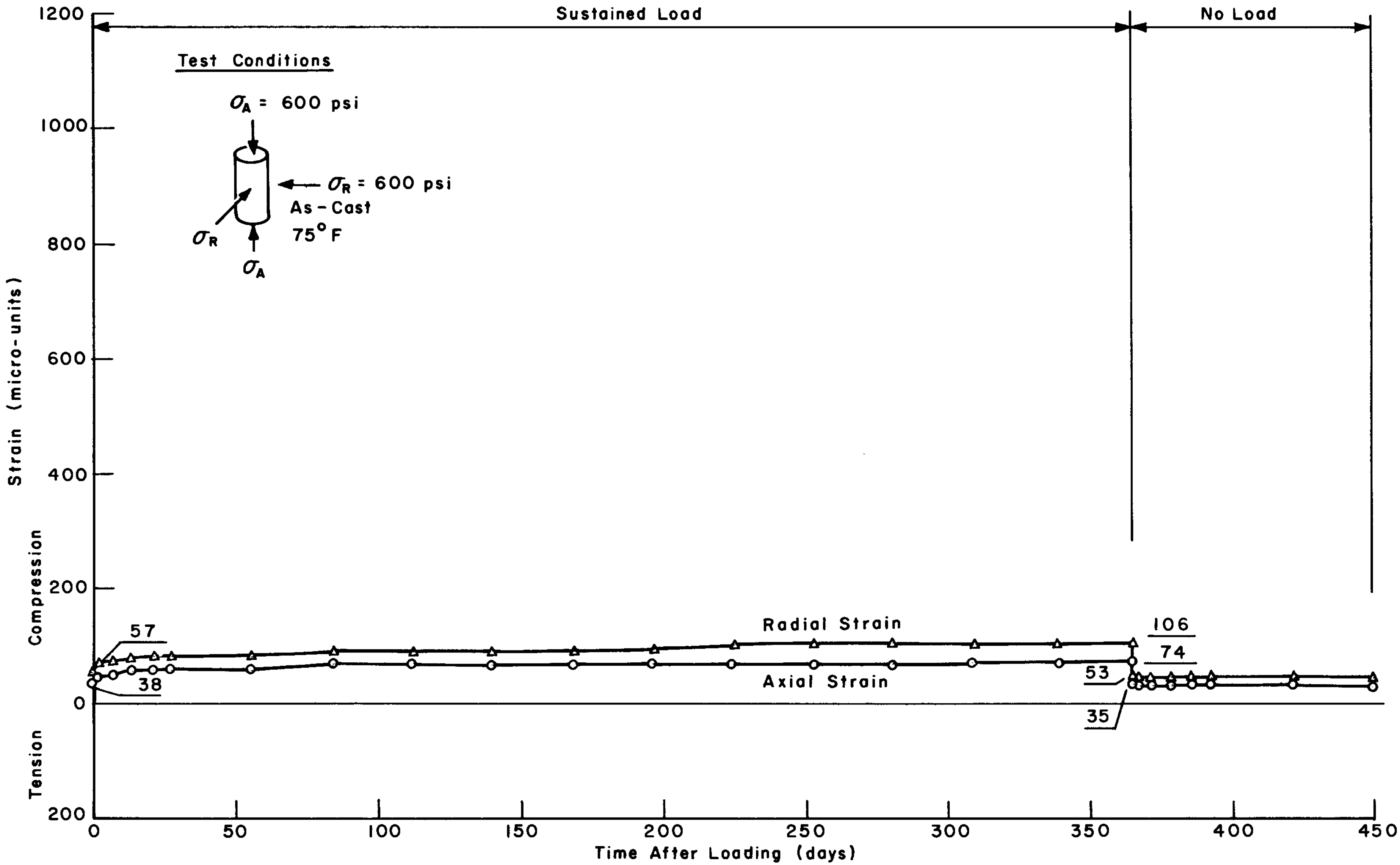


Fig E27. Total axial and radial strain curves for specimen E-5.

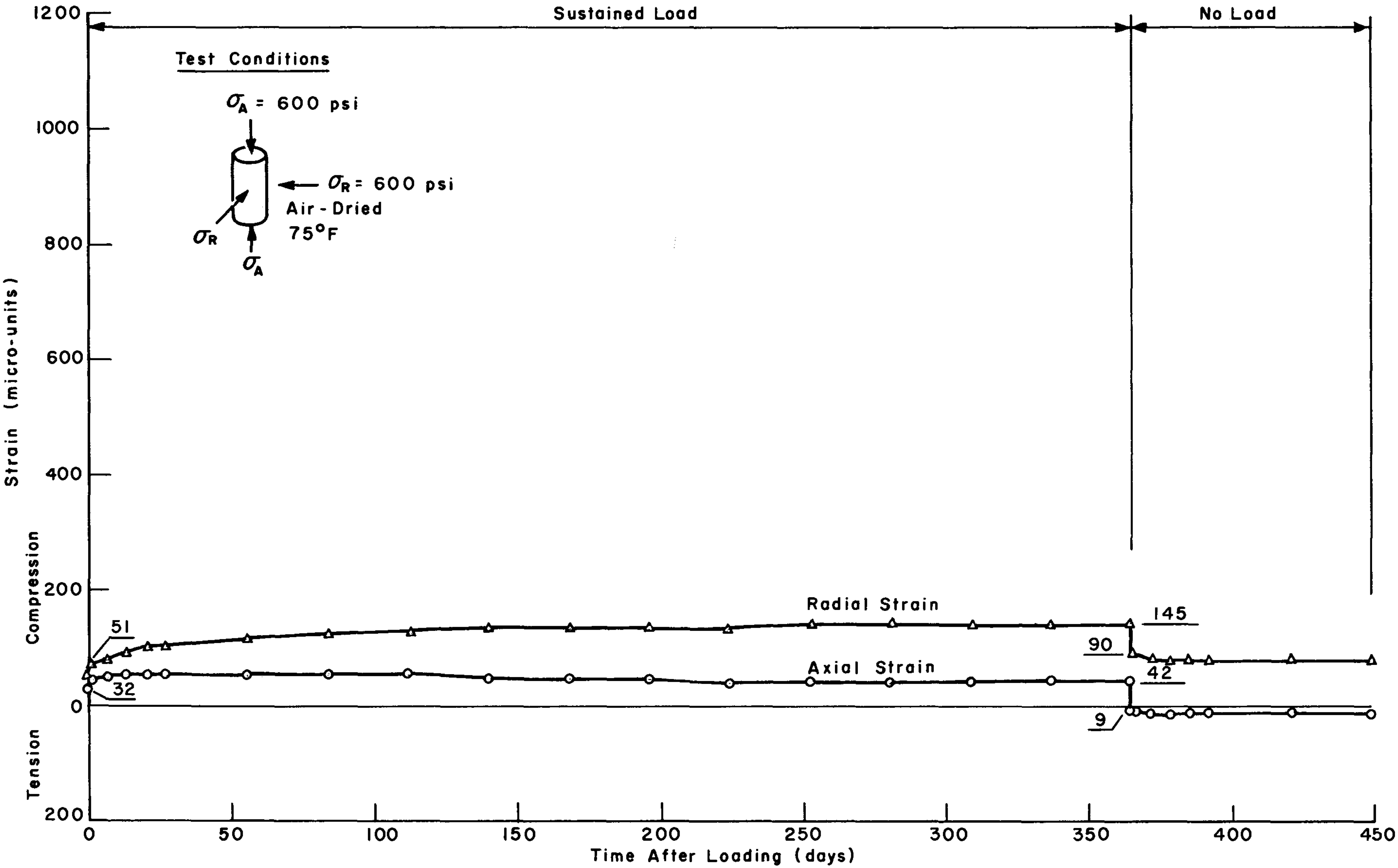


Fig E28. Total axial and radial strain curves for specimen E-13.

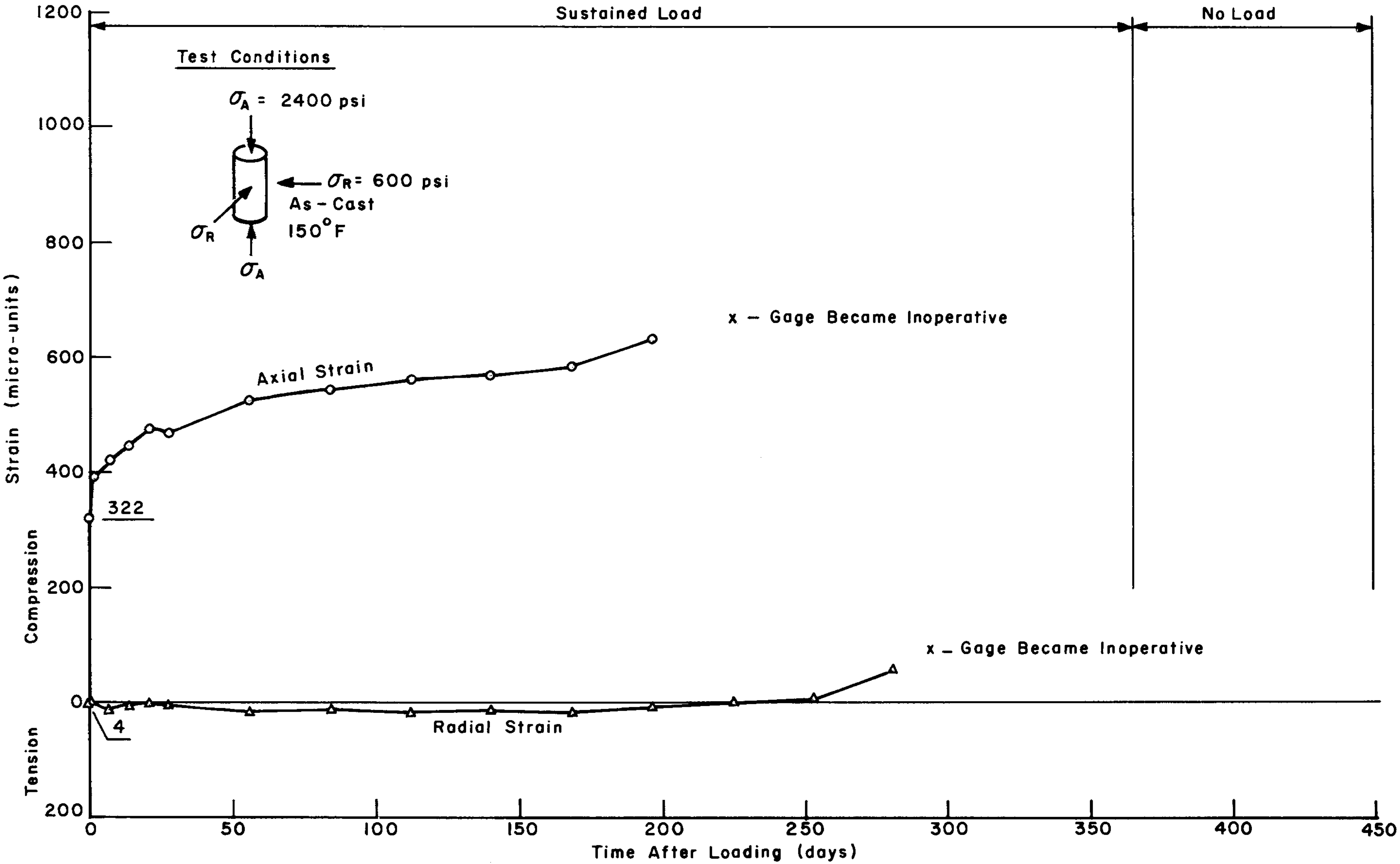


Fig E29. Total axial and radial strain curves for specimen E-18.

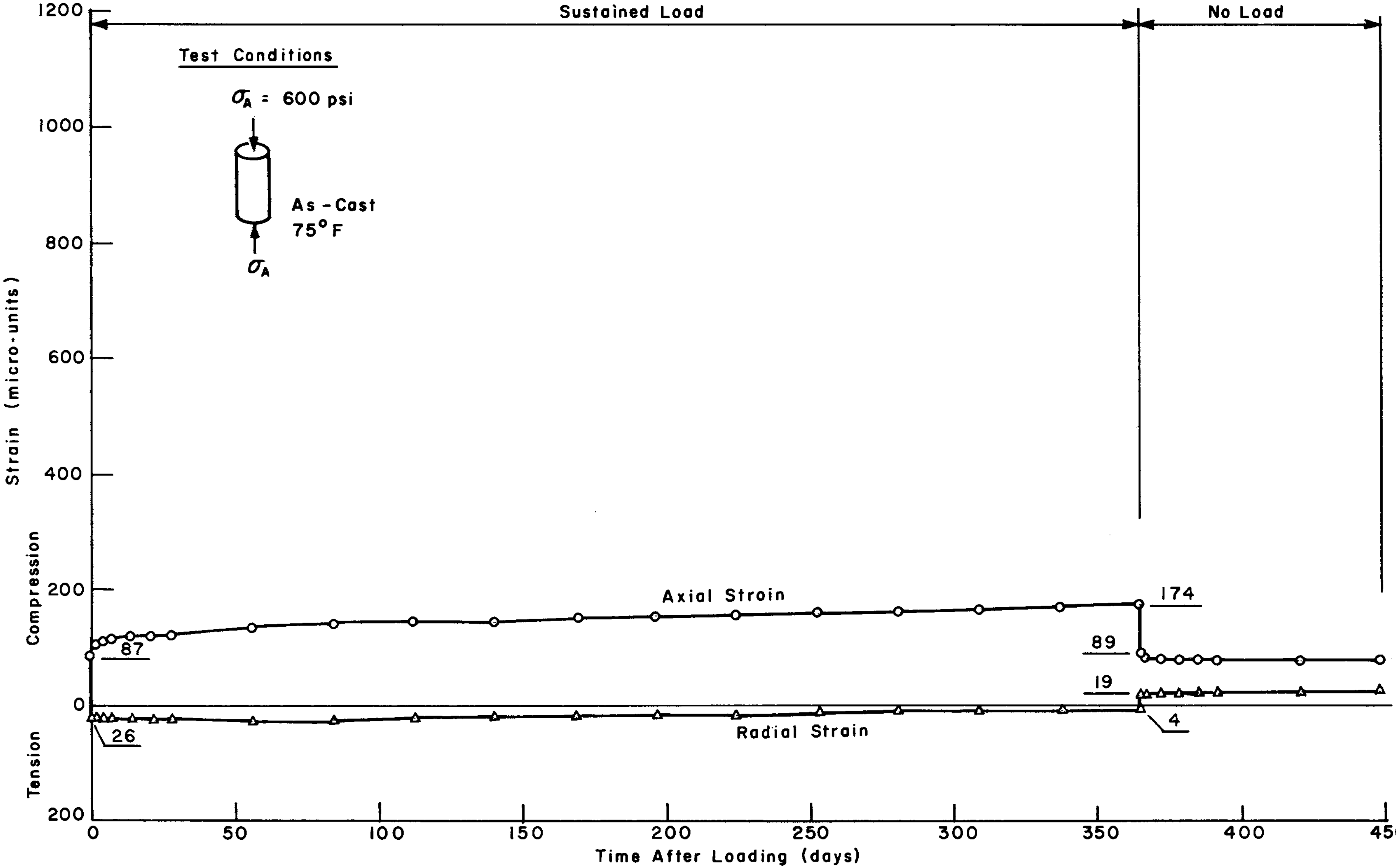


Fig E30. Total axial and radial strain curves for specimen E-39.

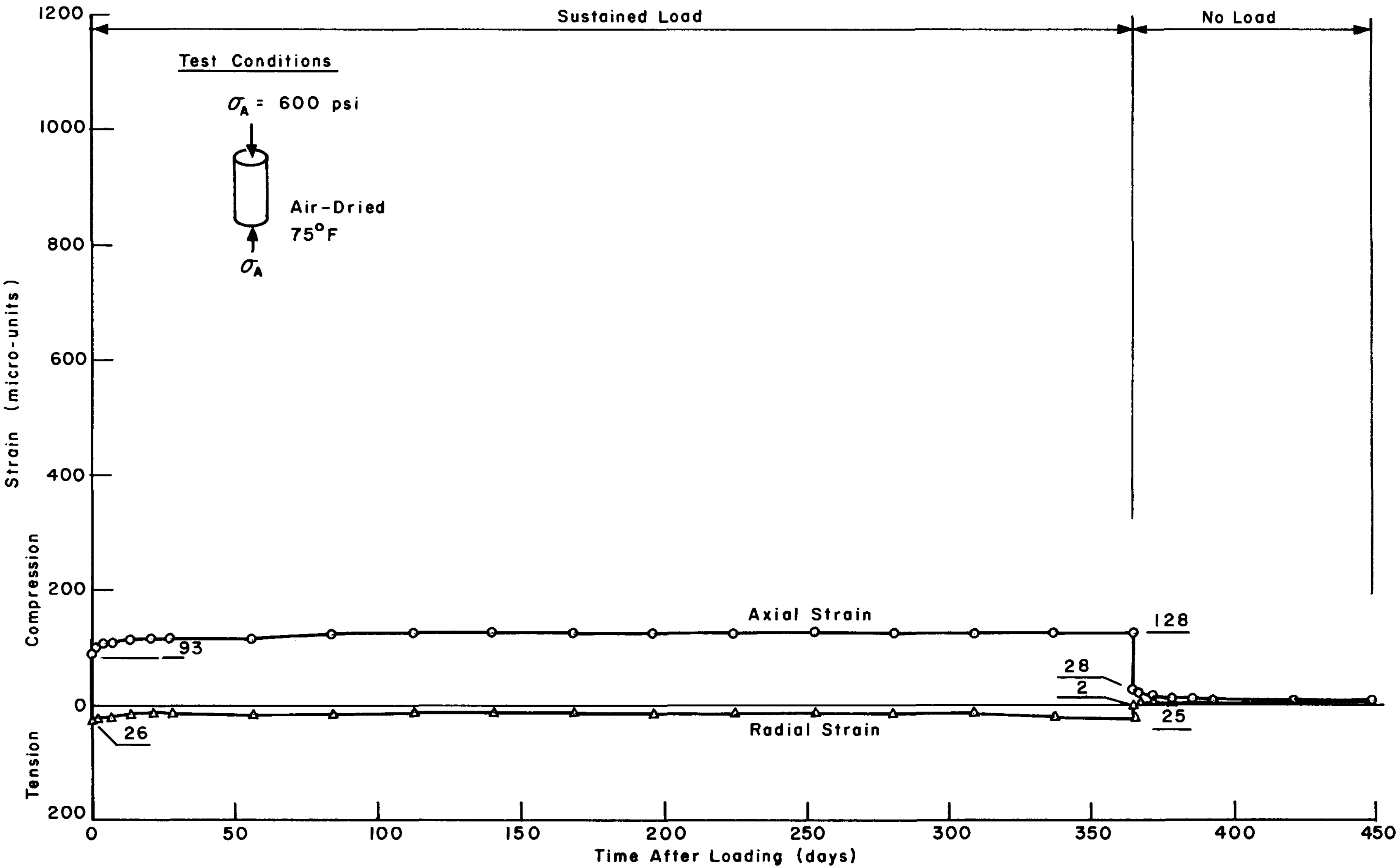


Fig E31. Total axial and radial strain curves for specimen E-40.

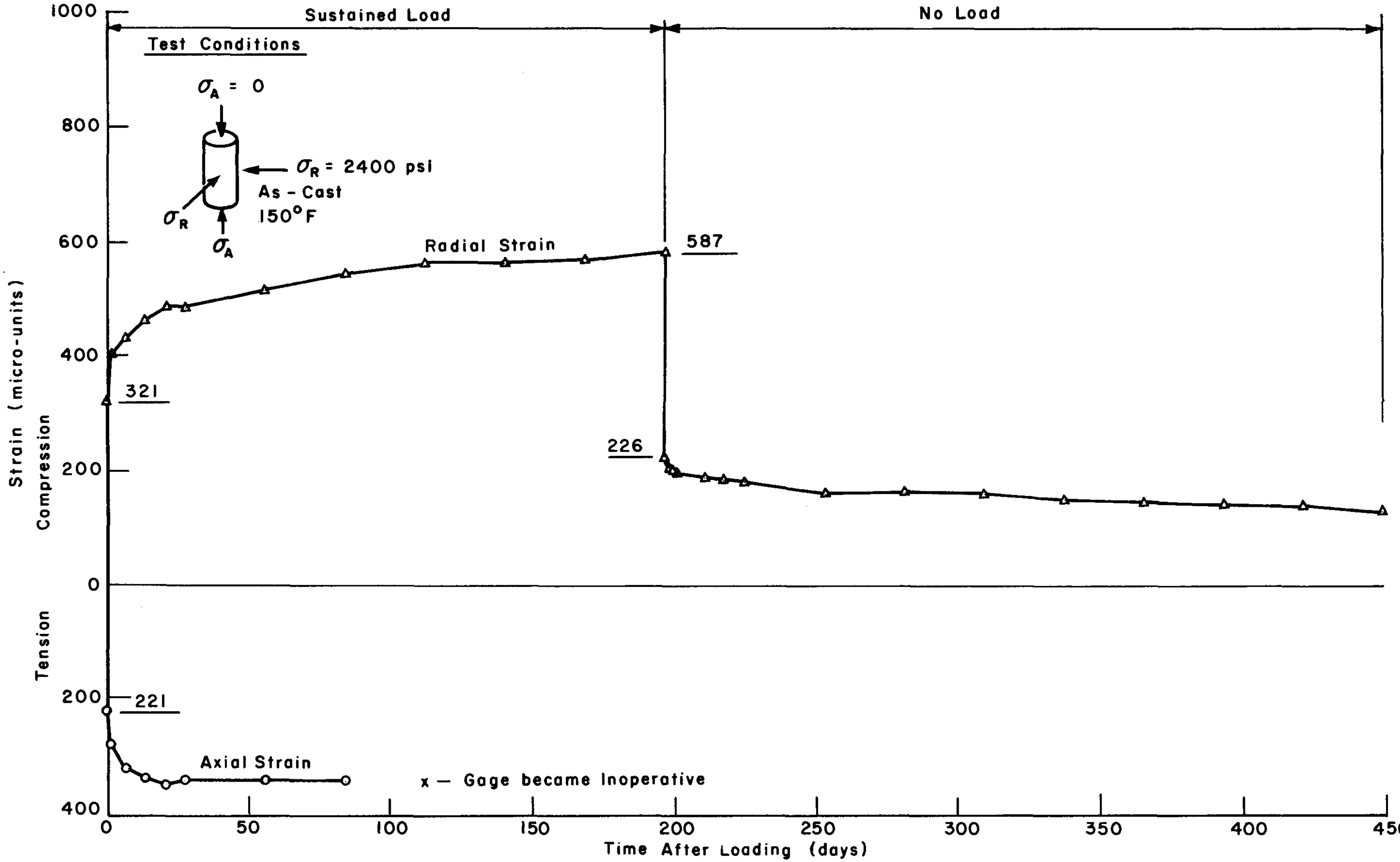


Fig E32. Total axial and radial strain curves for specimen E-43.

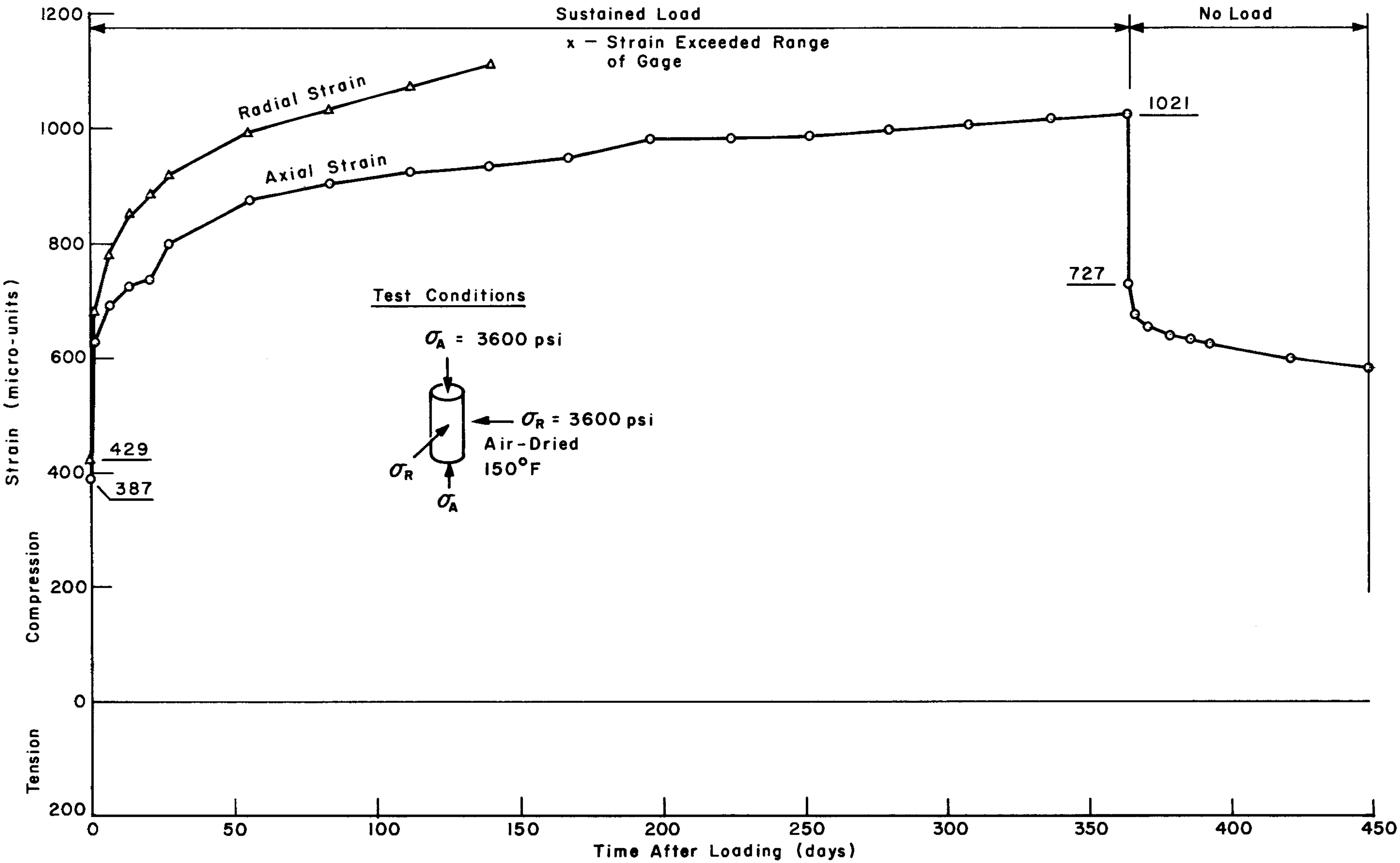


Fig E33. Total axial and radial strain curves for specimen F-6.

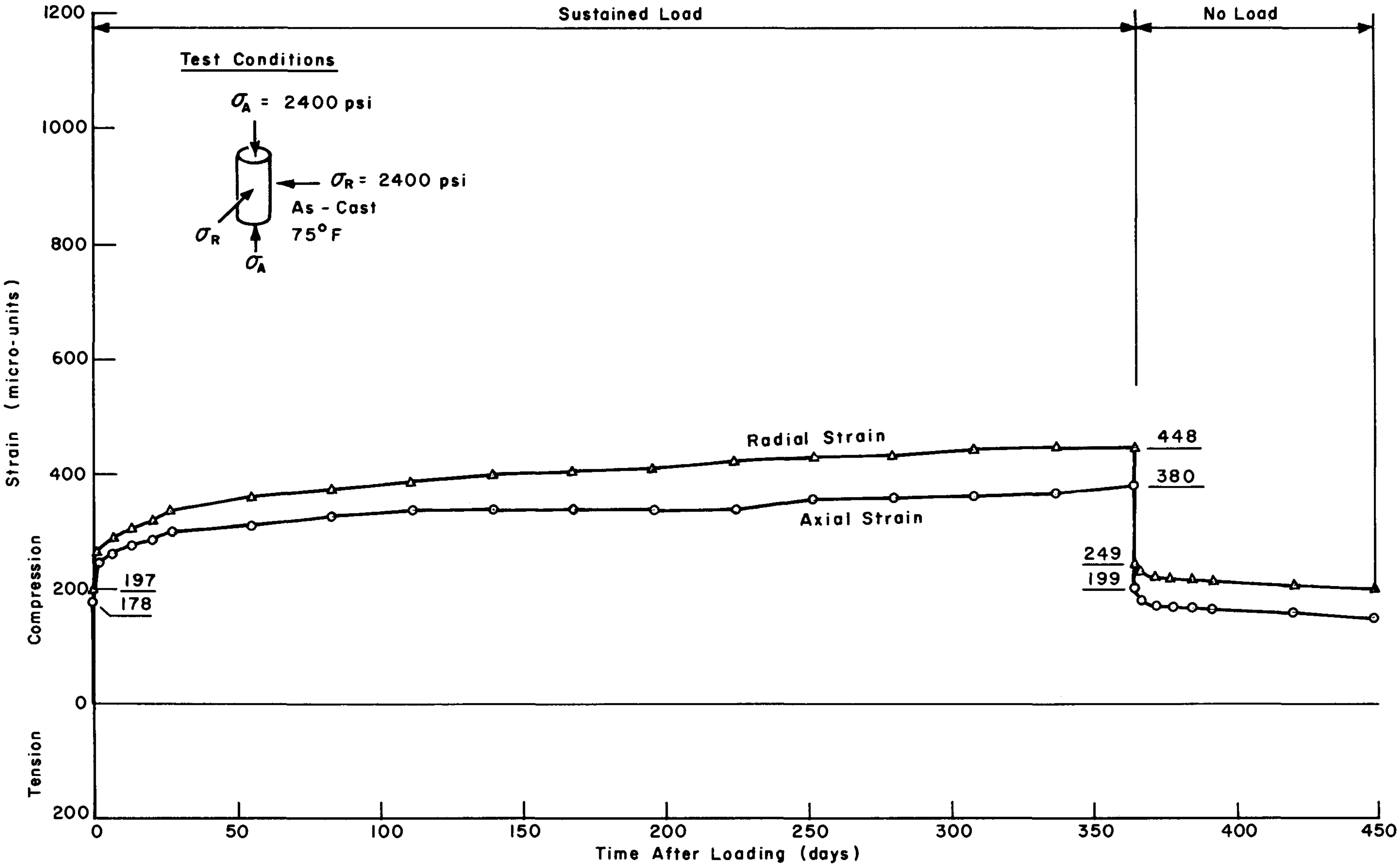


Fig E34. Total axial and radial strain curves for specimen F-9.

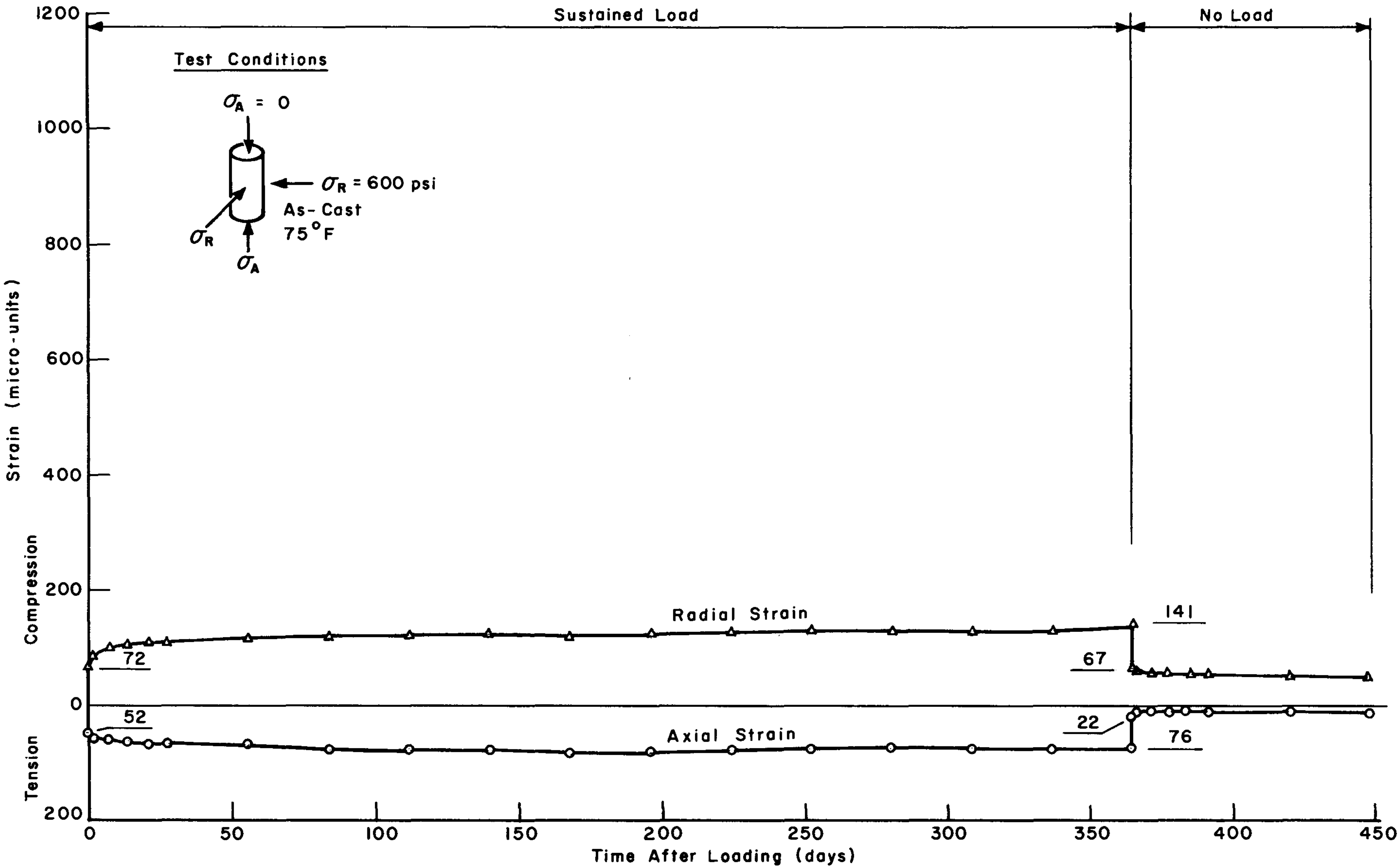


Fig E35. Total axial and radial strain curves for specimen F-13.

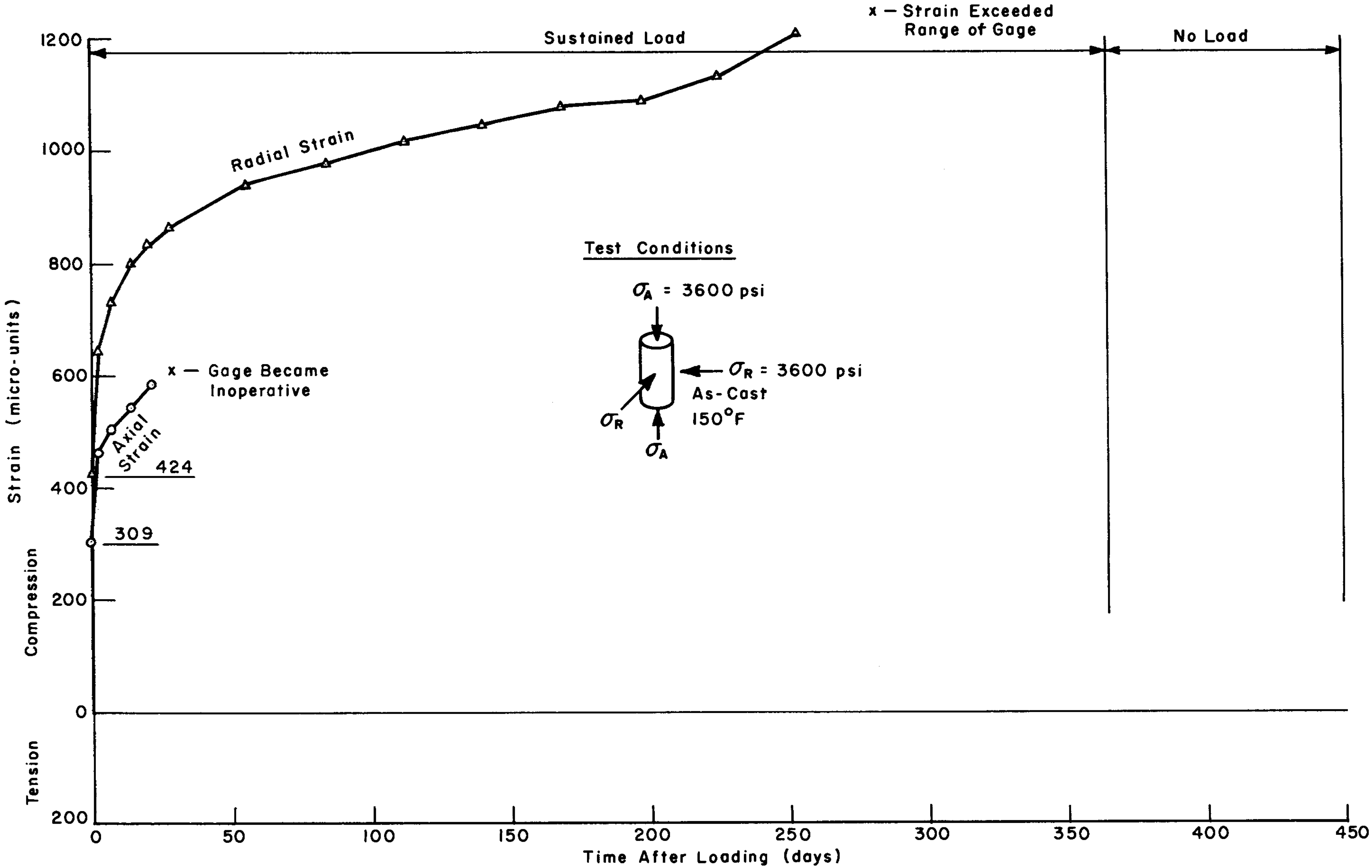


Fig E36. Total axial and radial strain curves for specimen F-20.

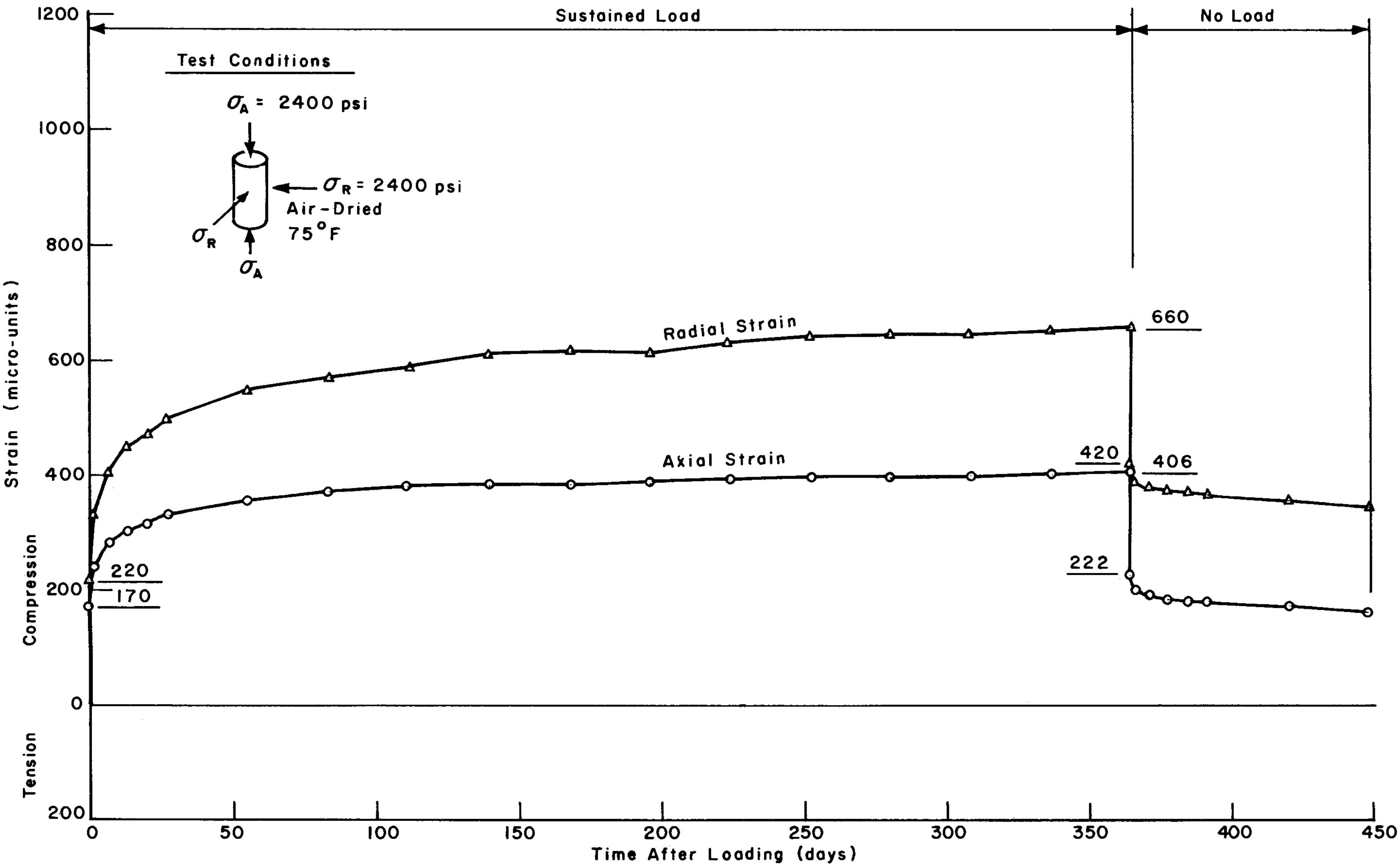


Fig E37. Total axial and radial strain curves for specimen F-30.

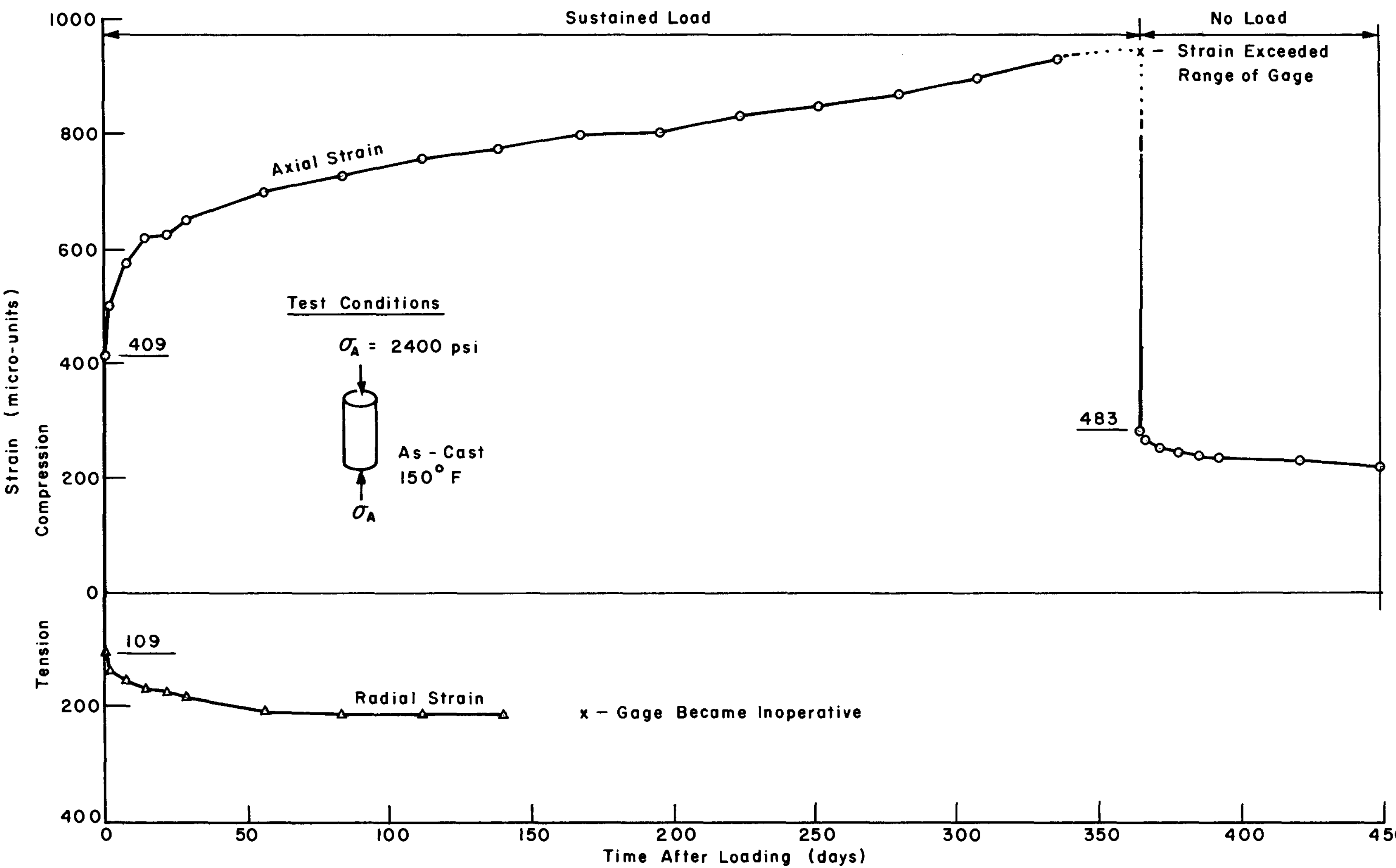


Fig E38. Total axial and radial strain curves for specimen F-33.

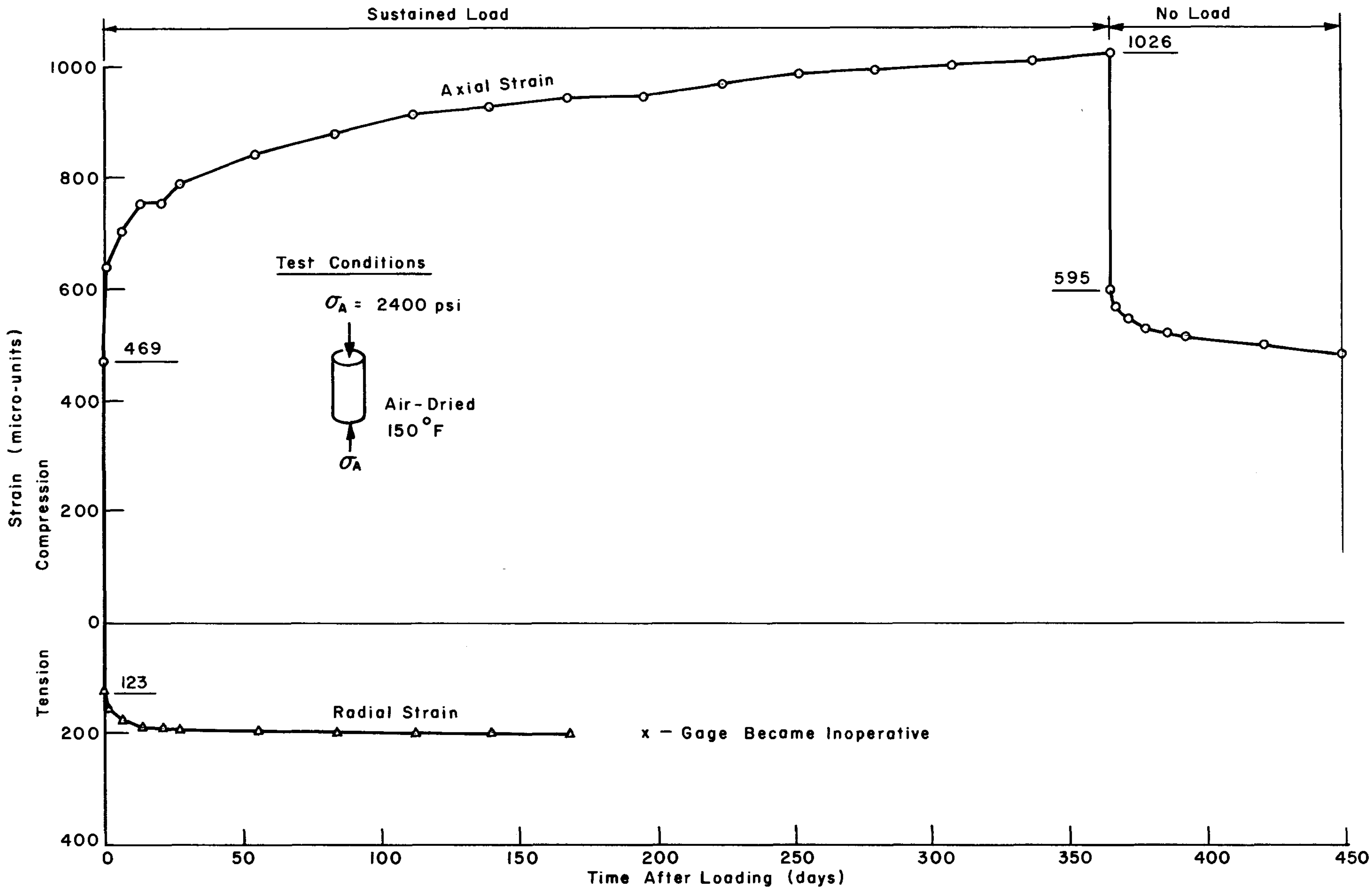


Fig E39. Total axial and radial strain curves for specimen F-34.

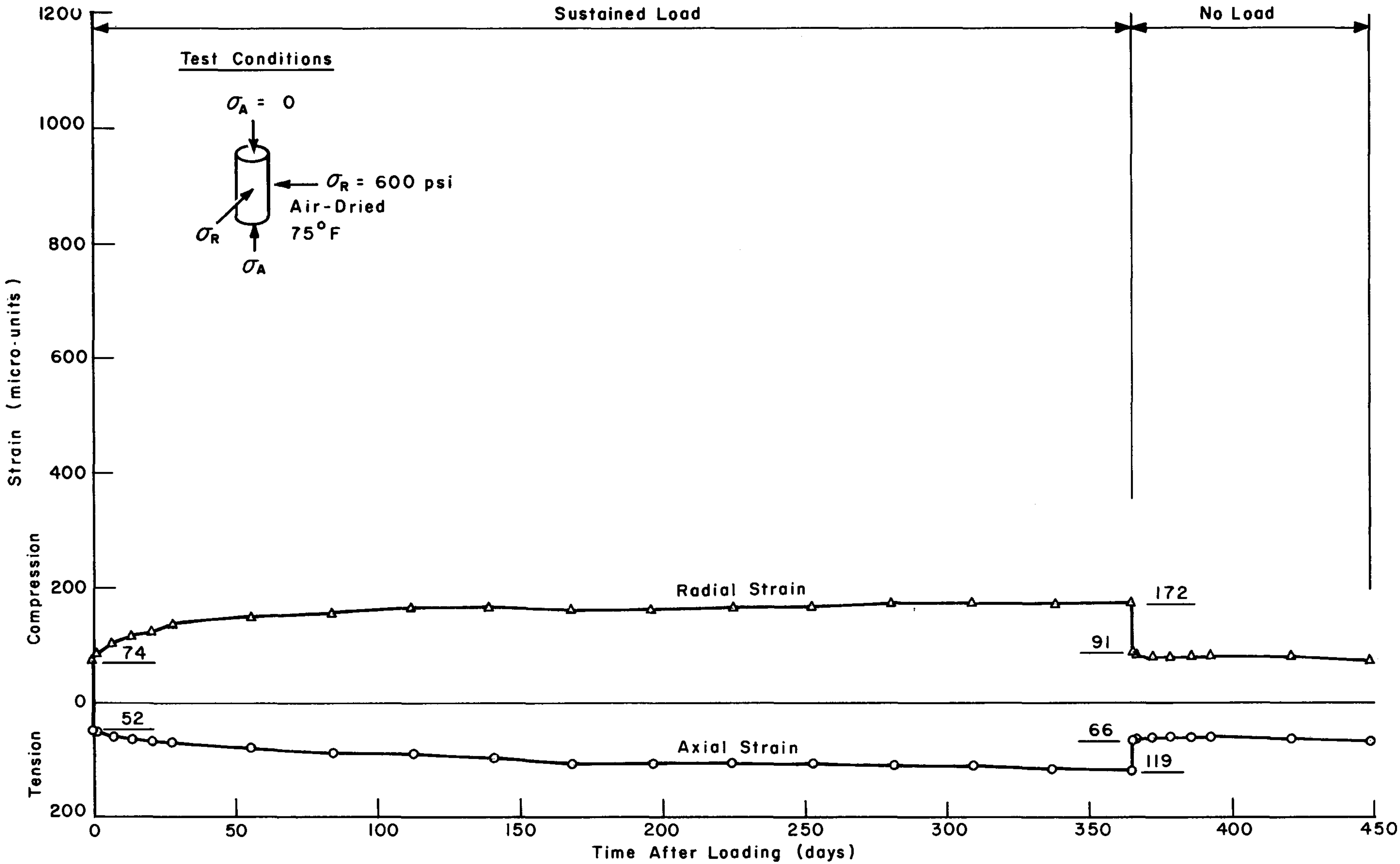


Fig E40. Total axial and radial strain curves for specimen F-42.

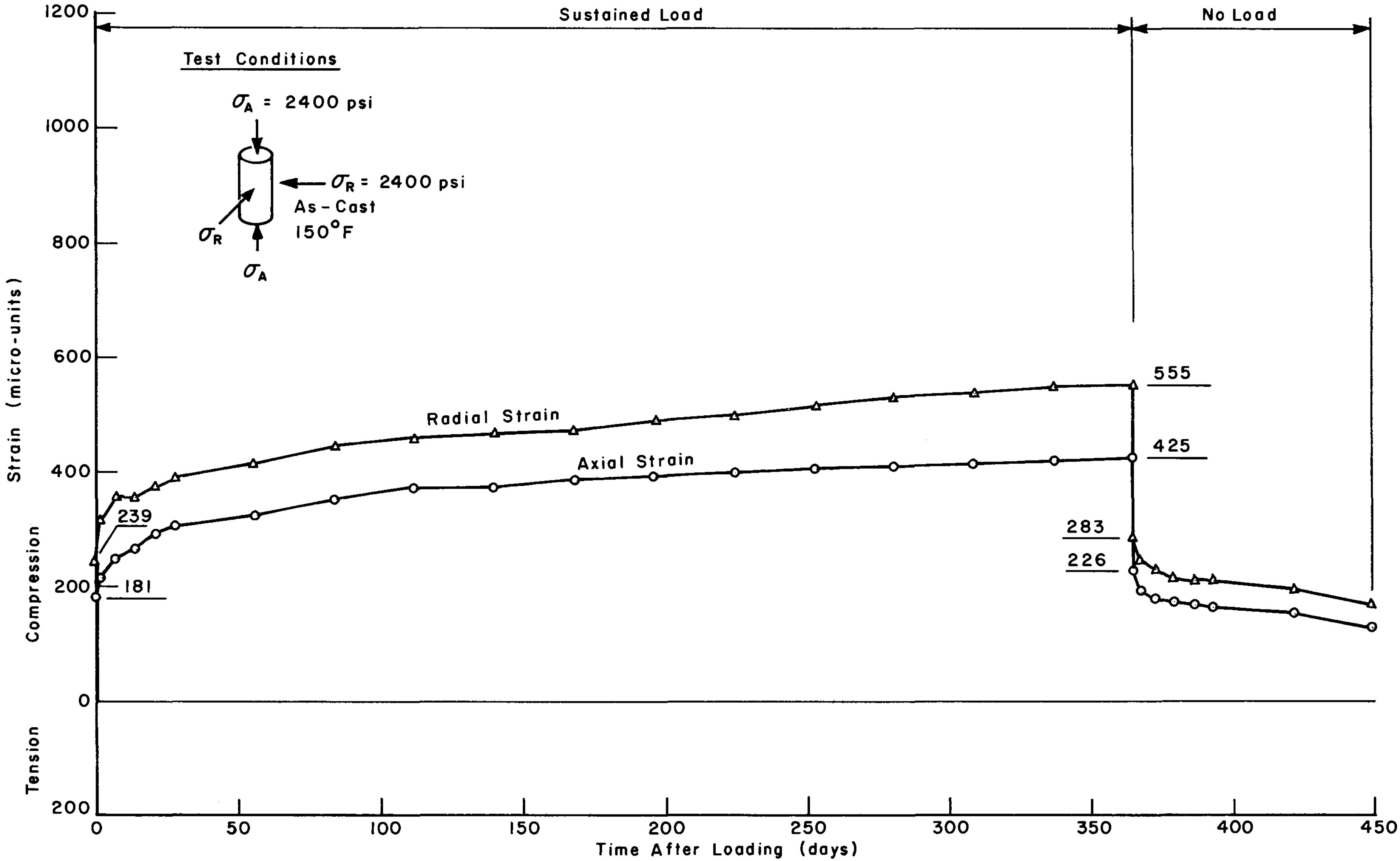


Fig E41. Total axial and radial strain curves for specimen G-9.

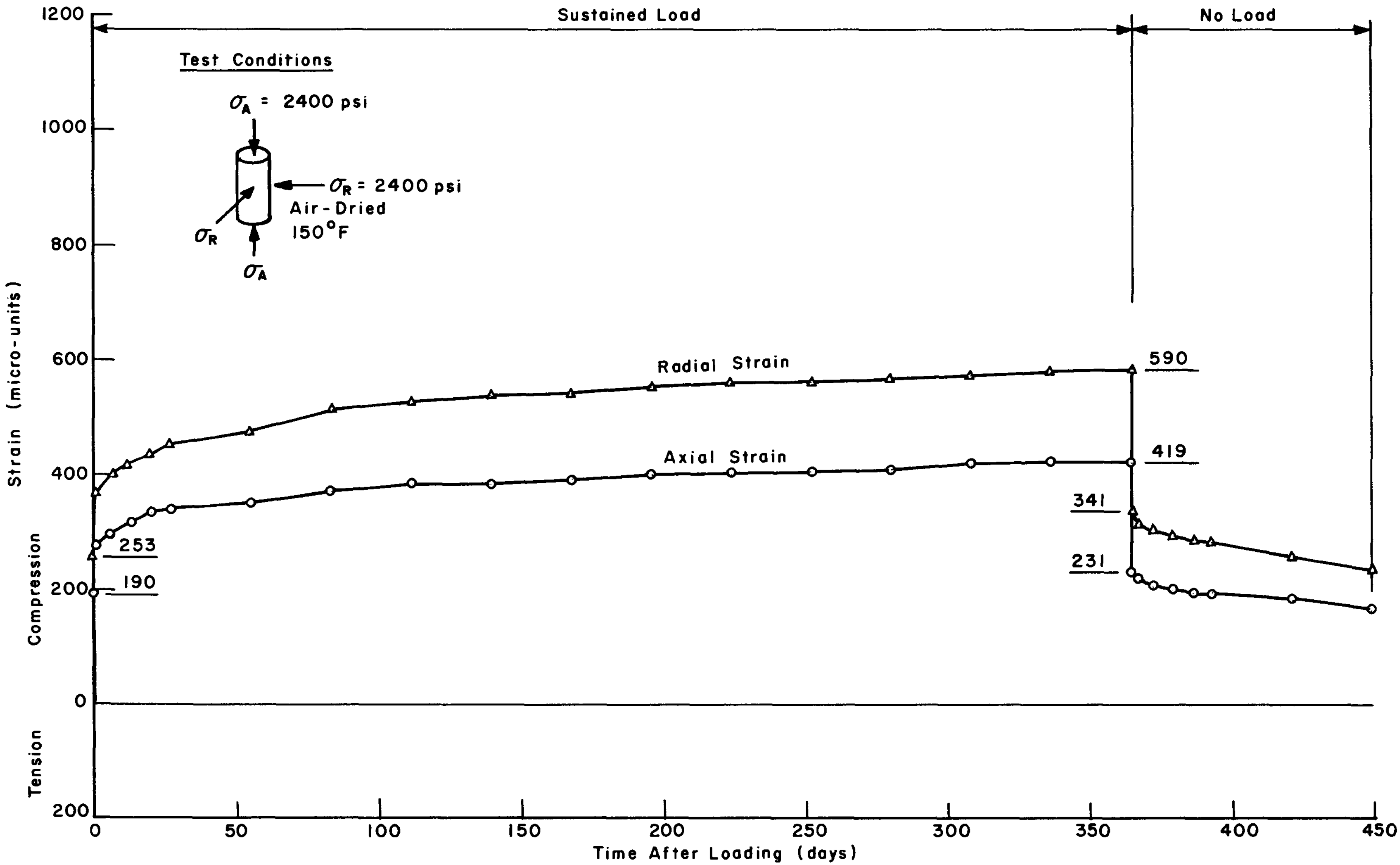


Fig E42. Total axial and radial strain curves for specimen G-19.

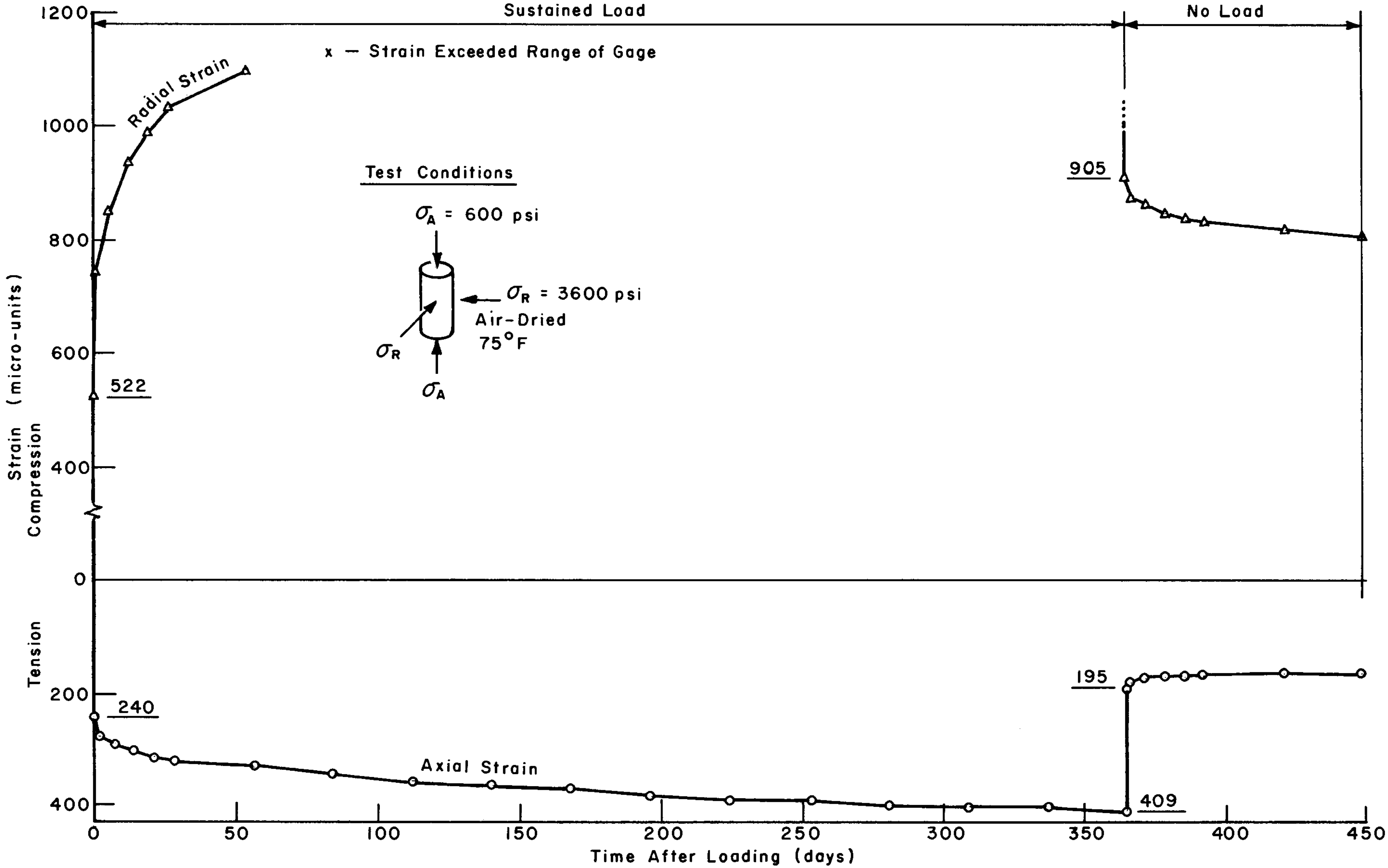


Fig E43. Total axial and radial strain curves for specimen G-30

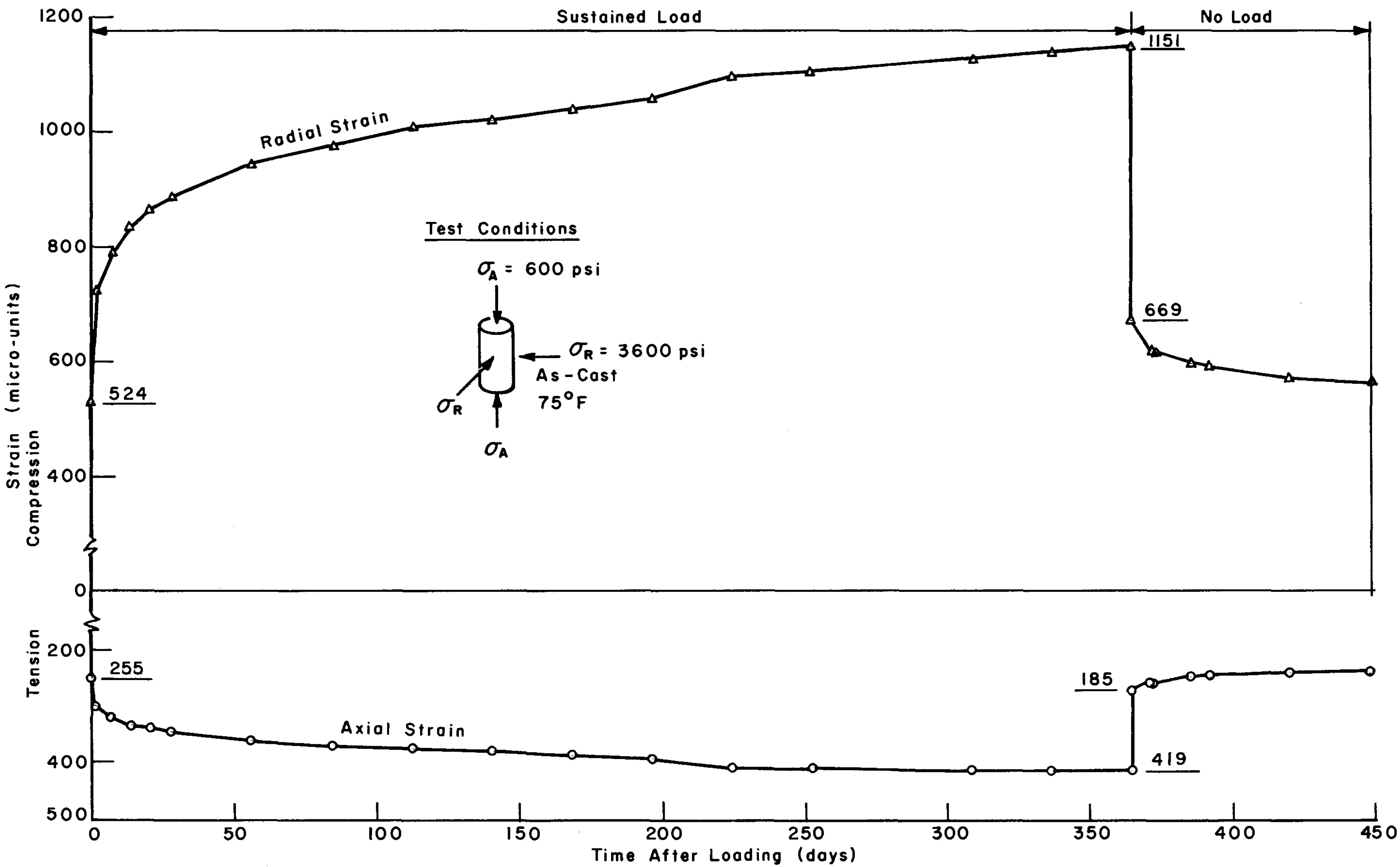


Fig E44. Total axial and radial strain curves for specimen G-35.

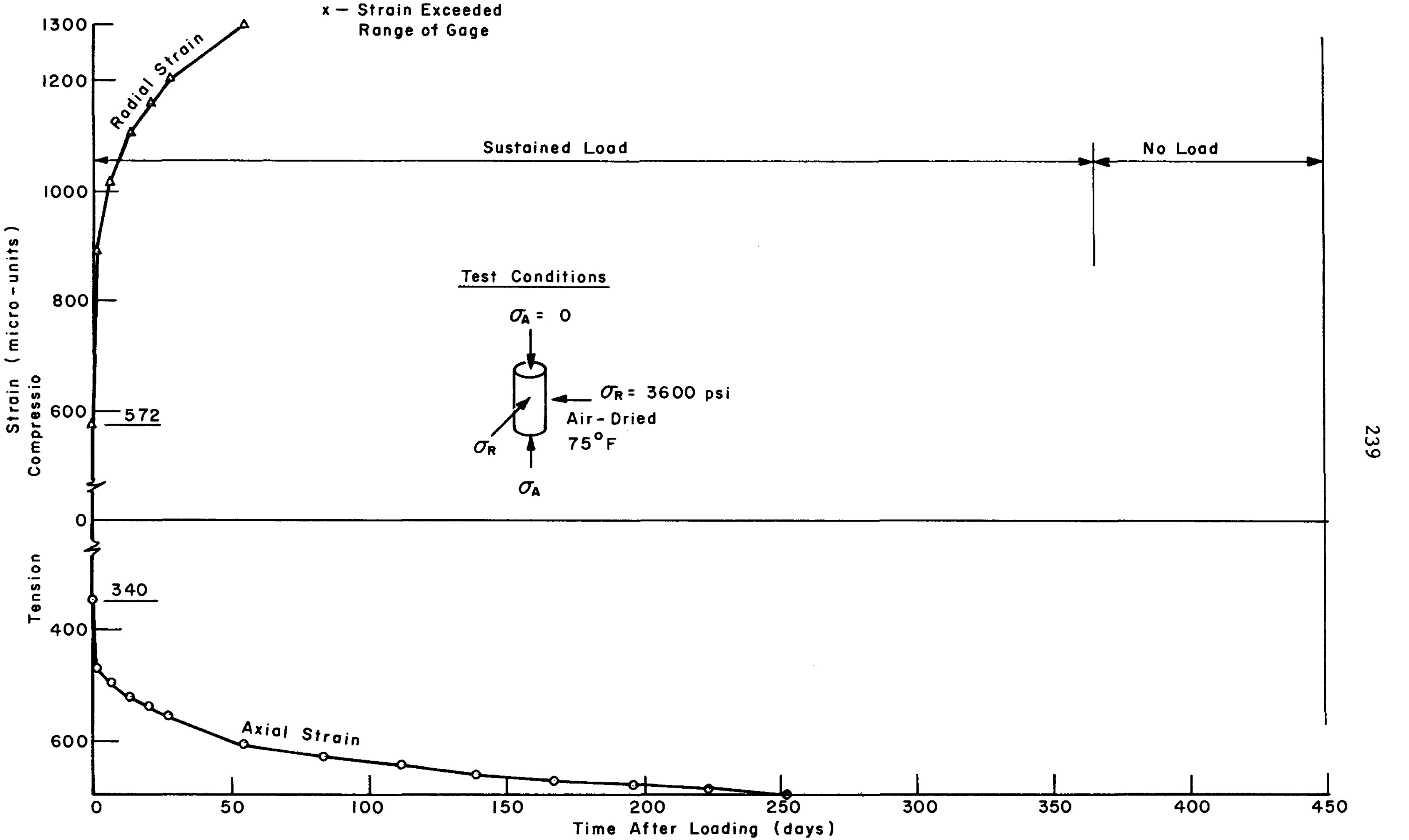


Fig E45. Total axial and radial strain curves for specimen H-14.

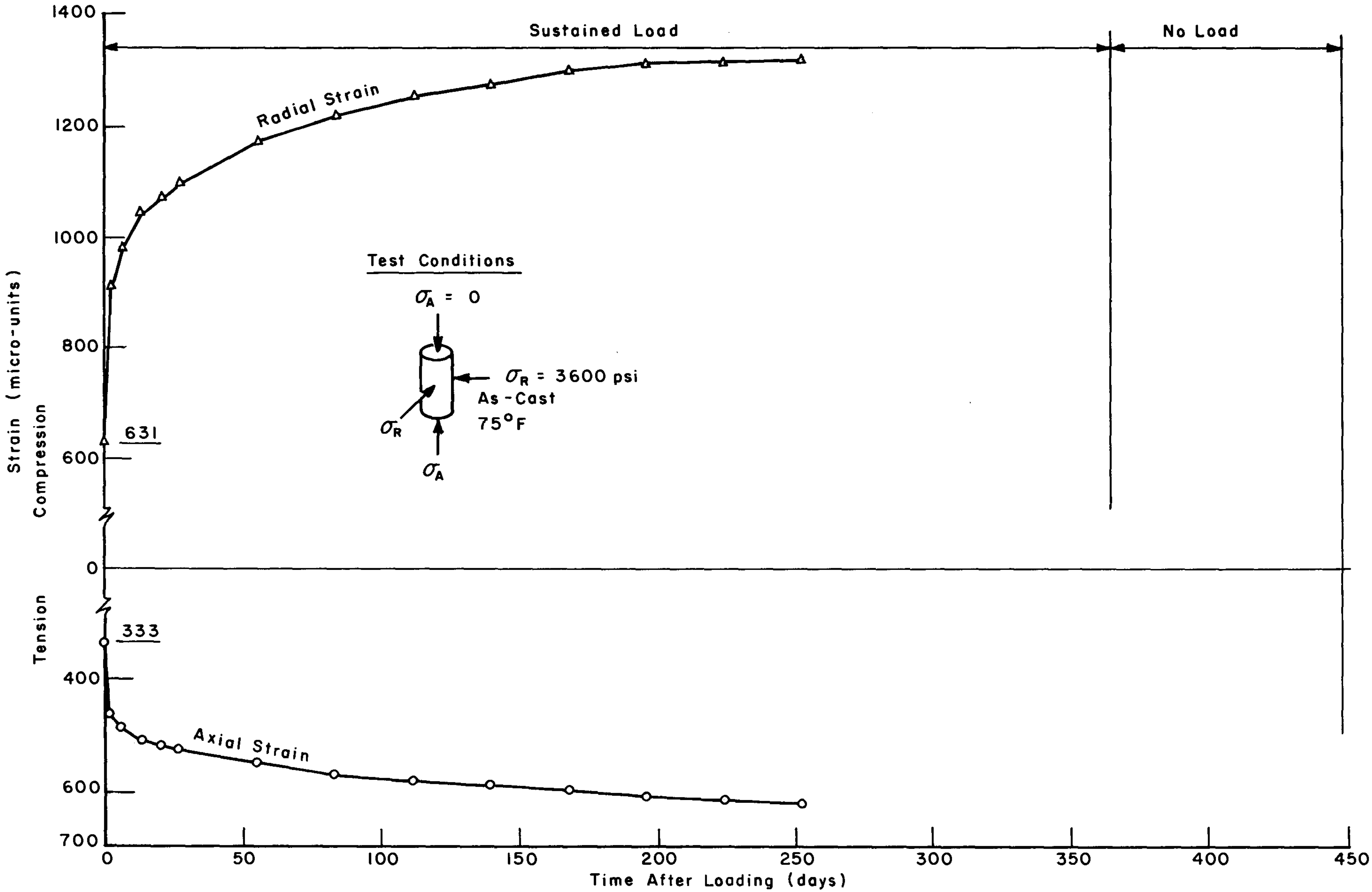


Fig E46. Total axial and radial strain curves for specimen H-22.

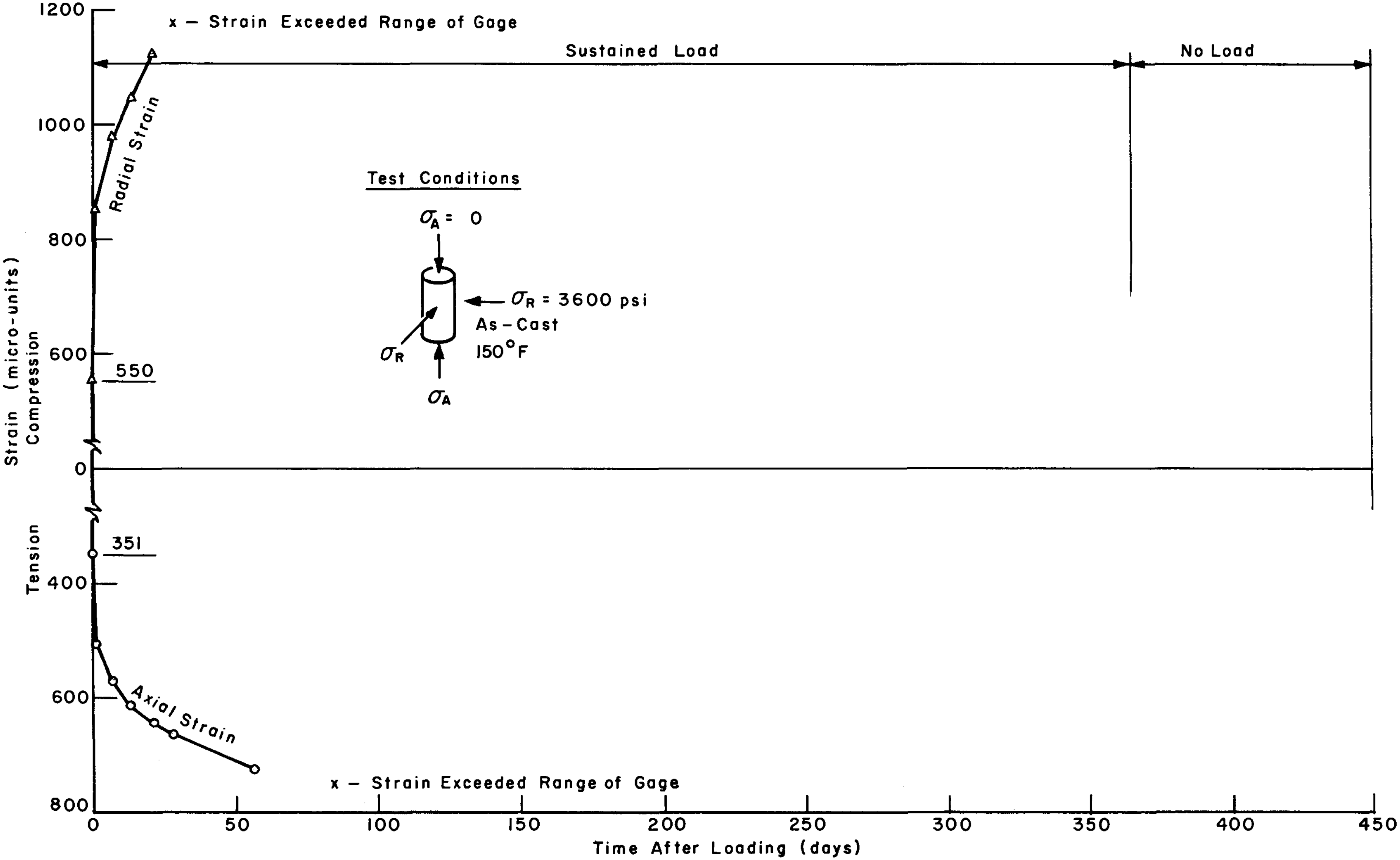


Fig E47. Total axial and radial strain curves for specimen I-16.

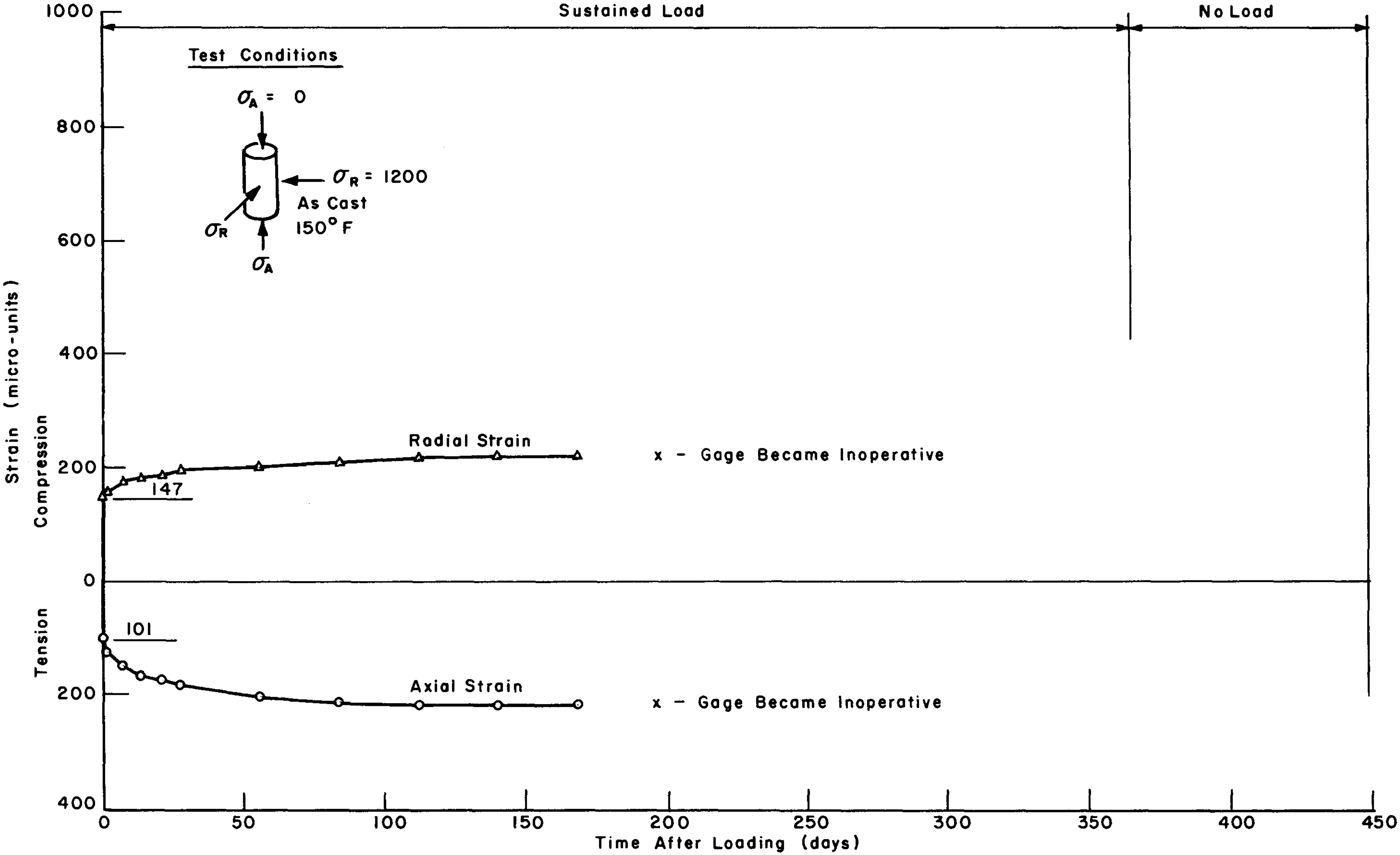


Fig E48. Total axial and radial strain curves for specimen I-27.

APPENDIX F

SHRINKAGE STRAIN DATA BEFORE LOADING

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN A-8

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	80.7	2119/2	3.9	86.0	2156/2	52.6
0.000	86.0	2165/2	-57.1	91.3	2173/2	29.8
.179	91.3	2152/2	-39.7	97.2	2184/2	14.9
1.096	82.2	2158/2	-47.8	87.5	2218/2	-31.5
2.242	79.2	2115/2	9.2	84.5	2186/2	12.2
3.096	72.5	2131/2	-11.9	76.3	2201/2	-8.2
3.913	71.0	2131/2	-11.9	75.5	2201/2	-8.2
4.908	70.2	2129/2	-9.2	75.5	2200/2	-6.8
5.921	70.2	2126/2	-5.3	74.7	2198/2	-4.1
7.083	71.0	2122/2	0.0	76.3	2195/2	0.0
14.117	72.5	2112/2	13.1	78.5	2188/2	9.5
27.929	70.2	2110/2	15.7	75.5	2185/2	13.6
55.954	71.0	2111/2	14.4	76.3	2190/2	6.8
82.958	72.5	2113/2	11.8	77.0	2194/2	1.4
90.083	68.8	2115/2	9.2	74.0	2195/2	0.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN A-9

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	80.7	2109/2	13.1	83.8	2120/2	53.1
0.000	89.7	2125/2	-7.9	89.0	2139/2	28.0
.179	95.7	2138/2	-25.1	95.7	2150/2	13.4
1.096	86.7	2154/2	-46.4	86.0	2184/2	-32.3
2.242	83.8	2111/2	10.5	83.8	2150/2	13.4
3.096	74.7	2128/2	-11.8	74.7	2167/2	-9.4
3.917	74.0	2126/2	-9.2	73.2	2167/2	-9.4
4.908	73.2	2127/2	-10.5	73.2	2167/2	-9.4
5.917	82.2	2122/2	-3.9	73.2	2162/2	-2.7
7.083	74.0	2119/2	0.0	74.0	2160/2	0.0
14.113	77.0	2110/2	11.8	75.5	2150/2	13.4
27.925	74.7	2105/2	18.3	73.2	2150/2	13.4
55.954	74.7	2106/2	17.0	74.0	2156/2	5.4
82.958	74.7	2109/2	13.1	74.0	2162/2	-2.7
83.333	75.5	2106/2	17.0	74.0	2161/2	-1.3
90.083	74.0	2106/2	17.0	73.2	2161/2	-1.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN A-12

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	82.2	2139/2	53.5	83.8	2167/2	63.8
0.000	86.7	2150/2	38.9	88.2	2178/2	49.0
.175	93.5	2162/2	22.9	92.7	2193/2	28.7
1.121	83.8	2180/2	-1.4	83.8	2213/2	1.4
2.217	68.8	2179/2	0.0	69.5	2212/2	2.7
7.108	70.2	2179/2	0.0	71.0	2214/2	0.0
7.925	70.2	2160/2	25.6	71.0	2204/2	13.7
8.925	71.0	2145/2	45.6	71.7	2195/2	26.0
9.921	74.0	2134/2	60.2	75.5	2188/2	35.5
10.954	70.2	2127/2	69.4	71.0	2184/2	40.9
11.946	73.2	2120/2	78.6	73.2	2177/2	50.4
12.967	72.5	2112/2	89.1	72.5	2171/2	58.5
14.196	71.7	2103/2	100.9	72.5	2163/2	69.2
27.929	71.7	2057/2	160.2	72.5	2131/2	111.8
55.954	72.5	3993/4	236.2	73.2	2088/2	168.0
80.912	71.7	3939/4	269.4	71.7	2068/2	193.8
81.871	72.5	3952/4	261.5	74.0	2077/2	182.2
82.871	73.2	3951/4	262.1	74.0	2076/2	183.5
90.083	71.0	3954/4	260.2	72.5	2071/2	190.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN A-19

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	83.0	2066/2	74.0	84.5	2126/2	82.9
0.000	87.5	2079/2	57.3	89.7	2141/2	63.1
.171	95.0	2092/2	40.5	96.5	2157/2	41.8
1.117	85.2	2120/2	3.9	86.0	2187/2	1.4
2.200	69.5	2117/2	7.9	71.7	2186/2	2.7
7.104	71.7	2123/2	0.0	73.2	2188/2	0.0
7.921	71.7	2102/2	27.5	73.2	2176/2	16.2
8.921	72.5	2087/2	47.0	74.0	2161/2	36.4
9.921	74.7	2076/2	61.2	77.0	2157/2	41.8
10.954	71.7	2070/2	68.9	73.2	2153/2	47.1
11.946	74.0	2060/2	81.7	75.5	2147/2	55.1
12.967	74.7	2054/2	89.3	77.0	2143/2	60.4
14.192	75.5	2046/2	99.5	75.5	2134/2	72.4
27.929	73.2	2001/2	156.0	74.0	2103/2	113.1
55.954	74.0	3875/4	233.5	75.5	2056/2	173.7
80.992	74.7	3826/4	262.7	74.7	2032/2	204.1
81.950	74.0	3847/4	250.3	74.7	2041/2	192.7
84.250	73.2	3843/4	252.6	74.7	2040/2	194.0
90.083	143.0	3825/4	263.3	145.2	3964/4	266.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN A-22

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	83.0	2134/2	40.0	83.0	2116/2	62.3
0.000	88.2	2146/2	24.0	87.5	2128/2	46.6
.167	95.0	2162/2	2.7	95.0	2151/2	16.0
1.100	86.0	2186/2	-29.7	84.5	2184/2	-28.3
2.233	81.5	2153/2	14.7	80.7	2155/2	10.7
3.092	74.0	2170/2	-8.1	73.2	2170/2	-9.4
3.904	73.2	2170/2	-8.1	72.5	2170/2	-9.4
4.908	72.5	2169/2	-6.7	71.7	2169/2	-8.1
5.917	77.0	2168/2	-5.4	77.7	2166/2	-4.0
7.079	73.2	2164/2	0.0	72.5	2163/2	0.0
14.108	76.3	2156/2	10.7	74.0	2154/2	12.0
27.929	73.2	2154/2	13.4	71.7	2152/2	14.7
55.950	74.0	2160/2	5.4	72.5	2158/2	6.7
83.000	74.0	2166/2	-2.7	73.2	2164/2	-1.3
90.083	145.2	2054/2	143.8	144.5	2062/2	132.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN A-32

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	76.3	2088/2	70.8	85.2	2132/2	65.5
0.000	80.7	2101/2	53.9	89.0	2144/2	49.6
.167	86.7	2111/2	40.9	95.0	2155/2	34.9
1.117	78.5	2138/2	5.3	86.7	2184/2	-4.1
2.221	62.0	2134/2	10.6	72.5	2184/2	-4.1
7.100	65.0	2142/2	0.0	73.2	2181/2	0.0
7.917	64.2	2121/2	27.8	73.2	2169/2	16.2
8.917	65.0	2106/2	47.4	74.0	2158/2	30.9
9.917	68.0	2097/2	59.1	77.7	2151/2	40.3
10.950	64.2	2091/2	66.9	73.2	2145/2	48.3
11.942	68.0	2083/2	77.3	75.5	2140/2	54.9
12.958	67.2	2079/2	82.4	77.0	2134/2	62.9
14.187	67.2	2067/2	97.9	77.0	2126/2	73.4
27.929	65.7	2026/2	149.9	74.7	2095/2	114.0
55.946	67.2	3934/4	222.9	76.3	2050/2	171.8
81.000	67.2	3890/4	249.6	75.5	2028/2	199.6
81.958	67.2	3980/4	194.7	74.7	2029/2	198.4
83.333	66.5	3907/4	239.3	75.5	2028/2	199.6
90.083	137.7	3816/4	293.8	147.5	3911/4	289.2

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN A-35

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	82.2	2082/2	23.3	85.2	2126/2	13.2
0.000	86.0	2094/2	7.8	89.7	2138/2	-2.6
.167	92.0	2107/2	-9.1	96.5	2152/2	-21.3
1.100	83.8	2127/2	-35.4	87.5	2167/2	-41.4
2.221	80.7	2094/2	7.8	83.8	2135/2	1.3
3.092	73.2	2109/2	-11.7	76.3	2148/2	-15.9
3.904	72.5	2108/2	-10.4	74.7	2147/2	-14.6
4.896	71.0	2107/2	-9.1	75.5	2145/2	-11.9
5.908	71.7	2104/2	-5.2	78.5	2142/2	-8.0
7.075	71.7	2100/2	0.0	75.5	2136/2	0.0
14.187	71.7	2091/2	11.7	77.0	2124/2	15.8
27.929	71.7	2089/2	14.3	75.5	2120/2	21.1
55.958	72.5	2091/2	11.7	75.5	2122/2	18.5
83.250	71.7	2092/2	10.4	76.3	2123/2	17.2
83.458	71.7	2094/2	7.8	74.7	2125/2	14.5
90.083	142.2	3975/4	142.6	146.0	2008/2	164.4

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN A-38

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	86.0	2134/2	58.8	83.0	2120/2	77.3
0.000	89.7	2147/2	41.6	88.2	2132/2	61.5
.162	96.5	2159/2	25.5	95.0	2146/2	42.9
1.108	87.5	2181/2	-4.1	86.7	2178/2	0.0
2.225	83.0	2160/2	24.2	81.5	2157/2	28.2
7.096	72.5	2178/2	0.0	71.7	2178/2	0.0
7.900	74.0	2161/2	22.9	73.2	2170/2	10.8
8.912	74.0	2148/2	40.2	73.2	2161/2	22.9
9.912	77.7	2140/2	50.9	76.3	2155/2	30.9
10.946	74.0	2132/2	61.5	73.2	2149/2	38.9
11.942	77.0	2124/2	72.0	76.3	2143/2	46.9
12.954	74.7	2118/2	79.9	75.5	2140/2	50.9
14.183	76.3	2109/2	91.7	74.7	2131/2	62.8
27.929	74.7	2065/2	148.6	74.0	2099/2	104.7
55.942	76.3	2007/2	221.8	74.7	2057/2	158.9
80.983	71.7	3790/4	357.3	71.7	2036/2	185.5
81.442	77.7	3985/4	239.8	76.3	2035/2	186.8
84.167	76.3	3990/4	236.7	74.7	2037/2	184.2
84.333	76.3	3991/4	236.1	75.5	2037/2	184.2
90.083	73.2	3996/4	233.0	71.7	2033/2	189.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN B-1

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	77.0	2115/2	35.6	72.5	2044/2	43.4
0.000	80.0	2124/2	23.8	76.3	2052/2	33.3
.125	80.0	2124/2	23.8	76.3	2052/2	33.3
.967	86.7	2139/2	4.0	82.2	2065/2	16.7
1.962	83.8	2144/2	-2.7	80.0	2071/2	9.0
7.200	71.7	2142/2	0.0	67.2	2078/2	0.0
7.979	74.0	2113/2	38.3	70.2	2057/2	26.9
9.162	74.7	2099/2	56.5	71.0	2045/2	42.2
10.208	74.7	2089/2	69.5	72.5	2036/2	53.6
10.958	74.7	2084/2	76.0	70.2	2033/2	57.3
11.950	74.7	2077/2	85.0	70.2	2027/2	64.9
13.096	74.7	2072/2	91.4	70.2	2022/2	71.2
14.158	74.7	2064/2	101.7	71.0	2016/2	78.7
22.117	78.5	2006/2	174.9	70.2	3991/4	104.2
28.004	75.5	2018/2	159.9	71.7	3962/4	122.1
56.096	73.2	3943/4	217.4	69.5	3886/4	168.3
83.012	74.0	3880/4	255.6	70.2	3828/4	203.0
83.179	92.7	3808/4	298.5	89.0	3778/4	232.4
89.917	152.0	3747/4	334.2	147.5	3710/4	271.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN B-4

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	74.0	2079/2	-18.0	79.2	2086/2	10.4
0.000	77.7	2088/2	-29.6	83.0	2096/2	-2.6
.125	77.7	2088/2	-29.6	83.0	2096/2	-2.6
.967	84.5	2099/2	-43.9	89.7	2112/2	-23.5
1.975	81.5	2100/2	-45.2	86.0	2114/2	-26.1
2.017	105.5	2058/2	8.9	111.5	2058/2	46.3
2.929	79.2	2076/2	-14.1	81.5	2097/2	-3.9
3.908	72.5	2077/2	-15.4	77.7	2101/2	-9.1
4.917	74.7	2071/2	-7.7	80.7	2099/2	-6.5
5.929	74.0	2070/2	-6.4	80.0	2096/2	-2.6
7.112	74.7	2065/2	0.0	79.2	2094/2	0.0
14.154	72.5	2053/2	15.3	77.7	2086/2	10.4
28.000	72.5	2046/2	24.2	77.7	2085/2	11.7
56.092	71.7	2050/2	19.1	78.5	2098/2	-5.2
82.917	71.7	2048/2	21.7	77.0	2101/2	-9.1
89.917	149.0	3797/4	204.6	155.0	3964/4	141.5

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN B-5

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	76.3	2101/2	38.0	70.2	2085/2	40.4
0.000	80.0	2112/2	23.7	74.7	2097/2	24.8
.125	80.7	2112/2	23.7	74.7	2096/2	26.1
.967	86.7	2127/2	4.0	80.0	2103/2	17.0
1.958	83.8	2128/2	2.6	77.7	2106/2	13.1
7.196	73.2	2130/2	0.0	66.5	2116/2	0.0
7.979	74.7	2103/2	35.4	68.8	2099/2	22.2
9.158	75.5	2088/2	54.9	69.5	2088/2	36.5
10.204	74.7	2077/2	69.1	68.8	2079/2	48.1
10.954	74.7	2073/2	74.3	68.8	2074/2	54.6
11.946	74.7	2065/2	84.5	68.8	2069/2	61.0
13.096	74.7	2058/2	93.5	68.8	2065/2	66.1
14.154	75.5	2051/2	102.4	69.5	2059/2	73.8
22.113	74.7	2022/2	139.0	69.5	2041/2	96.7
28.004	75.5	2005/2	160.2	69.5	2027/2	114.3
56.096	74.7	3916/4	218.0	68.0	3988/4	155.4
82.000	74.0	3853/4	255.9	68.0	3934/4	188.6
82.250	83.0	3818/4	276.7	77.7	3908/4	204.4
89.896	150.5	3785/4	296.2	144.5	3783/4	278.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN B-7

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	78.5	2079/2	-1.3	75.5	2133/2	-11.9
0.000	82.2	2092/2	-18.1	80.7	2144/2	-26.5
.125	82.2	2091/2	-16.8	80.7	2144/2	-26.5
.929	88.2	2106/2	-36.3	86.0	2153/2	-38.5
2.004	83.8	2110/2	-41.5	86.0	2150/2	-34.4
2.096	104.0	2058/2	25.6	105.5	2103/2	27.5
2.925	83.0	2086/2	-10.3	80.0	2131/2	-9.2
3.904	77.0	2088/2	-12.9	74.7	2134/2	-13.2
4.912	79.2	2082/2	-5.2	79.2	2131/2	-9.2
5.925	80.0	2081/2	-3.9	74.7	2128/2	-5.3
7.108	80.0	2078/2	0.0	77.0	2124/2	0.0
14.150	77.7	2070/2	10.3	75.5	2114/2	13.1
28.000	77.0	2068/2	12.9	74.7	2111/2	17.1
56.096	76.3	2076/2	2.6	74.0	2117/2	9.2
82.917	76.3	2079/2	-1.3	74.0	2120/2	5.3
89.875	74.7	2080/2	-2.6	73.2	2120/2	5.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN 8-13

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	73.2	2093/2	-2.6	76.3	2089/2	5.2
0.000	77.7	2104/2	-16.9	80.7	2102/2	-11.7
.125	77.7	2105/2	-18.2	80.7	2102/2	-11.7
.971	83.8	2122/2	-40.5	86.7	2122/2	-37.9
2.158	80.0	2117/2	-33.9	84.5	2115/2	-28.7
2.192	87.5	2117/2	-33.9	89.0	2106/2	-16.9
2.933	78.5	2098/2	-9.1	78.5	2099/2	-7.8
3.858	74.0	2098/2	-9.1	75.5	2101/2	-10.4
4.912	75.5	2099/2	-10.4	75.5	2100/2	-9.1
5.929	72.5	2095/2	-5.2	75.5	2096/2	-3.9
7.150	73.2	2091/2	0.0	76.3	2093/2	0.0
14.154	73.2	2081/2	12.9	76.3	2085/2	10.4
28.000	73.2	2080/2	14.2	75.5	2084/2	11.7
56.096	72.5	2090/2	1.3	74.7	2090/2	3.9
82.917	72.5	2094/2	-3.9	74.7	2094/2	-1.3
90.042	146.0	3928/4	159.6	148.2	3852/4	208.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN B-16

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	77.7	2106/2	2.6	74.0	2086/2	6.5
0.000	82.2	2118/2	-13.1	78.5	2100/2	-11.7
.125	82.2	2116/2	-10.5	77.7	2100/2	-11.7
.967	88.2	2137/2	-38.2	84.5	2128/2	-48.4
1.958	86.7	2135/2	-35.5	81.5	2122/2	-40.5
2.125	106.3	2086/2	28.6	103.2	2124/2	-43.1
2.921	80.7	2112/2	-5.2	80.0	2100/2	-11.7
3.904	76.3	2115/2	-9.2	73.2	2101/2	-13.0
4.908	80.0	2113/2	-6.5	75.5	2099/2	-10.4
5.929	77.7	2111/2	-3.9	73.2	2096/2	-6.5
7.146	77.7	2108/2	0.0	74.0	2091/2	0.0
14.158	77.7	2100/2	10.4	74.0	2079/2	15.5
27.996	77.7	2100/2	10.4	73.2	2077/2	18.1
56.096	77.0	2111/2	-3.9	72.5	2088/2	3.9
82.917	76.3	2114/2	-7.9	73.2	2091/2	0.0
89.896	152.0	2013/2	121.4	148.2	3962/4	138.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN B-19

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	76.3	2092/2	35.2	68.8	2113/2	64.9
0.000	80.7	2104/2	19.6	73.2	2125/2	49.2
.125	81.5	2105/2	18.3	73.2	2126/2	47.9
.963	87.5	2124/2	-6.6	80.0	2154/2	10.7
1.954	85.2	2121/2	-2.6	77.0	2153/2	12.0
7.188	71.7	2119/2	0.0	64.2	2162/2	0.0
7.971	75.5	2095/2	31.4	68.0	2146/2	21.4
9.158	75.5	2079/2	52.1	68.0	2133/2	38.6
10.204	76.3	2068/2	66.2	68.8	2124/2	50.5
10.946	76.3	2063/2	72.6	68.0	2119/2	57.1
11.942	76.3	2057/2	80.3	68.8	2114/2	63.6
13.092	75.5	2051/2	87.9	68.8	2109/2	70.2
14.162	76.3	2043/2	98.1	68.8	2102/2	79.3
22.104	75.5	2014/2	134.5	68.0	2080/2	107.8
28.000	68.8	3993/4	156.3	76.3	2065/2	127.1
56.096	68.0	3899/4	213.8	76.3	2025/2	177.8
82.000	79.2	3835/4	252.1	67.2	3999/4	209.6
82.167	87.5	3790/4	278.7	80.7	3966/4	230.0
82.958	91.3	3841/4	248.6	83.8	2002/2	206.5
89.875	74.7	3852/4	242.0	67.2	2000/2	209.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN B-23

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	76.3	2069/2	53.1	77.7	2051/2	42.3
0.000	82.2	2084/2	33.8	82.2	2064/2	25.7
.125	82.2	2083/2	35.1	82.2	2065/2	24.4
.958	89.0	2109/2	1.3	89.0	2090/2	-7.8
1.950	86.0	2101/2	11.7	86.0	2084/2	0.0
7.183	73.2	2110/2	0.0	73.2	2084/2	0.0
7.971	77.0	2086/2	31.2	73.2	2066/2	23.2
9.133	77.0	2070/2	51.8	77.0	2052/2	41.0
10.204	77.7	2059/2	65.9	77.7	2043/2	52.5
10.942	77.0	2055/2	71.0	77.0	2040/2	56.3
11.937	77.0	2048/2	79.9	77.0	2034/2	63.8
13.088	76.3	2041/2	88.8	76.3	2029/2	70.1
14.162	77.7	2033/2	98.9	77.7	2022/2	78.9
22.100	77.7	2005/2	133.9	77.0	2001/2	105.1
27.996	77.0	3975/4	155.6	77.7	3978/4	119.9
56.092	76.3	3875/4	216.4	76.3	3899/4	168.2
82.000	77.0	3804/4	258.7	77.0	3843/4	201.8
82.167	95.0	3758/4	285.7	92.7	3792/4	232.0
83.958	92.0	3823/4	247.5	92.0	3857/4	193.4
90.042	74.7	3834/4	240.9	74.7	3849/4	198.2

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN B-26

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	77.0	2054/2	47.5	74.0	2091/2	48.4
0.000	82.2	2069/2	28.4	79.2	2104/2	31.5
.125	82.2	2069/2	28.4	79.2	2106/2	28.9
.967	88.2	2087/2	5.2	86.0	2126/2	2.6
1.954	85.2	2087/2	5.2	83.0	2125/2	4.0
7.183	72.5	2091/2	0.0	69.5	2128/2	0.0
7.971	77.0	2065/2	33.5	74.7	2109/2	25.0
9.133	77.0	2047/2	56.4	74.7	2098/2	39.3
10.204	77.0	2036/2	70.4	74.7	2090/2	49.7
10.942	77.0	2030/2	77.9	74.0	2086/2	54.9
11.937	77.0	2023/2	86.7	74.0	2080/2	62.6
13.088	76.3	2016/2	95.5	74.0	2076/2	67.8
14.162	77.7	2007/2	106.7	74.0	2069/2	76.8
22.100	77.0	3951/4	145.6	74.0	2047/2	104.8
27.996	77.0	3910/4	170.6	75.5	2034/2	121.3
56.096	77.0	3800/4	236.3	74.7	3995/4	166.9
82.004	76.3	3729/4	277.7	74.0	3936/4	203.2
82.175	92.7	3671/4	311.0	92.7	3893/4	229.3
90.042	149.7	3690/4	300.2	147.5	3835/4	264.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN B-29

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	76.3	2065/2	10.3	76.3	2079/2	14.2
0.000	82.2	2080/2	-9.0	81.5	2090/2	0.0
.125	82.2	2080/2	-9.0	82.2	2092/2	-2.6
.971	88.2	2100/2	-34.9	87.5	2114/2	-31.3
1.954	88.2	2100/2	-34.9	85.2	2113/2	-30.0
2.150	82.2	2097/2	-31.0	81.5	2103/2	-16.9
2.917	80.0	2080/2	-9.0	81.5	2097/2	-9.1
3.900	77.0	2081/2	-10.3	76.3	2100/2	-13.0
4.908	80.7	2079/2	-7.7	80.7	2095/2	-6.5
5.925	77.0	2076/2	-3.9	77.0	2093/2	-3.9
7.183	77.0	2073/2	0.0	77.0	2090/2	0.0
14.162	77.0	2064/2	11.5	77.0	2083/2	9.1
28.000	77.0	2064/2	11.5	77.0	2084/2	7.8
56.096	77.7	2074/2	-1.3	77.0	2096/2	-7.8
82.917	76.3	2079/2	-7.7	75.5	2100/2	-13.0
90.042	74.7	2080/2	-9.0	74.0	2101/2	-14.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN B-41

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	66.5	2119/2	7.9	74.7	2052/2	-2.5
0.000	72.5	2129/2	-5.3	80.0	2066/2	-20.4
.121	72.5	2133/2	-10.6	80.7	2067/2	-21.7
.958	78.5	2156/2	-41.1	86.0	2091/2	-52.6
2.142	72.5	2150/2	-33.1	81.5	2080/2	-38.4
2.162	84.5	2143/2	-23.8	93.5	2063/2	-16.6
2.904	71.7	2131/2	-7.9	80.0	2060/2	-12.7
3.842	67.2	2133/2	-10.6	74.7	2060/2	-12.7
4.908	71.0	2130/2	-6.6	76.3	2055/2	-6.4
5.921	66.5	2127/2	-2.6	75.5	2053/2	-3.8
7.200	67.2	2125/2	0.0	74.7	2050/2	0.0
14.158	66.5	2116/2	11.8	75.5	2040/2	12.7
27.992	67.2	2114/2	14.5	75.5	2037/2	16.5
56.096	65.0	2121/2	5.3	77.0	2047/2	3.8
83.887	65.7	2125/2	0.0	74.0	2048/2	2.5
90.000	65.0	2116/2	11.8	72.5	4080/4	12.7

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN B-42

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	74.7	2093/2	43.2	70.2	2152/2	39.0
0.000	80.0	2105/2	27.5	75.5	2168/2	17.5
.121	80.0	2107/2	24.9	75.5	2167/2	18.9
.958	86.0	2130/2	-5.3	80.7	2188/2	-9.5
1.950	83.0	2127/2	-1.3	79.2	2182/2	-1.4
7.204	69.5	2126/2	0.0	65.7	2181/2	0.0
7.967	74.0	2103/2	30.2	69.5	2164/2	22.9
9.158	73.2	2088/2	49.6	71.0	2155/2	34.9
10.204	74.7	2079/2	61.3	71.0	2148/2	44.3
10.933	74.0	2074/2	67.7	70.2	2146/2	46.9
11.929	74.0	2067/2	76.7	71.0	2140/2	54.9
13.079	74.0	2061/2	84.4	70.2	2136/2	60.2
14.158	74.7	2052/2	95.8	71.0	2130/2	68.2
22.092	74.7	2023/2	132.5	70.2	2114/2	89.2
27.992	74.7	2005/2	155.0	71.0	2106/2	99.7
56.096	74.0	3921/4	209.7	69.5	2086/2	125.7
81.979	74.7	3855/4	249.4	69.5	2064/2	154.0
82.154	83.8	3821/4	269.7	80.7	2050/2	171.8
83.408	75.5	3857/4	248.2	71.7	2063/2	155.2
90.000	72.5	3851/4	251.8	68.8	2072/2	143.7

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-6

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	79.2	2080/2	9.0	83.8	2106/2	-18.2
0.000	74.7	2054/2	42.4	78.5	2098/2	-7.8
1.125	81.5	2086/2	1.3	86.0	2098/2	-7.8
1.904	77.0	2083/2	5.2	80.7	2093/2	-1.3
7.237	70.2	2087/2	0.0	74.7	2092/2	0.0
7.987	71.0	2068/2	24.5	73.2	2079/2	16.8
8.917	71.7	2057/2	38.5	76.3	2069/2	29.7
9.950	71.7	2048/2	50.0	78.5	2062/2	38.6
10.950	74.0	2040/2	60.1	76.3	2057/2	45.0
11.950	73.2	2035/2	66.4	78.5	2052/2	51.4
12.904	72.5	2027/2	76.5	77.0	2046/2	59.0
13.942	72.5	2022/2	82.8	77.7	2041/2	65.3
28.250	72.5	3954/4	138.6	77.0	2008/2	106.8
55.917	71.7	3850/4	201.5	77.0	3947/4	149.3
82.000	71.7	3796/4	233.5	76.3	3889/4	184.6
83.000	91.3	3727/4	273.7	98.8	3836/4	216.3
84.167	90.5	3809/4	225.8	86.7	3916/4	168.2
89.937	70.2	3816/4	221.7	73.2	3908/4	173.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-11

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	84.5	2112/2	-31.2	70.2	2104/2	-9.1
0.000	79.2	2086/2	2.6	66.5	2077/2	25.9
1.129	86.7	2106/2	-23.4	73.2	2093/2	5.2
1.904	83.0	2099/2	-14.3	70.2	2090/2	9.1
7.237	75.5	2088/2	0.0	62.0	2097/2	0.0
7.992	76.3	2068/2	25.8	62.7	2084/2	16.8
8.917	76.3	2056/2	41.1	62.7	2075/2	28.5
9.946	77.0	2045/2	55.1	63.5	2066/2	40.0
10.950	79.2	2037/2	65.2	66.5	2060/2	47.7
11.954	79.2	2029/2	75.3	65.7	2053/2	56.6
12.908	77.7	2021/2	85.3	64.2	2046/2	65.5
13.942	77.7	2015/2	92.9	64.2	2040/2	73.1
28.254	77.7	3923/4	158.8	64.2	2000/2	123.2
55.917	77.0	3808/4	227.7	64.2	3905/4	181.4
83.125	91.3	3704/4	288.3	80.0	3814/4	235.8
89.937	75.5	3773/4	248.3	62.0	3850/4	214.5

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-12

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	80.7	2143/2	-27.8	84.5	2100/2	-68.1
0.000	75.5	2120/2	2.6	79.2	2072/2	-31.9
1.100	83.0	2151/2	-38.4	86.7	2083/2	-46.1
1.879	83.0	2148/2	-34.4	86.7	2078/2	-39.6
1.925	85.2	2147/2	-33.1	89.7	2060/2	-16.6
3.217	74.7	2126/2	-5.3	79.2	2053/2	-7.6
3.954	74.7	2127/2	-6.6	78.5	2054/2	-8.9
4.954	73.2	2126/2	-5.3	78.5	2052/2	-6.4
6.096	73.2	2124/2	-2.6	78.5	2050/2	-3.8
7.179	73.2	2122/2	0.0	77.7	2047/2	0.0
13.942	73.2	2115/2	9.2	77.7	2037/2	12.7
28.379	73.2	2112/2	13.1	77.7	2032/2	19.0
55.942	74.0	2117/2	6.6	78.5	2032/2	19.0
83.125	69.5	2128/2	-7.9	74.0	2042/2	6.3
89.937	149.0	2013/2	139.7	153.5	3787/4	187.5

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-13

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	74.0	2107/2	1.3	84.5	2135/2	-36.8
0.000	68.0	2080/2	36.4	77.7	2106/2	1.3
1.125	75.5	2110/2	-2.6	86.0	2126/2	-24.9
1.900	72.5	2105/2	3.9	80.0	2119/2	-15.7
7.233	64.2	2108/2	0.0	73.2	2107/2	0.0
7.987	63.5	2090/2	23.4	74.0	2098/2	11.7
8.917	64.2	2078/2	38.9	74.7	2090/2	22.1
9.946	65.0	2067/2	53.1	76.3	2080/2	35.0
10.954	65.7	2058/2	64.6	76.3	2073/2	44.1
11.950	68.0	2051/2	73.5	78.5	2067/2	51.8
12.908	65.7	2044/2	82.4	77.0	2061/2	59.4
13.942	66.5	2038/2	90.0	77.0	2056/2	65.8
28.254	66.5	3977/4	151.8	77.0	2024/2	106.3
55.917	65.7	3867/4	218.6	77.0	3980/4	148.6
82.000	65.7	3810/4	252.5	77.0	3923/4	183.5
83.146	80.0	3768/4	277.2	93.5	3894/4	201.1
89.937	137.7	3745/4	290.6	149.0	3777/4	270.6

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-16

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	83.0	2124/2	-54.8	72.5	2109/2	-59.5
0.000	77.0	2096/2	-18.1	67.2	2080/2	-21.8
1.104	84.5	2121/2	-50.8	74.7	2091/2	-36.1
1.875	87.5	2114/2	-41.6	74.7	2084/2	-27.0
1.917	103.2	2063/2	24.4	93.5	2040/2	29.3
3.212	77.0	2088/2	-7.8	67.2	2069/2	-7.7
3.950	76.3	2089/2	-9.1	65.7	2068/2	-6.4
4.946	75.5	2087/2	-6.5	65.7	2068/2	-6.4
6.096	74.7	2085/2	-3.9	65.0	2067/2	-5.1
7.175	75.5	2082/2	0.0	65.7	2063/2	0.0
13.937	75.5	2072/2	12.9	65.0	2054/2	11.5
28.379	75.5	2070/2	15.4	65.0	2053/2	12.8
55.917	76.3	2072/2	12.9	65.0	2058/2	6.4
83.125	71.7	2080/2	2.6	62.0	2070/2	-9.0
89.937	74.0	2076/2	7.7	64.2	2067/2	-5.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-17

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	74.0	2112/2	7.9	84.5	2110/2	-29.9
0.000	68.0	2090/2	36.5	77.7	2082/2	6.5
1.125	75.5	2120/2	-2.6	85.2	2092/2	-6.5
1.896	70.2	2116/2	2.6	80.7	2093/2	-7.8
7.229	64.2	2118/2	0.0	74.0	2087/2	0.0
7.987	63.5	2102/2	20.9	74.0	2076/2	14.2
9.021	65.0	2088/2	39.1	75.5	2060/2	34.7
9.942	65.7	2078/2	52.0	76.3	2056/2	39.8
10.954	65.0	2070/2	62.3	78.5	2050/2	47.5
11.950	67.2	2065/2	68.7	78.5	2042/2	57.6
12.904	65.7	2056/2	80.2	76.3	2037/2	63.9
13.946	65.7	2050/2	87.9	76.3	2031/2	71.5
28.250	65.7	3988/4	158.1	77.0	2000/2	110.2
55.917	65.7	3900/4	211.9	76.3	3904/4	169.0
82.000	65.7	3842/4	246.7	77.0	3869/4	190.1
83.125	87.5	3784/4	280.9	100.2	3793/4	235.2
84.167	80.0	3887/4	219.7	90.5	3882/4	182.3
89.937	65.0	3879/4	224.5	74.7	3857/4	197.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-23

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	83.8	2096/2	-66.7	82.2	2122/2	-50.8
0.000	78.5	2073/2	-37.0	76.3	2094/2	-14.2
1.104	86.7	2097/2	-68.0	84.5	2117/2	-44.3
1.917	83.8	2085/2	-52.5	80.7	2109/2	-33.8
2.125	103.2	2063/2	-24.2	101.7	2069/2	18.0
3.217	78.5	2054/2	-12.7	76.3	2090/2	-9.1
3.954	78.5	2054/2	-12.7	75.5	2090/2	-9.1
4.950	77.0	2051/2	-8.9	74.7	2088/2	-6.5
6.104	77.0	2048/2	-5.1	74.7	2086/2	-3.9
7.175	77.0	2044/2	0.0	75.5	2083/2	0.0
13.946	77.0	2031/2	16.4	74.7	2074/2	11.6
28.379	76.3	2024/2	25.2	74.7	2071/2	15.5
55.942	77.7	2024/2	25.2	76.3	2074/2	11.6
83.125	73.2	2034/2	12.6	72.5	2086/2	-3.9
89.937	74.0	2030/2	17.7	73.2	2083/2	0.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-34

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	82.2	2100/2	-55.4	82.2	2123/2	-79.1
0.000	77.7	2077/2	-25.6	77.7	2097/2	-45.1
1.104	85.2	2104/2	-60.6	86.0	2099/2	-47.7
1.892	85.2	2096/2	-50.2	86.0	2091/2	-37.3
2.142	104.7	2050/2	8.9	110.7	2035/2	34.3
3.217	77.0	2067/2	-12.8	78.5	2070/2	-10.2
3.946	77.0	2066/2	-11.5	77.0	2070/2	-10.2
4.946	77.0	2064/2	-8.9	77.0	2068/2	-7.7
6.092	76.3	2060/2	-3.8	77.0	2065/2	-3.8
7.175	76.3	2057/2	0.0	77.0	2062/2	0.0
13.946	76.3	2046/2	14.0	77.0	2052/2	12.8
28.379	76.3	2042/2	19.1	77.0	2050/2	15.3
55.917	77.0	2043/2	17.8	77.7	2053/2	11.5
83.125	72.5	2051/2	7.6	74.7	2064/2	-2.6
89.937	146.0	3883/4	143.2	147.5	3892/4	144.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-36

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	82.2	2105/2	-5.2	80.0	2099/2	-45.2
0.000	78.5	2084/2	22.1	75.5	2076/2	-15.4
1.121	86.7	2109/2	-10.4	84.5	2076/2	-15.4
1.892	80.0	2105/2	-5.2	80.0	2070/2	-7.7
7.225	74.7	2101/2	0.0	72.5	2064/2	0.0
7.983	75.5	2086/2	19.5	73.2	2054/2	12.8
8.908	76.3	2073/2	36.2	74.0	2044/2	25.5
9.942	76.3	2061/2	51.6	74.7	2037/2	34.3
10.954	77.0	2050/2	65.6	74.7	2032/2	40.6
11.950	78.5	2047/2	69.4	76.3	2027/2	46.9
12.904	77.0	2039/2	79.6	74.7	2020/2	55.7
13.946	77.7	2033/2	87.1	74.7	2014/2	63.2
28.250	77.7	3967/4	148.8	74.7	3959/4	105.9
55.917	77.7	3860/4	213.7	74.7	3887/4	149.7
82.000	77.7	3785/4	258.1	75.5	3842/4	176.7
83.167	98.8	3738/4	285.5	98.8	3780/4	213.3
84.000	74.7	3828/4	232.7	72.5	3872/4	158.7
89.937	150.5	3718/4	297.1	147.5	3706/4	256.2

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-39

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	83.0	2077/2	-64.9	83.0	2146/2	-67.1
0.000	79.2	2055/2	-36.7	79.2	2119/2	-31.4
1.108	86.7	2082/2	-71.3	87.5	2129/2	-44.5
1.938	86.0	2073/2	-59.7	87.5	2123/2	-36.6
2.142	93.5	2073/2	-59.7	93.5	2106/2	-14.3
3.221	78.5	2038/2	-15.1	80.0	2103/2	-10.4
3.946	77.7	2037/2	-13.9	79.2	2102/2	-9.1
4.946	77.7	2035/2	-11.3	78.5	2101/2	-7.8
6.092	77.0	2031/2	-6.3	78.5	2099/2	-5.2
7.175	77.7	2026/2	0.0	78.5	2095/2	0.0
13.946	77.7	2015/2	13.8	78.5	2087/2	10.4
28.383	77.7	2009/2	21.3	78.5	2085/2	13.0
55.938	78.5	2007/2	23.8	78.5	2087/2	10.4
83.125	75.5	2011/2	18.8	77.0	2091/2	5.2
89.937	74.0	2012/2	17.5	75.5	2094/2	1.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-41

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	72.5	2122/2	-43.1	80.0	2105/2	-56.8
0.000	70.2	2100/2	-14.3	77.0	2086/2	-32.1
1.108	76.3	2117/2	-36.5	85.2	2107/2	-59.4
1.933	75.5	2110/2	-27.3	85.2	2099/2	-49.0
2.175	89.0	2081/2	10.3	98.0	2072/2	-14.1
3.217	68.8	2094/2	-6.5	77.7	2068/2	-9.0
3.950	67.2	2096/2	-9.1	75.5	2067/2	-7.7
4.942	66.5	2094/2	-6.5	75.5	2065/2	-5.1
6.088	66.5	2091/2	-2.6	75.5	2063/2	-2.6
7.171	67.2	2089/2	0.0	75.5	2061/2	0.0
13.942	67.2	2080/2	11.6	75.5	2051/2	12.7
28.379	67.2	2078/2	14.2	75.5	2047/2	17.8
55.921	66.5	2085/2	5.2	76.3	2051/2	12.7
83.129	65.7	2090/2	-1.3	74.7	2055/2	7.7
89.937	138.5	3968/4	132.6	149.0	3875/4	153.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN C-46

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	80.0	2096/2	19.6	80.0	2099/2	-2.6
0.000	*72.2	2078/2	42.9	76.3	2079/2	23.3
1.117	84.5	2114/2	-3.9	83.8	2099/2	-2.6
3.888	80.7	2108/2	3.9	80.7	2093/2	5.2
7.221	73.2	2111/2	0.0	72.5	2097/2	0.0
7.983	74.0	2093/2	23.5	73.2	2085/2	15.6
8.908	74.0	2080/2	40.3	74.7	2075/2	28.5
9.938	75.5	2067/2	57.0	75.5	2067/2	38.7
10.954	75.5	2059/2	67.2	75.5	2060/2	47.7
11.946	77.7	2052/2	76.1	77.0	2056/2	52.8
12.950	76.3	2043/2	87.6	75.5	2048/2	63.0
13.950	76.3	2037/2	95.2	75.5	2043/2	69.3
28.250	76.3	3990/4	147.7	75.5	2015/2	104.5
55.896	76.3	3859/4	227.3	75.5	3937/4	161.9
82.000	76.3	3761/4	285.2	74.7	3862/4	207.3
83.133	95.0	3740/4	297.4	95.7	3828/4	227.5
84.000	92.0	3833/4	242.8	90.5	3907/4	180.2
89.937	151.2	3748/4	292.8	150.5	3760/4	267.5

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-2

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	71.7	2106/2	-41.5	71.0	2119/2	-54.6
0.000	70.2	2103/2	-37.6	69.5	2113/2	-46.8
.921	77.0	2106/2	-41.5	77.0	2109/2	-41.5
1.925	69.5	2108/2	-44.1	69.5	2110/2	-42.8
2.225	80.0	2054/2	25.6	80.0	2058/2	24.4
2.950	69.5	2083/2	-11.6	68.0	2087/2	-12.9
3.992	66.5	2083/2	-11.6	65.0	2087/2	-12.9
4.992	68.8	2081/2	-9.0	67.2	2084/2	-9.0
6.146	66.5	2077/2	-3.9	65.7	2079/2	-2.6
6.992	66.5	2074/2	0.0	65.7	2077/2	0.0
14.042	66.5	2064/2	12.8	65.7	2067/2	12.8
28.254	65.7	2063/2	14.1	65.7	2066/2	14.1
56.008	66.5	2064/2	12.8	66.5	2066/2	14.1
83.100	62.7	2072/2	2.6	62.7	2074/2	3.9
89.937	140.7	3886/4	163.1	140.7	3885/4	167.6

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-3

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	71.0	2111/2	3.9	80.0	2100/2	-42.6
0.000	68.8	2108/2	7.9	77.7	2095/2	-36.1
.921	77.0	2116/2	-2.6	86.0	2085/2	-23.2
1.933	72.5	2130/2	-21.1	81.5	2095/2	-36.1
7.000	65.0	2114/2	0.0	73.2	2067/2	0.0
8.142	64.2	2094/2	26.1	73.2	2057/2	12.8
8.971	64.2	2083/2	40.3	73.2	2049/2	23.0
9.979	64.2	2072/2	54.5	74.0	2040/2	34.4
10.988	65.0	2062/2	67.3	74.0	2031/2	45.7
11.971	65.0	2056/2	75.0	74.0	2025/2	53.3
13.100	65.0	2048/2	85.2	74.0	2018/2	62.1
14.042	65.0	2043/2	91.5	74.0	2014/2	67.1
28.246	65.0	3995/4	148.5	73.2	3966/4	105.5
56.000	65.7	3886/4	215.1	74.7	3889/4	152.3
82.042	65.0	3822/4	253.3	73.2	3842/4	180.5
83.250	71.7	3825/4	251.5	82.2	3798/4	206.5
89.937	139.2	3796/4	268.6	148.2	3765/4	225.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-12

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	71.0	2115/2	-30.0	71.0	2115/2	-55.8
0.000	69.5	2115/2	-30.0	69.5	2112/2	-51.9
.912	76.3	2121/2	-37.9	75.5	2110/2	-49.3
1.904	69.5	2120/2	-36.6	68.8	2103/2	-40.1
2.208	80.0	2076/2	20.7	78.5	2059/2	16.6
2.942	68.8	2101/2	-11.7	68.0	2083/2	-14.2
3.983	65.7	2100/2	-10.4	65.7	2082/2	-12.9
4.983	68.8	2098/2	-7.8	68.8	2078/2	-7.7
5.929	65.7	2094/2	-2.6	66.5	2076/2	-5.1
6.983	66.5	2092/2	0.0	66.5	2072/2	0.0
14.033	66.5	2083/2	11.6	66.5	2062/2	12.8
28.254	65.0	2074/2	23.2	65.0	2061/2	14.1
56.013	67.2	2086/2	7.8	67.2	2062/2	12.8
83.096	65.0	2092/2	0.0	65.0	2066/2	7.7
89.937	138.5	2011/2	103.0	138.5	3908/4	147.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-15

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	70.2	2096/2	-47.7	77.7	2128/2	-62.6
0.000	68.0	2089/2	-38.6	74.7	2123/2	-56.0
.912	75.5	2094/2	-45.1	83.0	2116/2	-46.8
1.913	68.0	2093/2	-43.8	74.0	2112/2	-41.6
2.242	74.0	2051/2	10.2	81.5	2075/2	6.4
2.950	68.0	2065/2	-7.7	73.2	2089/2	-11.6
3.992	64.2	2066/2	-9.0	71.7	2089/2	-11.6
4.987	67.2	2064/2	-6.4	74.7	2087/2	-9.0
5.938	65.0	2060/2	-1.3	72.5	2083/2	-3.9
6.987	65.0	2059/2	0.0	72.5	2080/2	0.0
14.042	65.0	2051/2	10.2	71.7	2070/2	12.9
28.262	64.2	2052/2	8.9	71.0	2070/2	12.9
56.000	65.7	2056/2	3.8	72.5	2073/2	9.0
83.146	68.8	2066/2	-9.0	61.3	2082/2	-2.6
89.937	138.5	3910/4	129.4	146.0	3951/4	131.4

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-20

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

TIME (DAYS)	AXIAL GAGE TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	RADIAL GAGE TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	71.7	2095/2	-62.9	78.5	2062/2	-73.1
0.000	69.5	2088/2	-53.8	76.3	2056/2	-65.4
.912	77.0	2084/2	-48.7	84.5	2043/2	-48.9
1.883	70.2	2082/2	-46.1	77.0	2038/2	-42.6
2.217	80.0	4057/4	22.1	87.5	3979/4	18.0
2.950	68.8	2055/2	-11.4	74.7	2014/2	-12.5
3.992	66.5	2050/2	-5.1	72.5	2012/2	-10.0
4.987	68.8	2053/2	-8.9	74.7	2010/2	-7.5
5.942	66.5	2048/2	-2.5	73.2	2007/2	-3.7
6.987	66.5	2046/2	0.0	73.2	2004/2	0.0
14.042	66.5	2037/2	11.4	73.2	3994/4	8.7
28.258	65.7	2034/2	15.2	72.5	3992/4	9.9
56.000	67.2	2034/2	15.2	74.0	3996/4	7.4
83.083	65.7	2038/2	10.1	73.2	2002/2	2.5
89.958	63.5	2042/2	5.1	69.5	2006/2	-2.5

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-22

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	78.5	2091/2	-43.7	77.0	2108/2	-33.8
0.000	76.3	2085/2	-36.0	75.5	2103/2	-27.2
.912	82.2	2083/2	-33.4	81.5	2088/2	-7.8
1.917	79.2	2085/2	-36.0	79.2	2094/2	-15.5
6.987	72.5	2057/2	0.0	71.0	2082/2	0.0
8.133	71.7	2037/2	25.4	70.2	2074/2	10.3
8.967	71.7	2028/2	36.7	70.2	2065/2	21.9
9.971	71.7	2018/2	49.3	71.0	2059/2	29.5
10.979	72.5	2010/2	59.3	71.0	2053/2	37.2
11.967	72.5	2003/2	68.0	71.0	2047/2	44.8
13.096	73.2	3994/4	75.4	71.7	2041/2	52.4
14.033	73.2	3986/4	80.4	71.0	2037/2	57.5
28.250	72.5	3900/4	132.9	71.0	2007/2	95.1
55.979	74.0	3800/4	192.6	72.5	3937/4	142.5
82.012	71.0	3748/4	223.0	71.0	3889/4	171.6
83.250	79.2	3732/4	232.3	78.5	3876/4	179.5
89.958	148.2	3876/4	147.4	146.7	3759/4	248.7

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-23

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	81.5	2108/2	-24.7	83.0	2111/2	-29.9
0.000	79.2	2102/2	-16.9	80.0	2103/2	-19.5
.904	87.5	2093/2	-5.2	88.2	2092/2	-5.2
1.921	83.0	2107/2	-23.4	84.5	2103/2	-19.5
6.992	83.0	2089/2	0.0	77.0	2088/2	0.0
8.142	74.7	2066/2	29.6	76.3	2078/2	12.9
8.967	75.5	2056/2	42.4	76.3	2071/2	21.9
10.983	75.5	2038/2	65.2	76.3	2056/2	41.1
11.975	75.5	2030/2	75.3	76.3	2051/2	47.5
13.096	76.3	2022/2	85.4	77.7	2044/2	56.4
14.042	75.5	2016/2	92.9	77.0	2040/2	61.4
28.254	75.5	3974/4	128.9	77.0	2035/2	67.7
55.992	75.5	3827/4	217.8	77.7	3940/4	148.4
82.021	74.7	3768/4	252.5	76.3	3894/4	176.4
90.617	149.7	3714/4	283.8	149.7	3799/4	233.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-26

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	72.5	2091/2	-39.9	81.5	2096/2	-66.7
0.000	70.2	2085/2	-32.1	80.0	2091/2	-60.2
.912	76.3	2096/2	-46.4	85.2	2089/2	-57.7
1.908	69.5	2090/2	-38.6	80.0	2080/2	-46.0
2.242	82.2	2046/2	17.8	90.5	2027/2	21.5
2.950	68.8	2071/2	-14.1	77.7	2054/2	-12.7
3.987	67.2	2070/2	-12.8	75.5	2053/2	-11.4
4.983	69.5	2068/2	-10.2	78.5	2050/2	-7.6
5.933	66.5	2063/2	-3.8	76.3	2047/2	-3.8
6.979	67.2	2060/2	0.0	76.3	2044/2	0.0
14.037	67.2	2048/2	15.3	76.3	2032/2	15.2
28.250	66.5	2045/2	19.1	75.5	2032/2	15.2
56.000	68.0	2047/2	16.6	77.0	2032/2	15.2
83.083	63.5	2055/2	6.4	72.5	2042/2	2.5
89.917	65.7	2050/2	12.7	74.7	2037/2	8.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-31

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	83.0	2105/2	-60.7	80.0	2082/2	-60.0
0.000	81.5	2100/2	-54.1	78.5	2076/2	-52.3
.537	87.5	2101/2	-55.4	85.2	2079/2	-56.1
1.908	80.0	2099/2	-52.8	77.0	2076/2	-52.3
2.242	98.8	2023/2	44.3	93.5	2007/2	35.1
2.950	78.5	2067/2	-11.5	76.3	2046/2	-13.9
3.987	77.0	2066/2	-10.2	74.0	2044/2	-11.4
4.983	80.0	2066/2	-10.2	77.0	2043/2	-10.1
5.933	77.7	2060/2	-2.6	75.5	2038/2	-3.8
6.979	77.7	2058/2	0.0	74.7	2035/2	0.0
14.033	77.0	2049/2	11.5	74.0	2023/2	15.1
28.246	77.0	2047/2	14.0	74.0	2023/2	15.1
56.000	77.7	2048/2	12.7	74.7	2025/2	12.6
83.083	74.0	2057/2	1.3	71.0	2036/2	-1.3
89.937	75.5	2052/2	7.6	74.0	2033/2	2.5

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-33

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	80.0	2110/2	3.9	72.5	2079/2	-15.4
0.000	77.7	2105/2	10.5	70.2	2072/2	-6.4
.917	85.2	2112/2	1.3	77.0	2068/2	-1.3
1.913	81.5	2125/2	-15.8	74.0	2083/2	-20.6
6.967	74.7	2113/2	0.0	66.5	2067/2	0.0
8.133	73.2	2093/2	26.1	65.7	2056/2	14.1
8.958	73.2	2082/2	40.3	65.7	2049/2	23.0
9.971	74.0	2074/2	50.6	65.7	2040/2	34.4
10.979	74.0	2065/2	62.2	65.7	2033/2	43.2
11.967	74.0	2057/2	72.4	65.7	2028/2	49.5
13.092	74.7	2049/2	82.6	67.2	2020/2	59.5
14.033	74.0	2045/2	87.7	67.2	2017/2	63.3
28.250	73.2	2002/2	141.6	65.7	3968/4	104.2
55.987	72.5	3900/4	205.3	66.5	3886/4	154.1
82.021	74.0	3839/4	241.9	65.7	3835/4	184.7
90.196	71.7	3868/4	224.6	63.5	3839/4	182.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-40

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	81.5	2105/2	-5.2	71.7	2115/2	-14.4
0.000	80.0	2101/2	0.0	70.2	2108/2	-5.2
.917	86.7	2106/2	-6.5	77.0	2106/2	-2.6
1.917	83.0	2118/2	-22.2	73.2	2120/2	-21.0
6.983	75.5	2101/2	0.0	65.7	2104/2	0.0
8.133	75.5	2079/2	28.5	65.7	2092/2	15.6
8.958	75.5	2069/2	41.4	65.7	2086/2	23.4
9.967	75.5	2059/2	54.2	65.7	2077/2	35.0
10.979	76.3	2049/2	66.9	65.7	2069/2	45.3
11.971	76.3	2043/2	74.5	66.5	2065/2	50.4
13.100	76.3	2036/2	83.4	66.5	2059/2	58.1
14.033	75.5	2031/2	89.7	66.5	2056/2	61.9
28.238	75.5	3976/4	143.2	65.7	2023/2	103.6
55.979	77.0	3868/4	208.9	66.5	3972/4	149.6
82.000	75.5	3812/4	242.2	65.7	3928/4	176.6
83.250	81.5	3891/4	195.1	65.0	3910/4	187.5
89.937	74.7	3828/4	232.7	65.0	3927/4	177.2

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-41

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

TIME (DAYS)	AXIAL GAGE TEMP (F)	AXIAL GAGE READ/DIV (FREQ)	AXIAL GAGE SHR STRAIN* (MIC-UNITS)	RADIAL GAGE TEMP (F)	RADIAL GAGE READ/DIV (FREQ)	RADIAL GAGE SHR STRAIN* (MIC-UNITS)
0.000	71.7	2094/2	3.9	82.2	2129/2	-54.9
0.000	70.2	2089/2	10.4	80.7	2122/2	-45.7
.917	77.0	2094/2	3.9	87.5	2102/2	-19.5
1.917	73.2	2109/2	-15.6	83.8	2112/2	-32.5
6.971	66.5	2097/2	0.0	76.3	2087/2	0.0
8.129	65.0	2076/2	27.2	75.5	2076/2	14.2
8.958	65.0	2066/2	40.0	76.3	2070/2	21.9
9.962	65.0	2056/2	52.8	75.5	2061/2	33.4
10.979	65.0	2047/2	64.2	76.3	2054/2	42.4
11.971	65.0	2039/2	74.4	76.3	2047/2	51.3
13.096	65.7	2030/2	85.7	77.0	2040/2	60.1
14.033	65.7	2024/2	93.3	77.0	2036/2	65.2
28.233	65.0	3956/4	150.3	75.5	2006/2	102.8
55.979	66.5	3837/4	222.2	77.7	3940/4	147.1
82.021	65.0	3776/4	258.2	76.3	3893/4	175.7
82.833	68.0	3760/4	267.5	71.0	3883/4	181.7
89.958	141.5	3722/4	289.6	152.0	3793/4	235.2

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-44

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	78.5	2101/2	1.3	71.7	2102/2	-36.2
0.000	76.3	2097/2	6.5	70.2	2097/2	-29.7
.917	83.0	2101/2	1.3	77.0	2078/2	-5.1
1.904	79.2	2114/2	-15.7	73.2	2088/2	-18.1
6.904	72.5	2102/2	0.0	66.5	2074/2	0.0
8.129	71.0	2080/2	28.5	65.0	2064/2	12.8
8.954	71.0	2070/2	41.4	65.0	2057/2	21.8
9.967	71.7	2060/2	54.2	65.7	2049/2	32.0
10.979	71.7	2050/2	66.9	65.7	2042/2	40.8
11.971	71.7	2042/2	77.1	65.7	2036/2	48.4
13.096	72.5	2035/2	85.9	66.5	2029/2	57.2
14.029	71.7	2029/2	93.5	65.7	2026/2	61.0
28.233	65.7	3983/4	140.2	65.7	3968/4	113.2
55.979	72.5	3852/4	219.8	66.5	3898/4	155.9
82.021	71.7	3795/4	253.5	65.7	3848/4	185.9
83.271	87.5	3733/4	289.7	81.5	3806/4	210.8
89.937	70.2	3810/4	244.7	65.0	3848/4	185.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN D-46

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	71.7	2144/2	-60.5	81.5	2095/2	-84.4
0.000	69.5	2140/2	-55.2	78.5	2088/2	-75.3
.912	76.3	2135/2	-48.6	86.0	2067/2	-48.3
1.896	68.8	2133/2	-45.9	77.7	2064/2	-44.4
2.237	84.5	2072/2	33.6	94.2	2003/2	32.5
2.946	67.2	2108/2	-13.0	77.7	2040/2	-13.9
3.946	65.0	2107/2	-11.7	74.7	2039/2	-12.6
4.971	67.2	2102/2	-5.2	77.7	2035/2	-7.6
5.925	66.5	2101/2	-3.9	76.3	2033/2	-5.0
6.967	65.7	2098/2	0.0	75.5	2029/2	0.0
14.029	65.7	2088/2	13.0	75.5	2020/2	11.3
28.233	65.0	2087/2	14.3	74.7	2021/2	10.0
56.000	65.7	2089/2	11.7	75.5	2025/2	5.0
83.083	62.0	2099/2	-1.3	72.5	2037/2	-10.1
89.937	139.2	3986/4	133.2	149.7	3823/4	143.5

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN E-1

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	88.2	2204/2	-4.1	88.2	2240/2	-26.3
0.000	78.5	2179/2	29.9	77.7	2215/2	8.3
.967	89.0	2187/2	19.0	88.2	2209/2	16.5
1.950	77.7	2194/2	9.5	76.3	2218/2	4.1
7.258	74.7	2201/2	0.0	73.2	2221/2	0.0
7.933	76.3	2167/2	46.0	75.5	2194/2	37.0
8.979	75.5	2156/2	60.8	75.5	2188/2	45.1
10.242	76.3	2151/2	67.5	76.3	2183/2	51.9
10.992	77.0	2144/2	76.8	77.0	2179/2	57.3
11.988	77.0	2140/2	82.1	77.0	2173/2	65.4
13.154	77.7	2129/2	96.6	77.0	2165/2	76.1
14.225	75.5	2127/2	99.3	75.5	2165/2	76.1
28.154	76.3	2080/2	160.6	76.3	2138/2	112.2
56.000	76.3	2030/2	224.3	77.7	2096/2	167.3
81.862	74.7	2002/2	259.3	74.7	2077/2	191.9
82.883	77.0	2002/2	259.3	77.0	2078/2	190.6
89.767	151.2	3879/4	335.6	151.2	2005/2	283.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-4

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	87.5	2212/2	-17.8	87.5	2219/2	19.2
0.000	77.7	2185/2	19.0	77.7	2192/2	17.7
.971	88.2	2195/2	5.4	88.2	2194/2	15.0
1.946	76.3	2200/2	-1.4	76.3	2204/2	1.4
7.258	73.2	2199/2	0.0	73.2	2205/2	0.0
7.929	75.5	2175/2	32.5	76.3	2189/2	21.8
8.975	75.5	2164/2	47.3	75.5	2183/2	29.9
10.237	76.3	2158/2	55.4	76.3	2179/2	35.3
10.988	77.0	2152/2	63.4	77.0	2173/2	43.4
11.988	77.0	2144/2	74.0	77.0	2169/2	48.8
13.154	77.0	2138/2	82.0	77.0	2162/2	58.2
14.225	75.5	2138/2	82.0	75.5	2161/2	59.6
28.150	76.3	2095/2	138.4	76.3	2136/2	92.9
56.167	77.0	2048/2	198.8	76.3	2100/2	140.1
82.029	74.7	2022/2	231.6	74.7	2080/2	166.0
83.550	79.2	2018/2	236.6	78.5	2079/2	167.3
90.017	152.7	3950/4	289.8	152.7	2010/2	254.8

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-5

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	87.5	2231/2	-56.2	88.2	2204/2	-80.9
0.000	77.7	2205/2	-20.4	78.5	2179/2	-46.9
.975	88.2	2214/2	-32.8	88.2	2167/2	-30.7
1.958	74.7	2220/2	-41.0	76.3	2174/2	-40.2
2.067	95.7	2190/2	0.0	98.0	2140/2	5.3
3.138	90.5	2196/2	-8.2	90.5	2151/2	-9.3
4.004	90.5	2194/2	-5.4	90.5	2150/2	-8.0
4.983	85.2	2193/2	-4.1	86.7	2146/2	-2.7
5.983	84.5	2193/2	-4.1	85.2	2146/2	-2.7
7.275	77.0	2190/2	0.0	77.0	2144/2	0.0
14.221	76.3	2183/2	9.5	76.3	2137/2	9.3
28.150	76.3	2184/2	8.1	76.3	2138/2	8.0
56.167	76.3	2187/2	4.1	77.7	2143/2	1.3
83.125	72.5	2196/2	-8.2	72.5	2155/2	-14.7
89.925	74.0	2188/2	2.7	74.0	2153/2	-12.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN E-10

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	88.2	2211/2	-69.1	87.5	2115/2	-80.1
0.000	78.5	2182/2	-29.6	78.5	2090/2	-47.5
.979	89.7	2187/2	-36.4	89.0	2082/2	-37.2
1.950	75.5	2194/2	-45.9	75.5	2087/2	-43.6
2.063	102.5	2149/2	14.7	98.0	2052/2	1.3
3.133	91.3	2168/2	-10.7	91.3	2062/2	-11.5
4.004	89.7	2167/2	-9.4	89.7	2061/2	-10.2
4.987	91.3	2164/2	-5.4	89.7	2059/2	-7.6
5.967	92.0	2163/2	-4.0	89.7	2055/2	-2.5
7.271	77.0	2160/2	0.0	77.0	2053/2	0.0
14.225	77.0	2151/2	12.0	76.3	2044/2	11.4
28.158	75.5	2150/2	13.4	75.5	2041/2	15.2
56.179	77.0	2152/2	10.7	76.3	2044/2	11.4
83.121	75.5	2157/2	4.0	74.7	2049/2	5.1
89.925	151.2	2062/2	128.3	151.2	3860/4	151.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN E-13

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	87.5	2210/2	-34.1	74.0	2083/2	-21.9
0.000	78.5	2183/2	2.7	65.0	2056/2	12.8
.979	88.2	2185/2	0.0	75.5	2055/2	14.1
1.938	77.0	2190/2	-6.8	64.2	2067/2	-1.3
7.271	72.5	2185/2	0.0	59.0	2066/2	0.0
7.929	75.5	2160/2	33.7	62.0	2044/2	28.0
8.971	75.5	2150/2	47.0	62.0	2035/2	39.4
10.237	75.5	2144/2	55.0	62.0	2032/2	43.2
10.992	75.5	2138/2	63.0	62.7	2026/2	50.7
11.988	75.5	2130/2	73.6	62.0	2020/2	58.3
13.154	77.0	2122/2	84.1	62.0	2014/2	65.8
14.229	75.5	2122/2	84.1	62.0	2013/2	67.0
28.150	76.3	2079/2	140.1	62.0	3958/4	109.1
56.171	76.3	2032/2	200.0	63.5	3874/4	160.1
82.025	75.5	2007/2	231.3	61.3	3826/4	188.7
83.546	76.3	2010/2	227.6	62.0	3829/4	186.9
90.483	74.0	2011/2	226.3	60.5	3819/4	192.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN E-18

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	87.5	2215/2	-67.9	75.5	2099/2	-83.3
0.000	77.7	2186/2	-28.3	65.0	2070/2	-45.8
.979	88.2	2190/2	-33.8	76.3	2068/2	-43.2
1.946	77.7	2200/2	-47.4	65.0	2074/2	-50.9
2.063	95.7	2171/2	-8.1	81.5	2046/2	-15.2
3.125	90.5	2171/2	-8.1	78.5	2043/2	-11.4
4.000	89.7	2170/2	-6.7	78.5	2041/2	-8.8
4.987	90.5	2169/2	-5.4	78.5	2040/2	-7.6
5.967	89.7	2167/2	-2.7	77.7	2038/2	-5.0
7.267	76.3	2165/2	0.0	63.5	2034/2	0.0
14.225	75.5	2157/2	10.7	63.5	2024/2	12.6
28.158	77.0	2152/2	17.4	62.7	2016/2	22.6
56.183	76.3	2159/2	8.0	64.2	2016/2	22.6
83.121	72.5	2165/2	0.0	59.7	2024/2	12.6
89.933	152.7	2044/2	157.9	140.0	3785/4	172.2

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN E-23

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	87.5	2250/2	-33.3	88.2	2197/2	-32.5
0.000	77.7	2224/2	2.8	78.5	2170/2	4.0
.950	89.7	2227/2	-1.4	89.7	2170/2	4.0
1.925	77.0	2237/2	-15.2	77.0	2182/2	-12.2
7.242	76.3	2226/2	0.0	73.2	2173/2	0.0
7.921	75.5	2202/2	32.9	75.5	2155/2	24.2
8.967	75.5	2194/2	43.8	75.5	2149/2	32.2
10.225	75.5	2187/2	53.4	75.5	2145/2	37.5
10.992	76.3	2181/2	61.5	76.3	2141/2	42.8
11.979	76.3	2172/2	73.6	76.3	2135/2	50.7
13.146	77.0	2164/2	84.4	77.0	2127/2	61.3
14.221	76.3	2164/2	84.4	76.3	2127/2	61.3
28.142	75.5	2116/2	148.1	76.3	2098/2	99.3
56.154	77.0	2070/2	207.8	77.0	2058/2	150.8
82.008	74.0	2048/2	235.8	74.7	2040/2	173.7
83.529	77.7	2045/2	239.6	78.5	2039/2	175.0
90.383	73.2	2054/2	228.2	73.2	2040/2	173.7

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN E-28

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.0	2187/2	-64.4	77.0	2118/2	-77.7
0.000	78.5	2158/2	-25.3	67.2	2089/2	-39.9
.950	90.5	2167/2	-37.4	79.2	2084/2	-33.4
1.938	77.7	2177/2	-50.8	65.0	2093/2	-45.0
2.054	96.5	2144/2	-6.6	84.5	2066/2	-10.2
3.117	91.3	2148/2	-12.0	80.7	2067/2	-11.5
3.996	91.3	2146/2	-9.3	80.0	2065/2	-8.9
4.900	90.5	2145/2	-8.0	79.2	2064/2	-7.7
5.958	89.7	2142/2	-4.0	79.2	2062/2	-5.1
7.263	77.7	2139/2	0.0	65.7	2058/2	0.0
14.221	76.3	2130/2	11.9	65.0	2049/2	11.5
28.154	76.3	2126/2	17.2	64.2	2047/2	14.0
56.179	76.3	2132/2	9.3	65.0	2050/2	10.2
83.125	75.5	2137/2	2.7	63.5	2056/2	2.6
89.929	73.2	2139/2	0.0	62.7	2059/2	-1.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN E-39

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.0	2101/2	-72.0	76.3	2122/2	-79.1
0.000	78.5	2071/2	-33.2	66.5	2091/2	-38.6
.950	91.3	2076/2	-39.6	79.2	2087/2	-33.4
1.929	77.7	2086/2	-52.5	65.7	2097/2	-46.4
2.054	95.0	2062/2	-21.6	79.2	2075/2	-18.0
3.121	91.3	2055/2	-12.7	79.2	2070/2	-11.5
3.987	91.3	2053/2	-10.2	78.5	2069/2	-10.2
4.904	90.5	2050/2	-6.3	79.2	2066/2	-6.4
5.954	88.2	2050/2	-6.3	77.7	2065/2	-5.1
7.258	77.7	2045/2	0.0	64.2	2061/2	0.0
15.021	76.3	2036/2	11.4	63.5	2051/2	12.7
28.150	76.3	2030/2	18.9	63.5	2051/2	12.7
56.179	77.0	2031/2	17.7	65.0	2050/2	14.0
83.117	75.5	2032/2	16.4	62.7	2054/2	8.9
89.921	74.7	2032/2	16.4	62.0	2054/2	8.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN E-40

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	83.0	2156/2	-12.0	87.5	2120/2	-35.3
0.000	72.5	2131/2	21.2	77.0	2090/2	3.9
.946	86.0	2142/2	6.6	89.0	2087/2	7.8
1.921	72.5	2155/2	-10.7	76.3	2098/2	-6.5
7.263	67.2	2147/2	0.0	71.7	2093/2	0.0
7.917	70.2	2119/2	37.0	74.0	2073/2	25.8
8.967	70.2	2108/2	51.4	74.0	2066/2	34.8
10.221	69.5	2101/2	60.6	75.5	2061/2	41.2
10.988	71.0	2094/2	69.7	75.5	2056/2	47.6
11.975	74.0	2086/2	80.0	78.5	2048/2	57.8
13.142	71.7	2076/2	92.9	76.3	2041/2	66.6
15.025	71.0	2070/2	100.7	75.5	2037/2	71.7
28.142	69.5	2025/2	157.8	75.5	2008/2	108.1
56.167	71.7	3942/4	224.7	76.3	3931/4	160.4
82.012	69.5	3890/4	256.2	73.2	3890/4	185.3
83.533	71.7	3883/4	260.5	76.3	3892/4	184.1
90.388	68.8	3900/4	250.2	74.0	3883/4	189.5

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN E-42

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	80.7	2130/2	-23.7	87.5	2099/2	-28.5
0.000	69.5	2099/2	17.0	77.0	2064/2	16.7
.950	81.5	2111/2	1.3	88.2	2067/2	12.8
1.921	68.8	2119/2	-9.2	76.3	2077/2	0.0
7.263	64.2	2112/2	0.0	71.0	2077/2	0.0
7.900	67.2	2086/2	33.8	74.7	2058/2	24.4
8.962	67.2	2075/2	48.0	74.7	2048/2	37.1
10.221	67.2	2069/2	55.7	74.7	2045/2	40.9
10.983	68.0	2063/2	63.4	74.7	2042/2	44.7
11.971	68.0	2056/2	72.4	74.7	2034/2	54.8
13.142	69.5	2044/2	87.6	77.0	2026/2	64.9
15.017	67.2	2044/2	87.6	74.0	2024/2	67.4
28.137	68.0	3997/4	144.6	75.5	3991/4	102.9
56.167	70.2	3893/4	208.2	76.3	3906/4	154.9
81.596	66.5	3839/4	240.6	74.0	3867/4	178.4
83.117	70.2	3837/4	241.8	79.2	3868/4	177.8
89.992	143.0	3775/4	278.3	151.2	3722/4	263.7

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN E-43

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	77.7	2062/2	-53.1	87.5	2105/2	-79.7
0.000	67.2	2031/2	-13.8	77.0	2077/2	-43.4
.942	79.2	2047/2	-34.0	88.2	2084/2	-52.5
1.913	67.2	2061/2	-51.9	75.5	2091/2	-61.5
2.054	82.2	2029/2	-11.3	92.7	2064/2	-26.7
3.112	81.5	2028/2	-10.0	90.5	2038/2	6.3
3.987	80.7	2027/2	-8.8	89.7	2054/2	-14.0
4.896	79.2	2026/2	-7.5	89.7	2051/2	-10.2
5.950	79.2	2025/2	-6.3	89.7	2049/2	-7.6
7.263	66.5	2020/2	0.0	76.3	2043/2	0.0
14.221	65.7	2013/2	8.8	75.5	2030/2	16.4
28.146	65.0	4024/4	10.0	77.0	2023/2	25.2
56.167	65.7	2020/2	0.0	76.3	2023/2	25.2
83.100	62.0	2030/2	-12.6	71.7	2033/2	12.6
89.929	140.7	3763/4	167.5	151.2	3793/4	178.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-6

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.7	2224/2	-5.5	89.7	2256/2	5.6
0.000	82.2	2201/2	56.0	82.2	2235/2	34.8
1.012	86.0	2222/2	-2.8	86.0	2262/2	-2.8
1.971	84.5	2220/2	0.0	84.5	2260/2	0.0
7.254	76.3	2220/2	0.0	76.3	2260/2	0.0
8.050	74.7	2208/2	16.5	74.0	2255/2	7.0
8.971	74.7	2193/2	36.9	74.7	2243/2	23.7
10.000	76.3	2186/2	46.4	76.3	2236/2	33.5
10.988	76.3	2175/2	61.3	76.3	2231/2	40.4
11.992	77.7	2164/2	76.1	77.7	2222/2	52.8
12.996	77.7	2158/2	84.1	77.7	2218/2	58.3
14.008	77.7	2151/2	93.5	77.7	2213/2	65.2
27.958	77.0	2108/2	150.3	77.7	2186/2	102.0
59.208	76.3	2058/2	214.8	76.3	2150/2	150.4
81.071	77.0	2032/2	247.8	76.3	2129/2	178.2
82.254	89.7	2013/2	271.6	89.0	2115/2	196.7
88.933	171.5	2000/2	287.8	170.0	2076/2	247.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-9

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	*61.0	2221/2	-38.3	89.0	2261/2	-34.9
0.000	81.5	2200/2	-9.5	81.5	2242/2	-8.3
1.017	86.0	2222/2	-39.7	86.0	2262/2	-36.3
1.958	83.8	2220/2	-36.9	83.8	2259/2	-32.0
2.175	104.0	2174/2	25.7	104.7	2220/2	22.1
3.237	77.7	2198/2	-6.8	77.7	2240/2	-5.6
4.008	77.0	2196/2	-4.1	77.0	2238/2	-2.8
5.008	77.0	2194/2	-1.4	77.0	2234/2	2.8
6.171	77.7	2191/2	2.7	77.7	2234/2	2.8
7.263	76.3	2193/2	0.0	76.3	2236/2	0.0
14.029	77.7	2180/2	17.6	77.7	2221/2	20.7
27.988	77.0	2178/2	20.3	77.0	2216/2	27.6
59.233	75.5	2185/2	10.9	74.7	2224/2	16.6
83.233	73.2	2192/2	1.4	73.2	2230/2	8.3
89.433	75.5	2189/2	5.4	75.5	2228/2	11.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-13

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.7	2224/2	-56.0	89.7	2224/2	-46.5
0.000	81.5	2200/2	-23.1	81.5	2199/2	-12.2
1.021	85.2	2223/2	-54.6	85.2	2220/2	-41.0
1.967	84.5	2220/2	-50.5	84.5	2218/2	-38.3
2.175	101.0	2178/2	6.8	102.5	2183/2	9.5
3.237	77.7	2191/2	-10.8	78.5	2198/2	-10.9
4.008	77.7	2190/2	-9.5	77.7	2196/2	-8.2
5.012	77.0	2187/2	-5.4	77.7	2193/2	-4.1
6.171	77.7	2183/2	0.0	78.5	2190/2	0.0
7.263	75.5	2183/2	0.0	77.7	2190/2	0.0
14.029	77.7	2168/2	20.2	79.2	2175/2	20.3
28.000	77.7	2163/2	26.9	79.2	2171/2	25.7
59.229	74.7	2172/2	14.9	75.5	2183/2	9.5
83.221	73.2	2175/2	10.8	74.0	2189/2	1.4
90.421	75.5	2174/2	12.2	75.5	2184/2	8.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-15

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.7	2247/2	-45.6	89.7	2153/2	-71.2
0.000	81.5	2224/2	-13.8	81.5	2130/2	-40.6
1.012	86.0	2250/2	-49.8	86.0	2140/2	-53.9
1.958	84.5	2247/2	-45.6	84.5	2134/2	-45.9
2.171	107.0	2192/2	30.0	107.0	2082/2	22.0
3.233	77.7	2222/2	-11.0	77.7	2109/2	-13.0
4.004	77.7	2220/2	-8.2	77.7	2107/2	-10.4
5.008	77.7	2217/2	-4.1	77.7	2102/2	-3.9
6.167	77.7	2214/2	0.0	77.7	2099/2	0.0
7.263	75.5	2214/2	0.0	76.3	2099/2	0.0
14.029	77.7	2201/2	17.8	78.5	2086/2	16.9
27.988	77.0	2200/2	19.2	77.0	2084/2	19.5
59.229	76.3	2206/2	11.0	77.0	2091/2	10.4
83.221	74.7	2209/2	6.9	74.7	2094/2	6.5
89.921	150.5	2099/2	153.8	150.5	3979/4	138.8

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-17

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.0	2239/2	-4.2	89.0	2258/2	-12.6
0.000	81.5	2217/2	26.2	81.5	2237/2	16.7
1.012	86.0	2240/2	-5.6	86.0	2251/2	-2.8
1.971	83.8	2240/2	-5.6	83.8	2250/2	-1.4
7.254	74.7	2236/2	0.0	74.7	2249/2	0.0
8.046	73.2	2228/2	11.1	73.2	2242/2	9.7
8.967	75.5	2212/2	33.1	75.5	2230/2	26.4
10.004	75.5	2201/2	48.1	75.5	2222/2	37.4
10.983	75.5	2196/2	55.0	75.5	2216/2	45.7
11.988	77.7	2184/2	71.3	77.7	2207/2	58.0
12.992	77.0	2179/2	78.0	77.0	2203/2	63.5
14.008	77.7	2172/2	87.5	77.7	2197/2	71.7
27.967	76.3	2125/2	150.1	77.0	2164/2	116.3
59.263	76.3	2076/2	213.9	75.5	2128/2	164.2
82.079	76.3	2048/2	249.7	76.3	2106/2	193.1
83.254	82.2	2048/2	249.7	82.2	2099/2	202.2
89.937	74.0	2059/2	235.7	74.0	2110/2	187.8

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-20

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.0	2240/2	-56.4	89.0	2272/2	-48.9
0.000	81.5	2217/2	-24.6	81.5	2248/2	-15.3
1.017	85.2	2238/2	-53.6	85.2	2268/2	-43.3
1.958	84.5	2234/2	-48.1	84.5	2264/2	-37.7
2.167	104.0	2184/2	20.4	104.7	2222/2	20.7
3.229	77.7	2206/2	-9.6	77.7	2243/2	-8.3
4.008	77.7	2205/2	-8.2	77.7	2242/2	-6.9
5.008	77.0	2201/2	-2.7	77.0	2240/2	-4.2
6.167	77.7	2199/2	0.0	77.7	2237/2	0.0
7.254	76.3	2199/2	0.0	76.3	2237/2	0.0
14.021	77.7	2184/2	20.4	77.7	2225/2	16.6
27.979	77.0	2180/2	25.8	77.0	2221/2	22.1
59.229	75.5	2188/2	15.0	75.5	2230/2	9.7
83.267	74.0	2193/2	8.2	74.0	2238/2	-1.4
89.937	152.0	2080/2	157.9	152.0	2130/2	144.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-21

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.7	2258/2	-12.6	89.7	2247/2	-27.7
0.000	81.5	2224/2	34.7	81.5	2236/2	-12.5
1.012	86.0	2255/2	-8.4	86.0	2240/2	-18.0
1.971	83.8	2252/2	-4.2	83.8	2235/2	-11.1
7.263	74.7	2249/2	0.0	74.7	2227/2	0.0
8.050	73.2	2239/2	13.9	73.2	2225/2	2.8
8.967	75.5	2226/2	31.9	75.5	2214/2	17.9
10.004	75.5	2218/2	42.9	75.5	2207/2	27.5
10.992	76.3	2209/2	55.3	76.3	2200/2	37.1
11.992	77.0	2200/2	67.6	77.0	2191/2	49.3
12.992	77.0	2195/2	74.4	77.0	2186/2	56.1
14.012	77.0	2188/2	83.9	77.0	2180/2	64.2
27.979	76.3	2145/2	141.7	77.0	2148/2	107.1
59.263	75.5	2100/2	200.9	76.3	2111/2	156.0
82.079	76.3	2075/2	233.2	76.3	2092/2	180.8
83.267	79.2	2079/2	228.1	79.2	2084/2	191.1
89.950	149.7	2045/2	271.6	149.7	2024/2	267.5

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-23

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.7	2243/2	-52.4	89.0	2218/2	-57.2
0.000	81.5	2222/2	-23.3	81.5	2195/2	-25.7
1.012	85.2	2242/2	-51.0	86.0	2212/2	-49.0
1.954	84.5	2239/2	-46.8	84.5	2207/2	-42.1
2.167	104.0	2192/2	17.7	104.0	2163/2	17.5
3.229	77.7	2213/2	-11.0	77.7	2186/2	-13.5
4.012	77.7	2212/2	-9.6	77.7	2183/2	-9.5
5.012	77.7	2208/2	-4.1	77.7	2179/2	-4.1
6.167	77.7	2205/2	0.0	77.7	2176/2	0.0
7.254	76.3	2205/2	0.0	76.3	2176/2	0.0
14.025	77.7	2195/2	13.6	77.7	2163/2	17.5
27.979	77.0	2191/2	19.1	77.0	2160/2	21.5
59.221	75.5	2198/2	9.6	75.5	2166/2	13.5
83.225	74.7	2200/2	6.8	74.7	2168/2	10.8
89.933	74.7	2200/2	6.8	74.7	2170/2	8.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-30

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.0	2229/2	-15.2	90.5	2246/2	-16.7
0.000	81.5	2206/2	16.5	82.2	2225/2	12.4
1.008	86.0	2227/2	-12.4	86.0	2242/2	-11.1
1.958	84.5	2222/2	-5.5	84.5	2236/2	-2.8
7.258	75.5	2218/2	0.0	75.5	2234/2	0.0
8.037	74.0	2207/2	15.1	74.0	2228/2	8.3
8.958	75.5	2194/2	32.8	75.5	2218/2	22.1
10.000	75.5	2186/2	43.7	75.5	2211/2	31.7
10.983	75.5	2178/2	54.5	75.5	2206/2	38.5
11.988	77.0	2168/2	68.0	77.0	2197/2	50.8
12.988	77.0	2163/2	74.7	77.0	2192/2	57.6
14.000	77.0	2156/2	84.1	77.7	2187/2	64.4
27.958	76.3	2112/2	142.3	76.3	2154/2	108.8
59.229	76.3	2066/2	201.9	76.3	2116/2	159.1
82.071	76.3	2040/2	235.0	76.3	2094/2	187.8
83.246	95.7	2013/2	268.9	95.7	2069/2	220.1
89.513	74.7	2050/2	222.3	74.7	2094/2	187.8

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-33

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.0	2236/2	-53.6	89.0	2228/2	-50.7
0.000	81.5	2213/2	-21.9	81.5	2206/2	-20.4
1.012	84.5	2235/2	-52.2	84.5	2221/2	-41.0
1.962	83.8	2229/2	-43.9	83.8	2215/2	-32.8
2.167	103.2	2183/2	19.0	104.0	2173/2	24.4
3.225	77.7	2203/2	-8.2	77.7	2196/2	-6.8
4.008	77.7	2203/2	-8.2	77.7	2196/2	-6.8
5.008	77.7	2200/2	-4.1	77.7	2193/2	-2.7
6.167	77.7	2196/2	1.4	77.7	2190/2	1.4
7.250	76.3	2197/2	0.0	76.3	2191/2	0.0
14.021	77.7	2186/2	14.9	77.7	2180/2	14.9
27.979	76.3	2182/2	20.4	77.0	2179/2	16.3
59.229	75.5	2189/2	10.9	76.3	2188/2	4.1
83.183	73.2	2195/2	2.7	73.2	2194/2	-4.1
89.892	152.7	2081/2	153.8	152.7	2081/2	145.7

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-34

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.0	2238/2	-18.0	89.0	2269/2	-35.0
0.000	81.5	2214/2	15.1	81.5	2247/2	-4.2
1.012	84.5	2232/2	-9.7	84.5	2256/2	-16.7
1.958	84.5	2229/2	-5.5	84.5	2252/2	-11.2
7.250	74.7	2225/2	0.0	74.7	2244/2	0.0
8.042	74.0	2213/2	16.5	74.0	2239/2	6.9
8.962	75.5	2199/2	35.7	75.5	2227/2	23.6
10.000	75.5	2190/2	47.9	75.5	2220/2	33.2
10.988	75.5	2183/2	57.4	75.5	2215/2	40.1
11.992	77.7	2172/2	72.2	77.7	2206/2	52.4
12.988	77.0	2165/2	81.7	76.3	2202/2	57.9
14.000	77.7	2158/2	91.0	77.7	2198/2	63.3
27.971	76.3	2114/2	149.3	76.3	2170/2	101.3
59.258	76.3	2065/2	212.8	76.3	2134/2	149.3
82.087	76.3	2038/2	247.1	76.3	2112/2	178.2
83.258	97.2	2005/2	288.5	97.2	2084/2	214.7
89.942	152.7	2013/2	278.5	152.7	2040/2	270.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN F-42

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.0	2255/2	-25.1	89.0	2228/2	-31.6
0.000	81.5	2234/2	4.2	81.5	2204/2	1.4
1.008	84.5	2249/2	-16.7	84.5	2211/2	-8.2
1.954	84.5	2243/2	-8.3	84.5	2207/2	-2.7
7.263	76.3	2237/2	0.0	76.3	2205/2	0.0
8.042	74.7	2223/2	19.4	74.7	2195/2	13.6
8.958	76.3	2210/2	37.2	76.3	2185/2	27.2
9.996	75.5	2202/2	48.2	75.5	2177/2	38.0
10.983	75.5	2194/2	59.1	75.5	2172/2	44.8
11.988	77.0	2184/2	72.6	77.0	2162/2	58.2
12.988	77.0	2179/2	79.4	77.0	2158/2	63.6
13.992	77.0	2172/2	88.8	77.7	2153/2	70.3
27.958	76.3	2129/2	146.2	76.3	2123/2	110.0
59.250	75.5	2082/2	207.5	75.5	2088/2	155.7
82.062	76.3	2057/2	239.6	76.3	2065/2	185.3
83.233	84.5	2047/2	252.3	82.2	2055/2	198.1
89.917	74.0	2070/2	223.0	74.0	2064/2	186.6

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN G-1

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.0	2242/2	-34.6	89.0	2242/2	-55.1
0.000	86.0	2233/2	-22.1	86.7	2218/2	-21.9
1.000	86.7	2248/2	-42.9	86.0	2235/2	-45.4
1.938	76.3	2254/2	-51.3	76.3	2244/2	-57.9
2.096	105.5	2202/2	20.5	105.5	2190/2	16.3
2.996	77.7	2226/2	-12.4	77.7	2213/2	-15.1
3.979	77.0	2226/2	-12.4	76.3	2213/2	-15.1
4.971	78.5	2221/2	-5.5	78.5	2206/2	-5.5
5.971	77.7	2220/2	-4.1	77.7	2204/2	-2.7
7.013	78.5	2217/2	0.0	78.5	2202/2	0.0
14.158	76.3	2214/2	4.1	76.3	2200/2	2.7
28.000	76.3	2210/2	9.6	76.3	2194/2	10.9
56.000	77.0	2219/2	-2.8	77.0	2203/2	-1.4
83.083	76.3	2223/2	-8.3	76.3	2208/2	-8.2
90.167	149.7	2132/2	114.6	149.7	2103/2	132.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN G-9

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.0	2236/2	-48.1	86.7	2107/2	-53.0
0.000	86.0	2226/2	-34.3	83.8	2097/2	-40.0
1.000	89.0	2240/2	-53.7	86.7	2103/2	-47.8
1.942	76.3	2246/2	-62.0	72.5	2111/2	-58.3
2.096	103.2	2193/2	10.9	101.0	2058/2	10.2
2.996	78.5	2212/2	-15.0	75.5	2079/2	-16.7
3.983	77.0	2211/2	-13.7	74.0	2078/2	-15.4
4.975	78.5	2204/2	-4.1	75.5	2072/2	-7.7
5.971	78.5	2204/2	-4.1	75.5	2070/2	-5.1
7.017	78.5	2201/2	0.0	75.5	2066/2	0.0
14.158	77.0	2194/2	9.5	72.5	2060/2	7.7
28.012	79.2	2186/2	20.4	76.3	2047/2	24.2
56.013	75.5	2197/2	5.5	73.2	2058/2	10.2
83.117	74.0	2205/2	-5.5	74.0	2062/2	5.1
90.200	151.2	2090/2	147.7	152.0	3889/4	151.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN G-10

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	89.0	2272/2	5.6	89.0	2234/2	0.0
0.000	86.0	2263/2	18.3	86.0	2225/2	12.4
1.000	88.2	2278/2	-2.8	87.5	2237/2	-4.2
1.929	74.0	2282/2	-8.5	74.0	2241/2	-9.7
7.021	75.5	2276/2	0.0	76.3	2234/2	0.0
7.971	79.2	2256/2	28.1	79.2	2222/2	16.6
8.975	78.5	2242/2	47.6	79.2	2212/2	30.3
9.975	74.7	2241/2	49.0	74.7	2212/2	30.3
10.963	76.3	2231/2	62.9	76.3	2203/2	42.6
11.988	76.3	2224/2	72.5	76.3	2199/2	48.1
12.971	76.3	2219/2	79.4	77.0	2194/2	54.9
14.162	77.0	2213/2	87.7	77.0	2191/2	59.0
28.021	77.0	2164/2	154.2	77.0	2153/2	110.2
56.000	77.0	2115/2	219.2	77.0	2117/2	157.8
85.829	92.0	2094/2	246.6	92.0	2088/2	195.6

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN G-18

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	90.5	2242/2	-40.1	80.0	2142/2	-56.5
0.000	86.0	2233/2	-27.6	76.3	2132/2	-43.3
1.000	88.2	2246/2	-45.6	78.5	2130/2	-40.6
1.938	73.2	2251/2	-52.6	65.0	2137/2	-49.9
2.096	105.5	2198/2	20.5	95.7	2082/2	22.0
3.000	78.5	2222/2	-12.4	68.8	2108/2	-11.7
3.987	77.7	2222/2	-12.4	67.2	2108/2	-11.7
4.979	79.2	2216/2	-4.1	68.8	2101/2	-2.6
5.979	78.5	2214/2	-1.4	68.8	2101/2	-2.6
7.021	79.2	2213/2	0.0	68.8	2099/2	0.0
14.167	77.7	2208/2	6.9	66.5	2096/2	3.9
28.012	77.7	2205/2	11.0	67.2	2091/2	10.4
55.987	77.7	2214/2	-1.4	66.5	2099/2	0.0
84.071	77.0	2216/2	-4.1	66.5	2100/2	-1.3
90.946	75.5	2218/2	-6.9	65.0	2101/2	-2.6

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN G-19

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

TIME (DAYS)	AXIAL GAGE TEMP (F)	AXIAL GAGE READ/DIV (FREQ)	AXIAL GAGE SHR STRAIN* (MIC-UNITS)	RADIAL GAGE TEMP (F)	RADIAL GAGE READ/DIV (FREQ)	RADIAL GAGE SHR STRAIN* (MIC-UNITS)
0.000	88.2	2130/2	-1.3	88.2	2117/2	-28.7
0.000	84.5	2117/2	15.8	84.5	2108/2	-16.9
1.000	86.0	2134/2	-6.6	87.5	2106/2	-14.3
1.933	80.0	2140/2	-14.6	80.0	2111/2	-20.9
7.029	74.7	2129/2	0.0	75.5	2095/2	0.0
7.975	75.5	2111/2	23.7	77.7	2084/2	14.3
8.975	77.0	2098/2	40.6	77.7	2073/2	28.4
9.975	74.7	2097/2	41.9	74.7	2073/2	28.4
10.963	74.0	2090/2	51.0	75.5	2065/2	38.7
11.992	74.0	2082/2	61.4	76.3	2059/2	46.4
12.975	74.0	2078/2	66.5	75.5	2054/2	52.7
14.171	75.5	2070/2	76.8	75.5	2050/2	57.8
28.008	75.5	2022/2	137.7	77.0	2011/2	106.9
56.000	74.0	3963/4	188.0	75.5	3957/4	147.1
83.167	85.2	3870/4	244.4	87.5	3871/4	199.3
90.083	151.2	3835/4	265.3	151.2	3796/4	243.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN G-21

TEST TEMPERATURE AT 90 DAYS 150 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	79.2	2099/2	-6.5	87.5	2247/2	16.8
0.000	75.5	2089/2	6.5	83.0	2240/2	26.5
1.000	78.5	2105/2	-14.3	86.7	2262/2	-4.2
1.950	62.7	2109/2	-19.5	75.5	2269/2	-14.0
7.029	66.5	2094/2	0.0	75.5	2259/2	0.0
7.983	67.2	2074/2	25.8	76.3	2247/2	16.8
8.979	68.0	2059/2	45.1	77.0	2235/2	33.4
9.979	65.7	2058/2	46.3	74.7	2236/2	32.0
10.963	65.7	2049/2	57.8	75.5	2229/2	41.7
11.992	65.7	2041/2	67.9	74.7	2223/2	50.0
12.979	65.7	2037/2	73.0	75.5	2218/2	56.9
14.175	66.5	2030/2	81.8	74.0	2216/2	59.7
28.021	66.5	3968/4	139.1	76.3	2181/2	107.4
56.013	65.7	3878/4	193.8	74.7	2149/2	150.3
83.221	94.2	3722/4	285.7	92.7	2091/2	226.5
84.033	96.5	3815/4	231.3	104.0	2111/2	200.5
91.700	140.0	3746/4	271.8	149.7	2069/2	254.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN G-30

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	88.2	2111/2	-11.8	88.2	2133/2	-27.6
0.000	84.5	2100/2	2.6	86.0	2124/2	-15.8
1.000	86.7	2114/2	-15.7	86.7	2126/2	-18.4
1.946	74.0	2117/2	-19.6	74.7	2127/2	-19.7
7.033	76.3	2102/2	0.0	77.0	2112/2	0.0
7.987	77.0	2084/2	23.4	77.7	2100/2	15.7
8.983	78.5	2068/2	44.0	78.5	2089/2	30.0
9.979	75.5	2068/2	44.0	75.5	2089/2	30.0
10.967	75.5	2058/2	56.7	77.0	2081/2	40.3
11.996	76.3	2050/2	66.9	77.0	2074/2	49.3
12.979	76.3	2047/2	70.7	77.0	2069/2	55.7
14.179	76.3	2039/2	80.9	77.0	2065/2	60.9
28.021	77.0	3981/4	141.5	77.7	2024/2	112.8
56.000	76.3	3890/4	197.0	77.0	3974/4	158.8
83.208	89.0	3794/4	254.1	89.0	3884/4	213.6
90.000	77.0	3840/4	226.9	77.0	3908/4	199.2

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN G-35

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	88.2	2240/2	-38.6	88.2	2228/2	-66.9
0.000	84.5	2228/2	-22.0	84.5	2220/2	-55.9
1.000	86.7	2245/2	-45.6	86.0	2218/2	-53.2
1.950	76.3	2249/2	-51.2	76.3	2219/2	-54.5
2.104	113.7	2174/2	51.7	113.0	2148/2	41.6
3.008	77.7	2219/2	-9.6	77.7	2189/2	-13.5
3.996	76.3	2218/2	-8.2	76.3	2189/2	-13.5
4.987	77.7	2214/2	-2.7	77.7	2184/2	-6.8
5.987	77.7	2214/2	-2.7	77.7	2183/2	-5.4
7.033	77.0	2212/2	0.0	77.0	2179/2	0.0
14.179	76.3	2207/2	6.8	76.3	2172/2	9.4
28.029	77.7	2203/2	12.3	77.7	2165/2	18.9
56.021	75.5	2215/2	-4.1	75.5	2175/2	5.4
83.104	73.2	2223/2	-15.1	73.2	2181/2	-2.7
90.167	77.0	2218/2	-8.2	77.0	2173/2	8.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-1

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	81.5	2235/2	29.2	82.2	2237/2	8.3
0.000	85.2	2247/2	12.6	86.0	2248/2	-7.0
.979	80.0	2244/2	16.7	80.7	2235/2	11.1
1.917	74.0	2243/2	18.1	75.5	2243/2	0.0
7.063	76.3	2256/2	0.0	76.3	2243/2	0.0
9.167	77.0	2228/2	38.9	77.7	2226/2	23.6
10.208	76.3	2218/2	52.7	77.7	2220/2	31.8
11.021	76.3	2212/2	60.9	77.0	2217/2	35.9
12.021	75.5	2208/2	66.4	76.3	2213/2	41.4
13.042	76.3	2203/2	73.3	76.3	2209/2	46.9
14.125	75.5	2196/2	82.8	77.0	2204/2	53.8
28.000	77.7	2151/2	143.4	77.7	2172/2	97.2
56.021	77.7	2101/2	209.4	77.7	2136/2	145.3
81.125	74.7	2075/2	243.0	76.3	2113/2	175.5
82.917	74.7	2083/2	232.7	76.3	2118/2	169.0
83.292	89.7	2084/2	231.4	91.3	2119/2	167.7

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-4

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	81.5	2257/2	30.9	81.5	2234/2	1.4
0.000	85.2	2269/2	14.1	86.0	2245/2	-13.9
.979	80.7	2267/2	16.9	81.5	2223/2	16.6
1.917	74.7	2270/2	12.7	74.7	2230/2	6.9
7.063	73.2	2279/2	0.0	73.2	2235/2	0.0
8.208	76.3	2252/2	37.9	77.0	2220/2	20.7
9.167	76.3	2242/2	51.9	76.3	2214/2	29.0
10.208	76.3	2232/2	65.7	77.0	2209/2	35.8
11.167	76.3	2226/2	74.0	77.0	2204/2	42.7
12.021	75.5	2219/2	83.7	76.3	2200/2	48.1
13.021	75.5	2214/2	90.5	76.3	2196/2	53.6
14.125	75.5	2209/2	97.4	75.5	2192/2	59.0
28.000	77.0	2163/2	159.7	77.0	2160/2	102.2
56.021	76.3	2113/2	226.0	76.3	2123/2	151.3
90.562	59.0	2080/2	268.9	59.0	2095/2	187.9
117.937	59.0	2055/2	301.0	60.5	2075/2	213.8

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-5

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	82.2	2238/2	-2.8	82.2	2282/2	-1.4
0.000	85.2	2247/2	-15.3	85.2	2290/2	-12.8
.979	83.0	2242/2	-8.3	83.0	2286/2	-7.1
1.917	75.5	2254/2	-25.1	75.5	2298/2	-24.1
2.958	78.5	2241/2	-6.9	78.5	2287/2	-8.5
4.042	79.2	2240/2	-5.6	78.5	2285/2	-5.7
5.021	77.7	2239/2	-4.2	77.7	2284/2	-4.2
6.271	78.5	2237/2	-1.4	78.5	2281/2	0.0
7.042	77.7	2236/2	0.0	77.7	2281/2	0.0
14.125	77.0	2229/2	9.7	77.0	2274/2	9.9
28.000	77.0	2229/2	9.7	77.0	2276/2	7.1
56.021	77.0	2234/2	2.8	77.0	2280/2	1.4
90.562	60.5	2235/2	1.4	60.5	2284/2	-4.2
117.917	59.7	2234/2	2.8	59.7	2284/2	-4.2

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-14

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	81.5	2270/2	22.6	82.2	2231/2	0.0
0.000	85.2	2281/2	7.1	86.0	2246/2	-20.8
.979	82.2	2279/2	9.9	82.2	2224/2	9.7
1.917	74.0	2283/2	4.2	74.7	2234/2	-4.2
7.063	76.3	2286/2	0.0	76.3	2231/2	0.0
8.208	76.3	2273/2	18.4	77.0	2228/2	4.1
9.167	76.3	2261/2	35.2	77.0	2215/2	22.1
10.208	75.5	2253/2	46.4	77.7	2210/2	28.9
11.021	76.3	2247/2	54.8	77.0	2206/2	34.4
12.021	75.5	2241/2	63.2	76.3	2203/2	38.5
13.042	75.5	2235/2	71.5	76.3	2196/2	48.0
14.125	74.7	2231/2	77.0	76.3	2193/2	52.1
28.000	76.3	2188/2	135.9	76.3	2160/2	96.6
56.021	76.3	2139/2	201.6	76.3	2123/2	145.8
81.125	76.3	2115/2	233.3	74.7	2103/2	172.0
81.542	77.0	2112/2	237.2	78.5	2100/2	175.9
83.167	76.3	2136/2	205.6	76.3	2115/2	156.3
83.167	91.3	2138/2	203.0	92.0	2116/2	155.0
89.958	73.2	2140/2	200.3	74.7	2109/2	164.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-16

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	81.5	2235/2	39.0	81.5	2265/2	-21.0
0.000	86.0	2247/2	22.4	85.2	2277/2	-37.9
.979	82.2	2241/2	30.7	81.5	2254/2	-5.6
1.917	74.7	2253/2	14.0	74.0	2257/2	-9.8
7.063	74.0	2263/2	0.0	72.5	2250/2	0.0
8.208	76.3	2244/2	26.5	75.5	2234/2	22.2
9.146	76.3	2235/2	39.0	76.3	2225/2	34.7
10.208	76.3	2225/2	52.9	76.3	2219/2	42.9
11.021	76.3	2219/2	61.1	75.5	2213/2	51.2
12.021	75.5	2214/2	68.0	74.7	2209/2	56.7
13.042	76.3	2209/2	74.9	75.5	2203/2	64.9
14.125	76.3	2202/2	84.4	75.5	2197/2	73.1
28.000	76.3	2160/2	141.2	76.3	2162/2	120.4
56.021	76.3	2111/2	206.1	76.3	2128/2	165.6
90.562	59.0	2079/2	247.7	59.0	2101/2	201.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-17

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	81.5	2352/2	4.4	81.5	2228/2	27.8
0.000	84.5	2361/2	-8.8	84.5	2237/2	15.3
.979	82.2	2354/2	1.5	82.2	2235/2	18.1
1.917	74.7	2359/2	-5.8	74.7	2244/2	5.6
7.063	72.5	2355/2	0.0	74.0	2248/2	0.0
8.208	75.5	2330/2	36.3	75.5	2234/2	19.5
9.146	75.5	2322/2	47.8	76.3	2229/2	26.4
10.208	76.3	2312/2	62.2	76.3	2220/2	38.8
11.021	75.5	2305/2	72.2	75.5	2216/2	44.3
12.021	74.7	2301/2	77.9	74.7	2211/2	51.1
13.042	75.5	2297/2	83.6	75.5	2205/2	59.4
14.125	75.5	2290/2	93.6	75.5	2201/2	64.8
28.000	76.3	2241/2	162.4	76.3	2169/2	108.2
56.021	76.3	2195/2	225.7	76.3	2133/2	156.2
90.562	59.0	2167/2	263.5	59.7	2101/2	198.2
117.917	59.0	2144/2	294.3	59.7	2085/2	218.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-22

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	81.5	2223/2	36.0	82.2	2222/2	-23.3
0.000	99.5	2252/2	-4.2	86.0	2234/2	-39.9
.979	81.5	2214/2	48.4	81.5	2232/2	-37.1
1.917	74.7	2222/2	37.4	74.7	2240/2	-48.2
2.958	78.5	2252/2	-4.2	78.5	2212/2	-9.6
4.021	77.0	2254/2	-7.0	77.7	2209/2	-5.5
5.021	77.0	2251/2	-2.8	77.0	2208/2	-4.1
6.250	77.0	2249/2	0.0	77.7	2205/2	0.0
7.042	77.0	2249/2	0.0	77.0	2205/2	0.0
14.125	75.5	2241/2	11.1	77.0	2199/2	8.2
28.000	74.7	2237/2	16.7	76.3	2197/2	10.9
56.021	77.0	2235/2	19.5	77.0	2195/2	13.6
82.375	75.5	2229/2	27.8	77.0	2189/2	21.8
82.375	91.3	2232/2	23.6	92.0	2190/2	20.4
90.000	74.0	2234/2	20.8	74.7	2185/2	27.2

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-24

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	81.5	2228/2	11.1	81.5	2242/2	-6.9
0.000	84.5	2239/2	-4.2	84.5	2250/2	-18.1
.979	81.5	2240/2	-5.6	82.2	2243/2	-8.3
1.917	74.7	2253/2	-23.7	74.7	2254/2	-23.7
2.958	78.5	2242/2	-8.3	78.5	2243/2	-8.3
4.021	77.7	2241/2	-6.9	77.7	2241/2	-5.6
5.021	77.0	2240/2	-5.6	77.0	2240/2	-4.2
6.271	77.0	2236/2	0.0	77.0	2238/2	-1.4
7.042	77.0	2236/2	0.0	77.0	2237/2	0.0
14.125	76.3	2228/2	11.1	76.3	2229/2	11.1
28.000	74.7	2229/2	9.7	76.3	2228/2	12.5
56.021	76.3	2231/2	6.9	76.3	2230/2	9.7
90.562	59.7	2231/2	6.9	59.7	2232/2	6.9
117.917	59.7	2229/2	9.7	59.7	2230/2	9.7

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-28

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	82.2	2241/2	-6.9	82.2	2236/2	-35.8
0.000	85.2	2252/2	-22.3	86.0	2245/2	-48.3
.979	83.0	2246/2	-13.9	83.0	2224/2	-19.2
1.917	74.7	2257/2	-29.2	74.7	2233/2	-31.7
2.958	79.2	2244/2	-11.1	79.2	2219/2	-12.4
4.021	79.2	2242/2	-8.3	77.7	2217/2	-9.6
5.021	78.5	2240/2	-5.6	77.7	2215/2	-6.9
6.271	78.5	2237/2	-1.4	77.7	2211/2	-1.4
7.042	77.7	2236/2	0.0	77.7	2210/2	0.0
14.125	77.0	2231/2	6.9	77.0	2203/2	9.6
28.000	76.3	2230/2	8.3	76.3	2198/2	16.4
56.021	76.3	2232/2	5.5	76.3	2194/2	21.8
83.167	76.3	2234/2	2.8	76.3	2191/2	25.9
83.167	91.3	2234/2	2.8	91.3	2191/2	25.9
89.917	74.0	2237/2	-1.4	74.0	2192/2	24.6

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-31

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	81.5	2240/2	20.9	81.5	2233/2	-9.7
0.000	84.5	2250/2	7.0	83.8	2240/2	-19.4
.979	83.0	2237/2	25.1	82.2	2220/2	8.3
1.917	75.5	2247/2	11.2	74.7	2229/2	-4.1
7.063	76.3	2255/2	0.0	74.7	2226/2	0.0
8.208	77.0	2240/2	20.9	75.5	2217/2	12.4
9.146	77.0	2231/2	33.4	75.5	2213/2	17.9
10.208	77.0	2223/2	44.4	75.5	2209/2	23.4
11.021	77.0	2218/2	51.3	75.5	2206/2	27.5
12.021	76.3	2213/2	58.2	75.5	2202/2	32.9
13.042	77.0	2207/2	66.4	75.5	2198/2	38.4
14.125	76.3	2201/2	74.6	75.5	2191/2	47.9
28.000	76.3	2158/2	132.7	76.3	2161/2	88.4
56.021	77.0	2113/2	192.3	77.0	2128/2	132.3
90.562	59.7	2085/2	228.7	59.0	2104/2	163.8
117.917	61.3	2062/2	258.3	59.7	2086/2	187.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-34

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	81.5	2309/2	-7.2	81.5	2228/2	-45.2
0.000	82.2	2316/2	-17.2	84.5	2235/2	-54.9
.979	81.5	2318/2	-20.1	82.2	2213/2	-24.6
1.917	74.7	2324/2	-28.7	75.5	2218/2	-31.5
2.958	77.7	2313/2	-12.9	79.2	2203/2	-10.9
4.021	77.0	2310/2	-8.6	77.7	2200/2	-6.8
5.021	77.0	2308/2	-5.7	77.7	2199/2	-5.4
6.250	76.3	2305/2	-1.4	77.7	2196/2	-1.4
7.042	76.3	2304/2	0.0	77.0	2195/2	0.0
14.125	76.3	2296/2	11.4	77.0	2186/2	12.2
28.000	75.5	2290/2	19.9	76.3	2178/2	23.0
56.021	75.5	2284/2	28.4	75.5	2173/2	29.8
90.562	59.0	2275/2	41.2	59.0	2168/2	36.5
117.917	57.5	2268/2	51.0	59.0	2164/2	41.9

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-35

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	80.0	2245/2	29.4	81.5	2243/2	7.0
0.000	83.8	2252/2	19.6	84.5	2252/2	-5.6
.979	81.5	2251/2	21.0	82.2	2243/2	7.0
1.917	74.7	2263/2	4.2	74.0	2250/2	-2.8
7.063	74.0	2266/2	0.0	74.7	2248/2	0.0
8.208	74.7	2248/2	25.2	76.3	2237/2	15.3
9.146	75.5	2238/2	39.1	76.3	2233/2	20.8
10.208	75.5	2228/2	52.9	76.3	2229/2	26.4
11.021	75.5	2221/2	62.6	76.3	2225/2	31.9
12.021	75.5	2216/2	69.5	75.5	2223/2	34.7
13.042	75.5	2210/2	77.7	76.3	2217/2	42.9
14.125	75.5	2203/2	87.3	76.3	2213/2	48.4
28.000	76.3	2153/2	154.8	76.3	2182/2	90.6
56.021	77.0	2102/2	222.1	77.0	2147/2	137.6
90.562	60.5	2068/2	266.0	59.0	2119/2	174.6
117.917	59.7	2041/2	300.4	59.7	2100/2	199.5

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN H-45

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	82.2	2237/2	-29.0	81.5	2210/2	0.0
0.000	83.8	2243/2	-37.3	83.8	2217/2	-9.6
.979	82.2	2233/2	-23.4	81.5	2215/2	-6.9
1.917	75.5	2242/2	-35.9	74.7	2225/2	-20.6
2.958	78.5	2222/2	-8.3	78.5	2218/2	-11.0
4.021	77.7	2220/2	-5.5	77.7	2215/2	-6.9
5.021	77.7	2219/2	-4.1	77.7	2213/2	-4.1
6.250	77.7	2216/2	0.0	77.7	2210/2	0.0
7.042	77.0	2216/2	0.0	77.0	2210/2	0.0
14.125	77.0	2211/2	6.9	77.0	2204/2	8.2
28.000	76.3	2213/2	4.1	76.3	2204/2	8.2
56.021	75.5	2217/2	-1.4	75.5	2200/2	13.7
90.562	59.7	2220/2	-5.5	59.7	2199/2	15.0
117.917	59.7	2220/2	-5.5	59.7	2196/2	19.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN I-1

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	77.0	2300/2	31.5	79.2	2268/2	56.7
0.000	80.7	2309/2	18.7	83.8	2279/2	41.2
.938	78.5	2313/2	12.9	81.5	2291/2	24.2
1.958	69.5	2324/2	-2.9	77.7	2303/2	7.1
7.125	68.8	2322/2	0.0	71.0	2308/2	0.0
8.167	71.0	2302/2	28.7	74.0	2294/2	20.0
9.112	71.0	2292/2	42.9	74.0	2287/2	29.9
10.021	71.0	2283/2	55.7	74.0	2279/2	41.2
11.021	71.0	2275/2	67.0	74.0	2267/2	58.1
12.042	71.7	2266/2	79.6	74.0	2260/2	68.0
13.021	71.7	2260/2	88.1	74.7	2253/2	77.8
14.063	71.0	2253/2	97.9	74.7	2245/2	88.9
28.021	74.7	2210/2	157.4	74.7	2210/2	137.3
56.021	71.7	2165/2	218.4	74.0	2168/2	194.3
82.125	70.2	2143/2	247.8	73.2	2144/2	226.3
82.542	77.0	2146/2	243.8	80.7	2147/2	222.3
83.021	77.7	2158/2	227.8	81.5	2155/2	211.7
83.271	87.5	2161/2	223.7	89.7	2157/2	209.0
89.917	140.7	2148/2	241.1	161.0	2123/2	254.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN I-13

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	82.2	2203/2	60.7	81.5	2214/2	69.4
0.000	86.0	2210/2	51.1	85.2	2219/2	62.5
.938	84.5	2223/2	33.3	84.5	2239/2	34.9
1.958	75.5	2242/2	7.0	76.3	2257/2	9.8
7.125	74.0	2247/2	0.0	74.0	2264/2	0.0
8.167	76.3	2229/2	25.0	75.5	2253/2	15.4
9.125	76.3	2220/2	37.4	75.5	2245/2	26.6
10.021	77.0	2212/2	48.4	77.0	2236/2	39.1
11.021	75.5	2204/2	59.3	74.7	2228/2	50.1
12.042	75.5	2198/2	67.5	75.5	2220/2	61.2
13.021	75.5	2191/2	77.0	75.5	2211/2	73.5
14.063	75.5	2183/2	87.9	75.5	2207/2	79.0
28.021	76.3	2138/2	148.2	76.3	2170/2	129.2
56.021	77.0	2084/2	218.8	77.0	2126/2	187.8
82.125	75.5	2055/2	256.1	74.7	2099/2	223.2
82.542	81.5	2069/2	238.2	81.5	2106/2	214.0
83.271	77.7	2075/2	230.4	76.3	2110/2	208.8
83.271	93.5	2076/2	229.2	93.5	2112/2	206.2
89.917	147.5	2031/2	286.5	146.0	2064/2	268.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN I-16

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

		AXIAL GAGE			RADIAL GAGE	
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	0.0	2241/2	11.1	0.0	2261/2	29.6
0.000	84.5	2251/2	-2.8	86.0	2266/2	22.6
.938	83.8	2259/2	-14.0	84.5	2280/2	2.8
1.958	81.5	2260/2	-15.4	81.5	2282/2	0.0
3.208	77.7	2255/2	-8.4	78.5	2284/2	-2.8
4.021	77.0	2254/2	-7.0	78.5	2286/2	-5.7
5.021	76.3	2254/2	-7.0	77.0	2285/2	-4.2
6.042	76.3	2251/2	-2.8	77.0	2284/2	-2.8
7.125	76.3	2249/2	0.0	76.3	2282/2	0.0
14.208	76.3	2236/2	18.1	76.3	2272/2	14.1
28.021	77.0	2230/2	26.4	77.0	2270/2	16.9
56.021	75.5	2224/2	34.7	75.5	2273/2	12.7
82.542	77.0	2218/2	42.9	77.0	2269/2	18.3
82.542	94.2	2220/2	40.2	95.0	2271/2	15.5
89.917	147.5	2118/2	177.3	148.2	2150/2	181.4

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN I-17

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	0.0	4052/4	59.7	0.0	2129/2	60.0
0.000	89.0	2032/2	52.2	79.2	2136/2	50.8
.938	87.5	2044/2	37.0	78.5	2145/2	38.8
1.958	69.5	2064/2	11.5	77.7	2162/2	16.1
7.125	68.8	2073/2	0.0	77.7	2174/2	0.0
8.167	71.0	2053/2	25.6	79.2	2161/2	17.5
9.112	70.2	2041/2	40.8	79.2	2154/2	26.8
10.021	71.0	2031/2	53.4	79.2	2147/2	36.2
11.021	71.7	2021/2	66.0	79.2	2139/2	46.8
12.042	70.2	2014/2	74.8	79.2	2131/2	57.4
13.021	71.7	2006/2	84.7	80.0	2125/2	65.3
14.063	71.7	2000/2	92.2	80.0	2118/2	74.5
28.021	71.7	3894/4	157.0	80.0	2084/2	118.8
56.021	71.7	3776/4	227.2	80.0	2037/2	178.8
89.917	54.5	3700/4	271.2	63.5	2000/2	225.1

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN T-20

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	80.7	2249/2	53.4	81.5	2243/2	51.9
0.000	85.2	2253/2	47.9	85.2	2250/2	42.1
.938	83.8	2262/2	35.3	84.5	2256/2	33.7
1.958	74.0	2280/2	9.9	74.7	2273/2	9.9
7.125	74.0	2287/2	0.0	74.7	2280/2	0.0
8.167	75.5	2269/2	25.4	76.3	2271/2	12.7
9.112	76.3	2259/2	39.5	76.3	2264/2	22.5
10.021	75.5	2250/2	52.0	75.5	2258/2	30.9
11.021	75.5	2242/2	63.2	77.0	2251/2	40.7
12.042	75.5	2236/2	71.5	77.0	2246/2	47.7
13.021	75.5	2228/2	82.6	77.0	2239/2	57.4
14.063	76.3	2221/2	92.2	77.0	2232/2	67.1
28.021	76.3	2176/2	153.6	76.3	2200/2	111.1
56.021	77.0	2124/2	222.9	77.0	2160/2	165.2
82.125	75.5	2098/2	256.9	76.3	2140/2	191.8
82.542	79.2	2112/2	238.6	80.7	2141/2	190.5
83.271	77.0	2114/2	236.0	77.0	2142/2	189.2
83.271	94.2	2116/2	233.4	95.0	2143/2	187.8
89.917	147.5	2079/2	281.5	148.2	2084/2	265.2

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN I-21

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	0.0	2152/2	20.1	0.0	2287/2	37.1
0.000	81.5	2158/2	12.1	84.5	2292/2	30.0
.938	80.0	2164/2	4.0	84.5	2310/2	4.3
1.958	71.7	2183/2	-21.6	74.0	2326/2	-18.7
3.208	74.7	2171/2	-5.4	77.0	2316/2	-4.3
4.021	74.0	2171/2	-5.4	76.3	2316/2	-4.3
5.021	72.5	2172/2	-6.7	77.0	2318/2	-7.2
6.042	73.2	2170/2	-4.0	76.3	2316/2	-4.3
7.125	74.0	2167/2	0.0	77.0	2313/2	0.0
14.208	74.0	2157/2	13.4	77.7	2303/2	14.3
28.021	72.5	2156/2	14.7	76.3	2303/2	14.3
56.021	73.2	2161/2	8.1	76.3	2309/2	5.7
82.542	73.2	2164/2	4.0	77.0	2312/2	1.4
82.542	89.0	2168/2	-1.3	92.7	2313/2	0.0
89.917	143.8	2050/2	153.0	146.7	2221/2	129.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN T-23

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	0.0	3970/4	42.2	0.0	2233/2	37.6
0.000	73.2	3989/4	30.5	85.2	2238/2	30.7
.938	73.2	2010/2	11.2	84.5	2258/2	2.8
1.958	63.5	2040/2	-26.4	74.0	2275/2	-21.1
3.208	68.0	2023/2	-5.0	78.5	2262/2	-2.8
4.021	68.0	2023/2	-5.0	77.0	2264/2	-5.6
5.021	65.7	2025/2	-7.5	77.0	2264/2	-5.6
6.042	65.7	2020/2	-1.3	76.3	2262/2	-2.8
7.125	66.5	2019/2	0.0	77.0	2260/2	0.0
14.208	66.5	0/0	0.0	77.0	2248/2	16.8
28.021	65.7	0/0	0.0	77.0	2245/2	20.9
56.021	65.7	0/0	0.0	77.0	2249/2	15.4
89.917	48.5	0/0	0.0	59.7	2250/2	14.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN T-27

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AS CAST

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	0.0	2280/2	25.5	0.0	2286/2	-21.2
0.000	84.5	2286/2	17.1	84.5	2289/2	-25.4
.938	83.0	2300/2	-2.9	83.8	2302/2	-43.9
1.958	83.0	2300/2	-2.9	83.0	2290/2	-26.9
3.208	78.5	2302/2	-5.7	77.7	2283/2	-16.9
4.021	77.7	2302/2	-5.7	77.0	2280/2	-12.7
5.021	75.5	2301/2	-4.3	76.3	2278/2	-9.9
6.042	76.3	2300/2	-2.9	75.5	2274/2	-4.2
7.125	76.3	2298/2	0.0	76.3	2271/2	0.0
14.208	77.7	2288/2	14.2	77.7	2250/2	29.4
28.021	76.3	2285/2	18.5	76.3	2242/2	40.6
56.021	76.3	2290/2	11.4	76.3	2238/2	46.1
82.542	78.5	2290/2	11.4	77.7	2232/2	54.4
82.542	94.2	2290/2	11.4	93.5	2234/2	51.7
89.917	147.5	2193/2	146.2	146.7	2128/2	195.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN T-30

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	0.0	2120/2	67.8	0.0	2121/2	58.5
0.000	85.2	2128/2	57.3	85.2	2126/2	51.9
.938	84.5	2140/2	41.4	83.8	2147/2	24.1
1.958	74.7	2163/2	10.7	74.7	2159/2	8.0
7.125	74.7	2171/2	0.0	74.7	2165/2	0.0
8.179	77.0	2141/2	40.1	77.0	2159/2	8.0
9.112	76.3	2131/2	53.3	77.0	2151/2	18.7
10.021	76.3	2121/2	66.5	76.3	2144/2	28.1
11.021	77.0	2113/2	77.0	77.0	2136/2	38.7
12.042	77.0	2105/2	87.5	75.5	2129/2	47.9
13.021	77.0	2099/2	95.3	76.3	2122/2	57.1
14.063	77.0	2090/2	107.0	77.0	2117/2	63.7
28.021	77.0	2040/2	171.0	77.0	2082/2	109.3
56.021	77.7	3970/4	239.6	77.7	2037/2	166.7
89.917	59.7	3892/4	287.2	62.0	2000/2	213.0

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

SHRINKAGE STRAIN AND TEMPERATURE DATA BEFORE LOADING

SPECIMEN I-39

TEST TEMPERATURE AT 90 DAYS 75 F
TEST MOISTURE AIR DRY

	AXIAL GAGE			RADIAL GAGE		
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	SHR STRAIN* (MIC-UNITS)
0.000	0.0	2129/2	66.8	0.0	2130/2	66.8
0.000	85.2	2136/2	57.5	83.8	2135/2	60.2
.938	80.7	2158/2	28.2	81.5	2153/2	36.3
1.958	74.7	2169/2	13.5	72.5	2168/2	16.2
7.125	74.7	2179/2	0.0	74.0	2180/2	0.0
8.179	75.5	2169/2	13.5	74.7	2174/2	8.1
9.112	76.3	2162/2	22.9	74.7	2170/2	13.5
10.021	75.5	2156/2	30.9	75.5	2166/2	18.9
11.021	75.5	2150/2	38.9	75.5	2161/2	25.6
12.042	75.5	2141/2	50.9	74.0	2154/2	34.9
13.021	75.5	2133/2	61.5	74.7	2146/2	45.6
14.063	75.5	2128/2	68.1	75.5	2140/2	53.6
28.021	76.3	2080/2	130.7	76.3	2105/2	99.6
56.021	76.3	2021/2	205.7	76.3	2061/2	156.5
89.917	59.7	3963/4	254.7	58.2	2024/2	203.3

* SHRINKAGE STRAIN IS CALCULATED FROM STRAIN OBSERVED AT 7 DAYS

APPENDIX G

TOTAL STRAIN AND CREEP STRAIN DATA

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN A-8

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	68.8	2115/2	0.0	0.0	74.0	2195/2	0.0	0.0
0.000	68.8	2115/2	0.0	0.0	73.2	2195/2	0.0	0.0
1.271	68.0	2115/2	0.0	0.0	73.2	2195/2	0.0	0.0
1.779	68.8	2116/2	-1.3	0.0	73.2	2196/2	-1.4	0.0
3.000	68.8	2116/2	-1.3	0.0	74.0	2195/2	0.0	0.0
3.862	68.0	2118/2	-3.9	0.0	72.5	2197/2	-2.7	0.0
5.292	68.0	2118/2	-3.9	0.0	72.5	2198/2	-4.1	0.0
5.875	67.2	2117/2	-2.6	0.0	72.5	2198/2	-4.1	0.0
6.500	67.2	2118/2	-3.9	0.0	72.5	2198/2	-4.1	0.0
13.854	68.8	2117/2	-2.6	0.0	73.2	2197/2	-2.7	0.0
20.729	67.2	2118/2	-3.9	0.0	72.5	2199/2	-5.4	0.0
27.917	66.5	2120/2	-6.6	0.0	71.0	2200/2	-6.8	0.0
55.792	69.5	2121/2	-7.9	0.0	74.0	2196/2	-1.4	0.0
83.721	47.0	2115/2	0.0	0.0	74.0	2196/2	-1.4	0.0
111.721	69.5	2112/2	3.9	0.0	74.0	2194/2	1.4	0.0
139.721	68.8	2113/2	2.6	0.0	73.2	2195/2	0.0	0.0
167.729	68.8	2112/2	3.9	0.0	73.2	2194/2	1.4	0.0
195.792	68.0	2112/2	3.9	0.0	72.5	2194/2	1.4	0.0
224.000	68.0	2108/2	9.2	0.0	72.5	2191/2	5.4	0.0
252.000	68.8	2106/2	11.8	0.0	74.0	2190/2	6.8	0.0
280.000	68.0	2102/2	17.0	0.0	72.5	2186/2	12.2	0.0
308.000	69.5	2101/2	18.3	0.0	74.0	2185/2	13.6	0.0
336.000	69.5	2100/2	19.6	0.0	74.7	2183/2	16.3	0.0
-364.000	71.0	2098/2	22.2	0.0	76.3	2181/2	19.0	0.0
364.000	71.0	2098/2	22.2	0.0	76.3	2181/2	19.0	0.0
365.000	71.0	2098/2	22.2	0.0	76.3	2181/2	19.0	0.0
366.000	71.0	2098/2	22.2	0.0	76.3	2181/2	19.0	0.0
367.000	71.0	2098/2	22.2	0.0	76.3	2181/2	19.0	0.0
368.000	71.0	2098/2	22.2	0.0	76.3	2181/2	19.0	0.0
369.000	71.0	2098/2	22.2	0.0	76.3	2181/2	19.0	0.0
370.000	71.0	2098/2	22.2	0.0	76.3	2181/2	19.0	0.0
371.000	70.2	2098/2	22.2	0.0	75.5	2181/2	19.0	0.0
378.000	70.2	2098/2	22.2	0.0	75.5	2181/2	19.0	0.0
385.000	69.5	2097/2	23.5	0.0	74.0	2180/2	20.3	0.0
392.000	69.5	2096/2	24.8	0.0	74.0	2179/2	21.7	0.0
420.000	68.8	2095/2	26.1	0.0	73.2	2179/2	21.7	0.0
448.000	68.0	2095/2	26.1	0.0	74.0	2179/2	21.7	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN A-22

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	145.2	2054/2	0.0	0.0	144.5	2062/2	0.0	0.0
0.000	145.2	2055/2	-1.3	0.0	144.5	2062/2	0.0	0.0
.125	145.2	2055/2	-1.3	0.0	144.5	2062/2	0.0	0.0
1.292	144.5	2056/2	-2.5	0.0	143.8	2063/2	-1.3	0.0
1.792	146.0	2056/2	-2.5	0.0	145.2	2063/2	-1.3	0.0
3.008	145.2	2057/2	-3.8	0.0	145.2	2065/2	-3.8	0.0
3.875	146.7	2058/2	-5.1	0.0	146.0	2066/2	-5.1	0.0
5.300	146.0	2059/2	-6.4	0.0	145.2	2068/2	-7.7	0.0
5.875	146.0	2060/2	-7.7	0.0	145.2	2069/2	-9.0	0.0
7.013	146.0	2060/2	-7.7	0.0	145.2	2070/2	-10.2	0.0
13.917	145.2	2068/2	-17.9	0.0	144.5	2078/2	-20.5	0.0
20.792	146.0	2066/2	-15.3	0.0	146.0	2078/2	-20.5	0.0
27.846	146.0	2068/2	-17.9	0.0	145.2	2081/2	-24.4	0.0
55.763	146.0	2071/2	-21.7	0.0	145.2	2085/2	-29.6	0.0
83.742	146.0	2071/2	-21.7	0.0	145.2	2088/2	-33.4	0.0
111.742	143.8	2078/2	-30.7	0.0	143.8	2095/2	-42.5	0.0
139.742	143.0	2073/2	-24.3	0.0	143.0	2091/2	-37.3	0.0
167.737	143.0	2070/2	-20.5	0.0	143.0	2088/2	-33.4	0.0
195.804	142.2	2068/2	-17.9	0.0	143.0	2086/2	-30.9	0.0
224.300	142.2	2067/2	-16.6	0.0	142.2	2085/2	-29.6	0.0
252.000	140.7	2069/2	-19.2	0.0	141.5	2087/2	-32.2	0.0
280.000	142.2	2064/2	-12.8	0.0	143.0	2082/2	-25.7	0.0
308.000	141.5	2064/2	-12.8	0.0	141.5	2082/2	-25.7	0.0
336.000	142.2	2062/2	-10.2	0.0	143.8	2080/2	-23.1	0.0
-364.000	143.8	2060/2	-7.7	0.0	144.5	2080/2	-23.1	0.0
364.000	143.8	2060/2	-7.7	0.0	144.5	2080/2	-23.1	0.0
365.000	143.8	2060/2	-7.7	0.0	144.5	2080/2	-23.1	0.0
366.000	143.8	2060/2	-7.7	0.0	144.5	2080/2	-23.1	0.0
367.000	143.8	2060/2	-7.7	0.0	144.5	2080/2	-23.1	0.0
368.000	143.8	2060/2	-7.7	0.0	144.5	2080/2	-23.1	0.0
369.000	143.8	2060/2	-7.7	0.0	144.5	2080/2	-23.1	0.0
370.000	143.8	2060/2	-7.7	0.0	144.5	2080/2	-23.1	0.0
371.000	143.0	2060/2	-7.7	0.0	143.8	2079/2	-21.8	0.0
378.000	143.0	2060/2	-7.7	0.0	143.8	2079/2	-21.8	0.0
385.000	141.5	2060/2	-7.7	0.0	141.5	2079/2	-21.8	0.0
392.000	143.0	2059/2	-6.4	0.0	143.8	2077/2	-19.2	0.0
420.000	140.7	2056/2	-2.5	0.0	140.7	2077/2	-19.2	0.0
448.000	142.2	2054/2	0.0	0.0	142.2	2073/2	-14.1	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN A-32

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	137.7	3816/4	0.0	0.0	147.5	3911/4	0.0	0.0
0.000	137.7	3816/4	0.0	0.0	147.5	3911/4	0.0	0.0
.125	137.7	3817/4	-.6	0.0	147.5	3911/4	0.0	0.0
1.271	135.5	3834/4	-10.7	0.0	146.7	3921/4	-6.1	0.0
1.792	138.5	3821/4	-3.0	0.0	147.5	3914/4	-1.8	0.0
3.008	138.5	3826/4	-5.9	0.0	147.5	3916/4	-3.0	0.0
3.867	138.5	3828/4	-7.1	0.0	148.2	3917/4	-3.6	0.0
5.292	138.5	3830/4	-8.3	0.0	147.5	3919/4	-4.9	0.0
5.833	138.5	3836/4	-11.9	0.0	147.5	3921/4	-6.1	0.0
7.013	138.5	3836/4	-11.9	0.0	148.2	3920/4	-5.5	0.0
13.917	136.2	3858/4	-25.0	0.0	146.7	3934/4	-14.0	0.0
20.792	137.7	3861/4	-26.8	0.0	147.5	3930/4	-11.5	0.0
27.833	137.7	3865/4	-29.2	0.0	146.7	3928/4	-10.3	0.0
55.750	137.0	3873/4	-34.0	0.0	147.5	3929/4	-10.9	0.0
83.729	137.7	3873/4	-34.0	0.0	146.7	3927/4	-9.7	0.0
111.729	135.5	3880/4	-38.2	0.0	145.2	3934/4	-14.0	0.0
139.729	135.5	3868/4	-31.0	0.0	146.0	3927/4	-9.7	0.0
167.733	134.7	3854/4	-22.6	0.0	144.5	3923/4	-7.3	0.0
195.796	134.7	3839/4	-13.6	0.0	146.0	3917/4	-3.6	0.0
224.300	134.7	3820/4	-2.4	0.0	144.5	3915/4	-2.4	0.0
252.000	133.2	0/0	0.0	0.0	143.0	3916/4	-3.0	0.0
280.000	135.5	0/0	0.0	0.0	144.5	3902/4	5.4	0.0
308.000	134.7	0/0	0.0	0.0	143.8	3901/4	6.1	0.0
336.000	134.7	0/0	0.0	0.0	144.5	3892/4	11.5	0.0
-364.000	137.0	0/0	0.0	0.0	147.5	3887/4	14.5	0.0
364.000	137.0	0/0	0.0	0.0	147.5	3887/4	14.5	0.0
365.000	136.2	0/0	0.0	0.0	146.0	3886/4	15.1	0.0
366.000	136.2	0/0	0.0	0.0	146.0	3885/4	15.7	0.0
367.000	137.0	0/0	0.0	0.0	146.7	3886/4	15.1	0.0
368.000	135.5	0/0	0.0	0.0	145.2	3884/4	16.3	0.0
369.000	136.2	0/0	0.0	0.0	146.0	3884/4	16.3	0.0
370.000	136.2	0/0	0.0	0.0	147.5	3883/4	16.9	0.0
371.000	135.5	0/0	0.0	0.0	148.2	3883/4	16.9	0.0
378.000	135.5	0/0	0.0	0.0	148.2	3882/4	17.5	0.0
385.000	133.2	0/0	0.0	0.0	144.5	3883/4	16.9	0.0
392.000	134.0	0/0	0.0	0.0	145.2	3879/4	19.3	0.0
420.000	132.5	0/0	0.0	0.0	143.8	3875/4	21.7	0.0
448.000	133.2	0/0	0.0	0.0	144.5	3868/4	25.9	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN A-35

AXIAL STRESS	-0 PSI		AXIAL ELASTIC STRAIN	-47.9 MICRO-UNITS	
RADIAL STRESS	600 PSI		RADIAL ELASTIC STRAIN	70.6 MICRO-UNITS	
TEST TEMPERATURE	150 F		TEST MOISTURE	AS CAST	

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	142.2	3975/4	0.0	0.0	146.0	2008/2	0.0	0.0
0.000	142.2	4052/4	-47.9	-.0	146.0	3901/4	70.6	.0
.125	140.7	2028/2	-50.4	-1.2	146.0	3895/4	74.2	4.6
.250	143.0	2026/2	-47.9	1.3	146.7	3885/4	80.2	10.2
.375	143.0	2026/2	-47.9	.6	146.7	3880/4	83.2	13.3
1.000	143.0	2031/2	-54.2	-5.2	146.7	3878/4	84.4	16.3
1.792	144.5	2031/2	-54.2	-.3	148.2	3865/4	92.2	28.6
2.850	145.2	2034/2	-58.0	-3.6	148.2	3867/4	94.0	29.8
3.875	144.5	2036/2	-60.5	-4.7	148.2	3860/4	95.2	32.8
5.292	144.5	2037/2	-61.8	-4.8	148.2	3862/4	94.0	33.1
5.875	144.5	2040/2	-65.5	-8.0	148.2	3863/4	93.4	33.9
7.000	145.2	2041/2	-66.8	-4.6	149.0	3860/4	95.2	38.8
13.854	143.8	2051/2	-79.5	-12.8	148.2	3863/4	93.4	40.7
21.167	144.5	2055/2	-84.6	-16.9	149.0	3854/4	98.8	49.1
27.833	143.8	2060/2	-91.0	-20.6	148.2	3853/4	99.4	53.3
55.750	144.5	2070/2	-103.8	-20.3	149.0	3848/4	102.4	69.9
83.742	144.5	2076/2	-111.5	-30.2	148.2	3845/4	104.2	70.9
111.742	143.0	2087/2	-125.7	-43.8	147.5	3853/4	99.4	68.1
139.742	142.2	2089/2	-128.3	-48.0	146.0	3849/4	101.8	72.4
167.700	142.2	2088/2	-127.0	-46.8	146.7	3848/4	102.4	75.2
195.800	141.5	2085/2	-123.1	-42.5	146.0	3848/4	102.4	75.8
224.300	140.7	2082/2	-119.2	-38.8	145.2	3849/4	101.8	77.6
252.000	140.7	2074/2	-108.9	-32.0	145.2	3852/4	100.0	73.4
280.000	142.2	0/0	0.0	0.0	145.2	3846/4	103.6	74.7
308.000	141.5	0/0	0.0	0.0	144.5	3850/4	101.2	71.0
336.000	141.5	0/0	0.0	0.0	145.2	3848/4	102.4	71.2
-364.000	144.5	0/0	0.0	0.0	147.5	3845/4	104.2	69.8
364.000	144.5	0/0	0.0	0.0	147.5	3953/4	38.9	4.5
364.125	144.5	0/0	0.0	0.0	147.5	3953/4	38.9	4.5
364.250	144.5	0/0	0.0	0.0	147.5	3953/4	38.9	4.5
364.500	144.5	0/0	0.0	0.0	147.5	3953/4	38.9	4.5
365.000	149.0	0/0	0.0	0.0	147.5	3953/4	38.9	4.2
366.000	146.0	0/0	0.0	0.0	146.0	3954/4	38.3	3.6
367.000	142.2	0/0	0.0	0.0	146.0	3953/4	38.9	4.2
368.000	143.0	0/0	0.0	0.0	146.7	3954/4	38.3	3.6
369.000	141.5	0/0	0.0	0.0	146.0	3954/4	38.3	3.6
370.000	142.2	0/0	0.0	0.0	146.0	3955/4	37.7	2.3
371.000	141.5	0/0	0.0	0.0	145.2	3955/4	37.7	1.7
378.000	142.2	0/0	0.0	0.0	146.0	3960/4	34.6	-.7
385.000	140.7	0/0	0.0	0.0	145.2	3963/4	32.8	-3.6
392.000	140.7	0/0	0.0	0.0	144.5	3964/4	32.2	-5.5
420.000	140.0	0/0	0.0	0.0	143.8	3974/4	26.0	-10.1
448.000	140.7	0/0	0.0	0.0	144.5	3998/4	11.2	-28.6

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN A-38

AXIAL STRESS	-0 PSI		AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI		RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F		TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	73.2	3996/4	0.0	0.0	71.7	2033/2	0.0	0.0
0.000	73.2	3996/4	0.0	0.0	72.5	2033/2	0.0	0.0
1.271	72.5	3998/4	-1.2	0.0	71.7	2033/2	0.0	0.0
1.792	72.5	3999/4	-1.9	0.0	71.7	2033/2	0.0	0.0
3.013	72.5	2000/2	-2.5	0.0	71.7	2032/2	1.3	0.0
3.875	72.5	2002/2	-5.0	0.0	71.7	2033/2	0.0	0.0
5.292	72.5	2003/2	-6.2	0.0	71.7	2032/2	1.3	0.0
5.875	72.5	2004/2	-7.4	0.0	71.7	2033/2	0.0	0.0
7.008	71.7	2005/2	-8.7	0.0	71.0	2033/2	0.0	0.0
13.917	71.7	2006/2	-9.9	0.0	71.0	2030/2	3.8	0.0
20.812	72.5	2010/2	-14.9	0.0	70.2	2028/2	6.3	0.0
27.833	71.7	2014/2	-19.9	0.0	69.5	2028/2	6.3	0.0
55.750	72.5	2015/2	-21.1	0.0	72.5	2020/2	16.3	0.0
83.729	73.2	2020/2	-27.4	0.0	71.7	2020/2	16.3	0.0
111.729	74.0	2020/2	-27.4	0.0	73.2	2020/2	16.3	0.0
139.729	73.2	2026/2	-34.9	0.0	71.0	2022/2	13.8	0.0
167.762	73.2	2027/2	-36.2	0.0	71.7	2023/2	12.6	0.0
195.783	72.5	2030/2	-40.0	0.0	71.0	2024/2	11.3	0.0
224.292	72.5	2031/2	-41.2	0.0	71.0	2025/2	10.1	0.0
252.000	74.0	2030/2	-40.0	0.0	72.5	2025/2	10.1	0.0
280.000	72.5	2029/2	-38.7	0.0	71.7	2024/2	11.3	0.0
308.000	72.5	2030/2	-40.0	0.0	71.7	2025/2	10.1	0.0
336.000	72.5	2030/2	-40.0	0.0	71.7	2025/2	10.1	0.0
-364.000	85.2	2030/2	-40.0	0.0	84.5	2025/2	10.1	0.0
364.000	85.2	2030/2	-40.0	0.0	84.5	2025/2	10.1	0.0
365.000	75.5	2030/2	-40.0	0.0	73.2	2025/2	10.1	0.0
366.000	75.5	2030/2	-40.0	0.0	73.2	2025/2	10.1	0.0
367.000	76.3	2031/2	-41.2	0.0	74.0	2026/2	8.8	0.0
368.000	74.7	2031/2	-41.2	0.0	74.7	2026/2	8.8	0.0
369.000	75.5	2030/2	-40.0	0.0	74.0	2025/2	10.1	0.0
370.000	75.5	2031/2	-41.2	0.0	74.7	2026/2	8.8	0.0
371.000	74.7	2031/2	-41.2	0.0	74.0	2026/2	8.8	0.0
378.000	76.3	2031/2	-41.2	0.0	74.7	2026/2	8.8	0.0
385.000	74.0	2031/2	-41.2	0.0	72.5	2026/2	8.8	0.0
392.000	74.0	2030/2	-40.0	0.0	72.5	2025/2	10.1	0.0
420.000	73.2	2030/2	-40.0	0.0	71.7	2025/2	10.1	0.0
448.000	74.0	2034/2	-45.0	0.0	72.5	2029/2	5.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN B-1

AXIAL STRESS	600 PSI	AXIAL ELASTIC STRAIN	102.2 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-25.4 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	152.0	3747/4	0.0	0.0	147.5	3710/4	0.0	0.0
0.000	152.0	3566/4	102.6	.3	147.5	3754/4	-25.5	-.0
.125	152.0	3544/4	114.7	13.4	147.5	3755/4	-26.0	-.6
.250	152.0	3542/4	115.8	14.5	147.5	3756/4	-26.6	-.9
.500	152.0	3538/4	118.0	16.1	147.5	3758/4	-27.8	-2.3
1.000	152.0	3534/4	120.2	20.2	147.5	3763/4	-30.7	-4.5
2.063	152.7	3520/4	127.8	32.4	148.2	3763/4	-30.7	-1.1
3.167	151.2	3520/4	127.8	33.5	147.5	3770/4	-34.8	-5.5
4.179	151.2	3519/4	128.4	37.5	147.5	3775/4	-37.7	-6.0
5.000	151.2	3517/4	129.5	40.7	147.5	3776/4	-38.3	-5.8
6.083	152.0	3514/4	131.1	43.5	147.5	3778/4	-39.5	-6.4
7.096	150.5	3514/4	131.1	46.6	146.7	3784/4	-43.0	-7.8
13.992	152.0	3506/4	135.5	60.9	147.5	3790/4	-46.5	-6.1
21.917	150.5	3506/4	135.5	66.5	147.5	3796/4	-50.0	-7.9
28.042	152.7	3492/4	143.1	77.2	149.0	3797/4	-50.6	-7.3
56.000	150.5	3496/4	140.9	91.4	146.7	3805/4	-55.3	.4
84.000	148.2	3506/4	135.5	94.4	143.0	3854/4	-84.4	-18.6
112.000	149.0	3500/4	138.7	96.8	146.0	3839/4	-75.5	-13.5
140.000	149.0	3491/4	143.6	104.3	146.0	3840/4	-76.1	-11.5
168.000	149.0	3495/4	141.4	104.1	146.0	3842/4	-77.3	-9.6
196.000	146.7	3496/4	140.9	106.2	143.8	3846/4	-79.6	-9.0
224.000	147.5	3492/4	143.1	107.3	143.8	3850/4	-82.0	-9.3
252.000	148.2	3480/4	149.5	116.1	145.2	3850/4	-82.0	-4.6
280.000	145.2	3510/4	133.3	96.6	140.7	3868/4	-92.8	-14.3
308.000	147.5	3486/4	146.3	110.1	143.0	3853/4	-83.8	-6.5
336.000	149.0	3478/4	150.6	114.9	144.5	3846/4	-79.6	-1.0
-364.000	148.2	3478/4	150.6	114.2	144.5	3846/4	-79.6	.0
364.000	148.2	3651/4	55.0	18.6	144.5	3811/4	-58.9	20.8
364.125	148.2	3656/4	52.2	15.8	144.5	3812/4	-59.5	20.2
364.250	149.0	3656/4	52.2	15.8	145.2	3812/4	-59.5	20.2
364.500	149.0	3655/4	52.8	16.4	145.2	3812/4	-59.5	20.2
365.000	148.2	3657/4	51.6	15.0	145.2	3811/4	-58.9	20.6
366.000	148.2	3658/4	51.1	14.2	143.8	3811/4	-58.9	20.6
367.000	148.2	3660/4	49.9	13.0	143.8	3811/4	-58.9	20.6
368.000	148.2	3660/4	49.9	13.0	143.8	3810/4	-58.3	21.2
369.000	148.2	3660/4	49.9	13.0	143.8	3810/4	-58.3	21.0
370.000	148.2	3661/4	49.4	12.5	143.8	3809/4	-57.7	21.8
371.000	149.0	3663/4	48.2	11.8	145.2	3811/4	-58.9	21.2
378.000	147.5	3670/4	44.3	8.1	143.8	3812/4	-59.5	21.6
385.000	148.2	3667/4	46.0	9.3	144.5	3806/4	-55.9	24.6
392.000	147.5	3672/4	43.1	5.6	143.8	3809/4	-57.7	23.4
420.000	147.5	3675/4	41.4	3.2	143.0	3802/4	-53.6	27.5
448.000	147.5	3677/4	40.3	5.9	143.0	3800/4	-52.4	33.8

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN B-4

AXIAL STRESS	600 PSI	AXIAL ELASTIC STRAIN	94.4 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-22.2 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	149.0	3797/4	0.0	0.0	155.0	3964/4	0.0	0.0
0.000	149.0	3633/4	94.4	-.0	154.2	2000/2	-22.2	-.0
.125	149.0	3624/4	99.5	6.4	154.2	2001/2	-23.5	-.3
.250	149.0	3622/4	100.6	7.5	153.5	2001/2	-23.5	-.7
.500	149.0	3620/4	101.7	8.0	154.2	2002/2	-24.7	-1.9
1.008	149.0	3615/4	104.5	11.2	154.2	2003/2	-25.9	-1.3
2.083	150.5	3603/4	111.3	22.8	155.7	2003/2	-25.9	3.2
3.167	149.0	3604/4	110.7	22.7	154.2	2007/2	-30.9	-2.4
4.179	149.0	3603/4	111.3	24.7	154.2	2008/2	-32.2	-1.8
5.012	149.0	3601/4	112.4	27.0	154.2	2008/2	-32.2	-.4
6.071	149.7	3598/4	114.0	29.3	155.0	2009/2	-33.4	-.2
7.104	149.0	3596/4	115.2	35.0	154.2	2011/2	-35.9	.5
14.000	149.0	3581/4	123.5	47.9	154.2	2013/2	-38.4	1.6
21.083	148.2	3575/4	126.8	52.2	153.5	2012/2	-37.1	5.9
28.042	151.2	3550/4	140.6	68.7	155.7	2009/2	-33.4	13.2
55.987	149.0	3534/4	149.4	90.5	154.2	2000/2	-22.2	38.0
84.000	144.5	3538/4	147.2	86.2	150.5	2014/2	-39.6	19.8
112.000	148.2	3496/4	170.1	109.7	153.5	3987/4	-14.2	47.3
140.000	148.2	3478/4	179.9	117.8	154.2	3980/4	-9.9	53.5
168.000	148.2	3464/4	187.4	125.3	154.2	3975/4	-6.8	58.8
196.000	146.0	3440/4	200.2	138.5	152.0	3970/4	-3.7	62.5
224.000	146.7	3412/4	215.1	153.2	152.7	3964/4	0.0	68.6
252.000	151.2	3378/4	233.0	167.6	152.7	3957/4	4.3	70.5
280.000	147.5	3368/4	238.2	174.1	151.2	3958/4	3.7	67.6
308.000	146.7	3312/4	267.2	203.0	152.0	3944/4	12.3	74.8
336.000	148.2	0/0	0.0	0.0	153.5	3935/4	17.8	79.3
-364.000	149.7	0/0	0.0	0.0	152.7	3929/4	21.4	79.8
364.000	149.7	0/0	0.0	0.0	152.7	3893/4	43.2	101.6
364.129	149.7	0/0	0.0	0.0	152.7	3893/4	43.2	101.6
364.250	150.5	0/0	0.0	0.0	153.5	3893/4	43.2	101.6
364.497	150.5	0/0	0.0	0.0	153.5	3893/4	43.2	101.6
365.000	149.7	0/0	0.0	0.0	152.7	3893/4	43.2	101.3
366.000	150.5	0/0	0.0	0.0	153.5	3891/4	44.4	102.5
367.000	149.7	0/0	0.0	0.0	153.5	3890/4	45.0	103.1
368.000	147.5	0/0	0.0	0.0	152.7	3891/4	44.4	102.5
369.000	147.5	0/0	0.0	0.0	152.7	3892/4	43.8	101.9
370.000	148.2	0/0	0.0	0.0	153.5	3892/4	43.8	101.3
371.000	148.2	0/0	0.0	0.0	153.5	3892/4	43.8	100.6
378.000	146.7	0/0	0.0	0.0	152.7	3890/4	45.0	102.5
385.000	146.7	0/0	0.0	0.0	152.7	3887/4	46.9	103.3
392.000	146.7	0/0	0.0	0.0	152.0	3886/4	47.5	102.5
420.000	147.5	0/0	0.0	0.0	151.2	3877/4	52.9	109.6
448.000	147.5	0/0	0.0	0.0	151.2	3872/4	55.9	108.9

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN B-5

AXIAL STRESS	3600 PSI	AXIAL ELASTIC STRAIN	758.7 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-174.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	150.5	3785/4	0.0	0.0	144.5	3783/4	0.0	0.0
0.000	150.5	2130/4	758.7	-.0	144.5	4071/4	-175.3	-1.3
.125	150.5	2980/8	938.2	180.5	144.5	2064/2	-211.5	-37.6
.250	151.2	2724/8	966.5	208.7	144.5	2069/2	-217.9	-43.6
.500	151.2	2215/8	1015.2	256.9	144.5	2077/2	-228.2	-54.2
1.008	151.2	0/0	0.0	0.0	144.5	2084/2	-237.2	-62.5
2.087	152.0	0/0	0.0	0.0	145.2	2092/2	-247.6	-69.5
3.167	0.0	0/0	0.0	0.0	144.5	2101/2	-259.3	-81.5
4.167	150.5	0/0	0.0	0.0	144.5	2105/2	-264.5	-84.3
5.000	0.0	0/0	0.0	0.0	144.5	2107/2	-267.1	-86.1
6.083	0.0	0/0	0.0	0.0	144.5	2110/2	-271.0	-89.5
7.083	0.0	0/0	0.0	0.0	143.8	2117/2	-280.2	-96.6
13.979	151.2	0/0	0.0	0.0	144.5	2127/2	-293.4	-104.4
21.083	150.5	0/0	0.0	0.0	143.8	2132/2	-300.0	-109.4
28.042	152.0	0/0	0.0	0.0	146.0	2134/2	-302.6	-110.8
56.008	150.5	0/0	0.0	0.0	144.5	2142/2	-313.2	-108.9
84.008	0.0	0/0	0.0	0.0	141.5	21[illegible]8/2	-334.5	-120.2
112.008	150.5	0/0	0.0	0.0	144.5	2141/2	-311.9	-101.4
140.042	152.7	0/0	0.0	0.0	145.2	2128/2	-294.7	-81.6
168.000	149.7	0/0	0.0	0.0	145.2	2104/2	-263.2	-47.0
196.000	148.2	0/0	0.0	0.0	142.2	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN B-7

AXIAL STRESS 2400 PSI
RADIAL STRESS -0 PSI
TEST TEMPERATURE 75 F

AXIAL ELASTIC STRAIN 384.7 MICRO-UNITS
RADIAL ELASTIC STRAIN -93.5 MICRO-UNITS
TEST MOISTURE AS CAST

TIME (DAYS)	AXIAL GAGE TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	RADIAL GAGE TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.7	2080/2	0.0	0.0	73.2	2120/2	0.0	0.0
0.000	74.7	3513/4	384.7	.0	73.2	2190/2	-93.5	-.0
.125	74.7	3450/4	418.7	34.0	73.2	2191/2	-94.9	-1.7
.250	74.7	3440/4	424.1	39.3	73.2	2192/2	-96.2	-2.9
.500	74.7	3427/4	431.0	45.7	73.2	2192/2	-96.2	-3.2
1.033	73.2	3416/4	436.8	51.2	71.7	2191/2	-94.9	-1.9
2.092	76.3	3396/4	447.4	61.5	74.0	2191/2	-94.9	-2.3
3.188	75.5	3326/4	483.9	98.0	74.0	2198/2	-104.4	-12.4
4.000	74.7	3306/4	494.1	108.3	73.2	2200/2	-107.1	-14.7
5.125	75.5	3325/4	484.4	98.5	74.0	2197/2	-103.0	-10.6
6.083	75.5	3324/4	484.9	99.5	74.0	2196/2	-101.7	-8.6
7.083	74.7	3322/4	485.9	101.3	74.0	2196/2	-101.7	-8.7
14.083	76.3	3328/4	482.8	98.8	74.0	2202/2	-109.9	-17.1
21.083	74.7	3282/4	506.4	121.6	74.0	2199/2	-105.8	-12.6
28.083	76.3	3245/4	525.1	140.6	74.0	2200/2	-107.1	-14.5
56.017	76.3	3118/4	587.7	202.4	74.0	2207/2	-116.7	-23.8
84.017	75.5	3076/4	607.9	222.6	73.2	2210/2	-120.8	-28.3
112.000	77.0	3017/4	635.8	250.9	75.5	2211/2	-122.2	-29.0
140.029	76.3	2980/4	653.0	267.5	74.7	2213/2	-124.9	-32.5
168.000	77.0	2964/4	660.3	275.1	74.7	2212/2	-123.5	-31.5
196.000	76.3	2947/4	668.1	281.3	74.0	2214/2	-126.3	-34.8
224.000	75.5	2937/4	672.7	284.1	73.2	2214/2	-126.3	-36.8
252.000	76.3	2912/4	684.0	293.3	74.7	2213/2	-124.9	-37.0
280.000	75.5	2883/4	697.0	305.3	74.7	2213/2	-124.9	-38.4
308.000	77.0	2865/4	705.0	311.4	76.3	2212/2	-123.5	-39.4
336.000	78.5	2849/4	712.1	316.7	76.3	2213/2	-124.9	-42.6
-364.000	78.5	2835/4	718.3	321.7	76.3	2212/2	-123.5	-42.3
364.000	78.5	3635/4	317.2	-79.4	76.3	2142/2	-29.1	52.2
364.125	76.3	3656/4	305.3	-91.3	76.3	2140/2	-26.4	54.9
364.250	76.3	3659/4	303.6	-93.0	76.3	2140/2	-26.4	54.9
364.509	76.3	3664/4	300.8	-95.8	76.3	2140/2	-26.4	54.9
365.000	77.0	3667/4	299.1	-97.6	77.0	2139/2	-25.1	56.0
366.000	77.0	3674/4	295.1	-101.8	77.0	2138/2	-23.8	57.2
367.000	77.0	3677/4	293.4	-103.4	77.0	2137/2	-22.4	58.4
368.000	77.7	3682/4	290.5	-106.5	77.0	2137/2	-22.4	58.6
369.000	79.2	3684/4	289.4	-107.3	77.0	2136/2	-21.1	60.4
370.000	77.7	3690/4	285.9	-110.9	77.0	2137/2	-22.4	58.6
371.000	78.5	3692/4	284.8	-112.2	77.0	2137/2	-22.4	58.5
378.000	77.7	3702/4	279.1	-118.4	76.3	2135/2	-19.8	60.5
385.000	77.7	3708/4	275.6	-123.0	76.3	2132/2	-15.8	63.5
392.000	77.7	3715/4	271.6	-126.6	77.0	2132/2	-15.8	63.9
420.000	76.3	3732/4	261.8	-137.9	74.7	2129/2	-11.9	66.4
448.000	76.3	3738/4	258.3	-141.8	74.7	2125/2	-6.6	71.7

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN 8-13

AXIAL STRESS	-0 PSI		AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI		RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F		TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	146.0	3928/4	0.0	0.0	148.2	38[illegible]2/4	0.0	0.0
0.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
.125	146.0	3928/4	0.0	0.0	148.2	38[illegible]0/4	1.2	0.0
.354	146.0	3928/4	0.0	0.0	149.0	38[illegible]1/4	.6	0.0
1.958	145.2	3940/4	-7.3	0.0	148.2	38[illegible]9/4	-4.2	0.0
2.917	145.2	3939/4	-6.7	0.0	148.2	38[illegible]5/4	-1.8	0.0
3.917	146.0	3940/4	-7.3	0.0	149.0	38[illegible]4/4	-1.2	0.0
4.750	146.0	3941/4	-7.9	0.0	149.0	38[illegible]4/4	-1.2	0.0
5.813	146.0	3941/4	-7.9	0.0	149.0	38[illegible]4/4	-1.2	0.0
6.846	144.5	3955/4	-16.5	0.0	147.5	38[illegible]7/4	-9.0	0.0
13.971	143.8	3965/4	-22.6	0.0	146.7	38[illegible]4/4	-7.2	0.0
21.083	144.5	3963/4	-21.4	0.0	147.5	38[illegible]5/4	10.1	0.0
27.917	145.2	3966/4	-23.2	0.0	148.2	38[illegible]4/4	28.5	0.0
55.875	144.5	3976/4	-29.4	0.0	148.2	0/0	0.0	0.0
83.867	142.2	3996/4	-41.8	0.0	145.2	0/0	0.0	0.0
112.033	143.8	3984/4	-34.3	0.0	145.2	0/0	0.0	0.0
140.062	142.2	3980/4	-31.9	0.0	156.5	0/0	0.0	0.0
167.917	143.0	3976/4	-29.4	0.0	145.2	0/0	0.0	0.0
196.000	140.7	3976/4	-29.4	0.0	144.5	0/0	0.0	0.0
224.000	141.5	3972/4	-26.9	0.0	144.5	0/0	0.0	0.0
252.000	141.5	3967/4	-23.9	0.0	145.2	0/0	0.0	0.0
280.000	139.2	3976/4	-29.4	0.0	143.0	0/0	0.0	0.0
308.000	141.5	3957/4	-17.7	0.0	144.5	0/0	0.0	0.0
336.000	143.8	3950/4	-13.4	0.0	146.0	0/0	0.0	0.0
-364.000	141.5	3944/4	-9.8	0.0	145.2	0/0	0.0	0.0
364.000	141.5	3944/4	-9.8	0.0	145.2	0/0	0.0	0.0
365.000	141.5	3945/4	-10.4	0.0	146.0	0/0	0.0	0.0
366.000	141.5	3945/4	-10.4	0.0	145.2	0/0	0.0	0.0
367.000	142.2	3945/4	-10.4	0.0	146.0	0/0	0.0	0.0
368.000	142.2	3945/4	-10.4	0.0	146.0	0/0	0.0	0.0
369.000	142.2	3944/4	-9.8	0.0	146.0	0/0	0.0	0.0
370.000	141.5	3944/4	-9.8	0.0	146.0	0/0	0.0	0.0
371.000	142.2	3944/4	-9.8	0.0	146.7	0/0	0.0	0.0
378.000	140.7	3944/4	-9.8	0.0	145.2	0/0	0.0	0.0
385.000	141.5	3943/4	-9.2	0.0	145.2	0/0	0.0	0.0
392.000	141.5	3940/4	-7.3	0.0	145.2	0/0	0.0	0.0
420.000	140.7	3935/4	-4.3	0.0	144.5	0/0	0.0	0.0
448.000	140.7	3930/4	-1.2	0.0	144.5	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN B-16

AXIAL STRESS	3600 PSI		AXIAL ELASTIC STRAIN	537.6 MICRO-UNITS
RADIAL STRESS	-0 PSI		RADIAL ELASTIC STRAIN	-150.3 MICRO-UNITS
TEST TEMPERATURE	150 F		TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	152.0	2013/2	0.0	0.0	148.2	3962/4	0.0	0.0
0.000	152.0	3045/4	537.6	.0	148.2	2100/2	-150.5	-.2
.125	152.0	2845/4	628.9	92.6	147.5	2120/2	-176.7	-25.5
.250	152.7	2807/4	645.5	109.2	148.2	2122/2	-179.3	-28.5
.500	152.7	2727/4	679.8	142.9	148.2	2128/2	-187.2	-36.3
1.012	152.7	2656/4	709.5	173.0	148.2	2136/2	-197.8	-45.1
2.092	153.5	2567/4	745.5	213.9	149.0	2143/2	-207.1	-49.9
3.175	153.5	2488/4	776.4	245.3	148.2	2151/2	-217.8	-61.2
4.188	152.7	2435/4	796.7	267.0	149.0	2156/2	-224.4	-66.0
5.167	152.7	2402/4	809.0	280.5	149.0	2159/2	-228.4	-68.6
6.250	153.5	2360/4	824.5	296.6	149.0	2162/2	-232.5	-71.2
7.279	151.2	2352/4	827.4	304.2	146.7	2170/2	-243.2	-78.7
14.008	152.0	2148/4	898.6	379.8	149.0	2181/2	-258.0	-89.9
21.083	152.0	2067/4	925.1	407.3	148.2	2187/2	-266.2	-95.0
28.083	152.7	3878/8	964.8	449.7	149.0	2190/2	-270.2	-95.5
56.008	152.0	3208/8	1056.8	554.7	149.0	2196/2	-278.4	-90.1
84.008	149.7	2576/8	1127.6	623.4	145.2	2212/2	-300.3	-112.7
112.008	150.5	2000/8	1178.7	675.1	148.2	2201/2	-285.2	-95.7
140.042	151.2	0/0	0.0	0.0	147.5	2200/2	-283.8	-92.4
168.000	151.2	0/0	0.0	0.0	147.5	2202/2	-286.6	-92.9
196.000	149.7	0/0	0.0	0.0	145.2	2203/2	-287.9	-93.6
224.000	149.7	0/0	0.0	0.0	145.2	2204/2	-289.3	-92.6
224.010	149.7	2520/4	764.0	255.5	145.2	2108/2	-161.0	33.3
224.100	149.7	2587/4	737.5	230.2	144.5	2106/2	-158.4	33.6
224.205	149.7	2602/4	731.5	224.1	144.5	2107/2	-159.7	31.0
224.300	149.7	2608/4	729.0	222.3	145.2	2106/2	-158.4	31.3
224.600	149.7	2621/4	723.8	215.1	145.2	2105/2	-157.1	29.4
224.120	149.7	2633/4	718.9	210.2	145.2	2103/2	-154.5	32.0
225.000	149.0	2654/4	710.3	201.6	145.2	2103/2	-154.5	32.0
226.000	151.2	2681/4	699.1	190.5	144.5	2103/2	-154.5	32.0
227.000	151.2	2686/4	697.0	188.4	144.5	2102/2	-153.2	33.3
228.000	151.2	2696/4	692.9	184.2	145.2	2100/2	-150.5	35.6
229.000	151.2	2705/4	689.1	180.5	144.5	2100/2	-150.5	35.6
230.000	149.7	2712/4	686.2	177.5	146.0	2099/2	-149.2	36.9
231.000	149.7	2720/4	682.8	174.1	146.0	2099/2	-149.2	36.9
238.000	149.7	2746/4	671.8	163.1	146.0	2096/2	-145.3	40.8
245.000	149.7	2765/4	663.7	155.0	146.0	2094/2	-142.7	42.8
252.000	150.5	2779/4	657.7	149.0	148.2	2091/2	-138.9	46.0
280.000	159.5	2844/4	629.3	120.7	143.8	2099/2	-149.2	36.3
308.000	152.7	2834/4	633.7	125.1	146.0	2087/2	-133.7	50.8
336.000	151.2	2835/4	633.3	125.2	147.5	2080/2	-124.6	58.5
371.000	149.7	2841/4	630.6	122.0	146.7	2073/2	-115.6	69.2
392.000	149.7	2841/4	630.6	123.3	146.0	2070/2	-111.8	69.3
420.000	149.7	2839/4	631.5	0.0	146.0	2064/2	-104.1	0.0
448.000	149.7	2836/4	632.8	0.0	146.0	2060/2	-99.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN B-19

AXIAL STRESS	2400 PSI		AXIAL ELASTIC STRAIN	378.6 MICRO-UNITS
RADIAL STRESS	-0 PSI		RADIAL ELASTIC STRAIN	-103.6 MICRO-UNITS
TEST TEMPERATURE	75 F		TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.7	3852/4	0.0	0.0	0.0	2000/2	0.0	0.0
0.000	73.2	3153/4	379.5	.9	66.5	2082/2	-103.8	-.2
.125	73.2	3084/4	412.8	34.3	66.5	2086/2	-108.9	-5.3
.250	74.0	3070/4	419.5	41.3	66.5	2087/2	-110.2	-6.6
.500	74.0	3050/4	429.0	50.3	66.5	2087/2	-110.2	-7.2
1.021	74.0	3030/4	438.4	59.6	66.5	2086/2	-108.9	-6.3
2.100	74.0	2996/4	454.3	76.1	68.0	2083/2	-105.1	-3.5
3.183	74.0	2905/4	495.9	117.3	67.2	2089/2	-112.8	-12.8
4.188	74.0	2890/4	502.6	125.8	65.7	2090/2	-114.1	-13.9
5.025	74.0	2873/4	510.2	133.7	65.7	2090/2	-114.1	-15.0
6.083	74.0	2891/4	502.2	127.0	66.5	2086/2	-108.9	-9.3
7.125	74.7	2897/4	499.5	125.3	67.2	2084/2	-106.3	-7.0
14.021	74.7	2829/4	529.7	157.1	67.2	2089/2	-112.8	-15.8
21.104	73.2	2820/4	533.6	163.6	66.5	2083/2	-105.1	-11.1
28.062	74.7	2773/4	554.0	184.8	67.2	2083/2	-105.1	-14.3
56.021	74.7	2602/4	625.2	261.4	67.2	2088/2	-111.5	-25.1
84.021	74.7	2547/4	647.2	287.1	68.0	2089/2	-112.8	-28.3
112.021	75.5	2476/4	674.8	320.1	68.0	2090/2	-114.1	-29.1
140.054	74.7	2435/4	690.4	338.2	70.2	2092/2	-116.7	-31.4
168.000	75.5	2417/4	697.2	347.6	68.0	2094/2	-119.3	-32.9
196.000	74.7	2403/4	702.4	355.2	67.2	2095/2	-120.6	-33.4
224.000	74.7	2395/4	705.4	359.0	67.2	2096/2	-121.9	-35.3
252.000	77.0	2370/4	714.6	368.2	73.2	2097/2	-123.2	-36.9
280.000	75.5	2340/4	725.6	380.7	68.8	2099/2	-125.8	-38.7
308.000	77.0	2323/4	731.7	386.9	69.5	2099/2	-125.8	-40.0
336.000	78.5	2309/4	736.7	392.7	71.0	2100/2	-127.1	-41.0
-364.000	85.2	2296/4	741.4	397.8	70.2	2101/2	-128.4	-42.6
364.000	85.2	3295/4	308.5	-35.0	70.2	2020/2	-24.9	60.9
364.125	85.2	3326/4	292.6	-50.9	70.2	2017/2	-21.2	64.7
364.250	85.2	3332/4	289.5	-54.0	70.2	2016/2	-19.9	65.9
364.508	85.2	3340/4	285.4	-58.2	70.2	2016/2	-19.9	65.9
365.000	77.0	3345/4	282.8	-60.9	69.5	2015/2	-18.7	67.2
366.000	77.0	3355/4	277.6	-66.2	69.5	2014/2	-17.4	68.4
367.000	77.0	3359/4	275.5	-68.1	69.5	2013/2	-16.2	69.4
368.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
369.000	84.5	3371/4	269.3	-73.9	81.5	2013/2	-16.2	70.0
370.000	78.5	3376/4	266.6	-76.6	69.5	2013/2	-16.2	69.9
371.000	77.0	3380/4	264.5	-78.5	83.0	2013/2	-16.2	70.1
378.000	78.5	3394/4	257.2	-85.6	69.5	2012/2	-14.9	71.1
385.000	77.7	3402/4	253.0	-90.1	69.5	2010/2	-12.4	72.9
392.000	77.0	3412/4	247.7	-94.9	71.7	2010/2	-12.4	73.0
420.000	76.3	3437/4	234.4	-107.8	68.8	2009/2	-11.2	73.9
448.000	76.3	3449/4	228.0	-113.3	68.8	2007/2	-8.7	77.5

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN B-23

AXIAL STRESS	-0 PSI		AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI		RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F		TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.7	3834/4	0.0	0.0	74.7	3849/4	0.0	0.0
0.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
.125	74.0	3834/4	0.0	0.0	74.0	3849/4	0.0	0.0
.362	74.0	3834/4	0.0	0.0	74.0	3848/4	.6	0.0
.946	75.5	3833/4	.6	0.0	75.5	3845/4	2.4	0.0
1.958	74.7	3836/4	-1.2	0.0	75.5	3843/4	3.6	0.0
3.050	75.5	3836/4	-1.2	0.0	74.7	3843/4	3.6	0.0
4.042	74.0	3838/4	-2.4	0.0	74.0	3845/4	2.4	0.0
4.875	74.0	3838/4	-2.4	0.0	74.0	3843/4	3.6	0.0
5.938	74.7	3840/4	-3.6	0.0	74.7	3843/4	3.6	0.0
6.979	74.7	3841/4	-4.2	0.0	74.7	3841/4	4.8	0.0
13.854	74.7	3838/4	-2.4	0.0	74.7	3846/4	1.8	0.0
20.958	73.2	3854/4	-11.9	0.0	73.2	3839/4	6.0	0.0
27.937	75.5	3854/4	-11.9	0.0	75.5	3832/4	10.1	0.0
55.875	75.5	3864/4	-17.9	0.0	75.5	3823/4	15.5	0.0
112.000	76.3	3880/4	-27.5	0.0	76.3	3819/4	17.8	0.0
139.958	75.5	3887/4	-31.7	0.0	75.5	3821/4	16.6	0.0
168.000	75.5	3893/4	-35.3	0.0	75.5	3824/4	14.9	0.0
196.000	74.7	3897/4	-37.7	0.0	74.7	3822/4	16.1	0.0
224.000	74.7	3904/4	-42.0	0.0	74.7	3826/4	13.7	0.0
252.000	74.7	3905/4	-42.6	0.0	75.5	3825/4	14.3	0.0
280.000	76.3	3906/4	-43.2	0.0	76.3	3824/4	14.9	0.0
308.000	75.5	3905/4	-42.6	0.0	75.5	3822/4	16.1	0.0
336.000	77.0	3908/4	-44.4	0.0	77.0	3824/4	14.9	0.0
-364.000	77.0	3911/4	-46.2	0.0	77.0	3824/4	14.9	0.0
364.000	77.0	3911/4	-46.2	0.0	77.0	3824/4	14.9	0.0
365.000	77.0	3911/4	-46.2	0.0	77.0	3824/4	14.9	0.0
366.000	76.3	3910/4	-45.6	0.0	76.3	3822/4	16.1	0.0
367.000	76.3	3910/4	-45.6	0.0	76.3	3822/4	16.1	0.0
368.000	75.5	3910/4	-45.6	0.0	76.3	3824/4	14.9	0.0
369.000	75.5	3911/4	-46.2	0.0	76.3	3824/4	14.9	0.0
370.000	75.5	3912/4	-46.8	0.0	76.3	3824/4	14.9	0.0
371.000	78.5	3911/4	-46.2	0.0	79.2	3824/4	14.9	0.0
378.000	77.0	3910/4	-45.6	0.0	77.0	3824/4	14.9	0.0
385.000	77.0	3908/4	-44.4	0.0	77.0	3823/4	15.5	0.0
392.000	77.0	3910/4	-45.6	0.0	77.0	3822/4	16.1	0.0
420.000	75.5	3913/4	-47.4	0.0	75.5	3823/4	15.5	0.0
448.000	75.5	3910/4	-45.6	0.0	75.5	3822/4	16.1	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN B-26

AXIAL STRESS -0 PSI
RADIAL STRESS -0 PSI
TEST TEMPERATURE 150 F

AXIAL ELASTIC STRAIN -0.0 MICRO-UNITS
RADIAL ELASTIC STRAIN -0.0 MICRO-UNITS
TEST MOISTURE AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	149.7	3690/4	0.0	0.0	147.5	3835/4	0.0	0.0
0.000	149.7	3690/4	0.0	0.0	147.5	3835/4	0.0	0.0
.125	150.5	3689/4	.6	0.0	147.5	3835/4	0.0	0.0
.367	150.5	3689/4	.6	0.0	147.5	3835/4	0.0	0.0
.887	150.5	3694/4	-2.3	0.0	147.5	3837/4	-1.2	0.0
1.958	150.5	3696/4	-3.4	0.0	147.5	3839/4	-2.4	0.0
3.042	150.5	3702/4	-6.9	0.0	147.5	3842/4	-4.2	0.0
4.042	151.2	3706/4	-9.2	0.0	147.5	3845/4	-6.0	0.0
4.896	150.5	3710/4	-11.5	0.0	147.5	3846/4	-6.5	0.0
5.938	150.5	3715/4	-14.3	0.0	147.5	3850/4	-8.9	0.0
6.979	149.0	3727/4	-21.3	0.0	146.7	3859/4	-14.3	0.0
13.854	147.5	3744/4	-31.1	0.0	146.0	3870/4	-20.9	0.0
20.938	149.0	3745/4	-31.7	0.0	146.0	3867/4	-19.1	0.0
27.917	150.5	3748/4	-33.4	0.0	147.5	3870/4	-20.9	0.0
55.875	149.7	3764/4	-42.7	0.0	147.5	3880/4	-26.9	0.0
83.875	146.7	3795/4	-60.9	0.0	143.8	3912/4	-46.2	0.0
111.875	146.7	3793/4	-59.7	0.0	146.0	3904/4	-41.4	0.0
139.896	146.7	3796/4	-61.5	0.0	145.2	3903/4	-40.8	0.0
168.054	146.0	3802/4	-65.0	0.0	145.2	3906/4	-42.6	0.0
196.000	145.2	3805/4	-66.8	0.0	143.8	3911/4	-45.6	0.0
224.000	146.0	3805/4	-66.8	0.0	143.8	3913/4	-46.8	0.0
252.000	146.0	3806/4	-67.4	0.0	143.8	3915/4	-48.0	0.0
280.000	143.8	3800/4	-63.9	0.0	141.5	3928/4	-56.0	0.0
308.000	146.0	3810/4	-69.8	0.0	143.8	3917/4	-49.3	0.0
336.000	146.7	3811/4	-70.3	0.0	144.5	3917/4	-49.3	0.0
-364.000	146.0	3813/4	-71.5	0.0	143.8	3917/4	-49.3	0.0
364.000	146.0	3813/4	-71.5	0.0	143.8	3917/4	-49.3	0.0
365.000	146.0	3813/4	-71.5	0.0	143.8	3916/4	-48.7	0.0
366.000	146.0	3812/4	-70.9	0.0	143.8	3916/4	-48.7	0.0
367.000	146.0	3812/4	-70.9	0.0	143.8	3916/4	-48.7	0.0
368.000	146.0	3812/4	-70.9	0.0	143.8	3916/4	-48.7	0.0
369.000	145.2	3812/4	-70.9	0.0	143.8	3915/4	-48.0	0.0
370.000	145.2	3812/4	-70.9	0.0	143.8	3915/4	-48.0	0.0
371.000	146.7	3814/4	-72.1	0.0	146.0	3917/4	-49.3	0.0
378.000	145.2	3815/4	-72.7	0.0	142.2	3919/4	-50.5	0.0
385.000	146.0	3813/4	-71.5	0.0	143.8	3915/4	-48.0	0.0
392.000	146.0	3814/4	-72.1	0.0	143.0	3917/4	-49.3	0.0
420.000	145.2	3814/4	-72.1	0.0	142.2	3916/4	-48.7	0.0
448.000	145.2	3814/4	-72.1	0.0	142.2	3916/4	-48.7	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN B-29

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.7	2080/2	0.0	0.0	74.0	2101/2	0.0	0.0
0.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
.125	74.7	2080/2	0.0	0.0	74.0	2102/2	-1.3	0.0
.354	74.7	2080/2	0.0	0.0	74.0	2102/2	-1.3	0.0
.883	74.7	2080/2	0.0	0.0	74.7	2101/2	0.0	0.0
1.958	74.7	2080/2	0.0	0.0	74.7	2101/2	0.0	0.0
3.042	74.7	2080/2	0.0	0.0	74.7	2102/2	-1.3	0.0
4.042	74.0	2080/2	0.0	0.0	74.0	2102/2	-1.3	0.0
4.896	74.0	2080/2	0.0	0.0	74.0	2102/2	-1.3	0.0
5.979	74.0	2080/2	0.0	0.0	74.0	2102/2	-1.3	0.0
6.979	74.0	2081/2	-1.3	0.0	74.0	2102/2	-1.3	0.0
14.104	74.0	2081/2	-1.3	0.0	74.0	2102/2	-1.3	0.0
20.938	73.2	2083/2	-3.9	0.0	73.2	2106/2	-6.5	0.0
27.917	72.5	2082/2	-2.6	0.0	72.5	2104/2	-3.9	0.0
55.875	75.5	2081/2	-1.3	0.0	75.5	2104/2	-3.9	0.0
83.875	74.0	2084/2	-5.2	0.0	74.7	2106/2	-6.5	0.0
111.875	77.0	2080/2	0.0	0.0	75.5	2104/2	-3.9	0.0
139.896	75.5	2080/2	0.0	0.0	74.7	2104/2	-3.9	0.0
168.054	75.5	2081/2	-1.3	0.0	75.5	2105/2	-5.2	0.0
196.000	74.7	2080/2	0.0	0.0	74.7	2104/2	-3.9	0.0
224.000	74.0	2080/2	0.0	0.0	74.0	2105/2	-5.2	0.0
252.000	74.7	2079/2	1.3	0.0	74.7	2104/2	-3.9	0.0
280.000	75.5	2077/2	3.9	0.0	75.5	2102/2	-1.3	0.0
308.000	76.3	2074/2	7.7	0.0	76.3	2100/2	1.3	0.0
336.000	77.0	2074/2	7.7	0.0	77.0	2100/2	1.3	0.0
-364.000	76.3	2073/2	9.0	0.0	77.0	2100/2	1.3	0.0
364.000	76.3	2073/2	9.0	0.0	77.0	2100/2	1.3	0.0
365.000	76.3	2073/2	9.0	0.0	77.0	2100/2	1.3	0.0
366.000	75.5	2072/2	10.3	0.0	77.0	2100/2	1.3	0.0
367.000	75.5	2072/2	10.3	0.0	77.0	2099/2	2.6	0.0
368.000	75.5	2072/2	10.3	0.0	77.0	2100/2	1.3	0.0
369.000	74.7	2073/2	9.0	0.0	77.0	2100/2	1.3	0.0
370.000	74.7	2073/2	9.0	0.0	76.3	2100/2	1.3	0.0
371.000	77.0	2073/2	9.0	0.0	77.0	2100/2	1.3	0.0
378.000	76.3	2072/2	10.3	0.0	76.3	2099/2	2.6	0.0
385.000	77.0	2070/2	12.9	0.0	76.3	2098/2	3.9	0.0
392.000	76.3	2070/2	12.9	0.0	76.3	2098/2	3.9	0.0
420.000	74.7	2070/2	12.9	0.0	74.7	2097/2	5.2	0.0
448.000	74.7	2069/2	14.1	0.0	74.7	2097/2	5.2	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN B-41

AXIAL STRESS	1200 PSI	AXIAL ELASTIC STRAIN	-7.9 MICRO-UNITS
RADIAL STRESS	2400 PSI	RADIAL ELASTIC STRAIN	219.2 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	65.0	2116/2	0.0	0.0	72.5	4080/4	0.0	0.0
0.000	65.0	2122/2	-7.9	-.0	72.5	3717/4	219.3	.1
.125	65.0	2113/2	3.9	11.8	74.0	3687/4	236.6	17.0
.250	64.2	2107/2	11.8	19.7	73.2	3684/4	238.3	18.9
.500	64.2	2030/2	110.5	117.9	73.2	3718/4	218.8	-.9
.917	64.2	3981/4	159.8	166.7	73.2	3724/4	215.3	-4.5
1.996	65.0	3956/4	175.1	181.9	74.0	3708/4	224.5	4.4
3.067	65.0	3930/4	191.0	197.8	73.2	3684/4	238.3	17.6
4.083	64.2	3918/4	198.3	205.1	74.0	3680/4	240.6	20.3
4.917	64.2	3913/4	201.4	208.1	74.0	3671/4	245.7	25.4
5.979	64.2	3912/4	202.0	209.3	73.2	3697/4	230.8	11.3
7.000	64.2	3937/4	186.8	194.8	73.2	3672/4	245.1	25.3
13.896	65.0	2100/2	20.9	29.5	73.2	3610/4	280.1	60.1
20.979	64.2	3900/4	209.2	217.1	71.7	3656/4	254.2	34.6
27.958	65.0	3880/4	221.3	229.4	73.2	3641/4	262.7	42.6
55.917	65.7	3806/4	265.4	272.7	74.0	3573/4	300.7	80.9
83.917	65.7	3785/4	277.7	285.0	73.2	3546/4	315.6	95.4
111.917	66.5	3757/4	294.1	301.9	74.7	3515/4	332.6	113.0
139.946	77.0	3741/4	303.4	310.5	74.0	3495/4	343.4	123.2
168.000	67.2	3733/4	308.0	315.4	74.0	3492/4	345.1	124.4
196.000	65.0	3725/4	312.7	318.5	73.2	3488/4	347.2	126.0
224.000	64.2	3718/4	316.7	320.8	74.0	3475/4	354.2	131.0
252.000	66.5	3705/4	324.2	326.1	74.0	3459/4	362.8	138.1
280.000	66.5	3692/4	331.6	332.5	74.7	3440/4	373.0	146.8
308.000	66.5	3682/4	337.3	336.3	75.5	3432/4	377.3	148.7
336.000	68.0	3677/4	340.2	337.4	76.3	3424/4	381.5	151.2
-364.000	66.5	3670/4	344.2	340.2	75.5	3416/4	385.7	154.3
364.000	66.5	3971/4	165.9	162.0	75.5	3765/4	191.5	-39.9
364.130	66.5	3988/4	155.4	151.5	75.5	3775/4	185.7	-45.8
364.250	66.5	3990/4	154.2	150.3	75.5	3773/4	186.8	-44.6
364.500	66.5	3992/4	153.0	149.0	75.5	3772/4	187.4	-44.0
365.000	68.0	3992/4	153.0	148.9	74.7	3770/4	188.6	-43.1
366.000	68.0	3996/4	150.5	146.2	74.0	3773/4	186.8	-44.9
367.000	68.0	3995/4	151.1	147.0	74.0	3772/4	187.4	-44.4
368.000	66.5	3999/4	148.6	144.3	74.7	3775/4	185.7	-46.0
369.000	66.5	4000/4	148.0	144.0	75.5	3777/4	184.5	-46.7
370.000	65.7	2001/2	146.8	142.5	74.7	3780/4	182.7	-48.9
371.000	67.2	2001/2	146.8	142.4	76.3	3780/4	182.7	-49.0
378.000	66.5	2004/2	143.0	138.2	74.7	3784/4	180.4	-52.0
385.000	66.5	2004/2	143.0	137.1	75.5	3785/4	179.8	-53.6
392.000	66.5	2006/2	140.6	135.0	75.5	3791/4	176.3	-56.7
420.000	65.7	2010/2	135.6	128.6	74.0	3802/4	169.8	-64.7
448.000	65.7	2011/2	134.3	126.8	74.0	3802/4	169.8	-64.6

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN R-42

AXIAL STRESS	1200 PSI	AXIAL ELASTIC STRAIN	-4.3 MICRO-UNITS
RADIAL STRESS	2400 PSI	RADIAL ELASTIC STRAIN	262.2 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	72.5	3851/4	0.0	0.0	68.8	2072/2	0.0	0.0
0.000	72.5	3858/4	-4.2	.1	68.8	3712/4	263.0	.8
.125	72.5	3852/4	-.6	3.7	68.8	3680/4	281.4	19.3
.250	71.7	3833/4	10.7	15.4	68.0	3686/4	277.9	15.7
.500	71.7	3658/4	112.3	116.5	68.0	3708/4	265.3	2.5
.917	71.7	3563/4	165.5	169.5	68.0	3709/4	264.7	1.6
2.000	72.5	3533/4	182.0	186.7	68.8	3681/4	280.8	16.5
3.063	71.7	3499/4	200.5	204.8	68.8	3644/4	301.8	36.1
4.050	71.7	3488/4	206.5	212.5	68.8	3630/4 [?]	309.7	44.1
4.917	71.7	3478/4	211.9	218.2	68.8	3612/4	319.8	53.1
5.958	71.7	3491/4	204.8	212.5	68.0	3632/4 [?]	308.6	42.4
7.013	72.5	3500/4	200.0	208.6	69.5	3636/4 [?]	306.3	39.8
14.129	0.0	3747/4	61.2	71.4	0.0	3617/4	317.0	48.2
20.971	71.7	3603/4	143.3	156.0	69.5	3517/4	372.3	100.4
27.950	73.2	3528/4	184.7	198.3	68.8	3586/4	334.3	59.3
55.908	73.2	3515/4	191.8	210.8	68.8	3526/4	367.4	88.0
83.908	72.5	3515/4	191.8	214.6	68.8	3505/4	378.8	97.6
111.908	73.2	3514/4	192.4	220.5	70.2	3491/4	386.4	105.6
139.929	74.0	3511/4	194.0	224.6	69.5	3480/4	392.3	111.9
168.000	74.0	3515/4	191.8	225.0	69.5	3484/4	390.2	110.8
196.000	73.2	3522/4	188.0	223.7	68.8	3487/4	388.6	110.0
224.000	72.5	3522/4	188.0	224.4	69.5	3483/4	390.7	111.5
252.000	75.5	3515/4	191.8	228.2	69.5	3467/4	399.3	119.9
280.000	75.5	3512/4	193.4	231.4	69.5	3459/4 [?]	403.6	124.9
308.000	77.7	3508/4	195.6	233.6	69.5	3452/4 [?]	407.4	127.4
336.000	74.7	3511/4	194.0	232.8	71.0	3452/4 [?]	407.4	127.7
-364.000	74.0	3511/4	194.0	233.3	69.5	3449/4	409.0	129.0
364.000	74.0	3781/4	41.4	80.7	69.5	3841/4	187.5	-92.4
364.130	74.0	3771/4	47.3	86.5	69.5	3850/4 [?]	182.1	-97.8
364.250	74.0	3769/4	48.4	87.7	70.2	3851/4 [?]	181.5	-98.4
364.500	74.0	3768/4	49.0	88.3	70.2	3852/4 [?]	180.9	-99.0
365.000	74.7	3766/4	50.2	89.4	71.0	3852/4 [?]	180.9	-99.0
366.000	74.7	3770/4	47.8	86.9	71.0	3856/4 [?]	178.6	-101.4
367.000	74.7	3768/4	49.0	88.2	71.0	3855/4 [?]	179.2	-101.0
368.000	74.0	3770/4	47.8	87.2	70.2	3859/4 [?]	176.8	-102.9
369.000	74.7	3771/4	47.3	87.0	70.2	3861/4	175.6	-104.0
370.000	74.7	3773/4	46.1	85.7	70.2	3864/4	173.8	-105.9
371.000	74.7	3774/4	45.5	85.3	71.0	3865/4	173.2	-106.4
378.000	74.0	3777/4	43.7	83.8	70.2	3870/4	170.2	-109.6
385.000	74.7	3776/4	44.3	84.1	70.2	3870/4	170.2	-110.2
392.000	74.0	3781/4	41.4	81.6	70.2	3876/4	166.6	-113.7
420.000	73.2	3790/4	36.1	76.7	70.2	3885/4	161.2	-119.5
448.000	73.2	3793/4	34.4	75.9	70.2	3887/4	160.0	-119.6

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN C-6

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	70.2	3816/4	0.0	0.0	73.2	3908/4	0.0	0.0
.271	70.2	3816/4	0.0	0.0	73.2	3908/4	0.0	0.0
1.017	70.2	3816/4	0.0	0.0	73.2	3908/4	0.0	0.0
2.008	71.0	3816/4	0.0	0.0	74.0	3906/4	1.2	0.0
2.967	70.2	3817/4	-.6	0.0	74.0	3906/4	1.2	0.0
4.012	70.2	3821/4	-3.0	0.0	74.0	3904/4	2.4	0.0
5.000	70.2	3822/4	-3.6	0.0	73.2	3904/4	2.4	0.0
6.000	70.2	3822/4	-3.6	0.0	74.0	3904/4	2.4	0.0
7.167	69.5	3826/4	-5.9	0.0	73.2	3905/4	1.8	0.0
14.058	68.8	3834/4	-10.7	0.0	73.2	3905/4	1.8	0.0
21.058	69.5	3834/4	-10.7	0.0	73.2	3896/4	7.3	0.0
28.017	69.5	3834/4	-10.7	0.0	73.2	3892/4	9.7	0.0
56.000	71.0	3841/4	-14.8	0.0	75.5	3884/4	14.5	0.0
84.146	71.7	3844/4	-16.6	0.0	76.3	3879/4	17.5	0.0
111.167	70.2	3855/4	-23.2	0.0	74.7	3882/4	15.7	0.0
140.242	70.2	3862/4	-27.4	0.0	74.0	3885/4	13.9	0.0
167.979	71.0	3862/4	-27.4	0.0	75.5	3882/4	15.7	0.0
195.983	69.5	3871/4	-32.8	0.0	73.2	3890/4	10.9	0.0
224.062	70.2	3871/4	-32.8	0.0	74.0	3885/4	13.9	0.0
252.000	70.2	3870/4	-32.2	0.0	74.0	3884/4	14.5	0.0
280.000	70.2	3870/4	-32.2	0.0	74.0	3885/4	13.9	0.0
308.000	70.2	3870/4	-32.2	0.0	74.0	3885/4	13.9	0.0
336.000	71.7	3869/4	-31.6	0.0	77.0	3881/4	16.3	0.0
-364.000	71.0	3871/4	-32.8	0.0	76.3	3881/4	16.3	0.0
364.000	71.0	3871/4	-32.8	0.0	76.3	3881/4	16.3	0.0
365.000	71.0	3870/4	-32.2	0.0	76.3	3881/4	16.3	0.0
366.000	71.0	3870/4	-32.2	0.0	76.3	3881/4	16.3	0.0
367.000	71.0	3870/4	-32.2	0.0	76.3	3881/4	16.3	0.0
368.000	71.0	3870/4	-32.2	0.0	77.0	3881/4	16.3	0.0
369.000	71.0	3870/4	-32.2	0.0	77.0	3882/4	15.7	0.0
370.000	71.0	3870/4	-32.2	0.0	77.0	3881/4	16.3	0.0
371.000	71.0	3870/4	-32.2	0.0	77.0	3880/4	16.9	0.0
378.000	71.0	3866/4	-29.8	0.0	77.0	3878/4	18.1	0.0
385.000	71.0	3867/4	-30.4	0.0	77.0	3878/4	18.1	0.0
392.000	71.0	3870/4	-32.2	0.0	75.5	3880/4	16.9	0.0
420.000	71.0	3866/4	-29.8	0.0	75.5	3876/4	19.3	0.0
448.000	71.0	3869/4	-31.6	0.0	75.5	3877/4	18.7	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN C-11

AXIAL STRESS	2400 PSI	AXIAL ELASTIC STRAIN	331.5 MICRO-UNITS
RADIAL STRESS	600 PSI	RADIAL ELASTIC STRAIN	-20.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	75.5	3773/4	0.0	0.0	62.0	3850/4	0.0	0.0
0.000	75.5	3154/4	332.3	.8	62.0	3885/4	-21.0	-1.0
.125	75.5	3088/4	364.2	32.8	62.0	3883/4	-19.8	.3
.250	75.5	3070/4	372.8	41.8	62.0	3880/4	-18.0	2.0
.500	74.0	3047/4	383.7	52.2	63.5	3877/4	-16.2	3.3
1.000	74.7	3025/4	394.1	62.4	62.0	3870/4	-12.0	7.1
2.000	74.7	2991/4	409.9	78.9	62.0	3862/4	-7.2	10.8
3.000	74.0	2897/4	452.8	121.4	62.0	3870/4	-12.0	4.5
4.042	75.5	2857/4	470.7	141.0	62.0	3866/4	-9.6	7.1
5.000	74.7	2840/4	478.2	148.7	62.0	3860/4	-6.0	9.6
6.000	74.7	2820/4	486.9	158.8	62.0	3859/4	-5.4	10.6
7.208	74.7	2835/4	480.4	153.3	62.0	3839/4	6.6	22.3
14.167	74.0	2820/4	486.9	161.4	61.3	3835/4	8.9	22.4
21.146	75.5	2777/4	505.6	182.6	61.3	3824/4	15.5	25.8
27.979	75.5	2670/4	550.8	228.7	61.3	3834/4	9.5	16.7
55.979	76.3	2574/4	589.8	273.0	63.5	3826/4	14.3	17.1
84.146	77.0	2524/4	609.5	296.5	63.5	3834/4	9.5	10.5
111.958	76.3	2476/4	628.1	320.5	63.5	3842/4	4.8	6.2
140.229	75.5	2437/4	643.0	337.9	62.7	3847/4	1.8	3.5
168.000	76.3	2413/4	652.0	349.5	63.5	3850/4	0.0	2.8
196.000	74.7	2407/4	654.2	354.2	62.0	3854/4	-2.4	1.2
224.000	74.7	2381/4	663.9	364.6	63.5	3860/4	-6.0	-3.0
252.000	74.7	2354/4	673.8	374.4	63.5	3857/4	-4.2	-1.4
280.000	75.5	2343/4	677.8	380.0	63.5	3860/4	-6.0	-2.5
308.000	75.5	2324/4	684.7	387.0	63.5	3864/4	-8.4	-6.1
336.000	74.0	2316/4	687.6	390.6	64.2	3863/4	-7.8	-5.3
-364.000	77.0	2300/4	693.3	396.8	64.2	3867/4	-10.2	-7.9
364.000	77.0	3203/4	308.2	11.7	64.2	3842/4	4.8	7.0
364.125	77.0	3235/4	292.2	-4.2	64.2	3845/4	3.0	5.3
364.250	77.0	3240/4	289.7	-6.8	64.2	3845/4	3.0	5.3
364.500	77.0	3245/4	287.2	-9.3	64.2	3845/4	3.0	5.3
365.000	77.0	3251/4	284.2	-12.4	64.2	3844/4	3.6	5.8
366.000	77.0	3264/4	277.6	-19.1	64.2	3846/4	2.4	4.7
367.000	77.0	3269/4	275.1	-21.5	64.2	3846/4	2.4	4.4
368.000	77.0	3273/4	273.0	-23.3	64.2	3846/4	2.4	4.9
369.000	77.0	3278/4	270.5	-25.5	64.2	3847/4	1.8	4.4
370.000	76.3	3280/4	269.5	-26.7	64.2	3847/4	1.8	4.3
371.000	76.3	3284/4	267.4	-28.5	64.2	3849/4	.6	3.3
378.000	76.3	3296/4	261.3	-34.4	65.0	3848/4	1.2	3.6
385.000	76.3	3309/4	254.7	-41.3	65.0	3850/4	0.0	1.8
392.000	76.3	3320/4	249.0	-46.5	65.0	3854/4	-2.4	-.5
420.000	75.5	3343/4	237.1	-58.0	62.7	3857/4	-4.2	-2.7
448.000	88.2	3357/4	229.9	-64.3	64.2	3859/4	-5.4	-2.8

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN C-12

AXIAL STRESS	1200 PSI	AXIAL ELASTIC STRAIN	77.4 MICRO-UNITS
RADIAL STRESS	1200 PSI	RADIAL ELASTIC STRAIN	95.2 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	149.0	2013/2	0.0	0.0	153.5	3787/4	0.0	0.0
0.000	149.0	3900/4	77.4	-.0	153.5	3621/4	95.3	.1
.042	149.0	3896/4	79.8	3.7	153.5	3607/4	103.1	8.9
.250	149.0	3859/4	102.1	26.0	153.5	3560/4	129.3	34.7
.500	150.5	3858/4	102.6	25.9	152.7	3554/4	132.6	38.0
.988	150.5	3851/4	106.8	30.6	153.5	3545/4	137.5	44.8
1.988	149.0	3849/4	108.0	36.6	153.5	3539/4	140.8	52.6
2.987	149.0	3841/4	112.8	41.9	153.5	3532/4	144.6	55.8
4.021	149.7	3842/4	112.2	42.7	153.5	3525/4	148.5	61.5
5.000	149.7	3834/4	117.0	48.6	155.0	3515/4	153.9	68.4
6.000	150.5	3830/4	119.3	51.6	155.0	3510/4	156.6	72.5
7.188	148.2	3832/4	118.1	55.1	153.5	3527/4	147.4	66.4
14.000	149.0	3823/4	123.5	64.9	153.5	3506/4	158.8	81.5
21.000	150.5	3804/4	134.7	77.1	155.0	3483/4	171.3	97.0
27.958	149.7	3812/4	130.0	75.1	153.5	3488/4	168.6	97.8
55.958	149.0	3798/4	138.3	96.4	153.5	3473/4	176.7	119.6
84.104	151.2	3767/4	156.4	112.4	155.7	3454/4	186.9	129.0
111.979	148.2	3786/4	145.3	101.9	153.5	3453/4	187.4	131.5
140.208	149.0	3783/4	147.1	102.0	153.5	3433/4	198.1	144.1
168.000	149.0	3797/4	138.8	93.8	153.5	3416/4	207.1	155.4
196.000	147.5	3797/4	138.8	94.1	152.0	3387/4	222.4	171.3
224.000	147.5	3791/4	142.4	97.5	151.2	3341/4	246.4	197.6
252.000	148.2	3794/4	140.6	92.2	152.7	3200/4	317.9	266.7
280.000	148.2	3762/4	159.3	112.2	152.0	0/0	0.0	0.0
308.000	147.5	3741/4	171.6	124.4	152.0	0/0	0.0	0.0
336.000	149.0	3698/4	196.3	149.8	153.5	0/0	0.0	0.0
-364.000	149.0	3700/4	195.2	146.7	150.5	0/0	0.0	0.0
364.000	149.0	3942/4	51.9	3.4	150.5	0/0	0.0	0.0
364.125	149.0	3953/4	45.1	-3.3	150.5	0/0	0.0	0.0
364.250	149.0	3953/4	45.1	-3.3	150.5	0/0	0.0	0.0
364.000	149.0	3955/4	43.9	-4.5	150.5	0/0	0.0	0.0
365.000	149.0	3956/4	43.3	-5.2	150.5	0/0	0.0	0.0
366.000	149.0	3960/4	40.8	-7.6	150.5	0/0	0.0	0.0
367.000	149.0	3962/4	39.6	-8.8	150.5	0/0	0.0	0.0
368.000	149.0	3963/4	39.0	-9.5	150.5	0/0	0.0	0.0
369.000	149.0	3964/4	38.4	-10.1	150.5	0/0	0.0	0.0
370.000	149.0	3964/4	38.4	-10.1	149.7	0/0	0.0	0.0
371.000	149.0	3968/4	35.9	-12.5	149.7	0/0	0.0	0.0
378.000	149.0	3972/4	33.5	-15.0	149.7	0/0	0.0	0.0
385.000	149.0	3978/4	29.8	-18.7	149.7	0/0	0.0	0.0
392.000	148.2	3981/4	27.9	-19.9	149.0	0/0	0.0	0.0
420.000	147.5	3990/4	22.4	-26.1	151.2	0/0	0.0	0.0
448.000	147.5	3997/4	18.0	-29.2	152.0	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN C-16

AXIAL STRESS	1200 PSI		AXIAL ELASTIC STRAIN	57.9 MICRO-UNITS	
RADIAL STRESS	1200 PSI		RADIAL ELASTIC STRAIN	127.5 MICRO-UNITS	
TEST TEMPERATURE	75 F		TEST MOISTURE	AS CAST	

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.0	2076/2	0.0	0.0	64.2	2087/2	0.0	0.0
0.000	74.0	4061/4	57.9	.0	64.2	3930/4	127.5	.0
.067	74.0	4035/4	74.2	16.3	0.0	3925/4	130.5	2.7
.250	74.0	3852/4	186.1	128.2	64.2	2099/2	-41.3	-169.0
.500	71.0	3843/4	191.5	133.0	63.5	2101/2	-43.9	-171.9
1.000	74.0	3834/4	196.8	138.0	63.5	2102/2	-45.2	-173.3
2.000	73.2	3825/4	202.2	143.1	63.5	2103/2	-46.5	-175.0
3.000	73.2	3817/4	206.9	147.9	63.5	2103/2	-46.5	-175.5
4.042	74.0	3813/4	209.3	150.2	63.5	2103/2	-46.5	-175.1
5.000	73.2	3810/4	211.0	151.9	63.5	2104/2	-47.8	-176.5
6.000	73.2	3808/4	212.2	153.7	63.5	2105/2	-49.1	-177.0
7.192	73.2	3818/4	206.3	148.5	63.5	2102/2	-45.2	-173.3
14.046	72.5	3806/4	213.4	156.2	63.5	2106/2	-50.5	-178.7
21.004	73.2	3795/4	219.9	161.9	63.5	2107/2	-51.8	-179.6
27.988	74.7	3785/4	225.7	168.0	64.2	2105/2	-49.1	-177.5
55.987	74.7	3756/4	242.7	184.2	65.0	2109/2	-54.4	-182.5
84.133	74.7	3738/4	253.2	194.7	65.7	2110/2	-55.7	-184.2
111.967	74.7	3728/4	258.9	200.9	65.0	2115/2	-62.2	-190.1
140.237	74.7	3718/4	264.7	206.0	64.2	2116/2	-63.5	-192.1
168.000	74.7	3713/4	267.6	209.2	65.0	2118/2	-66.2	-195.1
196.000	73.2	3711/4	268.7	208.8	63.5	2120/2	-68.8	-198.3
224.000	74.0	3703/4	273.3	211.6	64.2	2119/2	-67.5	-199.0
252.000	74.7	3693/4	279.1	215.2	65.0	2119/2	-67.5	-200.5
280.000	74.7	3667/4	293.9	228.9	65.0	2121/2	-70.1	-204.6
308.000	74.7	3687/4	282.5	215.7	65.0	2119/2	-67.5	-204.3
336.000	76.3	3684/4	284.2	215.6	66.5	2118/2	-66.2	-204.8
-364.000	78.5	3681/4	285.9	216.2	68.0	2119/2	-67.5	-207.2
364.000	78.5	3962/4	119.5	49.7	68.0	2086/2	-24.5	-164.2
364.125	78.5	3970/4	114.6	44.8	68.0	2083/2	-20.6	-160.3
364.250	77.0	3970/4	114.6	44.8	66.5	2083/2	-20.6	-160.3
364.494	77.0	3972/4	113.3	43.6	66.5	2083/2	-20.6	-160.3
365.000	77.0	3972/4	113.3	43.5	67.2	2081/2	-18.0	-157.9
366.000	77.0	3975/4	111.5	41.4	67.2	2080/2	-16.7	-156.8
367.000	76.3	3976/4	110.9	40.9	66.5	2080/2	-16.7	-156.9
368.000	76.3	3978/4	109.6	39.5	66.5	2080/2	-16.7	-156.7
369.000	76.3	3980/4	108.4	38.6	66.5	2080/2	-16.7	-156.2
370.000	77.0	3980/4	108.4	38.3	67.2	2080/2	-16.7	-156.7
371.000	77.0	3982/4	107.2	37.0	67.2	2080/2	-16.7	-156.7
378.000	77.0	3982/4	107.2	36.5	68.0	2078/2	-14.1	-154.8
385.000	76.3	3990/4	102.2	30.4	66.5	2076/2	-11.6	-153.2
392.000	75.5	3994/4	99.7	28.4	65.7	2077/2	-12.8	-154.1
420.000	74.0	4000/4	96.0	23.2	65.0	2075/2	-10.3	-153.1
448.000	74.7	2002/2	93.5	20.2	65.0	2074/2	-9.0	-151.7

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN C-17

AXIAL STRESS	1200 PSI	AXIAL ELASTIC STRAIN	74.6 MICRO-UNITS
RADIAL STRESS	1200 PSI	RADIAL ELASTIC STRAIN	100.9 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	65.0	3879/4	0.0	0.0	74.7	3857/4	0.0	0.0
0.000	65.0	3752/4	75.1	.5	74.7	3684/4	101.1	.2
.067	65.0	3732/4	86.7	12.1	74.7	3677/4	105.1	4.3
.250	65.0	3716/4	95.9	21.7	74.7	3667/4	110.8	9.9
.500	67.2	3707/4	101.1	26.4	74.7	3675/4	106.2	4.8
1.000	65.0	3700/4	105.1	30.3	74.7	3685/4	100.5	-1.3
2.000	64.2	3696/4	107.4	33.2	74.7	3680/4	103.4	.4
3.000	64.2	3694/4	108.6	33.9	74.7	3678/4	104.5	.1
4.042	65.0	3693/4	109.2	36.3	75.5	3671/4	108.5	4.3
5.000	65.0	3693/4	109.2	36.6	74.7	3668/4	110.2	4.8
6.000	64.2	3693/4	109.2	37.9	74.7	3666/4	111.4	6.5
7.221	65.0	3705/4	102.3	32.0	74.7	3661/4	114.2	9.0
14.054	64.2	3710/4	99.4	30.7	73.2	3647/4	122.1	14.6
21.033	65.0	3711/4	98.8	32.7	75.5	3640/4	126.1	15.5
28.012	65.0	3717/4	95.4	30.1	75.5	3639/4	126.6	12.9
55.987	65.7	3752/4	75.1	15.2	76.3	3653/4	118.7	.6
84.142	66.5	3761/4	69.9	13.7	77.0	3640/4	126.1	6.2
111.921	65.7	3764/4	68.1	17.3	76.3	3633/4	130.0	10.5
140.192	65.7	3760/4	70.5	22.2	75.5	3616/4	139.6	20.4
168.000	65.0	3756/4	72.8	27.1	76.3	3610/4	142.9	24.9
196.000	65.7	3757/4	72.2	29.0	74.7	3601/4	148.0	30.7
224.000	65.0	3753/4	74.5	32.1	75.5	3608/4	144.1	26.1
252.000	65.7	3746/4	78.6	36.1	77.0	3590/4	154.1	35.9
280.000	65.7	3722/4	92.5	51.5	76.3	3587/4	155.8	38.4
308.000	66.5	3749/4	76.9	36.0	76.3	3581/4	159.1	40.4
336.000	68.0	3756/4	72.8	32.7	77.7	3573/4	163.5	45.1
-364.000	67.2	3753/4	74.5	34.9	82.2	3573/4	163.5	44.9
364.000	67.2	3872/4	4.2	-35.4	82.2	3740/4	68.9	-49.8
364.125	67.2	3883/4	-2.4	-42.0	82.2	3748/4	64.2	-54.4
364.250	68.8	3884/4	-3.0	-42.6	77.7	3750/4	63.1	-55.6
364.500	68.8	3885/4	-3.6	-43.2	77.7	3752/4	61.9	-56.7
365.000	68.8	3884/4	-3.0	-42.7	77.7	3750/4	63.1	-55.6
366.000	68.8	3886/4	-4.2	-44.0	77.7	3750/4	63.1	-55.5
367.000	68.8	3887/4	-4.8	-44.5	77.7	3753/4	61.3	-57.5
368.000	67.2	3888/4	-5.4	-44.9	77.7	3753/4	61.3	-57.1
369.000	67.2	3890/4	-6.6	-45.8	77.7	3755/4	60.2	-58.1
370.000	68.8	3889/4	-6.0	-45.3	77.7	3754/4	60.8	-57.6
371.000	68.8	3890/4	-6.6	-45.7	77.7	3755/4	60.2	-58.1
378.000	68.8	3892/4	-7.8	-46.7	77.7	3756/4	59.6	-58.9
385.000	66.5	3894/4	-9.0	-48.2	77.0	3760/4	57.3	-61.9
392.000	67.2	3897/4	-10.8	-49.5	77.7	3763/4	55.5	-63.5
420.000	66.5	3901/4	-13.3	-51.6	76.3	3766/4	53.8	-65.6
448.000	65.7	3906/4	-16.3	-53.6	77.0	3769/4	52.0	-66.3

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN C-23

AXIAL STRESS	2400 PSI	AXIAL ELASTIC STRAIN	282.5 MICRO-UNITS
RADIAL STRESS	600 PSI	RADIAL ELASTIC STRAIN	-10.4 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.0	2030/2	0.0	0.0	73.2	2083/2	0.0	0.0
0.000	74.0	3583/4	282.5	.0	73.2	2091/2	-10.4	.0
.125	74.0	3542/4	305.2	22.6	73.2	2087/2	-5.2	4.9
.250	74.0	3534/4	309.6	27.0	73.2	2086/2	-3.9	6.3
.500	74.0	3520/4	317.2	34.1	74.0	2086/2	-3.9	6.1
1.000	74.7	3515/4	319.9	36.5	73.2	2084/2	-1.3	8.5
2.000	74.7	3502/4	327.0	43.3	73.2	2085/2	-2.6	6.9
3.000	74.7	3444/4	358.2	74.6	72.5	2090/2	-9.1	-.1
4.042	75.5	3430/4	365.7	82.0	72.5	2092/2	-11.6	-2.3
5.000	74.7	3426/4	367.8	84.1	72.5	2091/2	-10.4	-1.1
6.000	74.7	3420/4	371.0	87.9	72.5	2092/2	-11.6	-1.6
7.208	75.5	3475/4	341.6	59.2	73.2	2085/2	-2.6	7.2
14.042	73.2	3450/4	355.0	73.2	71.7	2092/2	-11.6	-2.0
21.042	74.7	3431/4	365.2	82.6	73.2	2093/2	-12.9	-2.9
28.021	74.7	3368/4	398.4	116.0	73.2	2098/2	-19.4	-10.0
55.983	76.3	3313/4	426.8	143.7	74.0	2094/2	-14.2	-4.5
84.137	76.3	3267/4	450.3	167.2	74.7	2092/2	-11.6	-2.3
111.971	75.5	3231/4	468.4	185.8	74.0	2094/2	-14.2	-4.2
140.137	75.5	3202/4	482.9	199.6	73.2	2094/2	-14.2	-4.9
168.000	77.0	3184/4	491.8	208.8	77.7	2094/2	-14.2	-5.3
196.000	74.7	3179/4	494.3	209.7	73.2	2096/2	-16.8	-8.5
224.000	74.7	3158/4	504.6	218.2	73.2	2096/2	-16.8	-10.5
252.000	74.7	3137/4	514.8	226.3	73.2	2095/2	-15.5	-10.7
280.000	75.5	3135/4	515.8	226.2	73.2	2093/2	-12.9	-9.5
308.000	75.5	3110/4	527.9	236.4	73.2	2093/2	-12.9	-11.9
336.000	77.0	3104/4	530.8	237.5	74.7	2093/2	-12.9	-13.7
-364.000	76.3	3093/4	536.1	241.7	75.5	2093/2	-12.9	-14.8
364.000	76.3	3662/4	238.2	-56.2	75.5	2079/2	5.2	3.3
364.125	76.3	3683/4	226.2	-68.1	75.5	2077/2	7.7	5.9
364.250	76.3	3683/4	226.2	-68.1	75.5	2076/2	9.0	7.2
364.500	76.3	3684/4	225.7	-68.7	75.5	2076/2	9.0	7.2
365.000	76.3	3686/4	224.5	-69.9	75.5	2075/2	10.3	8.3
366.000	76.3	3690/4	222.2	-72.4	75.5	2074/2	11.6	9.4
367.000	76.3	3696/4	218.8	-75.8	74.7	2075/2	10.3	8.1
368.000	76.3	3697/4	218.2	-76.5	74.7	2074/2	11.6	9.5
369.000	76.3	3700/4	216.5	-77.9	74.7	2074/2	11.6	10.0
370.000	76.3	3700/4	216.5	-78.2	75.5	2074/2	11.6	9.5
371.000	76.3	3704/4	214.2	-80.6	75.5	2074/2	11.6	9.5
378.000	76.3	3711/4	210.2	-85.1	75.5	2072/2	14.2	11.4
385.000	76.3	3720/4	205.0	-91.4	74.7	2073/2	12.9	9.1
392.000	75.5	3727/4	201.0	-95.0	74.0	2073/2	12.9	9.5
420.000	75.5	3740/4	193.4	-104.0	73.2	2072/2	14.2	9.3
448.000	75.5	3750/4	187.6	-110.3	89.0	2072/2	14.2	9.4

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN C-36

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	150.5	3718/4	0.0	0.0	147.5	3706/4	0.0	0.0
0.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
.125	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
.275	151.2	3719/4	-.6	0.0	148.2	3705/4	.6	0.0
1.021	151.2	3719/4	-.6	0.0	148.2	3704/4	1.1	0.0
2.021	151.2	3732/4	-8.1	0.0	148.2	3712/4	-3.4	0.0
3.021	151.2	3734/4	-9.2	0.0	148.2	3712/4	-3.4	0.0
4.063	151.2	3734/4	-9.2	0.0	148.2	3715/4	-5.2	0.0
5.000	151.2	3714/4	2.3	0.0	149.0	3716/4	-5.8	0.0
6.000	151.2	3744/4	-15.0	0.0	148.2	3717/4	-6.3	0.0
7.229	149.0	3759/4	-23.8	0.0	146.0	3728/4	-12.7	0.0
14.063	148.2	3762/4	-25.5	0.0	146.0	3723/4	-9.8	0.0
21.042	152.0	3767/4	-28.4	0.0	149.0	3720/4	-8.1	0.0
28.000	150.5	3778/4	-34.9	0.0	148.2	3726/4	-11.5	0.0
56.000	149.7	3790/4	-41.9	0.0	147.5	3722/4	-9.2	0.0
84.154	152.0	3782/4	-37.2	0.0	149.0	3722/4	-9.2	0.0
111.975	148.2	3793/4	-43.7	0.0	146.0	3724/4	-10.4	0.0
140.254	149.0	3785/4	-39.0	0.0	146.0	0/0	0.0	0.0
167.979	148.2	3782/4	-37.2	0.0	148.2	0/0	0.0	0.0
196.000	147.5	0/0	0.0	0.0	146.0	0/0	0.0	0.0
224.000	145.2	3784/4	-38.4	0.0	143.0	0/0	0.0	0.0
252.000	144.5	3769/4	-29.6	0.0	*04.7	0/0	0.0	0.0
280.000	147.5	3764/4	-26.7	0.0	145.2	0/0	0.0	0.0
308.000	147.5	3761/4	-24.9	0.0	145.2	0/0	0.0	0.0
336.000	149.0	3756/4	-22.0	0.0	146.7	0/0	0.0	0.0
-364.000	148.2	3752/4	-19.7	0.0	146.7	0/0	0.0	0.0
364.000	148.2	3752/4	-19.7	0.0	146.7	0/0	0.0	0.0
365.000	148.2	3751/4	-19.1	0.0	146.0	0/0	0.0	0.0
366.000	148.2	3751/4	-19.1	0.0	146.0	0/0	0.0	0.0
367.000	148.2	3752/4	-19.7	0.0	146.0	0/0	0.0	0.0
368.000	148.2	3752/4	-19.7	0.0	146.0	0/0	0.0	0.0
369.000	148.2	3752/4	-19.7	0.0	146.7	0/0	0.0	0.0
370.000	148.2	3751/4	-19.1	0.0	146.0	0/0	0.0	0.0
371.000	148.2	3750/4	-18.5	0.0	146.0	0/0	0.0	0.0
378.000	148.2	3749/4	-17.9	0.0	146.7	0/0	0.0	0.0
385.000	148.2	3749/4	-17.9	0.0	145.2	0/0	0.0	0.0
392.000	146.7	3750/4	-18.5	0.0	144.5	0/0	0.0	0.0
420.000	147.5	3743/4	-14.5	0.0	145.2	0/0	0.0	0.0
448.000	148.2	3739/4	-12.1	0.0	144.5	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN C-39

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.0	2012/2	0.0	0.0	75.5	2094/2	0.0	0.0
0.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
.125	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
.271	74.0	2012/2	0.0	0.0	74.7	2094/2	0.0	0.0
1.021	75.5	2011/2	1.2	0.0	75.5	2094/2	0.0	0.0
2.004	74.7	2012/2	0.0	0.0	75.5	2094/2	0.0	0.0
2.971	74.7	2011/2	1.2	0.0	76.3	2093/2	1.3	0.0
4.021	74.7	2012/2	0.0	0.0	76.3	2094/2	0.0	0.0
5.063	74.0	2013/2	-1.2	0.0	75.5	2094/2	0.0	0.0
6.000	74.0	2013/2	-1.2	0.0	75.5	2095/2	-1.3	0.0
7.154	74.0	2014/2	-2.5	0.0	74.7	2095/2	-1.3	0.0
14.071	73.2	2015/2	-3.7	0.0	74.0	2097/2	-3.9	0.0
21.042	74.7	2013/2	-1.2	0.0	74.7	2096/2	-2.6	0.0
28.000	74.7	2012/2	0.0	0.0	74.7	2095/2	-1.3	0.0
56.000	76.3	2009/2	3.7	0.0	76.3	2094/2	0.0	0.0
84.146	77.0	2006/2	7.5	0.0	77.0	2093/2	1.3	0.0
112.146	75.5	2007/2	6.2	0.0	76.3	2095/2	-1.3	0.0
140.237	74.7	2006/2	7.5	0.0	75.5	2096/2	-2.6	0.0
167.979	75.5	2004/2	10.0	0.0	75.5	2094/2	0.0	0.0
196.000	75.5	2004/2	10.0	0.0	75.5	2096/2	-2.6	0.0
224.000	74.7	2002/2	12.4	0.0	76.3	2094/2	0.0	0.0
252.000	74.7	2000/2	14.9	0.0	75.5	2094/2	0.0	0.0
280.000	75.5	3998/4	16.2	0.0	75.5	2092/2	2.6	0.0
308.000	75.5	3995/4	18.0	0.0	75.5	2091/2	3.9	0.0
336.000	77.7	3990/4	21.1	0.0	77.7	2090/2	5.2	0.0
-364.000	76.3	3990/4	21.1	0.0	77.0	2090/2	5.2	0.0
364.000	76.3	3990/4	21.1	0.0	77.0	2090/2	5.2	0.0
365.000	76.3	3989/4	21.7	0.0	77.0	2089/2	6.5	0.0
366.000	76.3	3989/4	21.7	0.0	77.0	2089/2	6.5	0.0
367.000	76.3	3988/4	22.4	0.0	77.0	2089/2	6.5	0.0
368.000	76.3	3988/4	22.4	0.0	77.0	2089/2	6.5	0.0
369.000	76.3	3989/4	21.7	0.0	75.5	2090/2	5.2	0.0
370.000	76.3	3989/4	21.7	0.0	75.5	2090/2	5.2	0.0
371.000	75.5	3988/4	22.4	0.0	76.3	2090/2	5.2	0.0
378.000	75.5	3985/4	24.2	0.0	75.5	2088/2	7.8	0.0
385.000	77.0	3985/4	24.2	0.0	77.0	2088/2	7.8	0.0
392.000	76.3	3987/4	23.0	0.0	77.7	2089/2	6.5	0.0
420.000	75.5	3982/4	26.1	0.0	77.0	2087/2	9.1	0.0
448.000	74.7	3983/4	25.4	0.0	75.5	2087/2	9.1	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN C-41

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	138.5	3968/4	0.0	0.0	149.0	3875/4	0.0	0.0
0.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
.279	138.5	3968/4	0.0	0.0	149.7	3875/4	0.0	0.0
1.021	140.7	3968/4	0.0	0.0	149.7	3874/4	.6	0.0
2.021	140.7	3976/4	-4.9	0.0	149.7	3884/4	-5.4	0.0
3.021	140.0	3976/4	-4.9	0.0	149.7	3883/4	-4.8	0.0
4.063	140.7	3978/4	-6.2	0.0	149.7	3887/4	-7.2	0.0
5.000	140.0	3980/4	-7.4	0.0	149.7	3888/4	-7.8	0.0
6.000	140.0	3982/4	-8.6	0.0	149.0	3890/4	-9.0	0.0
7.229	138.5	3994/4	-16.0	0.0	146.7	3903/4	-16.9	0.0
14.063	139.2	3994/4	-16.0	0.0	148.2	3903/4	-16.9	0.0
21.062	140.7	3994/4	-16.0	0.0	149.0	3906/4	-18.7	0.0
28.021	140.0	4000/4	-19.8	0.0	149.0	3916/4	-24.8	0.0
56.000	138.5	2003/2	-23.5	0.0	148.2	3926/4	-30.8	0.0
84.154	140.7	2000/2	-19.8	0.0	149.7	3925/4	-30.2	0.0
111.975	137.7	2003/2	-23.5	0.0	146.0	3937/4	-37.5	0.0
140.254	137.7	2002/2	-22.2	0.0	146.7	3936/4	-36.9	0.0
167.979	138.5	2003/2	-23.5	0.0	147.5	3938/4	-38.1	0.0
195.983	137.0	2005/2	-26.0	0.0	146.0	3940/4	-39.4	0.0
224.000	134.0	2011/2	-33.4	0.0	143.8	3950/4	-45.5	0.0
252.000	135.5	2008/2	-29.7	0.0	144.5	3942/4	-40.6	0.0
288.000	135.5	2008/2	-29.7	0.0	145.2	3941/4	-40.0	0.0
308.000	135.5	2009/2	-30.9	0.0	144.5	3941/4	-40.0	0.0
336.000	137.0	2010/2	-32.2	0.0	145.2	3940/4	-39.4	0.0
-364.000	136.2	2010/2	-32.2	0.0	144.5	3936/4	-36.9	0.0
364.000	136.2	2010/2	-32.2	0.0	144.5	3936/4	-36.9	0.0
365.000	136.2	2010/2	-32.2	0.0	144.5	3935/4	-36.3	0.0
366.000	136.2	2010/2	-32.2	0.0	144.5	3935/4	-36.3	0.0
367.000	136.2	2010/2	-32.2	0.0	144.5	3935/4	-36.3	0.0
368.000	136.2	2010/2	-32.2	0.0	144.5	3935/4	-36.3	0.0
369.000	135.5	2010/2	-32.2	0.0	144.5	3935/4	-36.3	0.0
370.000	136.2	2010/2	-32.2	0.0	144.5	3935/4	-36.3	0.0
371.000	136.2	2010/2	-32.2	0.0	144.5	3935/4	-36.3	0.0
378.000	136.2	2010/2	-32.2	0.0	144.5	3935/4	-36.3	0.0
385.000	134.7	2011/2	-33.4	0.0	145.2	3936/4	-36.9	0.0
392.000	134.0	2012/2	-34.7	0.0	142.2	3936/4	-36.9	0.0
420.000	133.2	2012/2	-34.7	0.0	140.7	3932/4	-34.5	0.0
448.000	146.0	2012/2	-34.7	0.0	159.5	3926/4	-30.8	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN C-46

AXIAL STRESS	1200 PSI	AXIAL ELASTIC STRAIN	100.9 MICRO-UNITS
RADIAL STRESS	1200 PSI	RADIAL ELASTIC STRAIN	117.3 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DYR

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	151.2	3748/4	0.0	0.0	150.5	3760/4	0.0	0.0
0.000	151.2	3570/4	101.0	.0	150.5	3583/4	117.3	-.0
.042	151.2	3289/4	250.3	150.4	150.5	3846/4	-50.7	-168.0
.250	151.2	3280/4	254.9	154.9	150.5	3868/4	-63.8	-180.8
.500	152.7	3266/4	262.0	161.4	151.2	3868/4	-63.8	-181.2
.992	152.7	3243/4	273.6	174.9	152.0	3873/4	-66.8	-183.4
1.992	152.7	3225/4	282.6	188.4	151.2	3883/4	-72.9	-186.0
2.992	152.7	3202/4	294.1	201.1	151.2	3890/4	-77.1	-190.5
3.992	150.5	3195/4	297.6	207.9	151.2	3894/4	-79.5	-190.6
5.000	152.7	3180/4	305.0	217.5	151.2	3894/4	-79.5	-189.8
6.000	152.7	3170/4	309.9	223.6	151.2	3897/4	-81.3	-191.0
7.200	150.5	3172/4	308.9	225.7	149.7	3915/4	-92.2	-199.8
14.033	151.2	3145/4	322.1	248.8	149.7	3923/4	-97.1	-199.4
21.012	152.7	3114/4	337.2	269.5	152.0	3925/4	-98.3	-198.9
28.000	152.0	3124/4	332.3	267.8	151.2	3930/4	-101.3	-200.8
55.917	151.2	3078/4	354.4	306.2	151.2	3953/4	-115.4	-202.4
84.104	153.5	3032/4	376.2	336.4	152.0	3967/4	-124.0	-200.9
111.929	149.7	3044/4	370.6	329.9	149.7	3978/4	-130.7	-211.5
140.208	150.5	3023/4	380.4	342.4	150.5	3987/4	-136.3	-214.5
168.000	152.0	3035/4	374.8	338.8	150.5	3994/4	-140.6	-215.7
196.000	149.0	3024/4	380.0	346.6	148.2	4004/4	-146.8	-218.9
224.000	148.2	3018/4	382.8	348.3	148.2	2005/2	-150.5	-220.6
252.000	152.0	3016/4	383.7	351.5	149.0	2004/2	-149.3	-214.6
280.000	149.0	3010/4	386.5	351.1	149.0	2008/2	-154.3	-218.5
308.000	149.0	3009/4	387.0	352.1	149.0	2010/2	-156.8	-222.2
336.000	150.5	2998/4	392.1	357.7	150.5	2012/2	-159.3	-223.3
-364.000	149.7	2993/4	394.4	359.3	149.7	2015/2	-163.0	-226.1
364.000	149.7	3448/4	167.3	132.2	149.7	3945/4	-110.5	-173.6
364.125	149.7	3467/4	157.1	122.0	149.7	3942/4	-108.6	-171.7
364.250	150.5	3471/4	155.0	119.8	149.7	3941/4	-108.0	-171.1
364.494	150.5	3476/4	152.3	117.2	149.7	3940/4	-107.4	-170.5
365.000	149.7	3480/4	150.1	114.7	149.7	3939/4	-106.8	-170.1
366.000	149.7	3487/4	146.3	110.7	149.7	3938/4	-106.2	-169.5
367.000	149.7	3492/4	143.6	108.0	149.0	3937/4	-105.6	-168.9
368.000	149.7	3497/4	140.9	105.3	149.0	3937/4	-105.6	-168.9
369.000	149.7	3500/4	139.3	103.7	149.0	3936/4	-105.0	-168.5
370.000	149.7	3500/4	139.3	103.7	149.0	3937/4	-105.6	-168.9
371.000	149.7	3507/4	135.5	100.4	149.0	3937/4	-105.6	-168.3
378.000	149.7	3519/4	129.0	94.1	149.0	3935/4	-104.4	-166.0
385.000	149.0	3533/4	121.3	85.9	148.2	3935/4	-104.4	-166.6
392.000	149.0	3540/4	117.5	81.2	148.2	3936/4	-105.0	-166.7
420.000	148.2	3566/4	103.2	66.2	149.7	3935/4	-104.4	-166.1
448.000	148.2	3583/4	93.7	60.7	148.2	3936/4	-105.0	-161.6

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-2

AXIAL STRESS	1200 PSI	AXIAL ELASTIC STRAIN	-53.6 MICRO-UNITS
RADIAL STRESS	2400 PSI	RADIAL ELASTIC STRAIN	266.4 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	140.7	3886/4	0.0	0.0	140.7	3885/4	0.0	0.0
0.000	140.7	3974/4	-53.6	.0	140.7	3414/4	266.4	.0
.013	140.7	3911/4	-15.1	39.8	140.7	3400/4	273.8	8.3
.250	134.7	3531/4	204.1	259.0	134.0	3993/4	-65.9	-331.8
.500	140.0	3514/4	213.3	267.6	140.0	3989/4	-63.5	-329.3
1.000	140.0	3497/4	222.6	277.3	140.0	3993/4	-65.9	-329.9
2.125	140.7	3478/4	232.8	292.4	139.2	2000/2	-70.3	-329.8
2.958	140.7	3463/4	240.9	301.0	139.2	2004/2	-75.2	-335.4
4.000	140.0	3468/4	238.2	299.8	139.2	2005/2	-76.5	-334.7
5.000	140.0	3465/4	239.8	302.5	140.0	2006/2	-77.7	-334.6
6.000	140.0	3461/4	242.0	305.3	139.2	2007/2	-79.0	-334.4
6.958	140.0	3457/4	244.1	312.1	139.2	2009/2	-81.5	-333.7
13.979	141.5	3422/4	262.8	335.2	141.5	2014/2	-87.7	-336.3
20.938	140.7	3421/4	263.3	336.7	140.7	2020/2	-95.2	-340.8
28.062	140.0	3414/4	267.0	343.2	140.0	2024/2	-100.2	-342.2
55.938	140.0	3378/4	286.0	375.2	139.2	2038/2	-117.8	-346.2
83.917	135.5	3391/4	279.2	366.2	135.5	2060/2	-145.8	-375.0
111.896	139.2	3356/4	297.5	385.1	138.5	2054/2	-138.1	-365.3
140.021	138.5	3343/4	304.2	390.2	138.5	2060/2	-145.8	-371.1
168.000	138.5	3356/4	297.5	383.4	138.5	2062/2	-148.3	-371.4
196.000	138.5	3344/4	303.7	390.0	137.7	2067/2	-154.7	-377.2
224.000	137.7	3352/4	299.5	385.7	137.0	2071/2	-159.9	-379.9
252.000	136.2	3347/4	302.1	384.8	135.5	2072/2	-161.2	-383.6
280.000	135.5	3340/4	305.8	389.7	135.5	2073/2	-162.4	-387.2
308.000	138.5	3340/4	305.8	389.6	138.5	2075/2	-165.0	-391.1
336.000	139.2	3336/4	307.8	392.3	138.5	2077/2	-167.6	-394.6
-364.000	139.2	3334/4	308.9	391.4	138.5	2080/2	-171.5	-401.7
364.000	139.2	3700/4	109.4	191.9	138.5	2040/2	-120.4	-350.6
364.125	139.2	3717/4	99.6	182.1	138.5	2039/2	-119.1	-349.4
364.275	139.2	3718/4	99.0	181.6	138.5	2039/2	-119.1	-349.4
364.484	139.2	3720/4	97.9	180.4	138.5	2038/2	-117.8	-348.1
365.000	137.7	3722/4	96.7	179.2	137.7	2038/2	-117.8	-348.4
366.000	137.7	3727/4	93.8	176.4	137.7	2037/2	-116.6	-347.1
367.000	137.7	3728/4	93.2	175.8	137.7	2037/2	-116.6	-347.1
368.000	137.7	3731/4	91.5	174.0	137.7	2036/2	-115.3	-345.9
369.000	137.7	3731/4	91.5	174.0	137.7	2035/2	-114.1	-344.6
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	138.5	3734/4	89.8	172.3	138.5	2036/2	-115.3	-347.2
378.000	137.7	3745/4	83.4	165.9	137.7	2036/2	-115.3	-346.5
385.000	137.7	3751/4	79.9	162.4	137.0	2036/2	-115.3	-347.5
392.000	137.7	3755/4	77.6	160.7	137.0	2035/2	-114.1	-347.6
420.000	137.0	3770/4	68.8	151.3	136.2	2035/2	-114.1	-346.0
448.000	137.0	3784/4	60.6	144.4	136.2	2037/2	-116.6	-352.2

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-3

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-85.8 MICRO-UNITS
RADIAL STRESS	1200 PSI	RADIAL ELASTIC STRAIN	160.1 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	139.2	3796/4	0.0	0.0	148.2	3765/4	0.0	0.0
0.000	139.2	3940/4	-86.3	-.5	148.2	3480/4	160.0	-.1
.125	130.2	3978/4	-109.7	-22.9	130.2	3471/4	164.9	4.7
.250	137.0	3971/4	-105.3	-18.6	146.7	3447/4	177.7	17.9
.383	137.0	3967/4	-102.9	-16.7	146.7	3440/4	181.5	21.3
1.000	140.0	3966/4	-102.3	-14.2	148.2	3426/4	188.9	29.5
1.988	137.0	3986/4	-114.6	-22.0	148.2	3417/4	193.7	37.7
3.000	137.7	3990/4	-117.1	-23.3	148.2	3406/4	199.5	43.2
3.979	137.0	2005/2	-129.5	-32.3	146.7	3401/4	202.2	48.2
4.875	137.7	2004/2	-128.2	-28.9	147.5	3391/4	207.4	54.3
5.875	138.5	2005/2	-129.5	-29.0	148.2	3387/4	209.5	57.0
6.833	138.5	2007/2	-131.9	-28.4	148.2	3385/4	210.6	60.1
13.833	139.2	2016/2	-143.2	-29.7	149.0	3374/4	216.3	71.2
20.812	138.5	2023/2	-151.9	-32.9	149.0	3364/4	221.6	78.1
27.937	138.5	2030/2	-160.7	-38.5	148.2	3336/4	236.1	93.8
55.812	137.7	2050/2	-186.0	-47.5	147.5	3328/4	240.2	110.4
83.792	134.0	2071/2	-212.9	-65.9	144.5	3340/4	234.0	114.2
111.771	137.0	2067/2	-207.7	-61.6	146.7	3308/4	250.5	126.9
139.896	137.0	2068/2	-209.0	-60.3	146.7	3311/4	249.0	127.9
168.000	137.0	2071/2	-212.9	-62.1	146.7	3306/4	251.5	133.6
196.000	136.2	2074/2	-216.7	-63.3	146.0	3288/4	260.7	145.8
224.000	135.5	2078/2	-221.9	-69.6	146.0	3273/4	268.4	155.5
253.000	133.2	2079/2	-223.1	-68.6	143.8	0/0	0.0	0.0
280.000	135.5	2077/2	-220.6	-69.3	146.0	0/0	0.0	0.0
308.000	135.5	2071/2	-212.9	-61.0	146.0	0/0	0.0	0.0
336.000	137.0	2064/2	-203.9	-51.5	146.7	0/0	0.0	0.0
-364.000	137.0	2051/2	-187.3	-35.7	146.7	0/0	0.0	0.0
364.000	135.5	3943/4	-88.2	63.5	146.0	0/0	0.0	0.0
364.127	135.5	3945/4	-89.4	62.2	146.0	0/0	0.0	0.0
364.287	135.5	3940/4	-86.3	65.3	146.0	0/0	0.0	0.0
364.494	135.5	3940/4	-86.3	65.3	146.0	0/0	0.0	0.0
365.000	136.2	3938/4	-85.1	66.3	146.0	0/0	0.0	0.0
366.000	136.2	3933/4	-82.1	69.1	146.0	0/0	0.0	0.0
367.000	136.2	3931/4	-80.8	70.3	146.0	0/0	0.0	0.0
368.000	136.2	3930/4	-80.2	70.9	146.0	0/0	0.0	0.0
369.000	136.2	3926/4	-77.8	73.3	146.0	0/0	0.0	0.0
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	136.2	3920/4	-74.2	77.5	146.0	0/0	0.0	0.0
378.000	136.2	3910/4	-68.1	83.8	146.0	0/0	0.0	0.0
385.000	135.5	3900/4	-62.0	89.3	146.0	0/0	0.0	0.0
392.000	135.5	0/0	0.0	0.0	146.0	0/0	0.0	0.0
420.000	135.5	0/0	0.0	0.0	146.0	0/0	0.0	0.0
448.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-12

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	138.5	2011/2	0.0	0.0	138.5	3908/4	0.0	0.0
.221	138.5	2015/2	-5.0	0.0	138.5	3914/4	-3.6	0.0
1.000	138.5	4027/4	-3.1	0.0	138.5	3915/4	-4.2	0.0
1.958	137.0	2019/2	-10.0	0.0	137.0	3921/4	-7.9	0.0
3.125	138.5	2017/2	-7.5	0.0	138.5	3917/4	-5.5	0.0
3.958	137.7	2021/2	-12.5	0.0	137.0	3926/4	-10.9	0.0
5.000	137.7	2021/2	-12.5	0.0	137.7	3923/4	-9.1	0.0
6.000	138.5	2021/2	-12.5	0.0	138.5	3921/4	-7.9	0.0
6.958	138.5	2021/2	-12.5	0.0	138.5	3923/4	-9.1	0.0
13.979	139.2	2025/2	-17.5	0.0	139.2	3927/4	-11.5	0.0
20.938	138.5	2031/2	-25.1	0.0	137.7	3934/4	-15.8	0.0
28.104	137.7	2033/2	-27.6	0.0	137.7	3933/4	-15.2	0.0
55.938	136.2	2037/2	-32.6	0.0	137.0	3922/4	-8.5	0.0
83.917	133.2	2047/2	-45.3	0.0	134.0	3933/4	-15.2	0.0
111.896	135.5	2035/2	-30.1	0.0	137.0	3906/4	1.2	0.0
140.021	135.5	2033/2	-27.6	0.0	136.2	3880/4	16.9	0.0
167.937	135.5	2030/2	-23.8	0.0	135.5	0/0	0.0	0.0
196.000	134.7	2025/2	-17.5	0.0	135.5	0/0	0.0	0.0
223.958	134.0	2023/2	-15.0	0.0	134.7	0/0	0.0	0.0
253.000	131.7	2019/2	-10.0	0.0	132.5	0/0	0.0	0.0
280.000	134.0	2014/2	-3.7	0.0	134.7	0/0	0.0	0.0
308.000	134.7	2009/2	2.5	0.0	136.2	0/0	0.0	0.0
336.000	134.7	2003/2	10.0	0.0	136.2	0/0	0.0	0.0
-364.000	134.0	3990/4	19.9	0.0	136.2	0/0	0.0	0.0
364.000	134.0	3990/4	19.9	0.0	136.2	0/0	0.0	0.0
365.000	134.0	3988/4	21.1	0.0	136.2	0/0	0.0	0.0
366.000	134.0	3987/4	21.7	0.0	136.2	0/0	0.0	0.0
367.000	134.0	3985/4	23.0	0.0	136.2	0/0	0.0	0.0
368.000	134.0	3983/4	24.2	0.0	136.2	0/0	0.0	0.0
369.000	134.0	3981/4	25.4	0.0	136.2	0/0	0.0	0.0
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	134.0	3979/4	26.7	0.0	136.2	0/0	0.0	0.0
378.000	134.0	3973/4	30.4	0.0	136.2	0/0	0.0	0.0
385.000	133.2	3963/4	36.5	0.0	135.5	0/0	0.0	0.0
392.000	133.2	3949/4	45.1	0.0	135.5	0/0	0.0	0.0
420.000	134.0	3900/4	74.9	0.0	136.2	0/0	0.0	0.0
448.000	134.0	3849/4	105.5	0.0	0.0	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-15

AXIAL STRESS	1200 PSI	AXIAL ELASTIC STRAIN	202.6 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-52.5 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

TIME (DAYS)	AXIAL GAGE TEMP (F)	AXIAL GAGE READ/DIV (FREQ)	AXIAL GAGE TOT STRAIN (MIC-UNITS)	AXIAL GAGE CREEP* (MIC-UNITS)	RADIAL GAGE TEMP (F)	RADIAL GAGE READ/DIV (FREQ)	RADIAL GAGE TOT STRAIN (MIC-UNITS)	RADIAL GAGE CREEP* (MIC-UNITS)
0.000	138.5	3910/4	0.0	0.0	146.0	3951/4	0.0	0.0
0.000	138.5	3560/4	202.6	.0	146.0	2018/2	-52.6	-.1
.146	138.5	3531/4	218.6	17.2	146.0	2024/2	-60.1	-6.7
.292	138.5	3530/4	219.1	17.8	146.0	2024/2	-60.1	-7.0
.500	139.2	3516/4	226.8	24.8	145.2	2023/2	-58.9	-5.7
1.000	138.5	3500/4	235.5	34.0	146.0	2025/2	-61.4	-6.4
2.000	137.7	3499/4	236.0	39.3	146.0	2031/2	-68.9	-9.5
3.146	138.5	3475/4	249.0	52.8	146.7	2031/2	-68.9	-10.1
4.000	137.0	3471/4	251.1	56.4	146.0	2036/2	-75.2	-14.5
5.000	137.7	3462/4	256.0	62.4	146.0	2037/2	-76.5	-14.4
6.042	137.7	3457/4	258.6	65.7	146.0	2037/2	-76.5	-13.0
7.000	138.5	3453/4	260.8	72.5	146.0	2038/2	-77.8	-11.0
14.000	139.2	3418/4	279.4	95.6	147.5	2043/2	-84.1	-13.7
20.958	138.5	3420/4	278.4	95.5	147.5	2047/2	-89.2	-15.8
28.104	137.7	3405/4	286.3	106.2	147.5	2050/2	-93.0	-16.0
55.958	137.7	3357/4	311.4	144.4	146.0	2058/2	-103.2	-12.6
83.937	134.0	3363/4	308.3	139.1	143.0	2073/2	-122.4	-32.6
111.917	138.5	3320/4	330.6	162.0	146.7	2062/2	-108.3	-16.5
139.971	138.5	3320/4	330.6	160.3	146.7	2060/2	-105.7	-12.0
168.000	137.7	3312/4	334.7	164.4	146.0	2060/2	-105.7	-9.7
196.000	137.0	3298/4	341.9	172.0	145.2	2060/2	-105.7	-9.1
224.000	136.2	3286/4	348.0	177.9	146.0	2057/2	-101.9	-2.9
253.000	136.2	3274/4	354.1	180.5	143.8	0/0	0.0	0.0
280.000	103.2	3270/4	356.1	183.8	144.5	0/0	0.0	0.0
308.000	80.7	3261/4	360.7	188.3	144.5	0/0	0.0	0.0
336.000	68.8	3252/4	365.2	193.5	144.5	0/0	0.0	0.0
-364.000	0.0	3245/4	368.8	195.1	143.0	0/0	0.0	0.0
364.000	93.5	3640/4	158.0	-15.7	143.0	0/0	0.0	0.0
364.130	93.5	3656/4	148.9	-24.7	143.0	0/0	0.0	0.0
364.290	78.5	3658/4	147.8	-25.9	143.0	0/0	0.0	0.0
364.500	71.0	3662/4	145.5	-28.1	143.0	0/0	0.0	0.0
365.000	71.0	3666/4	143.3	-30.4	143.0	0/0	0.0	0.0
366.000	44.7	3672/4	139.8	-33.8	143.0	0/0	0.0	0.0
367.000	0.0	3675/4	138.1	-35.5	143.0	0/0	0.0	0.0
368.000	0.0	3678/4	136.4	-37.2	143.0	0/0	0.0	0.0
369.000	48.5	3679/4	135.9	-37.8	143.0	0/0	0.0	0.0
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	38.0	3683/4	133.6	-40.1	143.8	0/0	0.0	0.0
378.000	48.5	3696/4	126.1	-47.5	142.2	0/0	0.0	0.0
385.000	33.5	3705/4	121.0	-52.7	142.2	0/0	0.0	0.0
392.000	41.0	3709/4	118.7	-54.4	145.2	0/0	0.0	0.0
420.000	0.0	3730/4	106.6	-67.1	140.7	0/0	0.0	0.0
448.000	0.0	3740/4	100.8	-71.6	0.0	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-20

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	63.5	2042/2	0.0	0.0	69.5	2006/2	0.0	0.0
0.000	63.5	2042/2	0.0	0.0	69.5	2006/2	0.0	0.0
.221	63.5	2042/2	0.0	0.0	70.2	2006/2	0.0	0.0
1.000	63.5	2041/2	1.3	0.0	70.2	2007/2	-1.2	0.0
1.958	63.5	2041/2	1.3	0.0	70.2	2006/2	0.0	0.0
3.167	64.2	2040/2	2.5	0.0	71.0	2004/2	2.5	0.0
3.979	63.5	2040/2	2.5	0.0	71.0	2004/2	2.5	0.0
5.000	63.5	2041/2	1.3	0.0	71.0	2005/2	1.2	0.0
6.000	62.7	2042/2	0.0	0.0	69.5	2007/2	-1.2	0.0
6.958	62.7	2043/2	-1.3	0.0	69.5	2007/2	-1.2	0.0
13.979	62.7	2042/2	0.0	0.0	70.2	2006/2	0.0	0.0
20.979	63.5	2041/2	1.3	0.0	71.0	2006/2	0.0	0.0
28.104	65.0	2040/2	2.5	0.0	72.5	2003/2	3.7	0.0
55.938	65.7	2039/2	3.8	0.0	71.7	2003/2	3.7	0.0
83.917	65.0	2039/2	3.8	0.0	71.7	2002/2	5.0	0.0
111.896	64.2	2040/2	2.5	0.0	71.7	2002/2	5.0	0.0
140.029	64.2	2040/2	2.5	0.0	71.0	2003/2	3.7	0.0
167.937	65.7	2039/2	3.8	0.0	71.0	4002/4	6.2	0.0
196.000	63.5	2039/2	3.8	0.0	71.0	4001/4	6.8	0.0
224.000	64.2	2037/2	6.3	0.0	71.0	3998/4	8.7	0.0
253.000	65.7	2034/2	10.1	0.0	72.5	3992/4	12.4	0.0
280.000	65.0	2034/2	10.1	0.0	71.0	3993/4	11.8	0.0
308.000	65.0	2035/2	8.8	0.0	71.7	3993/4	11.8	0.0
336.000	66.5	2031/2	13.9	0.0	73.2	3984/4	17.4	0.0
-364.000	65.0	2031/2	13.9	0.0	71.7	3984/4	17.4	0.0
364.000	65.0	2031/2	13.9	0.0	71.7	3984/4	17.4	0.0
365.000	65.0	2031/2	13.9	0.0	71.7	3984/4	17.4	0.0
366.000	65.0	2031/2	13.9	0.0	71.7	3983/4	18.0	0.0
367.000	65.0	2031/2	13.9	0.0	71.7	3982/4	18.6	0.0
368.000	65.0	2030/2	15.1	0.0	71.7	3982/4	18.6	0.0
369.000	65.0	2030/2	15.1	0.0	71.7	3982/4	18.6	0.0
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	65.0	2030/2	15.1	0.0	71.7	3981/4	19.2	0.0
378.000	65.7	2030/2	15.1	0.0	72.5	3981/4	19.2	0.0
385.000	65.0	2030/2	15.1	0.0	71.7	3982/4	18.6	0.0
392.000	64.2	2031/2	13.9	0.0	71.7	3984/4	17.4	0.0
420.000	65.0	2030/2	15.1	0.0	72.5	3982/4	18.6	0.0
448.000	65.0	2028/2	17.7	0.0	72.5	3980/4	19.8	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-22

AXIAL STRESS	1200 PSI	AXIAL ELASTIC STRAIN	254.9 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-53.5 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	148.2	3876/4	0.0	0.0	146.7	3759/4	0.0	0.0
0.000	148.2	3425/4	255.2	.3	146.7	3850/4	-53.7	-.2
.146	147.5	3405/4	265.8	11.8	146.0	3858/4	-58.4	-4.9
.292	142.2	3403/4	266.8	12.8	140.7	3858/4	-58.4	-4.6
.500	147.5	3395/4	271.0	16.5	146.0	3854/4	-56.1	-2.6
1.000	147.5	3383/4	277.3	24.6	146.7	3858/4	-58.4	-4.2
2.000	147.5	3380/4	278.9	30.8	146.0	3868/4	-64.4	-6.8
3.154	148.2	3367/4	285.7	38.7	146.7	3867/4	-63.8	-6.5
4.000	146.7	3360/4	289.4	45.8	145.2	3877/4	-69.8	-10.1
5.000	147.5	3351/4	294.0	52.6	146.0	3879/4	-71.0	-10.5
6.000	146.7	3348/4	295.6	55.3	146.0	3879/4	-71.0	-9.9
7.000	147.5	3348/4	295.6	58.4	146.0	3880/4	-71.6	-8.4
14.021	149.7	3327/4	306.5	79.2	147.5	3886/4	-75.2	-6.7
20.979	148.2	3327/4	306.5	84.8	146.7	3896/4	-81.3	-11.1
28.125	148.2	3323/4	308.5	90.0	147.5	3902/4	-84.9	-13.6
55.967	148.2	3288/4	326.5	124.3	146.7	3916/4	-93.4	-9.6
83.946	143.0	3300/4	320.3	126.5	143.0	3954/4	-116.6	-22.7
111.929	147.5	3251/4	345.2	150.6	146.0	3932/4	-103.1	-13.1
140.062	146.0	3251/4	345.2	153.2	146.0	3929/4	-101.3	-8.7
168.000	146.0	3232/4	354.8	164.8	146.0	3937/4	-106.2	-10.4
196.000	145.2	3214/4	363.8	176.4	144.5	3940/4	-108.0	-9.2
224.000	145.2	3211/4	365.2	176.8	144.5	3942/4	-109.2	-8.5
253.000	143.0	3203/4	369.2	183.1	143.0	3941/4	-108.6	-3.1
280.000	145.2	3191/4	375.2	185.7	145.2	3940/4	-108.0	-1.4
308.000	146.0	3180/4	380.6	191.8	146.0	3938/4	-106.8	-1.4
336.000	146.7	3167/4	387.0	198.6	145.2	3938/4	-106.8	-.0
-364.000	145.2	3158/4	391.4	202.3	144.5	3937/4	-106.2	1.6
364.000	145.2	3604/4	157.7	-31.4	144.5	3859/4	-59.0	48.7
364.130	145.2	3620/4	148.7	-40.4	144.5	3863/4	-61.4	46.3
364.290	145.2	3620/4	148.7	-40.4	144.5	3862/4	-60.8	46.9
364.500	145.2	3622/4	147.6	-41.5	144.5	3861/4	-60.2	47.5
365.000	145.2	3625/4	145.9	-43.4	144.5	3860/4	-59.6	47.9
366.000	145.2	3631/4	142.5	-47.1	144.5	3860/4	-59.6	47.9
367.000	144.5	3635/4	140.3	-49.3	143.8	3861/4	-60.2	47.3
368.000	145.2	3636/4	139.7	-49.9	143.8	3859/4	-59.0	48.5
369.000	145.2	3637/4	139.2	-50.4	144.5	3858/4	-58.4	48.9
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	145.2	3640/4	137.5	-51.7	144.5	3857/4	-57.8	50.3
378.000	144.5	3653/4	130.1	-58.8	143.8	3861/4	-60.2	48.9
385.000	144.5	3660/4	126.2	-63.2	143.8	3860/4	-59.6	48.9
392.000	144.5	3663/4	124.5	-65.8	144.5	3857/4	-57.8	51.3
420.000	143.0	3672/4	119.3	-71.6	143.0	3852/4	-54.9	54.2
448.000	143.0	3670/4	120.5	-66.5	143.0	3853/4	-55.5	58.7

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-23

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	149.7	3714/4	0.0	0.0	149.7	3799/4	0.0	0.0
0.000	149.7	3714/4	0.0	0.0	149.7	3799/4	0.0	0.0
.042	149.0	3715/4	-.6	0.0	150.5	3798/4	.6	0.0
.821	149.0	3713/4	.6	0.0	150.5	3797/4	1.2	0.0
1.821	149.7	3725/4	-6.3	0.0	149.7	3805/4	-3.5	0.0
2.946	149.7	3725/4	-6.3	0.0	150.5	3800/4	-.6	0.0
3.804	148.2	3738/4	-13.9	0.0	149.7	3810/4	-6.5	0.0
4.825	149.0	3737/4	-13.3	0.0	150.5	3808/4	-5.3	0.0
5.825	149.0	3738/4	-13.9	0.0	150.5	3807/4	-4.7	0.0
6.825	149.7	3740/4	-15.0	0.0	151.2	3809/4	-5.9	0.0
13.846	149.7	3761/4	-27.2	0.0	150.5	3818/4	-11.2	0.0
20.804	148.2	3777/4	-36.6	0.0	149.7	3826/4	-16.0	0.0
27.917	149.0	3780/4	-38.3	0.0	150.5	3827/4	-16.5	0.0
55.763	148.2	3802/4	-51.3	0.0	149.7	3840/4	-24.3	0.0
82.917	144.5	3837/4	-72.0	0.0	146.7	3873/4	-44.0	0.0
111.721	146.0	3829/4	-67.2	0.0	148.2	3859/4	-35.6	0.0
139.867	146.0	3834/4	-70.2	0.0	147.5	3868/4	-41.0	0.0
167.762	146.0	3839/4	-73.2	0.0	147.5	3874/4	-44.6	0.0
196.000	145.2	3842/4	-75.0	0.0	146.7	3879/4	-47.6	0.0
224.000	145.2	3847/4	-77.9	0.0	146.7	3884/4	-50.6	0.0
253.000	142.2	3848/4	-78.5	0.0	144.5	3889/4	-53.6	0.0
280.000	145.2	3849/4	-79.1	0.0	146.7	3893/4	-56.0	0.0
308.000	145.2	3849/4	-79.1	0.0	146.7	3897/4	-58.5	0.0
336.000	145.2	3850/4	-79.7	0.0	147.5	3900/4	-60.3	0.0
-364.000	144.5	3847/4	-77.9	0.0	146.7	3902/4	-61.5	0.0
364.000	144.5	3847/4	-77.9	0.0	146.7	3902/4	-61.5	0.0
365.000	145.2	3847/4	-77.9	0.0	146.7	3902/4	-61.5	0.0
366.000	145.2	3847/4	-77.9	0.0	146.7	3902/4	-61.5	0.0
367.000	145.2	3847/4	-77.9	0.0	146.7	3902/4	-61.5	0.0
368.000	145.2	3847/4	-77.9	0.0	146.7	3902/4	-61.5	0.0
369.000	145.2	3847/4	-77.9	0.0	146.7	3902/4	-61.5	0.0
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	145.2	3847/4	-77.9	0.0	146.7	3903/4	-62.1	0.0
378.000	144.5	3850/4	-79.7	0.0	146.0	3906/4	-63.9	0.0
385.000	144.5	3851/4	-80.3	0.0	146.0	3908/4	-65.1	0.0
392.000	144.5	3850/4	-79.7	0.0	146.0	3908/4	-65.1	0.0
420.000	143.8	3845/4	-76.7	0.0	145.2	3907/4	-64.5	0.0
448.000	143.8	3847/4	-77.9	0.0	146.0	3913/4	-68.1	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-26

AXIAL STRESS	3600 PSI	AXIAL ELASTIC STRAIN	472.5 MICRO-UNITS
RADIAL STRESS	1200 PSI	RADIAL ELASTIC STRAIN	-11.6 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	65.7	2050/2	0.0	0.0	74.7	2037/2	0.0	0.0
0.000	65.7	3273/4	472.6	.0	74.7	4092/4	-11.4	.2
.167	66.5	3196/4	511.2	38.6	74.7	4088/4	10.1	21.3
.250	67.2	3162/4	527.9	55.4	74.7	2029/2	10.1	21.5
.500	67.2	3136/4	540.6	67.5	74.7	2028/2	11.3	22.5
1.042	66.5	3119/4	548.8	75.4	74.7	2028/2	11.3	22.4
2.000	67.2	3090/4	562.8	89.1	74.7	2028/2	11.3	22.0
3.167	65.7	3058/4	578.0	104.4	74.7	2029/2	10.1	20.2
4.000	65.0	3052/4	580.9	107.2	74.0	2028/2	11.3	21.8
5.000	65.0	3039/4	587.0	113.3	74.0	2028/2	11.3	21.8
6.042	64.2	3034/4	589.4	116.2	72.5	2032/2	6.3	17.5
7.000	64.2	3020/4	595.9	123.5	73.2	2033/2	5.0	16.0
14.021	65.7	2969/4	619.6	147.8	74.0	2031/2	7.6	18.4
20.979	65.0	2935/4	635.2	162.6	74.0	2030/2	8.8	20.0
28.104	65.7	2867/4	665.7	193.4	75.5	2028/2	11.3	22.0
55.983	65.7	2780/4	703.8	230.7	75.5	2025/2	15.1	26.1
83.962	66.5	2710/4	733.6	260.5	75.5	2023/2	17.6	28.2
111.942	74.7	2654/4	756.9	284.2	66.5	2023/2	17.6	28.8
140.087	65.7	2616/4	772.4	299.1	74.7	2028/2	11.3	21.9
168.000	66.5	2592/4	782.1	309.1	75.5	2022/2	18.9	29.0
196.000	65.7	2573/4	789.7	315.1	74.0	2020/2	21.4	30.9
224.000	65.7	2510/4	814.5	338.2	74.7	2023/2	17.6	25.1
253.000	67.2	2469/4	830.3	351.8	76.3	2019/2	22.6	28.7
280.000	66.5	2465/4	831.9	352.3	75.5	2020/2	21.4	26.0
308.000	66.5	2440/4	841.4	359.9	75.5	2021/2	20.1	22.3
336.000	68.0	2415/4	850.8	367.5	77.0	2015/2	27.6	28.1
-364.000	66.5	2398/4	857.1	372.7	74.7	2016/2	26.4	25.7
364.000	66.5	3484/4	362.1	-122.3	74.7	2017/2	25.1	24.5
364.130	66.5	3533/4	335.4	-149.0	74.7	2014/2	28.9	28.2
364.294	66.5	3535/4	334.3	-150.1	74.7	2013/2	30.1	29.5
364.500	66.5	3540/4	331.6	-152.8	74.7	2013/2	30.1	29.5
365.000	67.2	3543/4	329.9	-154.5	75.5	2012/2	31.4	30.5
366.000	67.2	3552/4	325.0	-159.7	75.5	2011/2	32.6	31.6
367.000	65.7	3559/4	321.1	-163.4	74.0	2012/2	31.4	30.3
368.000	65.7	3559/4	321.1	-163.7	74.0	2011/2	32.6	31.8
369.000	66.5	3563/4	318.9	-165.5	74.7	2009/2	35.1	34.7
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	66.5	3569/4	315.6	-169.2	74.7	2010/2	33.9	32.9
378.000	66.5	3585/4	306.7	-178.6	75.5	2010/2	33.9	32.3
385.000	66.5	3598/4	299.5	-186.9	75.5	2011/2	32.6	30.0
392.000	65.7	3610/4	292.8	-193.2	74.7	2012/2	31.4	29.2
420.000	64.2	3625/4	284.4	-203.1	72.5	2011/2	32.6	28.9
448.000	65.7	3639/4	276.5	-211.5	73.2	2010/2	33.9	30.3

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-31

AXIAL STRESS 3600 PSI
RADIAL STRESS 3600 PSI
TEST TEMPERATURE 75 F

AXIAL ELASTIC STRAIN 286.4 MICRO-UNITS
RADIAL ELASTIC STRAIN 342.2 MICRO-UNITS
TEST MOISTURE AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	75.5	2052/2	0.0	0.0	74.0	2033/2	0.0	0.0
0.000	75.5	3626/4	286.4	-.0	74.0	3480/4	342.7	.5
.125	75.5	3531/4	339.1	52.7	74.0	3375/4	398.5	55.9
.250	74.7	3508/4	351.6	65.2	74.0	3352/4	410.5	68.1
.375	74.7	3500/4	355.9	69.0	73.2	3340/4	416.7	74.0
1.000	75.5	3472/4	371.1	83.8	73.2	3311/4	431.6	88.9
2.000	74.7	3448/4	383.9	96.4	73.2	3293/4	440.9	97.7
3.000	75.5	3420/4	398.8	111.4	73.2	3269/4	453.1	109.4
4.000	75.5	3411/4	403.6	116.1	73.2	3250/4	462.7	119.4
4.875	75.5	3410/4	404.1	116.6	72.5	3228/4	473.7	130.4
5.875	73.2	3410/4	404.1	117.2	71.7	3221/4	477.2	134.6
6.833	74.7	3395/4	412.1	125.8	71.7	3221/4	477.2	134.4
13.833	75.5	3338/4	441.8	156.2	73.2	3186/4	494.6	151.6
20.812	75.5	3325/4	448.5	162.1	73.2	3154/4	510.3	167.7
27.967	77.0	3290/4	466.5	180.3	74.0	3122/4	525.9	182.8
55.817	77.0	3252/4	485.7	198.8	74.0	3029/4	570.2	227.4
83.796	77.0	3207/4	508.2	221.3	74.0	2976/4	594.9	251.7
111.942	76.3	3164/4	529.5	243.0	74.0	2948/4	607.7	265.2
139.921	76.3	3154/4	534.4	247.3	73.2	2912/4	624.1	280.8
168.000	77.7	3127/4	547.5	260.7	74.7	2879/4	638.9	295.2
196.000	75.5	3117/4	552.4	263.9	73.2	2877/4	639.8	295.6
224.000	76.3	3078/4	571.1	280.9	73.2	2853/4	650.4	304.2
253.000	77.7	3068/4	575.8	283.5	74.7	2782/4	681.4	333.7
280.000	76.3	3054/4	582.5	289.1	74.0	2799/4	674.1	324.9
308.000	76.3	3044/4	587.2	291.9	74.0	2774/4	684.9	333.3
336.000	78.5	3025/4	596.1	299.1	75.5	2744/4	697.7	344.4
-364.000	77.0	3021/4	598.0	299.8	74.0	2733/4	702.4	348.0
364.000	77.0	3561/4	322.6	24.4	74.0	3410/4	380.1	25.6
364.130	77.0	3595/4	303.7	5.5	74.0	3450/4	358.8	4.4
364.294	77.0	3590/4	306.5	8.3	74.0	3453/4	357.2	2.8
364.500	77.0	3588/4	307.6	9.4	74.0	3455/4	356.1	1.7
365.000	77.0	3583/4	310.4	12.1	74.0	3455/4	356.1	1.5
366.000	77.0	3581/4	311.5	13.0	74.0	3459/4	354.0	-.8
367.000	76.3	3584/4	309.8	11.5	73.2	3462/4	352.4	-2.5
368.000	76.3	3583/4	310.4	11.8	73.2	3461/4	352.9	-1.7
369.000	77.0	3582/4	310.9	12.7	74.0	3461/4	352.9	-1.3
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	77.0	3584/4	309.8	11.2	74.0	3462/4	352.4	-2.3
378.000	77.0	3603/4	299.2	.1	74.0	3480/4	342.7	-12.7
385.000	75.5	3611/4	294.8	-5.5	73.2	3490/4	337.3	-19.1
392.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
420.000	75.5	3623/4	288.0	-13.2	73.2	3504/4	329.7	-27.8
448.000	75.5	3627/4	285.8	-16.0	74.0	3510/4	326.4	-30.9

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-33

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	71.7	3868/4	0.0	0.0	63.5	3839/4	0.0	0.0
0.000	71.7	3868/4	0.0	0.0	63.5	3839/4	0.0	0.0
.125	71.0	3868/4	0.0	0.0	63.5	3840/4	-.6	0.0
.833	71.0	3867/4	.6	0.0	63.5	3836/4	1.8	0.0
1.792	71.0	3868/4	0.0	0.0	63.5	3835/4	2.4	0.0
2.958	71.7	3867/4	.6	0.0	64.2	3831/4	4.8	0.0
3.804	71.0	3868/4	0.0	0.0	63.5	3833/4	3.6	0.0
4.804	71.0	3872/4	-2.4	0.0	64.2	3830/4	5.3	0.0
5.846	69.5	3877/4	-5.4	0.0	62.7	3835/4	2.4	0.0
6.783	70.2	3878/4	-6.0	0.0	63.5	3833/4	3.6	0.0
13.783	71.7	3880/4	-7.2	0.0	64.2	3824/4	8.9	0.0
20.783	71.7	3879/4	-6.6	0.0	64.2	3822/4	10.1	0.0
27.908	74.0	3881/4	-7.8	0.0	65.7	3810/4	17.2	0.0
55.775	73.2	3890/4	-13.2	0.0	66.5	3800/4	23.1	0.0
83.733	73.2	3897/4	-17.5	0.0	65.7	3799/4	23.7	0.0
111.713	73.2	3908/4	-24.1	0.0	65.7	3800/4	23.1	0.0
139.858	71.7	3915/4	-28.3	0.0	65.0	3803/4	21.3	0.0
167.762	74.0	3915/4	-28.3	0.0	66.5	3803/4	21.3	0.0
196.000	74.0	4007/4	-84.8	0.0	75.5	0/0	0.0	0.0
224.000	74.7	3923/4	-33.2	0.0	75.5	0/0	0.0	0.0
253.000	73.2	3918/4	-30.2	0.0	74.0	0/0	0.0	0.0
280.000	73.2	3926/4	-35.0	0.0	65.7	3800/4	23.1	0.0
308.000	74.0	3930/4	-37.5	0.0	65.7	3800/4	23.1	0.0
336.000	74.7	3927/4	-35.6	0.0	67.2	0/0	0.0	0.0
-364.000	73.2	3927/4	-35.6	0.0	65.7	0/0	0.0	0.0
364.000	73.2	3927/4	-35.6	0.0	65.7	0/0	0.0	0.0
365.000	73.2	3927/4	-35.6	0.0	65.7	0/0	0.0	0.0
366.000	73.2	3927/4	-35.6	0.0	65.7	0/0	0.0	0.0
367.000	73.2	3928/4	-36.3	0.0	66.5	0/0	0.0	0.0
368.000	73.2	3928/4	-36.3	0.0	65.7	0/0	0.0	0.0
369.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
370.000	73.2	3928/4	-36.3	0.0	66.5	0/0	0.0	0.0
371.000	73.2	3931/4	-38.1	0.0	65.7	0/0	0.0	0.0
378.000	73.2	3934/4	-39.9	0.0	65.7	0/0	0.0	0.0
385.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
392.000	72.5	3934/4	-39.9	0.0	65.0	0/0	0.0	0.0
420.000	71.7	3936/4	-41.1	0.0	64.2	0/0	0.0	0.0
448.000	71.7	3938/4	-42.3	0.0	64.2	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-40

AXIAL STRESS	3600 PSI	AXIAL ELASTIC STRAIN	298.4 MICRO-UNITS
RADIAL STRESS	3600 PSI	RADIAL ELASTIC STRAIN	357.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.7	3828/4	0.0	0.0	65.0	3927/4	0.0	0.0
0.000	74.7	3284/4	299.8	1.4	65.0	3283/4	359.9	2.9
.125	74.7	3175/4	354.4	56.0	65.0	3125/4	438.3	81.4
.250	74.7	3142/4	370.6	72.6	66.5	3082/4	459.0	102.0
.375	74.7	3126/4	378.3	79.8	65.0	3057/4	470.9	113.3
1.000	74.7	3073/4	403.8	105.2	65.0	2990/4	502.3	144.4
2.000	74.0	3023/4	427.4	129.4	64.2	2930/4	529.8	170.8
3.000	74.7	2974/4	450.2	151.8	65.0	2879/4	552.8	192.3
4.000	74.7	2951/4	460.8	164.1	64.2	2830/4	574.5	214.1
4.896	74.0	2932/4	469.4	173.0	64.2	2778/4	597.1	235.6
5.875	72.5	2922/4	474.0	178.9	62.7	2741/4	612.9	251.9
6.813	73.2	2888/4	489.3	195.3	63.5	2723/4	620.5	259.2
13.812	74.7	2767/4	542.3	249.8	65.0	2516/4	704.6	341.0
20.812	74.7	2688/4	575.7	285.8	65.0	2387/4	753.6	386.9
27.937	74.7	2608/4	608.5	319.5	65.7	2278/4	793.0	423.2
55.821	75.5	2480/4	659.0	375.3	65.7	3983/8	887.8	513.6
83.800	75.5	2388/4	693.7	413.8	66.5	3661/8	935.5	559.5
111.779	75.5	2311/4	721.7	447.2	66.5	3472/8	961.6	586.0
139.917	74.7	2288/4	729.9	457.9	65.0	3276/8	987.2	612.0
168.000	77.0	2250/4	743.3	473.8	66.5	3152/8	1002.7	628.5
196.000	74.7	2233/4	749.2	482.2	65.0	3065/8	1013.1	639.8
224.000	74.7	2170/4	770.7	504.5	65.0	2987/8	1022.3	648.3
253.000	77.0	2156/4	775.4	509.1	65.0	2688/8	1055.2	680.9
280.000	75.5	2131/4	783.7	519.0	66.5	2699/8	1054.0	680.5
308.000	75.5	2117/4	788.3	523.7	66.5	2667/8	1063.5	688.7
336.000	77.0	2094/4	795.8	531.9	68.0	2490/8	1075.0	700.5
-364.000	75.5	2094/4	795.8	532.4	66.5	2442/8	1079.6	704.9
364.000	75.5	2907/4	480.7	217.3	66.5	2533/4	697.9	323.2
364.127	75.5	2949/4	461.7	198.3	66.5	2583/4	678.1	303.4
364.294	75.5	2957/4	458.0	194.6	66.5	2595/4	673.3	298.5
364.500	75.5	2964/4	454.8	191.4	66.5	2603/4	670.0	295.3
365.000	76.3	2971/4	451.6	188.1	67.2	2611/4	666.8	292.1
366.000	76.3	2982/4	446.5	182.9	67.2	2629/4	659.5	284.8
367.000	75.5	2990/4	442.8	179.3	66.5	2640/4	655.0	280.0
368.000	76.3	2993/4	441.4	178.1	66.5	2643/4	653.8	279.3
369.000	76.3	2996/4	440.0	177.1	66.5	2650/4	650.9	276.5
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	76.3	3001/4	437.7	174.8	66.5	2659/4	647.2	272.9
378.000	76.3	3021/4	428.4	165.7	66.5	2688/4	635.2	260.6
385.000	76.3	3035/4	421.8	158.8	66.5	2717/4	627.2	252.0
392.000	74.7	3047/4	416.1	153.7	65.7	2734/4	620.1	245.0
420.000	74.0	0/0	0.0	0.0	66.5	0/0	0.0	0.0
448.000	74.7	3088/4	396.6	135.5	66.5	2780/4	596.2	221.8

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-41

AXIAL STRESS	1200 PSI	AXIAL ELASTIC STRAIN	-23.2 MICRO-UNITS
RADIAL STRESS	2400 PSI	RADIAL ELASTIC STRAIN	382.1 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	141.5	3722/4	0.0	0.0	152.0	3793/4	0.0	0.0
0.000	141.5	3760/4	-22.0	1.2	152.0	3073/4	383.1	1.0
.013	141.5	3721/4	.6	24.8	152.0	3028/4	404.4	22.3
.250	134.7	3705/4	9.8	34.0	138.5	2939/4	445.6	63.8
.500	139.2	3700/4	12.7	36.3	151.2	2889/4	468.1	86.1
1.000	140.7	3686/4	20.7	46.1	152.0	2845/4	487.7	106.4
2.000	138.5	3677/4	25.8	55.8	151.2	2796/4	509.1	131.2
3.125	139.2	3665/4	32.6	63.8	152.0	2735/4	535.3	157.0
3.987	138.5	3677/4	25.8	60.4	150.5	2710/4	545.8	170.0
5.000	140.0	3681/4	23.5	60.2	152.0	2686/4	555.8	180.8
6.021	140.0	3683/4	22.4	60.3	151.2	2663/4	565.4	190.9
6.958	140.0	3687/4	20.1	61.1	152.0	2639/4	575.2	202.9
13.958	142.2	3676/4	26.4	77.3	153.5	2540/4	615.0	247.9
20.917	141.5	3701/4	12.1	68.6	152.7	2470/4	642.2	276.7
28.062	140.7	3701/4	12.1	71.7	152.7	2425/4	659.2	295.0
55.946	139.2	3683/4	22.4	98.4	152.0	2335/4	692.4	340.7
83.912	137.0	3700/4	12.7	97.0	148.2	2295/4	706.8	365.0
111.850	140.7	3677/4	25.8	109.3	152.0	2189/4	743.6	398.1
140.004	140.0	3668/4	30.9	117.1	152.0	2145/4	758.4	415.4
170.000	140.7	3680/4	24.1	112.3	152.0	2095/4	774.8	435.0
196.000	139.2	3660/4	35.5	126.3	151.2	2100/4	773.2	436.4
224.000	138.5	3674/4	27.5	117.3	151.2	2043/4	791.5	456.7
253.000	137.7	3671/4	29.2	121.2	149.7	2021/4	798.4	468.4
280.000	139.2	3668/4	30.9	119.7	151.2	2006/4	803.1	474.1
308.000	139.2	3668/4	30.9	120.2	150.5	3943/8	813.8	483.5
336.000	139.2	3661/4	34.9	124.7	152.0	3905/8	819.5	490.7
-364.000	137.7	3649/4	41.7	130.8	150.5	3853/8	827.3	499.5
364.000	137.7	3644/4	44.5	133.6	150.5	2969/4	459.2	131.3
364.124	137.7	3652/4	40.0	129.1	150.5	2946/4	442.4	114.5
364.274	137.7	3653/4	39.4	128.5	150.5	2953/4	439.2	111.3
364.483	137.7	3652/4	40.0	129.1	150.5	2960/4	436.0	108.1
365.000	137.7	3652/4	40.0	128.8	150.5	2973/4	430.0	101.9
366.000	137.7	3655/4	38.3	126.9	150.5	2988/4	423.0	95.0
367.000	137.7	3654/4	38.9	127.5	150.5	2996/4	419.3	91.3
368.000	137.7	3656/4	37.7	126.3	150.5	3004/4	415.6	87.6
369.000	137.7	3656/4	37.7	126.3	150.5	3009/4	413.3	85.0
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	137.7	3656/4	37.7	126.8	150.5	3020/4	408.1	80.7
378.000	137.7	3659/4	36.0	125.3	150.5	3047/4	395.5	69.0
385.000	137.7	3660/4	35.5	124.3	150.5	3063/4	387.9	60.8
392.000	137.7	3657/4	37.2	125.1	150.5	3074/4	382.6	56.2
420.000	137.7	3650/4	41.1	128.4	150.5	3105/4	367.8	41.3
448.000	137.7	3626/4	54.7	145.8	150.5	3123/4	359.1	37.7

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN D-44

AXIAL STRESS	3600 PSI		AXIAL ELASTIC STRAIN	532.7 MICRO-UNITS
RADIAL STRESS	1200 PSI		RADIAL ELASTIC STRAIN	-15.7 MICRO-UNITS
TEST TEMPERATURE	75 F		TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	70.2	3810/4	0.0	0.0	65.0	3848/4	0.0	0.0
0.000	70.2	2760/4	534.6	1.9	65.0	3874/4	-15.6	.1
.167	70.2	2575/4	611.1	78.4	65.0	3845/4	1.8	17.5
.208	70.2	2568/4	613.9	81.6	65.0	3835/4	7.7	23.4
.500	69.5	2516/4	634.4	101.6	65.0	3828/4	11.9	27.0
1.042	70.2	2454/4	658.3	125.4	64.2	3817/4	18.4	33.2
2.000	70.2	2376/4	687.5	155.2	65.0	3806/4	24.9	38.5
3.167	70.2	2294/4	717.2	184.4	64.2	3795/4	31.4	43.5
4.000	71.0	2264/4	727.8	196.8	63.5	3783/4	38.4	50.8
5.042	71.0	2219/4	743.4	212.7	63.5	3774/4	43.7	54.9
6.067	71.0	2191/4	753.0	223.6	63.5	3776/4	42.5	54.2
7.021	70.2	2156/4	764.8	236.4	63.5	3769/4	46.6	58.0
14.021	70.2	3981/8	817.9	291.2	63.5	3744/4	61.2	70.3
20.979	71.0	3768/8	849.9	325.7	63.5	3724/4	72.8	78.8
28.104	71.7	3440/8	895.7	372.4	65.7	3714/4	78.5	81.4
55.987	71.7	2956/8	955.7	437.7	65.7	3682/4	96.9	95.4
83.967	71.7	2624/8	991.6	477.4	65.7	3668/4	104.8	101.5
111.946	71.7	2587/8	995.3	486.5	65.7	3663/4	107.7	104.7
140.104	71.0	2149/8	1035.5	529.2	65.0	3660/4	109.4	106.8
168.000	72.5	0/0	0.0	0.0	65.7	3656/4	111.7	110.2
196.000	71.0	0/0	0.0	0.0	65.0	3652/4	113.9	113.2
224.000	71.7	0/0	0.0	0.0	65.7	3658/4	110.5	109.2
253.000	73.2	0/0	0.0	0.0	67.2	3651/4	114.5	112.9
280.000	71.7	0/0	0.0	0.0	65.7	3650/4	115.1	114.2
308.000	71.7	0/0	0.0	0.0	65.7	3654/4	112.8	110.7
336.000	73.2	0/0	0.0	0.0	67.2	3647/4	116.8	114.9
-364.000	71.7	0/0	0.0	0.0	65.7	3648/4	116.2	114.1
364.000	71.7	2580/4	609.1	111.4	65.7	3671/4	103.1	101.1
364.134	71.7	2642/4	584.0	86.4	65.7	3673/4	102.0	99.9
364.294	71.7	2656/4	578.3	80.6	65.7	3673/4	102.0	99.9
364.500	71.7	2666/4	574.2	76.5	65.7	3674/4	101.4	99.4
365.000	71.7	2678/4	569.2	71.4	65.7	3674/4	101.4	99.4
366.000	71.7	2697/4	561.3	63.4	65.7	3677/4	99.7	97.7
367.000	71.0	2708/4	556.7	58.9	65.0	3678/4	99.2	96.8
368.000	71.0	2714/4	554.1	56.6	65.0	3680/4	98.0	96.2
369.000	71.0	2720/4	551.6	54.4	65.0	3680/4	98.0	96.3
370.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
371.000	71.7	2729/4	547.8	50.7	65.0	3681/4	97.4	95.8
378.000	71.7	2761/4	534.2	37.3	65.7	3687/4	94.0	92.1
385.000	71.7	2780/4	526.0	28.8	65.7	3691/4	91.7	89.2
392.000	71.7	2799/4	517.8	21.1	65.0	3696/4	88.9	86.4
420.000	71.0	2840/4	499.9	3.5	64.2	3704/4	84.3	81.4
448.000	71.0	2860/4	491.1	-4.3	65.0	3706/4	83.1	81.4

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-1

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-233.4 MICRO-UNITS
RADIAL STRESS	2400 PSI	RADIAL ELASTIC STRAIN	368.7 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	151.2	3879/4	0.0	0.0	151.2	2065/2	0.0	0.0
0.000	151.2	2125/2	-233.7	-.3	151.2	3362/4	370.2	1.5
.125	151.2	2141/2	-254.9	-20.5	151.2	3253/4	426.1	57.4
.250	151.2	2147/2	-262.9	-28.6	151.2	3225/4	440.2	71.7
.500	152.0	2156/2	-274.9	-41.1	152.0	3172/4	466.4	97.7
1.000	152.0	2162/2	-282.9	-47.3	152.0	3140/4	482.1	114.1
2.021	151.2	2172/2	-296.3	-56.2	150.5	3104/4	499.5	134.9
3.188	152.0	2186/2	-315.3	-73.9	151.2	3033/4	533.3	168.4
4.000	152.0	2191/2	-322.0	-77.3	152.0	3018/4	540.3	177.8
5.271	151.2	2196/2	-328.8	-82.0	151.2	2991/4	552.9	191.2
6.042	151.2	2200/2	-334.3	-86.3	150.5	2970/4	562.6	201.5
7.042	150.5	2204/2	-339.7	-88.7	150.5	2956/4	569.0	210.0
14.158	149.7	2222/2	-364.4	-103.4	149.7	2861/4	611.8	258.1
21.042	150.5	2231/2	-376.9	-110.2	150.5	2791/4	642.5	290.4
28.000	149.7	0/0	0.0	0.0	149.7	2791/4	642.5	291.6
56.029	150.5	0/0	0.0	0.0	150.5	2627/4	711.4	373.0
84.071	149.0	0/0	0.0	0.0	149.0	2484/4	779.5	451.1
112.112	148.2	0/0	0.0	0.0	148.2	2151/4	887.6	555.4
140.062	149.0	0/0	0.0	0.0	149.0	0/0	0.0	0.0
365.000	145.2	0/0	0.0	0.0	145.2	0/0	0.0	0.0
366.000	145.2	0/0	0.0	0.0	145.2	0/0	0.0	0.0
367.000	145.2	0/0	0.0	0.0	145.2	0/0	0.0	0.0
368.000	145.2	0/0	0.0	0.0	145.2	0/0	0.0	0.0
369.000	145.2	0/0	0.0	0.0	145.2	0/0	0.0	0.0
370.000	146.0	0/0	0.0	0.0	146.0	0/0	0.0	0.0
371.000	141.5	0/0	0.0	0.0	146.0	0/0	0.0	0.0
378.000	146.7	0/0	0.0	0.0	146.0	0/0	0.0	0.0
385.000	146.7	0/0	0.0	0.0	141.5	0/0	0.0	0.0
392.000	146.7	0/0	0.0	0.0	146.0	0/0	0.0	0.0
420.000	143.8	0/0	0.0	0.0	143.0	0/0	0.0	0.0
448.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-4

AXIAL STRESS 2400 PSI
RADIAL STRESS 600 PSI
TEST TEMPERATURE 150 F

AXIAL ELASTIC STRAIN 377.6 MICRO-UNITS
RADIAL ELASTIC STRAIN -14.6 MICRO-UNITS
TEST MOISTURE AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	152.7	3950/4	0.0	0.0	152.7	2010/2	0.0	0.0
0.000	152.7	3274/4	378.5	.9	152.7	4043/4	-14.4	.3
.125	152.7	3209/4	411.1	34.5	152.7	2016/2	-7.5	7.2
.250	152.7	3192/4	419.6	42.9	152.7	2016/2	-7.5	7.5
.500	152.7	3170/4	430.4	53.2	152.7	2015/2	-6.2	8.4
.979	153.5	3095/4	466.8	91.4	153.5	2017/2	-8.7	6.7
2.000	152.0	3070/4	478.8	107.9	152.0	2019/2	-11.2	7.6
3.188	152.0	3014/4	505.2	135.5	152.0	2020/2	-12.5	6.0
4.000	152.0	2999/4	512.2	145.9	152.0	2022/2	-15.0	5.9
5.208	151.2	2987/4	517.7	153.6	151.2	2022/2	-15.0	6.7
6.083	151.2	2976/4	522.8	159.8	151.2	2023/2	-16.3	6.0
7.042	151.2	2968/4	526.5	166.6	151.2	2023/2	-16.3	8.1
14.158	151.2	2912/4	552.0	202.0	151.2	2023/2	-16.3	13.4
21.050	151.2	2850/4	579.7	235.4	151.2	2020/2	-12.5	18.8
27.971	151.2	2767/4	615.8	274.6	151.2	2018/2	-10.0	22.5
56.029	149.0	2757/4	620.1	295.2	149.0	2027/2	-21.3	23.7
84.071	149.7	2687/4	649.6	333.2	150.5	2018/2	-10.0	45.0
112.112	149.7	2638/4	669.9	352.5	150.5	2014/2	-5.0	46.2
140.096	150.5	2646/4	666.6	351.9	150.5	2010/2	0.0	53.7
168.000	148.2	2629/4	673.5	360.9	148.2	2008/2	2.5	59.4
196.130	147.5	2610/4	681.3	371.2	148.2	2001/2	11.2	71.1
224.000	148.2	2556/4	702.9	391.8	149.0	3989/4	19.2	81.1
252.000	149.7	2556/4	702.9	394.0	147.5	3970/4	31.0	97.6
280.000	146.7	2528/4	713.9	401.8	149.0	0/0	0.0	0.0
308.000	147.5	2514/4	719.4	407.8	149.7	0/0	0.0	0.0
366.000	146.7	2500/4	724.8	413.7	148.2	0/0	0.0	0.0
-364.000	146.7	2491/4	728.3	416.5	147.5	0/0	0.0	0.0
364.000	146.7	3260/4	385.6	73.8	147.5	0/0	0.0	0.0
364.125	146.7	3291/4	369.8	58.0	147.5	0/0	0.0	0.0
364.250	146.7	3296/4	367.3	55.5	147.5	0/0	0.0	0.0
364.500	146.7	3302/4	364.2	52.4	147.5	0/0	0.0	0.0
365.000	146.7	3310/4	360.1	48.0	147.5	0/0	0.0	0.0
366.000	146.7	3322/4	353.9	41.6	147.5	0/0	0.0	0.0
367.000	146.7	3329/4	350.3	38.0	147.5	0/0	0.0	0.0
368.000	146.7	3335/4	347.2	34.9	147.5	0/0	0.0	0.0
369.000	146.0	3342/4	343.6	31.3	148.2	0/0	0.0	0.0
370.000	146.7	3346/4	341.5	29.2	147.5	0/0	0.0	0.0
371.000	146.7	3350/4	339.4	27.6	147.5	0/0	0.0	0.0
378.000	145.2	3371/4	328.5	16.9	147.5	0/0	0.0	0.0
385.000	145.2	3386/4	320.7	8.6	147.5	0/0	0.0	0.0
392.000	145.2	3400/4	313.3	.4	146.7	0/0	0.0	0.0
420.000	145.2	3436/4	294.2	-19.4	146.7	0/0	0.0	0.0
448.000	140.0	3478/4	271.7	-38.0	143.8	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-5

AXIAL STRESS	600 PSI		AXIAL ELASTIC STRAIN	37.7 MICRO-UNITS
RADIAL STRESS	600 PSI		RADIAL ELASTIC STRAIN	56.7 MICRO-UNITS
TEST TEMPERATURE	75 F		TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.0	2188/2	0.0	0.0	74.0	2153/2	0.0	0.0
0.000	74.0	2160/2	37.7	.0	74.0	2110/2	56.8	.1
.125	74.7	2155/2	44.4	6.7	74.7	2104/2	64.7	7.6
.250	75.5	2154/2	45.8	8.0	75.5	2104/2	64.7	7.7
.500	74.7	2154/2	45.8	7.5	74.7	2102/2	67.3	10.1
1.000	74.7	2153/2	47.1	8.4	74.7	2100/2	69.9	12.6
2.000	75.5	2151/2	49.8	10.9	75.5	2100/2	69.9	12.2
3.167	74.7	2150/2	51.1	12.2	75.5	2099/2	71.2	13.0
4.021	74.7	2150/2	51.1	12.2	74.7	2099/2	71.2	13.3
5.208	74.0	2150/2	51.1	12.2	74.0	2099/2	71.2	13.3
6.125	74.0	2150/2	51.1	12.8	74.0	2098/2	72.5	15.3
7.083	74.7	2150/2	51.1	13.5	74.7	2097/2	73.8	16.4
14.196	76.3	2145/2	57.8	20.7	76.3	2092/2	80.3	22.8
21.062	75.5	2144/2	59.1	21.3	75.5	2088/2	85.5	28.3
28.021	74.7	2144/2	59.1	21.6	74.7	2089/2	84.2	26.5
56.042	74.7	2142/2	61.7	23.4	74.7	2087/2	86.8	29.4
84.075	74.7	2136/2	69.7	31.4	74.7	2083/2	91.9	34.1
112.112	75.5	2136/2	69.7	31.9	75.5	2081/2	94.5	37.4
140.083	76.3	2139/2	65.7	27.2	75.5	2082/2	93.2	35.4
168.000	74.7	2138/2	67.1	28.8	74.7	2080/2	95.8	37.6
196.130	74.7	2137/2	68.4	28.6	75.5	2080/2	95.8	37.0
224.000	74.7	2138/2	67.1	25.5	75.5	2077/2	99.7	38.8
252.000	76.3	2137/2	68.4	24.7	76.3	2075/2	102.2	39.9
280.000	75.5	2135/2	71.0	26.3	77.0	2074/2	103.5	39.8
308.000	77.0	2136/2	69.7	23.1	77.0	2074/2	103.5	37.4
336.000	76.3	2135/2	71.0	22.6	76.3	2074/2	103.5	35.6
-364.000	76.3	2133/2	73.7	24.1	76.3	2072/2	106.1	37.1
364.000	76.3	2162/2	35.1	-14.5	76.3	2113/2	52.9	-16.1
364.125	76.3	2163/2	33.7	-15.8	76.3	2114/2	51.6	-17.4
364.254	76.3	2164/2	32.4	-17.2	76.3	2114/2	51.6	-17.4
364.500	76.3	2163/2	33.7	-15.8	76.3	2114/2	51.6	-17.4
365.000	76.3	2164/2	32.4	-17.3	76.3	2115/2	50.3	-18.9
366.000	76.3	2165/2	31.0	-18.8	76.3	2116/2	49.0	-20.3
367.000	76.3	2165/2	31.0	-18.7	76.3	2116/2	49.0	-20.4
368.000	76.3	2165/2	31.0	-18.9	76.3	2117/2	47.7	-21.5
369.000	76.3	2165/2	31.0	-18.6	76.3	2116/2	49.0	-19.8
370.000	76.3	2165/2	31.0	-18.8	76.3	2117/2	47.7	-21.5
371.000	76.3	2165/2	31.0	-18.9	76.3	2116/2	49.0	-20.3
378.000	74.7	2167/2	28.4	-22.2	75.5	2119/2	45.0	-24.9
385.000	74.0	2167/2	28.4	-23.3	74.7	2118/2	46.3	-24.6
392.000	74.7	2167/2	28.4	-22.8	75.5	2119/2	45.0	-25.5
420.000	74.7	2167/2	28.4	-24.3	75.5	2119/2	45.0	-27.0
448.000	77.0	2168/2	27.0	-26.1	77.0	2119/2	45.0	-26.9

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-10

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	151.2	2062/2	0.0	0.0	151.2	3860/4	0.0	0.0
0.000	151.2	2062/2	0.0	0.0	151.2	3860/4	0.0	0.0
.125	151.2	2064/2	-2.6	0.0	151.2	3862/4	-1.2	0.0
.250	151.2	2064/2	-2.6	0.0	151.2	3861/4	-.6	0.0
.500	152.0	2063/2	-1.3	0.0	152.0	3862/4	-1.2	0.0
.979	152.0	2064/2	-2.6	0.0	152.0	3864/4	-2.4	0.0
2.000	150.5	2068/2	-7.7	0.0	150.5	3874/4	-8.4	0.0
3.167	150.5	2070/2	-10.2	0.0	150.5	3874/4	-8.4	0.0
4.021	150.5	2070/2	-10.2	0.0	150.5	3876/4	-9.6	0.0
5.208	150.5	2070/2	-10.2	0.0	150.5	3877/4	-10.2	0.0
6.104	150.5	2071/2	-11.5	0.0	150.5	3879/4	-11.4	0.0
7.083	149.7	2073/2	-14.1	0.0	150.5	3884/4	-14.4	0.0
14.196	149.0	2076/2	-18.0	0.0	149.7	3890/4	-18.0	0.0
21.062	150.5	2077/2	-19.2	0.0	150.5	3892/4	-19.2	0.0
28.021	149.7	2078/2	-20.5	0.0	149.7	3895/4	-21.0	0.0
56.029	146.7	2091/2	-37.3	0.0	147.5	3921/4	-36.8	0.0
84.063	147.5	2087/2	-32.2	0.0	148.2	3902/4	-25.3	0.0
112.104	147.5	2086/2	-30.9	0.0	149.0	3894/4	-20.4	0.0
140.083	147.5	2086/2	-30.9	0.0	147.5	3893/4	-19.8	0.0
168.000	146.0	2086/2	-30.9	0.0	147.5	3892/4	-19.2	0.0
196.130	146.0	2086/2	-30.9	0.0	149.7	3890/4	-18.0	0.0
224.000	146.0	2086/2	-30.9	0.0	147.5	3890/4	-18.0	0.0
252.000	143.0	2094/2	-41.2	0.0	146.0	3906/4	-27.7	0.0
280.000	146.0	2086/2	-30.9	0.0	147.5	3882/4	-13.2	0.0
308.000	146.7	2085/2	-29.6	0.0	148.2	0/0	0.0	0.0
336.000	146.0	2085/2	-29.6	0.0	147.5	0/0	0.0	0.0
-364.000	146.0	2082/2	-25.7	0.0	148.2	0/0	0.0	0.0
364.000	146.0	2082/2	-25.7	0.0	148.2	0/0	0.0	0.0
365.000	146.0	2082/2	-25.7	0.0	147.5	0/0	0.0	0.0
366.000	146.0	2082/2	-25.7	0.0	147.5	0/0	0.0	0.0
367.000	146.0	2082/2	-25.7	0.0	147.5	0/0	0.0	0.0
368.000	146.0	2082/2	-25.7	0.0	147.5	0/0	0.0	0.0
369.000	146.0	2082/2	-25.7	0.0	147.5	0/0	0.0	0.0
370.000	146.0	2082/2	-25.7	0.0	147.5	0/0	0.0	0.0
371.000	146.0	2082/2	-25.7	0.0	147.5	0/0	0.0	0.0
378.000	145.2	2082/2	-25.7	0.0	146.7	0/0	0.0	0.0
385.000	145.2	2081/2	-24.4	0.0	146.7	0/0	0.0	0.0
392.000	144.5	2081/2	-24.4	0.0	147.5	0/0	0.0	0.0
420.000	144.5	2080/2	-23.1	0.0	147.5	0/0	0.0	0.0
448.000	141.5	2087/2	-32.2	0.0	153.5	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-13

AXIAL STRESS	600 PSI		AXIAL ELASTIC STRAIN	32.0 MICRO-UNITS
RADIAL STRESS	600 PSI		RADIAL ELASTIC STRAIN	50.7 MICRO-UNITS
TEST TEMPERATURE	75 F		TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.0	2011/2	0.0	0.0	60.5	3819/4	0.0	0.0
0.000	74.0	3970/4	32.2	.2	60.5	3732/4	50.9	.2
.125	74.7	3960/4	38.4	6.3	61.3	3722/4	56.7	6.1
.250	74.7	3957/4	40.2	8.5	61.3	3722/4	56.7	6.0
.500	75.5	3958/4	39.6	7.4	62.0	3717/4	59.6	8.3
1.000	75.5	3954/4	42.0	9.8	62.0	3711/4	63.0	11.4
2.000	75.5	3951/4	43.9	12.2	62.0	3701/4	68.8	16.0
3.167	75.5	3950/4	44.5	12.4	62.0	3696/4	71.6	17.4
4.021	74.7	3950/4	44.5	14.2	61.3	3695/4	72.2	18.2
5.271	74.0	3950/4	44.5	14.5	60.5	3692/4	73.9	18.8
6.104	74.7	3950/4	44.5	15.8	60.5	3690/4	75.1	20.4
7.083	74.7	3950/4	44.5	16.8	61.3	3685/4	77.9	23.0
14.196	77.0	3939/4	51.2	25.1	62.0	3658/4	93.3	36.0
21.062	75.5	3939/4	51.2	27.7	62.0	3646/4	100.1	39.7
28.021	74.7	3940/4	50.6	27.9	62.0	3640/4	103.5	40.0
56.021	74.0	3939/4	51.2	33.9	61.3	3620/4	114.7	46.9
84.063	75.5	3933/4	54.9	41.3	62.0	3600/4	125.9	56.2
112.104	75.5	3933/4	54.9	46.7	62.0	3593/4	129.8	60.5
140.083	74.7	3943/4	48.8	43.1	61.3	3589/4	132.0	63.1
168.000	74.7	3944/4	48.2	45.0	61.3	3584/4	134.8	67.0
196.130	75.5	3943/4	48.8	48.1	62.0	3583/4	135.4	68.3
224.000	75.5	3945/4	47.5	47.7	62.0	3582/4	135.9	68.2
252.000	75.5	3953/4	42.6	42.7	62.0	3574/4	140.4	72.4
280.000	77.0	3952/4	43.3	44.9	62.7	3573/4	140.9	73.8
308.000	77.0	3957/4	40.2	41.9	63.5	3571/4	142.0	73.6
336.000	76.3	3955/4	41.4	43.9	62.7	3571/4	142.0	73.9
-364.000	77.0	3954/4	42.0	45.0	63.5	3565/4	145.4	76.9
364.000	77.0	2018/2	-8.7	-5.8	63.5	3664/4	89.9	21.5
364.125	77.0	2019/2	-10.0	-7.0	63.5	3667/4	88.2	19.8
364.250	77.0	2019/2	-10.0	-7.0	62.7	3667/4	88.2	19.8
364.500	77.0	2020/2	-11.2	-8.3	63.5	3668/4	87.6	19.2
365.000	77.0	2021/2	-12.5	-9.6	63.5	3673/4	84.8	16.4
366.000	76.3	2022/2	-13.8	-11.0	62.0	3674/4	84.2	15.8
367.000	77.0	2022/2	-13.8	-10.9	62.7	3674/4	84.2	15.6
368.000	76.3	2023/2	-15.0	-11.9	62.0	3675/4	83.6	15.5
369.000	76.3	2022/2	-13.8	-10.3	62.0	3675/4	83.6	15.6
370.000	76.3	2023/2	-15.0	-11.7	62.0	3675/4	83.6	15.5
371.000	76.3	2023/2	-15.0	-11.5	62.0	3676/4	83.1	15.0
378.000	74.7	2026/2	-18.8	-15.0	61.3	3682/4	79.6	11.4
385.000	75.5	2025/2	-17.5	-14.1	62.0	3682/4	79.6	10.7
392.000	75.5	2026/2	-18.8	-14.9	62.0	3683/4	79.1	10.3
420.000	75.5	2027/2	-20.0	-15.8	62.0	3683/4	79.1	9.9
448.000	76.3	2030/2	-23.8	-18.6	63.5	3687/4	76.8	8.7

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-18

AXIAL STRESS	2400 PSI	AXIAL ELASTIC STRAIN	322.3 MICRO-UNITS
RADIAL STRESS	600 PSI	RADIAL ELASTIC STRAIN	-4.2 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	152.7	2044/2	0.0	0.0	140.0	3785/4	0.0	0.0
0.000	152.7	3543/4	322.3	.0	140.0	3792/4	-4.1	.1
.125	152.7	3511/4	339.8	18.8	140.0	3779/4	3.5	8.6
.250	152.0	3501/4	345.2	24.2	140.0	3777/4	4.7	9.4
.500	152.7	3490/4	351.2	29.5	140.7	3776/4	5.3	10.1
.979	153.5	3433/4	381.8	60.6	139.2	3780/4	2.9	9.6
2.000	152.0	3413/4	392.4	76.1	138.5	3789/4	-2.3	8.8
3.146	152.0	3383/4	408.2	92.3	138.5	3790/4	-2.9	7.5
4.250	152.0	3371/4	414.5	100.1	138.5	3797/4	-7.1	5.3
5.250	151.2	3369/4	415.5	102.2	138.5	3794/4	-5.3	8.5
6.083	151.2	3356/4	422.3	109.6	138.5	3797/4	-7.1	8.1
7.042	150.5	3351/4	424.9	116.9	138.5	3802/4	-10.0	8.4
14.167	151.2	3310/4	446.1	142.5	138.5	3799/4	-8.2	13.8
21.062	151.2	3257/4	473.0	170.5	138.5	3795/4	-5.9	19.1
28.021	150.5	3268/4	467.5	167.7	138.5	3798/4	-7.6	21.0
56.021	148.2	3159/4	521.8	235.0	135.5	3825/4	-23.6	18.6
84.075	149.0	3122/4	539.8	250.9	136.2	3813/4	-16.5	24.9
112.104	149.0	3078/4	560.9	272.6	137.0	3813/4	-16.5	26.9
140.083	147.5	3063/4	568.1	278.1	136.2	3814/4	-17.1	28.3
168.000	146.7	3021/4	587.9	297.9	134.7	3813/4	-16.5	31.1
196.130	146.7	2944/4	623.5	333.8	134.7	3804/4	-11.2	37.0
224.000	146.7	0/0	0.0	0.0	134.7	3791/4	-3.5	47.1
252.000	144.5	0/0	0.0	0.0	132.5	3779/4	3.5	51.7
280.000	146.7	0/0	0.0	0.0	134.7	3687/4	56.7	102.6
308.000	148.2	0/0	0.0	0.0	136.2	0/0	0.0	0.0
336.000	146.7	0/0	0.0	0.0	139.2	0/0	0.0	0.0
-364.000	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
364.000	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
364.125	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
364.250	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
364.500	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
365.000	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
366.000	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
367.000	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
368.000	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
369.000	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
370.000	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
371.000	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0
371.000	146.7	0/0	0.0	0.0	134.7	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-23

AXIAL STRESS	-0 PSI		AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI		RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F		TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	73.2	2054/2	0.0	0.0	73.2	2040/2	0.0	0.0
0.000	73.2	2054/2	0.0	0.0	73.2	2040/2	0.0	0.0
.125	73.2	2055/2	-1.3	0.0	73.2	2040/2	0.0	0.0
.250	73.2	2055/2	-1.3	0.0	73.2	2041/2	-1.3	0.0
.500	73.2	2054/2	0.0	0.0	73.2	2040/2	0.0	0.0
1.000	73.2	2054/2	0.0	0.0	74.0	2040/2	0.0	0.0
2.000	74.0	2053/2	1.3	0.0	74.0	2038/2	2.5	0.0
3.146	74.0	2053/2	1.3	0.0	74.7	2037/2	3.8	0.0
4.021	74.0	2054/2	0.0	0.0	74.7	2037/2	3.8	0.0
5.250	74.0	2056/2	-2.5	0.0	74.0	2037/2	3.8	0.0
6.083	74.0	2056/2	-2.5	0.0	74.0	2037/2	3.8	0.0
8.250	74.0	2056/2	-2.5	0.0	74.0	2036/2	5.1	0.0
15.363	74.7	2056/2	-2.5	0.0	74.7	2031/2	11.4	0.0
21.062	75.5	2057/2	-3.8	0.0	75.5	2028/2	15.1	0.0
28.021	74.7	2058/2	-5.1	0.0	74.7	2027/2	16.4	0.0
56.021	74.0	2064/2	-12.8	0.0	74.7	2025/2	18.9	0.0
84.075	75.5	2064/2	-12.8	0.0	75.5	2020/2	25.2	0.0
112.104	74.7	2067/2	-16.6	0.0	74.7	2019/2	26.4	0.0
140.096	74.7	2069/2	-19.2	0.0	75.5	2020/2	25.2	0.0
168.000	74.0	2070/2	-20.5	0.0	74.0	2020/2	25.2	0.0
196.130	73.2	2072/2	-23.0	0.0	75.5	2020/2	25.2	0.0
224.000	74.0	2073/2	-24.3	0.0	74.0	2020/2	25.2	0.0
252.000	75.5	2072/2	-23.0	0.0	75.5	2019/2	26.4	0.0
280.000	75.5	2073/2	-24.3	0.0	75.5	2020/2	25.2	0.0
308.000	75.5	2074/2	-25.6	0.0	76.3	2020/2	25.2	0.0
336.000	75.5	2075/2	-26.9	0.0	75.5	2020/2	25.2	0.0
-364.000	75.5	2074/2	-25.6	0.0	75.5	2019/2	26.4	0.0
364.000	75.5	2074/2	-25.6	0.0	75.5	2019/2	26.4	0.0
365.000	75.5	2074/2	-25.6	0.0	75.5	2019/2	26.4	0.0
366.000	75.5	2075/2	-26.9	0.0	76.3	2020/2	25.2	0.0
367.000	75.5	2074/2	-25.6	0.0	75.5	2019/2	26.4	0.0
368.000	75.5	2075/2	-26.9	0.0	77.0	2020/2	25.2	0.0
369.000	75.5	2075/2	-26.9	0.0	77.0	2020/2	25.2	0.0
370.000	75.5	2075/2	-26.9	0.0	77.0	2020/2	25.2	0.0
371.000	75.5	2075/2	-26.9	0.0	77.0	2020/2	25.2	0.0
378.000	75.5	2076/2	-28.2	0.0	74.7	2021/2	23.9	0.0
385.000	74.0	2076/2	-28.2	0.0	74.0	2020/2	25.2	0.0
392.000	74.7	2076/2	-28.2	0.0	74.7	2020/2	25.2	0.0
420.000	74.7	2076/2	-28.2	0.0	74.7	2020/2	25.2	0.0
448.000	74.7	2078/2	-30.7	0.0	74.7	2021/2	23.9	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-28

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	73.2	2139/2	0.0	0.0	62.7	2059/2	0.0	0.0
0.000	73.2	2139/2	0.0	0.0	62.7	2059/2	0.0	0.0
.125	73.2	2139/2	0.0	0.0	63.5	2057/2	2.6	0.0
.250	73.2	2140/2	-1.3	0.0	62.7	2058/2	1.3	0.0
.500	74.0	2139/2	0.0	0.0	63.5	2058/2	1.3	0.0
1.000	74.7	2138/2	1.3	0.0	63.5	2057/2	2.6	0.0
2.000	75.5	2137/2	2.7	0.0	64.2	2056/2	3.8	0.0
3.146	75.5	2138/2	1.3	0.0	64.2	2056/2	3.8	0.0
4.021	74.7	2137/2	2.7	0.0	64.2	2056/2	3.8	0.0
5.250	74.0	2138/2	1.3	0.0	62.7	2057/2	2.6	0.0
6.083	74.0	2138/2	1.3	0.0	63.5	2057/2	2.6	0.0
8.250	74.7	2139/2	0.0	0.0	63.5	2057/2	2.6	0.0
15.363	75.5	2138/2	1.3	0.0	64.2	2055/2	5.1	0.0
21.062	75.5	2136/2	4.0	0.0	64.2	2054/2	6.4	0.0
28.021	75.5	2138/2	1.3	0.0	64.2	2056/2	3.8	0.0
56.021	74.7	2139/2	0.0	0.0	63.5	2059/2	0.0	0.0
84.075	75.5	2139/2	0.0	0.0	64.2	2055/2	5.1	0.0
112.104	75.5	2140/2	-1.3	0.0	64.2	2056/2	3.8	0.0
140.100	75.5	2140/2	-1.3	0.0	64.2	2056/2	3.8	0.0
168.000	74.0	2140/2	-1.3	0.0	63.5	2055/2	5.1	0.0
196.130	74.0	2139/2	0.0	0.0	63.5	2055/2	5.1	0.0
224.000	74.7	2138/2	1.3	0.0	63.5	2054/2	6.4	0.0
252.000	75.5	2136/2	4.0	0.0	65.0	2052/2	8.9	0.0
280.000	82.2	2134/2	6.6	0.0	67.2	2050/2	11.5	0.0
308.000	77.7	2134/2	6.6	0.0	66.5	2049/2	12.7	0.0
336.000	76.3	2132/2	9.3	0.0	66.5	2047/2	15.3	0.0
-364.000	76.3	2130/2	11.9	0.0	65.0	2045/2	17.8	0.0
364.000	76.3	2130/2	11.9	0.0	65.0	2045/2	17.8	0.0
365.000	76.3	2130/2	11.9	0.0	65.0	2045/2	17.8	0.0
366.000	75.5	2131/2	10.6	0.0	65.0	2046/2	16.5	0.0
367.000	75.5	2131/2	10.6	0.0	65.0	2046/2	16.5	0.0
368.000	75.5	2131/2	10.6	0.0	65.0	2046/2	16.5	0.0
369.000	75.5	2131/2	10.6	0.0	65.0	2046/2	16.5	0.0
370.000	75.5	2131/2	10.6	0.0	65.0	2046/2	16.5	0.0
371.000	75.5	2131/2	10.6	0.0	65.0	2046/2	16.5	0.0
378.000	74.7	2131/2	10.6	0.0	65.0	2046/2	16.5	0.0
385.000	74.7	2130/2	11.9	0.0	65.0	2045/2	17.8	0.0
392.000	74.7	2130/2	11.9	0.0	64.2	2044/2	19.1	0.0
420.000	74.7	2129/2	13.2	0.0	64.2	2044/2	19.1	0.0
448.000	74.7	2127/2	15.9	0.0	63.5	2043/2	20.3	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-39

AXIAL STRESS	600 PSI	AXIAL ELASTIC STRAIN	87.3 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-25.6 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.7	2032/2	0.0	0.0	62.0	2054/2	0.0	0.0
0.000	74.7	3923/4	87.3	-.0	62.0	2074/2	-25.6	-.0
.125	74.7	3911/4	94.6	7.3	62.7	2074/2	-25.6	-.4
.250	74.7	3907/4	97.0	9.7	62.0	2074/2	-25.6	-.2
.500	74.0	3912/4	94.0	6.1	62.7	2074/2	-25.6	-.5
1.000	74.7	3900/4	101.2	13.0	62.7	2075/2	-26.9	-1.9
2.000	75.5	3896/4	103.6	15.2	62.7	2073/2	-24.3	.4
3.146	75.5	3891/4	106.7	18.3	63.5	2074/2	-25.6	-1.5
4.021	74.7	3891/4	106.7	18.2	62.0	2074/2	-25.6	-1.1
5.250	74.7	3890/4	107.3	18.8	62.0	2075/2	-26.9	-2.4
6.083	75.5	3890/4	107.3	19.4	62.7	2075/2	-26.9	-1.7
8.250	75.5	3887/4	109.1	21.9	63.5	2074/2	-25.6	-.6
15.363	76.3	3870/4	119.3	32.7	63.5	2073/2	-24.3	.5
21.062	76.3	3863/4	123.5	36.2	63.5	2074/2	-25.6	-.4
28.021	75.5	3861/4	124.7	37.6	63.5	2075/2	-26.9	-2.2
56.029	74.7	3849/4	131.9	44.0	62.7	2076/2	-28.2	-3.2
84.071	75.5	3835/4	140.2	52.3	63.5	2073/2	-24.3	.3
112.104	76.3	3827/4	144.9	57.6	63.5	2072/2	-23.0	2.2
140.104	76.3	3823/4	147.3	59.3	63.5	2072/2	-23.0	1.5
168.000	76.3	3816/4	151.5	63.7	63.5	2070/2	-20.5	3.7
196.130	75.5	3812/4	153.8	64.5	62.7	2070/2	-20.5	3.1
224.000	74.7	3803/4	159.1	68.0	62.7	2069/2	-19.2	2.3
252.000	76.3	3799/4	161.5	68.2	63.5	2065/2	-14.0	6.0
280.000	77.0	3795/4	163.8	69.5	64.2	2062/2	-10.2	8.4
308.000	77.0	3791/4	166.2	70.0	65.0	2062/2	-10.2	6.0
336.000	77.0	3784/4	170.3	72.3	64.2	2060/2	-7.7	6.8
-364.000	76.3	3777/4	174.4	75.3	64.2	2057/2	-3.8	9.5
364.000	76.3	3920/4	89.1	-10.0	64.2	2039/2	19.0	32.4
364.125	76.3	3925/4	86.1	-13.0	64.2	2038/2	20.3	33.6
364.250	76.3	3925/4	86.1	-13.0	64.2	2038/2	20.3	33.6
364.500	76.3	3927/4	84.8	-14.3	64.2	2038/2	20.3	33.6
365.000	76.3	3930/4	83.0	-16.2	63.5	2039/2	19.0	32.2
366.000	76.3	3934/4	80.6	-18.8	63.5	2040/2	17.8	30.8
367.000	76.3	3932/4	81.8	-17.5	64.2	2039/2	19.0	32.0
368.000	76.3	3933/4	81.2	-18.3	63.5	2039/2	19.0	32.2
369.000	76.3	3932/4	81.8	-17.4	64.2	2038/2	20.3	33.9
370.000	76.3	3932/4	81.8	-17.6	64.2	2039/2	19.0	32.2
371.000	76.3	3932/4	81.8	-17.7	63.5	2038/2	20.3	33.3
378.000	75.5	3937/4	78.7	-21.3	63.5	2038/2	20.3	32.7
385.000	76.3	3935/4	80.0	-21.2	63.5	2037/2	21.6	33.0
392.000	75.5	3936/4	79.4	-21.4	63.5	2036/2	22.8	34.7
420.000	75.5	3935/4	80.0	-22.2	63.5	2033/2	26.6	36.9
448.000	76.3	3938/4	78.1	-24.5	64.2	2031/2	29.1	39.5

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-40

AXIAL STRESS	600 PSI	AXIAL ELASTIC STRAIN	93.4 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-26.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	68.8	3900/4	0.0	0.0	74.0	3883/4	0.0	0.0
0.000	68.8	3742/4	93.6	.1	74.0	3926/4	-26.0	.0
.125	69.5	3732/4	99.4	5.9	74.0	3925/4	-25.4	.7
.250	69.5	3727/4	102.3	9.2	74.0	3925/4	-25.4	.6
.500	70.2	3724/4	104.0	10.4	74.0	3924/4	-24.8	.7
1.000	69.5	3721/4	105.7	12.1	74.0	3926/4	-26.0	-.9
2.000	68.8	3717/4	108.0	15.0	74.0	3924/4	-24.8	-.8
3.146	69.5	3714/4	109.8	16.3	74.7	3923/4	-24.2	-1.7
4.021	69.5	3715/4	109.2	17.5	74.0	3924/4	-24.8	-2.1
5.250	68.8	3715/4	109.2	17.8	74.0	3925/4	-25.4	-3.8
6.083	69.5	3714/4	109.8	19.7	74.0	3922/4	-23.6	-1.5
8.250	69.5	3712/4	110.9	21.9	74.0	3921/4	-23.0	-1.2
15.363	71.0	3700/4	117.8	30.3	74.7	3914/4	-18.7	.7
21.062	71.0	3694/4	121.2	36.3	75.5	3912/4	-17.5	-1.1
28.021	70.2	3695/4	120.7	36.6	75.5	3911/4	-16.9	-3.7
56.021	69.5	3692/4	122.4	43.7	73.2	3909/4	-15.7	-6.8
84.071	69.5	3685/4	126.4	51.4	75.5	3903/4	-12.1	-5.0
112.104	70.2	3683/4	127.5	57.9	74.7	3904/4	-12.7	-5.2
140.104	70.2	3688/4	124.7	57.6	75.5	3908/4	-15.1	-7.3
168.000	70.2	3687/4	125.2	60.7	74.0	3910/4	-16.3	-7.4
196.130	69.5	3687/4	125.2	63.2	74.0	3915/4	-19.3	-9.7
224.000	70.2	3685/4	126.4	65.1	74.0	3915/4	-19.3	-10.3
252.000	71.7	3685/4	126.4	65.0	75.5	3917/4	-20.6	-11.8
280.000	71.0	3685/4	126.4	66.6	75.5	3917/4	-20.6	-11.0
308.000	73.2	3687/4	125.2	65.5	76.3	3920/4	-22.4	-14.1
336.000	71.7	3684/4	127.0	68.0	76.3	3923/4	-24.2	-15.6
-364.000	71.0	3683/4	127.5	69.1	75.5	3924/4	-24.8	-16.5
364.000	71.0	3854/4	27.6	-30.8	75.5	3880/4	1.8	10.1
364.125	71.0	3858/4	25.3	-33.2	75.5	3879/4	2.4	10.7
364.250	71.0	3859/4	24.7	-33.8	75.5	3878/4	3.0	11.3
364.500	71.0	3862/4	22.9	-35.6	75.5	3878/4	3.0	11.3
365.000	71.0	3866/4	20.5	-38.1	75.5	3880/4	1.8	10.1
366.000	71.0	3869/4	18.7	-40.0	75.5	3881/4	1.2	9.5
367.000	71.0	3870/4	18.1	-40.5	75.5	3880/4	1.8	9.9
368.000	71.0	3870/4	18.1	-40.2	75.5	3880/4	1.8	10.4
369.000	71.0	3870/4	18.1	-39.9	75.5	3878/4	3.0	11.7
370.000	71.0	3871/4	17.5	-40.6	75.5	3879/4	2.4	11.0
371.000	71.0	3871/4	17.5	-40.4	75.5	3878/4	3.0	11.7
378.000	70.2	3880/4	12.1	-45.6	74.0	3880/4	1.8	10.3
385.000	70.2	3878/4	13.3	-44.7	74.7	3877/4	3.6	11.4
392.000	70.2	3880/4	12.1	-45.4	74.7	3877/4	3.6	11.6
420.000	70.2	3886/4	8.4	-48.7	74.7	3875/4	4.8	12.4
448.000	71.0	3892/4	4.8	-51.3	75.5	3877/4	3.6	12.3

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-42

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	143.0	3775/4	0.0	0.0	151.2	3722/4	0.0	0.0
0.000	143.0	3775/4	0.0	0.0	151.2	3722/4	0.0	0.0
.125	143.0	3776/4	-.6	0.0	150.5	3723/4	-.6	0.0
.250	143.0	3775/4	0.0	0.0	151.2	3723/4	-.6	0.0
.500	142.2	3774/4	.6	0.0	152.0	3722/4	0.0	0.0
1.000	143.8	3779/4	-2.3	0.0	151.2	3725/4	-1.7	0.0
2.000	141.5	3792/4	-10.0	0.0	149.7	3736/4	-8.1	0.0
3.146	142.2	3794/4	-11.1	0.0	150.5	3736/4	-8.1	0.0
4.021	141.5	3799/4	-14.1	0.0	150.5	3737/4	-8.7	0.0
5.250	141.5	3802/4	-15.9	0.0	149.7	3739/4	-9.8	0.0
6.083	141.5	3802/4	-15.9	0.0	150.5	3740/4	-10.4	0.0
8.250	140.7	3808/4	-19.4	0.0	149.7	3743/4	-12.1	0.0
15.363	140.7	3825/4	-29.4	0.0	149.7	3750/4	-16.2	0.0
21.062	141.5	3835/4	-35.4	0.0	149.7	3752/4	-17.4	0.0
28.021	140.7	3845/4	-41.3	0.0	149.7	3756/4	-19.7	0.0
56.013	138.5	3881/4	-62.9	0.0	146.7	3787/4	-37.8	0.0
84.000	138.5	3881/4	-62.9	0.0	148.2	3775/4	-30.8	0.0
112.029	138.5	3881/4	-62.9	0.0	148.2	3778/4	-32.5	0.0
140.104	138.5	3885/4	-65.3	0.0	154.2	3783/4	-35.5	0.0
168.000	137.7	3888/4	-67.1	0.0	147.5	3790/4	-39.6	0.0
196.130	137.7	3889/4	-67.7	0.0	146.0	3795/4	-42.5	0.0
224.000	138.5	3887/4	-66.5	0.0	149.7	3798/4	-44.3	0.0
252.000	104.7	3905/4	-77.4	0.0	143.8	3815/4	-54.3	0.0
280.000	137.7	3886/4	-65.9	0.0	147.5	3803/4	-47.2	0.0
308.000	140.0	3884/4	-64.7	0.0	148.2	3804/4	-47.8	0.0
336.000	138.5	3885/4	-65.3	0.0	146.7	3808/4	-50.2	0.0
-364.000	137.7	3884/4	-64.7	0.0	146.7	3811/4	-52.0	0.0
364.000	137.7	3884/4	-64.7	0.0	146.7	3811/4	-52.0	0.0
365.000	137.7	3884/4	-64.7	0.0	146.7	3811/4	-52.0	0.0
366.000	137.7	3884/4	-64.7	0.0	146.7	3811/4	-52.0	0.0
367.000	137.7	3884/4	-64.7	0.0	146.7	3811/4	-52.0	0.0
368.000	137.7	3884/4	-64.7	0.0	146.7	3811/4	-52.0	0.0
369.000	137.7	3884/4	-64.7	0.0	146.7	3811/4	-52.0	0.0
370.000	137.7	3884/4	-64.7	0.0	146.7	3811/4	-52.0	0.0
371.000	137.7	3884/4	-64.7	0.0	146.7	3812/4	-52.5	0.0
378.000	137.0	3883/4	-64.1	0.0	146.0	3812/4	-52.5	0.0
385.000	137.0	3882/4	-63.5	0.0	146.0	3811/4	-52.0	0.0
392.000	137.0	3880/4	-62.3	0.0	145.2	3812/4	-52.5	0.0
420.000	137.0	3880/4	-62.3	0.0	145.2	3814/4	-53.7	0.0
448.000	134.0	3889/4	-67.7	0.0	142.2	3830/4	-63.2	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN E-43

AXIAL STRESS	-0 PSI		AXIAL ELASTIC STRAIN	-220.7 MICRO-UNITS	
RADIAL STRESS	2400 PSI		RADIAL ELASTIC STRAIN	321.1 MICRO-UNITS	
TEST TEMPERATURE	150 F		TEST MOISTURE	AS CAST	

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	140.7	3763/4	0.0	0.0	151.2	3793/4	0.0	0.0
0.000	140.7	2062/2	-220.7	.0	151.2	3200/4	321.4	.2
.125	140.7	2080/2	-243.8	-21.8	151.2	3144/4	348.9	28.7
.250	140.7	2080/2	-243.8	-21.8	151.2	3128/4	356.7	36.1
.500	141.5	2086/2	-251.5	-30.2	152.0	3091/4	374.5	54.0
1.054	141.5	2094/2	-261.9	-40.1	152.7	3070/4	384.6	65.9
2.075	140.7	2108/2	-280.1	-53.5	151.2	3041/4	398.3	84.1
3.229	140.7	2120/2	-295.9	-68.7	151.2	3007/4	414.2	99.4
4.125	140.0	2124/2	-301.1	-72.5	151.2	3000/4	417.5	104.5
5.358	140.0	2133/2	-313.0	-83.3	151.2	2986/4	424.0	112.4
6.208	140.7	2136/2	-317.0	-86.6	150.5	2973/4	430.0	119.8
7.188	140.0	2140/2	-322.3	-87.3	150.5	2966/4	433.2	126.2
14.292	140.0	2152/2	-338.2	-98.8	149.7	2902/4	462.3	159.0
21.050	140.0	2160/2	-348.9	-108.5	150.5	2842/4	489.0	188.7
28.008	140.0	2154/2	-340.9	-97.7	150.5	2845/4	487.7	191.0
56.000	137.7	2154/2	-340.9	-84.7	146.7	2769/4	520.8	237.7
84.054	137.7	2156/2	-343.6	-89.5	148.2	2709/4	546.2	262.3
112.083	137.7	0/0	0.0	0.0	149.0	2665/4	564.6	282.7
139.958	137.7	0/0	0.0	0.0	147.5	2657/4	567.9	287.9
168.000	137.0	0/0	0.0	0.0	147.5	2647/4	572.0	294.2
-196.000	137.0	0/0	0.0	0.0	147.5	2610/4	587.0	309.9
196.000	0.0	0/0	0.0	0.0	147.5	3386/4	226.4	-48.3
196.125	137.0	0/0	0.0	0.0	147.5	3400/4	219.1	-58.1
196.250	137.0	0/0	0.0	0.0	147.5	3400/4	219.1	-60.4
196.500	137.0	0/0	0.0	0.0	147.5	3400/4	219.1	-61.7
197.000	137.7	0/0	0.0	0.0	147.5	3411/4	213.3	-68.5
198.000	137.0	0/0	0.0	0.0	146.0	3419/4	209.0	-75.9
199.000	135.5	0/0	0.0	0.0	145.2	3423/4	206.9	-78.0
200.000	135.5	0/0	0.0	0.0	145.2	3420/4	208.5	-76.5
201.000	136.2	0/0	0.0	0.0	145.2	3423/4	206.9	-78.0
202.000	136.2	0/0	0.0	0.0	146.7	3427/4	204.8	-80.2
203.000	137.0	0/0	0.0	0.0	146.7	3426/4	205.3	-79.9
210.000	136.2	0/0	0.0	0.0	146.7	3442/4	196.8	-88.4
217.000	136.2	0/0	0.0	0.0	147.5	3454/4	190.4	-94.9
224.000	136.2	0/0	0.0	0.0	147.5	3461/4	186.6	-98.6
252.000	133.2	0/0	0.0	0.0	144.5	3505/4	162.9	-122.4
280.000	135.5	0/0	0.0	0.0	146.7	3502/4	164.5	-121.4
308.000	137.0	0/0	0.0	0.0	148.2	3513/4	158.5	-128.0
336.000	137.7	0/0	0.0	0.0	148.2	3520/4	154.7	-131.2
364.000	137.7	0/0	0.0	0.0	148.2	3527/4	150.9	-136.0
392.000	137.7	0/0	0.0	0.0	146.7	3534/4	147.1	-141.2
420.000	137.7	0/0	0.0	0.0	146.7	3538/4	144.9	-141.8
448.000	132.5	0/0	0.0	0.0	143.0	3547/4	128.9	-161.4

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-6

AXIAL STRESS	3600 PSI		AXIAL ELASTIC STRAIN	386.9 MICRO-UNITS
RADIAL STRESS	3600 PSI		RADIAL ELASTIC STRAIN	429.3 MICRO-UNITS
TEST TEMPERATURE	150 F		TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	155.0	2600/2	0.0	0.0	153.5	2076/2	0.0	0.0
0.000	155.0	3312/4	389.9	3.0	153.5	3412/4	433.8	4.5
.208	155.0	3036/4	525.7	139.7	153.5	3166/4	588.4	159.0
.250	152.7	3032/4	527.5	141.5	152.0	3099/4	591.7	162.7
.500	152.0	3025/4	530.8	144.3	152.0	3062/4	609.4	180.1
1.042	152.7	2952/4	564.6	179.9	152.0	2980/4	647.8	219.2
1.958	151.2	2820/4	623.7	243.5	152.0	2910/4	679.8	254.6
3.042	152.0	2778/4	641.9	262.9	152.0	2872/4	718.8	293.4
4.000	152.0	2734/4	660.7	285.1	152.0	2794/4	731.0	307.9
5.083	152.7	2710/4	670.8	297.4	152.7	2744/4	752.5	330.2
6.250	151.2	2679/4	683.8	311.5	151.2	2713/4	765.6	343.9
7.167	151.2	2653/4	694.5	325.3	151.2	2679/4	779.8	360.2
14.042	152.0	2528/4	744.7	385.4	152.0	2565/4	849.7	435.4
21.012	152.0	2442/4	777.8	424.2	152.0	2410/4	885.9	473.2
27.971	152.0	2380/4	801.0	450.5	151.2	2372/4	918.2	506.7
56.179	152.7	2165/4	876.7	542.6	152.7	2093/4	996.5	597.5
83.992	155.7	2085/4	903.1	577.3	152.0	3936/8	1035.9	646.9
112.271	151.2	2025/4	922.2	595.6	151.2	3627/8	1081.1	688.3
140.029	151.2	3973/8	934.2	610.2	151.2	3370/8	1116.0	725.8
168.000	150.5	3852/8	952.5	630.5	156.5	2849/8	1178.8	791.7
196.000	149.7	3673/8	978.6	659.3	149.7	0/0	0.0	0.0
224.000	149.7	3610/8	987.5	667.1	150.5	0/0	0.0	0.0
252.000	149.7	3628/8	985.0	666.8	152.7	0/0	0.0	0.0
280.000	149.7	3569/8	993.2	671.8	152.7	0/0	0.0	0.0
308.000	152.0	3498/8	1002.9	682.1	152.0	0/0	0.0	0.0
336.000	150.5	3438/8	1011.0	690.6	149.7	0/0	0.0	0.0
-364.000	158.0	3362/8	1021.0	699.9	156.5	0/0	0.0	0.0
364.000	158.0	2573/4	726.9	405.8	156.5	0/0	0.0	0.0
364.125	158.0	2655/4	693.7	372.6	156.5	0/0	0.0	0.0
364.250	158.0	2665/4	689.6	368.5	156.5	0/0	0.0	0.0
364.490	158.0	2676/4	685.0	363.9	156.5	0/0	0.0	0.0
365.000	158.7	2690/4	679.2	357.8	151.2	0/0	0.0	0.0
366.000	151.2	2706/4	672.5	350.9	151.2	0/0	0.0	0.0
367.000	151.2	2720/4	666.6	345.0	151.2	0/0	0.0	0.0
368.000	151.2	2730/4	662.4	340.8	151.2	0/0	0.0	0.0
369.000	149.7	2739/4	658.6	337.0	148.2	0/0	0.0	0.0
370.000	149.7	2740/4	658.2	336.6	148.2	0/0	0.0	0.0
371.000	149.7	2753/4	652.6	331.5	148.2	0/0	0.0	0.0
378.000	149.7	2784/4	639.3	318.4	146.7	0/0	0.0	0.0
385.000	149.7	2808/4	628.9	307.6	148.2	0/0	0.0	0.0
392.000	151.2	2824/4	621.9	299.7	148.2	0/0	0.0	0.0
420.000	153.5	2868/4	602.5	279.6	161.0	0/0	0.0	0.0
448.000	147.5	2920/4	579.2	260.2	145.2	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-9

AXIAL STRESS	2400 PSI	AXIAL ELASTIC STRAIN	177.6 MICRO-UNITS
RADIAL STRESS	2400 PSI	RADIAL ELASTIC STRAIN	197.4 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	75.5	2189/2	0.0	0.0	75.5	2228/2	0.0	0.0
0.000	75.5	2054/2	177.6	-.0	75.5	2080/2	197.7	.3
.125	74.7	2035/2	201.7	24.1	74.7	2068/2	225.9	28.1
.250	74.7	2032/2	205.4	27.9	74.7	2064/2	231.0	33.4
.500	74.7	2028/2	210.5	32.3	74.7	2049/2	237.3	39.5
1.042	75.5	2016/2	225.5	47.0	75.5	2034/2	256.3	58.4
2.000	74.7	2000/2	245.4	66.7	74.7	2028/2	263.9	65.6
3.083	76.3	3995/4	248.5	69.8	76.3	2015/2	280.2	81.3
4.042	76.3	3988/4	252.9	74.2	76.3	2012/2	283.9	85.4
5.125	77.0	3982/4	256.6	77.8	77.0	2008/2	288.9	90.4
6.292	75.5	3976/4	260.3	82.1	75.5	2004/2	293.9	96.1
7.208	75.5	3970/4	264.0	86.5	75.5	2005/2	292.6	94.7
14.083	75.5	3950/4	276.2	99.4	75.5	3976/4	313.7	115.5
21.029	74.7	3937/4	284.2	106.6	74.7	3965/4	320.4	122.7
27.988	76.3	3927/4	290.3	112.9	76.3	3942/4	334.5	136.2
56.196	76.3	3892/4	311.5	133.3	76.3	3900/4	360.1	162.0
83.992	75.5	3866/4	327.1	149.0	75.5	3881/4	371.5	173.1
112.263	74.7	3849/4	337.3	159.6	74.7	3860/4	384.1	186.3
140.029	74.0	3848/4	337.9	159.6	74.0	3836/4	398.4	200.0
168.000	74.7	3843/4	340.9	162.8	73.2	3825/4	405.0	206.1
196.000	74.7	3824/4	352.2	172.5	74.7	3823/4	406.1	206.7
224.000	75.5	3816/4	356.9	175.5	75.5	3798/4	420.9	219.5
252.000	75.5	3811/4	359.8	176.3	75.5	3785/4	428.6	225.6
280.000	75.5	3802/4	365.2	180.6	75.5	3774/4	435.0	230.6
308.000	76.3	3799/4	366.9	180.4	77.0	3760/4	443.2	236.4
336.000	76.3	3789/4	372.8	184.5	76.3	3753/4	447.2	238.7
-364.000	76.3	3776/4	380.4	191.0	76.3	3752/4	447.8	238.2
364.000	76.3	2037/2	199.1	9.7	76.3	2040/2	248.7	39.1
364.125	76.3	2047/2	186.5	-2.9	76.3	2050/2	236.1	26.4
364.250	76.3	2049/2	183.9	-5.5	76.3	2050/2	236.1	26.4
364.500	76.3	2050/2	182.7	-6.7	76.3	2051/2	234.8	25.2
365.000	75.5	2051/2	181.4	-8.1	75.5	2052/2	233.5	23.7
366.000	75.5	2053/2	178.8	-10.9	75.5	2055/2	229.7	19.7
367.000	76.3	2054/2	177.6	-12.0	76.3	2056/2	228.4	18.4
368.000	76.3	2056/2	175.0	-14.8	76.3	2059/2	224.6	14.8
369.000	74.7	2057/2	173.7	-15.7	74.7	2059/2	224.6	15.2
370.000	74.7	2057/2	173.7	-16.0	74.7	2060/2	223.3	13.5
371.000	74.7	2059/2	171.2	-18.6	74.7	2061/2	222.0	12.1
378.000	74.7	2061/2	168.6	-21.7	74.7	2063/2	219.5	8.9
385.000	74.7	2063/2	166.1	-25.4	74.7	2065/2	216.9	5.4
392.000	74.7	2064/2	164.8	-26.2	75.5	2066/2	215.6	4.5
420.000	75.5	2069/2	158.4	-34.1	75.5	2072/2	207.9	-4.7
448.000	74.0	2074/2	152.0	-41.0	74.0	2077/2	201.5	-11.1

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-13

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-51.7 MICRO-UNITS
RADIAL STRESS	600 PSI	RADIAL ELASTIC STRAIN	72.1 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	75.5	2174/2	0.0	0.0	75.5	2184/2	0.0	0.0
0.000	75.5	2212/2	-51.7	.0	75.5	2130/2	72.2	.1
.167	75.5	2214/2	-54.4	-2.7	75.5	2121/2	84.1	11.6
.250	75.5	2215/2	-55.8	-4.1	75.5	2120/2	85.4	13.1
.500	75.5	2213/2	-53.0	-1.9	75.5	2120/2	85.4	12.8
1.000	75.5	2214/2	-54.4	-3.7	75.5	2120/2	85.4	12.7
1.979	74.7	2218/2	-59.9	-9.4	74.7	2118/2	88.0	15.0
3.063	76.3	2215/2	-55.8	-5.2	76.3	2114/2	93.3	19.7
4.021	76.3	2217/2	-58.5	-8.0	76.3	2111/2	97.2	24.0
5.104	77.0	2216/2	-57.2	-6.7	76.3	2111/2	97.2	23.9
6.271	76.3	2218/2	-59.9	-8.8	76.3	2111/2	97.2	24.7
7.188	75.5	2218/2	-59.9	-8.1	75.5	2110/2	98.5	25.8
14.063	75.5	2221/2	-64.0	-11.6	76.3	2105/2	105.0	32.1
21.025	75.5	2222/2	-65.4	-13.8	76.3	2104/2	106.3	33.8
27.983	76.3	2222/2	-65.4	-13.5	76.3	2101/2	110.3	37.2
56.192	76.3	2225/2	-69.5	-18.5	76.3	2095/2	118.1	45.3
84.017	75.5	2229/2	-75.1	-24.0	75.5	2094/2	119.4	46.2
112.304	73.2	2232/2	-79.2	-27.6	75.5	2091/2	123.2	50.7
140.050	74.0	2231/2	-77.8	-26.9	75.5	2091/2	123.2	50.1
168.000	72.5	2237/2	-86.1	-35.0	73.2	2093/2	120.7	47.1
196.000	74.7	2233/2	-80.6	-31.0	75.5	2091/2	123.2	49.1
224.000	75.5	2232/2	-79.2	-31.3	76.3	2086/2	129.7	53.5
252.000	75.5	2230/2	-76.5	-30.7	77.0	2083/2	133.6	55.9
280.000	75.5	2230/2	-76.5	-31.8	76.3	2082/2	134.9	55.8
308.000	77.0	2229/2	-75.1	-32.3	78.5	2080/2	137.5	56.0
336.000	74.7	2230/2	-76.5	-35.5	75.5	2080/2	137.5	54.2
-364.000	77.0	2230/2	-76.5	-36.6	77.7	2077/2	141.3	57.0
364.000	77.0	2190/2	-21.6	18.2	77.7	2134/2	66.9	-17.4
364.125	77.0	2188/2	-18.9	20.9	77.7	2136/2	64.3	-20.1
364.250	77.0	2188/2	-18.9	20.9	77.7	2136/2	64.3	-20.1
364.500	77.0	2187/2	-17.6	22.3	77.7	2136/2	64.3	-20.1
365.000	77.0	2186/2	-16.2	23.5	77.0	2137/2	63.0	-21.6
366.000	77.0	2185/2	-14.9	24.7	77.7	2137/2	63.0	-21.7
367.000	77.0	2185/2	-14.9	24.8	77.7	2138/2	61.6	-23.2
368.000	77.0	2187/2	-17.6	21.9	77.7	2140/2	59.0	-25.6
369.000	74.7	2186/2	-16.2	23.5	74.7	2140/2	59.0	-25.2
370.000	74.7	2186/2	-16.2	23.3	74.7	2140/2	59.0	-25.6
371.000	75.5	2186/2	-16.2	23.2	76.3	2140/2	59.0	-25.7
378.000	74.7	2184/2	-13.5	25.4	74.7	2140/2	59.0	-26.4
385.000	75.5	2183/2	-12.2	25.6	75.5	2141/2	57.7	-28.7
392.000	75.5	2183/2	-12.2	26.1	75.5	2142/2	56.3	-29.6
420.000	76.3	2180/2	-8.1	28.7	76.3	2143/2	55.0	-32.4
448.000	74.7	2182/2	-10.8	25.5	74.7	2146/2	51.0	-36.3

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-15

AXIAL STRESS	-0 PSI		AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI		RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F		TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	150.5	2099/2	0.0	0.0	150.5	3979/4	0.0	0.0
0.000	150.5	2099/2	0.0	0.0	150.5	3979/4	0.0	0.0
.125	150.5	2100/2	-1.3	0.0	150.5	3981/4	-1.2	0.0
.250	150.5	2100/2	-1.3	0.0	149.7	3981/4	-1.2	0.0
.500	149.7	2100/2	-1.3	0.0	149.7	3981/4	-1.2	0.0
1.042	149.7	2100/2	-1.3	0.0	149.7	3988/4	-5.6	0.0
2.000	149.0	2104/2	-6.5	0.0	149.0	3993/4	-8.6	0.0
3.083	150.5	2102/2	-3.9	0.0	150.5	3992/4	-8.0	0.0
4.042	150.5	2103/2	-5.2	0.0	150.5	3992/4	-8.0	0.0
5.125	149.7	2104/2	-6.5	0.0	150.5	3995/4	-9.9	0.0
6.292	150.5	2105/2	-7.8	0.0	150.5	3998/4	-11.7	0.0
7.208	150.5	2105/2	-7.8	0.0	150.5	3999/4	-12.4	0.0
14.083	149.7	2106/2	-9.1	0.0	149.7	2002/2	-15.5	0.0
21.042	149.0	2107/2	-10.4	0.0	149.0	2005/2	-19.2	0.0
28.000	149.0	2108/2	-11.7	0.0	149.0	2007/2	-21.7	0.0
56.208	149.7	2106/2	-9.1	0.0	149.7	2012/2	-27.9	0.0
84.021	146.7	0/0	0.0	0.0	146.7	2017/2	-34.2	0.0
112.312	146.7	0/0	0.0	0.0	147.5	2017/2	-34.2	0.0
140.062	146.7	0/0	0.0	0.0	146.7	2020/2	-37.9	0.0
168.000	144.5	0/0	0.0	0.0	146.0	0/0	0.0	0.0
196.000	143.0	0/0	0.0	0.0	143.8	0/0	0.0	0.0
224.000	144.5	0/0	0.0	0.0	146.0	0/0	0.0	0.0
252.000	141.5	0/0	0.0	0.0	143.0	0/0	0.0	0.0
280.000	143.8	0/0	0.0	0.0	146.0	0/0	0.0	0.0
308.000	144.5	0/0	0.0	0.0	146.0	0/0	0.0	0.0
336.000	143.8	0/0	0.0	0.0	144.5	0/0	0.0	0.0
-364.000	143.0	0/0	0.0	0.0	143.0	0/0	0.0	0.0
364.000	143.0	0/0	0.0	0.0	143.0	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-17

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.0	2059/2	0.0	0.0	74.0	2110/2	0.0	0.0
0.000	74.0	2059/2	0.0	0.0	74.0	2110/2	0.0	0.0
.125	74.0	2060/2	-1.3	0.0	74.0	2110/2	0.0	0.0
.250	74.0	2059/2	0.0	0.0	74.0	2110/2	0.0	0.0
.500	74.7	2059/2	0.0	0.0	74.7	2109/2	1.3	0.0
1.042	75.5	2059/2	0.0	0.0	74.7	2109/2	1.3	0.0
2.000	74.7	2060/2	-1.3	0.0	74.7	2109/2	1.3	0.0
3.083	75.5	2058/2	1.3	0.0	75.5	2105/2	6.5	0.0
4.042	76.3	2059/2	0.0	0.0	76.3	2105/2	6.5	0.0
5.125	76.3	2059/2	0.0	0.0	75.5	2105/2	6.5	0.0
6.292	75.5	2061/2	-2.6	0.0	75.5	2105/2	6.5	0.0
7.208	75.5	2061/2	-2.6	0.0	75.5	2105/2	6.5	0.0
14.083	76.3	2063/2	-5.1	0.0	76.3	2103/2	9.1	0.0
21.042	75.5	2066/2	-9.0	0.0	75.5	2102/2	10.4	0.0
28.021	75.5	2067/2	-10.2	0.0	75.5	2102/2	10.4	0.0
56.229	76.3	2070/2	-14.1	0.0	76.3	2099/2	14.4	0.0
84.054	74.7	2076/2	-21.8	0.0	74.7	2100/2	13.1	0.0
112.333	72.5	2079/2	-25.7	0.0	73.2	2101/2	11.7	0.0
140.062	74.7	2079/2	-25.7	0.0	74.7	2100/2	13.1	0.0
168.000	73.2	2084/2	-32.1	0.0	73.2	2103/2	9.1	0.0
196.000	74.7	2084/2	-32.1	0.0	74.7	2101/2	11.7	0.0
224.000	74.7	2084/2	-32.1	0.0	74.7	2101/2	11.7	0.0
252.000	74.7	2085/2	-33.4	0.0	74.7	2101/2	11.7	0.0
280.000	74.7	2086/2	-34.7	0.0	74.7	2102/2	10.4	0.0
308.000	76.3	2086/2	-34.7	0.0	76.3	2101/2	11.7	0.0
336.000	76.3	2088/2	-37.3	0.0	76.3	2102/2	10.4	0.0
-364.000	76.3	2088/2	-37.3	0.0	76.3	2102/2	10.4	0.0
364.000	76.3	2088/2	-37.3	0.0	76.3	2102/2	10.4	0.0
365.000	75.5	2088/2	-37.3	0.0	75.5	2102/2	10.4	0.0
366.000	75.5	2088/2	-37.3	0.0	74.7	2102/2	10.4	0.0
367.000	75.5	2088/2	-37.3	0.0	75.5	2102/2	10.4	0.0
368.000	75.5	2089/2	-38.6	0.0	74.7	2102/2	10.4	0.0
369.000	75.5	2089/2	-38.6	0.0	74.7	2102/2	10.4	0.0
370.000	75.5	2089/2	-38.6	0.0	74.7	2103/2	9.1	0.0
371.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
378.000	74.0	2090/2	-39.9	0.0	74.0	2103/2	9.1	0.0
385.000	74.0	2090/2	-39.9	0.0	74.0	2102/2	10.4	0.0
392.000	75.5	2088/2	-37.3	0.0	75.5	2101/2	11.7	0.0
420.000	74.7	2090/2	-39.9	0.0	74.7	2102/2	10.4	0.0
448.000	71.7	2093/2	-43.8	0.0	71.7	2105/2	6.5	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-20

AXIAL STRESS	3600 PSI	AXIAL ELASTIC STRAIN	308.7 MICRO-UNITS
RADIAL STRESS	3600 PSI	RADIAL ELASTIC STRAIN	423.2 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	152.0	2080/2	0.0	0.0	152.0	2130/2	0.0	0.0
0.000	152.0	3650/4	308.7	.0	152.0	3560/4	424.2	1.1
.208	152.0	3493/4	395.6	88.2	152.0	3285/4	570.1	147.9
.250	151.2	3487/4	398.8	91.5	152.0	3280/4	572.7	150.1
.500	152.0	3466/4	410.2	102.1	152.0	3250/4	587.8	165.3
1.042	152.0	3436/4	426.2	118.6	152.0	3180/4	622.7	202.0
1.958	152.0	3366/4	463.1	160.4	152.0	3128/4	648.1	231.9
3.083	152.0	3347/4	473.0	170.8	152.0	3057/4	682.2	265.3
4.042	152.0	3322/4	485.9	185.1	152.0	3036/4	692.1	277.1
5.104	151.2	3311/4	491.6	191.9	151.2	2992/4	712.7	299.1
6.271	151.2	3291/4	501.8	202.8	151.2	2970/4	722.8	310.6
7.188	150.5	3279/4	507.9	213.5	150.5	2942/4	735.6	326.7
14.054	152.0	3202/4	546.6	256.7	152.0	2797/4	800.1	394.8
21.012	151.2	3150/4	572.2	283.3	151.2	2739/4	833.5	431.1
27.971	151.2	0/0	0.0	0.0	151.2	2642/4	865.5	466.7
56.179	151.2	0/0	0.0	0.0	151.2	2446/4	942.8	557.6
83.997	149.7	0/0	0.0	0.0	149.7	2350/4	978.4	592.5
112.283	147.5	0/0	0.0	0.0	147.5	2225/4	1022.8	638.8
140.029	150.5	0/0	0.0	0.0	148.2	2134/4	1053.5	671.5
168.000	148.2	0/0	0.0	0.0	148.2	2040/4	1083.9	704.2
196.000	147.5	0/0	0.0	0.0	151.2	3991/8	1097.8	718.7
224.000	148.2	0/0	0.0	0.0	153.5	3716/8	1138.9	762.1
252.000	149.0	0/0	0.0	0.0	148.2	3152/8	1213.9	834.7
280.000	148.2	0/0	0.0	0.0	148.2	0/0	0.0	0.0
308.000	149.0	0/0	0.0	0.0	149.0	0/0	0.0	0.0
336.000	168.5	0/0	0.0	0.0	149.0	0/0	0.0	0.0
-364.000	150.5	0/0	0.0	0.0	147.5	0/0	0.0	0.0
364.000	150.5	0/0	0.0	0.0	147.5	0/0	0.0	0.0
364.125	150.5	0/0	0.0	0.0	147.5	0/0	0.0	0.0
364.250	150.5	0/0	0.0	0.0	147.5	0/0	0.0	0.0
364.500	150.5	0/0	0.0	0.0	147.5	0/0	0.0	0.0
365.000	148.2	0/0	0.0	0.0	149.0	0/0	0.0	0.0
366.000	149.0	0/0	0.0	0.0	149.7	0/0	0.0	0.0
367.000	149.0	0/0	0.0	0.0	149.7	0/0	0.0	0.0
368.000	149.0	0/0	0.0	0.0	149.7	0/0	0.0	0.0
369.000	148.2	0/0	0.0	0.0	148.2	0/0	0.0	0.0
370.000	148.2	0/0	0.0	0.0	148.2	0/0	0.0	0.0
371.000	149.7	0/0	0.0	0.0	148.2	0/0	0.0	0.0
378.000	148.2	0/0	0.0	0.0	146.7	0/0	0.0	0.0
385.000	149.0	0/0	0.0	0.0	148.2	0/0	0.0	0.0
392.000	150.5	0/0	0.0	0.0	149.7	0/0	0.0	0.0
420.000	149.7	0/0	0.0	0.0	149.7	0/0	0.0	0.0
448.000	142.2	0/0	0.0	0.0	143.0	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-21

AXIAL STRESS	-0 PSI		AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI		RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F		TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	149.7	2045/2	0.0	0.0	149.7	2024/2	0.0	0.0
0.000	149.7	2045/2	0.0	0.0	149.7	2024/2	0.0	0.0
.125	149.7	2047/2	-2.5	0.0	149.7	2025/2	-1.3	0.0
.250	149.7	2047/2	-2.5	0.0	149.7	2025/2	-1.3	0.0
.500	149.7	2046/2	-1.3	0.0	149.7	2025/2	-1.3	0.0
1.042	149.0	2049/2	-5.1	0.0	149.0	2027/2	-3.8	0.0
2.000	148.2	2051/2	-7.6	0.0	148.2	2029/2	-6.3	0.0
3.083	149.7	2052/2	-8.9	0.0	149.7	0/0	0.0	0.0
4.042	149.7	2053/2	-10.2	0.0	149.7	0/0	0.0	0.0
5.125	149.7	2055/2	-12.7	0.0	149.7	0/0	0.0	0.0
6.292	149.7	2056/2	-14.0	0.0	142.2	0/0	0.0	0.0
7.208	151.2	2058/2	-16.5	0.0	149.7	0/0	0.0	0.0
14.083	150.5	2063/2	-22.9	0.0	150.5	0/0	0.0	0.0
21.042	149.7	2068/2	-29.3	0.0	150.5	0/0	0.0	0.0
28.021	148.2	2071/2	-33.2	0.0	148.2	0/0	0.0	0.0
56.208	149.7	2076/2	-39.6	0.0	149.7	0/0	0.0	0.0
84.033	148.2	2083/2	-48.6	0.0	146.7	0/0	0.0	0.0
112.325	147.5	2082/2	-47.3	0.0	146.7	0/0	0.0	0.0
140.083	145.2	2083/2	-48.6	0.0	146.0	0/0	0.0	0.0
168.000	145.2	2083/2	-48.6	0.0	145.2	0/0	0.0	0.0
196.000	145.2	2089/2	-56.4	0.0	144.5	0/0	0.0	0.0
224.000	145.2	2083/2	-48.6	0.0	145.2	0/0	0.0	0.0
252.000	144.5	2082/2	-47.3	0.0	145.2	0/0	0.0	0.0
280.000	145.2	2081/2	-46.0	0.0	145.2	0/0	0.0	0.0
308.000	145.2	2080/2	-44.8	0.0	145.2	0/0	0.0	0.0
336.000	145.2	2080/2	-44.8	0.0	146.0	0/0	0.0	0.0
-364.000	144.5	2080/2	-44.8	0.0	144.5	0/0	0.0	0.0
364.000	144.5	2080/2	-44.8	0.0	144.5	0/0	0.0	0.0
365.000	144.5	2079/2	-43.5	0.0	144.5	0/0	0.0	0.0
366.000	144.5	2079/2	-43.5	0.0	144.5	0/0	0.0	0.0
367.000	144.5	2079/2	-43.5	0.0	144.5	0/0	0.0	0.0
368.000	144.5	2079/2	-43.5	0.0	144.5	0/0	0.0	0.0
369.000	144.5	2079/2	-43.5	0.0	144.5	0/0	0.0	0.0
370.000	144.5	2079/2	-43.5	0.0	144.5	0/0	0.0	0.0
371.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
378.000	143.0	2079/2	-43.5	0.0	143.0	0/0	0.0	0.0
385.000	144.5	2079/2	-43.5	0.0	144.5	0/0	0.0	0.0
392.000	143.8	2078/2	-42.2	0.0	143.8	0/0	0.0	0.0
420.000	143.8	2077/2	-40.9	0.0	143.8	0/0	0.0	0.0
448.000	142.2	2082/2	-47.3	0.0	142.2	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-23

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.7	2200/2	0.0	0.0	74.7	2170/2	0.0	0.0
0.000	74.7	2200/2	0.0	0.0	74.7	2170/2	0.0	0.0
.125	74.7	2200/2	0.0	0.0	74.7	2170/2	0.0	0.0
.250	74.7	2200/2	0.0	0.0	74.7	2170/2	0.0	0.0
.500	74.7	2200/2	0.0	0.0	74.7	2169/2	1.3	0.0
1.042	75.5	2200/2	0.0	0.0	75.5	2169/2	1.3	0.0
2.000	74.7	2200/2	0.0	0.0	74.7	2169/2	1.3	0.0
3.083	75.5	2199/2	1.4	0.0	75.5	2168/2	2.7	0.0
4.042	76.3	2198/2	2.7	0.0	76.3	2168/2	2.7	0.0
5.125	76.3	2198/2	2.7	0.0	76.3	2167/2	4.0	0.0
6.292	76.3	2198/2	2.7	0.0	76.3	2167/2	4.0	0.0
7.208	75.5	2198/2	2.7	0.0	75.5	2168/2	2.7	0.0
14.083	75.5	2200/2	0.0	0.0	75.5	2168/2	2.7	0.0
21.042	75.5	2200/2	0.0	0.0	75.5	2169/2	1.3	0.0
28.021	74.7	2200/2	0.0	0.0	74.7	2169/2	1.3	0.0
56.221	76.3	2200/2	0.0	0.0	76.3	2168/2	2.7	0.0
84.033	74.7	2200/2	0.0	0.0	74.7	2169/2	1.3	0.0
112.312	74.0	2201/2	-1.4	0.0	74.7	2170/2	0.0	0.0
140.083	73.2	2199/2	1.4	0.0	73.2	2167/2	4.0	0.0
168.000	73.2	2201/2	-1.4	0.0	73.2	2169/2	1.3	0.0
196.000	74.0	2198/2	2.7	0.0	74.0	2166/2	5.4	0.0
224.000	74.7	2197/2	4.1	0.0	74.7	2164/2	8.1	0.0
252.000	74.7	2195/2	6.8	0.0	74.7	2163/2	9.4	0.0
280.000	74.7	2194/2	8.2	0.0	74.7	2162/2	10.7	0.0
308.000	76.3	2192/2	10.9	0.0	76.3	2159/2	14.8	0.0
336.000	75.5	2192/2	10.9	0.0	76.3	2158/2	16.1	0.0
-364.000	75.5	2190/2	13.6	0.0	76.3	2156/2	18.8	0.0
364.000	75.5	2190/2	13.6	0.0	76.3	2156/2	18.8	0.0
365.000	74.7	2190/2	13.6	0.0	74.7	2156/2	18.8	0.0
366.000	74.7	2190/2	13.6	0.0	74.7	2156/2	18.8	0.0
367.000	74.7	2190/2	13.6	0.0	74.7	2156/2	18.8	0.0
368.000	74.7	2190/2	13.6	0.0	74.7	2156/2	18.8	0.0
369.000	74.7	2190/2	13.6	0.0	74.7	2157/2	17.4	0.0
370.000	74.7	2190/2	13.6	0.0	74.7	2156/2	18.8	0.0
371.000	74.7	2190/2	13.6	0.0	74.7	2156/2	18.8	0.0
378.000	74.0	2190/2	13.6	0.0	74.0	2156/2	18.8	0.0
385.000	74.7	2189/2	15.0	0.0	74.0	2155/2	20.1	0.0
392.000	74.7	2188/2	16.3	0.0	74.0	2154/2	21.4	0.0
420.000	74.0	2187/2	17.7	0.0	74.0	2153/2	22.8	0.0
448.000	71.7	2189/2	15.0	0.0	71.7	2155/2	20.1	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-30

AXIAL STRESS 2400 PSI
RADIAL STRESS 2400 PSI
TEST TEMPERATURE 75 F

AXIAL ELASTIC STRAIN 170.0 MICRO-UNITS
RADIAL ELASTIC STRAIN 219.8 MICRO-UNITS
TEST MOISTURE AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.7	2050/2	0.0	0.0	74.7	2094/2	0.0	0.0
0.000	74.7	3822/4	170.7	.6	74.7	3832/4	221.3	1.5
.125	75.5	3781/4	194.8	24.8	75.5	3764/4	261.3	41.6
.250	74.7	3772/4	200.1	30.5	75.5	3750/4	269.5	49.6
.500	74.7	3763/4	205.4	35.2	74.7	3726/4	283.4	63.0
1.042	75.5	3729/4	225.1	54.9	75.5	3678/4	310.9	90.2
2.000	74.7	3689/4	248.1	78.5	74.7	3640/4	332.5	110.6
3.083	76.3	3672/4	257.8	87.8	76.3	3592/4	359.4	136.0
4.042	76.3	3660/4	264.6	96.3	76.3	3569/4	372.1	149.0
5.125	77.0	3648/4	271.4	103.4	77.0	3541/4	387.6	163.3
6.292	75.5	3638/4	277.1	110.4	75.5	3517/4	400.7	176.9
7.208	77.0	3626/4	283.8	118.2	77.0	3510/4	404.5	180.4
14.071	75.5	3591/4	303.4	139.3	75.5	3422/4	451.8	225.4
21.029	75.5	3565/4	317.8	156.3	75.5	3388/4	469.7	240.2
28.012	76.3	3547/4	327.7	167.1	76.3	3337/4	496.3	263.7
56.212	76.3	3501/4	352.9	197.6	76.3	3237/4	547.2	310.3
84.033	75.5	3468/4	370.7	219.1	75.5	3188/4	571.6	332.8
112.312	75.5	3451/4	379.8	233.6	76.3	3147/4	591.8	353.4
140.071	74.7	3450/4	380.3	236.7	74.7	3110/4	609.7	371.7
168.000	75.5	3448/4	381.4	240.3	74.0	3095/4	616.9	380.0
196.000	75.5	3432/4	389.9	251.3	75.5	3090/4	619.3	383.1
224.000	74.7	3423/4	394.7	256.9	74.7	3060/4	633.6	396.8
252.000	81.5	3421/4	395.8	257.9	75.5	3044/4	641.2	404.1
280.000	75.5	3416/4	398.4	262.1	75.5	3033/4	646.4	410.1
308.000	76.3	3414/4	399.5	263.2	77.0	3018/4	653.4	415.8
336.000	76.3	3406/4	403.7	268.2	77.0	3012/4	656.2	418.9
-364.000	76.3	3401/4	406.3	271.3	76.3	3003/4	660.4	422.9
364.000	76.3	3734/4	222.2	87.2	76.3	3482/4	419.7	182.1
364.125	76.3	3756/4	209.4	74.4	76.3	3529/4	405.0	167.5
364.250	76.3	3759/4	207.7	72.7	76.3	3514/4	402.3	164.8
364.500	76.3	3764/4	204.8	69.8	76.3	3518/4	400.1	162.6
365.000	75.5	3768/4	202.4	67.3	75.5	3525/4	396.3	158.8
366.000	75.5	3773/4	199.5	64.3	75.5	3533/4	391.9	154.4
367.000	75.5	3775/4	198.4	63.2	75.5	3535/4	390.8	153.1
368.000	75.5	3783/4	193.7	58.8	75.5	3544/4	385.9	148.6
369.000	74.7	3786/4	191.9	57.3	74.7	3547/4	384.3	147.1
370.000	74.7	3786/4	191.9	57.2	74.7	3551/4	382.1	144.8
371.000	74.7	3790/4	189.6	55.1	74.7	3553/4	381.0	143.8
378.000	74.7	3798/4	184.9	50.6	74.7	3564/4	374.9	137.5
385.000	75.5	3804/4	181.3	46.7	75.5	3571/4	371.0	133.0
392.000	75.5	3806/4	180.1	46.1	75.5	3578/4	367.1	129.2
420.000	74.7	3823/4	170.1	36.4	74.7	3597/4	356.6	118.3
448.000	74.7	3840/4	160.0	27.3	74.7	3615/4	346.5	109.3

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-33

AXIAL STRESS	2400 PSI	AXIAL ELASTIC STRAIN	409.3 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-109.1 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	152.7	2081/2	0.0	0.0	152.7	2081/2	0.0	0.0
0.000	152.7	3470/4	409.3	.0	152.7	2164/2	-109.2	-.1
.125	152.0	3392/4	450.8	42.8	152.0	2171/2	-118.6	-8.6
.250	152.0	3370/4	462.3	54.3	152.0	2173/2	-121.3	-11.6
.500	152.0	3344/4	475.8	67.2	152.0	2175/2	-124.0	-14.3
1.042	152.7	3299/4	499.0	90.8	152.7	2180/2	-130.8	-19.2
1.979	151.2	3242/4	527.9	124.6	151.2	2185/2	-137.5	-21.5
3.083	152.0	3220/4	538.9	136.1	152.0	2188/2	-141.6	-26.2
4.021	152.7	3203/4	547.4	146.0	152.7	2190/2	-144.3	-27.0
5.104	152.0	3182/4	557.8	157.5	152.0	2193/2	-148.4	-29.7
6.271	152.0	3153/4	572.0	172.4	152.0	2196/2	-152.5	-32.3
7.188	152.0	3140/4	578.4	183.4	152.0	2198/2	-155.2	-31.9
14.063	152.0	3053/4	620.1	229.6	152.0	2207/2	-167.5	-40.5
21.021	150.5	3046/4	623.4	233.9	150.5	2213/2	-175.7	-45.7
28.000	151.2	2986/4	651.5	264.7	151.2	2219/2	-184.0	-50.4
56.200	150.5	2866/4	705.9	332.2	150.5	2234/2	-204.7	-57.5
84.021	149.0	2801/4	734.4	358.5	149.0	2239/2	-211.6	-65.2
112.300	149.7	2725/4	767.0	391.7	151.2	2240/2	-213.0	-64.6
140.062	147.5	2687/4	782.9	406.0	148.2	2240/2	-213.0	-62.7
168.000	148.2	2644/4	800.7	423.7	148.2	0/0	0.0	0.0
196.000	147.5	2631/4	806.0	429.4	146.7	0/0	0.0	0.0
224.000	145.2	2556/4	836.2	459.4	144.5	0/0	0.0	0.0
252.000	147.5	2508/4	855.0	474.7	146.7	0/0	0.0	0.0
280.000	146.7	2454/4	875.8	496.7	146.0	0/0	0.0	0.0
308.000	143.8	2382/4	902.7	523.7	143.8	0/0	0.0	0.0
336.000	146.7	2298/4	933.2	554.8	145.2	0/0	0.0	0.0
-364.000	146.7	0/0	0.0	0.0	145.2	0/0	0.0	0.0
364.000	146.7	3330/4	483.1	102.7	145.2	0/0	0.0	0.0
364.125	146.7	3327/4	484.6	104.3	145.2	0/0	0.0	0.0
364.250	146.7	3330/4	483.1	102.7	145.2	0/0	0.0	0.0
364.490	146.7	3337/4	479.5	99.1	145.2	0/0	0.0	0.0
365.000	146.0	3347/4	474.3	93.9	144.5	0/0	0.0	0.0
366.000	146.0	3358/4	468.6	88.2	145.2	0/0	0.0	0.0
367.000	146.7	3367/4	463.9	83.5	145.2	0/0	0.0	0.0
368.000	146.7	3372/4	461.3	80.9	145.2	0/0	0.0	0.0
369.000	146.0	3377/4	458.7	78.3	143.8	0/0	0.0	0.0
370.000	146.0	3380/4	457.1	76.7	143.8	0/0	0.0	0.0
371.000	146.0	3385/4	454.5	74.1	143.8	0/0	0.0	0.0
378.000	146.0	3404/4	444.5	64.1	143.0	0/0	0.0	0.0
385.000	146.0	3411/4	440.8	60.4	143.8	0/0	0.0	0.0
392.000	146.0	3413/4	439.7	60.0	143.8	0/0	0.0	0.0
420.000	145.2	3429/4	431.2	50.8	144.5	0/0	0.0	0.0
448.000	142.2	3445/4	422.7	43.6	140.0	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-34

AXIAL STRESS	2400 PSI	AXIAL ELASTIC STRAIN	468.8 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-122.7 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	152.7	2013/2	0.0	0.0	152.7	2040/2	0.0	0.0
0.000	152.7	3184/4	470.5	1.7	152.7	2135/2	-123.0	-.3
.125	152.0	3052/4	534.3	66.4	152.0	2142/2	-132.2	-9.6
.250	152.0	3017/4	550.7	82.8	152.0	2145/2	-136.2	-13.2
.500	152.7	2979/4	568.4	100.0	152.7	2148/2	-140.2	-17.6
1.042	152.7	2910/4	599.9	133.3	152.7	2154/2	-148.2	-24.8
1.979	152.7	2819/4	640.3	178.2	152.7	2159/2	-154.9	-28.1
3.083	152.0	2789/4	653.3	192.4	152.0	2164/2	-161.6	-35.1
4.021	152.7	2762/4	665.0	207.5	152.7	2166/2	-164.3	-35.4
5.104	152.0	2732/4	677.7	222.4	152.0	2169/2	-168.3	-38.6
6.271	152.7	2689/4	695.8	241.6	152.7	2171/2	-171.0	-40.7
7.188	152.0	2669/4	704.1	253.0	152.0	2174/2	-175.0	-42.7
14.063	152.7	2547/4	753.4	312.2	152.7	2181/2	-184.5	-46.8
21.021	152.7	2541/4	755.8	320.2	152.0	2182/2	-185.9	-46.5
28.000	151.2	2462/4	786.4	354.0	151.2	2187/2	-192.6	-52.1
56.290	150.5	2305/4	844.4	428.3	151.2	2202/2	-213.0	-60.1
84.021	150.5	2204/4	879.7	472.0	150.5	2200/2	-210.3	-47.3
112.304	151.2	2104/4	913.1	504.6	151.2	2201/2	-211.7	-52.5
140.062	149.0	2060/4	927.3	521.4	150.5	2202/2	-213.0	-51.3
168.000	147.5	2016/4	941.2	537.3	149.0	2202/2	-213.0	-46.1
196.000	147.5	3986/8	948.3	547.1	149.0	0/0	0.0	0.0
224.000	145.2	3843/8	970.0	567.7	146.7	0/0	0.0	0.0
252.000	146.7	3757/8	982.7	582.6	149.0	0/0	0.0	0.0
280.000	147.5	3683/8	993.4	590.0	149.7	0/0	0.0	0.0
308.000	147.5	3593/8	1006.0	603.3	149.7	0/0	0.0	0.0
336.000	148.2	3513/8	1017.1	614.8	149.7	0/0	0.0	0.0
-364.000	148.2	3447/8	1026.0	623.0	149.7	0/0	0.0	0.0
364.000	148.2	2920/4	595.4	192.4	149.7	0/0	0.0	0.0
364.125	148.2	2960/4	577.1	174.1	149.7	0/0	0.0	0.0
364.250	148.2	2968/4	573.5	170.5	149.7	0/0	0.0	0.0
364.490	148.2	2975/4	570.2	167.2	149.7	0/0	0.0	0.0
365.000	146.7	2984/4	566.1	162.8	148.2	0/0	0.0	0.0
366.000	146.7	2999/4	559.1	155.6	149.0	0/0	0.0	0.0
367.000	146.7	3110/4	506.6	103.1	149.0	0/0	0.0	0.0
368.000	146.7	3015/4	551.7	148.2	149.0	0/0	0.0	0.0
369.000	146.7	3024/4	547.5	144.0	149.0	0/0	0.0	0.0
370.000	146.7	3030/4	544.7	141.2	149.0	0/0	0.0	0.0
371.000	146.7	3035/4	542.3	139.3	148.2	0/0	0.0	0.0
378.000	146.0	3057/4	531.9	129.1	148.2	0/0	0.0	0.0
385.000	146.7	3074/4	523.8	120.6	148.2	0/0	0.0	0.0
392.000	146.7	3086/4	518.1	114.0	148.2	0/0	0.0	0.0
420.000	146.0	3117/4	503.2	98.4	147.5	0/0	0.0	0.0
448.000	143.8	3152/4	486.2	85.3	145.2	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN F-42

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-51.8 MICRO-UNITS
RADIAL STRESS	600 PSI	RADIAL ELASTIC STRAIN	74.3 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.0	2070/2	0.0	0.0	74.0	2064/2	0.0	0.0
0.000	74.0	2110/2	-51.8	-.0	74.0	2065/2	74.4	.2
.125	75.5	2110/2	-51.8	-.0	75.5	2060/2	80.6	6.5
.250	75.5	2110/2	-51.8	.4	75.5	3997/4	82.5	8.2
.500	74.7	2110/2	-51.8	-.1	74.7	3996/4	83.1	8.3
1.042	75.5	2111/2	-53.1	-1.5	75.5	3991/4	86.2	11.0
1.979	75.5	2112/2	-54.4	-2.2	75.5	3984/4	90.5	14.2
3.083	75.5	2113/2	-55.8	-3.9	75.5	3974/4	96.7	18.9
4.021	76.3	2115/2	-58.4	-4.8	76.3	3964/4	102.8	25.2
5.104	75.5	2115/2	-58.4	-4.5	76.3	3960/4	105.3	26.6
6.271	75.5	2116/2	-59.7	-4.5	75.5	3960/4	105.3	27.1
7.188	74.7	2116/2	-59.7	-3.5	74.0	3958/4	106.5	28.0
14.071	75.5	2122/2	-67.6	-9.8	75.5	3938/4	118.8	37.9
21.029	75.5	2124/2	-70.2	-9.9	76.3	3927/4	125.5	41.5
27.996	75.5	2125/2	-71.5	-10.3	75.5	3914/4	133.4	46.3
56.196	75.5	2133/2	-82.1	-15.5	75.5	3887/4	149.7	58.3
84.029	74.7	2140/2	-91.4	-21.0	74.7	3878/4	155.1	61.8
112.312	75.5	2143/2	-95.3	-19.7	75.5	3869/4	160.5	67.6
140.067	74.7	2146/2	-99.3	-21.1	75.5	3868/4	161.1	68.6
168.000	72.5	2154/2	-110.0	-29.2	72.5	3871/4	159.3	67.9
196.000	73.2	2151/2	-106.0	-22.8	73.2	3870/4	159.9	69.3
224.000	71.7	2153/2	-108.7	-24.6	71.7	3861/4	165.3	74.0
252.000	75.5	2155/2	-111.3	-27.4	75.5	3857/4	167.7	76.2
280.000	75.5	2157/2	-114.0	-28.5	75.5	3856/4	168.3	77.5
308.000	75.5	2159/2	-116.7	-31.1	76.3	3852/4	170.7	78.7
336.000	76.3	2160/2	-118.0	-31.7	76.3	3854/4	169.5	77.7
-364.000	76.3	2161/2	-119.4	-32.5	76.3	3849/4	172.5	80.5
364.000	76.3	2121/2	-66.3	20.6	76.3	3983/4	91.1	-.9
364.125	76.3	2121/2	-66.3	20.6	76.3	3987/4	88.7	-3.3
364.250	76.3	2121/2	-66.3	20.6	76.3	3987/4	88.7	-3.3
364.500	76.3	2121/2	-66.3	20.6	76.3	3988/4	88.1	-3.9
365.000	76.3	2121/2	-66.3	20.5	76.3	3990/4	86.8	-5.2
366.000	76.3	2121/2	-66.3	20.4	76.3	3990/4	86.8	-5.2
367.000	76.3	2120/2	-64.9	21.8	76.3	3990/4	86.8	-5.4
368.000	76.3	2121/2	-66.3	20.7	76.3	3995/4	83.7	-8.0
369.000	74.7	2122/2	-67.6	19.7	75.5	3997/4	82.5	-9.1
370.000	74.7	2122/2	-67.6	19.6	75.5	3997/4	82.5	-9.3
371.000	75.5	2122/2	-67.6	19.8	75.5	3998/4	81.9	-9.7
378.000	75.5	2120/2	-64.9	22.7	75.5	4000/4	80.6	-11.2
385.000	75.5	2121/2	-66.3	21.0	75.5	4000/4	80.6	-11.9
392.000	76.3	2120/2	-64.9	22.9	76.3	4000/4	80.6	-11.7
420.000	75.5	2120/2	-64.9	23.2	75.5	2003/2	76.9	-15.9
448.000	74.7	2123/2	-68.9	20.2	75.5	2007/2	71.9	-19.7

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN G-1

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	149.7	2132/2	0.0	0.0	149.7	2103/2	0.0	0.0
0.000	149.7	2132/2	0.0	0.0	149.7	2103/2	0.0	0.0
.125	149.7	2134/2	-2.6	0.0	149.7	2104/2	-1.3	0.0
.250	149.7	2134/2	-2.6	0.0	149.7	2103/2	0.0	0.0
.500	149.7	2133/2	-1.3	0.0	149.7	2103/2	0.0	0.0
1.000	151.2	2133/2	-1.3	0.0	151.2	2104/2	-1.3	0.0
2.000	149.7	2135/2	-4.0	0.0	150.5	2107/2	-5.2	0.0
3.021	151.2	2135/2	-4.0	0.0	151.2	2106/2	-3.9	0.0
4.021	150.5	2138/2	-7.9	0.0	150.5	2109/2	-7.8	0.0
5.375	150.5	2140/2	-10.6	0.0	149.7	2111/2	-10.5	0.0
6.042	149.7	2140/2	-10.6	0.0	149.7	2112/2	-11.8	0.0
7.000	150.5	2140/2	-10.6	0.0	150.5	2113/2	-13.1	0.0
14.071	149.0	2146/2	-18.6	0.0	149.7	2119/2	-20.9	0.0
21.062	149.0	2149/2	-22.6	0.0	149.0	2123/2	-26.2	0.0
28.092	148.2	2152/2	-26.6	0.0	148.2	2126/2	-30.2	0.0
56.042	145.2	2171/2	-52.0	0.0	145.2	2146/2	-56.6	0.0
84.063	146.7	2162/2	-39.9	0.0	146.7	2139/2	-47.3	0.0
115.062	144.5	2164/2	-42.6	0.0	145.2	2138/2	-46.0	0.0
140.062	146.0	2165/2	-44.0	0.0	146.7	2140/2	-48.7	0.0
167.000	146.0	2164/2	-42.6	0.0	149.7	2140/2	-48.7	0.0
196.000	144.5	2163/2	-41.3	0.0	146.0	2140/2	-48.7	0.0
224.000	142.2	2157/2	-33.2	0.0	140.7	2139/2	-47.3	0.0
252.000	145.2	2152/2	-26.6	0.0	146.0	2139/2	-47.3	0.0
280.000	145.2	2142/2	-13.2	0.0	146.0	2136/2	-43.4	0.0
308.000	146.7	0/0	0.0	0.0	147.5	2134/2	-40.7	0.0
336.000	145.2	0/0	0.0	0.0	146.0	2133/2	-39.4	0.0
-364.000	145.2	0/0	0.0	0.0	146.0	2130/2	-35.4	0.0
364.000	145.2	0/0	0.0	0.0	146.0	2130/2	-35.4	0.0
365.000	145.2	0/0	0.0	0.0	146.0	2130/2	-35.4	0.0
366.000	145.2	0/0	0.0	0.0	146.0	2130/2	-35.4	0.0
367.000	145.2	0/0	0.0	0.0	146.0	2130/2	-35.4	0.0
368.000	145.2	0/0	0.0	0.0	146.0	2130/2	-35.4	0.0
369.000	145.2	0/0	0.0	0.0	146.0	2130/2	-35.4	0.0
370.000	145.2	0/0	0.0	0.0	146.0	2129/2	-34.1	0.0
371.000	145.2	0/0	0.0	0.0	146.0	2128/2	-32.8	0.0
378.000	145.2	0/0	0.0	0.0	146.0	2129/2	-34.1	0.0
385.000	144.5	0/0	0.0	0.0	144.5	2127/2	-31.5	0.0
392.000	145.2	0/0	0.0	0.0	145.2	2125/2	-28.8	0.0
420.000	145.2	0/0	0.0	0.0	145.2	0/0	0.0	0.0
448.000	143.0	0/0	0.0	0.0	141.5	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN G-9

AXIAL STRESS	2400 PSI	AXIAL ELASTIC STRAIN	181.4 MICRO-UNITS
RADIAL STRESS	2400 PSI	RADIAL ELASTIC STRAIN	238.7 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	151.2	2090/2	0.0	0.0	152.0	3889/4	0.0	0.0
0.000	151.2	3890/4	181.4	.0	152.0	3470/4	239.0	.2
.125	151.2	3849/4	206.0	25.9	152.0	3419/4	266.2	28.4
.250	151.2	3857/4	201.2	21.1	152.0	3403/4	274.7	36.5
.500	151.2	3861/4	198.8	18.1	151.2	3383/4	285.2	47.1
1.000	152.7	3848/4	206.6	26.3	150.5	3349/4	302.9	66.6
2.000	152.0	3835/4	214.3	38.9	151.2	3328/4	313.8	82.0
3.000	152.7	3815/4	226.2	51.2	151.2	3301/4	327.6	95.2
4.000	152.0	3801/4	234.4	61.0	150.5	3287/4	334.8	104.2
5.375	151.2	3790/4	240.9	68.6	150.5	3274/4	341.4	112.3
6.042	151.2	3784/4	244.4	72.7	150.5	3265/4	346.0	118.2
7.000	152.0	3778/4	247.9	80.9	150.5	3253/4	352.0	127.5
14.054	151.2	3752/4	263.1	100.5	150.5	3251/4	353.0	132.1
21.046	150.5	3708/4	288.5	127.0	149.0	3210/4	373.6	155.7
28.004	150.5	3679/4	305.1	146.3	148.2	3178/4	389.4	175.1
55.983	146.7	3642/4	326.1	180.3	146.7	3131/4	412.4	211.7
84.004	149.7	3590/4	355.3	207.3	149.7	3058/4	447.4	245.9
115.004	149.7	3557/4	373.6	226.2	147.5	3025/4	463.0	263.5
140.042	149.0	3556/4	374.1	225.1	147.5	3007/4	471.4	273.8
167.000	149.7	3541/4	382.4	233.3	147.5	3005/4	472.3	277.0
196.000	148.2	3526/4	390.6	241.9	146.7	2969/4	489.0	294.3
224.000	148.2	3509/4	399.8	251.0	146.7	2946/4	499.5	307.2
252.000	148.2	3502/4	403.7	251.3	146.7	2921/4	510.9	316.1
280.000	148.2	3491/4	409.6	258.5	146.7	2891/4	524.4	327.3
308.000	150.5	3481/4	415.0	263.9	148.2	2869/4	534.2	335.8
336.000	149.7	3469/4	421.5	271.0	147.5	2844/4	545.3	345.9
-364.000	149.7	3462/4	425.2	272.8	147.5	2821/4	555.4	352.8
364.000	149.7	3815/4	226.2	73.7	147.5	3387/4	283.1	80.5
364.125	149.7	3850/4	205.4	52.9	147.5	3435/4	257.7	55.1
364.250	149.7	3854/4	203.0	50.5	147.5	3440/4	255.0	52.5
364.500	149.7	3855/4	202.4	50.0	147.5	3444/4	252.9	50.3
365.000	149.7	3863/4	197.6	45.2	147.5	3452/4	248.6	45.8
366.000	148.2	3871/4	192.8	40.4	147.5	3465/4	241.7	38.8
367.000	148.2	3875/4	190.4	38.0	147.5	3470/4	239.0	36.1
368.000	148.2	3880/4	187.4	35.0	147.5	3475/4	236.3	33.4
369.000	149.0	3882/4	186.2	33.8	147.5	3480/4	233.6	30.7
370.000	149.0	3884/4	185.0	32.6	147.5	3483/4	232.0	28.4
371.000	149.0	3887/4	183.2	30.8	147.5	3487/4	229.8	25.6
378.000	149.0	3900/4	175.3	22.9	147.5	3504/4	220.6	17.1
385.000	148.2	3910/4	169.3	16.8	146.0	3517/4	213.5	9.0
392.000	148.2	3914/4	166.9	15.0	146.0	3517/4	213.5	7.7
420.000	149.0	3938/4	152.3	-.2	146.0	3552/4	194.3	-9.9
448.000	146.0	3965/4	135.7	-15.5	143.8	3591/4	172.8	-35.2

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN G-10

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	75.5	2094/2	0.0	0.0	75.5	2088/2	0.0	0.0
0.000	75.5	2094/2	0.0	0.0	75.5	2088/2	0.0	0.0
.125	75.5	2094/2	0.0	0.0	75.5	2088/2	0.0	0.0
.250	75.5	2095/2	-1.3	0.0	75.5	2088/2	0.0	0.0
.500	75.5	2094/2	0.0	0.0	75.5	2088/2	0.0	0.0
1.000	76.3	2094/2	0.0	0.0	76.3	2088/2	0.0	0.0
2.000	74.7	2095/2	-1.3	0.0	74.7	2087/2	1.3	0.0
3.000	74.7	2095/2	-1.3	0.0	74.7	2087/2	1.3	0.0
4.042	75.5	2098/2	-5.2	0.0	75.5	2087/2	1.3	0.0
5.375	75.5	2095/2	-1.3	0.0	75.5	2084/2	5.2	0.0
6.042	74.7	2096/2	-2.6	0.0	74.7	2084/2	5.2	0.0
7.000	75.5	2098/2	-5.2	0.0	75.5	2085/2	3.9	0.0
14.071	74.7	2100/2	-7.8	0.0	74.7	2083/2	6.5	0.0
21.062	75.5	2101/2	-9.1	0.0	75.5	2081/2	9.0	0.0
28.062	74.7	2102/2	-10.4	0.0	76.3	2078/2	12.9	0.0
56.042	75.5	2106/2	-15.6	0.0	75.5	2075/2	16.8	0.0
84.063	74.7	2109/2	-19.5	0.0	74.7	2074/2	18.1	0.0
115.062	74.7	2114/2	-26.1	0.0	75.5	2075/2	16.8	0.0
140.104	74.7	2114/2	-26.1	0.0	74.7	2073/2	19.3	0.0
169.000	74.7	2117/2	-30.0	0.0	74.7	2075/2	16.8	0.0
196.000	74.7	2118/2	-31.3	0.0	74.7	2074/2	18.1	0.0
225.000	75.5	2116/2	-28.7	0.0	78.5	2072/2	20.6	0.0
252.000	75.5	2118/2	-31.3	0.0	77.7	2073/2	19.3	0.0
280.000	75.5	2119/2	-32.7	0.0	75.5	2074/2	18.1	0.0
308.000	77.0	2117/2	-30.0	0.0	77.0	2071/2	21.9	0.0
336.000	75.5	2118/2	-31.3	0.0	76.3	2072/2	20.6	0.0
-364.000	74.7	2119/2	-32.7	0.0	75.5	2072/2	20.6	0.0
364.000	74.7	2119/2	-32.7	0.0	75.5	2072/2	20.6	0.0
365.000	74.7	2119/2	-32.7	0.0	75.5	2072/2	20.6	0.0
366.000	74.7	2118/2	-31.3	0.0	76.3	2072/2	20.6	0.0
367.000	74.7	2119/2	-32.7	0.0	76.3	2072/2	20.6	0.0
368.000	74.7	2118/2	-31.3	0.0	76.3	2072/2	20.6	0.0
369.000	74.7	2119/2	-32.7	0.0	76.3	2072/2	20.6	0.0
370.000	74.7	2118/2	-31.3	0.0	76.3	2071/2	21.9	0.0
371.000	74.0	2118/2	-31.3	0.0	75.5	2072/2	20.6	0.0
378.000	74.7	2118/2	-31.3	0.0	76.3	2071/2	21.9	0.0
385.000	75.5	2117/2	-30.0	0.0	75.5	2071/2	21.9	0.0
392.000	74.0	2119/2	-32.7	0.0	74.0	2072/2	20.6	0.0
420.000	74.7	2118/2	-31.3	0.0	75.5	2071/2	21.9	0.0
448.000	75.5	2118/2	-31.3	0.0	74.7	2071/2	21.9	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN G-18

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	75.5	2218/2	0.0	0.0	65.0	2101/2	0.0	0.0
0.000	75.5	2218/2	0.0	0.0	65.0	2101/2	0.0	0.0
.125	75.5	2218/2	0.0	0.0	65.7	2100/2	1.3	0.0
.250	75.5	2217/2	1.4	0.0	65.7	2100/2	1.3	0.0
.500	75.5	2216/2	2.7	0.0	65.7	2100/2	1.3	0.0
1.000	76.3	2217/2	1.4	0.0	66.5	2100/2	1.3	0.0
2.000	75.5	2217/2	1.4	0.0	65.7	2100/2	1.3	0.0
3.000	75.5	2218/2	0.0	0.0	66.5	2100/2	1.3	0.0
4.042	75.5	2218/2	0.0	0.0	65.7	2101/2	0.0	0.0
5.375	76.3	2216/2	2.7	0.0	65.7	2100/2	1.3	0.0
6.042	75.5	2217/2	1.4	0.0	65.7	2100/2	1.3	0.0
7.000	75.5	2218/2	0.0	0.0	65.7	2100/2	1.3	0.0
14.071	74.7	2220/2	-2.8	0.0	65.7	2101/2	0.0	0.0
21.062	75.5	2220/2	-2.8	0.0	65.7	2101/2	0.0	0.0
28.062	76.3	2220/2	-2.8	0.0	65.7	2100/2	1.3	0.0
56.042	75.5	2220/2	-2.8	0.0	65.7	2100/2	1.3	0.0
84.063	74.7	2220/2	-2.8	0.0	64.2	2101/2	0.0	0.0
115.083	74.7	2222/2	-5.5	0.0	65.0	2102/2	-1.3	0.0
140.062	75.5	2222/2	-5.5	0.0	65.7	2100/2	1.3	0.0
169.000	74.0	2223/2	-6.9	0.0	64.2	2100/2	1.3	0.0
196.000	75.5	2221/2	-4.1	0.0	75.5	2100/2	1.3	0.0
225.000	76.3	2219/2	-1.4	0.0	66.5	2096/2	6.5	0.0
252.000	75.5	2219/2	-1.4	0.0	65.7	2096/2	6.5	0.0
280.000	75.5	2220/2	-2.8	0.0	65.7	2096/2	6.5	0.0
308.000	77.7	2217/2	1.4	0.0	68.0	2092/2	11.7	0.0
336.000	76.3	2217/2	1.4	0.0	67.2	2092/2	11.7	0.0
-364.000	75.5	2217/2	1.4	0.0	65.7	2091/2	13.0	0.0
364.000	75.5	2217/2	1.4	0.0	65.7	2091/2	13.0	0.0
365.000	75.5	2217/2	1.4	0.0	65.7	2091/2	13.0	0.0
366.000	76.3	2216/2	2.7	0.0	65.7	2090/2	14.3	0.0
367.000	75.5	2217/2	1.4	0.0	65.7	2091/2	13.0	0.0
368.000	75.5	2217/2	1.4	0.0	65.7	2091/2	13.0	0.0
369.000	75.5	2217/2	1.4	0.0	65.7	2091/2	13.0	0.0
370.000	76.3	2216/2	2.7	0.0	65.7	2090/2	14.3	0.0
371.000	75.5	2216/2	2.7	0.0	65.7	2090/2	14.3	0.0
378.000	75.5	2216/2	2.7	0.0	65.7	2090/2	14.3	0.0
385.000	76.3	2215/2	4.1	0.0	66.5	2088/2	16.9	0.0
392.000	74.0	2216/2	2.7	0.0	64.2	2090/2	14.3	0.0
420.000	75.5	2215/2	4.1	0.0	65.7	2088/2	16.9	0.0
448.000	74.7	2215/2	4.1	0.0	65.7	2088/2	16.9	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN G-19

AXIAL STRESS	2400 PSI		AXIAL ELASTIC STRAIN	189.7 MICRO-UNITS
RADIAL STRESS	2400 PSI		RADIAL ELASTIC STRAIN	253.4 MICRO-UNITS
TEST TEMPERATURE	150 F		TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	151.2	3835/4	0.0	0.0	151.2	3796/4	0.0	0.0
0.000	151.2	3500/4	190.4	.8	151.2	3335/4	254.8	1.4
.125	151.2	3440/4	222.7	34.0	151.2	3257/4	294.6	41.3
.250	151.2	3413/4	237.0	48.3	151.2	3236/4	305.2	52.1
.500	151.2	3390/4	249.2	59.9	151.2	3200/4	323.1	69.8
1.000	151.2	3365/4	262.3	74.8	152.7	3156/4	344.8	92.2
2.000	151.2	3346/4	272.1	89.2	152.0	3117/4	363.8	114.6
3.000	151.2	3324/4	283.5	101.8	152.0	3082/4	380.6	131.1
4.000	150.5	3319/4	286.1	107.7	152.7	3064/4	389.2	142.0
5.333	151.2	3306/4	292.8	116.5	152.0	3050/4	395.8	149.5
6.000	151.2	3300/4	295.8	120.8	152.0	3036/4	402.4	156.7
6.958	151.2	3296/4	297.9	125.9	152.0	3022/4	409.0	165.3
14.058	150.5	3263/4	314.7	152.6	152.0	3010/4	414.6	176.2
21.046	149.0	3232/4	330.3	173.8	151.2	2959/4	438.2	201.5
28.046	149.7	3210/4	341.2	188.0	151.2	2925/4	453.7	218.2
56.025	145.2	3190/4	351.2	214.2	145.2	2881/4	473.5	250.4
84.025	149.7	3145/4	373.3	244.7	149.7	2797/4	510.4	297.4
115.054	149.0	3119/4	385.9	256.5	150.5	2761/4	526.0	309.1
140.096	147.5	3118/4	386.4	259.6	149.0	2740/4	534.9	320.6
169.000	147.5	3103/4	393.6	268.9	149.0	2740/4	534.9	323.8
196.000	147.5	3093/4	398.4	276.3	149.0	2704/4	550.1	342.0
225.000	144.5	3082/4	403.7	280.5	146.0	2691/4	555.5	349.4
252.000	147.5	3075/4	407.0	286.1	149.0	2667/4	565.5	364.1
280.000	147.5	3067/4	410.8	286.6	149.0	2647/4	573.7	373.5
308.000	148.2	3060/4	414.1	290.5	150.5	2634/4	579.1	377.5
336.000	146.7	3054/4	417.0	293.8	149.0	2622/4	583.9	383.8
-364.000	146.7	3050/4	418.9	295.0	150.5	2608/4	589.6	390.5
364.000	146.7	3425/4	230.7	106.8	150.5	3164/4	340.9	141.8
364.125	146.7	3441/4	222.2	98.3	150.5	3192/4	327.1	128.0
364.250	146.7	3442/4	221.6	97.8	150.5	3196/4	325.1	126.0
364.500	146.7	3442/4	221.6	97.8	150.5	3198/4	324.1	125.0
365.000	146.7	3450/4	217.4	93.2	150.5	3208/4	319.2	119.8
366.000	146.0	3450/4	217.4	93.0	150.5	3218/4	314.2	114.9
367.000	146.0	3450/4	217.4	93.0	150.5	3224/4	311.2	111.9
368.000	146.7	3450/4	217.4	93.0	149.0	3229/4	308.7	109.4
369.000	146.7	3470/4	206.6	82.3	148.2	3233/4	306.7	107.2
370.000	146.0	3470/4	206.6	82.3	149.0	3236/4	305.2	105.9
371.000	146.0	3474/4	204.5	80.6	149.0	3239/4	303.7	105.0
378.000	146.0	3484/4	199.1	75.4	149.0	3260/4	293.1	95.4
385.000	146.0	3495/4	193.1	69.0	149.0	3275/4	285.5	87.2
392.000	146.0	3495/4	193.1	68.2	149.0	3285/4	280.4	82.7
420.000	146.0	3520/4	179.6	53.9	149.0	3326/4	259.4	61.7
488.000	145.2	3552/4	162.0	40.2	146.0	3369/4	237.1	44.4

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN G-21

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	140.0	3746/4	0.0	0.0	149.7	2069/2	0.0	0.0
0.000	140.0	3746/4	0.0	0.0	149.7	2069/2	0.0	0.0
.125	140.0	3749/4	-1.7	0.0	149.7	2069/2	0.0	0.0
.250	140.0	3750/4	-2.3	0.0	149.7	2070/2	-1.3	0.0
.500	140.0	3749/4	-1.7	0.0	149.7	2069/2	0.0	0.0
1.000	141.5	3749/4	-1.7	0.0	150.5	2070/2	-1.3	0.0
2.000	140.0	3757/4	-6.4	0.0	149.0	2071/2	-2.6	0.0
3.000	141.5	3757/4	-6.4	0.0	149.7	2071/2	-2.6	0.0
4.042	140.7	3762/4	-9.3	0.0	149.7	2072/2	-3.9	0.0
5.375	140.7	3770/4	-14.0	0.0	149.7	2074/2	-6.4	0.0
6.042	140.7	3772/4	-15.1	0.0	149.7	2074/2	-6.4	0.0
7.000	140.7	3774/4	-16.3	0.0	149.0	2074/2	-6.4	0.0
14.071	140.0	3793/4	-27.5	0.0	148.2	2078/2	-11.6	0.0
21.062	140.0	3803/4	-33.3	0.0	148.2	2080/2	-14.1	0.0
28.062	139.2	3807/4	-35.7	0.0	148.2	2080/2	-14.1	0.0
56.042	134.7	3860/4	-67.2	0.0	144.5	2094/2	-32.3	0.0
84.063	138.5	3850/4	-61.2	0.0	147.5	2083/2	-18.0	0.0
115.083	137.7	3855/4	-64.2	0.0	146.7	2082/2	-16.7	0.0
140.071	136.2	3863/4	-69.0	0.0	146.0	2081/2	-15.4	0.0
169.000	136.2	3866/4	-70.8	0.0	146.0	2080/2	-14.1	0.0
196.000	137.7	3869/4	-72.6	0.0	146.7	2079/2	-12.9	0.0
225.000	134.0	3869/4	-72.6	0.0	143.0	2077/2	-10.3	0.0
252.000	137.7	3870/4	-73.2	0.0	147.5	2075/2	-7.7	0.0
280.000	137.0	3869/4	-72.6	0.0	146.0	2073/2	-5.1	0.0
308.000	137.7	3868/4	-72.0	0.0	146.0	2072/2	-3.9	0.0
336.000	135.5	3869/4	-72.6	0.0	144.5	2071/2	-2.6	0.0
-364.000	136.2	3865/4	-70.2	0.0	145.2	2070/2	-1.3	0.0
364.000	136.2	3865/4	-70.2	0.0	145.2	2070/2	-1.3	0.0
365.000	136.2	3865/4	-70.2	0.0	145.2	2070/2	-1.3	0.0
366.000	135.5	3864/4	-69.6	0.0	144.5	2069/2	0.0	0.0
367.000	135.5	3864/4	-69.6	0.0	145.2	2069/2	0.0	0.0
368.000	135.5	3864/4	-69.6	0.0	145.2	2069/2	0.0	0.0
369.000	135.5	3864/4	-69.6	0.0	145.2	2069/2	0.0	0.0
370.000	136.2	3864/4	-69.6	0.0	145.2	2069/2	0.0	0.0
371.000	135.5	3866/4	-70.8	0.0	145.2	2069/2	0.0	0.0
378.000	136.2	3865/4	-70.2	0.0	145.2	2069/2	0.0	0.0
385.000	135.5	3863/4	-69.0	0.0	144.5	2067/2	2.6	0.0
392.000	135.5	3860/4	-67.2	0.0	144.5	2066/2	3.8	0.0
420.000	135.5	3861/4	-67.8	0.0	145.2	2066/2	3.8	0.0
448.000	134.0	3872/4	-74.4	0.0	142.2	2071/2	-2.6	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN G-30

AXIAL STRESS 600 PSI
RADIAL STRESS 3600 PSI
TEST TEMPERATURE 75 F

AXIAL ELASTIC STRAIN -239.6 MICRO-UNITS
RADIAL ELASTIC STRAIN 522.0 MICRO-UNITS
TEST MOISTURE AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	77.0	3840/4	0.0	0.0	77.0	3968/4	0.0	0.0
0.000	77.0	2112/2	-240.0	-.3	77.0	2915/4	525.1	3.1
.125	77.7	2123/2	-254.4	-14.8	77.7	2710/4	614.4	92.6
.250	77.7	2128/2	-261.0	-21.0	77.7	2650/4	639.4	117.4
.500	77.7	2130/2	-263.7	-24.1	77.7	2600/4	659.7	137.2
1.000	76.3	2137/2	-272.9	-33.5	76.3	2493/4	701.9	179.1
2.000	76.3	2140/2	-276.9	-36.8	76.3	2393/4	739.8	215.8
3.000	75.5	2142/2	-279.5	-39.9	76.3	2305/4	771.9	246.4
4.000	74.7	2146/2	-284.9	-43.5	74.7	2231/4	797.9	272.6
5.333	74.7	2146/2	-284.9	-43.2	75.5	2140/4	828.7	302.3
6.000	74.7	2146/2	-284.9	-41.8	75.5	2109/4	838.9	313.0
7.000	76.3	2147/2	-286.2	-42.1	76.3	2060/4	854.7	328.5
14.071	75.5	2156/2	-298.2	-52.6	75.5	3570/8	936.7	408.1
21.062	76.3	2163/2	-307.6	-59.4	76.3	3156/8	990.6	459.0
28.062	75.5	2168/2	-314.3	-65.3	76.3	2832/8	1028.2	493.5
56.042	76.3	2180/2	-330.5	-76.1	76.3	2107/8	1097.6	558.5
84.063	75.5	2185/2	-337.2	-79.1	76.3	0/0	0.0	0.0
115.071	74.0	2197/2	-353.5	-90.0	75.5	0/0	0.0	0.0
140.125	75.5	2202/2	-360.3	-94.3	77.0	2000/8	1106.1	565.9
169.000	75.5	2206/2	-365.8	-97.2	76.3	0/0	0.0	0.0
196.000	75.5	2215/2	-378.1	-107.1	76.3	0/0	0.0	0.0
225.000	77.0	2224/2	-390.5	-118.7	77.0	0/0	0.0	0.0
252.000	75.5	2224/2	-390.5	-118.8	76.3	0/0	0.0	0.0
280.000	75.5	2231/2	-400.2	-126.9	77.0	0/0	0.0	0.0
308.000	77.0	2231/2	-400.2	-126.8	77.7	0/0	0.0	0.0
336.000	77.0	2232/2	-401.6	-127.4	77.0	0/0	0.0	0.0
-364.000	75.5	2237/2	-408.5	-133.8	76.3	0/0	0.0	0.0
364.000	75.5	2077/2	-194.5	80.1	76.3	3795/8	904.6	364.9
364.125	75.5	2072/2	-188.1	86.6	76.3	3969/8	887.6	347.9
364.250	75.5	2071/2	-186.8	87.9	76.3	3934/8	883.8	344.1
364.500	75.5	2070/2	-185.5	89.1	76.3	3953/8	880.9	341.2
365.000	75.5	2068/2	-183.0	91.6	76.3	3994/8	874.5	334.8
366.000	75.5	2066/2	-180.4	94.1	76.3	4032/8	868.6	328.9
367.000	75.5	2065/2	-179.1	95.4	76.3	4056/8	864.9	324.9
368.000	76.3	2065/2	-179.1	95.7	77.0	4082/8	860.8	321.3
369.000	76.3	2064/2	-177.8	97.3	77.0	2050/4	857.9	318.6
370.000	76.3	2063/2	-176.6	98.4	76.3	2057/4	855.7	316.2
371.000	75.5	2063/2	-176.6	98.6	75.5	2063/4	853.8	314.5
378.000	75.5	2060/2	-172.7	102.7	75.5	2097/4	842.8	303.3
385.000	74.7	2057/2	-168.9	106.2	74.7	2119/4	835.6	295.4
392.000	74.7	2059/2	-171.5	104.2	74.7	2145/4	827.0	287.0
420.000	74.7	2055/2	-166.4	109.6	74.7	2190/4	811.9	271.4
448.000	75.5	2055/2	-166.4	110.6	77.0	2223/4	800.6	261.3

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN G-35

AXIAL STRESS	600 PSI	AXIAL ELASTIC STRAIN	-254.6 MICRO-UNITS
RADIAL STRESS	3600 PSI	RADIAL ELASTIC STRAIN	524.4 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	77.0	2218/2	0.0	0.0	77.0	2173/2	0.0	0.0
0.000	77.0	2396/2	-254.6	-.0	77.0	3480/4	525.2	.9
.125	77.0	2413/2	-279.9	-25.3	77.0	3290/4	624.9	100.2
.250	77.0	2416/2	-284.4	-29.8	77.0	3246/4	647.2	122.7
.500	77.0	2419/2	-288.9	-34.9	77.0	3215/4	662.7	137.9
1.000	75.5	2427/2	-300.9	-47.3	75.5	3142/4	698.7	173.8
2.000	76.3	2430/2	-305.5	-52.0	76.3	3090/4	723.8	198.5
3.000	75.5	2434/2	-311.5	-58.0	75.5	3044/4	745.7	219.9
4.021	74.7	2437/2	-316.0	-62.6	74.7	3013/4	760.2	234.8
5.375	74.7	2438/2	-317.5	-64.1	74.7	2974/4	778.3	252.9
6.042	74.7	2438/2	-317.5	-63.5	74.7	2963/4	783.4	258.6
7.000	75.5	2440/2	-320.6	-65.8	75.5	2946/4	791.2	266.2
14.071	75.5	2448/2	-332.7	-77.4	75.5	2861/4	829.4	304.3
21.062	75.5	2452/2	-338.8	-84.2	75.5	2785/4	862.7	338.0
28.062	74.0	2456/2	-344.8	-90.0	74.7	2731/4	885.8	360.5
56.042	75.5	2465/2	-358.6	-104.6	74.7	2590/4	943.9	418.9
84.063	75.5	2470/2	-366.2	-112.2	75.5	2517/4	972.8	447.4
115.071	74.7	2477/2	-377.0	-122.5	74.0	2434/4	1004.7	479.9
140.083	74.7	2481/2	-383.1	-129.3	76.3	2392/4	1020.4	494.9
169.000	74.7	2483/2	-386.2	-132.1	1.3	2346/4	1037.3	511.4
196.000	74.7	2490/2	-397.0	-144.4	75.5	2291/4	1057.0	530.6
225.000	76.3	2498/2	-409.3	-158.5	77.0	2177/4	1096.5	568.1
252.000	76.3	2498/2	-409.3	-160.7	77.0	2161/4	1101.9	572.0
280.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
308.000	74.7	2501/2	-414.0	-168.3	77.0	2076/4	1129.8	596.1
336.000	76.3	2501/2	-414.0	-170.1	77.0	2050/4	1138.1	602.6
-364.000	75.5	2504/2	-418.7	-175.9	75.5	2010/4	1150.7	614.1
364.000	75.5	2349/2	-185.5	57.3	75.5	3202/4	669.2	132.6
364.125	75.5	2344/2	-178.2	64.6	75.5	3257/4	641.7	105.1
364.250	75.5	2342/2	-175.3	67.5	75.5	3265/4	637.6	101.0
364.500	75.5	2341/2	-173.8	68.9	75.5	3270/4	635.1	98.5
365.000	75.5	2340/2	-172.4	70.3	75.5	3280/4	630.0	93.2
366.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
367.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
368.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
369.000	75.5	2334/2	-163.7	79.0	75.5	3309/4	615.2	78.8
370.000	75.5	2333/2	-162.2	80.2	75.5	3310/4	614.7	77.9
371.000	75.5	2333/2	-162.2	80.1	75.5	3314/4	612.6	75.7
378.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
385.000	74.7	2327/2	-153.6	87.2	74.7	3347/4	595.6	57.1
392.000	76.3	2326/2	-152.1	89.0	76.3	3363/4	587.3	49.2
420.000	75.5	2320/2	-143.5	96.2	75.5	3397/4	569.5	29.8
448.000	75.5	2320/2	-143.5	95.7	76.3	3405/4	565.3	25.7

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN H-1

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	73.2	2084/2	0.0	0.0	74.7	2119/2	0.0	0.0
0.000	73.2	2084/2	0.0	0.0	74.7	2119/2	0.0	0.0
1.000	74.0	2088/2	-5.2	0.0	75.5	2116/2	3.9	0.0
2.000	72.5	2089/2	-6.5	0.0	74.0	2117/2	2.6	0.0
3.000	72.5	2089/2	-6.5	0.0	74.0	2117/2	2.6	0.0
4.000	72.5	2090/2	-7.8	0.0	74.0	2117/2	2.6	0.0
5.000	72.5	2091/2	-9.1	0.0	74.0	2118/2	1.3	0.0
6.000	73.2	2091/2	-9.1	0.0	74.0	2117/2	2.6	0.0
7.000	74.0	2091/2	-9.1	0.0	74.0	2116/2	3.9	0.0
14.000	74.0	2093/2	-11.7	0.0	74.7	2114/2	6.6	0.0
21.000	74.7	2094/2	-13.0	0.0	74.7	2113/2	7.9	0.0
28.000	73.2	2097/2	-16.8	0.0	74.0	2114/2	6.6	0.0
56.000	74.0	2101/2	-22.1	0.0	74.0	2113/2	7.9	0.0
84.000	76.3	2103/2	-24.7	0.0	74.7	2113/2	7.9	0.0
112.000	76.3	2106/2	-28.6	0.0	77.0	2113/2	7.9	0.0
140.000	76.3	2109/2	-32.5	0.0	74.7	2113/2	7.9	0.0
168.000	74.7	2109/2	-32.5	0.0	76.3	2113/2	7.9	0.0
196.000	74.0	2110/2	-33.8	0.0	75.5	2115/2	5.3	0.0
224.000	74.0	2109/2	-32.5	0.0	75.5	2113/2	7.9	0.0
252.000	74.0	2112/2	-36.4	0.0	75.5	2114/2	6.6	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN H-14

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-340.1 MICRO-UNITS
RADIAL STRESS	3600 PSI	RADIAL ELASTIC STRAIN	571.7 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	73.2	2140/2	0.0	0.0	73.2	2169/2	0.0	0.0
0.000	74.7	2384/2	-342.2	-2.1	74.7	3221/4	574.8	3.1
.042	74.7	2417/2	-391.3	-51.2	74.7	2967/4	696.6	125.0
.250	74.7	2426/2	-404.8	-64.3	74.7	2888/4	732.5	160.8
.500	74.7	2438/2	-422.9	-82.9	74.7	2791/4	775.1	202.9
1.000	74.0	2447/2	-436.5	-96.6	74.7	2696/4	815.5	243.0
2.000	74.0	2467/2	-467.0	-126.5	74.0	2510/4	890.6	316.9
3.000	74.0	2470/2	-471.6	-131.5	74.7	2426/4	922.7	347.5
4.000	74.0	2477/2	-482.3	-140.5	74.0	2345/4	952.7	377.7
5.000	74.0	2481/2	-488.5	-146.4	74.0	2274/4	978.1	402.0
6.000	73.2	2484/2	-493.1	-149.6	74.7	2225/4	995.2	419.5
7.000	73.2	2487/2	-497.7	-153.2	74.7	2172/4	1013.2	437.3
14.000	74.7	2501/2	-519.4	-173.3	75.5	3777/8	1102.4	524.2
21.000	74.0	2514/2	-539.6	-191.0	74.7	3390/8	1156.2	574.9
28.000	74.7	2523/2	-553.6	-204.2	75.5	3051/8	1198.5	614.0
56.000	75.5	2556/2	-605.6	-250.8	76.3	2100/8	1293.4	704.6
84.000	75.5	2573/2	-632.6	-274.0	76.3	0/0	0.0	0.0
112.000	77.0	2583/2	-648.6	-284.6	78.5	0/0	0.0	0.0
140.000	77.0	2592/2	-663.0	-296.6	78.5	0/0	0.0	0.0
168.000	76.3	2600/2	-675.9	-306.9	77.7	0/0	0.0	0.0
196.000	76.3	2608/2	-688.8	-317.3	77.0	0/0	0.0	0.0
224.000	76.3	2613/2	-696.9	-324.7	77.0	0/0	0.0	0.0
252.000	76.3	2619/2	-706.7	-334.5	77.0	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN H-22

AXIAL STRESS	-0 PSI		AXIAL ELASTIC STRAIN	-333.4 MICRO-UNITS
RADIAL STRESS	3600 PSI		RADIAL ELASTIC STRAIN	630.8 MICRO-UNITS
TEST TEMPERATURE	75 F		TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.0	2234/2	0.0	0.0	74.7	2185/2	0.0	0.0
0.000	74.7	2463/2	-333.4	-.0	74.0	3308/4	631.9	1.1
.125	74.7	2500/2	-390.4	-56.9	74.0	3050/4	759.1	127.9
.250	74.7	2510/2	-405.9	-72.5	74.0	2986/4	789.0	158.0
.500	74.7	2520/2	-421.5	-88.6	74.7	2908/4	824.6	193.3
1.000	74.7	2530/2	-437.1	-104.6	74.7	2840/4	854.9	223.5
2.000	74.0	2547/2	-463.9	-131.6	74.0	2697/4	916.3	284.5
3.000	74.0	2551/2	-470.2	-137.9	74.0	2650/4	935.8	303.5
4.000	75.5	2552/2	-471.8	-139.5	75.5	2596/4	957.7	325.8
5.000	75.5	2557/2	-479.7	-147.5	75.5	2577/4	965.3	333.4
6.000	74.0	2561/2	-486.1	-153.2	74.0	2559/4	972.5	341.3
7.000	74.0	2563/2	-489.2	-155.7	74.7	2523/4	986.7	355.3
14.000	74.7	2574/2	-506.8	-172.6	75.5	2389/4	1037.7	406.1
21.000	74.7	2581/2	-517.9	-184.5	75.5	2311/4	1066.1	434.9
28.000	75.5	2588/2	-529.2	-195.5	75.5	2231/4	1094.3	462.5
56.000	75.5	2603/2	-553.3	-220.5	76.3	2069/4	1167.2	535.8
84.000	76.3	2613/2	-569.5	-236.6	76.3	3693/8	1215.8	583.9
112.000	77.7	2621/2	-582.5	-249.1	79.2	3434/8	1251.5	620.3
140.000	77.0	2626/2	-590.6	-257.9	78.5	3272/8	1272.6	640.7
168.000	76.3	2632/2	-600.4	-267.4	78.5	3065/8	1298.0	665.7
196.000	75.5	2637/2	-608.5	-277.2	77.7	2874/8	1320.0	687.1
224.000	75.5	2640/2	-613.4	-283.8	77.7	2716/8	1337.1	702.2
252.000	75.5	2642/2	-616.7	-289.2	77.7	2585/8	1350.5	714.2

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN H-28

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	75 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	74.0	2237/2	0.0	0.0	74.0	2192/2	0.0	0.0
0.000	74.0	2237/2	0.0	0.0	74.0	2192/2	0.0	0.0
1.000	74.0	2236/2	1.4	0.0	74.0	2192/2	0.0	0.0
2.000	74.0	2235/2	2.8	0.0	74.0	2192/2	0.0	0.0
3.000	74.0	2236/2	1.4	0.0	74.0	2192/2	0.0	0.0
4.000	74.0	2237/2	0.0	0.0	74.7	2192/2	0.0	0.0
5.000	74.0	2236/2	1.4	0.0	74.7	2192/2	0.0	0.0
6.000	74.0	2237/2	0.0	0.0	74.7	2192/2	0.0	0.0
7.000	74.0	2236/2	1.4	0.0	74.7	2191/2	1.4	0.0
14.000	74.7	2236/2	1.4	0.0	74.7	2190/2	2.7	0.0
21.000	75.5	2235/2	2.8	0.0	75.5	2189/2	4.1	0.0
28.000	74.7	2237/2	0.0	0.0	74.0	2191/2	1.4	0.0
56.000	74.7	2236/2	1.4	0.0	74.7	2187/2	6.8	0.0
84.000	74.7	2234/2	4.2	0.0	74.7	2185/2	9.5	0.0
112.000	77.0	2234/2	4.2	0.0	77.0	2183/2	12.2	0.0
140.000	77.0	2233/2	5.5	0.0	76.3	2182/2	13.6	0.0
168.000	77.0	2232/2	6.9	0.0	76.3	2180/2	16.3	0.0
196.000	77.0	2231/2	8.3	0.0	76.3	2180/2	16.3	0.0
224.000	77.0	2231/2	8.3	0.0	76.3	2178/2	19.0	0.0
252.000	77.0	2231/2	8.3	0.0	76.3	2178/2	19.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN I-1

AXIAL STRESS -0 PSI
RADIAL STRESS -0 PSI
TEST TEMPERATURE 150 F

AXIAL ELASTIC STRAIN -0.0 MICRO-UNITS
RADIAL ELASTIC STRAIN -0.0 MICRO-UNITS
TEST MOISTURE AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	140.7	2148/2	0.0	0.0	144.5	2123/2	0.0	0.0
0.000	140.7	2148/2	0.0	0.0	144.5	2123/2	0.0	0.0
1.000	140.0	2153/2	-6.7	0.0	145.2	2127/2	-5.3	0.0
2.000	140.0	2156/2	-10.7	0.0	143.8	2129/2	-7.9	0.0
3.000	140.0	2158/2	-13.3	0.0	143.8	2131/2	-10.5	0.0
4.000	140.0	2160/2	-16.0	0.0	143.8	2132/2	-11.9	0.0
5.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
6.000	140.7	2166/2	-24.1	0.0	144.5	2136/2	-17.2	0.0
7.000	140.7	2167/2	-25.4	0.0	144.5	2136/2	-17.2	0.0
14.000	139.2	2178/2	-40.2	0.0	143.0	2142/2	-25.1	0.0
21.000	140.7	2181/2	-44.3	0.0	144.5	2140/2	-22.5	0.0
28.000	140.7	2185/2	-49.7	0.0	143.8	2140/2	-22.5	0.0
56.000	140.0	2194/2	-61.9	0.0	143.8	2139/2	-21.1	0.0
84.000	140.7	2197/2	-66.0	0.0	143.8	2136/2	-17.2	0.0
112.000	140.7	2200/2	-70.1	0.0	143.8	2135/2	-15.8	0.0
140.000	141.5	2200/2	-70.1	0.0	145.2	2135/2	-15.8	0.0
168.000	140.7	2203/2	-74.2	0.0	144.5	2135/2	-15.8	0.0
196.000	140.0	2202/2	-72.8	0.0	143.0	2133/2	-13.2	0.0
224.000	139.2	2202/2	-72.8	0.0	142.2	2133/2	-13.2	0.0
252.000	137.7	2207/2	-79.7	0.0	141.5	2139/2	-21.1	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN I-13

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-53.4 MICRO-UNITS
RADIAL STRESS	600 PSI	RADIAL ELASTIC STRAIN	86.8 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	147.5	2031/2	0.0	0.0	146.0	2064/2	0.0	0.0
0.000	147.5	2073/2	-53.4	-.0	146.0	3990/4	86.8	.0
.125	145.2	2075/2	-56.0	-1.6	143.8	3988/4	88.1	1.2
.250	145.2	2074/2	-54.7	-.4	143.8	3981/4	92.4	5.9
.500	145.2	0/0	0.0	0.0	0.0	0/0	0.0	0.0
1.000	145.2	2051/2	-25.3	30.3	0.0	0/0	0.0	0.0
2.000	145.2	2042/2	-13.9	46.3	0.0	0/0	0.0	0.0
3.000	145.2	2044/2	-16.4	44.9	0.0	0/0	0.0	0.0
4.000	145.2	0/0	0.0	0.0	0.0	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN I-16

AXIAL STRESS -0 PSI
RADIAL STRESS 3600 PSI
TEST TEMPERATURE 150 F

AXIAL ELASTIC STRAIN -350.6 MICRO-UNITS
RADIAL ELASTIC STRAIN 549.7 MICRO-UNITS
TEST MOISTURE AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	147.5	2118/2	0.0	0.0	148.2	2150/2	0.0	0.0
0.000	147.5	2370/2	-350.6	-.0	148.2	3374/4	550.7	1.0
.125	144.5	2422/2	-427.8	-75.9	146.7	3129/4	674.2	125.4
.250	144.5	2434/2	-445.9	-94.0	146.7	3050/4	712.0	162.9
.500	143.8	2450/2	-470.1	-118.9	146.0	2962/4	753.0	204.0
1.000	145.2	2457/2	-480.8	-129.1	146.0	2870/4	794.6	247.4
2.000	146.0	2474/2	-506.8	-150.2	147.5	2738/4	852.0	309.2
3.000	146.0	2484/2	-522.1	-165.1	147.5	2657/4	885.9	342.5
4.000	146.0	2493/2	-536.0	-177.5	147.5	2576/4	918.7	377.2
5.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
6.000	146.0	2509/2	-560.8	-200.6	147.5	2476/4	957.9	419.2
7.000	146.0	2513/2	-567.1	-202.2	147.5	2427/4	976.5	441.0
14.000	146.7	2540/2	-609.4	-240.0	146.7	2233/4	1046.5	514.7
21.000	146.0	2558/2	-637.8	-267.4	147.5	2013/4	1118.9	590.1
28.000	146.0	2573/2	-661.7	-288.6	147.5	0/0	0.0	0.0
56.000	146.0	2613/2	-726.0	-339.8	147.5	0/0	0.0	0.0
84.000	147.5	0/0	0.0	0.0	147.5	0/0	0.0	0.0
112.000	146.7	0/0	0.0	0.0	147.5	0/0	0.0	0.0
140.000	146.7	0/0	0.0	0.0	148.2	0/0	0.0	0.0
168.000	146.7	0/0	0.0	0.0	148.2	0/0	0.0	0.0
196.000	144.5	0/0	0.0	0.0	147.5	0/0	0.0	0.0
224.000	143.8	0/0	0.0	0.0	146.7	0/0	0.0	0.0
252.000	143.0	0/0	0.0	0.0	145.2	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN I-21

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
RADIAL STRESS	-0 PSI	RADIAL ELASTIC STRAIN	-0.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	143.8	2050/2	0.0	0.0	146.7	2221/2	0.0	0.0
0.000	143.8	2050/2	0.0	0.0	146.7	2221/2	0.0	0.0
1.000	143.0	2056/2	-7.6	0.0	146.7	2225/2	-5.5	0.0
2.000	143.0	2057/2	-8.9	0.0	146.7	2228/2	-9.7	0.0
3.000	143.0	2058/2	-10.2	0.0	146.7	2229/2	-11.0	0.0
4.000	143.0	2058/2	-10.2	0.0	146.7	2230/2	-12.4	0.0
5.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
6.000	143.8	2062/2	-15.3	0.0	146.7	2233/2	-16.6	0.0
7.000	143.8	2063/2	-16.6	0.0	146.7	2233/2	-16.6	0.0
14.000	142.2	2071/2	-26.8	0.0	146.0	2240/2	-26.3	0.0
21.000	143.8	2073/2	-29.4	0.0	146.0	2240/2	-26.3	0.0
28.000	143.8	2076/2	-33.3	0.0	146.7	2243/2	-30.4	0.0
56.000	143.8	2085/2	-44.9	0.0	146.7	2250/2	-40.2	0.0
84.000	143.8	2091/2	-52.6	0.0	146.7	2253/2	-44.4	0.0
112.000	143.8	2095/2	-57.8	0.0	146.7	2255/2	-47.2	0.0
140.000	145.2	2099/2	-63.0	0.0	147.5	2257/2	-50.0	0.0
168.000	145.2	2102/2	-66.9	0.0	147.5	2258/2	-51.4	0.0
196.000	142.2	2103/2	-68.2	0.0	146.0	2257/2	-50.0	0.0
224.000	143.0	2105/2	-70.8	0.0	146.7	2257/2	-50.0	0.0
252.000	140.7	2112/2	-80.0	0.0	140.7	2262/2	-57.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN I-27

AXIAL STRESS	-0 PSI	AXIAL ELASTIC STRAIN	-100.9 MICRO-UNITS
RADIAL STRESS	1200 PSI	RADIAL ELASTIC STRAIN	147.0 MICRO-UNITS
TEST TEMPERATURE	150 F	TEST MOISTURE	AS CAST

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	147.5	2193/2	0.0	0.0	146.7	2128/2	0.0	0.0
0.000	147.5	2266/2	-100.9	.0	146.7	4027/4	147.0	-.0
.125	146.0	2275/2	-113.6	-11.4	172.2	2015/2	145.1	-1.0
.250	147.5	2277/2	-116.4	-14.2	145.2	2012/2	148.9	2.4
.500	146.7	2279/2	-119.2	-17.7	145.2	2009/2	152.6	6.2
1.000	147.5	2279/2	-119.2	-17.2	146.0	2007/2	155.1	10.5
2.000	146.7	2282/2	-123.5	-16.6	146.0	2005/2	157.6	17.5
3.000	146.7	2287/2	-130.5	-23.2	146.7	2001/2	162.6	21.8
4.000	146.7	2292/2	-137.6	-28.8	146.7	3991/4	169.4	30.5
5.000	0.0	0/0	0.0	0.0	0.0	0/0	0.0	0.0
6.000	146.7	2298/2	-146.2	-35.6	146.7	3986/4	172.5	36.4
7.000	147.5	2299/2	-147.6	-32.4	146.7	3980/4	176.2	43.3
14.000	146.7	2310/2	-163.3	-43.6	146.7	3973/4	180.5	51.3
21.000	146.7	2316/2	-171.9	-51.2	146.7	3965/4	185.4	59.2
28.000	146.0	2322/2	-180.6	-57.1	146.7	3952/4	193.4	70.8
56.000	146.7	2338/2	-203.7	-67.2	146.0	3935/4	203.8	94.8
84.000	146.7	2344/2	-212.4	-78.1	146.0	3923/4	211.1	101.3
112.000	146.7	2346/2	-215.3	-80.4	146.0	3916/4	215.3	107.5
140.000	147.5	2347/2	-216.7	-83.5	147.5	3904/4	222.6	116.7
168.000	147.5	2346/2	-215.3	-82.1	147.5	3902/4	223.8	120.2
196.000	146.0	2287/2	-130.5	3.1	145.2	3928/4	208.0	105.0
224.000	145.2	2077/2	153.5	287.0	143.8	0/0	0.0	0.0
252.000	144.5	0/0	0.0	0.0	143.8	2067/2	79.3	-23.7

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME

STRAIN AND TEMPERATURE DATA AFTER LOADING

SPECIMEN I-30

AXIAL STRESS -0 PSI
RADIAL STRESS 3600 PSI
TEST TEMPERATURE 150 F

AXIAL ELASTIC STRAIN -376.7 MICRO-UNITS
RADIAL ELASTIC STRAIN 629.4 MICRO-UNITS
TEST MOISTURE AIR DRY

	AXIAL GAGE				RADIAL GAGE			
TIME (DAYS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)	TEMP (F)	READ/DIV (FREQ)	TOT STRAIN (MIC-UNITS)	CREEP* (MIC-UNITS)
0.000	149.0	3900/4	0.0	0.0	149.0	3966/4	0.0	0.0
0.000	149.0	2240/2	-376.7	-.0	149.0	2754/4	631.2	1.8
.125	146.7	2347/2	-528.8	-151.2	146.7	2226/4	835.0	205.6
.250	146.7	2368/2	-559.5	-181.9	146.7	2080/4	883.7	254.6
.500	146.7	2391/2	-593.5	-216.4	146.7	3754/8	946.0	316.5
1.000	147.5	2416/2	-630.7	-251.8	147.5	3328/8	1004.4	375.8
2.000	149.0	2441/2	-668.4	-284.9	149.0	2769/8	1070.5	445.2
3.000	149.0	2460/2	-697.2	-312.6	149.0	3283/8	1010.2	384.6
4.000	149.0	2475/2	-720.2	-332.2	149.0	2051/8	1137.5	514.3
5.000	149.7	2486/2	-737.1	-346.9	0.0	0/0	0.0	0.0
7.000	149.7	2503/2	-763.4	-372.1	0.0	0/0	0.0	0.0
14.000	149.0	2531/2	-807.1	-412.7	0.0	0/0	0.0	0.0
21.000	149.0	2569/2	-867.2	-462.8	0.0	0/0	0.0	0.0
28.000	149.0	2569/2	-867.2	-457.2	0.0	0/0	0.0	0.0

* CREEP STRAIN = TOTAL STRAIN - ELASTIC STRAIN - AVERAGE SHRINKAGE STRAIN AT TIME