EXPERIMENTAL TESTING OF HOLLOW CIRCULAR SECTION BEARING CAPACITY

by

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ABSTRACT

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More and more, Overhead Tri-Chord Signing Structures are being used in the United States. The most common type includes a circular hollow structural section loaded through a strut with a Tee- shaped cross-section. This poses a problem in that the sidewall bearing limit state for this particular case is not currently treated in the existing design specifications. There are, however, many similar cases that are given consideration in the present specifications. However, it is not clear that these provisions are portable to the case previously described.

The purpose of this research is three-fold: First to determine the capacity of a particular HSS-ST connection through full-scale experimental testing in the Watkins-Hagaart Structural Engineering Laboratory at the University of Pittsburgh; second to evaluate the effectiveness of modifying the existing specification capacity equations for similar cases to fit the aforementioned connection geometry; and third, to use the results to validate nonlinear finite element modeling techniques being performed as part of a follow-up research program.

After testing is performed it is apparent that the nominal capacity for the geometry used is 70 kips. The ultimate capacity is 96 kips, while the yield load is 30 kips. Certain modifications of

the existing specification's capacity equations are useful, however, should be used with the proper amount of care and engineering judgment.

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1.0 INTRODUCTION

The usage of Circular Hollow Structural Shapes (HSS) for many different kinds of structural applications is fast growing. Along with the pleasing look of this particular shape, it is a very effective cross-section against compressive and torsional stresses by virtue of its closed, symmetrical geometry. Although the material cost may be higher for the required grade of steel, the HSS structural performance frequently offsets this cost penalty. For instance, the surface area requiring protective coating is much smaller since the section is enclosed, the fabrication costs are kept low due to the simple joint connection and lack of stiffeners needed, and finally the HSS has greater structural efficiency, as compared with other shapes. When combined with its low drag coefficient, the HSS becomes an ideal selection for applications dealing with wind, water, or wave loadings. For these reasons in particular, the HSS is commonplace in offshore platforms, building and stadium space trusses, as well as overhead highway signing structures. It is design problems with these overhead highway-signing structures that are the center of this research being conducted at the University of Pittsburgh.

The Pennsylvania Department of Transportation (PennDOT) expressed concern about the safety of their long-span overhead highway sign structures (tri-chord sign structures) after the failure of one in District 6 (See Figure 1). During the final erection of a 180’ span structure, it experienced a “crushing failure” at the HSS-column joint. Since similar structures were to be erected in District 12 soon there after, PennDOT needed a quick fix to assure this problem would not surface again. The damaged parts from the failure in District 6 were cut out and repaired with a new piece that had a 100% greater wall thickness, and reinforced with two annular plate stiffeners added at each tower location. In addition, saddles for the HSS section to bear down upon were employed. In direct response to the District 6 failure and retrofit, similar structures in District 12 are modified to have the circular end sections filled with non-shrink grout; curved bearing saddles were also employed. Although PennDOT feels that these retrofits are enough to prevent any additional problems, a more meticulous understanding of the problem is necessary to ensure reliable designs in the future.

Figure 1 Tri-Chord Overhead Sign Structure

The focus of the current research effort is at the connection location that precipitated the structural failure in PennDOT District 6. This connection occurs at the location where the chord member attaches to the uprights of the sign. While it is that new detailing strategies have been adopted by PennDOT to hopefully eliminate the crushing failure experienced by the structure in District 6, some concerns remain. Since the reaction force at the connection saddle is transferred throughout the tri-chord span through internal shear, the concern that a similar failure could occur at the location of the first truss diagonal, nearest the chord end, seems warranted. In addition, reserve capacities in existing tri-chord systems not benefiting from the latest design and detailing modifications must be quantified in order to determine whether it is that other sign structures in the PennDOT system may be deficient.

Tubular structures such as these overhead signs may have simple joints consisting of an HSS to HSS connection, or a “plate type” connection, which can be an HSS and an open section or a connection through gusset plates. Although the HSS to HSS connection has been thoroughly researched and is understood well, not much work has been done on the “plate-type” HSS connections, which may include a T-connection, Y-connection, Cross-Connection, or a K-Connection.

For this research, the joint connection of greatest import is the configuration employing an HSS section connected to a Structural Tee (ST) (See Figure 2). This specific connection can be found in many overhead sign structures and is arranged so the HSS chords are laced together by ST sections. Although research has been performed on concentrated loads being applied on HSS walls through a gusset plate, no research has been found where the ST rests directly on an HSS section resulting in a bearing condition.

There are three main objectives in the current effort to research this particular joint connection. The first is to determine the capacity of an HSS-ST connection through testing portions of a full-scale structure. The second intent is to evaluate the efficiency of applying modified versions of the existing specifications to fit the given geometry, while the third is to validate nonlinear finite element modeling procedures to be used in future research. The present work hopes to shed some light on these cases.

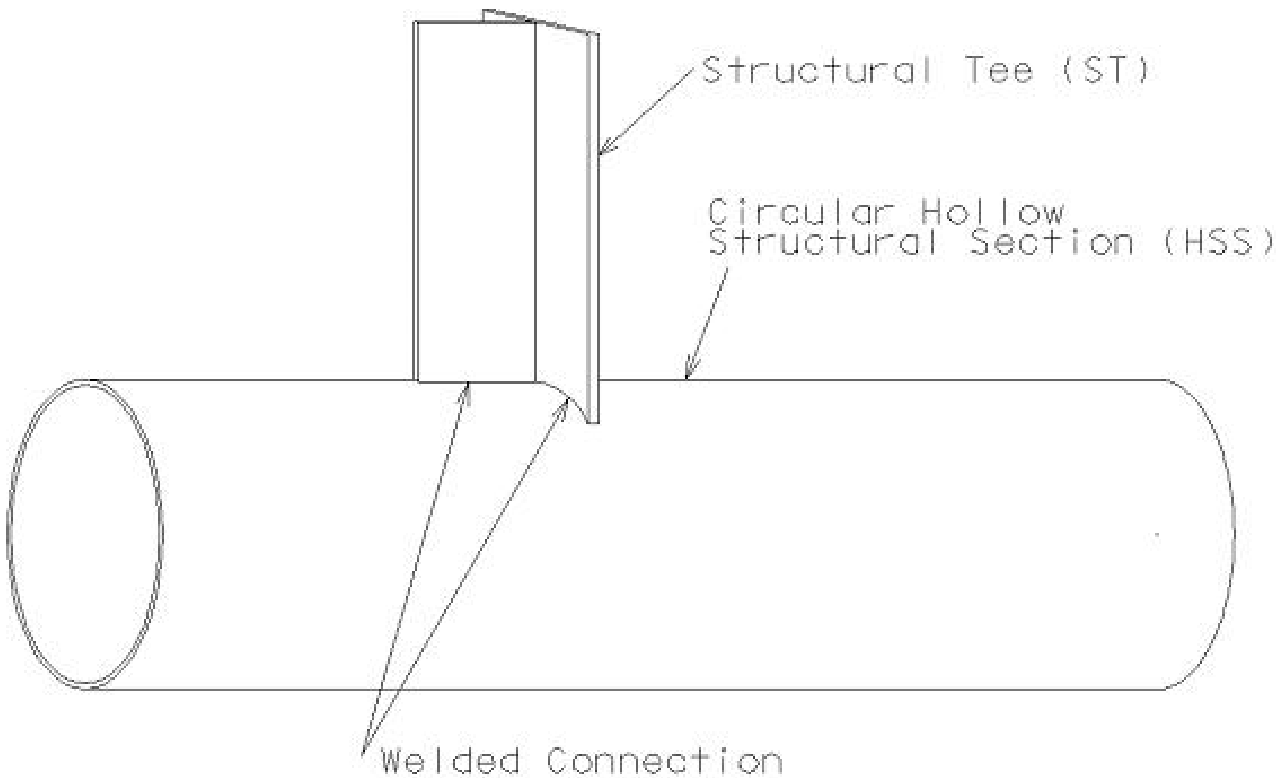


Figure 2 Joint Connection of Research

1.1 REVIEW OF EXISTING SPECIFICATIONS

Currently the specification used in the design of overhead sign structures is the *Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, 4th Edition*, which does not cover the capacity of tubular joints. The American Specification that does address this topic is the *Load and Resistance Factor Design Specification for Steel Hollow Structural Sections* (AISC 2000). This can be found in Part 16 of *AISC LRFD Manual 3d Edition* (AISC 2001). A more detailed look into this topic, however, is given in the *AISC Hollow Structural Sections Connection Manual* (AISC 1997a).

The *AISC Hollow Structural Sections Connection Manual* (AISC 1997a) provides the most up-to-date knowledge in hollow structural section connection design and detailing. Dimensions and properties of HSS members, along with welding practice, bolting issues, simple shear connections, moment connections, tension and compression connections, cap plates, base plates, column splices, and welded truss connections are all treated within this manual. Also included in this manual is the AISC 1997b or the *Specification for the Design of Steel Hollow Structural Sections* in which material properties, loads and load combinations, effective net area for tension members, local plate buckling, limiting slenderness ratios, and design for tension, compression, flexure, shear, torsion, combined loading, and the localized effects of various types of transverse loading scenarios, weld design, truss connections design, and fabrication requirements are all dealt with in detail.

The AISC 1997a has a Canadian counterpart called the CISC Hollow Structural Section Connections and Trusses Design Guide (Packer 1997), which deals with, the same topics included in the American manual as well as many others. Some of the other topics included in this Canadian Manual are material property and cross-sectional geometric definitions, standard truss design, standard truss welded connections, non-standard truss design, multiplanar welded connections, HSS-to-HSS moment connections, bolted HSS connections, fabrications, welding, and inspection, beam to HSS column connections, trusses and base plates to HSS connections, plate to HSS connections, HSS welded connections subjected to fatigue loading, and standard truss examples.

Although the context of these two manuals appears to be very similar, the manuals are in fact very different from each other. The American HSS Manual (AISC 1997a) closely follows the format and fundamental approaches that are seen in all other AISC design manuals. Meaning that while the Americans take a very general approach to the creation of design guidelines, the Canadian HSS manual (Packer 1997) is much more focused on the specific design case of the HSS truss.

The American and Canadian specifications are not the only ones that should be considered as they have both taken significant material from the Comite International pour le Developpement et l’Etude de la Construction Tubulaire (CIDECT). CIDECT, which was founded in 1962, is a worldwide organization of major HSS manufacturers that was put together in order to combine all of the resources from industry, universities, and other national and international bodies for research and application of technical data, development of simple design and calculation methods and dissemination of the results of research (Wardenier et al. 1991). Buckling behavior of columns and trusses, bending strength of members, static strength of welded and bolted joints, and fatigue resistance of joints are just some examples of the technical and research activities being conducted at CIDECT. CIDECT's publication *Design Guide for Circular Hollow Section (CHS) Joints Under Predominantly Static Loading* (Wardenier et al. 1991) is most relevant to the current research on circular HSS connections, as it contains capacity equations for many of the same, as well as many additional types of joints, as compared with the American and Canadian Specifications. This information becomes important when trying to accurately predict the capacity of Structural Tees connected at right angles to circular HSS chord members, as the research reported on herein attempts to do.

1.2 THESIS ORGANIZATION

The organization of this thesis is such that the experimental testing regimen is discussed first; this includes the specimen and load frame geometry and design, as well as the instrumentation package deployed. Then the results of the testing are reported and followed up with a discussion of the results and finally the conclusions and recommendations.

2.0 EXPERIMENTAL TESTING

The purpose of the current experimental research program being conducted at the University of Pittsburgh is to investigate the connection of a Structural Tee that bears on the sidewall of a circular HSS member. There are three main objectives in performing this research: to determine the capacity of a specific ST to HSS connection through a series of tests, to analyze the adequacy and applicability of any existing design specifications provisions related to this subject, and to validate nonlinear finite element modeling techniques.

2.1 SPECIMEN GEOMETRY AND DESIGN

Full-scale portions of a particularly large tri-chord signing structures (the connection would likely occur in a sign structure spanning between 220’ and 240’) were instrumented and tested to failure in the Watkins-Hagaart Structural Engineering Laboratory at the University of Pittsburgh Main Campus. The Sippel Company, INC. in Ambridge, PA, fabricated the specimens as well as parts of the load frame. The rest of the load frame was constructed at the University of Pittsburgh.

Two (2) identical specimens are tested under the same loading conditions to ensure repeatability. These specimens are designed exactly to match PennDOT practice for the case of a tri-chord sign structure spanning greater than 220’ as called out in BD-644M and BC-744M (PennDOT 2003a,b). The specimens employ a combination of a 26” O.D. circular HSS member having a

0.5” wall thickness and a ST10x48 vertical member oriented normally to the side wall of the HSS bearing directly upon it. Also as specified in the BD-744M (PennDOT 2003b), the specimen is supported on two saddles that are proportioned and positioned within the load frame. Generally, the testing set-up depicted in Figure 3 is designed to closely represent the connection geometry and loading configuration present in a field installation.

As a means of ensuring this reproduction of field conditions, detailed finite element models of the specimens and loading configuration were carried out as part of a preliminary design effort. After reviewing several different testing configurations, the 26” circular HSS was designed to be 7.5’ long and the ST10x48 was 2.6’ long. The HSS length was selected so that the specimen was long enough to capture the local effects of continuity in HSS sidewall provided by a 220’ + long piece as would be used in the field. The 7.5’ length was observed to be more than adequate for this purpose based on the finite element modeling results. The other requirement to pay attention to in the decision on the HSS length was the desire to have the end of Circular HSS bear firmly against the saddles and not “lift-off” as a result of pivoting around the support of an excessively short HSS section. Similarly, the length of the ST10x48 was arrived at through finite element modeling in which it became clear that 30 inches of member length would be sufficient for St. Venant’s principle to act so as to subsequently attenuate the effects of concentrations in loading occurring at the top of the ST 10x48. Additionally, the specimen was tack-welded to the saddles to further prevent “lift-off” as well as to promote stability during testing by restraining any tendency of the specimen to rotate within the saddles on the load frame.

A single circular rod is positioned at the end of the HSS section farthest from the saddles, which serves as the “pinned end” shown in Figure 3. The grade of steel used for the HSS is A53 Gr. B and the grade used for the ST10x48 is A709 Gr. 50. Exact dimensions of the specimens are presented in Figure 3. Figure 4 displays a photograph of the actual, complete test set-up used in this work.

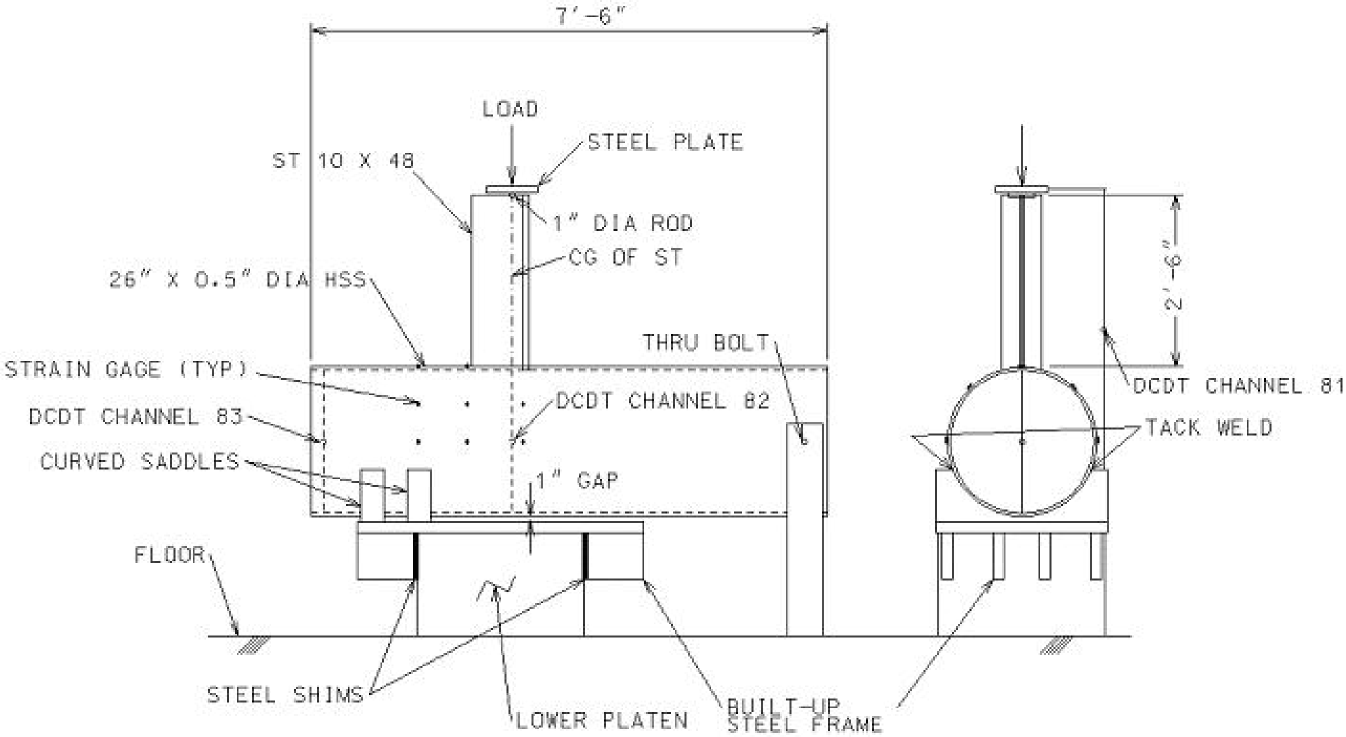


Figure 3 Schematic of Experimental Test Setup

Figure 4 Photograph of the Experimental Test Setup

2.2 INSTRUMENTATION

In order to compare the experimental test results to future finite element modeling results obtained as part of a planned parametric study, the strains at certain critical points on the HSS section need to be accurately measured. After reviewing the finite element models of the specimen geometry, it is decided that three circumferential slices along the longitudinal axis of the HSS shall contain rows of strain rosettes to capture the needed information. The first row falls directly over the saddle closest to the ST10x48; the third is directly under the ST10x48 aligned with the center of the flange; the second row of rosettes is oriented at the midpoint between the two. Rosettes are placed in each row at each 90 and 45 degree angular positions around the cross-sectional circumference; the rosettes located at the top of the HSS are possible at only certain locations, as seen in Figure 5. The third and second rosette rows, located under the ST10x48, do not have any gauges on top since the ST occupies the needed space. Three uniaxial strain gauges are also placed at the midpoint of the ST10x48 on each of the flange tips as well as on the web tip to measure the strains in the ST section.

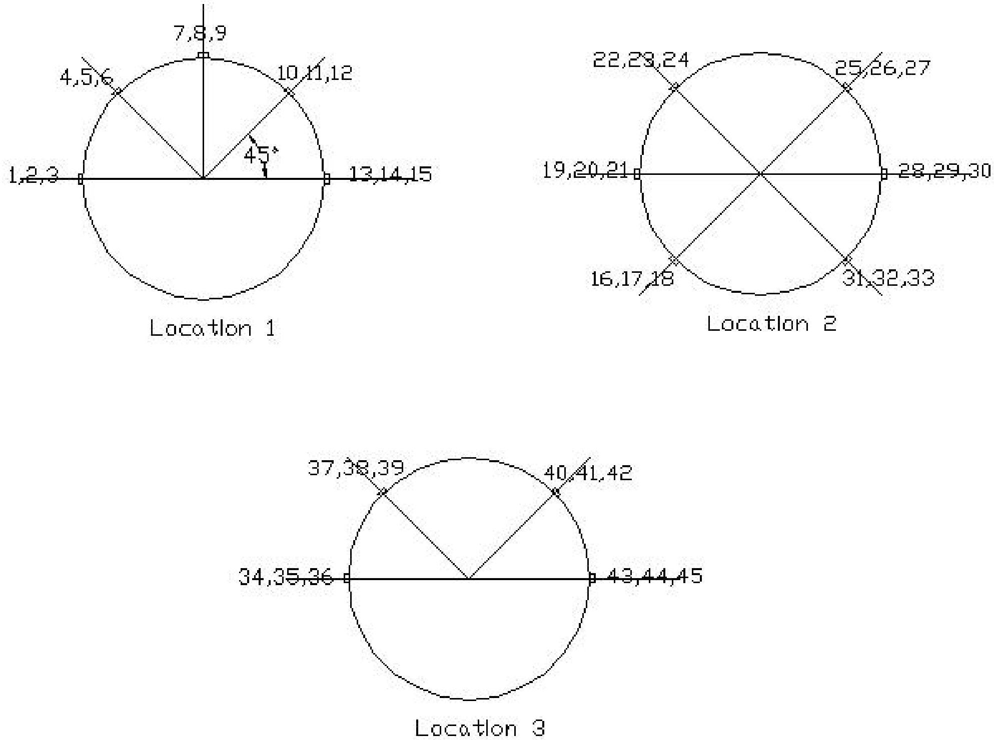


Figure 5 Rosette assignment

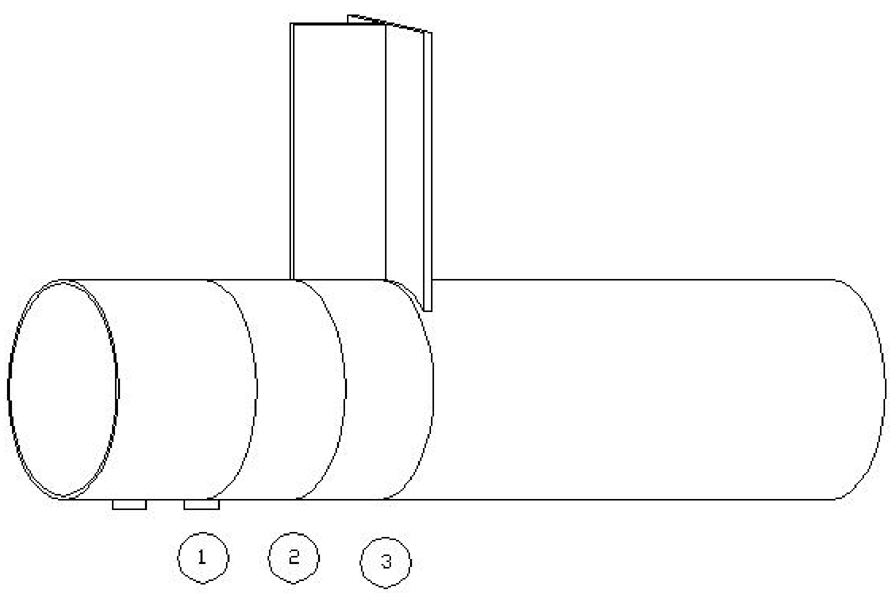


Figure 6 Rosette assignment locations

In addition to measuring the strains around the HSS-ST joint, it is important to monitor the deformations and cross-sectional distortions. Three displacement transducers (DCDTs) identified as Channels 81, 82, and 83, are used to measure displacements at different locations. The locations of the DCDTs are chosen in order to determine the fraction of the overall specimen deformation that results from local wall distortion and the fraction that came from global bending. The first DCDT, selected as Channel 81, is mounted externally to a bar that is attached to the lower platen of the loading frame, which serves as a fixed point. This DCDT also extends to the upper platen of the loading frame, and therefore measures the total displacement including global and local deformation effects within the specimen. The DCDT selected as Channel 82, is positioned inside the HSS section directly under the flange-web junction of the ST10x48. This DCDT is used to measure the relative displacement of the top and bottom walls of the HSS, which is the deflection due to local wall distortion under the ST. The final DCDT, Channel 83, is oriented inside the HSS as Channel 82 is, however this one is positioned at the open end of the HSS section directly over adjacent to the saddles. This DCDT is used to observe the ovalization effects of the load at the opening, an important observation to make when deciding whether or not to install a cap on the end of a chord member. Orientation of the DCDTs is shown in Figure 3.

2.3 TESTING PROTOCOL

Testing of the specimens was conducted in August 2003 in the Watkins-Hagaart Structural Engineering Laboratory at the University of Pittsburgh. The compressive load is applied monotonically, in 5 kip increments, to the top of the ST through an actuator. At each increment, the load is held constant so that a data acquisition system could scan and record the information from the instrumentation on the specimen. In order to ensure minimal eccentricities in the loading to the ST, a semi-circular notch is cut into the ST stem directly at the centroid of the cross-section. A ¾" diameter rod (which fits into the notch) is welded onto the center of a steel plate which then is inserted into the space between the actuator and the top of the ST such that the bar fits into the centroidal notch in the ST. This set up guarantees that any moments will be released instead of passing into the load cell in the testing machine.

Upon completion of the specimen testing, coupons are tested in order to determine the actual mechanical properties of the steel used in the specimens. Three samples are cut from each HSS top section as well as the flanges and web of the ST. These samples are then taken to the machine shop at the University of Pittsburgh where they are cut down to the size and shape required by ASTM standards. After uniaxial strain gauges are applied to the midpoint of each coupon, they are tested to failure in the same laboratory as the specimens. The load is applied again in 5 kip increments so the strain reading from a Micro-measurements P-3500 strain indicator device can be recorded. The strains are then plotted against the stress for each coupon and the Elastic Modulus is calculated. This will be discussed further in the Results section of the thesis.

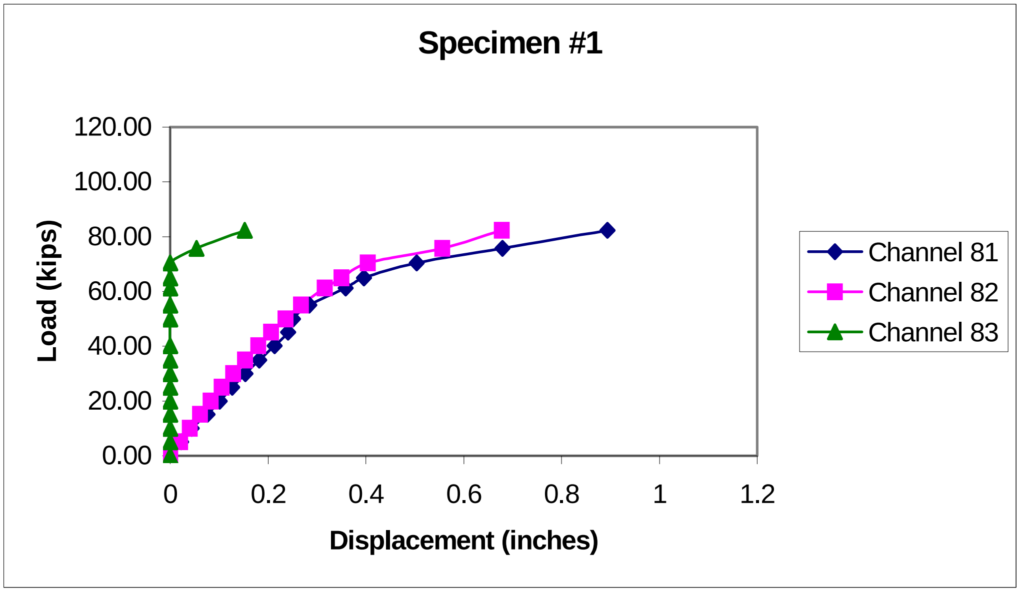
3.0 RESULTS

Testing of both specimens was completed without any considerable setbacks. However, while performing the test on Specimen #1, the thru bolt serving as the pinned end yielded from a bending overstress. At approximately 60% of ultimate, the bolt began to yield, causing the pinned end to sag slightly. A direct effect of this yielding occurred when a tack weld between the HSS and the outside saddle broke, allowing some rotation. This unwanted rotation caused some eccentricity and moment to be applied to the joint. Despite this glitch, the testing was continued until failure in the HSS sidewall occurred. It is a possibility that the ultimate load was compromised due to the addition of the moment into the ST emanating from the additional rotations occurring as a result of the sagging rod. Since the resulting ultimate load was slightly lower than that of Specimen #2, it was felt that more attention should be focused on the ramifications of the bar yielding on the test capacity. This possibility will be talked about further in the Discussion of Results section.

The original thru bolt was designed only for shear. However, in the testing of Specimen 1, the bolt experienced failure in bending, as this case had not been considered. To ensure that this problem did not surface again in the testing of Specimen 2, the bolt was redesigned for bending. The new design required a diameter that was deemed too large, so stiffening bars were welded to the inside of the HSS to decrease the length of the bolt and add strength. This design was again checked in bending and was considered an adequate final design. Since the design for Specimen

1 was adequate in shear, it was obvious that the new design would also be sufficient in shear. As a result of these changes, Specimen #2 was tested without any bolt yielding problems.

After testing was performed on the two (2) specimens, the load versus deflection data from the DCDTs was plotted (See Figures 7 and 8). The data as a whole is recorded in Appendix A. The comparison of plots from Specimen #1 and Specimen #2 shows that the increased diameter of the thru bolt and the addition of the stiffening bars had the right effect since the plot is a smoother shape. Also from this deflection data, a number of other important observations can be made.



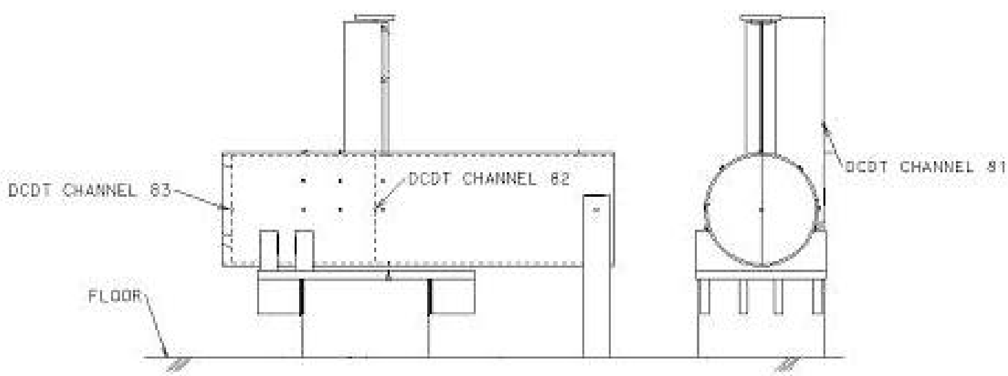
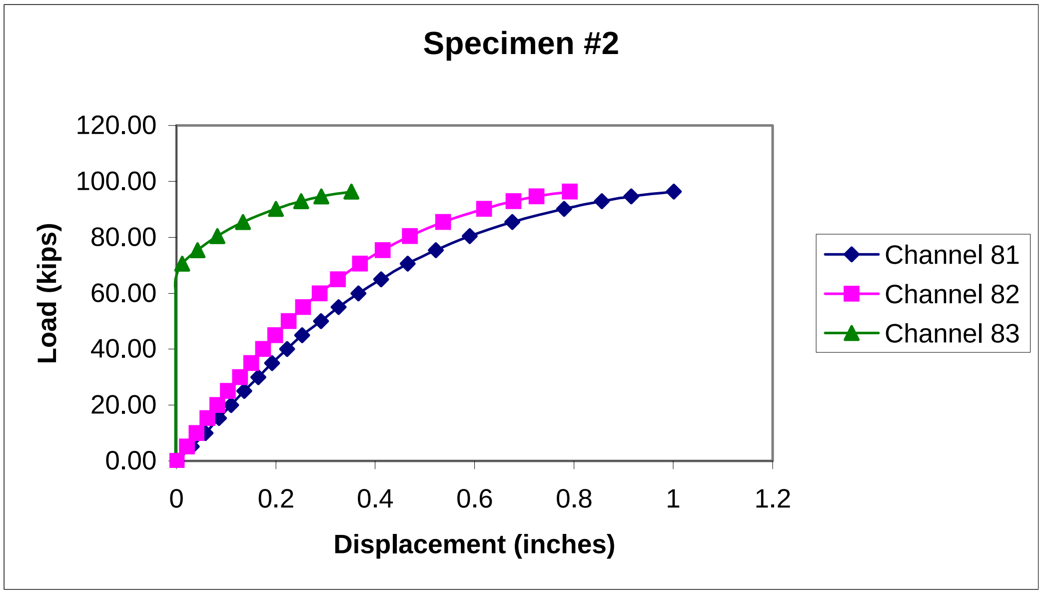


Figure 7 Specimen 1 Load versus Deflection



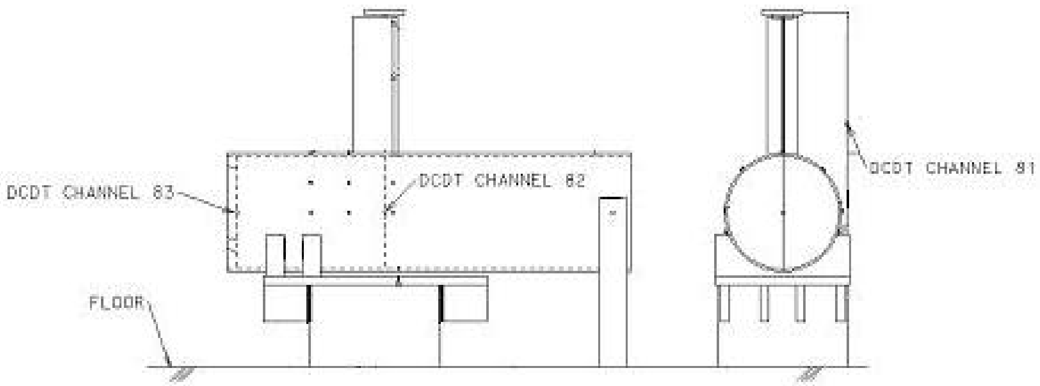


Figure 8 Specimen 2 Load versus Deflection

After reviewing the data recorded by the DCDTs, it becomes obvious that the difference in the measured displacements of Channel 81 and Channel 82 is small at any load. This observation means that the majority of the displacement is local displacement or ovalization of the HSS section, not global displacement due to overall bending of the specimen. This is arrived at since the difference between Channel 81, which measures the total deformation and Channel 82, which measures the local deformation, is so small.

When the measurements of Channels 81, 82, and 83 are analyzed, it appears that both specimens begin to yield at about 30 kips. After this point the specimen seems to be behaving non-linearly, which is also conveyed in the plot of load versus deflection. At this same load during the experimental testing, the specimen started to form small "dimples" in the HSS wall next to each of the ST flange tips, but no other sign of deformation was observed.

The ultimate load of the specimens is much higher than the yield load. Specimen #1 achieved an ultimate load of 82 kips, while Specimen #2 reached an ultimate load of 96 kips.

When Channel 83, located at the open end of the HSS, is considered, it is noted that the deflection remained zero throughout the bulk of the test. However, after a load of 70 kips is achieved, the deflection increases quickly until the ultimate load is reached not long after. It seems that a collapse mechanism is formed around 70 kips and the stability of the structure becomes questionable. Since this behavior is detected in both experimental tests, it is recommended that this 70 kip mark be considered the nominal capacity.

The coupon tests are also completed without incident. First signs of yielding are apparent when the coupons experienced a slight thinning out in the sides. The samples are pulled until failure, which occurred around 36 kips in the specimen's cut from the HSS section and 52 kips in coupons from the ST locations. Once the data were collected, the load-deflection graphs are plotted for each individual case. Each graph is studied to determine the yield stress. Since there were multiple coupons from each section of each specimen, the average of the results is taken to establish the actual Elastic Modulus. As shown in Table 1, the elastic moduli for the HSS sections are found to be much lower than expected. Although this may seem puzzling, there is one possible explanation. It is thought that the working of the material during rolling may have affected the crystallographic texture of the steel such that the properties in the orthogonal direction are different from the properties exhibited in the direction of rolling. This is one possible explanation for the unexpectedly low elastic modulus obtained from the HSS coupon test results. The complete set of results can be seen in Appendix C. This information becomes crucial when trying to accurately predict the behavior of these connections with finite element modeling in ABAQUS (See report by Kozy and Earls 2004). This information is also needed when predicting capacity based on methods already provided by existing specifications for related connection geometries.

Table 1 Summary of Coupon Test Results

Location	Elastic Modulus (ksi)	Min. Specified Yield Stress (ksi)	Observed Yield Stress (ksi)	Design Ultimate Stress (ksi)	Observed Ultimate Stress (ksi)
Specimen 1 Web	3.03E+07	50.00	55.11	65.00	58.44
Specimen 2 Web	3.08E+07	50.00	54.30	65.00	55.50
Specimen 1 Flange	3.05E+07	50.00	51.50	65.00	53.78
Specimen 2 Flange	3.05E+07	50.00	52.10	65.00	58.20
Specimen 1 HSS	2.21E+07	45.00	47.00	60.00	47.68
Specimen 2 HSS	2.10E+07	45.00	47.00	60.00	54.86

4.0 DISCUSSION OF RESULTS

As previously stated, it is believed that the ultimate load of Specimen #1 may be somewhat compromised based on the yielding of the thru bolt at the pinned end of the specimen. In order to determine whether or not the results are affected significantly by this yielding, calculations are performed to establish just how much bending moment is present throughout the test. The following tables and figures display the outcome of these calculations. The calculations are based on elementary flexural theory wherein Navier's plane section hypothesis is enforced. Since we have uniaxial strain gauges located at the extreme fibers of the mid-height cross-sectional slice of the ST, it becomes possible to use superposition of the uniform compressive stress field in conjunction with the linearly varying stress field to back calculate the bending moment as well as the loading eccentricities inducing this effect. Tables 2 and 3 list the results from these calculations at each specific load level while figures 9 through 12 display the results graphically.

Table 2 Specimen 1 Bending Moments and Eccentricities

	Strains		Bending Moment (lb-in)		Eccentricities (in.)	
Load (lbs)	Strain Web	Strain Flange	Moment Web	Moment Flange	Web	Flange
0	4.7625E-07	7.12742E-07	293.7988164	-993.1705648	#DIV/0!	#DIV/0!
5100	1.4287E-05	1.04826E-05	1497.94388	1918.073039	0.293714486	0.376092753
10000	2.7622E-05	2.16809E-05	2694.968794	2190.776522	0.269496879	0.219077652
15100	4.2861E-05	3.19255E-05	4779.973352	4440.533636	0.316554527	0.294075075
20000	5.8099E-05	4.16915E-05	7151.589096	6709.130009	0.357579455	0.3354565
25000	7.3337E-05	5.24107E-05	9379.469053	7973.421264	0.375178762	0.318936851
30000	8.9051E-05	6.28905E-05	11900.80895	9571.324351	0.396693632	0.319044145
35000	0.00010334	7.28951E-05	13540.6306	11831.54832	0.38687516	0.338044238
40200	0.00012	8.43278E-05	16361.94763	12749.59917	0.407013623	0.317154208
45100	0.00013619	9.38569E-05	19319.5499	15348.38894	0.428371395	0.340319045
50000	0.00015285	0.000103623	22570.53769	17616.46083	0.451410754	0.352329217
55000	0.00017094	0.000113149	26558.83001	20544.36217	0.482887818	0.373533858
61200	0.00019998	0.000122684	35580.07501	27347.06702	0.581373775	0.4468475
65000	0.00021522	0.000129594	39526.67279	30030.04083	0.608102658	0.462000628
70400	0.00024568	0.000135537	50574.88629	39246.43831	0.718393271	0.557477817
82300	0.00027996	0.000156984	54646.85205	47919.22361	0.663995772	0.582250591
75700	0.0002909	0.000167721	70868.00097	11573.213	0.936169101	0.152882602

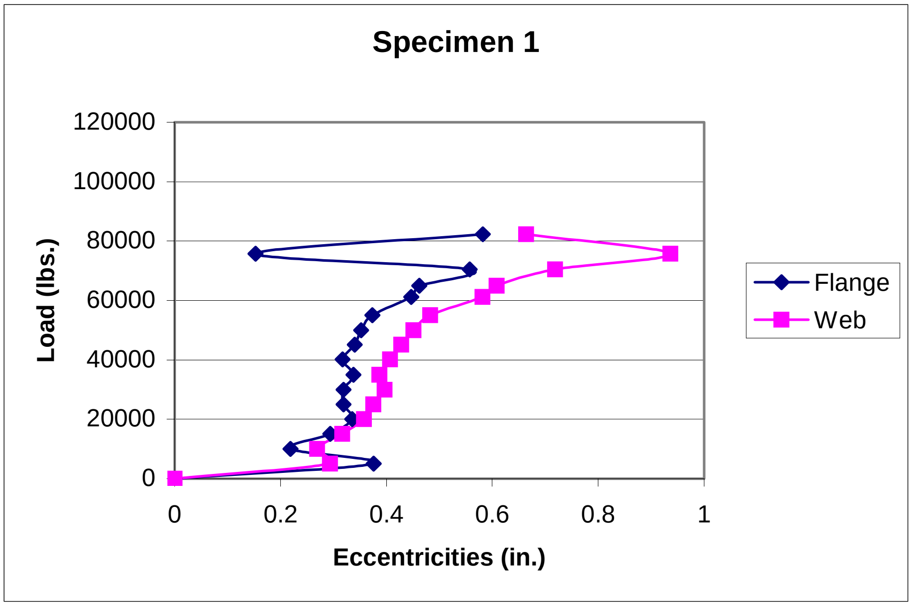


Figure 9 Load versus Eccentricity – Specimen 1

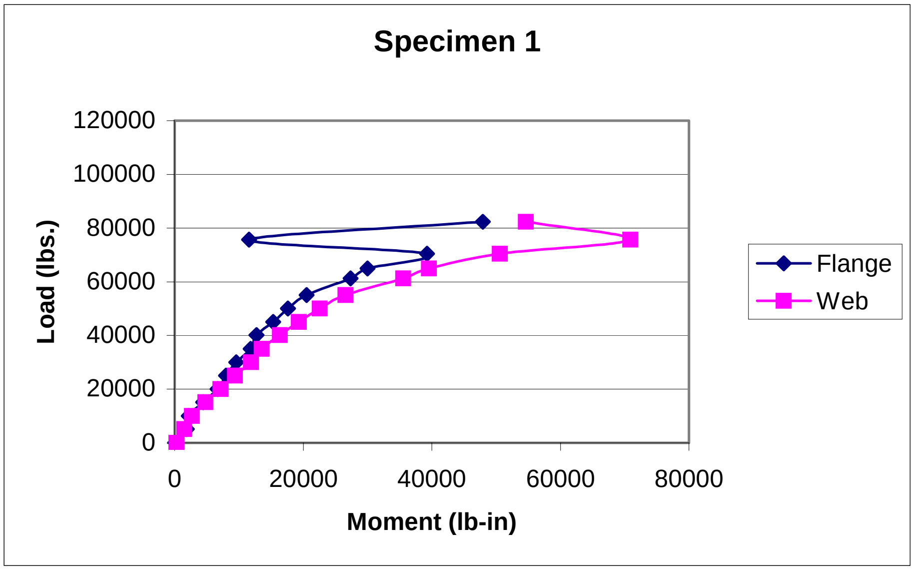


Figure 10 Load versus Moment – Specimen 1

Table 3 Specimen 2 Bending Moments and Eccentricities

	Strains		Bending Moment (lb-in)		Eccentricities (in.)	
Load (lbs)	Strain Web	Strain Flange	Web	Flange	Web	Flange
0	-2.36173E-06	-1.2331E-06	-1464.12275	1726.71554	#DIV/0!	#DIV/0!
5100	1.08638E-05	1.02719E-05	-581.023276	2141.2826	-0.11392613	0.419859333
10000	2.50337E-05	2.01835E-05	1174.37607	4138.97	0.117437607	0.413897
15300	3.87308E-05	3.15046E-05	2062.92928	5459.15348	0.134831979	0.356807417
20000	5.24275E-05	4.18857E-05	3811.94366	6151.46324	0.190597183	0.307573162
25000	6.61239E-05	5.1782E-05	5130.37827	8494.66483	0.205215131	0.339786593
30000	8.07645E-05	6.2449E-05	7034.13369	9758.62353	0.234471123	0.325287451
35000	9.49323E-05	7.25724E-05	8644.85506	11783.7527	0.246995859	0.336678649
40000	0.000108628	8.28938E-05	9962.56728	13531.6887	0.249064182	0.338292218
45000	0.000123739	9.25324E-05	12158.302	16235.858	0.270184489	0.360796844
50000	0.000138378	0.000103353	14061.0107	17285.3429	0.281220215	0.345706857
55000	0.000152544	0.00011346	15670.7192	19332.2182	0.284922168	0.351494877
60000	0.000167654	0.000124053	17865.6304	20700.9667	0.297760507	0.345016111
65000	0.000181348	0.000134601	19182.1068	22131.7683	0.295109335	0.340488744
70600	0.000197401	0.000146315	21101.2008	23872.7827	0.298883864	0.338141398
75400	0.000210621	0.000156591	22411.3693	25036.5486	0.297233015	0.332049716
80400	0.000223841	0.000167124	23434.423	26488.8953	0.291472923	0.329463872
85400	0.000238005	0.000177913	25042.6291	27581.7993	0.293239216	0.322971889
90200	0.00025028	0.00018799	25766.7776	29023.9026	0.285662723	0.321772756
92900	0.000257834	0.000193142	26576.4543	30557.8325	0.286075934	0.328932535
94600	0.000262555	0.000196657	27064.5351	31143.4198	0.286094452	0.329211626
96300	0.00026822	0.000200643	28137.9222	31071.3086	0.292190262	0.32265118

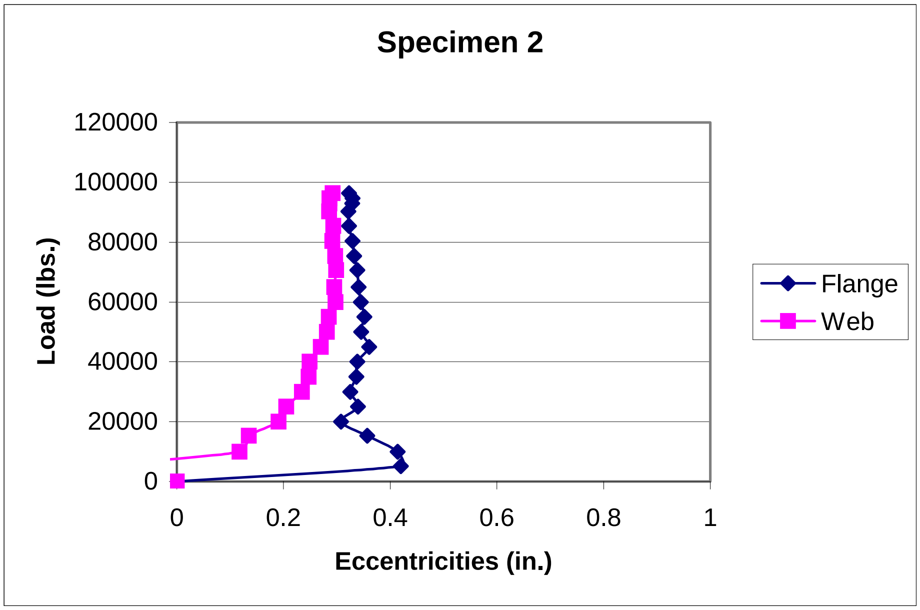


Figure 11 Load versus Eccentricity – Specimen 2

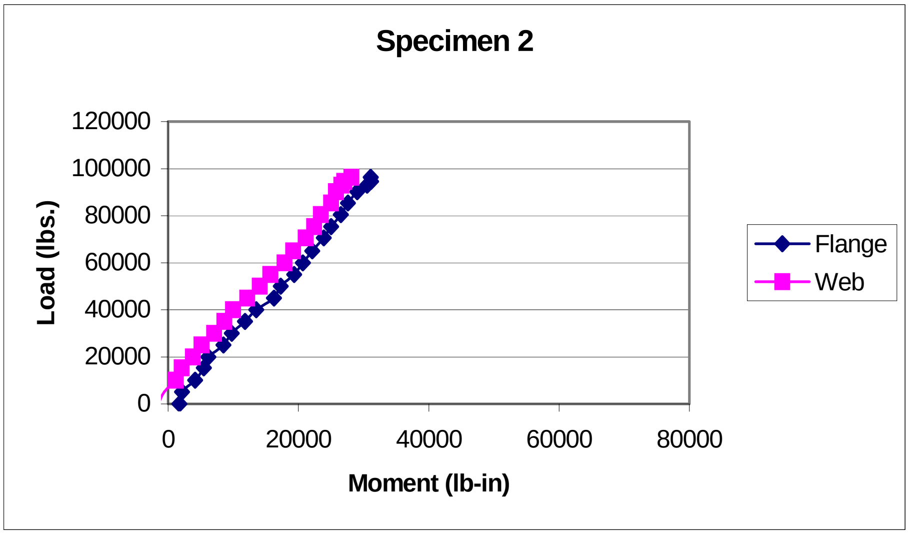


Figure 12 Load versus Moment – Specimen 2

As shown by the differences in the results from Specimens 1 and 2, the yielding of the thru bolt significantly affects the outcome of the experimental tests. It is believed that the introduction of this moment when the bolt yielded around the 70 kip load level in Specimen 1 caused the specimen to fail somewhat earlier than Specimen 2. As a result the ultimate capacity of this connection geometry might best be considered as 96 kips rather than the average of the two specimens. Seeing as the ultimate load was so much higher than the yield load, it appears that there is a lot of reserve capacity within the specimen that should be taken into account in any efficient design. From these observations it should be noted that designing these joints to prevent all yielding would be too costly, not to mention unnecessary. More will be said about this in what follows.

4.1 METHODS FOR PREDICTING BEARING CAPACITY

As previously stated, the HSS-ST joint configuration was selected for this study because of the lack of existing knowledge about this specific connection. Although the behavior of this particular joint is basically unknown, there has been research performed on similar joint connections such as HSS-I and HSS-plate connections. Capacity equations from the existing research were developed, and similarities were looked into in order to predict the capacity of the Structural Tee end-connected to a circular HSS.

4.1.1 Method 1

Section 8 of the LRFD HSS specification (AISC 2000) addresses capacity equations for a concentrated force being applied to unstiffened HSS wall through a single bearing plate. To validate this scenario, the Structural Tee can be looked at as two separate plates: one longitudinal and one traverse to the HSS axis. Sections 8.1 and 8.2 provide the equations for plates in the transverse and longitudinal directions respectively (See figures 13, 14). This case can be applied correctly if it is assumed that the capacity of the total ST is the capacity of its longitudinal and transverse components summed together. This approach does however exclude the interaction of the two plates, which may prove to be a problem.

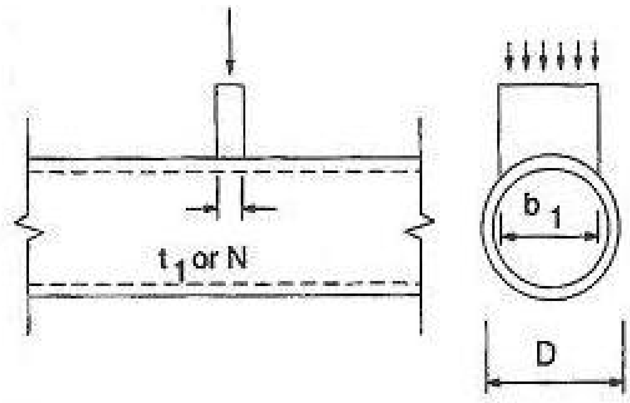


Figure 13 Concentrated Force Distributed Transversely (AISC 2000)

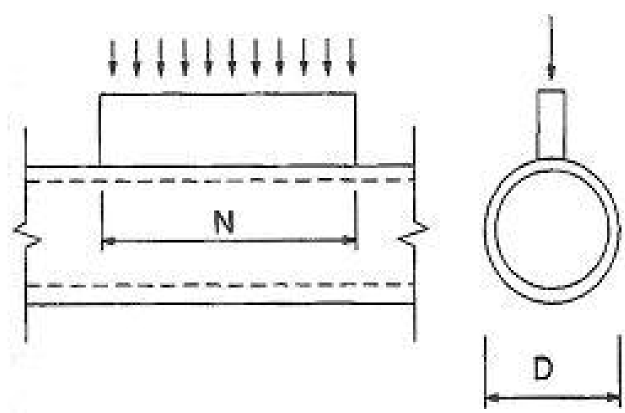


Figure 14 Concentrated Force Distributed Longitudinally

The capacity of the flange of the ST, or plate in the transverse direction, is calculated using the equation from Section 8.1:

$$R_n = \frac{5F_y t^2}{1 - 0.81 b_1 / D} Q_f$$

Equation 1

Where,

b_1 ≡ the width of the load
Q_f ≡ 1.0 for tension in the HSS (for compression see eqn. 8.1-1 in AISC (2000))
F_y ≡ specified minimum yield strength of the HSS
t ≡ HSS wall thickness
D ≡ HSS diameter

The capacity for the stem of the ST, or longitudinal component, is calculated using the equation from Section 8.2:

$$R_n = 5F_y t^2 (1 + 0.25N / D) \cdot Q_f$$

Equation 2

Where,

N ≡ the bearing length of the load
Q_f ≡ 1.0 for tension in the HSS (for compression see eqn. 8.1-1 in AISC (2000))
F_y ≡ specified minimum yield strength of the HSS
t ≡ HSS wall thickness
D ≡ HSS diameter

This method is identical to that in the "Factored Connection Resistance" equations in table 11.2 of the Canadian HSS manual (Packer 1997) and also the "Design Strength" equations shown in Figure 25 if the CIDECT Design Guide (Wardenier et al. 1991). However, the Canadian manual also treats the case of a cruxiform, or X-shaped open section with plates in both transverse and longitudinal directions. It is stated in this manual that since the transverse plate is so much stronger than the longitudinal plate, the cruxiform is not considered to be any stronger than a simple transverse connection (Packer 1997). When considering the ST connection and applying this same logic it seems reasonable to estimate the capacity of the connection by considering only that in the transverse direction. Further discussion of this will take place in the later sections.

4.1.2 Method 2

The second type of joint that can be considered similar to the ST connection is that of the HSS to HSS connection (See figure 15). These can be called “similar” since both cases are governed by the limit state of chord wall plastification and both generate similar yield line mechanisms at failure (See Figure 16). Unlike the ST connection however, the HSS-HSS connection has been well researched and capacity equations have been published in American, Canadian, and CIDECT references.

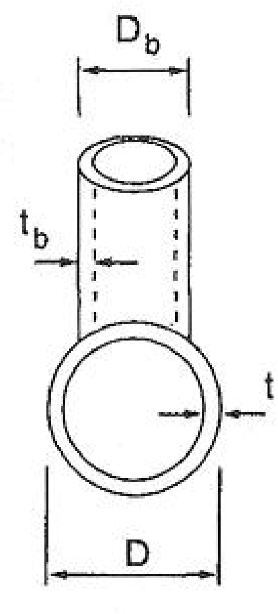


Figure 15 HSS to HSS Truss Connection

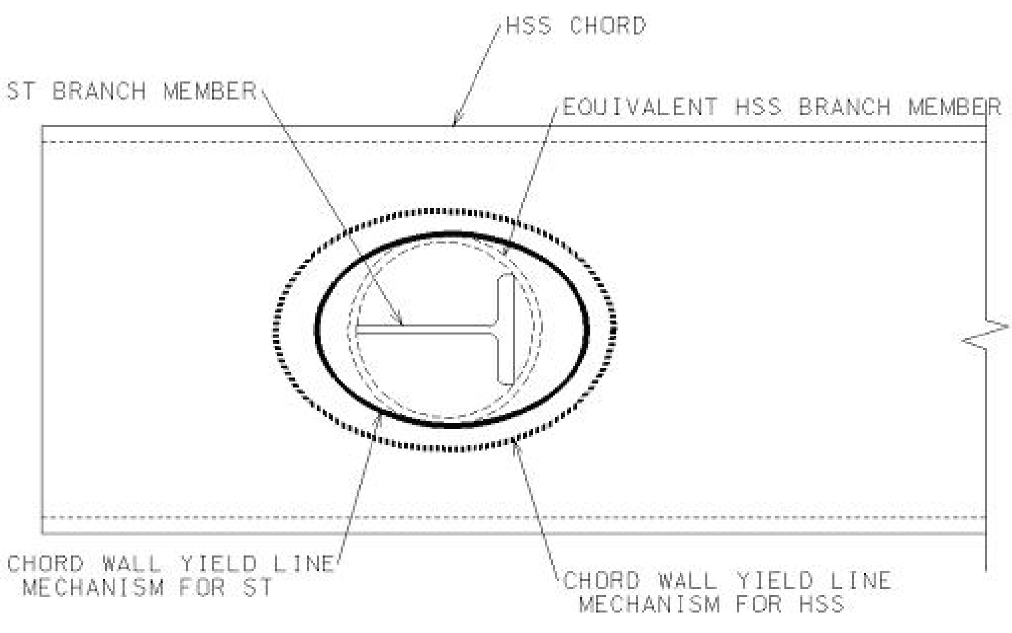


Figure 16 Yield Line Mechanisms for ST and Equivalent HSS Branch Members

The LRFD HSS specification (AISC 2000) shows the terms that concern the axially loaded circular HSS-to-HSS Truss connection in Section 9.4. In subsection 2b the limit state of chord wall plastification is given for branches with axial loads. The capacity equation for this is given:

$$P_n \sin\theta = t^2 F_y (6\pi \cdot \beta \cdot Q_q) \cdot Q_f$$

Equation 3

Where,

θ ≡ Angle between the branch and chord
β ≡ Branch Diameter / Chord Diameter
Q_q ≡ see Eqn. 9.4-3 in (AISC 2000)
Q_f ≡ see Eqn. 9.4-3 in (AISC 2000)

In order for this method to be applicable for an ST as well as the HSS, a comparable branch diameter must be calculated. This diameter must be such that it will generate similar yield lines to that of the HSS section at failure. It seems logical to use a diameter that will exactly encompass the ST footprint (See Figure 17). A general formula that can be used to calculate such diameter is

$$D_{b,eq} = b_f^2 / 4d + d \qquad \text{[for bf<2d]}$$

Equation 4

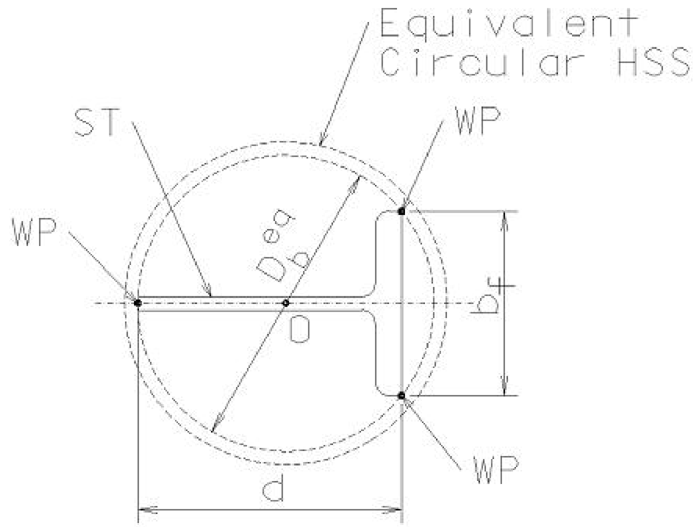


Figure 17 Equivalent Circular HSS Diameter

4.1.3 Method 3

The third joint that can be compared to the ST joint connection is the use of a wide flange I-shape end connected to a circular HSS (See Figure 18). This particular joint has been researched and is published in the CIDECT Design Guide (Type XP-4). The capacity equation presented in this text makes use of equations 1 and 2 to provide the following (rewritten in LRFD format):

$$R_n = \frac{5F_y t^2}{1-0.81b_f / D} \cdot (1 + 0.25 \cdot d / D) \cdot Q_f$$

Equation 5

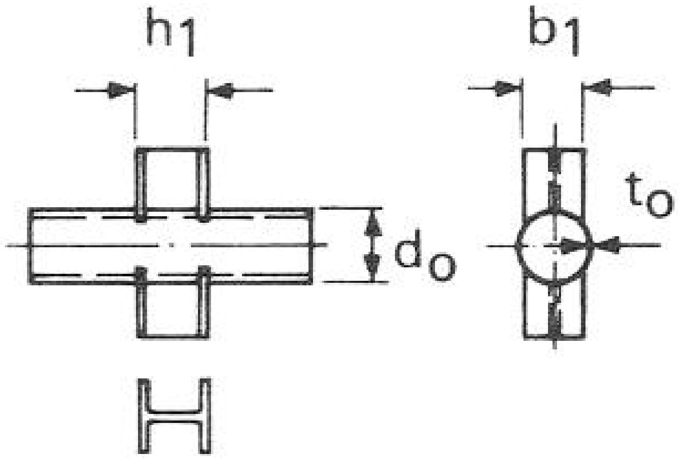


Figure 18 WT-to-HSS Joint Covered by CIDECT

4.1.4 Method 4

The last thing to consider is the limit state of punching shear in the chord wall. This limit state is considered by the American, Canadian, and CIDECT and may prove to govern depending on the geometry of the given joint. The American LRFD considers shear rupture, and will not be the focus of this topic as no rupture occurred during experimental testing. Therefore the main concentration will be on the Canadian and CIDECT as they are more easily applied. The Canadian specification (Packer 1997) uses Equation 9.19 to check the punching shear capacity. The equation has been rewritten to calculate the nominal branch axial load capacity and is as follows:

$$R_n = 1.16 F_y A \cdot t / t_p$$

Equation 6

When this equation is applied, it seems that A should equal the area of the flange area alone since most of the traverse plate component will be transferred to the chord during a punching shear failure.

4.2 LEGITIMACY OF METHODS

In order to determine whether or not these proposed methods can be applied to the ST-HSS connection, the numerous capacity equations are applied to the test geometry. The necessary dimensions are the thickness, the diameter, and the material strength of the HSS chord and the ST10x48 individual dimensions. These specific dimensions are listed below:

ST255x71.5 (10x48)	HSS Chord
b_f =7.2”	D =26”
t_f = 0.92”	t = .5”
d = 10.15”	F_y = 48 ksi
t_w = 0.80”	

4.2.1 Method 1

The capacity equations (Equations 1 and 2) are recalled for a concentrated force distributed both transversely and longitudinally:

$$R_n = \frac{5F_y t^2}{1-0.81b_1/D}Q_f \text{ , and } R_n = 5F_y t^2(1+0.25N/D)\cdot Q_f$$

After applying the appropriate values for the test specimen, the capacity can be calculated in the transverse and longitudinal directions respectively as follows:

$$R_n = \frac{5F_y t^2}{1-0.81 b_1 / D} Q_f = \frac{5(48ksi)(.5''\cdot 0.93)^2}{1-0.81(7.2'')/(26'')}(1.0) = 67kips$$

and

$$R_n = 5F_y t^2 (1+0.25N/D)\cdot Q_f = 5(48kips)(.5''\cdot 0.93)^2(1+0.25(10.15'')/(26''))\cdot(1.0) = 57kips$$

4.2.2 Method 2

In order to obtain the capacity using the second method, the equivalent branch diameter and the Q_q factor must first be calculated using Equation 4 as well as LRFD Equation 9.4-3.

$$D_{b,eq} = b_f^2 / 4d + d = (7.2'')^2 / 4(10.2'') + 10.2'' = 11.5''$$

$$Q_q = (\frac{1.7}{2.4} + \frac{0.18}{(11.42''/26'')})\cdot(1.0)^{0.7(2.4-1)} = 1.12$$

Now, the capacity can be calculated using Equation 3:

$$P_n \sin\theta = t^2 F_y (6\pi\cdot\beta\cdot Q_q)\cdot Q_f = (.5''\cdot 0.93)^2 (48ksi)(6\pi\cdot(11.42''/26'')\cdot(1.12))\cdot(1.0) = 96kips$$

4.2.3 Method 3

When the conditions are applied to the case of the WT-to-HSS joint, it gives:

$$R_n = \frac{5F_y t^2}{1-0.81 b_f / D}\cdot(1+0.25\cdot d/D)\cdot Q_f = \frac{5(48ksi)(.5''\cdot 0.93)^2}{1-.81(7.2'')/(26'')}\cdot(1+0.25(10.15'')/(26''))\cdot(1.0)$$
$$= 73kips$$

4.2.4 Method 4

To see if punching shear governs for the experimental geometry, the limit state is checked using equation 7.

$$R_n = 1.16 F_y A \cdot t / t_p = 1.16(48ksi)(7.2"\cdot.921")\cdot(.5\cdot 0.93)/(.921") = 186kips$$

Equation 7

4.3 DISCUSSION OF METHODS

Since all of the different methods of predicting the capacity of the HSS section have been evaluated, they are then compared to the experimental results obtained in the laboratory to determine which method will give the best approximation for design. These results are compared in the table below.

Table 4Comparison of Results

Experimental	Nominal	70	Kips
	Ultimate	96	Kips
Theoretical	Method 1	67/57	Kips
	Method 2	96	Kips
	Method 3	73	Kips
	Method 4	186	Kips

Upon first glance it appears that the theoretical approaches described in methods 1 through 4 are not good approximations of the actual capacity as viewed in experimental testing. Recall that the capacity equations are based on research geometries of a typical interior joint with a continuous chord member. The results show that these equations cannot be applied to an end section without further consideration of the effects of the open end. It seems then that the open end reduces the capacity from what it would be at an interior location.

4.3.1 Method 1

The capacity as predicted by method 1 is 67 kips for the flange plate, or transverse component, while it is 57 kips for the longitudinal component, or the stem plate. When summed together as suggested in the application of this method to the HSS-ST joint, the net theoretical capacity of 124 kips is an over approximation of what the nominal capacity was in testing. For this reason the method is considered to be an inaccurate estimate. However, when considering the case of the cruxiform as applied to the ST geometry, the Canadian HSS Manual suggests that only the transverse component should be considered when calculating the capacity. When this theory is applied, the theoretical capacity of 67 kips agrees very well with the capacity of 70 kips observed in experimental testing.

Although the superposition method is an overestimate of the nominal capacity, it may be a good approximation of the ultimate capacity since it takes into account the effect of the longitudinal component. However, applying this method once again exceeds the values depicted in actual testing by a margin of 30%. Perhaps applying only a fraction of the longitudinal would produce a more accurate result. However, more research would need to be performed in order to make this judgment accurate.

4.3.2 Method 2

The theoretical capacity calculated using Method 2 is 96 kips, which is a gross overestimate when considering the results of the experimental test being 70 kips. This difference can again be explained by considering the open end of the HSS section. Since the end section seems to be an important factor in this calculation, Method 2 is not recommended for nominal capacity estimates.

Even though this method is not a very good judge of nominal capacity, it is a good prediction of the ultimate capacity. This may not be the case for all geometries though, as it is governed by the limit state of chord wall plastification. In any case, this method is the most flexible method of them all since it can be applied to many different geometries as mentioned earlier, and therefore is recommended for calculating the ultimate capacity. This method also treats the case of the branch member experiencing flexure as well as axial loading. Since this research only encompasses axial loading at 90 degrees, extrapolating this method to other cases should be handled carefully.

4.3.3 Method 3

The capacity calculated using Method 3 is 73 kips and agrees reasonably well with the experimental results. Since this method is based on the use of a wide flange connection, it is safe to say that the additional flange as seen on the ST connection does not add much strength to the joint.

4.3.4 Method 4

Method 4 predicts the capacity of the ST connection to be 186 kips, which does not agree well with the experimental results at all. This Method is based on punching shear and the inaccurate result is not surprising since no punching shear was observed in testing. However, it is not safe to say that this same occurrence will happen in all cases, as punching shear is directly related to specimen geometry. For instance, when the flange width (b_f) is much smaller than the HSS chord diameter, punching shear will probably govern the capacity.

5.0 CONCLUSION

Two similar experimental tests are conducted on an axially loaded HSS section connection to an ST10x48 branch member. The HSS section is 26” outer diameter with a .5” wall thickness and is 7.5’ long. The ST is connected at 90 degrees and is 33” from the open end of the HSS section. The results from these tests show the nominal capacity of this section to be 70 kips while the ultimate capacity is 96 kips. The yield load is considered to be 30 kips.

Four existing specification capacity methods are modified so as to fit the connection geometry considered herein in order that to predict these connection capacities accurately. As discussed earlier, these methods are limited in applicability and not entirely robust in nature. Methods 1 and 3 are observed to provide accurate calculations for the nominal joint capacity, while Method 2 is a better prediction of the ultimate capacity. Not much is known about the accuracy of Method 4 since it is based on a limit state that was not observed during these experimental tests.

APPENDIX A

LOAD DEFLECTION DATA

The load-deflection data is presented in this appendix. Table 5 contains the results gathered from Specimen 1, while Table 6 reports the results of test Specimen 2.

Table 5 Specimen 1 DCDT Full Results

ID	Seconds Elapsed	Load (kips)	[81] (in)	[82] (in)	[83] (in)
1	26.8	0	0.000	0.000	0.000
2	56.7	5.1	0.022	0.020	0.000
3	107.2	10	0.044	0.040	0.000
4	142.8	15.1	0.076	0.061	0.000
5	229.7	20	0.101	0.083	0.000
6	274.3	25	0.127	0.105	0.000
7	320.2	30	0.154	0.129	0.000
8	365.8	35	0.182	0.153	0.000
9	417.3	40.2	0.213	0.180	0.000
10	659.8	45.1	0.241	0.206	0.000
11	694.5	50	0.251	0.236	0.000
12	734.4	55	0.284	0.268	0.000
13	826.9	61.2	0.359	0.316	0.000
14	909	65	0.396	0.350	0.000
15	956.7	70.4	0.504	0.404	0.000
16	1114.1	75.7	0.679	0.557	0.054
17	1161.3	82.3	0.894	0.678	0.152

Table 6 Specimen 2 DCDT Full Results

ID	Seconds Elapsed	Load (kips)	[81] (in)	[82] (in)	[83] (in)
1	334.2	0	0.002	0.001	-0.001
2	382.8	5.1	0.031	0.021	-0.002
3	418.1	10	0.058	0.041	-0.002
4	440.7	15.3	0.086	0.062	-0.002
5	466.7	20	0.110	0.082	-0.002
6	500.1	25	0.136	0.104	-0.002
7	527.4	30	0.165	0.128	-0.002
8	560.7	35	0.192	0.150	-0.002
9	594.1	40	0.222	0.175	-0.002
10	619.7	45	0.253	0.199	-0.002
11	646	50	0.291	0.226	-0.002
12	670.9	55	0.327	0.255	-0.002
13	701.9	60	0.366	0.289	-0.002
14	729.2	65	0.412	0.325	-0.002
15	762.5	70.6	0.465	0.370	0.012
16	786.5	75.4	0.522	0.415	0.042
17	812.7	80.4	0.590	0.470	0.082
18	845.2	85.4	0.676	0.537	0.134
19	876.4	90.2	0.780	0.619	0.200
20	896.3	92.9	0.856	0.679	0.251
21	908	94.6	0.915	0.725	0.292
22	921.7	96.3	1.001	0.792	0.352

APPENDIX B

FULL-REDUCED DATA SET

This Appendix contains all of the information captured by the strain rosettes during the experimental testing of Specimens 1 and 2. The data was retrieved from Strain Smart and was reduced into Excel files. Columns 4, 5, and 6 represent the strains of the corresponding rosette assignment. The next two columns are the maximum and minimum principle strains respectively, followed by the shear strain. Columns 10 and 11 are the maximum and minimum principle stresses followed by the shear stress. Table 7 contains the results from the first experimental test and Table 8 includes the results from test specimen #2.

Table 7 Reduced Data Specimen 1

Specimen 1

ID	Seconds Elapsed	Load (kips)	[1, 2, 3] e(1)	[1, 2, 3] e(2)	[1, 2, 3] e(3)	[1, 2, 3] e(max)	[1, 2, 3] e(min)	[1, 2, 3] Shear Strain	[1, 2, 3] s(max)	[1, 2, 3] s(min)	[1, 2, 3] Shear Stress
1	26.8	0	3.416	0.978	1.966	4.551	0.831	3.721	0.156	0.071	0.042
2	56.7	5.1	59.046	32.752	30.969	63.643	26.372	37.271	2.320	1.474	0.423
3	107.2	10	109.314	60.128	57.024	118.018	48.320	69.698	4.296	2.714	0.791
4	142.8	15.1	162.028	87.995	85.047	175.928	71.147	104.781	6.395	4.017	1.189
5	229.7	20	216.211	115.375	114.546	236.683	94.074	142.609	8.588	5.351	1.618
6	274.3	25	271.865	144.711	145.031	298.359	118.536	179.823	10.825	6.744	2.040
7	320.2	30	330.455	176.006	180.434	364.701	146.188	218.514	13.244	8.286	2.479
8	365.8	35	390.516	211.214	218.791	431.552	177.755	253.797	15.719	9.959	2.880
9	417.3	40.2	458.887	248.871	266.495	511.718	213.665	298.053	18.667	11.903	3.382
10	659.8	45.1	521.895	285.551	318.139	588.718	251.316	337.402	21.529	13.872	3.828
11	694.5	50	593.703	324.680	378.150	679.875	291.978	387.898	24.879	16.077	4.401
12	734.4	55	670.408	367.237	448.992	781.732	337.668	444.065	28.626	18.549	5.038
13	826.9	61.2	830.206	448.935	633.031	1031.000	432.237	598.763	37.626	24.039	6.794
14	909	65	901.081	495.906	721.138	1138.902	483.317	655.585	41.621	26.744	7.438
15	956.7	70.4	894.237	438.172	819.599	1277.323	436.512	840.811	45.653	26.573	9.540
16	1114.1	75.7	1002.277	549.242	903.798	1359.824	546.251	813.573	49.395	30.933	9.231
17	1161.3	82.3	1044.815	609.436	922.018	1362.404	604.429	757.975	50.044	32.844	8.600
18	1171.8		1055.083	630.970	919.063	1349.613	624.534	725.079	49.825	33.371	8.227
19	1178.5		1067.308	643.206	924.973	1356.179	636.102	720.077	50.150	33.810	8.170
20	1188		1066.330	646.632	923.003	1350.003	639.330	710.672	49.981	33.855	8.063
21	1201.7		1070.242	654.953	921.033	1344.395	646.880	697.516	49.873	34.045	7.914
22	1208.7		1075.621	658.868	923.496	1348.636	650.480	698.155	50.046	34.203	7.921
23	1219.9		1075.132	662.294	923.003	1344.324	653.811	690.512	49.938	34.269	7.835
24	1226.5		1080.022	666.210	924.480	1347.174	657.328	689.846	50.065	34.411	7.827
25	1240.7		1084.912	674.531	921.526	1341.906	664.531	677.375	49.964	34.593	7.686
26	1256.4		1093.225	687.747	926.450	1342.547	677.128	665.420	50.107	35.007	7.550
27	1271		1095.181	693.621	924.480	1337.357	682.304	655.052	49.989	35.125	7.432
28	1290.6		1105.939	706.837	926.450	1338.307	694.082	644.224	50.135	35.516	7.309
29	1303.4		1107.895	725.438	921.033	1318.216	710.712	607.504	49.645	35.860	6.893
30	1315.7		1101.049	736.208	919.556	1299.028	721.576	577.452	49.129	36.025	6.552
31	1330.7		1085.401	750.404	921.526	1269.457	737.470	531.987	48.325	36.253	6.036
32	1364.8		1065.841	772.924	939.747	1241.153	764.435	476.718	47.670	36.852	5.409
33	1379.9		1045.304	786.142	950.089	1214.541	780.852	433.689	46.966	37.125	4.921

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[4, 5, 6] e(1)	[4, 5, 6] e(2)	[4, 5, 6] e(3)	[4, 5, 6] e(max)	[4, 5, 6] e(min)	[4, 5, 6] Shear Strain	[4, 5, 6] s(max)	[4, 5, 6] s(min)	[4, 5, 6] Shear Stress
1	26.8	0	1.467	1.963	0.580	2.063	-0.016	2.079	0.067	0.020	0.024
2	56.7	5.1	11.740	5.399	1.739	11.916	1.562	10.354	0.401	0.167	0.117
3	107.2	10	21.034	11.780	0.290	21.094	0.230	20.864	0.686	0.213	0.237
4	142.8	15.1	30.328	16.197	0.000	30.363	-0.035	30.399	0.984	0.294	0.345
5	229.7	20	39.134	21.596	1.739	39.170	1.703	37.467	1.286	0.436	0.425
6	274.3	25	50.385	26.014	2.898	50.393	2.889	47.504	1.662	0.584	0.539
7	320.2	30	60.169	30.431	2.898	60.190	2.876	57.314	1.979	0.679	0.650
8	365.8	35	70.932	35.340	2.318	70.956	2.294	68.662	2.323	0.764	0.779
9	417.3	40.2	81.695	38.285	4.057	81.966	3.786	78.179	2.694	0.920	0.887
10	659.8	45.1	89.523	42.211	0.580	89.613	0.489	89.124	2.910	0.887	1.011
11	694.5	50	97.840	45.647	1.449	98.005	1.283	96.722	3.190	0.995	1.097
12	734.4	55	105.668	49.574	2.898	105.883	2.682	103.201	3.459	1.117	1.171
13	826.9	61.2	103.222	65.282	2.318	104.750	0.790	103.960	3.403	1.044	1.180
14	909	65	106.646	68.718	3.477	108.423	1.700	106.723	3.531	1.110	1.211
15	956.7	70.4	110.560	75.099	5.216	113.301	2.475	110.826	3.697	1.182	1.257
16	1114.1	75.7	128.663	72.154	11.011	128.709	10.966	117.743	4.279	1.607	1.336
17	1161.3	82.3	144.320	55.955	12.750	148.088	8.983	139.105	4.888	1.731	1.578
18	1171.8		154.596	41.721	13.329	166.263	1.662	164.602	5.406	1.671	1.868
19	1178.5		159.978	34.849	13.909	176.654	-2.767	179.420	5.700	1.628	2.036
20	1188		162.424	31.413	14.488	181.865	-4.953	186.818	5.847	1.608	2.120
21	1201.7		168.296	22.578	14.488	194.589	-11.805	206.394	6.193	1.510	2.342
22	1208.7		170.253	21.105	14.199	197.803	-13.351	211.153	6.282	1.491	2.396
23	1219.9		173.189	18.160	13.909	203.212	-16.114	219.327	6.431	1.454	2.489
24	1226.5		177.104	14.234	13.909	210.673	-19.660	230.334	6.638	1.412	2.613
25	1240.7		184.933	1.963	14.488	229.393	-29.971	259.364	7.145	1.259	2.943
26	1256.4		213.315	-24.540	15.068	284.696	-56.313	341.010	8.682	0.943	3.869
27	1271		222.124	-38.282	15.358	306.741	-69.259	376.000	9.270	0.738	4.266
28	1290.6		239.741	-66.746	15.358	351.910	-96.811	448.721	10.467	0.284	5.091
29	1303.4		287.213	-146.240	16.227	479.041	-175.600	654.641	13.822	-1.034	7.428
30	1315.7		325.880	-214.929	15.937	586.705	-244.888	831.593	16.638	-2.233	9.435
31	1330.7		381.193	-311.078	15.648	739.709	-342.869	1082.579	20.645	-3.921	12.283
32	1364.8		449.240	-424.863	15.358	924.344	-459.746	1384.090	25.494	-5.914	15.704
33	1379.9		493.305	-499.889	15.358	1045.505	-536.843	1582.348	28.672	-7.235	17.954

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[7, 8, 9] e(1)	[7, 8, 9] e(2)	[7, 8, 9] e(3)	[7, 8, 9] e(max)	[7, 8, 9] e(min)	[7, 8, 9] Shear Strain	[7, 8, 9] s(max)	[7, 8, 9] s(min)	[7, 8, 9] Shear Stress
1	26.8	0	-1.474	0.490	-0.489	0.570	-2.534	3.104	-0.006	-0.077	0.035
2	56.7	5.1	-58.961	-13.727	-60.205	-13.723	-105.443	91.719	-1.470	-3.552	1.041
3	107.2	10	-118.407	-29.906	-118.445	-29.906	-206.946	177.040	-2.982	-7.000	2.009
4	142.8	15.1	-182.266	-45.593	-183.529	-45.592	-320.203	274.611	-4.592	-10.824	3.116
5	229.7	20	-247.100	-59.320	-249.094	-59.317	-436.877	377.560	-6.172	-14.739	4.284
6	274.3	25	-314.380	-74.026	-316.118	-74.024	-556.474	482.450	-7.812	-18.759	5.474
7	320.2	30	-385.089	-86.771	-387.046	-86.770	-685.366	598.596	-9.478	-23.062	6.792
8	365.8	35	-455.297	-98.536	-459.432	-98.530	-816.199	717.670	-11.132	-27.417	8.143
9	417.3	40.2	-536.785	-111.280	-542.076	-111.272	-967.589	856.317	-13.017	-32.449	9.716
10	659.8	45.1	-615.806	-124.024	-627.151	-123.992	-1118.965	994.973	-14.902	-37.480	11.289
11	694.5	50	-703.156	-135.298	-723.454	-135.209	-1291.402	1156.193	-16.942	-43.179	13.118
12	734.4	55	-799.813	-153.433	-831.956	-153.238	-1478.532	1325.294	-19.347	-49.421	15.037
13	826.9	61.2	-965.117	-191.661	-1028.375	-191.040	-1802.452	1611.412	-23.722	-60.289	18.283
14	909	65	-1082.318	-224.006	-1156.836	-223.231	-2015.923	1792.692	-26.842	-67.522	20.340
15	956.7	70.4	-1347.514	-272.029	-1414.150	-271.529	-2490.135	2218.606	-33.020	-83.365	25.173
16	1114.1	75.7	-1968.538	-318.088	-1984.949	-318.068	-3635.419	3317.351	-45.666	-120.945	37.639
17	1161.3	82.3	-2464.125	-299.959	-2459.637	-299.958	-4623.804	4323.846	-54.692	-152.810	49.059
18	1171.8		-2714.913	-268.109	-2710.448	-268.108	-5157.253	4889.145	-58.847	-169.793	55.473
19	1178.5		-2832.199	-250.468	-2831.669	-250.468	-5413.399	5162.931	-60.766	-177.925	58.579
20	1188		-2887.900	-240.668	-2888.132	-240.668	-5535.364	5294.696	-61.635	-181.784	60.074
21	1201.7		-2999.772	-217.145	-3004.931	-217.144	-5787.559	5570.415	-63.325	-189.730	63.203
22	1208.7		-3042.755	-208.814	-3050.670	-208.811	-5884.614	5675.803	-63.999	-192.796	64.399
23	1219.9		-3076.944	-200.483	-3086.674	-200.478	-5963.140	5762.661	-64.492	-195.260	65.384
24	1226.5		-3125.293	-187.250	-3139.216	-187.242	-6077.267	5890.025	-65.173	-198.831	66.829
25	1240.7		-3257.618	-149.512	-3281.248	-149.489	-6389.377	6239.888	-66.985	-208.582	70.799
26	1256.4		-3498.742	-50.006	-3552.554	-49.901	-7001.395	6951.493	-69.708	-227.454	78.873
27	1271		-3602.673	-1.471	-3672.116	-1.305	-7273.484	7272.179	-70.779	-235.801	82.511
28	1290.6		-3797.790	107.872	-3900.468	108.205	-7806.464	7914.668	-72.412	-252.014	89.801
29	1303.4		-4157.097	425.246	-4350.555	426.246	-8933.898	9360.144	-73.067	-285.470	106.202
30	1315.7		-4357.360	725.635	-4630.019	727.415	-9714.794	10442.209	-70.898	-307.856	118.479
31	1330.7		-4530.272	1188.836	-4914.661	1191.960	-10636.893	11828.853	-64.806	-333.230	134.212
32	1364.8		-4662.230	1810.377	-5177.825	1815.312	-11655.367	13470.679	-54.504	-360.184	152.840
33	1379.9		-4712.862	2235.665	-5314.441	2241.903	-12269.205	14511.108	-46.644	-375.935	164.645

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[10, 11, 12] e(1)	[10, 11, 12] e(2)	[10, 11, 12] e(3)	[10, 11, 12] e(max)	[10, 11, 12] e(min)	[10, 11, 12] gamma	[10, 11, 12] s(max)	[10, 11, 12] s(min)	[10, 11, 12] tau
1	26.8	0	1.473		0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	56.7	5.1	36.827		13.370	0.000	0.000	0.000	0.000	0.000	0.000
3	107.2	10	72.184		22.779	0.000	0.000	0.000	0.000	0.000	0.000
4	142.8	15.1	111.963		34.665	0.000	0.000	0.000	0.000	0.000	0.000
5	229.7	20	154.202		45.064	0.000	0.000	0.000	0.000	0.000	0.000
6	274.3	25	195.461		58.436	0.000	0.000	0.000	0.000	0.000	0.000
7	320.2	30	238.197		71.313	0.000	0.000	0.000	0.000	0.000	0.000
8	365.8	35	282.411		85.180	0.000	0.000	0.000	0.000	0.000	0.000
9	417.3	40.2	332.525		96.076	0.000	0.000	0.000	0.000	0.000	0.000
10	659.8	45.1	378.712		105.487	0.000	0.000	0.000	0.000	0.000	0.000
11	694.5	50	430.310		116.384	0.000	0.000	0.000	0.000	0.000	0.000
12	734.4	55	484.370		126.290	0.000	0.000	0.000	0.000	0.000	0.000
13	826.9	61.2	583.659		134.710	0.000	0.000	0.000	0.000	0.000	0.000
14	909	65	629.378		141.149	0.000	0.000	0.000	0.000	0.000	0.000
15	956.7	70.4	704.601		139.168	0.000	0.000	0.000	0.000	0.000	0.000
16	1114.1	75.7	850.164		172.356	0.000	0.000	0.000	0.000	0.000	0.000
17	1161.3	82.3	926.404		201.088	0.000	0.000	0.000	0.000	0.000	0.000
18	1171.8		951.000		219.417	0.000	0.000	0.000	0.000	0.000	0.000
19	1178.5		972.153		230.317	0.000	0.000	0.000	0.000	0.000	0.000
20	1188		975.597		233.289	0.000	0.000	0.000	0.000	0.000	0.000
21	1201.7		988.388		241.711	0.000	0.000	0.000	0.000	0.000	0.000
22	1208.7		995.768		247.161	0.000	0.000	0.000	0.000	0.000	0.000
23	1219.9		997.244		249.638	0.000	0.000	0.000	0.000	0.000	0.000
24	1226.5		1007.083		256.079	0.000	0.000	0.000	0.000	0.000	0.000
25	1240.7		1021.351		268.465	0.000	0.000	0.000	0.000	0.000	0.000
26	1256.4		1050.380		307.607	0.000	0.000	0.000	0.000	0.000	0.000
27	1271		1065.633		320.986	0.000	0.000	0.000	0.000	0.000	0.000
28	1290.6		1104.998		351.213	0.000	0.000	0.000	0.000	0.000	0.000
29	1303.4		1180.292		421.583	0.000	0.000	0.000	0.000	0.000	0.000
30	1315.7		1253.628		478.581	0.000	0.000	0.000	0.000	0.000	0.000
31	1330.7		1365.376		554.422	0.000	0.000	0.000	0.000	0.000	0.000
32	1364.8		1524.424		650.603	0.000	0.000	0.000	0.000	0.000	0.000
33	1379.9		1623.424		711.593	0.000	0.000	0.000	0.000	0.000	0.000

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[13, 14, 15] e(1)	[13, 14, 15] e(2)	[13, 14, 15] e(3)	[13, 14, 15] e(max)	[13, 14, 15] e(min)	[13, 14, 15] gamma	[13, 14, 15] s(max)	[13, 14, 15] s(min)	[13, 14, 15] tau
1	26.8	0	1.469	2.450	1.470	2.450	0.490	1.959	0.084	0.040	0.022
2	56.7	5.1	36.737	37.235	57.352	61.274	32.815	28.459	2.305	1.660	0.323
3	107.2	10	68.578	69.083	110.299	118.584	60.292	58.292	4.431	3.108	0.661
4	142.8	15.1	103.850	98.483	164.231	180.687	87.395	93.292	6.707	4.590	1.059
5	229.7	20	141.085	129.844	223.073	248.479	115.679	132.800	9.180	6.167	1.507
6	274.3	25	183.712	163.658	284.374	320.572	147.514	173.058	11.827	7.900	1.964
7	320.2	30	230.263	199.925	349.116	397.342	182.036	215.306	14.651	9.765	2.443
8	365.8	35	282.699	237.665	415.337	478.625	219.412	259.213	17.650	11.768	2.941
9	417.3	40.2	345.434	280.309	490.890	574.023	262.300	311.723	21.159	14.086	3.537
10	659.8	45.1	411.118	324.428	567.925	672.287	306.756	365.531	24.777	16.482	4.147
11	694.5	50	486.615	373.453	652.825	782.857	356.583	426.274	28.846	19.173	4.837
12	734.4	55	565.066	421.012	743.139	903.620	404.585	499.035	33.228	21.904	5.662
13	826.9	61.2	647.943	401.399	779.957	1033.394	394.505	638.889	37.337	22.839	7.249
14	909	65	689.632	441.115	842.798	1100.213	432.217	667.996	39.870	24.711	7.579
15	956.7	70.4	861.819	534.779	1024.491	1359.552	526.758	832.794	49.196	30.298	9.449
16	1114.1	75.7	994.800	694.194	1260.298	1580.781	674.317	906.464	57.803	37.233	10.285
17	1161.3	82.3	1017.867	779.072	1362.515	1635.965	744.417	891.548	60.274	40.042	10.116
18	1171.8		1015.904	810.476	1399.869	1649.239	766.533	882.706	60.919	40.888	10.015
19	1178.5		1023.757	826.669	1423.462	1668.022	779.197	888.826	61.651	41.482	10.085
20	1188		1020.812	833.048	1429.361	1667.152	783.021	884.131	61.660	41.597	10.031
21	1201.7		1021.303	844.826	1445.090	1675.611	790.782	884.829	62.010	41.931	10.039
22	1208.7		1023.266	849.733	1452.464	1681.372	794.357	887.015	62.231	42.103	10.064
23	1219.9		1021.793	852.677	1456.888	1683.002	795.679	887.322	62.297	42.162	10.068
24	1226.5		1024.247	859.548	1465.736	1689.171	800.813	888.358	62.547	42.388	10.079
25	1240.7		1019.830	871.326	1481.467	1694.679	806.618	888.060	62.782	42.630	10.076
26	1256.4		1020.812	890.466	1512.930	1716.566	817.176	899.390	63.594	43.185	10.205
27	1271		1017.376	897.827	1523.254	1720.565	820.065	900.500	63.752	43.317	10.217
28	1290.6		1014.922	911.079	1549.803	1739.939	824.786	915.153	64.426	43.659	10.383
29	1303.4		994.309	925.803	1582.253	1754.983	821.580	933.403	64.882	43.701	10.591
30	1315.7		983.513	932.674	1595.037	1759.014	819.536	939.478	64.993	43.674	10.659
31	1330.7		970.262	937.091	1593.562	1746.699	817.125	929.575	64.571	43.476	10.547
32	1364.8		963.392	945.435	1585.203	1726.860	821.735	905.125	63.972	43.433	10.270
33	1379.9		957.012	947.889	1567.011	1699.844	824.179	875.665	63.120	43.249	9.935

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[16, 17, 18] e(1)	[16, 17, 18] e(2)	[16, 17, 18] e(3)	[16, 17, 18] e(max)	[16, 17, 18] e(min)	[16, 17, 18] gamma	[16, 17, 18] s(max)	[16, 17, 18] s(min)	[16, 17, 18] tau
1	26.8	0	0.000	0.981	0.985	1.186	-0.201	1.387	0.036	0.005	0.016
2	56.7	5.1	-24.904	-8.825	-3.939	-2.539	-26.304	23.765	-0.338	-0.877	0.270
3	107.2	10	-49.318	-20.593	-8.862	-7.150	-51.031	43.881	-0.728	-1.724	0.498
4	142.8	15.1	-73.732	-30.888	-15.755	-12.615	-76.872	64.258	-1.157	-2.615	0.729
5	229.7	20	-95.214	-41.184	-21.664	-17.817	-99.061	81.244	-1.541	-3.385	0.922
6	274.3	25	-119.625	-52.951	-26.587	-22.408	-123.804	101.396	-1.930	-4.231	1.150
7	320.2	30	-144.035	-66.187	-34.464	-29.808	-148.691	118.883	-2.412	-5.110	1.349
8	365.8	35	-167.467	-78.933	-41.357	-36.404	-172.420	136.017	-2.857	-5.943	1.543
9	417.3	40.2	-193.339	-95.601	-53.172	-47.913	-198.598	150.685	-3.485	-6.904	1.710
10	659.8	45.1	-217.257	-109.817	-68.434	-61.433	-224.258	162.825	-4.172	-7.867	1.847
11	694.5	50	-242.151	-123.543	-83.695	-74.448	-251.398	176.950	-4.858	-8.874	2.008
12	734.4	55	-267.531	-139.228	-101.909	-90.236	-279.203	188.967	-5.641	-9.929	2.144
13	826.9	61.2	-317.311	-203.437	-175.251	-163.330	-329.232	165.902	-8.497	-12.261	1.882
14	909	65	-341.223	-213.239	-195.431	-176.957	-359.697	182.741	-9.235	-13.381	2.073
15	956.7	70.4	-326.583	-180.891	-241.693	-172.507	-395.769	223.262	-9.441	-14.508	2.533
16	1114.1	75.7	-416.369	-224.021	-290.903	-209.638	-497.634	287.996	-11.636	-18.171	3.268
17	1161.3	82.3	-475.892	-247.545	-312.062	-226.191	-561.764	335.573	-12.796	-20.411	3.807
18	1171.8		-502.236	-257.837	-320.427	-232.938	-589.726	356.788	-13.287	-21.383	4.048
19	1178.5		-517.847	-262.737	-326.332	-236.179	-607.999	371.820	-13.569	-22.007	4.219
20	1188		-522.725	-263.717	-327.316	-236.434	-613.607	377.173	-13.632	-22.191	4.279
21	1201.7		-532.969	-268.618	-331.744	-240.176	-624.537	384.361	-13.860	-22.582	4.361
22	1208.7		-537.847	-270.578	-333.221	-241.424	-629.643	388.219	-13.950	-22.759	4.405
23	1219.9		-540.286	-270.578	-333.713	-241.131	-632.867	391.736	-13.972	-22.861	4.445
24	1226.5		-545.164	-272.048	-334.697	-241.793	-638.068	396.276	-14.044	-23.036	4.496
25	1240.7		-556.871	-276.949	-339.617	-245.409	-651.079	405.670	-14.287	-23.493	4.603
26	1256.4		-585.162	-289.689	-343.061	-251.800	-676.423	424.624	-14.741	-24.377	4.818
27	1271		-592.478	-293.120	-345.521	-254.103	-683.897	429.794	-14.888	-24.642	4.877
28	1290.6		-606.623	-300.960	-351.918	-260.151	-698.390	438.239	-15.225	-25.170	4.972
29	1303.4		-623.206	-315.170	-359.298	-271.214	-711.290	440.076	-15.710	-25.696	4.993
30	1315.7		-630.522	-324.480	-364.710	-279.350	-715.882	436.531	-16.018	-25.924	4.953
31	1330.7		-633.448	-334.280	-369.630	-288.524	-714.554	426.031	-16.302	-25.970	4.834
32	1364.8		-635.399	-346.529	-371.598	-298.469	-708.528	410.058	-16.566	-25.871	4.653
33	1379.9		-631.497	-350.939	-375.042	-304.155	-702.385	398.230	-16.691	-25.728	4.518

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[19, 20, 21] e(1)	[19, 20, 21] e(2)	[19, 20, 21] e(3)	[19, 20, 21] e(max)	[19, 20, 21] e(min)	[19, 20, 21] gamma	[19, 20, 21] s(max)	[19, 20, 21] s(min)	[19, 20, 21] tau
1	26.8	0	1.961	1.959	2.447	2.549	1.859	0.690	0.101	0.085	0.008
2	56.7	5.1	30.886	23.997	37.682	45.117	23.450	21.666	1.691	1.199	0.246
3	107.2	10	57.851	46.036	68.025	80.588	45.287	35.301	3.053	2.252	0.401
4	142.8	15.1	86.288	64.648	100.817	123.356	63.749	59.607	4.619	3.266	0.676
5	229.7	20	115.218	84.730	134.101	165.690	83.629	82.061	6.185	4.322	0.931
6	274.3	25	144.149	104.812	167.387	208.031	103.504	104.527	7.750	5.379	1.186
7	320.2	30	173.082	123.916	200.675	251.334	122.422	128.912	9.338	6.413	1.463
8	365.8	35	202.016	141.551	232.007	293.948	140.075	153.872	10.891	7.400	1.746
9	417.3	40.2	234.385	159.676	263.830	339.743	158.472	181.271	12.555	8.441	2.057
10	659.8	45.1	262.342	171.433	290.270	382.104	170.508	211.597	14.045	9.244	2.401
11	694.5	50	293.244	182.701	316.221	427.304	182.161	245.142	15.624	10.061	2.781
12	734.4	55	326.109	193.969	342.174	474.544	193.739	280.805	17.268	10.896	3.186
13	826.9	61.2	368.298	174.863	389.186	582.889	174.595	408.293	20.594	11.329	4.633
14	909	65	398.716	172.903	388.696	614.565	172.846	441.719	21.604	11.580	5.012
15	956.7	70.4	416.869	76.893	311.325	656.109	72.085	584.024	21.971	8.718	6.626
16	1114.1	75.7	516.478	91.587	257.955	709.870	64.563	645.306	23.640	8.997	7.322
17	1161.3	82.3	578.313	101.384	196.269	731.141	43.441	687.700	24.124	8.519	7.803
18	1171.8		598.436	100.404	162.492	735.352	25.576	709.776	24.087	7.981	8.053
19	1178.5		612.670	103.343	152.212	744.244	20.638	723.605	24.327	7.907	8.210
20	1188		615.124	102.363	142.422	742.455	15.092	727.363	24.215	7.710	8.253
21	1201.7		623.959	101.384	125.780	744.788	4.950	739.838	24.192	7.404	8.394
22	1208.7		628.867	103.833	122.843	747.354	4.356	742.998	24.270	7.409	8.430
23	1219.9		631.322	103.343	117.459	747.861	0.919	746.942	24.253	7.303	8.475
24	1226.5		635.739	104.812	113.543	750.114	-0.832	750.946	24.309	7.268	8.520
25	1240.7		643.593	103.833	96.412	751.707	-11.702	763.408	24.255	6.931	8.662
26	1256.4		656.355	96.485	73.898	761.336	-31.083	792.420	24.378	6.397	8.991
27	1271		661.755	95.996	60.684	762.050	-39.611	801.661	24.319	6.127	9.096
28	1290.6		675.499	99.424	43.065	768.574	-50.009	818.583	24.429	5.853	9.288
29	1303.4		687.281	98.445	6.851	768.443	-74.311	842.754	24.188	5.064	9.562
30	1315.7		689.244	98.445	-16.638	761.914	-89.307	851.221	23.831	4.515	9.658
31	1330.7		680.408	100.404	-43.061	741.159	-103.812	844.970	23.017	3.843	9.587
32	1364.8		665.191	112.650	-58.230	712.444	-105.483	817.926	22.070	3.509	9.280
33	1379.9		649.974	120.487	-67.526	688.531	-106.083	794.614	21.289	3.257	9.016

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[22, 23, 24] e(1)	[22, 23, 24] e(2)	[22, 23, 24] e(3)	[22, 23, 24] e(max)	[22, 23, 24] e(min)	[22, 23, 24] gamma	[22, 23, 24] s(max)	[22, 23, 24] s(min)	[22, 23, 24] tau
1	26.8	0	1.954	1.470	2.459	2.985	1.428	1.557	0.111	0.075	0.018
2	56.7	5.1	17.101	9.799	31.470	40.456	8.115	32.341	1.390	0.657	0.367
3	107.2	10	31.760	18.128	60.975	78.161	14.573	63.588	2.676	1.233	0.721
4	142.8	15.1	48.373	27.437	95.400	122.172	21.601	100.571	4.171	1.888	1.141
5	229.7	20	64.499	35.277	132.286	170.033	26.752	143.281	5.772	2.521	1.626
6	274.3	25	81.113	45.076	171.142	218.841	33.415	185.426	7.419	3.212	2.104
7	320.2	30	99.194	54.876	210.002	268.677	40.519	228.159	9.104	3.926	2.589
8	365.8	35	116.787	65.166	252.308	321.819	47.276	274.543	10.892	4.662	3.115
9	417.3	40.2	136.336	76.926	300.029	381.438	54.927	326.511	12.899	5.490	3.705
10	659.8	45.1	152.953	89.666	347.263	437.673	62.543	375.130	14.797	6.284	4.256
11	694.5	50	174.947	106.327	402.867	504.133	73.681	430.452	17.059	7.291	4.884
12	734.4	55	199.386	124.459	456.016	568.059	87.343	480.716	19.265	8.356	5.454
13	826.9	61.2	241.423	172.976	522.952	634.346	130.029	504.317	21.829	10.384	5.722
14	909	65	270.265	195.032	571.683	692.568	149.380	543.188	23.904	11.578	6.163
15	956.7	70.4	327.953	236.204	696.732	844.385	180.300	664.085	29.126	14.057	7.535
16	1114.1	75.7	473.180	299.929	866.631	1088.933	250.878	838.055	37.740	18.723	9.509
17	1161.3	82.3	600.838	338.658	981.407	1281.971	300.274	981.697	44.479	22.202	11.138
18	1171.8		677.154	356.798	1038.065	1389.941	325.278	1064.663	48.222	24.062	12.080
19	1178.5		715.806	367.094	1074.035	1452.310	337.531	1114.778	50.363	25.066	12.648
20	1188		733.421	371.016	1085.861	1476.359	342.922	1133.437	51.195	25.475	12.860
21	1201.7		774.524	379.351	1118.383	1539.045	353.862	1185.183	53.334	26.439	13.447
22	1208.7		792.629	384.254	1133.660	1566.626	359.663	1206.963	54.284	26.895	13.694
23	1219.9		806.332	387.196	1144.009	1586.906	363.435	1223.471	54.978	27.215	13.882
24	1226.5		826.396	392.099	1162.243	1619.514	369.125	1250.389	56.091	27.716	14.187
25	1240.7		884.637	403.377	1208.571	1709.911	383.298	1326.613	59.159	29.055	15.052
26	1256.4		1031.982	429.364	1307.649	1922.986	416.645	1506.341	66.391	32.208	17.091
27	1271		1099.059	442.114	1363.851	2031.823	431.087	1600.735	70.059	33.735	18.162
28	1290.6		1232.262	462.219	1482.190	2260.916	453.537	1807.379	77.704	36.691	20.507
29	1303.4		1598.750	502.922	1800.858	2900.944	498.664	2402.281	98.891	44.378	27.257
30	1315.7		1897.820	523.030	2089.113	3467.010	519.922	2947.088	117.448	50.572	33.438
31	1330.7		2300.125	520.087	2504.012	4286.809	517.328	3769.480	143.999	58.461	42.769
32	1364.8		2757.274	460.748	2991.950	5291.327	457.898	4833.429	175.985	66.304	54.841
33	1379.9		3051.127	397.002	3305.128	5962.151	394.104	5568.047	197.111	70.759	63.176

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[25, 26, 27] e(1)	[25, 26, 27] e(2)	[25, 26, 27] e(3)	[25, 26, 27] e(max)	[25, 26, 27] e(min)	[25, 26, 27] gamma	[25, 26, 27] s(max)	[25, 26, 27] s(min)	[25, 26, 27] tau
1	26.8	0	3.424	0.000	0.987	4.725	-0.314	5.039	0.150	0.036	0.057
2	56.7	5.1	40.595	15.750	25.673	52.052	14.216	37.836	1.826	0.967	0.429
3	107.2	10	76.790	30.023	48.879	98.491	27.178	71.313	3.457	1.839	0.809
4	142.8	15.1	117.880	46.266	75.049	151.041	41.888	109.153	5.304	2.827	1.238
5	229.7	20	163.377	63.001	102.208	208.991	56.594	152.397	7.325	3.867	1.729
6	274.3	25	209.366	81.706	132.331	267.957	73.740	194.217	9.404	4.996	2.204
7	320.2	30	255.360	101.396	162.455	326.026	91.790	234.236	11.462	6.146	2.658
8	365.8	35	302.337	122.072	195.052	386.211	111.178	275.034	13.601	7.360	3.121
9	417.3	40.2	356.659	144.225	228.144	453.911	130.892	323.020	15.988	8.658	3.665
10	659.8	45.1	405.603	164.410	261.238	517.201	149.641	367.560	18.222	9.881	4.170
11	694.5	50	460.426	193.458	300.756	584.043	177.139	406.904	20.656	11.422	4.617
12	734.4	55	517.213	224.477	345.218	655.128	207.304	447.824	23.254	13.092	5.081
13	826.9	61.2	624.441	261.899	418.836	800.982	242.295	558.687	28.322	15.644	6.339
14	909	65	682.226	299.324	481.098	881.374	281.949	599.425	31.314	17.712	6.801
15	956.7	70.4	785.569	402.750	600.702	997.878	388.394	609.484	36.126	22.295	6.915
16	1114.1	75.7	1085.924	566.798	941.383	1466.315	560.991	905.324	52.990	32.446	10.272
17	1161.3	82.3	1372.725	682.599	1255.070	1947.931	679.864	1268.067	69.759	40.984	14.388
18	1171.8		1542.431	746.670	1442.186	2239.630	744.987	1494.642	79.849	45.932	16.958
19	1178.5		1630.739	779.202	1530.819	2383.911	777.646	1606.265	84.843	48.394	18.225
20	1188		1676.862	794.976	1578.360	2461.701	793.520	1668.181	87.520	49.665	18.927
21	1201.7		1769.611	827.510	1672.464	2615.884	826.191	1789.693	92.836	52.223	20.306
22	1208.7		1807.893	840.328	1708.625	2677.531	838.987	1838.544	94.958	53.238	20.860
23	1219.9		1840.288	852.159	1742.806	2732.199	850.896	1881.303	96.846	54.155	21.346
24	1226.5		1884.466	867.442	1784.422	2802.739	866.149	1936.589	99.282	55.336	21.973
25	1240.7		2010.150	907.870	1909.289	3012.776	906.662	2106.114	106.484	58.692	23.896
26	1256.4		2281.752	1006.489	2194.318	3470.356	1005.713	2464.643	122.281	66.353	27.964
27	1271		2421.784	1048.901	2322.757	3696.566	1047.975	2648.591	130.026	69.923	30.051
28	1290.6		2708.356	1135.215	2577.747	4152.302	1133.801	3018.501	145.634	77.137	34.248
29	1303.4		3438.049	1335.026	3200.878	5307.441	1331.486	3975.954	185.003	94.780	45.112
30	1315.7		4028.276	1471.239	3669.596	6233.387	1464.485	4768.901	216.314	108.096	54.109
31	1330.7		4824.045	1611.438	4258.217	7484.452	1597.810	5886.642	258.167	124.585	66.791
32	1364.8		5742.719	1715.132	4911.320	8962.751	1691.289	7271.463	306.999	141.993	82.503
33	1379.9		6321.260	1743.774	5312.763	9921.342	1712.681	8208.661	338.282	152.009	93.137

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[28, 29, 30] e(1)	[28, 29, 30] e(2)	[28, 29, 30] e(3)	[28, 29, 30] e(max)	[28, 29, 30] e(min)	[28, 29, 30] gamma	[28, 29, 30] s(max)	[28, 29, 30] s(min)	[28, 29, 30] tau
1	26.8	0	0.000	2.435	1.474	2.588	-1.114	3.701	0.073	-0.011	0.042
2	56.7	5.1	34.866	23.861	27.522	39.395	22.993	16.402	1.501	1.129	0.186
3	107.2	10	65.805	41.880	52.589	77.732	40.662	37.071	2.915	2.074	0.421
4	142.8	15.1	94.782	58.438	77.656	115.290	57.148	58.142	4.293	2.974	0.660
5	229.7	20	124.252	77.919	103.708	151.475	76.484	74.991	5.654	3.953	0.851
6	274.3	25	155.197	94.965	132.219	193.786	93.629	100.157	7.193	4.920	1.136
7	320.2	30	185.652	111.525	160.240	235.668	110.224	125.444	8.712	5.865	1.423
8	365.8	35	215.127	128.572	191.212	278.720	127.620	151.100	10.277	6.848	1.714
9	417.3	40.2	243.130	145.620	225.629	323.568	145.190	178.379	11.901	7.853	2.024
10	659.8	45.1	265.729	160.720	257.588	362.680	160.638	202.042	13.319	8.735	2.292
11	694.5	50	291.769	172.411	293.976	413.340	172.406	240.934	15.076	9.609	2.734
12	734.4	55	313.880	181.179	332.825	465.841	180.864	284.977	16.860	10.394	3.233
13	826.9	61.2	284.891	128.572	361.349	521.388	124.852	396.536	18.116	9.118	4.499
14	909	65	288.330	131.494	390.366	553.371	125.325	428.047	19.158	9.444	4.857
15	956.7	70.4	328.130	104.706	442.503	671.695	98.938	572.757	22.737	9.740	6.499
16	1114.1	75.7	279.977	105.680	566.473	771.586	74.865	696.721	25.741	9.931	7.905
17	1161.3	82.3	212.179	104.219	641.263	814.066	39.376	774.690	26.773	9.194	8.790
18	1171.8		171.406	96.913	668.328	827.338	12.397	814.941	26.941	8.448	9.246
19	1178.5		158.144	97.400	686.536	841.131	3.549	837.581	27.302	8.295	9.503
20	1188		147.337	95.452	691.457	842.431	-3.636	846.067	27.274	8.075	9.600
21	1201.7		128.181	92.530	701.792	846.537	-16.564	863.101	27.282	7.696	9.793
22	1208.7		123.269	92.530	708.190	851.610	-20.150	871.760	27.411	7.629	9.891
23	1219.9		117.375	91.068	711.143	853.112	-24.594	877.706	27.417	7.499	9.959
24	1226.5		110.990	92.043	718.033	857.356	-28.333	885.689	27.518	7.420	10.049
25	1240.7		88.888	86.198	728.860	863.309	-45.560	908.870	27.543	6.919	10.312
26	1256.4		48.617	70.126	750.516	880.915	-81.782	962.697	27.762	5.916	10.923
27	1271		28.482	66.230	757.899	883.002	-96.621	979.623	27.685	5.455	11.115
28	1290.6		-8.839	57.464	778.079	896.324	-127.084	1023.408	27.821	4.597	11.612
29	1303.4		-95.746	34.088	800.721	902.298	-197.323	1099.621	27.331	2.378	12.476
30	1315.7		-152.695	19.965	809.089	899.392	-242.998	1142.390	26.793	0.869	12.962
31	1330.7		-220.435	7.304	806.136	880.216	-294.515	1174.731	25.670	-0.987	13.329
32	1364.8		-286.203	2.435	796.783	852.911	-342.331	1195.242	24.320	-2.803	13.561
33	1379.9		-323.010	3.896	783.493	828.004	-367.521	1195.525	23.268	-3.862	13.565

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[31, 32, 33] e(1)	[31, 32, 33] e(2)	[31, 32, 33] e(3)	[31, 32, 33] e(max)	[31, 32, 33] e(min)	[31, 32, 33] gamma	[31, 32, 33] s(max)	[31, 32, 33] s(min)	[31, 32, 33] tau
1	26.8	0	0.980	0.000	0.000	1.183	-0.203	1.386	0.036	0.005	0.016
2	56.7	5.1	-5.882	-13.271	-17.627	-5.689	-17.820	12.130	-0.358	-0.633	0.138
3	107.2	10	-14.705	-27.525	-35.254	-14.394	-35.564	21.170	-0.812	-1.293	0.240
4	142.8	15.1	-24.017	-39.321	-46.515	-23.309	-47.223	23.914	-1.215	-1.758	0.271
5	229.7	20	-31.860	-50.625	-57.775	-30.618	-59.017	28.399	-1.567	-2.211	0.322
6	274.3	25	-40.192	-60.946	-71.484	-39.379	-72.296	32.917	-1.980	-2.727	0.373
7	320.2	30	-49.994	-72.250	-86.171	-49.520	-86.645	37.124	-2.448	-3.290	0.421
8	365.8	35	-60.286	-81.587	-100.858	-60.261	-100.883	40.622	-2.935	-3.856	0.461
9	417.3	40.2	-73.519	-91.416	-117.013	-73.181	-117.351	44.170	-3.514	-4.516	0.501
10	659.8	45.1	-89.202	-103.210	-131.209	-88.068	-132.343	44.275	-4.142	-5.147	0.502
11	694.5	50	-106.844	-114.022	-146.873	-103.081	-150.636	47.555	-4.807	-5.886	0.540
12	734.4	55	-124.976	-122.376	-161.558	-115.500	-171.035	55.534	-5.408	-6.668	0.630
13	826.9	61.2	-160.748	-94.856	-142.468	-94.125	-209.091	114.966	-5.085	-7.694	1.304
14	909	65	-181.818	-109.599	-157.642	-108.396	-231.064	122.668	-5.761	-8.545	1.392
15	956.7	70.4	-267.558	-169.549	-177.222	-152.875	-291.905	139.030	-7.795	-10.950	1.577
16	1114.1	75.7	-328.793	-209.348	-254.554	-201.366	-381.980	180.614	-10.243	-14.341	2.049
17	1161.3	82.3	-355.244	-230.966	-312.789	-228.802	-439.231	210.429	-11.689	-16.464	2.388
18	1171.8		-363.571	-235.879	-341.660	-235.366	-469.865	234.499	-12.200	-17.521	2.661
19	1178.5		-368.959	-240.301	-355.850	-240.125	-484.684	244.559	-12.498	-18.048	2.775
20	1188		-369.938	-241.283	-361.722	-241.215	-490.444	249.229	-12.589	-18.245	2.828
21	1201.7		-374.836	-243.740	-372.486	-243.734	-503.588	259.854	-12.799	-18.695	2.948
22	1208.7		-375.816	-245.213	-377.868	-245.209	-508.475	263.265	-12.894	-18.868	2.987
23	1219.9		-375.816	-245.705	-381.293	-245.677	-511.432	265.756	-12.938	-18.969	3.015
24	1226.5		-378.265	-246.196	-386.186	-246.138	-518.312	272.174	-13.020	-19.196	3.088
25	1240.7		-383.163	-249.144	-400.864	-248.870	-535.157	286.287	-13.272	-19.769	3.248
26	1256.4		-387.081	-255.039	-435.600	-253.168	-569.514	316.346	-13.746	-20.924	3.589
27	1271		-390.999	-257.496	-446.363	-255.136	-582.227	327.091	-13.933	-21.356	3.711
28	1290.6		-398.836	-263.391	-471.313	-259.608	-610.541	350.933	-14.354	-22.317	3.982
29	1303.4		-413.529	-273.216	-521.208	-265.889	-668.848	402.958	-15.124	-24.268	4.572
30	1315.7		-422.345	-282.550	-552.513	-272.461	-702.396	429.935	-15.664	-25.420	4.878
31	1330.7		-431.650	-292.866	-582.837	-279.929	-734.558	454.629	-16.218	-26.535	5.158
32	1364.8		-438.506	-303.674	-615.116	-286.836	-766.786	479.950	-16.756	-27.647	5.446
33	1379.9		-440.955	-306.621	-624.408	-288.720	-776.642	487.922	-16.913	-27.985	5.536

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[34, 35, 36] e(1)	[34, 35, 36] e(2)	[34, 35, 36] e(3)	[34, 35, 36] e(max)	[34, 35, 36] e(min)	[34, 35, 36] gamma	[34, 35, 36] s(max)	[34, 35, 36] s(min)	[34, 35, 36] tau
1	26.8	0	2.937		0.983	0.000	0.000	0.000	0.000	0.000	0.000
2	56.7	5.1	29.375		25.560	0.000	0.000	0.000	0.000	0.000	0.000
3	107.2	10	53.856		48.663	0.000	0.000	0.000	0.000	0.000	0.000
4	142.8	15.1	80.296		70.292	0.000	0.000	0.000	0.000	0.000	0.000
5	229.7	20	105.758		92.906	0.000	0.000	0.000	0.000	0.000	0.000
6	274.3	25	131.711		116.012	0.000	0.000	0.000	0.000	0.000	0.000
7	320.2	30	157.666		138.627	0.000	0.000	0.000	0.000	0.000	0.000
8	365.8	35	183.132		161.736	0.000	0.000	0.000	0.000	0.000	0.000
9	417.3	40.2	209.579		185.337	0.000	0.000	0.000	0.000	0.000	0.000
10	659.8	45.1	232.109		204.021	0.000	0.000	0.000	0.000	0.000	0.000
11	694.5	50	255.620		221.724	0.000	0.000	0.000	0.000	0.000	0.000
12	734.4	55	280.111		240.410	0.000	0.000	0.000	0.000	0.000	0.000
13	826.9	61.2	303.624		260.080	0.000	0.000	0.000	0.000	0.000	0.000
14	909	65	322.729		266.473	0.000	0.000	0.000	0.000	0.000	0.000
15	956.7	70.4	336.936		216.806	0.000	0.000	0.000	0.000	0.000	0.000
16	1114.1	75.7	410.916		223.199	0.000	0.000	0.000	0.000	0.000	0.000
17	1161.3	82.3	459.915		213.364	0.000	0.000	0.000	0.000	0.000	0.000
18	1171.8		476.575		204.513	0.000	0.000	0.000	0.000	0.000	0.000
19	1178.5		487.846		204.021	0.000	0.000	0.000	0.000	0.000	0.000
20	1188		489.806		200.088	0.000	0.000	0.000	0.000	0.000	0.000
21	1201.7		495.197		194.679	0.000	0.000	0.000	0.000	0.000	0.000
22	1208.7		501.077		195.171	0.000	0.000	0.000	0.000	0.000	0.000
23	1219.9		501.077		193.695	0.000	0.000	0.000	0.000	0.000	0.000
24	1226.5		505.488		192.220	0.000	0.000	0.000	0.000	0.000	0.000
25	1240.7		510.879		186.812	0.000	0.000	0.000	0.000	0.000	0.000
26	1256.4		520.680		183.370	0.000	0.000	0.000	0.000	0.000	0.000
27	1271		524.110		179.928	0.000	0.000	0.000	0.000	0.000	0.000
28	1290.6		532.932		177.469	0.000	0.000	0.000	0.000	0.000	0.000
29	1303.4		535.872		169.602	0.000	0.000	0.000	0.000	0.000	0.000
30	1315.7		530.971		162.719	0.000	0.000	0.000	0.000	0.000	0.000
31	1330.7		514.309		151.410	0.000	0.000	0.000	0.000	0.000	0.000
32	1364.8		489.316		145.511	0.000	0.000	0.000	0.000	0.000	0.000
33	1379.9		468.735		135.677	0.000	0.000	0.000	0.000	0.000	0.000

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[37, 38, 39] e(1)	[37, 38, 39] e(2)	[37, 38, 39] e(3)	[37, 38, 39] e(max)	[37, 38, 39] e(min)	[37, 38, 39] gamma	[37, 38, 39] s(max)	[37, 38, 39] s(min)	[37, 38, 39] tau
1	26.8	0	2.447	0.984	1.966	3.453	0.960	2.493	0.121	0.065	0.028
2	56.7	5.1	35.245	18.201	37.844	54.934	18.155	36.779	1.957	1.123	0.417
3	107.2	10	67.066	32.468	72.251	106.939	32.377	74.561	3.782	2.090	0.846
4	142.8	15.1	105.743	49.194	108.134	164.695	49.182	115.513	5.817	3.196	1.311
5	229.7	20	149.319	67.889	147.461	228.896	67.884	161.012	8.080	4.427	1.827
6	274.3	25	198.286	86.585	190.233	302.008	86.510	215.498	10.632	5.742	2.445
7	320.2	30	252.154	106.758	234.975	380.641	106.488	274.152	13.375	7.154	3.111
8	365.8	35	311.906	130.867	284.146	465.761	130.292	335.468	16.366	8.753	3.806
9	417.3	40.2	381.953	159.407	346.601	569.908	158.646	411.262	20.018	10.685	4.666
10	659.8	45.1	452.498	188.932	410.047	674.541	188.004	486.537	23.695	12.655	5.520
11	694.5	50	540.205	226.825	488.259	802.810	225.654	577.155	28.220	15.123	6.548
12	734.4	55	635.277	270.136	576.324	942.757	268.844	673.914	33.176	17.884	7.646
13	826.9	61.2	768.605	352.336	700.328	1118.119	350.814	767.305	39.658	22.247	8.706
14	909	65	875.980	414.365	803.196	1266.365	412.811	853.555	45.067	25.698	9.685
15	956.7	70.4	1063.817	489.203	1010.965	1586.215	488.567	1097.648	56.173	31.265	12.454
16	1114.1	75.7	1585.514	791.623	1555.897	2349.930	791.482	1558.448	83.876	48.512	17.682
17	1161.3	82.3	2033.532	1031.125	2045.158	3047.583	1031.108	2016.475	108.823	63.065	22.879
18	1171.8		2287.683	1155.848	2319.586	3451.532	1155.737	2295.795	123.130	71.033	26.048
19	1178.5		2404.724	1206.634	2449.942	3648.242	1206.424	2441.817	130.000	74.590	27.705
20	1188		2464.238	1234.741	2518.590	3748.381	1234.447	2513.934	133.519	76.472	28.523
21	1201.7		2588.207	1286.520	2653.937	3956.028	1286.116	2669.913	140.753	80.166	30.293
22	1208.7		2634.949	1305.261	2707.295	4037.463	1304.782	2732.681	143.574	81.563	31.005
23	1219.9		2675.791	1323.509	2754.235	4107.070	1322.956	2784.113	146.007	82.829	31.589
24	1226.5		2732.384	1345.704	2815.017	4202.295	1345.106	2857.189	149.310	84.474	32.418
25	1240.7		2898.755	1407.360	2995.922	4488.083	1406.594	3081.489	159.172	89.246	34.963
26	1256.4		3270.087	1535.630	3369.798	5104.951	1534.934	3570.017	180.418	99.406	40.506
27	1271		3435.155	1588.428	3552.880	5400.517	1587.519	3812.998	190.511	103.985	43.263
28	1290.6		3785.672	1686.635	3922.707	6022.827	1685.553	4337.274	211.638	113.215	49.211
29	1303.4		4740.837	1899.402	4880.452	7722.723	1898.565	5824.159	268.816	136.652	66.082
30	1315.7		5556.241	2012.485	5661.061	9205.198	2012.103	7193.095	317.979	154.751	81.614
31	1330.7		6784.030	2145.354	6777.433	11416.111	2145.353	9270.759	390.947	180.572	105.187
32	1364.8		8364.483	2167.584	8183.821	14381.388	2166.916	12214.472	487.284	210.109	138.587
33	1379.9		9462.396	2102.378	9142.573	16504.367	2100.602	14403.765	555.461	228.606	163.427

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[40, 41, 42] e(1)	[40, 41, 42] e(2)	[40, 41, 42] e(3)	[40, 41, 42] e(max)	[40, 41, 42] e(min)	[40, 41, 42] gamma	[40, 41, 42] s(max)	[40, 41, 42] s(min)	[40, 41, 42] tau
1	26.8	0	-5.862	1.469	1.952	3.240	-7.150	10.390	0.036	-0.200	0.118
2	56.7	5.1	34.195	23.018	43.930	55.829	22.296	33.533	2.027	1.266	0.380
3	107.2	10	70.347	43.099	82.006	109.764	42.589	67.175	3.972	2.448	0.762
4	142.8	15.1	115.784	64.649	123.990	175.278	64.497	110.781	6.309	3.795	1.257
5	229.7	20	156.828	86.691	170.861	241.317	86.372	154.944	8.663	5.147	1.758
6	274.3	25	199.830	110.692	221.154	310.859	110.124	200.735	11.148	6.593	2.278
7	320.2	30	245.279	136.165	271.940	381.778	135.441	246.336	13.694	8.104	2.795
8	365.8	35	292.687	161.149	324.196	456.575	160.308	296.267	16.360	9.637	3.361
9	417.3	40.2	351.831	189.073	383.297	546.747	188.381	358.366	19.556	11.424	4.066
10	659.8	45.1	413.916	215.039	437.519	636.725	214.709	422.016	22.729	13.153	4.788
11	694.5	50	492.143	252.766	505.915	745.388	252.670	492.718	26.621	15.440	5.590
12	734.4	55	581.631	294.906	580.673	867.398	294.906	572.492	30.987	17.996	6.496
13	826.9	61.2	741.085	328.719	702.850	1115.680	328.254	787.426	39.360	21.492	8.934
14	909	65	870.250	388.019	811.368	1294.555	387.063	907.493	45.731	25.138	10.297
15	956.7	70.4	1071.402	495.854	979.567	1557.102	493.868	1063.235	55.280	31.153	12.064
16	1114.1	75.7	1672.397	773.882	1526.601	2428.328	770.670	1657.659	86.216	48.599	18.808
17	1161.3	82.3	2196.583	1000.044	2043.838	3242.977	997.444	2245.534	114.830	63.874	25.478
18	1171.8		2485.140	1121.262	2347.765	3713.463	1119.442	2594.022	131.268	72.404	29.432
19	1178.5		2621.133	1177.709	2489.495	3934.491	1176.137	2758.354	138.985	76.392	31.297
20	1188		2692.826	1206.671	2565.526	4053.105	1205.248	2847.857	143.113	78.489	32.312
21	1201.7		2835.752	1263.128	2717.132	4290.918	1261.966	3028.952	151.374	82.640	34.367
22	1208.7		2889.298	1283.257	2774.548	4381.651	1282.195	3099.456	154.512	84.178	35.167
23	1219.9		2937.936	1302.897	2828.043	4464.038	1301.942	3162.097	157.375	85.620	35.878
24	1226.5		2999.847	1328.429	2896.762	4568.999	1327.609	3241.390	161.027	87.473	36.777
25	1240.7		3183.656	1400.614	3104.937	4888.424	1400.169	3488.254	172.088	92.931	39.578
26	1256.4		3554.918	1554.347	3557.913	5558.485	1554.347	4004.138	195.309	104.446	45.432
27	1271		3733.516	1623.125	3766.359	5876.813	1623.061	4253.752	206.297	109.769	48.264
28	1290.6		4090.406	1756.776	4199.253	6533.503	1756.156	4777.346	228.879	120.470	54.205
29	1303.4		4952.405	2072.865	5323.541	8208.694	2067.253	6141.441	286.211	146.847	69.682
30	1315.7		3278.044	1474.282	1024.561	3465.800	836.805	2628.995	120.491	60.833	29.829
31	1330.7		1488.154	674.324	1525.622	2339.662	674.113	1665.550	82.402	44.607	18.898
32	1364.8		1240.804	655.689	1056.841	1650.460	647.184	1003.276	59.798	37.031	11.383
33	1379.9		1078.745	631.662	1173.262	1622.599	629.408	993.191	58.722	36.184	11.269

Table 7 (continued)

ID	Seconds Elapsed	Load (kips)	[43, 44, 45] e(1)	[43, 44, 45] e(2)	[43, 44, 45] e(3)	[43, 44, 45] e(max)	[43, 44, 45] e(min)	[43, 44, 45] gamma	[43, 44, 45] s(max)	[43, 44, 45] s(min)	[43, 44, 45] tau
1	26.8	0	-20.860	-27.446	36.511	53.289	-37.639	90.927	1.361	-0.702	1.032
2	56.7	5.1	-11.540	-24.790	81.491	110.710	-40.759	151.469	3.193	-0.245	1.719
3	107.2	10	-8.877	-34.086	139.178	188.957	-58.656	247.613	5.555	-0.064	2.809
4	142.8	15.1	-11.096	-14.609	173.052	213.698	-51.742	265.439	6.424	0.401	3.012
5	229.7	20	-4.438	-52.678	250.866	340.545	-94.118	434.663	10.124	0.261	4.932
6	274.3	25	27.963	10.625	304.337	374.197	-41.897	416.094	11.723	2.281	4.721
7	320.2	30	23.968	-37.185	385.347	506.547	-97.231	603.777	15.475	1.774	6.851
8	365.8	35	65.250	25.234	436.714	543.315	-41.351	584.665	17.211	3.943	6.634
9	417.3	40.2	161.588	65.966	462.664	600.668	23.584	577.083	19.702	6.606	6.548
10	659.8	45.1	51.933	-72.597	489.675	678.024	-136.417	814.441	20.653	2.172	9.241
11	694.5	50	89.666	-55.777	517.746	722.085	-114.673	836.758	22.293	3.305	9.494
12	734.4	55	193.557	27.448	532.577	739.994	-12.930	751.994	23.833	6.768	8.532
13	826.9	61.2	388.968	48.699	612.565	966.453	35.080	931.373	31.671	10.536	10.567
14	909	65	428.504	4.427	605.148	1036.781	-3.129	1039.911	33.580	9.982	11.799
15	956.7	70.4	617.788	-237.670	600.380	1455.883	-237.714	1693.597	44.884	6.453	19.216
16	1114.1	75.7	1181.191	-634.853	708.461	2542.090	-652.438	3194.529	76.063	3.572	36.246
17	1161.3	82.3	1170.958	-1031.710	762.510	2975.585	-1042.117	4017.703	86.326	-4.845	45.585
18	1171.8		1016.594	-801.944	800.136	2622.094	-805.365	3427.458	77.170	-0.607	38.888
19	1178.5		944.989	-834.648	830.875	2611.456	-835.592	3447.048	76.531	-1.691	39.111
20	1188		886.290	-803.711	827.695	2517.954	-803.970	3321.924	73.807	-1.575	37.691
21	1201.7		813.371	-708.238	841.474	2363.148	-708.303	3071.450	69.719	0.021	34.849
22	1208.7		737.351	-591.081	861.085	2190.893	-592.457	2783.350	65.262	2.101	31.580
23	1219.9		734.684	-585.333	850.485	2171.717	-586.549	2758.267	64.697	2.106	31.296
24	1226.5		716.014	-585.333	852.075	2155.111	-587.022	2742.133	64.155	1.929	31.113
25	1240.7		590.679	-530.060	858.965	1986.854	-537.209	2524.063	59.184	1.908	28.638
26	1256.4		363.649	-129.693	895.538	1434.107	-174.920	1609.027	44.789	8.277	18.256
27	1271		217.979	-7.526	914.620	1237.569	-104.970	1342.539	39.098	8.633	15.233
28	1290.6		15.091	71.279	923.632	1073.374	-134.651	1208.024	33.487	6.074	13.706
29	1303.4		503.142	-160.672	943.245	1634.041	-187.653	1821.694	51.147	9.808	20.669
30	1315.7		804.479	-626.895	947.486	2380.560	-628.595	3009.154	71.059	2.774	34.142
31	1330.7		1235.921	-668.010	906.669	2818.374	-675.784	3494.158	84.793	5.502	39.645
32	1364.8		902.298	-627.337	893.948	2423.588	-627.342	3050.930	72.466	3.233	34.616
33	1379.9		1013.035	-987.091	854.195	2855.962	-988.732	3844.694	82.968	-4.277	43.622

Table 8 Reduced data Specimen 2

Specimen 2											
ID	**Seconds Elapsed**	**Load**	**[1, 2, 3] e(1)**	**[1, 2, 3] e(2)**	**[1, 2, 3] e(3)**	**[1, 2, 3] e(max)**	**[1, 2, 3] e(min)**	**[1, 2, 3] Shear Strain**	**[1, 2, 3] s(max)**	**[1, 2, 3] s(min)**	**[1, 2, 3] Shear Stress**
1	334.2	0	-0.436	0.446	0.427	0.619	-0.628	1.247	0.010	-0.010	0.010
2	382.8	5.1	57.115	40.547	31.635	57.678	31.072	26.605	2.170	1.570	0.300
3	418.1	10	106.387	73.075	59.425	108.361	57.450	50.912	4.070	2.920	0.580
4	440.7	15.3	159.588	106.497	87.643	163.454	83.778	79.676	6.110	4.310	0.900
5	466.7	20	208.870	135.911	114.580	215.475	107.975	107.500	8.040	5.600	1.220
6	500.1	25	260.774	168.000	144.512	270.314	134.972	135.342	10.080	7.000	1.540
7	527.4	30	317.482	182.708	177.012	342.632	151.862	190.770	12.580	8.260	2.160
8	560.7	35	369.397	213.017	208.230	399.443	178.184	221.258	14.680	9.660	2.510
9	594.1	40	423.935	245.557	241.589	458.926	206.598	252.328	16.890	11.160	2.860
10	619.7	45	480.225	280.773	276.234	519.299	237.159	282.140	19.140	12.740	3.200
11	646	50	538.266	315.992	313.874	583.249	268.892	314.357	21.520	14.390	3.570
12	670.9	55	602.861	357.456	357.935	653.927	306.870	347.057	24.180	16.310	3.940
13	701.9	60	672.703	404.719	408.845	730.290	351.258	379.032	27.090	18.490	4.300
14	729.2	65	750.414	455.555	464.038	815.809	398.643	417.166	30.320	20.860	4.730
15	762.5	70.6	848.660	521.113	532.503	922.333	458.831	463.501	34.360	23.840	5.260
16	786.5	75.4	953.041	595.156	599.694	1029.451	523.284	506.167	38.460	26.980	5.740
17	812.7	80.4	1069.238	674.116	674.170	1151.097	592.311	558.787	43.080	30.400	6.340
18	845.2	85.4	1202.068	766.922	757.220	1287.415	671.872	615.542	48.270	34.300	6.980
19	876.4	90.2	1346.734	867.777	842.424	1433.726	755.431	678.295	53.820	38.430	7.700
20	896.3	92.9	1447.281	938.746	898.092	1533.423	811.950	721.473	57.610	41.230	8.190
21	908	94.6	1522.924	990.527	939.205	1609.271	852.858	756.412	60.460	43.300	8.580
22	921.7	96.3	1628.754	1059.280	994.028	1716.705	906.077	810.628	64.460	46.070	9.200

Table 8 (continued)

ID	Seconds Elapsed	Load	[4, 5, 6] e(1)	[4, 5, 6] e(2)	[4, 5, 6] e(3)	[4, 5, 6] e(max)	[4, 5, 6] e(min)	[4, 5, 6] Shear Strain	[4, 5, 6] s(max)	[4, 5, 6] s(min)	[4, 5, 6] Shear Stress
1	334.2	0	3.540	9.639	2.389	9.664	-3.734	13.398	0.280	-0.030	0.150
2	382.8	5.1	16.817	18.402	22.099	22.303	16.613	5.690	0.880	0.760	0.060
3	418.1	10	27.438	26.288	41.512	45.270	23.679	21.591	1.700	1.210	0.240
4	440.7	15.3	39.387	34.613	63.314	71.924	30.777	41.147	2.630	1.700	0.470
5	466.7	20	51.779	45.129	83.325	94.968	40.137	54.831	3.470	2.220	0.620
6	500.1	25	63.729	55.645	106.324	121.316	48.738	72.578	4.410	2.760	0.820
7	527.4	30	79.220	68.352	134.403	154.144	59.478	94.666	5.580	3.430	1.070
8	560.7	35	93.383	81.497	158.300	180.796	70.888	109.908	6.550	4.060	1.250
9	594.1	40	107.990	107.352	183.991	200.185	91.796	108.389	7.380	4.920	1.230
10	619.7	45	122.597	111.734	210.879	237.263	96.212	141.051	8.630	5.430	1.600
11	646	50	137.647	122.689	238.365	270.482	105.530	164.952	9.790	6.050	1.870
12	670.9	55	153.140	136.275	269.438	306.202	116.376	189.826	11.060	6.750	2.150
13	701.9	60	169.962	155.119	302.904	341.458	131.408	210.051	12.350	7.580	2.380
14	729.2	65	185.899	166.952	337.268	382.758	140.409	242.349	13.770	8.270	2.750
15	762.5	70.6	203.164	173.088	377.313	436.205	144.272	291.933	15.540	8.920	3.310
16	786.5	75.4	216.003	180.101	413.476	481.702	147.777	333.925	17.050	9.480	3.790
17	812.7	80.4	235.483	189.743	458.608	539.894	154.197	385.696	19.000	10.250	4.380
18	845.2	85.4	256.292	197.194	509.424	607.559	158.158	449.401	21.230	11.040	5.100
19	876.4	90.2	278.873	200.700	566.823	687.571	158.125	529.446	23.830	11.810	6.010
20	896.3	92.9	295.699	205.521	604.793	739.685	160.807	578.878	25.540	12.410	6.570
21	908	94.6	307.655	206.398	630.805	777.754	160.706	617.049	26.780	12.770	7.000
22	921.7	96.3	322.267	201.577	665.192	832.481	154.978	677.503	28.490	13.120	7.690

Table 8 (continued)

ID	Seconds Elapsed	Load	[7, 8, 9] e(1)	[7, 8, 9] e(2)	[7, 8, 9] e(3)	[7, 8, 9] e(max)	[7, 8, 9] e(min)	[7, 8, 9] Shear Strain	[7, 8, 9] s(max)	[7, 8, 9] s(min)	[7, 8, 9] Shear Stress
1	334.2	0	6.967	2.727	3.632	8.366	2.234	6.132	0.290	0.150	0.070
2	382.8	5.1	-47.461	-9.349	-39.549	-9.121	-77.890	68.768	-1.050	-2.610	0.780
3	418.1	10	-99.707	-20.646	-83.938	-20.211	-163.434	143.223	-2.240	-5.490	1.630
4	440.7	15.3	-158.477	-33.501	-131.954	-32.717	-257.714	224.997	-3.570	-8.670	2.550
5	466.7	20	-212.888	-44.408	-178.351	-43.425	-347.814	304.389	-4.790	-11.700	3.450
6	500.1	25	-272.080	-58.042	-229.182	-56.851	-444.412	387.561	-6.160	-14.960	4.400
7	527.4	30	-331.265	-68.558	-283.235	-67.353	-547.147	479.794	-7.500	-18.390	5.440
8	560.7	35	-393.055	-82.970	-338.492	-81.657	-649.889	568.232	-8.970	-21.860	6.450
9	594.1	40	-460.492	-98.939	-396.969	-97.413	-760.047	662.634	-10.550	-25.590	7.520
10	619.7	45	-527.050	-114.908	-456.649	-113.268	-870.431	757.163	-12.140	-29.320	8.590
11	646	50	-604.908	-139.055	-525.191	-137.194	-992.905	855.711	-14.100	-33.520	9.710
12	670.9	55	-686.668	-162.032	-598.159	-159.998	-1124.829	964.831	-16.130	-38.020	10.950
13	701.9	60	-774.501	-188.124	-679.177	-186.019	-1267.659	1081.639	-18.360	-42.900	12.270
14	729.2	65	-878.403	-221.613	-770.257	-219.192	-1429.468	1210.276	-21.010	-48.470	13.730
15	762.5	70.6	-1004.449	-258.993	-882.673	-256.291	-1630.831	1374.541	-24.170	-55.360	15.600
16	786.5	75.4	-1133.939	-292.477	-991.037	-289.169	-1835.806	1546.637	-27.230	-62.320	17.550
17	812.7	80.4	-1280.770	-327.906	-1120.721	-324.245	-2077.246	1753.001	-30.710	-70.490	19.890
18	845.2	85.4	-1462.295	-368.003	-1276.540	-363.706	-2375.129	2011.424	-34.890	-80.530	22.820
19	876.4	90.2	-1686.290	-399.145	-1467.725	-394.086	-2759.929	2365.843	-39.620	-93.300	26.840
20	896.3	92.9	-1851.184	-406.151	-1605.737	-400.469	-3056.452	2655.983	-42.710	-102.980	30.140
21	908	94.6	-1982.627	-404.984	-1714.349	-398.765	-3298.211	2899.446	-45.000	-110.800	32.900
22	921.7	96.3	-2173.007	-391.360	-1871.193	-384.392	-3659.807	3275.415	-48.050	-122.380	37.160

Table 8 (continued)

ID	Seconds Elapsed	Load	[10, 11, 12] e(1)	[10, 11, 12] e(2)	[10, 11, 12] e(3)	[10, 11, 12] e(max)	[10, 11, 12] e(min)	[10, 11, 12] gamma	[10, 11, 12] s(max)	[10, 11, 12] s(min)	[10, 11, 12] tau
1	334.2	0	-1.680		1.817	0.000	0.000	0.000	0.000	0.000	0.000
2	382.8	5.1	24.363		9.086	0.000	0.000	0.000	0.000	0.000	0.000
3	418.1	10	51.248		17.718	0.000	0.000	0.000	0.000	0.000	0.000
4	440.7	15.3	79.815		25.896	0.000	0.000	0.000	0.000	0.000	0.000
5	466.7	20	107.123		34.074	0.000	0.000	0.000	0.000	0.000	0.000
6	500.1	25	137.374		41.798	0.000	0.000	0.000	0.000	0.000	0.000
7	527.4	30	163.844		47.704	0.000	0.000	0.000	0.000	0.000	0.000
8	560.7	35	194.098		56.337	0.000	0.000	0.000	0.000	0.000	0.000
9	594.1	40	225.615		65.424	0.000	0.000	0.000	0.000	0.000	0.000
10	619.7	45	257.554		74.057	0.000	0.000	0.000	0.000	0.000	0.000
11	646	50	292.016		84.962	0.000	0.000	0.000	0.000	0.000	0.000
12	670.9	55	329.843		96.321	0.000	0.000	0.000	0.000	0.000	0.000
13	701.9	60	371.877		109.044	0.000	0.000	0.000	0.000	0.000	0.000
14	729.2	65	416.016		122.677	0.000	0.000	0.000	0.000	0.000	0.000
15	762.5	70.6	471.510		138.127	0.000	0.000	0.000	0.000	0.000	0.000
16	786.5	75.4	531.636		151.305	0.000	0.000	0.000	0.000	0.000	0.000
17	812.7	80.4	594.712		168.120	0.000	0.000	0.000	0.000	0.000	0.000
18	845.2	85.4	665.788		185.844	0.000	0.000	0.000	0.000	0.000	0.000
19	876.4	90.2	743.604		200.387	0.000	0.000	0.000	0.000	0.000	0.000
20	896.3	92.9	794.506		210.386	0.000	0.000	0.000	0.000	0.000	0.000
21	908	94.6	830.267		216.749	0.000	0.000	0.000	0.000	0.000	0.000
22	921.7	96.3	875.708		224.475	0.000	0.000	0.000	0.000	0.000	0.000

Table 8 (continued)

ID	Seconds Elapsed	Load	[13, 14, 15] e(1)	[13, 14, 15] e(2)	[13, 14, 15] e(3)	[13, 14, 15] e(max)	[13, 14, 15] e(min)	[13, 14, 15] gamma	[13, 14, 15] s(max)	[13, 14, 15] s(min)	[13, 14, 15] tau
1	334.2	0	1.888	1.246	1.770	2.415	1.243	1.172	0.090	0.060	0.010
2	382.8	5.1	36.636	38.633	50.007	51.487	35.156	16.331	2.010	1.640	0.190
3	418.1	10	68.742	74.776	95.592	97.492	66.842	30.650	3.810	3.110	0.350
4	440.7	15.3	102.361	111.753	146.051	149.351	99.060	50.291	5.800	4.660	0.570
5	466.7	20	134.093	145.824	192.531	197.364	129.259	68.105	7.660	6.110	0.770
6	500.1	25	167.338	183.637	242.556	248.174	161.720	86.454	9.620	7.660	0.980
7	527.4	30	203.230	226.439	299.228	305.252	197.207	108.045	11.810	9.360	1.230
8	560.7	35	239.881	268.414	355.021	361.929	232.973	128.957	14.000	11.070	1.460
9	594.1	40	278.045	312.471	413.034	420.700	270.380	150.320	16.270	12.860	1.710
10	619.7	45	317.347	356.532	468.397	476.685	309.059	167.626	18.460	14.650	1.900
11	646	50	359.297	404.338	530.853	540.035	350.115	189.920	20.910	16.600	2.150
12	670.9	55	405.786	457.137	596.417	606.068	396.135	209.933	23.500	18.740	2.380
13	701.9	60	454.547	514.516	667.751	677.505	444.793	232.711	26.290	21.010	2.640
14	729.2	65	505.203	575.228	742.196	751.727	495.673	256.055	29.190	23.380	2.910
15	762.5	70.6	562.292	645.929	833.939	843.619	552.611	291.008	32.720	26.120	3.300
16	786.5	75.4	606.152	695.010	928.801	944.330	590.624	353.706	36.360	28.330	4.010
17	812.7	80.4	660.984	772.384	1024.125	1037.212	647.896	389.316	39.920	31.090	4.420
18	845.2	85.4	717.712	863.917	1130.110	1138.660	709.161	429.498	43.810	34.060	4.870
19	876.4	90.2	775.581	967.952	1251.642	1255.982	771.241	484.741	48.220	37.220	5.500
20	896.3	92.9	810.759	1037.043	1336.821	1339.376	808.204	531.172	51.280	39.230	6.030
21	908	94.6	834.591	1084.496	1398.053	1399.845	832.799	567.045	53.480	40.610	6.430
22	921.7	96.3	865.234	1145.692	1484.144	1485.499	863.878	621.621	56.560	42.450	7.050

Table 8 (continued)

ID	Seconds Elapsed	Load	[16, 17, 18] e(1)	[16, 17, 18] e(2)	[16, 17, 18] e(3)	[16, 17, 18] e(max)	[16, 17, 18] e(min)	[16, 17, 18] gamma	[16, 17, 18] s(max)	[16, 17, 18] s(min)	[16, 17, 18] tau
1	334.2	0	6.748	3.832	4.538	7.764	3.522	4.242	0.290	0.190	0.050
2	382.8	5.1	-26.147	-13.796	-7.839	-7.297	-26.689	19.393	-0.500	-0.940	0.220
3	418.1	10	-53.558	-24.910	-16.090	-13.628	-56.020	42.391	-0.990	-1.950	0.480
4	440.7	15.3	-77.594	-35.257	-22.691	-18.914	-81.370	62.456	-1.400	-2.820	0.710
5	466.7	20	-98.256	-43.687	-27.641	-22.729	-103.168	80.439	-1.740	-3.570	0.910
6	500.1	25	-117.652	-51.735	-33.829	-27.441	-124.040	96.599	-2.100	-4.290	1.100
7	527.4	30	-126.084	-39.855	-30.942	-17.215	-139.811	122.596	-1.920	-4.700	1.390
8	560.7	35	-144.636	-45.220	-34.654	-18.952	-160.339	141.387	-2.170	-5.380	1.600
9	594.1	40	-164.452	-52.501	-40.017	-22.583	-181.886	159.304	-2.500	-6.120	1.810
10	619.7	45	-182.159	-58.249	-42.905	-24.245	-200.819	176.573	-2.740	-6.750	2.000
11	646	50	-206.189	-67.446	-49.093	-28.680	-226.602	197.922	-3.130	-7.620	2.250
12	670.9	55	-226.424	-73.576	-54.043	-31.275	-249.192	217.917	-3.440	-8.380	2.470
13	701.9	60	-250.873	-79.707	-59.406	-33.259	-277.020	243.762	-3.770	-9.300	2.770
14	729.2	65	-278.272	-87.754	-65.594	-36.308	-307.558	271.249	-4.170	-10.320	3.080
15	762.5	70.6	-313.256	-99.249	-74.669	-41.642	-346.283	304.641	-4.720	-11.630	3.460
16	786.5	75.4	-349.923	-112.277	-73.431	-41.406	-381.949	340.543	-5.060	-12.780	3.860
17	812.7	80.4	-384.060	-120.323	-80.444	-43.642	-420.862	377.220	-5.510	-14.070	4.280
18	845.2	85.4	-423.672	-128.369	-89.106	-45.741	-467.037	421.296	-6.020	-15.590	4.780
19	876.4	90.2	-466.230	-137.181	-101.481	-49.817	-517.894	468.076	-6.650	-17.270	5.310
20	896.3	92.9	-494.460	-141.395	-109.318	-51.207	-552.572	501.365	-7.030	-18.410	5.690
21	908	94.6	-516.368	-145.993	-116.743	-53.845	-579.266	525.421	-7.380	-19.300	5.960
22	921.7	96.3	-544.596	-152.123	-128.292	-58.413	-614.475	556.062	-7.870	-20.490	6.310

Table 8 (continued)

ID	Seconds Elapsed	Load	[19, 20, 21] e(1)	[19, 20, 21] e(2)	[19, 20, 21] e(3)	[19, 20, 21] e(max)	[19, 20, 21] e(min)	[19, 20, 21] gamma	[19, 20, 21] s(max)	[19, 20, 21] s(min)	[19, 20, 21] tau
1	334.2	0	1.605	0.832	0.000	1.606	-0.001	1.606	0.050	0.020	0.020
2	382.8	5.1	26.890	26.621	43.500	47.132	23.258	23.874	1.750	1.210	0.270
3	418.1	10	47.761	46.171	78.389	85.883	40.266	45.618	3.180	2.140	0.520
4	440.7	15.3	70.238	65.723	112.849	125.019	58.067	66.952	4.620	3.100	0.760
5	466.7	20	89.906	83.611	143.435	159.206	74.135	85.071	5.880	3.950	0.970
6	500.1	25	111.582	101.915	175.314	195.798	91.099	104.699	7.230	4.860	1.190
7	527.4	30	134.062	107.324	198.149	233.053	99.157	133.896	8.520	5.480	1.520
8	560.7	35	155.339	123.133	226.585	267.576	114.347	153.229	9.790	6.310	1.740
9	594.1	40	177.018	141.855	255.023	299.816	132.225	167.591	11.010	7.200	1.900
10	619.7	45	199.500	160.994	282.600	331.247	150.854	180.394	12.210	8.110	2.050
11	646	50	221.181	178.469	308.456	361.568	168.069	193.499	13.360	8.960	2.200
12	670.9	55	246.477	200.106	336.036	392.813	189.700	203.112	14.580	9.970	2.300
13	701.9	60	273.781	223.824	362.326	422.164	213.942	208.222	15.770	11.040	2.360
14	729.2	65	301.890	247.544	386.461	449.654	238.697	210.957	16.900	12.110	2.390
15	762.5	70.6	338.836	277.923	412.753	480.411	271.177	209.234	18.210	13.460	2.370
16	786.5	75.4	379.398	314.131	442.494	512.772	309.120	203.652	19.630	15.010	2.310
17	812.7	80.4	424.383	345.346	462.754	543.646	343.490	200.156	20.960	16.420	2.270
18	845.2	85.4	473.790	373.234	474.824	575.381	373.233	202.149	22.280	17.700	2.290
19	876.4	90.2	529.630	394.879	476.117	614.133	391.614	222.519	23.720	18.670	2.520
20	896.3	92.9	567.797	405.702	473.099	644.580	396.317	248.263	24.750	19.120	2.820
21	908	94.6	594.717	409.448	467.927	668.697	393.946	274.751	25.510	19.270	3.120
22	921.7	96.3	629.675	410.281	454.564	700.382	383.856	316.527	26.440	19.260	3.590

Table 8 (continued)

ID	Seconds Elapsed	Load	[22, 23, 24] e(1)	[22, 23, 24] e(2)	[22, 23, 24] e(3)	[22, 23, 24] e(max)	[22, 23, 24] e(min)	[22, 23, 24] gamma	[22, 23, 24] s(max)	[22, 23, 24] s(min)	[22, 23, 24] tau
1	334.2	0	2.409	4.382	1.822	4.401	-0.170	4.571	0.140	0.040	0.050
2	382.8	5.1	26.496	15.934	34.165	45.229	15.432	29.797	1.620	0.940	0.340
3	418.1	10	47.775	27.088	66.509	88.622	25.662	62.960	3.120	1.690	0.710
4	440.7	15.3	70.660	39.438	102.957	136.856	36.761	100.095	4.790	2.520	1.140
5	466.7	20	92.342	52.584	137.584	181.316	48.609	132.707	6.350	3.340	1.510
6	500.1	25	116.434	66.528	176.770	232.170	61.034	171.137	8.120	4.240	1.940
7	527.4	30	142.936	81.667	226.441	295.849	73.528	222.321	10.310	5.260	2.520
8	560.7	35	168.637	96.409	268.368	350.387	86.618	263.769	12.200	6.220	2.990
9	594.1	40	196.749	112.346	316.225	412.516	100.457	312.059	14.350	7.270	3.540
10	619.7	45	226.067	129.080	363.174	473.794	115.447	358.347	16.480	8.350	4.070
11	646	50	256.591	145.417	412.863	539.528	129.926	409.603	18.750	9.460	4.650
12	670.9	55	292.340	165.340	468.940	613.343	147.936	465.406	21.320	10.760	5.280
13	701.9	60	332.911	187.257	530.038	694.832	168.117	526.715	24.160	12.210	5.980
14	729.2	65	378.708	210.370	594.793	783.499	190.002	593.496	27.250	13.780	6.730
15	762.5	70.6	435.760	240.657	674.151	891.096	218.814	672.282	31.020	15.760	7.630
16	786.5	75.4	490.005	269.751	747.135	990.327	246.812	743.514	34.500	17.630	8.440
17	812.7	80.4	569.976	309.209	846.592	1130.646	285.922	844.724	39.430	20.260	9.580
18	845.2	85.4	676.490	362.623	969.344	1305.940	339.894	966.047	45.640	23.720	10.960
19	876.4	90.2	818.008	431.192	1130.928	1539.826	409.111	1130.715	53.900	28.240	12.830
20	896.3	92.9	929.400	485.415	1256.031	1721.593	463.839	1257.754	60.320	31.780	14.270
21	908	94.6	1019.497	527.283	1355.131	1868.346	506.283	1362.063	65.490	34.580	15.450
22	921.7	96.3	1157.086	591.487	1506.787	2092.751	571.122	1521.628	73.400	38.870	17.260

Table 8 (continued)

ID	Seconds Elapsed	Load	[25, 26, 27] e(1)	[25, 26, 27] e(2)	[25, 26, 27] e(3)	[25, 26, 27] e(max)	[25, 26, 27] e(min)	[25, 26, 27] gamma	[25, 26, 27] s(max)	[25, 26, 27] s(min)	[25, 26, 27] tau
1	334.2	0	-0.405	0.000	-0.831	0.036	-1.271	1.307	-0.010	-0.040	0.010
2	382.8	5.1	26.335	13.666	19.105	32.469	12.971	19.498	1.180	0.740	0.220
3	418.1	10	54.292	27.332	39.456	67.776	25.972	41.804	2.450	1.500	0.470
4	440.7	15.3	83.871	41.440	60.639	105.187	39.323	65.864	3.790	2.300	0.750
5	466.7	20	111.021	55.107	80.162	138.916	52.266	86.650	5.010	3.050	0.980
6	500.1	25	141.819	67.893	100.931	178.632	64.118	114.514	6.410	3.820	1.300
7	527.4	30	169.783	82.001	120.455	212.884	77.353	135.530	7.650	4.580	1.540
8	560.7	35	200.990	96.992	143.718	252.973	91.735	161.238	9.090	5.430	1.830
9	594.1	40	236.252	111.543	168.645	299.436	105.461	193.975	10.730	6.330	2.200
10	619.7	45	273.544	127.416	195.234	348.302	120.476	227.827	12.460	7.290	2.580
11	646	50	313.271	142.408	223.071	401.776	134.566	267.209	14.330	8.270	3.030
12	670.9	55	358.271	157.401	255.065	464.603	148.733	315.870	16.510	9.340	3.580
13	701.9	60	410.574	176.804	291.217	534.931	166.859	368.072	18.960	10.610	4.180
14	729.2	65	466.937	193.121	332.358	616.860	182.435	434.424	21.770	11.910	4.930
15	762.5	70.6	539.935	215.171	386.802	723.107	203.630	519.477	25.420	13.630	5.890
16	786.5	75.4	621.866	239.869	443.330	838.637	226.560	612.076	29.390	15.500	6.940
17	812.7	80.4	715.171	271.184	518.989	976.616	257.544	719.072	34.160	17.850	8.160
18	845.2	85.4	830.000	309.999	618.775	1152.023	296.752	855.271	40.230	20.820	9.700
19	876.4	90.2	976.922	361.610	751.853	1379.605	349.170	1030.434	48.120	24.740	11.690
20	896.3	92.9	1089.779	400.874	856.261	1556.959	389.081	1167.877	54.260	27.750	13.250
21	908	94.6	1180.733	433.081	943.214	1701.982	421.966	1280.016	59.280	30.230	14.520
22	921.7	96.3	1315.976	481.616	1077.210	1921.469	471.717	1449.751	66.880	33.980	16.450

Table 8 (continued)

ID	Seconds Elapsed	Load	[28, 29, 30] e(1)	[28, 29, 30] e(2)	[28, 29, 30] e(3)	[28, 29, 30] e(max)	[28, 29, 30] e(min)	[28, 29, 30] gamma	[28, 29, 30] s(max)	[28, 29, 30] s(min)	[28, 29, 30] tau
1	334.2	0	28.702	2.061	2.504	34.443	-3.238	37.681	1.090	0.230	0.430
2	382.8	5.1	58.672	16.902	22.952	70.655	10.968	59.687	2.400	1.040	0.680
3	418.1	10	87.377	31.743	42.984	105.314	25.047	80.267	3.660	1.840	0.910
4	440.7	15.3	116.928	48.647	64.268	140.128	41.068	99.059	4.940	2.690	1.120
5	466.7	20	140.992	63.901	85.136	169.606	56.522	113.084	6.050	3.480	1.280
6	500.1	25	165.902	80.805	106.840	199.296	73.445	125.851	7.170	4.320	1.430
7	527.4	30	193.346	101.833	133.136	231.631	94.851	136.781	8.430	5.330	1.550
8	560.7	35	217.836	119.976	156.094	260.726	113.205	147.521	9.550	6.210	1.670
9	594.1	40	242.328	136.882	179.470	291.312	130.486	160.827	10.710	7.060	1.820
10	619.7	45	263.442	153.788	204.100	319.080	148.462	170.618	11.790	7.920	1.940
11	646	50	285.824	171.520	228.731	347.661	166.894	180.767	12.890	8.790	2.050
12	670.9	55	304.828	190.490	256.286	373.837	187.277	186.560	13.940	9.710	2.120
13	701.9	60	325.100	209.873	285.513	402.771	207.842	194.929	15.080	10.650	2.210
14	729.2	65	341.994	228.432	314.741	429.228	227.507	201.721	16.130	11.550	2.290
15	762.5	70.6	356.355	249.466	351.905	458.817	249.442	209.375	17.300	12.550	2.380
16	786.5	75.4	347.063	252.353	388.654	485.220	250.496	234.725	18.170	12.840	2.660
17	812.7	80.4	347.907	272.563	426.658	508.572	265.993	242.578	19.070	13.570	2.750
18	845.2	85.4	341.994	292.774	468.842	534.691	276.146	258.545	20.020	14.150	2.930
19	876.4	90.2	326.790	312.985	515.207	564.324	277.673	286.650	20.990	14.490	3.250
20	896.3	92.9	310.318	323.298	546.537	586.548	270.307	316.241	21.640	14.470	3.590
21	908	94.6	293.003	327.423	569.096	603.663	258.436	345.226	22.080	14.250	3.920
22	921.7	96.3	267.665	328.248	597.923	628.235	237.352	390.883	22.670	13.800	4.440

Table 8 (continued)

ID	Seconds Elapsed	Load	[31, 32, 33] e(1)	[31, 32, 33] e(2)	[31, 32, 33] e(3)	[31, 32, 33] e(max)	[31, 32, 33] e(min)	[31, 32, 33] gamma	[31, 32, 33] s(max)	[31, 32, 33] s(min)	[31, 32, 33] tau
1	334.2	0	2.311	2.889	3.324	3.329	2.306	1.023	0.130	0.110	0.010
2	382.8	5.1	-5.085	-1.238	-19.114	0.830	-25.029	25.860	-0.220	-0.800	0.290
3	418.1	10	-9.245	-7.015	-40.305	-1.183	-48.367	47.184	-0.510	-1.580	0.540
4	440.7	15.3	-11.556	-17.332	-62.742	-4.781	-69.517	64.737	-0.830	-2.300	0.730
5	466.7	20	-12.019	-26.823	-84.347	-6.182	-90.183	84.001	-1.080	-2.980	0.950
6	500.1	25	-12.943	-37.139	-105.119	-8.008	-110.055	102.047	-1.330	-3.650	1.160
7	527.4	30	-5.547	-48.281	-130.461	-2.507	-133.502	130.995	-1.380	-4.350	1.490
8	560.7	35	-6.934	-60.247	-152.063	-4.424	-154.573	150.150	-1.650	-5.050	1.700
9	594.1	40	-10.170	-71.800	-175.325	-7.554	-177.941	170.387	-1.980	-5.840	1.930
10	619.7	45	-12.481	-83.353	-197.341	-10.000	-199.821	189.821	-2.270	-6.570	2.150
11	646	50	-16.179	-95.319	-222.263	-13.443	-224.998	211.555	-2.620	-7.420	2.400
12	670.9	55	-20.801	-107.284	-247.598	-17.651	-250.749	233.098	-3.010	-8.300	2.640
13	701.9	60	-24.037	-118.424	-273.348	-20.415	-276.971	256.556	-3.360	-9.180	2.910
14	729.2	65	-29.122	-131.213	-302.419	-24.820	-306.721	281.902	-3.790	-10.180	3.200
15	762.5	70.6	-33.282	-141.115	-333.980	-27.386	-339.876	312.490	-4.190	-11.280	3.550
16	786.5	75.4	-30.046	-126.675	-354.743	-17.249	-367.540	350.292	-4.130	-12.080	3.970
17	812.7	80.4	-36.055	-134.514	-388.792	-19.613	-405.234	385.620	-4.580	-13.330	4.380
18	845.2	85.4	-44.837	-144.415	-429.482	-23.643	-450.676	427.033	-5.150	-14.840	4.850
19	876.4	90.2	-56.393	-154.316	-474.320	-28.723	-501.990	473.267	-5.810	-16.550	5.370
20	896.3	92.9	-64.713	-157.617	-504.209	-30.731	-538.191	507.459	-6.230	-17.750	5.760
21	908	94.6	-70.721	-158.442	-524.550	-31.431	-563.840	532.410	-6.500	-18.580	6.040
22	921.7	96.3	-81.352	-159.267	-553.192	-33.329	-601.215	567.886	-6.930	-19.810	6.440

Table 8 (continued)

ID	Seconds Elapsed	Load	[34, 35, 36] e(1)	[34, 35, 36] e(2)	[34, 35, 36] e(3)	[34, 35, 36] e(max)	[34, 35, 36] e(min)	[34, 35, 36] gamma	[34, 35, 36] s(max)	[34, 35, 36] s(min)	[34, 35, 36] tau
1	334.2	0	1.774		2.436	0.000	0.000	0.000	0.000	0.000	0.000
2	382.8	5.1	26.161		33.127	0.000	0.000	0.000	0.000	0.000	0.000
3	418.1	10	47.446		58.947	0.000	0.000	0.000	0.000	0.000	0.000
4	440.7	15.3	70.506		83.308	0.000	0.000	0.000	0.000	0.000	0.000
5	466.7	20	92.236		105.720	0.000	0.000	0.000	0.000	0.000	0.000
6	500.1	25	114.411		129.596	0.000	0.000	0.000	0.000	0.000	0.000
7	527.4	30	139.248		145.188	0.000	0.000	0.000	0.000	0.000	0.000
8	560.7	35	160.537		165.167	0.000	0.000	0.000	0.000	0.000	0.000
9	594.1	40	182.715		188.071	0.000	0.000	0.000	0.000	0.000	0.000
10	619.7	45	205.337		211.950	0.000	0.000	0.000	0.000	0.000	0.000
11	646	50	226.630		231.931	0.000	0.000	0.000	0.000	0.000	0.000
12	670.9	55	249.697		255.813	0.000	0.000	0.000	0.000	0.000	0.000
13	701.9	60	275.428		277.258	0.000	0.000	0.000	0.000	0.000	0.000
14	729.2	65	298.498		298.704	0.000	0.000	0.000	0.000	0.000	0.000
15	762.5	70.6	326.893		323.076	0.000	0.000	0.000	0.000	0.000	0.000
16	786.5	75.4	355.734		353.786	0.000	0.000	0.000	0.000	0.000	0.000
17	812.7	80.4	385.907		376.698	0.000	0.000	0.000	0.000	0.000	0.000
18	845.2	85.4	415.195		397.174	0.000	0.000	0.000	0.000	0.000	0.000
19	876.4	90.2	448.035		414.237	0.000	0.000	0.000	0.000	0.000	0.000
20	896.3	92.9	470.225		424.963	0.000	0.000	0.000	0.000	0.000	0.000
21	908	94.6	484.871		428.863	0.000	0.000	0.000	0.000	0.000	0.000
22	921.7	96.3	503.068		431.789	0.000	0.000	0.000	0.000	0.000	0.000

Table 8 (continued)

ID	Seconds Elapsed	Load	[37, 38, 39] e(1)	[37, 38, 39] e(2)	[37, 38, 39] e(3)	[37, 38, 39] e(max)	[37, 38, 39] e(min)	[37, 38, 39] gamma	[37, 38, 39] s(max)	[37, 38, 39] s(min)	[37, 38, 39] tau
1	334.2	0	0.397	26.463	-0.532	26.467	-26.602	53.069	0.600	-0.600	0.600
2	382.8	5.1	35.711	48.115	48.429	50.844	33.296	17.548	1.970	1.570	0.200
3	418.1	10	71.027	74.580	93.670	96.079	68.618	27.461	3.780	3.160	0.310
4	440.7	15.3	106.742	102.490	142.108	152.600	96.250	56.350	5.880	4.600	0.640
5	466.7	20	141.666	125.590	189.487	212.167	118.986	93.181	8.040	5.920	1.060
6	500.1	25	180.562	158.315	241.661	272.109	150.114	121.995	10.280	7.510	1.380
7	527.4	30	221.049	187.674	302.361	346.164	177.245	168.919	12.950	9.110	1.920
8	560.7	35	262.729	215.591	357.742	416.134	204.337	211.798	15.480	10.670	2.400
9	594.1	40	308.780	246.397	418.988	493.652	234.116	259.536	18.280	12.390	2.940
10	619.7	45	357.615	281.056	481.839	571.674	267.781	303.893	21.140	14.240	3.450
11	646	50	411.616	317.161	550.559	659.127	303.048	356.079	24.310	16.230	4.040
12	670.9	55	471.581	362.899	630.477	755.246	346.811	408.434	27.860	18.590	4.630
13	701.9	60	540.290	417.790	724.263	865.656	398.897	466.759	31.940	21.350	5.300
14	729.2	65	617.351	481.836	831.925	990.087	459.189	530.898	36.560	24.510	6.020
15	762.5	70.6	717.468	567.565	971.067	1148.640	539.895	608.744	42.490	28.670	6.910
16	786.5	75.4	817.207	660.053	1114.514	1305.885	625.837	680.048	48.420	32.990	7.720
17	812.7	80.4	955.126	783.397	1316.689	1532.071	739.744	792.327	56.860	38.880	8.990
18	845.2	85.4	1139.208	945.812	1592.607	1843.268	888.547	954.721	68.400	46.730	10.830
19	876.4	90.2	1384.622	1146.855	1960.554	2272.020	1073.156	1198.865	84.090	56.890	13.600
20	896.3	92.9	1575.626	1293.469	2244.306	2611.286	1208.645	1402.641	96.410	64.580	15.910
21	908	94.6	1728.878	1406.352	2469.923	2885.278	1313.523	1571.755	106.310	70.640	17.830
22	921.7	96.3	1960.635	1565.589	2806.397	3304.295	1462.737	1841.558	121.340	79.550	20.890

Table 8 (continued)

ID	Seconds Elapsed	Load	[40, 41, 42] e(1)	[40, 41, 42] e(2)	[40, 41, 42] e(3)	[40, 41, 42] e(max)	[40, 41, 42] e(min)	[40, 41, 42] gamma	[40, 41, 42] s(max)	[40, 41, 42] s(min)	[40, 41, 42] tau
1	334.2	0	12.094	2.607	2.190	13.857	0.427	13.430	0.450	0.150	0.150
2	382.8	5.1	44.751	25.200	36.352	56.466	24.636	31.830	2.070	1.350	0.360
3	418.1	10	78.216	46.056	71.830	104.165	45.881	58.284	3.820	2.500	0.660
4	440.7	15.3	113.699	69.521	108.187	152.457	69.429	83.028	5.620	3.730	0.940
5	466.7	20	147.169	89.944	143.232	200.491	89.909	110.582	7.370	4.860	1.250
6	500.1	25	184.270	113.410	180.908	251.788	113.390	138.398	9.270	6.120	1.570
7	527.4	30	219.760	137.312	218.587	301.037	137.310	163.727	11.090	7.380	1.860
8	560.7	35	259.690	161.215	261.965	360.447	161.209	199.238	13.250	8.730	2.260
9	594.1	40	304.061	187.293	308.414	425.202	187.273	237.930	15.610	10.210	2.700
10	619.7	45	351.259	216.414	358.374	493.265	216.368	276.897	18.090	11.810	3.140
11	646	50	405.724	245.537	415.352	575.609	245.467	330.142	21.050	13.560	3.750
12	670.9	55	468.668	280.313	480.664	669.112	280.220	388.892	24.420	15.590	4.410
13	701.9	60	544.534	320.308	558.262	782.590	320.206	462.384	28.480	17.990	5.250
14	729.2	65	633.732	366.393	650.780	918.251	366.261	551.990	33.330	20.800	6.260
15	762.5	70.6	755.647	429.006	771.825	1098.564	428.908	669.656	39.780	24.590	7.600
16	786.5	75.4	894.957	491.627	899.479	1302.816	491.621	811.196	47.020	28.610	9.200
17	812.7	80.4	1072.683	582.963	1069.735	1559.458	582.960	976.498	56.220	34.060	11.080
18	845.2	85.4	1311.499	704.769	1298.002	1904.770	704.731	1200.039	68.600	41.370	13.620
19	876.4	90.2	1625.241	863.161	1594.901	2357.136	863.007	1494.129	84.810	50.900	16.950
20	896.3	92.9	1868.362	982.423	1822.085	2708.335	982.113	1726.222	97.350	58.180	19.590
21	908	94.6	2067.072	1076.459	2005.839	2996.940	1075.971	1920.969	107.620	64.030	21.800
22	921.7	96.3	2363.458	1214.062	2282.035	3432.178	1213.314	2218.864	123.060	72.710	25.180

Table 8 (continued)

ID	Seconds Elapsed	Load	[43, 44, 45] e(1)	[43, 44, 45] e(2)	[43, 44, 45] e(3)	[43, 44, 45] e(max)	[43, 44, 45] e(min)	[43, 44, 45] gamma	[43, 44, 45] s(max)	[43, 44, 45] s(min)	[43, 44, 45] tau
1	334.2	0	2.108	1.802	1.416	2.110	1.414	0.696	0.080	0.070	0.010
2	382.8	5.1	15.054	13.214	18.763	21.042	12.774	8.268	0.810	0.620	0.090
3	418.1	10	27.699	25.827	37.173	40.567	24.305	16.262	1.550	1.180	0.180
4	440.7	15.3	42.453	39.943	55.937	60.643	37.747	22.896	2.330	1.810	0.260
5	466.7	20	54.798	52.557	72.578	77.933	49.443	28.491	3.010	2.360	0.320
6	500.1	25	68.950	66.373	90.281	96.620	62.612	34.008	3.740	2.970	0.390
7	527.4	30	86.415	83.493	111.526	118.901	79.041	39.860	4.620	3.720	0.450
8	560.7	35	100.870	98.511	129.231	136.836	93.264	43.572	5.340	4.350	0.490
9	594.1	40	115.023	113.530	146.936	154.625	107.334	47.292	6.060	4.980	0.540
10	619.7	45	128.574	128.248	164.997	172.772	120.799	51.972	6.780	5.600	0.590
11	646	50	142.428	143.268	183.057	190.884	134.601	56.284	7.500	6.220	0.640
12	670.9	55	157.184	159.189	202.181	210.116	149.250	60.867	8.260	6.880	0.690
13	701.9	60	172.544	176.613	222.723	230.365	164.902	65.463	9.070	7.590	0.740
14	729.2	65	185.495	192.234	241.848	249.076	178.267	70.809	9.810	8.200	0.800
15	762.5	70.6	199.952	210.260	264.870	271.708	193.114	78.595	10.690	8.900	0.890
16	786.5	75.4	201.157	222.878	286.123	290.924	196.355	94.569	11.340	9.190	1.070
17	812.7	80.4	211.698	240.905	307.730	311.282	208.146	103.137	12.120	9.770	1.170
18	845.2	85.4	219.530	258.632	329.692	331.963	217.259	114.705	12.870	10.270	1.300
19	876.4	90.2	225.855	277.561	351.656	352.644	224.867	127.778	13.620	10.720	1.450
20	896.3	92.9	225.855	287.477	365.472	365.950	225.377	140.574	14.060	10.870	1.590
21	908	94.6	223.144	292.585	375.037	375.316	222.866	152.450	14.330	10.870	1.730
22	921.7	96.3	216.216	297.393	385.666	385.740	216.142	169.598	14.610	10.760	1.920

APPENDIX C

COUPON TEST RESULTS

Table 9 HSS Coupon Results Specimen 1

Sample 1 P1			Sample 2 P1		
Area =	0.65	in^2	**Area =**	0.79	in^2
Load (lbs.)	**Stress (psi)**	**Strain**	**Load (lbs.)**	**Stress (psi)**	**Strain**
500	763.94	2.10E-05	500	631.67	2.10E-05
1000	1527.88	6.00E-05	1000	1263.34	4.20E-05
1500	2291.83	8.20E-05	1500	1895.01	6.30E-05
2000	3055.77	1.13E-04	2000	2526.68	8.60E-05
2500	3819.71	1.36E-04	2500	3158.34	1.11E-04
3000	4583.65	1.63E-04	3000	3790.01	1.34E-04
3500	5347.59	1.83E-04	3500	4421.68	1.53E-04
4000	6111.54	2.11E-04	4000	5053.35	1.79E-04
4500	6875.48	2.33E-04	4500	5685.02	2.00E-04
5000	7639.42	2.57E-04	5000	6316.69	2.24E-04
5500	8403.36	2.81E-04	5500	6948.36	2.48E-04
6000	9167.3	3.05E-04	6000	7580.03	2.71E-04
6500	9931.25	3.32E-04	6500	8211.69	2.95E-04
7000	10695.19	3.60E-04	7000	8843.36	3.20E-04
7600	11611.92	3.82E-04	7500	9475.03	3.47E-04
8000	12223.07	4.34E-04	8000	10106.7	3.70E-04
9000	13750.95	4.83E-04	8500	10738.37	3.96E-04
10000	15278.84	5.38E-04	9000	11370.04	4.22E-04
11000	16806.72	5.97E-04	9500	12001.71	4.52E-04
12000	18334.61	6.51E-04	10000	12633.38	4.77E-04
13000	19862.49	7.03E-04	11000	13896.71	5.06E-04
14000	21390.37	7.67E-04	12000	15160.05	5.35E-04
15000	22918.26	8.25E-04	13000	16423.39	5.88E-04
16000	24446.14	8.89E-04	14000	17686.73	6.47E-04
17000	25974.03	9.51E-04	15000	18950.07	7.13E-04
18000	27501.91	1.02E-03	16000	20213.4	7.75E-04
19000	29029.79	1.09E-03	17000	21476.74	8.47E-04
20000	30557.68	1.17E-03	18000	22740.08	9.16E-04
21000	32085.56	1.25E-03	19000	24003.42	9.87E-04
22000	33613.45	1.34E-03	20000	25266.75	1.07E-03
23000	35141.33	1.42E-03	21000	26530.09	1.16E-03
24000	36669.21	1.54E-03	22000	27793.43	1.25E-03
25000	38197.1	1.67E-03	23000	29056.77	1.37E-03
26000	39724.98	1.82E-03	24000	30320.1	1.48E-03
27000	41252.86	2.03E-03	25000	31583.44	1.60E-03
28000	42780.75	2.32E-03	26000	32846.78	1.76E-03
29000	44308.63	2.86E-03	27000	34110.12	1.95E-03
30000	45836.52	4.47E-03	28000	35373.46	2.19E-03
30600	46753.25	4.99E-03	29000	36636.79	2.48E-03
31000	47364.4	5.55E-03	30000	37900.13	2.87E-03
31600	48281.13	5.41E-03	31000	39163.47	3.35E-03
31800	48586.71	5.67E-03	32000	40426.81	4.11E-03
31900	48739.5	5.90E-03	32300	40805.81	5.02E-03
32000	48892.28	6.14E-03	32500	41058.47	6.51E-03
32200	49197.86	6.45E-03	32700	41311.14	7.00E-03
32300	49350.65	6.60E-03	32800	41437.48	7.52E-03

Table 9 (continued)

32400	49503.44	7.12E-03
32600	49809.01	7.59E-03
32700	49961.8	9.27E-03
32900	50267.38	1.00E-02
33200	50725.74	1.20E-02
33800	51642.48	1.40E-02
34100	52100.84	
34700	53017.57	
34900	53323.15	
42800		

E =	**2.21E+07**

33200	41942.81	8.02E-03
33500	42321.81	9.02E-03
34100	43079.82	1.00E-02
34600	43711.48	1.20E-02
42200		1.40E-02

Table 10 HSS Coupon Results Specimen 2

Sample 3 P2		
Area =	0.617733	in^2
Load (lbs.)	**Stress (psi)**	**Strain**
500	809.4111857	1.50E-05
1000	1618.822371	3.50E-05
1500	2428.233557	5.20E-05
2000	3237.644743	7.00E-05
2500	4047.055929	9.30E-05
3000	4856.467114	1.13E-04
3500	5665.8783	1.38E-04
4000	6475.289486	1.61E-04
4500	7284.700672	1.86E-04
5000	8094.111857	2.07E-04
5500	8903.523043	2.30E-04
6000	9712.934229	2.52E-04
6500	10522.34541	2.82E-04
7000	11331.7566	3.09E-04
7500	12141.16779	3.36E-04
8000	12950.57897	3.59E-04
9000	14569.40134	4.15E-04
10000	16188.22371	4.78E-04
11000	17807.04609	5.31E-04
12000	19425.86846	5.95E-04
13000	21044.69083	6.62E-04
14000	22663.5132	7.27E-04
15000	24282.33557	7.96E-04
16000	25901.15794	8.64E-04
17000	27519.98032	9.42E-04
18000	29138.80269	1.03E-03
19000	30757.62506	1.10E-03
20000	32376.44743	1.18E-03
21000	33995.2698	1.27E-03
22000	35614.09217	1.37E-03
23000	37232.91454	1.47E-03
24000	38851.73692	1.59E-03
25000	40470.55929	1.73E-03
26000	42089.38166	1.89E-03
27000	43708.20403	2.16E-03
28000	45327.0264	2.74E-03
29000	46945.84877	3.54E-03
30000	48564.67114	4.95E-03
30500	49374.08233	6.02E-03
30700	49697.8468	6.52E-03
30900	50021.61128	7.01E-03
31100	50345.37575	7.55E-03
31300	50669.14023	8.04E-03
31600	51154.78694	9.01E-03
31900	51640.43365	1.00E-02
32500	52611.72707	1.22E-02
33000	53421.13826	1.40E-02
33600	54392.43168	1.60E-02
34000	55039.96063	1.81E-02
34400	55687.48958	2.00E-02
40600		

E =	**2.10E+07**

Sample 4 P2		
Area =	0.6285	in^2
Load (lbs.)	**Stress (psi)**	**Strain**
0	0	-1.30E-04
500	795.5449483	-8.00E-05
1000	1591.089897	-5.50E-05
1500	2386.634845	-3.10E-05
2000	3182.179793	-7.00E-06
2510	3993.63564	1.80E-05
3000	4773.26969	4.10E-05
3510	5584.725537	6.60E-05
4000	6364.359586	8.90E-05
4500	7159.904535	1.14E-04
5000	7955.449483	1.39E-04
5520	8782.816229	1.65E-04
6000	9546.539379	1.89E-04
6520	10373.90613	2.15E-04
7000	11137.62928	2.41E-04
7520	11964.99602	2.68E-04
7960	12665.07558	2.89E-04
8540	13587.90772	3.22E-04
9520	15147.17582	3.76E-04
10000	15910.89897	4.04E-04
10500	16706.44391	4.32E-04
11000	17501.98886	4.60E-04
11500	18297.53381	4.90E-04
12000	19093.07876	5.18E-04
13000	20684.16866	5.80E-04
14040	22338.90215	6.40E-04
15020	23898.17025	7.03E-04
16000	25457.43835	7.71E-04
17000	27048.52824	8.40E-04
18120	28830.54893	9.21E-04
19000	30230.70804	9.91E-04
20000	31821.79793	1.08E-03
21000	33412.88783	1.17E-03
22000	35003.97772	1.26E-03
23000	36595.06762	1.40E-03
24000	38186.15752	1.55E-03
25020	39809.06921	1.73E-03
26000	41368.33731	1.98E-03
27000	42959.42721	2.31E-03
28000	44550.5171	2.78E-03
29000	46141.607	3.63E-03
30000	47732.6969	5.05E-03
30260	48146.38027	5.51E-03
30470	48480.50915	6.01E-03
30690	48830.54893	6.51E-03
30920	49196.4996	7.02E-03
31140	49546.53938	7.60E-03
31330	49848.84646	8.22E-03
31600	50278.44073	9.01E-03
31800	50596.65871	9.63E-03
32040	50978.52029	1.05E-02
32330	51439.93636	1.15E-02
32600	51869.53063	1.26E-02
32840	52251.3922	1.35E-02
33070	52617.34288	1.45E-02
33320	53015.11535	1.56E-02
33510	53317.42243	1.65E-02
33710	53635.64041	1.75E-02
33960	54033.41289	1.85E-02
40310		

Table 11 Flange Coupon Results Specimen 1

Sample 5 B1		
Area =	0.76	in^2
Load (lbs)	**Stress (psi)**	**Strain**
500	661.37	0.00E+00
1000	1322.74	2.60E-05
1500	1984.10	4.90E-05
2000	2645.47	7.20E-05
2500	3306.84	9.50E-05
2800	3703.66	1.18E-04
3000	3968.21	1.32E-04
3500	4629.57	1.41E-04
4000	5290.94	1.63E-04
4510	5965.54	1.85E-04
5000	6613.68	2.10E-04
6000	7936.41	2.30E-04
6590	8716.83	2.77E-04
7000	9259.15	3.02E-04
8000	10581.88	3.22E-04
9000	11904.62	3.67E-04
10000	13227.36	4.12E-04
11000	14550.09	4.56E-04
12000	15872.83	5.00E-04
13000	17195.56	5.45E-04
14000	18518.30	5.88E-04
15160	20052.67	6.32E-04
16000	21163.77	6.81E-04
17000	22486.50	7.20E-04
18000	23809.24	7.64E-04
19000	25131.98	8.09E-04
20000	26454.71	8.52E-04
21000	27777.45	8.95E-04
22000	29100.18	9.39E-04
23000	30422.92	9.82E-04
24000	31745.65	1.03E-03
25000	33068.39	1.07E-03
26000	34391.12	1.11E-03
27000	35713.86	1.15E-03
28000	37036.60	1.20E-03
29000	38359.33	1.24E-03
30000	39682.07	1.29E-03
31000	41004.80	1.33E-03
32000	42327.54	1.37E-03
33000	43650.27	1.42E-03
34090	45092.06	1.46E-03
35020	46322.20	1.51E-03
36000	47618.48	1.55E-03
38000	50263.95	1.59E-03
40030	52949.11	1.68E-03
42000	55554.89	1.77E-03

Sample 6 B1		
Area =	0.76 in^2	
Load (lbs)	**Stress (psi)**	**Strain**
500	662.24	2.50E-05
1000	1324.49	5.40E-05
1500	1986.73	8.30E-05
2000	2648.98	1.10E-04
2500	3311.22	1.40E-04
3000	3973.47	1.58E-04
3500	4635.71	1.82E-04
4000	5297.96	2.02E-04
4500	5960.20	2.25E-04
5000	6622.45	2.44E-04
5500	7284.69	2.72E-04
6000	7946.94	2.93E-04
6500	8609.18	3.15E-04
7000	9271.42	3.37E-04
7500	9933.67	3.60E-04
8000	10595.91	3.83E-04
8500	11258.16	4.06E-04
9000	11920.40	4.28E-04
10000	13244.89	4.71E-04
11000	14569.38	5.15E-04
12000	15893.87	5.57E-04
13000	17218.36	6.00E-04
14000	18542.85	6.44E-04
15000	19867.34	6.86E-04
16000	21191.83	7.31E-04
17000	22516.32	7.75E-04
18000	23840.81	8.20E-04
19000	25165.30	8.64E-04
20000	26489.79	9.12E-04
21000	27814.27	9.53E-04
22000	29138.76	9.98E-04
23000	30463.25	1.04E-03
24000	31787.74	1.09E-03
25000	33112.23	1.13E-03
26000	34436.72	1.17E-03
27000	35761.21	1.22E-03
28000	37085.70	1.27E-03
29000	38410.19	1.30E-03
30000	39734.68	1.35E-03
31000	41059.17	1.39E-03
32000	42383.66	1.44E-03
33000	43708.15	1.48E-03
34000	45032.64	1.53E-03
35000	46357.12	1.57E-03
36000	47681.61	1.62E-03
38200	50595.49	1.71E-03
39100	51787.53	1.75E-03
40000	52979.57	1.78E-03
51800		

Sample 7, B1		
Area =	0.76	in^2
Load (lbs)	**Stress (psi)**	**Strain**
1000	1320.13	5.90E-05
1500	1980.20	8.00E-05
2000	2640.26	9.90E-05
2500	3300.33	1.25E-04
3500	4620.46	1.66E-04
4000	5280.53	1.86E-04
4500	5940.59	2.08E-04
5000	6600.66	2.29E-04
5500	7260.73	2.53E-04
6000	7920.79	2.73E-04
6500	8580.86	2.93E-04
7000	9240.92	3.17E-04
8000	10561.06	3.59E-04
8500	11221.12	3.82E-04
9000	11881.19	4.03E-04
10000	13201.32	4.45E-04
11000	14521.45	4.88E-04
12000	15841.58	5.32E-04
13000	17161.72	5.76E-04
14000	18481.85	6.18E-04
15000	19801.98	6.59E-04
16000	21122.11	7.03E-04
17100	22574.26	7.49E-04
18000	23762.38	7.99E-04
19000	25082.51	8.37E-04
20000	26402.64	8.75E-04
21000	27722.77	9.18E-04
22000	29042.90	9.62E-04
23000	30363.04	1.01E-03
24000	31683.17	1.05E-03
25000	33003.30	1.10E-03
26000	34323.43	1.13E-03
27000	35643.56	1.18E-03
28000	36963.70	1.22E-03
29000	38283.83	1.26E-03
30000	39603.96	1.31E-03
31000	40924.09	1.36E-03
32000	42244.22	1.40E-03
33000	43564.36	1.44E-03
34000	44884.49	1.49E-03
35000	46204.62	1.53E-03
36000	47524.75	1.57E-03
37000	48844.88	1.62E-03
38000	50165.02	1.67E-03
39000	51485.15	1.73E-03
40000	52805.28	2.39E-03
40400	53333.33	2.41E-03
39800	52541.25	3.18E-03
39400	52013.20	7.45E-03
39100	51617.16	1.11E-02
39200	51749.17	1.61E-02
39400	52013.20	1.93E-02
39600	52277.23	
52000		
E =	**30500000.00**	

Table 12 Flange Coupon Results Specimen 2

Sample 8, B2,1		
Area =	0.75	In^2
Load (lbs)	**Stress (psi)**	**Strain**
500	663.13	2.70E-05
1000	1326.25	5.20E-05
1500	1989.38	7.70E-05
2000	2652.5	9.90E-05
2500	3315.63	1.24E-04
3000	3978.75	1.44E-04
3500	4641.88	1.65E-04
4000	5305	1.86E-04
4500	5968.13	2.10E-04
5000	6631.26	2.31E-04
5500	7294.38	2.53E-04
6000	7957.51	2.71E-04
6500	8620.63	2.97E-04
7000	9283.76	3.18E-04
8000	10610.01	3.61E-04
9000	11936.26	4.05E-04
10000	13262.51	4.48E-04
11000	14588.76	4.92E-04
12000	15915.01	5.33E-04
13000	17241.26	5.75E-04
14000	18567.52	6.20E-04
15000	19893.77	6.61E-04
16000	21220.02	7.02E-04
17000	22546.27	7.43E-04
18000	23872.52	7.84E-04
19000	25198.77	8.23E-04
20000	26525.02	8.64E-04
21000	27851.27	9.04E-04
22000	29177.53	9.44E-04
23000	30503.78	9.85E-04
24000	31830.03	1.03E-03
25000	33156.28	1.06E-03
26000	34482.53	1.10E-03
27000	35808.78	1.14E-03
28000	37135.03	1.18E-03
29000	38461.28	1.22E-03
30000	39787.53	1.25E-03
31000	41113.79	1.29E-03
32000	42440.04	1.33E-03
33000	43766.29	1.38E-03
34000	45092.54	1.41E-03
35000	46418.79	1.45E-03
36000	47745.04	1.49E-03
37000	49071.29	1.54E-03
38000	50397.54	1.59E-03
39000	51723.79	1.63E-03
40000	53050.05	1.68E-03
41000	54376.3	1.73E-03
40600	53845.8	7.50E-03
42600	56498.3	4.50E-03
44300	58752.93	5.00E-03
45300	60079.18	5.35E-03
46900	62201.18	5.40E-03
47600	63129.55	5.50E-03
52500		

Sample 9, B2,2		
Area =	0.76	In^2
Load (lbs)	**Stress (psi)**	**Strain**
500	660.5	2.60E-05
1000	1320.99	4.50E-05
1500	1981.49	6.70E-05
2000	2641.98	8.60E-05
2500	3302.48	1.10E-04
3000	3962.97	1.29E-04
3500	4623.47	1.52E-04
4000	5283.96	1.70E-04
4500	5944.46	1.92E-04
5000	6604.95	2.13E-04
5500	7265.45	2.35E-04
6000	7925.94	2.56E-04
6500	8586.44	2.78E-04
7000	9246.93	2.98E-04
8000	10567.92	3.38E-04
9000	11888.91	3.81E-04
10000	13209.9	4.24E-04
11000	14530.89	4.65E-04
12000	15851.88	5.08E-04
13000	17172.87	5.49E-04
14000	18493.86	5.96E-04
15000	19814.85	6.35E-04
16000	21135.84	6.80E-04
17000	22456.83	7.21E-04
18000	23777.82	7.64E-04
19000	25098.81	8.08E-04
20000	26419.8	8.52E-04
21000	27740.79	8.91E-04
22000	29061.78	9.05E-04
23000	30382.77	9.80E-04
24000	31703.76	1.02E-03
25000	33024.75	1.06E-03
26000	34345.74	1.10E-03
27000	35666.73	1.15E-03
28000	36987.72	1.19E-03
29000	38308.71	1.23E-03
30000	39629.7	1.27E-03
31000	40950.69	1.31E-03
32000	42271.68	1.36E-03
33000	43592.67	1.40E-03
34000	44913.66	1.44E-03
35000	46234.65	1.48E-03
36000	47555.64	1.53E-03
37000	48876.63	1.56E-03
38000	50197.62	1.61E-03
39000	51518.61	1.64E-03
39100	51650.71	8.00E-03
38900	51386.51	1.00E-02
39000	51518.61	1.40E-02
39000	51518.61	1.20E-02
38900	51386.51	9.00E-03
51700		

Sample 16, B2,3		
Area =	0.75	In^2
Load (lbs)	**Stress (psi)**	**Strain**
500	662.69	2.70E-05
1000	1325.37	4.80E-05
1500	1988.06	7.10E-05
2000	2650.74	9.10E-05
2500	3313.43	1.18E-04
3000	3976.11	1.38E-04
3500	4638.8	1.61E-04
4000	5301.48	1.80E-04
4500	5964.17	2.02E-04
5000	6626.85	2.23E-04
5500	7289.54	2.46E-04
6000	7952.22	2.66E-04
6500	8614.91	2.89E-04
7000	9277.59	3.10E-04
8000	10602.96	3.52E-04
9000	11928.33	3.94E-04
10000	13253.71	4.39E-04
11000	14579.08	4.83E-04
12000	15904.45	5.25E-04
13000	17229.82	5.68E-04
14000	18555.19	6.11E-04
15000	19880.56	6.53E-04
16000	21205.93	6.96E-04
17000	22531.3	7.40E-04
18000	23856.67	7.79E-04
19000	25182.04	8.15E-04
20000	26507.41	8.59E-04
21000	27832.78	9.42E-04
22000	29158.15	9.87E-04
23000	30483.52	1.02E-03
24000	31808.89	1.07E-03
25000	33134.26	1.11E-03
26000	34459.63	1.15E-03
27000	35785	1.20E-03
28000	37110.37	1.23E-03
29000	38435.74	1.27E-03
30000	39761.12	1.31E-03
31000	41086.49	1.34E-03
32000	42411.86	1.39E-03
33000	43737.23	1.42E-03
34000	45062.6	1.47E-03
35000	46387.97	1.51E-03
36000	47713.34	1.55E-03
37000	49038.71	1.58E-03
38000	50364.08	1.65E-03
39000	51689.45	1.72E-03
40200	53279.89	2.26E-03
39400	52219.6	3.96E-03
39400	52219.6	5.56E-03
39500	52352.14	7.39E-03
39500	52352.14	8.68E-03
39500	52352.14	1.01E-02
39500	52352.14	1.09E-02
39400	52219.6	1.16E-02
39300	52087.06	1.23E-02
39200	51954.52	1.38E-02
39200	51954.52	1.45E-02
39200	51954.52	1.62E-02

Table 12 (continued)

				39400	52219.6	1.84E-02
				39400	52219.6	1.94E-02
				39300	52087.06	1.99E-02
				39200	51954.52	
				52000		
				E =	**3.05E+07**	

Table 13 Web Coupon Results Specimen 1

Sample 10, U1,1		
Area =	0.76	in^2
Load (lbs)	**Stress (psi)**	**Strain**
500	662.25	2.50E-05
1000	1324.49	4.70E-05
1500	1986.74	7.10E-05
2000	2648.98	9.10E-05
2500	3311.23	1.18E-04
3000	3973.48	1.38E-04
3500	4635.72	1.59E-04
4000	5297.97	1.80E-04
4500	5960.22	2.01E-04
5000	6622.46	2.23E-04
5500	7284.71	2.46E-04
6000	7946.95	2.67E-04
6500	8609.2	2.89E-04
7000	9271.45	3.09E-04
8000	10595.94	3.51E-04
9000	11920.43	3.96E-04
10000	13244.92	4.37E-04
11000	14569.42	4.84E-04
12000	15893.91	5.28E-04
13000	17218.4	5.71E-04
14000	18542.89	6.20E-04
15000	19867.39	6.59E-04
16000	21191.88	7.04E-04
17000	22516.37	7.45E-04
18000	23840.86	7.89E-04
19000	25165.35	8.33E-04
20000	26489.85	8.81E-04
21000	27814.34	9.20E-04
22000	29138.83	9.63E-04
23000	30463.32	1.01E-03
24000	31787.82	1.06E-03
25000	33112.31	1.10E-03
26000	34436.8	1.14E-03
27000	35761.29	1.19E-03
28000	37085.79	1.23E-03
29000	38410.28	1.27E-03
30000	39734.77	1.32E-03
31000	41059.26	1.36E-03
32000	42383.76	1.41E-03
33000	43708.25	1.45E-03
34000	45032.74	1.49E-03
35000	46357.23	1.54E-03
36000	47681.72	1.58E-03
37000	49006.22	1.63E-03
38000	50330.71	1.67E-03
39000	51655.2	1.72E-03
40000	52979.69	1.76E-03
41000	54304.19	1.81E-03
42000	55628.68	1.85E-03
43000	56953.17	1.90E-03
41200	54569.08	1.51E-02
41000	54304.19	1.75E-02
42600	56423.37	9.66E-03
42800	56688.27	9.80E-03
43000	56953.17	1.00E-02
43600	57747.87	1.02E-02
44100	58410.11	1.10E-02

Sample 11, U1,2		
Area =	0.75	in^2
Load (lbs)	**Stress (psi)**	**Strain**
500	663.13	2.30E-05
1000	1326.25	4.70E-05
1500	1989.38	6.90E-05
2000	2652.5	9.20E-05
2500	3315.63	1.16E-04
3000	3978.75	1.40E-04
3500	4641.88	1.59E-04
4500	5968.13	1.99E-04
5100	6763.88	2.27E-04
6000	7957.51	2.65E-04
10000	13262.51	4.72E-04
13000	17241.26	5.77E-04
15000	19893.77	6.56E-04
16000	21220.02	7.09E-04
18000	23872.52	7.92E-04
19000	25198.77	8.38E-04
20000	26525.02	8.89E-04
21000	27851.27	9.28E-04
22100	29310.15	9.74E-04
23000	30503.78	1.01E-03
24000	31830.03	1.06E-03
25000	33156.28	1.10E-03
26000	34482.53	1.15E-03
27000	35808.78	1.19E-03
28000	37135.03	1.24E-03
29000	38461.28	1.28E-03
30000	39787.53	1.33E-03
31000	41113.79	1.38E-03
32000	42440.04	1.42E-03
33000	43766.29	1.47E-03
34000	45092.54	1.51E-03
35000	46418.79	1.56E-03
36000	47745.04	1.60E-03
37000	49071.29	1.65E-03
38000	50397.54	1.69E-03
39000	51723.79	1.74E-03
40000	53050.05	1.78E-03
41000	54376.3	1.83E-03
39800	52784.8	1.06E-02
39700	52652.17	1.85E-02
39600	52519.55	1.93E-02
40700	53978.42	1.99E-02
52400	69495.56	

Sample 12, U1,3		
Area=	0.74	in^2
Load (lbs)	**Stress (psi)**	**Strain**
500	672.06	2.60E-05
1000	1344.11	4.40E-05
1500	2016.17	6.90E-05
2000	2688.23	8.80E-05
2500	3360.28	1.15E-04
3000	4032.34	1.36E-04
3500	4704.4	1.57E-04
4000	5376.45	1.78E-04
4500	6048.51	1.98E-04
5000	6720.57	2.22E-04
6000	8064.68	2.65E-04
7000	9408.79	3.05E-04
8000	10752.9	3.48E-04
9000	12097.02	3.94E-04
10000	13441.13	4.37E-04
11000	14785.24	4.82E-04
12000	16129.36	5.28E-04
13000	17473.47	5.71E-04
14000	18817.58	6.15E-04
15000	20161.7	6.59E-04
16000	21505.81	7.05E-04
17000	22849.92	7.47E-04
18000	24194.04	7.94E-04
19000	25538.15	8.37E-04
20000	26882.26	8.80E-04
21000	28226.38	9.24E-04
22000	29570.49	9.68E-04
23000	30914.6	1.01E-03
24000	32258.71	1.06E-03
25000	33602.83	1.10E-03
26000	34946.94	1.15E-03
27000	36291.05	1.19E-03
28000	37635.17	1.24E-03
29000	38979.28	1.28E-03
30000	40323.39	1.33E-03
31000	41667.51	1.37E-03
32000	43011.62	1.42E-03
33000	44355.73	1.46E-03
34000	45699.85	1.50E-03
35000	47043.96	1.55E-03
36000	48388.07	1.60E-03
37000	49732.19	1.64E-03
38000	51076.3	1.68E-03
39000	52420.41	1.73E-03
40000	53764.52	1.77E-03
41000	55108.64	1.81E-03
39900	53630.11	9.03E-03
40200	54033.35	1.74E-02
52400	70431.53	
E =	**3.03E+07**	

Table 13 (continued)

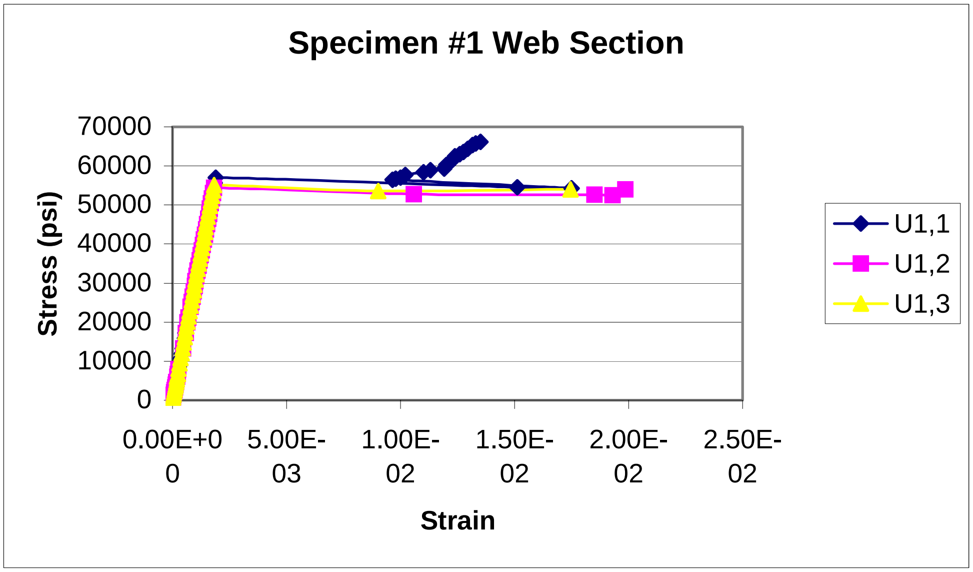
44500	58939.91	1.13E-02
44800	59337.26	1.19E-02
45500	60264.4	1.20E-02
46100	61059.1	1.22E-02
46600	61721.34	1.23E-02
47200	62516.04	1.24E-02
47600	63045.84	1.26E-02
48000	63575.63	1.28E-02
48600	64370.33	1.30E-02
49300	65297.47	1.32E-02
49700	65827.27	1.33E-02
50000	66224.62	1.35E-02
53000	70198.09	

Table 14 Web Coupon Results Specimen 2

Sample 13 U2,1		
Area =	0.76	in^2
Load (lbs)	**Stress (psi)**	**Strain**
500	662.03	2.60E-05
1000	1324.06	4.70E-05
2000	2648.11	7.30E-05
3000	3972.17	1.25E-04
4000	5296.23	1.47E-04
5000	6620.28	1.76E-04
6000	7944.34	2.24E-04
7000	9268.40	2.65E-04
8000	10592.46	2.91E-04
9000	11916.51	3.17E-04
10000	13240.57	3.40E-04
11000	14564.63	3.62E-04
12000	15888.68	3.82E-04
13000	17212.74	4.24E-04
14000	18536.80	4.66E-04
15000	19860.85	5.12E-04
16000	21184.91	5.58E-04
17000	22508.97	6.01E-04
18000	23833.03	6.44E-04
19100	25289.49	6.88E-04
20000	26481.14	7.30E-04
21000	27805.20	7.70E-04
22000	29129.25	8.10E-04
23000	30453.31	8.54E-04
24000	31777.37	8.94E-04
25000	33101.42	9.33E-04
26000	34425.48	9.78E-04
27000	35749.54	1.01E-03
28000	37073.60	1.06E-03
29000	38397.65	1.10E-03
30000	39721.71	1.14E-03
31000	41045.77	1.18E-03
32000	42369.82	1.21E-03
33000	43693.88	1.25E-03
34000	45017.94	1.29E-03
35000	46341.99	1.32E-03
36000	47666.05	1.37E-03
37000	48990.11	1.40E-03
38000	50314.17	1.44E-03
39000	51638.22	1.48E-03
40000	52962.28	1.52E-03
41000	54286.34	1.57E-03
42000	55610.39	1.60E-03
39600	52432.66	1.64E-03
52400		1.68E-03
		1.72E-03
		1.76E-03
		4.45E-03

Sample 14 U2,2		
Area =	0.75	in^2
Load (lbs)	**Stress (psi)**	**Strain**
600	796.81	3.10E-05
1000	1328.02	4.70E-05
1500	1992.03	6.70E-05
2000	2656.04	8.80E-05
2500	3320.05	1.10E-04
3000	3984.06	1.31E-04
3500	4648.07	1.52E-04
4000	5312.08	1.73E-04
4500	5976.10	1.97E-04
5000	6640.11	2.18E-04
5500	7304.12	2.41E-04
6000	7968.13	2.61E-04
6700	8897.74	2.93E-04
8000	10624.17	3.48E-04
9000	11952.19	3.91E-04
10000	13280.21	4.38E-04
11000	14608.23	4.83E-04
12000	15936.25	5.25E-04
13000	17264.28	5.67E-04
14000	18592.30	6.10E-04
15000	19920.32	6.50E-04
16000	21248.34	6.99E-04
17000	22576.36	7.40E-04
18000	23904.38	7.82E-04
19000	25232.40	8.27E-04
20000	26560.42	8.70E-04
21000	27888.45	9.12E-04
22000	29216.47	9.54E-04
23000	30544.49	9.97E-04
24000	31872.51	1.04E-03
25000	33200.53	1.08E-03
26000	34528.55	1.13E-03
27000	35856.57	1.17E-03
28000	37184.59	1.21E-03
29000	38512.62	1.25E-03
30000	39840.64	1.30E-03
31000	41168.66	1.34E-03
32000	42496.68	1.38E-03
33000	43824.70	1.42E-03
34000	45152.72	1.47E-03
35000	46480.74	1.51E-03
36000	47808.76	1.55E-03
37000	49136.79	1.59E-03
38000	50464.81	1.63E-03
39000	51792.83	1.68E-03
40000	53120.85	1.72E-03
40600	53917.66	1.75E-03
38600	51261.62	7.12E-03
38700	51394.42	1.49E-02
50700		

Sample 15 U2,3		
Area =	0.75	in^2
Load (lbs)	**Stress (psi)**	**Strain**
500	662.46	2.40E-05
1000	1324.93	4.50E-05
1500	1987.39	6.80E-05
2000	2649.86	9.10E-05
2500	3312.32	1.17E-04
3100	4107.28	1.41E-04
3500	4637.25	1.59E-04
4000	5299.72	1.80E-04
5000	6624.65	2.21E-04
6000	7949.58	2.66E-04
7000	9274.51	3.10E-04
8000	10599.44	3.56E-04
9000	11924.37	3.98E-04
10000	13249.30	4.42E-04
11000	14574.23	4.86E-04
12000	15899.16	5.32E-04
13000	17224.09	5.73E-04
14000	18549.02	6.13E-04
15000	19873.95	6.55E-04
16000	21198.88	6.97E-04
17000	22523.81	7.40E-04
18000	23848.74	7.90E-04
19000	25173.67	8.34E-04
20000	26498.59	8.71E-04
21000	27823.52	9.16E-04
22000	29148.45	9.61E-04
23000	30473.38	1.01E-03
24000	31798.31	1.04E-03
25000	33123.24	1.09E-03
26000	34448.17	1.14E-03
27000	35773.10	1.17E-03
28000	37098.03	1.22E-03
29000	38422.96	1.27E-03
30000	39747.89	1.30E-03
31000	41072.82	1.34E-03
32000	42397.75	1.39E-03
33000	43722.68	1.43E-03
34000	45047.61	1.48E-03
35000	46372.54	1.52E-03
36000	47697.47	1.55E-03
37000	49022.40	1.60E-03
38000	50347.33	1.65E-03
39000	51672.26	1.69E-03
40000	52997.19	1.74E-03
41000	54322.12	1.78E-03
42000	55647.05	1.82E-03
43000	56971.98	1.86E-03
41400	54852.09	1.91E-03
41200	54587.11	2.35E-03
41000	54322.12	7.23E-03
41000	54322.12	1.21E-02
41000	54322.12	1.73E-02
52500		
E =	**3.08E+07**	



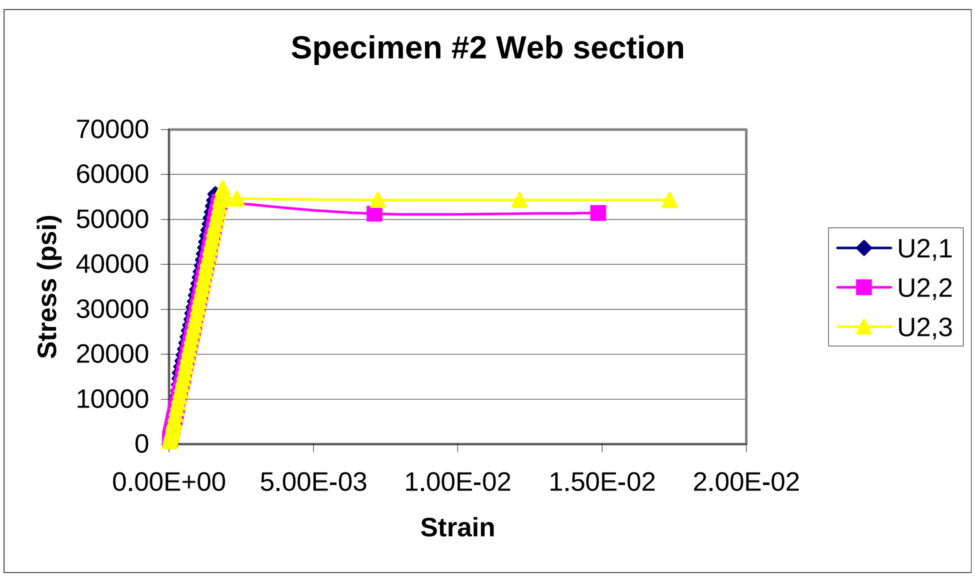
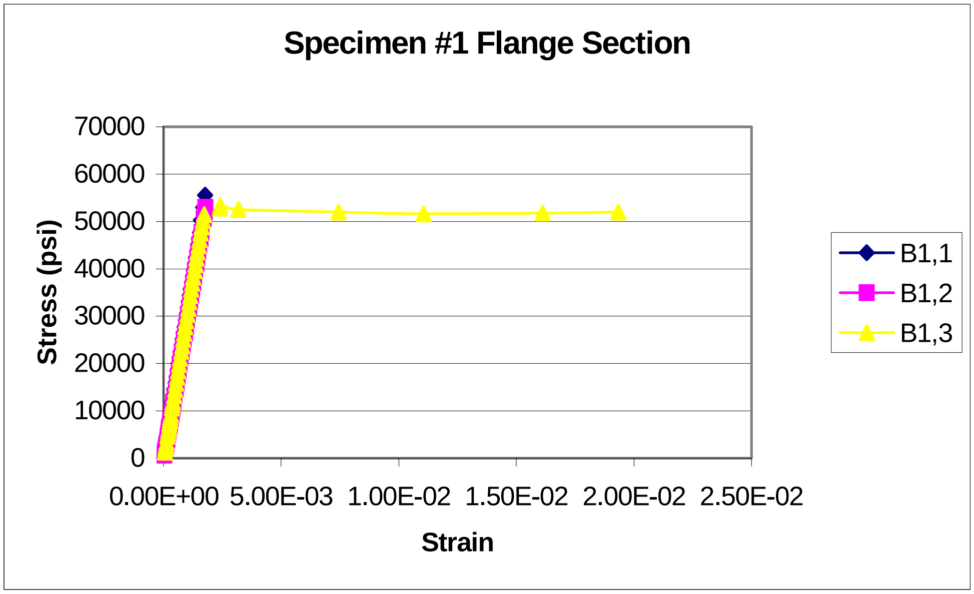


Figure 19 Coupon Test Results for Web Sections



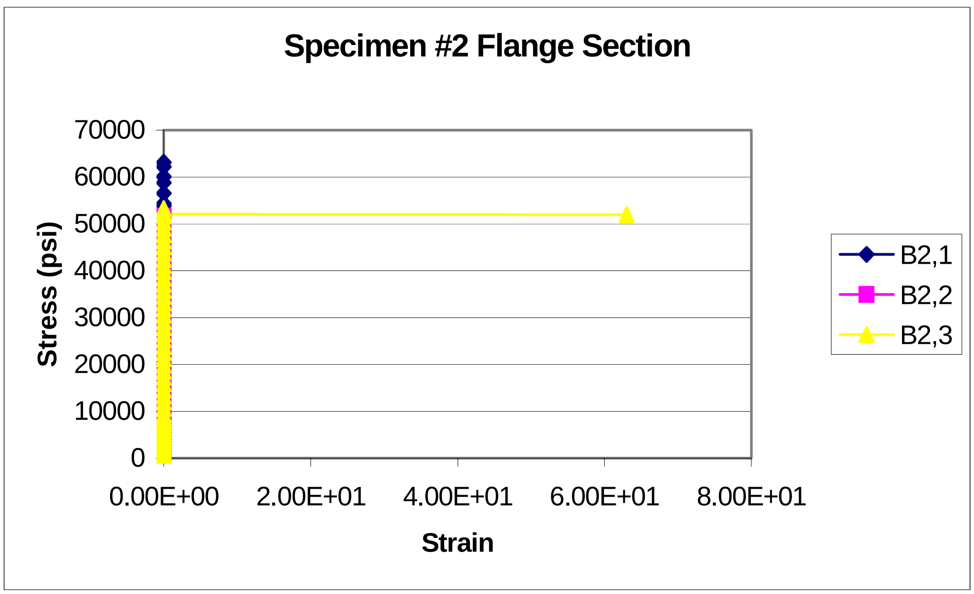


Figure 20 Coupon Test Results for Flange Sections

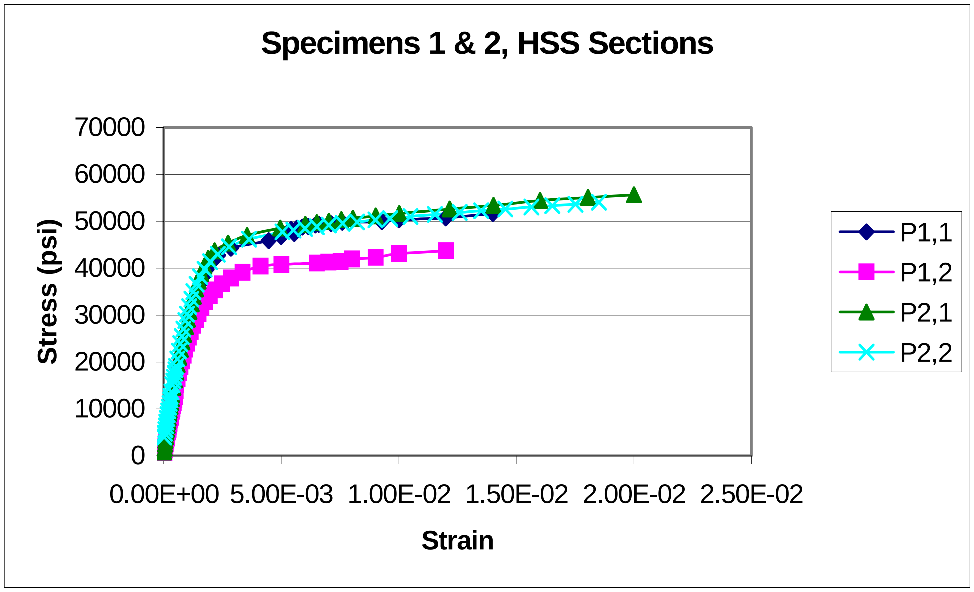


Figure 21 Coupon Test Results for HSS Sections

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