ELECTRIC RESISTANCE STRAIN GAGE TEST OF 1,000,000 POUND TEST FRAME

A THESIS

PRESENTED TO

THE FACULTY OF THE GRADUATE SCHOOL

UNIVERSITY OF HOUSTON, HOUSTON, TEXAS

IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE

MASTER OF SCIENCE

IN

CIVIL ENGINEERING

BY

DONG MIN KIM

NOVEMBER, 1977

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ABSTRACT

Several years prior to the initiation of the present work, a test frame was developed to provide a static tensile force of 500,000 pounds in the testing of undersea pipe couplings. Within recent years, work was done to increase the test capacity of this frame to 1,000,000 pounds. This thesis presents structural details of the modified frame, a computer analysis of the frame, details and results of a 420,000 pound fracture test and a static test to 980,000 pounds. Electric resistance strain gages were used extensively to obtain strain data during the test work, and a comparison between the computer and experimental results is presented.

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CHAPTER I

INTRODUCTION

The primary purpose of this thesis was to perform a thorough strain gage study of a large test frame in the structural test laboratory of the Department of Civil Engineering at the University of Houston, and to determine safe load limits for both fracture and non-fracture static tests using the frame. A photograph of the 10-foot by 25-foot frame studied in this thesis essentially as it exists today is shown as Fig. 1 on page 2. The frame consists essentially of four major elements, two horizontal members (top and bottom) made up of large car channels and one-inch plates, and two large box-type end members also made up of car channels and plates. The four sections were initially (in the 500,000 pound capacity version) in four separate parts and the frame was broken down this way when it was disassembled to be taken out of the laboratory to be modified to obtain a 1,000,000 pound capacity. When it was returned to the laboratory, however, it was in one five-ton piece, the source of a considerable problem of handling and transportation. It was assembled completely in the machine shop where the modification work was done because of the much greater ease of fitting up and replacing the high strength prestressed bolts which hold the four major sections of the frame together.

In both the old and new versions, the frame was designed to provide simultaneous static loadings in tension and bending, and the new frame can also be used for fracture or rupture tests up to several hundred thousand pounds. This is a highly significant feature of the modified

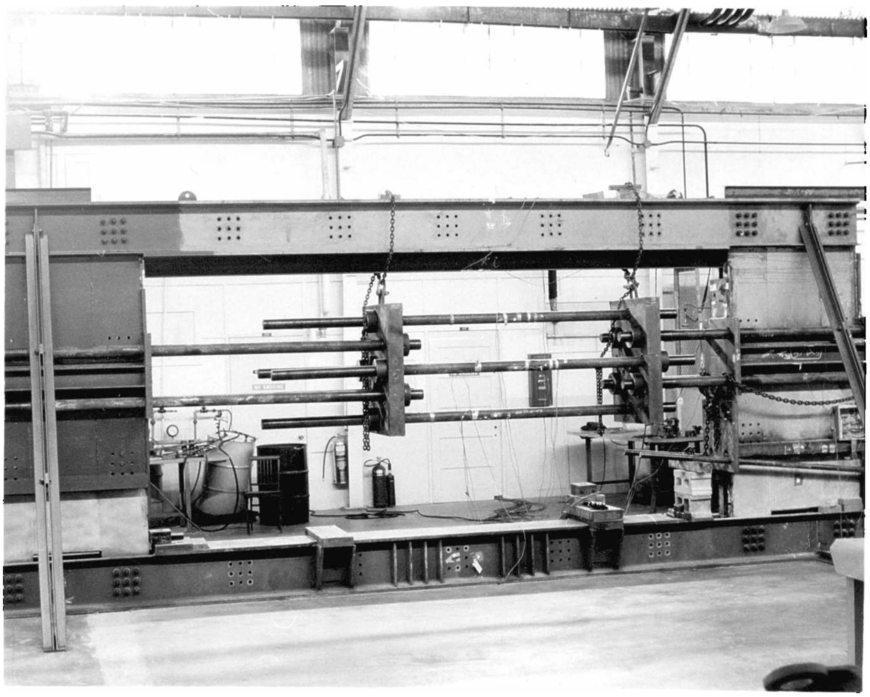


Figure 1

1,000,000 Pound Test Frame

frame in comparison with the old version, and is possible because of the "stay rods" which appear in the center of the photograph of page 2 and which parallel the test specimen. A set of four rods and two plates is used at each end of the frame, with the two large plates near the center of the frame holding the tensile specimen and the stay rods. The load is applied at the right end of the frame by a hydraulic cylinder which pushes between the end of the frame and the large plate held by the rods at that end of the frame. The stay rods are of the same size as the main pull rods and go through holes in the main pull plates holding the test specimen, and the nuts on these stay rods are kept slightly loose so that they carry no load until the test specimen breaks, at which time there is an almost instantaneous transfer of load to the stay rods. This feature of the frame is simple in concept, but makes the frame of much greater value in that fracture tests may be performed routinely, and there is no concern about the possible traumatic consequences of the sudden unexpected change of an intended static test into a fracture test without the presence of the stay rods. Because of the size and mass of the frame and its deflection under loading, a tremendous amount of elastic energy is stored in the frame when loaded to 1,000,000 pounds, and sudden release of this energy upon fracture of a specimen without the stay rods could be very dangerous and destructive. A crude measure of the elastic energy stored in the frame is provided by the observation that when a 1,000,000 pound load is applied to the frame the piston of the hydraulic cylinder moves outward about four inches, indicating a stored energy of about 2,000,000 inch-pounds of energy. Upon one occasion in years past, a static test was performed on a clamp-sleeve type of pipe connection and at a load of 470,000 pounds. One of the two clamps on the test pipe slipped approximately one inch, and the load dropped to about 270,000 pounds, releasing energy of approximately 100,000 inch pounds. The sudden release of this energy resulted in no damage to the frame nor injury to test personnel, but the sound produced could be heard about two blocks away, resulting in an immediate and very curious audience. This incident led to the concern and considerations which finally resulted in the concept of the stay rods. Theoretically, if a specimen of zero length were being tested and the slack in the stay rod-nut system were essentially zero as well, there would be zero release of energy upon fracture of a specimen. The energy stored in the frame would then be released very slowly by opening a valve and releasing the pressure in the hydraulic cylinder which applied the load. The energy suddenly released in a test is thus a function of the length of the test specimen and the slack in the stay rod system. Further details of the operation of the test frame as a whole (and the stay rod system, in particular) will be presented later in the description of the test work.

CHAPTER II

STATIC COMPUTER ANALYSIS

Prior to the final decision regarding installation of strain gages, a computer analysis of the frame was made to check on the approximate magnitude of the stresses at critical points on the frame. However, before this could be done, the geometric properties of the frame had to be determined, and these are summarized in Appendix A, along with the drawing of the frame and the details of the representative sections of the frame. A few comments regarding the computer analysis and graphical presentation of the results from that analysis are given in this portion of the thesis, and the entire computer input and output are given in Appendix B.

The following assumptions were made to simplify the computer analysis:

(1) Only five different sections (1, 2, 3, 11, and 13) were used in the analysis. Fig. 2 on page 6 shows the location and properties of these sections.

(2) The entire frame is supported in a vertical direction only at the center point of the lower beam when the major test load is applied.

(3) The 1,000,000 pound live load is applied uniformly through the loading plate underneath the hydraulic cylinder at the right end of the frame and through the corresponding plate at the left end of the frame.

The input data for the computer analysis are listed as follows:

(1) Geometry of frame.

Coordinates of joints and lengths of members.

(2) Properties of members.

Sectional area (A).

Moment of inertia (I).

Edge distance (C).

Modulus of elasticity of material (E).

Density of material (ρ).

(3) Loads.

Load type, magnitude and direction of application. (The dead load of the frame is generated by the computer, based on sectional area and material density, and is applied as downward loads at appropriate points in the frame.)

The output from the computer analysis is listed as follows:

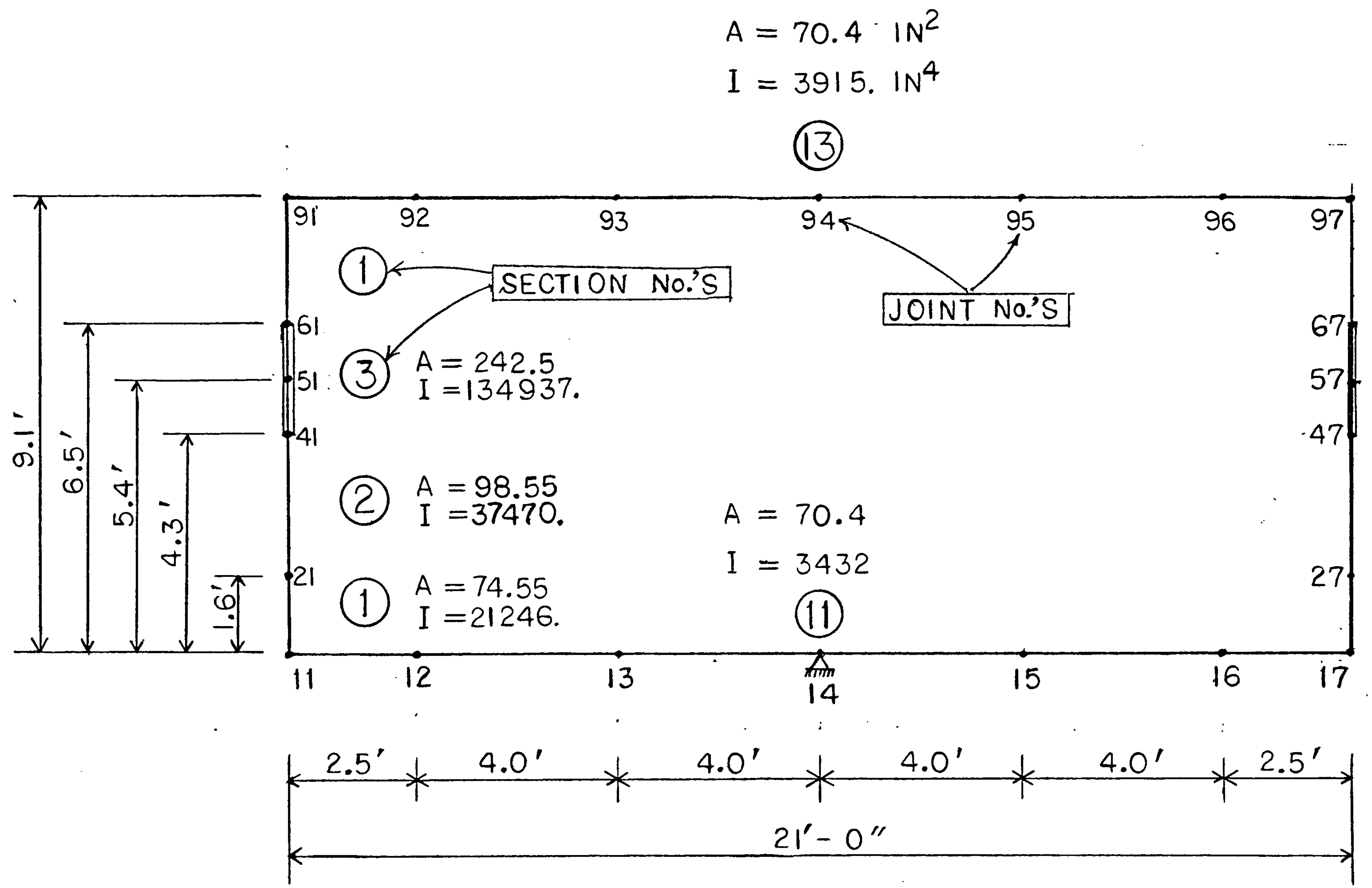
(1) Reaction at support point.

(2) Deflection and rotation at each joint.

(3) Force, bending moment, and stress in the members at each joint.

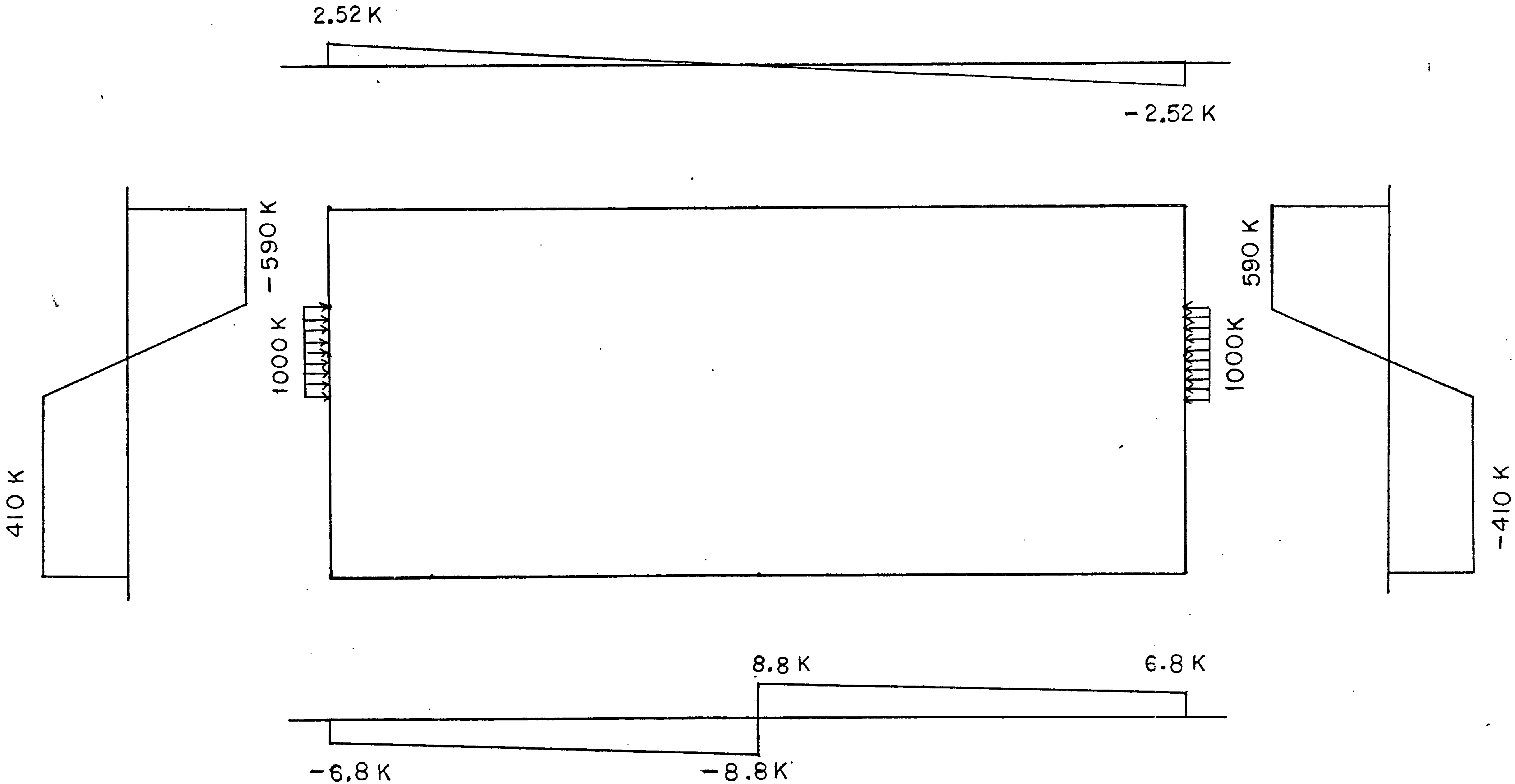
The shear, axial force, bending moment, deformed shape, and the stress diagrams due to the live and dead loads are all presented on the following pages. The computer analysis indicated a maximum stress of 21.5 and 10.3 ksi in the vertical and horizontal members, respectively. The diagrams are all self-explanatory, except for the different scales in Fig. 4 and the omission of the points of inflection in Fig. 5. These were not shown because of the extremely low corner bending moments due to the ratio (1/20) of horizontal to vertical member section moduli.

Table I on page 14 provides a detailed summary of the computer analysis of the frame.



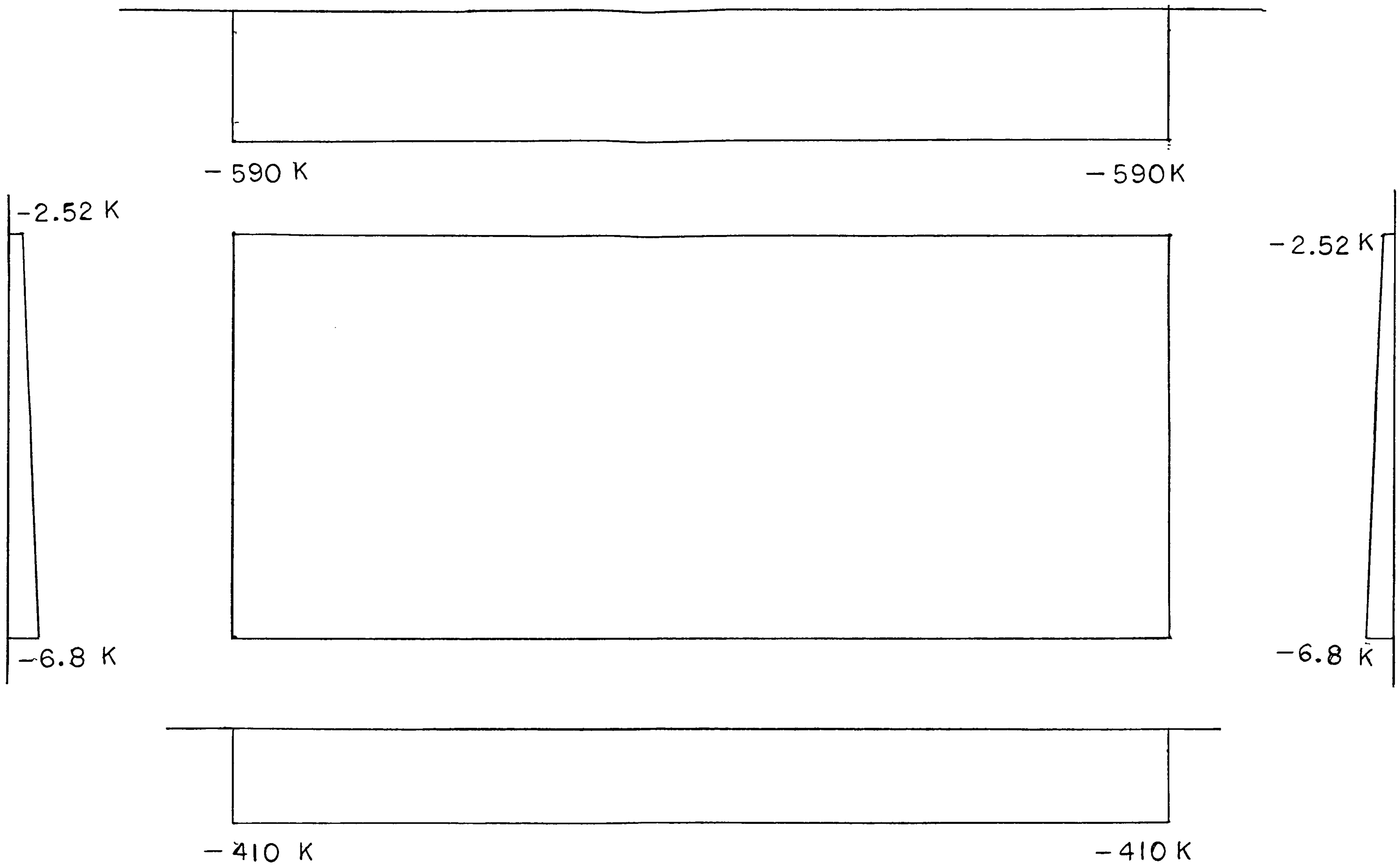
GEOMETRY FOR COMPUTER ANALYSIS

FIG. 2



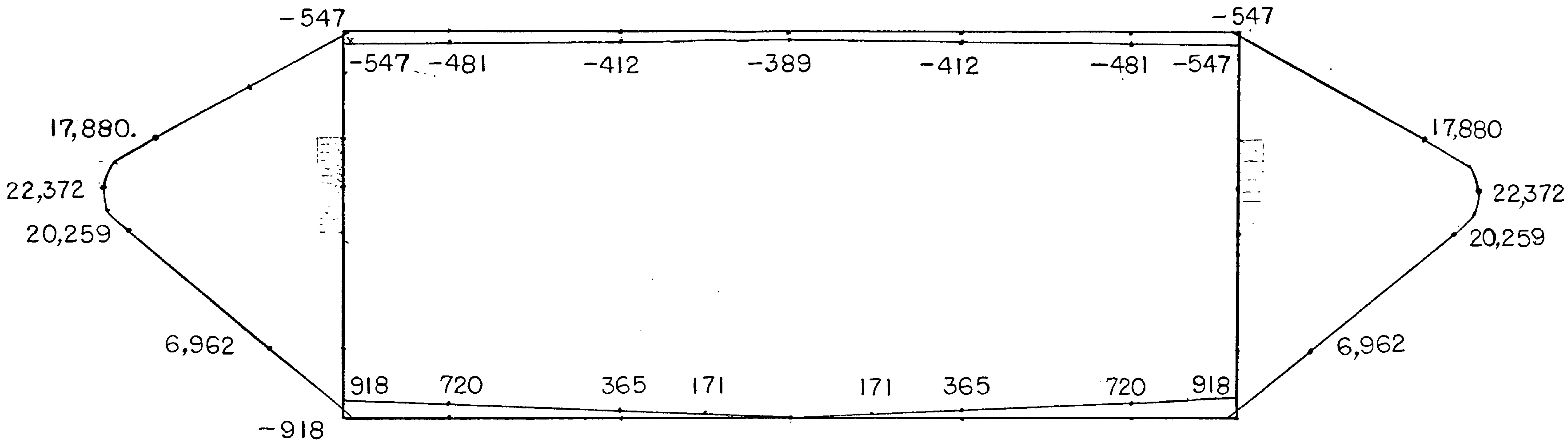
SHEAR DIAGRAM

FIG. 3



AXIAL FORCE

FIG. 3-A

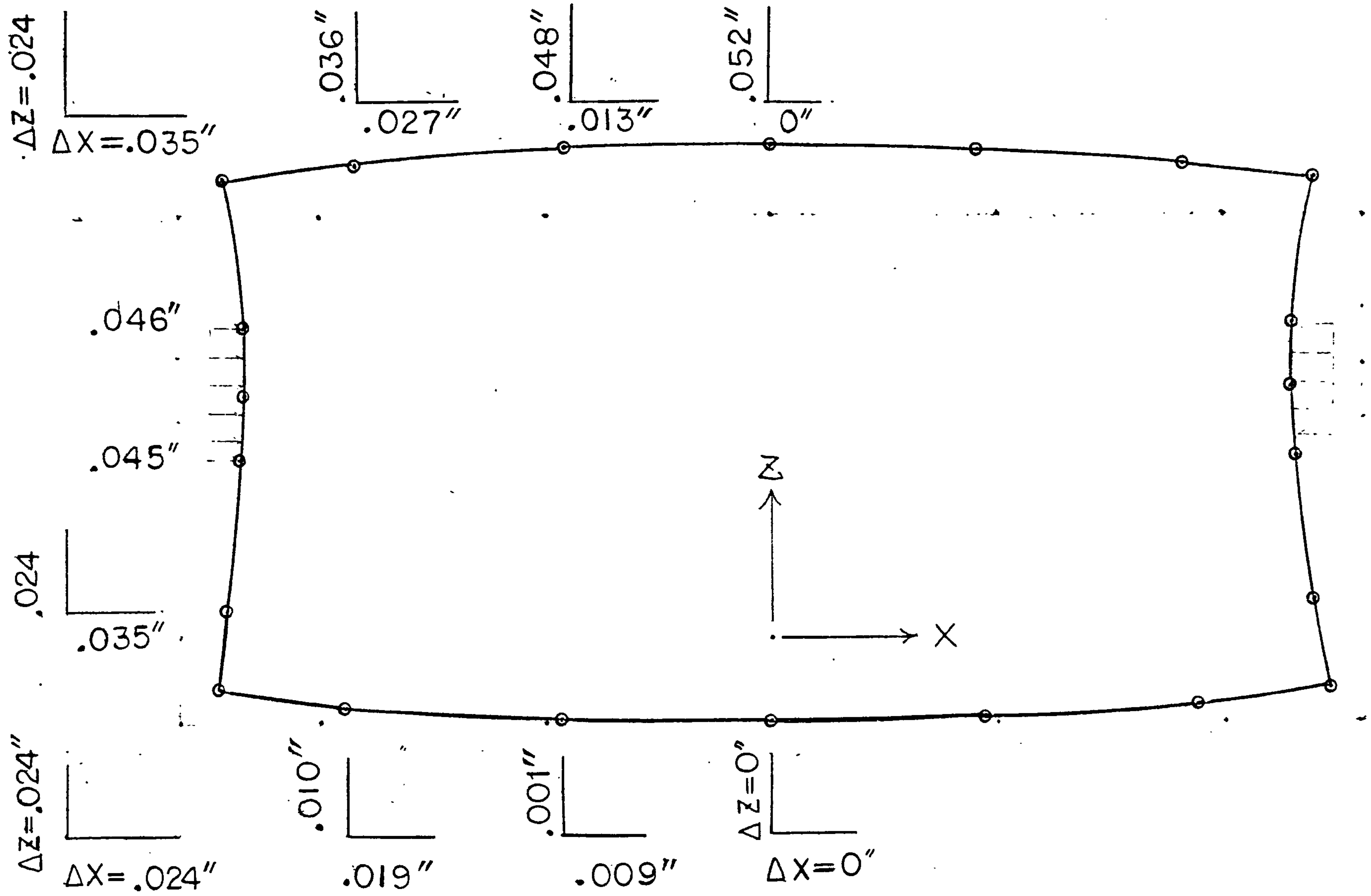


Note: Scales are different for horizontal and vertical plotted values.

BENDING MOMENT DIAGRAM

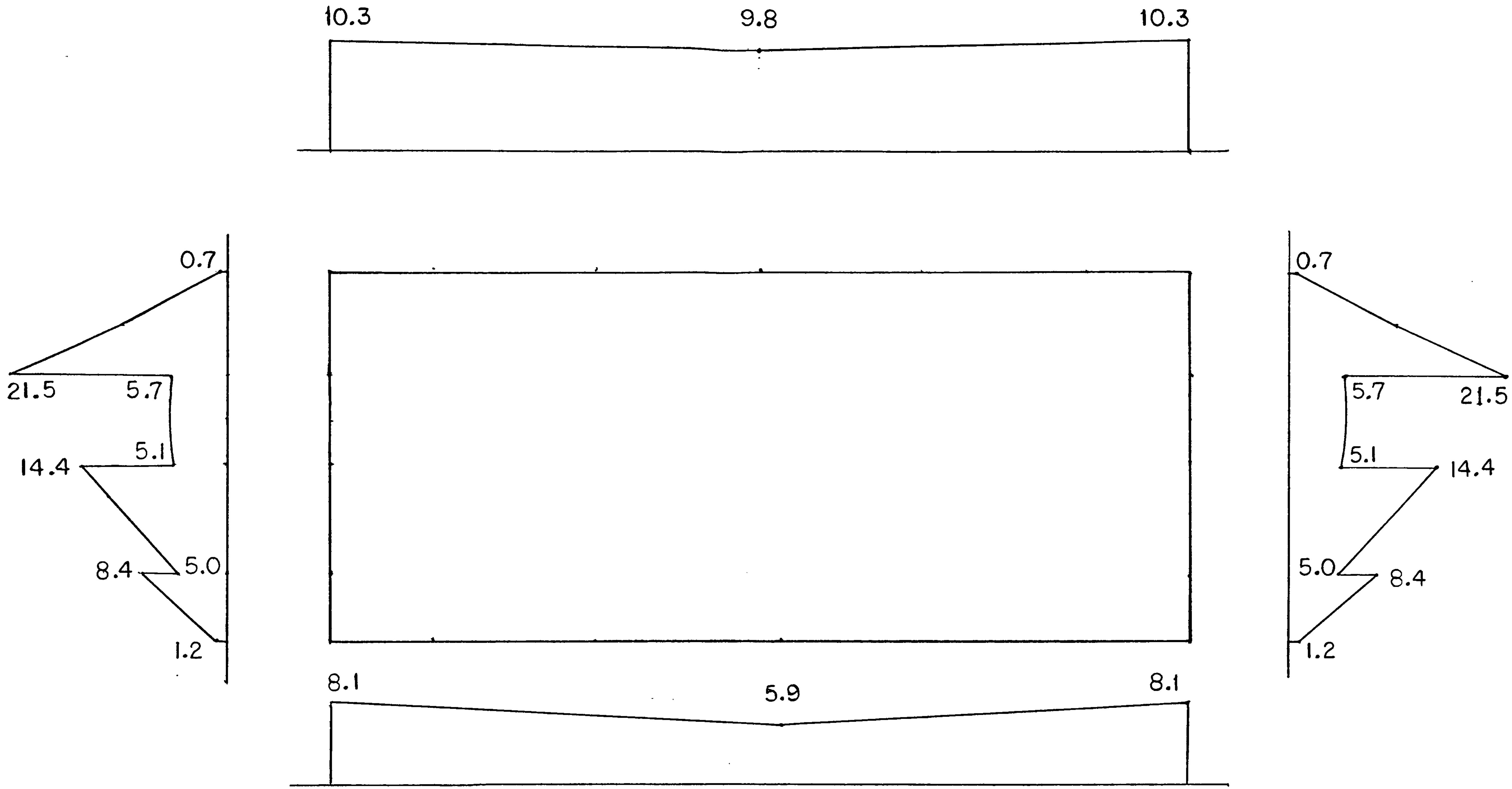
(VALUES IN INCH-KIPS)

FIG. 4



DEFORMED SHAPE

FIG. 5



STRESS DIAGRAM

(VALUES IN KSI)

FIG. 6

TABLE I

SUMMARY OF RESULTS, STATIC COMPUTER ANALYSIS OF FRAME

Section (Group No.)	Member	Joint No.	Force (Kips)		Moment (In.-K.)	Stress (ksi)			Remarks
			Axial	Shear		Axial	Bending	Combined	
1	Vertical	61	3.2	590	17,880	-0.04	-21.46	-21.5	Maximum Stressed Point
	Vertical	21	6.3	410	6,962	-0.08	- 8.36	- 8.4	
2	Vertical	41	5.0	410	20,259	-0.05	-14.33	-14.4	
3	Vertical	51	4.1	90	22,372	-0.02	- 5.65	- 5.7	Loading Point
11	Lower Horizontal (Connection)	11	410	6.3	918	-5.83	- 2.27	- 8.1	*Stress Concentration Expected
	Horizontal (Center)	14	410	8.8	35	-5.83	- 0.09	- 5.9	
13	Upper Horizontal (Connection)	91	590	2.5	547	-8.39	- 1.94	-10.3	*Stress Concentration Expected
	Upper Horizontal (Center)	94	590	0.0	389	-8.39	- 1.38	- 9.8	

CHAPTER III

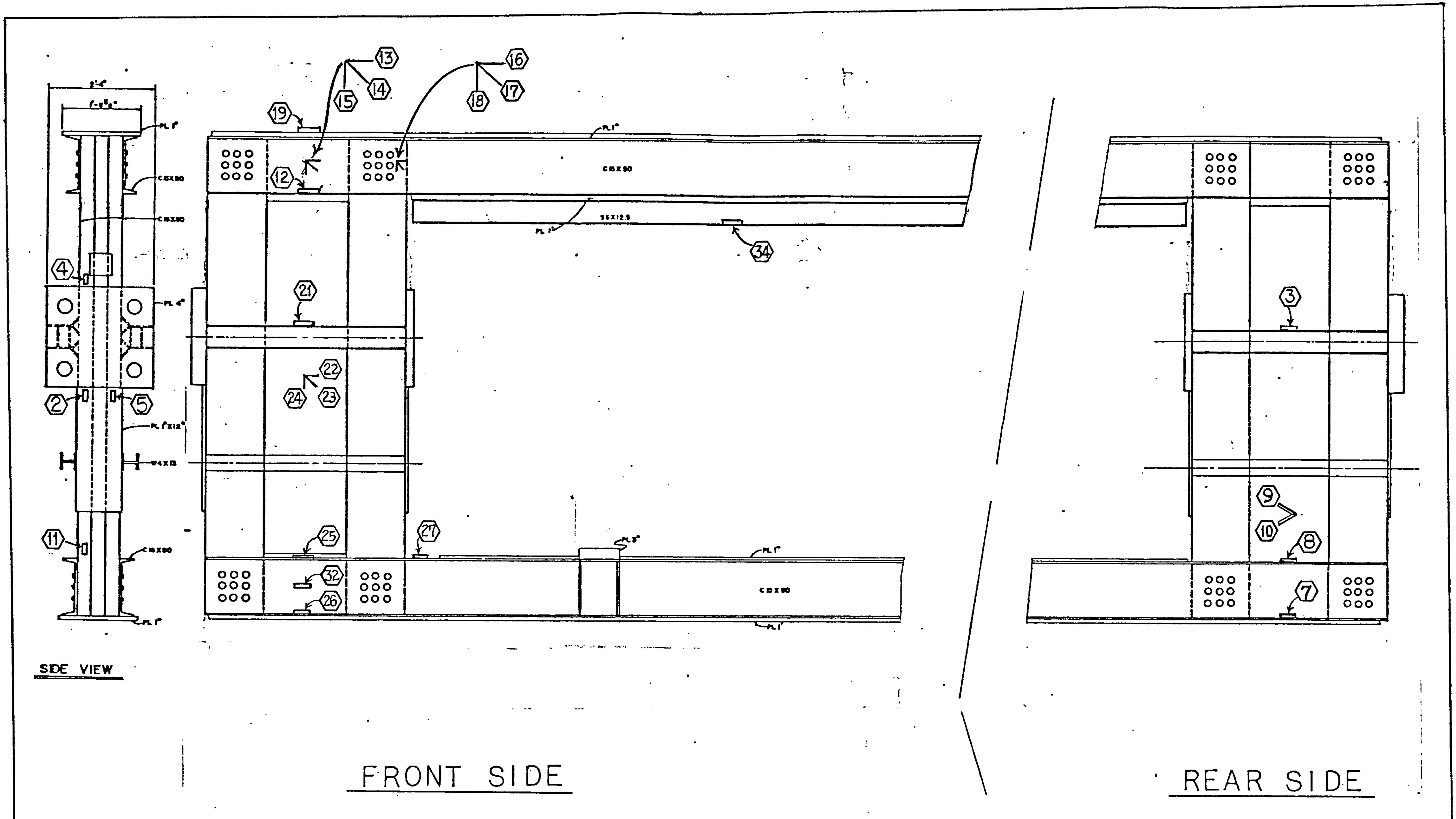
PREPARATION FOR STRAIN GAGE TEST WORK

Initially, it was intended that extensive brittle lacquer work would be done on the frame prior to strain gage placement, and some of this was done. However, the results of this work were not very helpful, confirming only that there was essentially pure shear in the lower portion of the one-half inch web at the center of the upright end sections. The remainder of this thesis will be concerned with the use of electric resistance strain gages and the data obtained from their use.

The installation of etched foil strain gages at room temperature with Eastman 910 cement has become such a routine and well-known procedure that there is little reason for detailing the work of installation of the strain gages for this test work. To permit checking of the entire circuit, lead wires were usually connected through the switching boxes to the strain indicators before soldering the leads of the gage.

Fig. 7 on page 16 shows the location of the twenty-six strain gages which were placed on the frame. Originally, it was planned to use about forty gages, but as the amount of work necessary to install that many gages became evident, some of the gages known to be planned for low-stress areas were omitted. The excellent check obtained later between computed and experimental results justified this decision.

Three three-element strain rosettes and one two-element rosette were used in the work; all the other gages were used in uni-axial stress areas and were single element gages. The lead wires from all gages ended at the data acquisition equipment located in a room adjacent to



GAGE LOCATIONS

FIG. 7

the frame. The static test gages were read with ordinary switching equipment and manual strain indicators, as shown in Fig. 8, page 18.

In addition to the gages placed on the frame, a pair of single-element gages was placed on each of the stay rods at the same longitudinal position along the rod and 180° apart around the circumference to obtain an average of the tensile strains and to cancel any bending in the rod. These two gages were two opposite arms of a four-arm bridge, the other two arms being identical gages placed on unstrained steel plates. One diagonal of each such bridge was connected to a DC power supply, and the signal from the other diagonal was fed to the Dana amplifiers which were in turn connected to the four-trace plug-in in the Tektronix oscilloscope. The only other equipment involved in the transient strain measurement on the stay rods were a balancing and switching box between the four-arm bridges and the amplifiers, and a polaroid camera used with the oscilloscope. Fig. 9, page 18, shows the equipment listed above.

The only additional steps involved in the preparation of the electronic equipment for the test work were those of obtaining zero readings for the static strain measurement gages, and zeroing and calibrating each of the four-arm bridges used for dynamic strain measurement. This calibration will be explained in the next portion of this thesis.

The final step in preparation for the test was that of installing a test specimen between the main pull plates. This specimen was a two-inch diameter 4140 steel rod, notched with a cutting torch to provide a brittle fracture, and held at each end with a one-inch plate and a nut on each side of the pull plates. This rod is visible in the center of Fig. 10, page 19, along with the stay rods and the leads from the gages

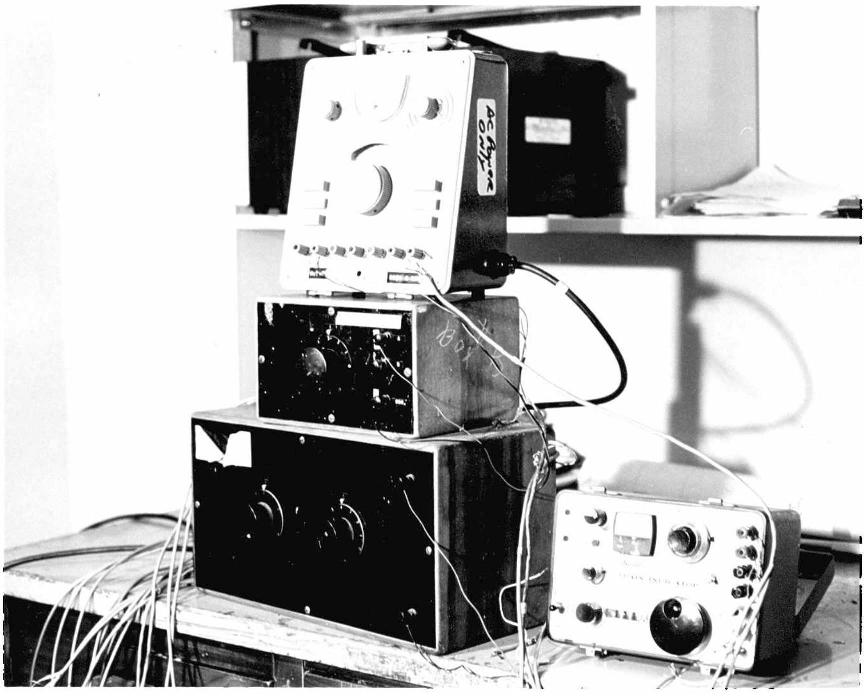


Figure 8

Static Strain Measurement Equipment

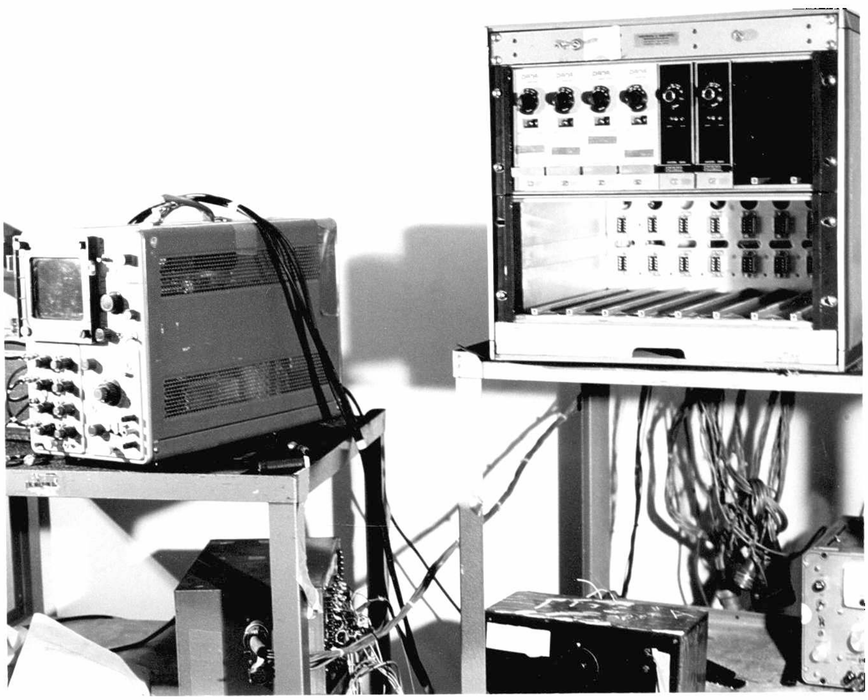


Figure 9

Transient Strain Measurement Equipment

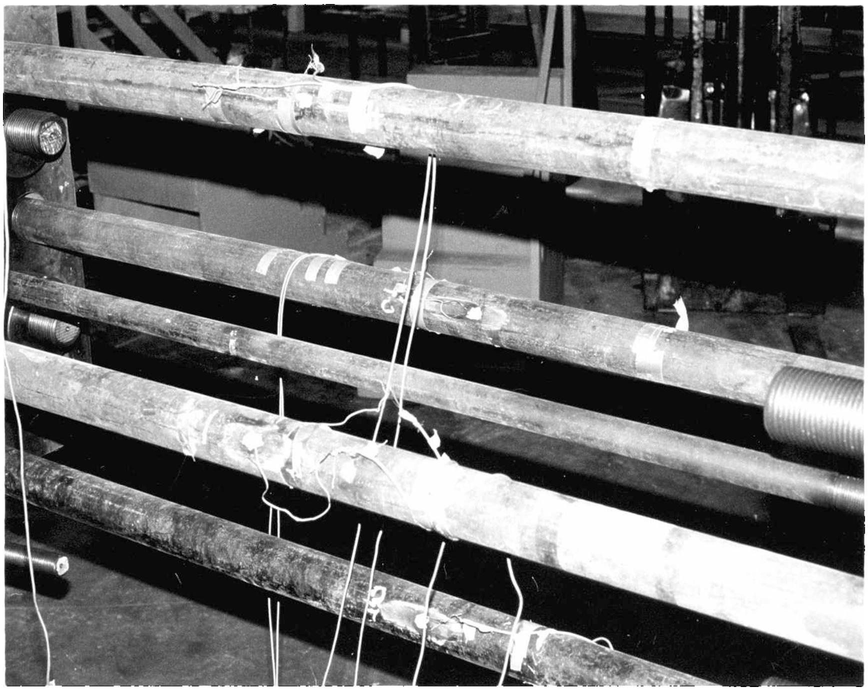


Figure 10

Tensile Specimen and Stay Rods

mounted on them. A considerable amount of work was involved in vertical and horizontal adjustment and alignment of all elements of the loading system, which included the fixed loading plates at the outer ends of the frame, the alignment plates at corresponding points inside the frame, the loading plate at the end of the hydraulic cylinder, the main pull rods, the two loading plates, and the specimen and stay rods. This work was accomplished with the use of the hydraulic fork lift in the laboratory, various chain hoists, sledge hammers and large pry bars and various other items. The procedure just described is rather impractical for any significant amount of test work, and plans are currently under execution to simplify the procedure, a major item being the use of trolleys to support the pull plates and rods. These trolleys will be supported by the I-beam welded to the bottom of the top horizontal member of the frame.

CHAPTER IV

PERFORMANCE OF TEST AND ACQUISITION OF DATA

Just prior to beginning the strain gage test work, static gage zero readings were obtained, the transient strain measurement apparatus was checked, and the loading was then applied in approximately 50,000 pound increments up to 201,000 pounds. At the beginning of the test, and after each interval of loading, the nuts on the stay rods were backed off sufficiently to permit application of the next interval of load. Approximately one-half turn (1/10 inch) of the nuts was used for each 50,000 pound interval. Static strain readings were taken at each of these loads, and as fracture of the test specimen was expected prior to a load of 300,000 pounds, the next static readings were taken at a load of 302,400 pounds. Another set of static readings was taken at 400,000 pounds, and thereafter the specimen suddenly fractured at a load of 430,000 pounds. The transient strain equipment worked properly, as will be described later, and the loading was reduced to zero to check on the zero shift which may have occurred in the static strain readings. The loading was then resumed in increments of 100,000 pounds up to 980,000 pounds, at which time the electric motor-powered pump continued to run for several seconds without increasing the load. This behavior was interpreted as being possibly due to yielding of the frame, and a set of readings was quickly taken at that load, and then the load reduced to zero by releasing the hydraulic pressure.

All basic static strain data from the test work are presented in Appendix C.

The load was obtained during the test work from a load cell which was placed between the piston of the hydraulic cylinder and the loading plate. The calibration of this load cell is traceable to the National Bureau of Standards, with an error no greater than one percent.

The above is a brief presentation of the procedures used during the actual performance of the test work. Some minor points of significance not covered above will be discussed in the next portion of this thesis.

CHAPTER V

PRESENTATION AND DISCUSSION OF RESULTS

The steel frame studied in this thesis is an exceedingly complex structure when both geometric properties and the realities of the use of the structure are considered. It is true that there are only four major parts of the structure, but the two end upright portions vary considerably in section properties, and are connected to the top and bottom horizontal members by means of bolts. Considered as individual units, the end members were purposely made rather flexible near the upper and lower ends, with the two pairs of channels in each end member being connected only with the one-half inch web on each side of the frame. This was done to permit each pair of channels to act very much like vertical cantilever elements above and below the point of application of the horizontal load from the hydraulic cylinder and steel rod loading system. The reason for this was so that each pair of vertical channels could deflect essentially the same amount and distribute uniformly the load to the bolted connections at each of the four corners of the frame. The opposite extreme of such a condition would be provided by extremely stiff and inflexible end members (say solid steel members several inches in thickness); for this imagined case the bolts at the inside four connection points would carry almost all the load, and would be considerably overloaded.

In addition to the structural complexities of the frame as built, other complexities and uncertainties arise when the frame is actually loaded in use. The load is applied by means of a hydraulic cylinder and piston, the base of which may not be concentric with either the centroid of the four loading bolts or the loading plates at each end of the cylinder. Furthermore, in spite of the care used to take the slack out of the rods in such a way that the bolts are loaded uniformly, the bolts are not stressed with precisely the same stress, and some eccentricity of loading must exist when the frame is loaded.

To determine with much precision the "exact" behavior of the frame under loading, several times as many strain gages would be needed than were used in the test work. That was not the purpose of the study; the purpose of the study was to obtain a gross picture of the behavior of the frame and to determine a safe upper limit for both static and fracture load tests.

There are several ways in which stresses from the strain gage readings (strains) may be considered; by comparison with the results of the computer analysis, by comparison of results between pairs of gages placed at corresponding points of the frame, and by consideration of the known condition (from statics) of structural behavior of the frame at the location of an individual gage. In the discussion which follows, all of these will be discussed as appropriate, and conclusions will then be drawn regarding the major objectives of the test work.

For purposes of discussion of results, the strain gage locations on the frame were divided into the following groups according to the purpose and characteristics of the gage locations.

Horizontal Members

(1) Gages at Corner Connections. These gages were installed for the purpose of checking the restraining moment at the joint and to

check the axial force transferred to the upper and lower members.

(2) Other Locations. These gages were installed to determine the maximum stress in the horizontal members.

Vertical Member

(1) Flexural Side. The gage locations were placed at points where the highest stresses were expected.

(2) Center Web. One two-element rosette was placed to determine the shearing stress in the web.

Stay Rods

Four pairs of gages were installed on the stay rods to study the transient strain phenomenon upon failure of the tensile specimen. This will be discussed later in detail.

Load Balance and Eccentricity

Four pairs of gages were installed at symmetrical locations with respect to the point of load application. Both gages of each pair would have indicated the same strain had the load been applied and distributed ideally without any eccentricity. Three pairs of these gages were on the horizontal members and one pair was on the vertical member.

Discussion of Stresses

A tabulation of stresses from all static strains measured is provided in Appendix C, and this the source of all values discussed below. The highest load obtained in the test work was 980,000 pounds, but for purposes of discussion, all the values obtained for that load were extrapolated to obtain values for 1,000,000 pounds.

Reference must be made to Fig. 7, page 16, showing location of the gages, for a more meaningful understanding of the discussions which follow.

Stresses from Gages at Corner Joints of Horizontal Member

Gages 7 and 8 were in compression, with values of 2.11 and 7.29 ksi, respectively. These are consistent values, both in sign and magnitude, as the member is in compression, and is also subjected to bending from the action of the upright end members in transferring the load to the horizontal frame members.

Gages 25 and 26 at the bottom of the frame were in locations which corresponded to the locations of gages 7 and 8 on the other side of the frame. The stress of 2.42 ksi compression from gage 26 correlated well with the 2.11 ksi compression obtained from gage 7. The stress of 10.65 ksi compression from gage 25 is reasonable for the location of the gage, probably being subjected to compression both from the load transmitted by the outer set of bolts in that member, as well as from the bending of the horizontal member from the action of the outer pair of channels of the upright member.

Gages 12 and 19 were at the bottom and top flanges, respectively, of the horizontal member at the hydraulic cylinder end of the frame, and both gave stresses considerably lower than 10.0 ksi. The value of 1.74 ksi from gage 19 seems a reasonable value, as there is no doubt some bending in the top horizontal member which occurs between the top ends of the two pairs of channels of the upright end member. The value of

5.73 ksi from gage 12, however, is rejected as an unacceptable value, inasmuch as there was a zero shift of 484 microstrain upon fracture of the tensile specimen, and the behavior of this gage was erratic throughout its use.

Bending Moment at the Corner Joints

The data obtained from gage 7 and 8 along with that from gages 25 and 26 were used to estimate the bending moment at the lower joint, and an experimental value of 914 inch-kips was obtained. This is very close to the value of 918 inch-kips obtained from the computer analysis, with a difference of less than 0.5 percent.

For the upper joint, data were not available to check the bending moment because gage 12 provided unreliable data as described above, and duplicate gages were not installed on the other side of the frame.

Axial Stress in Upper Horizontal Member

An experimental value of 11.2 ksi of compressive stress was obtained from gage 16, which checks within 5 percent of the computer axial stress of 11.8 ksi in that section. This is an excellent agreement between the two values.

Stresses from Other Gages on Horizontal Members

Gages 13, 14, and 15, the three elements of a rosette, all provided very low stresses (all less than 5.0 ksi) which is quite reasonable as the rosette is at the centroid of the upper horizontal member of the frame.

The maximum principal stress from the three-element rosette consisting of gages 16, 17, and 18 was slightly greater than 10.0 ksi. This rosette was located at the same level as the one consisting of gages 13, 14, and 15, but was inside the bolted connection point, and was thus subjected to essentially the full load of one of the car channels of the pair making up the top horizontal member.

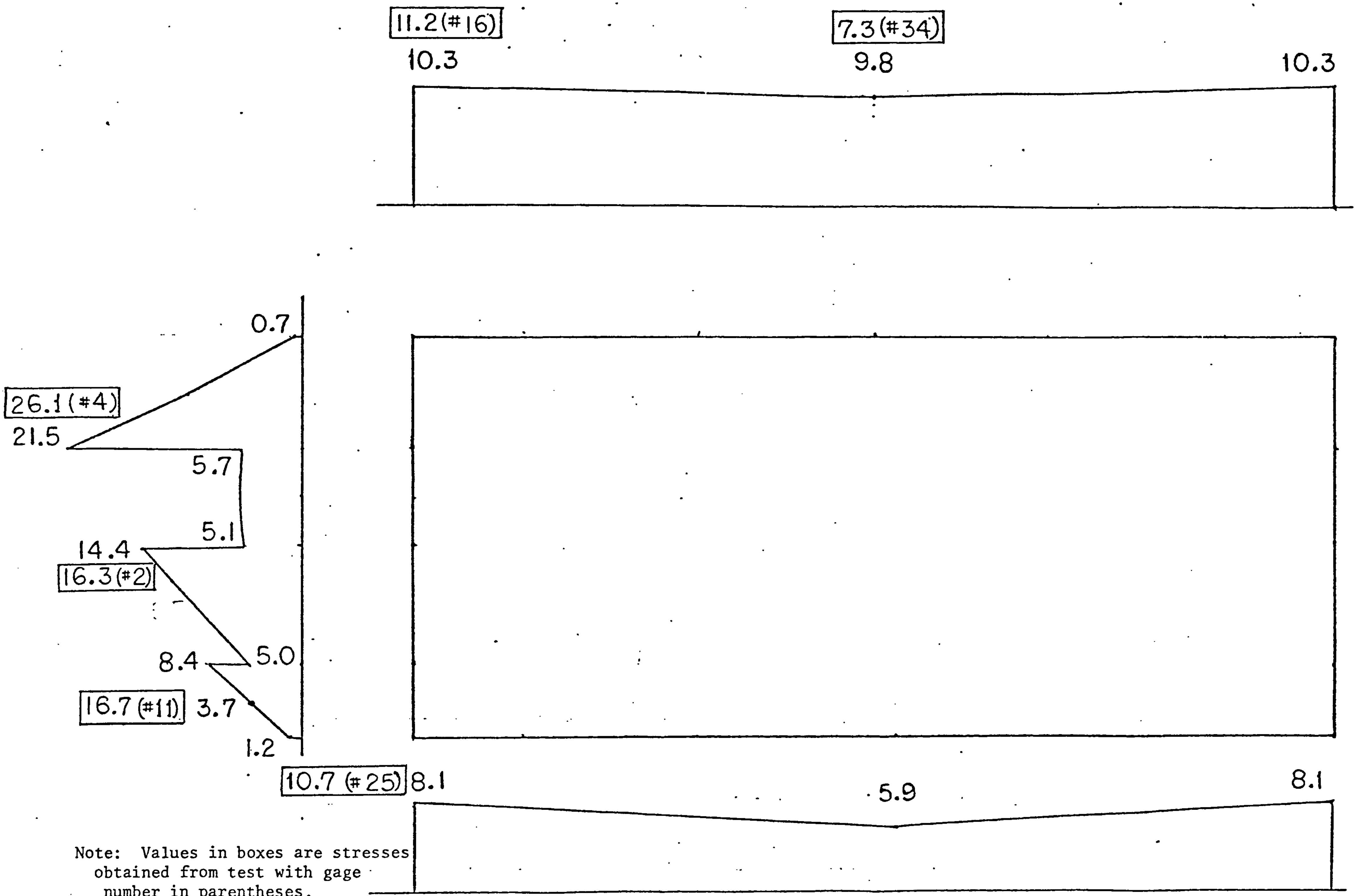
Gage 34 was located on the bottom flange of the I-beam trolley support welded beneath the upper horizontal member of the frame. The stress from this gage was 7.29 ksi in compression, a difference of only 2.04 ksi from the combined computer value of 9.33 ksi, of which 7.97 ksi was compressive axial stress and 1.36 ksi was compressive bending stress. The dead load of the loading plates and stay rods supported by the upper horizontal member was not considered in the computer solution, and if approximately 5.0 kips of this dead load were considered, it would reduce most of the bending stress and the resultant difference in stress between the computer solution and the test results for gage 34 would become less than 1.0 ksi.

Gage 27 was located on the upper flange of the one car channel which is part of the lower horizontal member at the inside frame corner. The stress obtained from the test was 21.4 ksi whereas the computer value was 14.5 ksi. There is no doubt some stress concentration effect at this point because of the abrupt difference in the section moduli of the horizontal and vertical members, but there is also evidence (discussed in detail later) of torsion due to load application eccentricity, both of which could account for some of the 6.9 ksi difference between the computer and experimental values.

Gages on Vertical Member, Flexural Side, and Comparison of Computer and Experimental Results

All of the gages mounted on the flexural side of the vertical member indicated high stresses, as these gages are located near the point of application of the load to the frame where high bending moment occurs. The two highest stresses were obtained from gages 2 and 4, with values of 16.3 and 26.1 ksi, respectively, which check well with the computer results summarized in Fig. 11, page 30. The maximum discrepancy between the two sources of results for the two gages is approximately 20 percent for gage 4, which was located just above the loading plate at the end of the hydraulic cylinder.

Fig. 11 provides comparison of the most significant values from both the experimental and computer solution results for both the vertical and the horizontal members, and some of these have already been discussed. In general, there is excellent agreement between the two sets of values. For gage 11, however, the experimental value is 16.7 ksi, whereas the computer value is only 3.7 ksi. Gage 11 is on the outside of the vertical member, and the computer value is probably affected considerably by the assumptions necessary for the computer solution. All the experimental values for the vertical member are larger than the computer solution values, and a significant portion of the discrepancy is no doubt due to the deep beam characteristics of the vertical member, which was neglected in the computer solution. The shear deflection of this member was checked, and found to be approximately 50 percent of the deflection due to bending moment alone.



Note: Values in boxes are stresses obtained from test with gage number in parentheses.

FIG. 11 COMPARISON STRESS DIAGRAM

(VALUES IN KSI)

Shear Stress in Web

The shear stress obtained from the two-element gage 9-10 was 10.85 ksi, and the gages are located at the border line of Section 1 and 2. The computed shear stress values based on Section 1 and Section 2 are 11.2 ksi and 9.8 ksi, respectively, with an average value of 10.5 ksi. The difference between the experimental and computed values is thus only about 3.0 percent.

Load Balance and Eccentricity

Reference has been made above to four pairs of gages which permitted a study of the eccentricity of application of the load. These gages were placed at symmetrical points with respect to the load and on opposite sides of the frame, and if there had been no eccentricity of loading, the strain and stress from corresponding gages would have been equal. Three of these pairs of gages (8-25, 7-26, and one pair to be mentioned below) were on the horizontal members, and one pair (3-21) was on the vertical member. For this latter pair, the stresses were 6.18 and 9.28 ksi, respectively, and the discrepancy indicates torsion of the vertical member due to eccentricity of the loading. These two gages were on opposite sides of the frame at the mid-point of the 6-inch wide flange beam welded to the frame at the loading plates to stiffen it at that point.

Two of the pairs of gages on the horizontal members were at the lower part of the vertical member, and for these gages (8-25 and 7-26) the stresses were 7.29 versus 10.65 and 2.11 versus 2.42 ksi compression, respectively. Thus, as for gages 3-21, the other two pairs of gages at the end of the frame indicated some eccentricity of loading.

One other pair of gages was used to check on eccentricity of loading, or more specifically, lateral bending or buckling of the upper horizontal member at the center of the frame. The possibility of such buckling was one matter of initial concern, and a pair of gages was placed on this member at the center, one gage on each side of the plate at the top of this member. The gages were then connected directly to a strain indicator, with one of the gages in the active position and the other in the compensating position. The indicator was then balanced prior to the beginning of the test work, and was watched closely throughout the test. The strain from any lateral bending of the top member would be doubled by the gage location and electrical arrangement used, but there was only twenty-five to fifty microstrain movement (750 psi maximum stress) of the galvanometer needle through the test, indicating a negligible tendency toward buckling of the top horizontal member.

Fracture Test Transient Strain Measurement

The equipment used to obtain the transient strains in the stay rods upon fracture of the test specimen has already been described with reference to a photograph of this equipment, but an additional oscilloscope used was not shown in that photograph. Careful computations were made to estimate the magnitude and frequency of the signals which would be generated in the stay rods when the specimen failed, but it was deemed desirable to have two measurements of the strains as there was only one chance to obtain them and they would not last very long.

Both oscilloscopes were set to be triggered when the specimen fractured and the pull plates touched the nuts on the stay rods. The photographs from the two oscilloscopes are shown in Figs. 12 and 13, page 34. Fig. 12 is from the four-trace oscilloscope used for the primary strain measurement, and for this scope the speed was set at 2 milliseconds per division, and the amplifier gain was set so that a shunt calibration gave 240 microstrain per cm. of height on the oscilloscope. The other oscilloscope was set with a speed of 2 seconds per division, and with one cm. being equal to about 480 microstrain. The order of magnitude check between maximum strains for the two oscilloscopes was good, but the slower speed caused loss of some of the peaks measured with the second oscilloscope. The signals from the four-trace oscilloscopes are somewhat difficult to read, but a very close examination of Fig. 12 will reveal an envelope height for each trace of about two cm., or about 480 microstrain, indicating 14,400 psi in the rods, a very low value for metal with a yield point of at least 90,000 psi.

Linearity of Behavior of Frame Under Loading

For most of the gages for which the maximum (1,000,000 pound) stresses were more than 10.0 ksi, curves were drawn of stress versus load. This was done to permit study in detail of the frame behavior at the gage location, particularly with regard to linearity of the relationship between the load and the stress at various points in the frame. Study of the curves presented in Appendix D reveals good linearity, especially in view of the fact that the test was a fracture test, and that this test work involved loading of the frame to 980,000 pounds for the first time. A break occurs in most of the curves at the first reading after fracture of the specimen, indicating slight changes in the load distribution, possibly due to a lack of perfect uniformity of

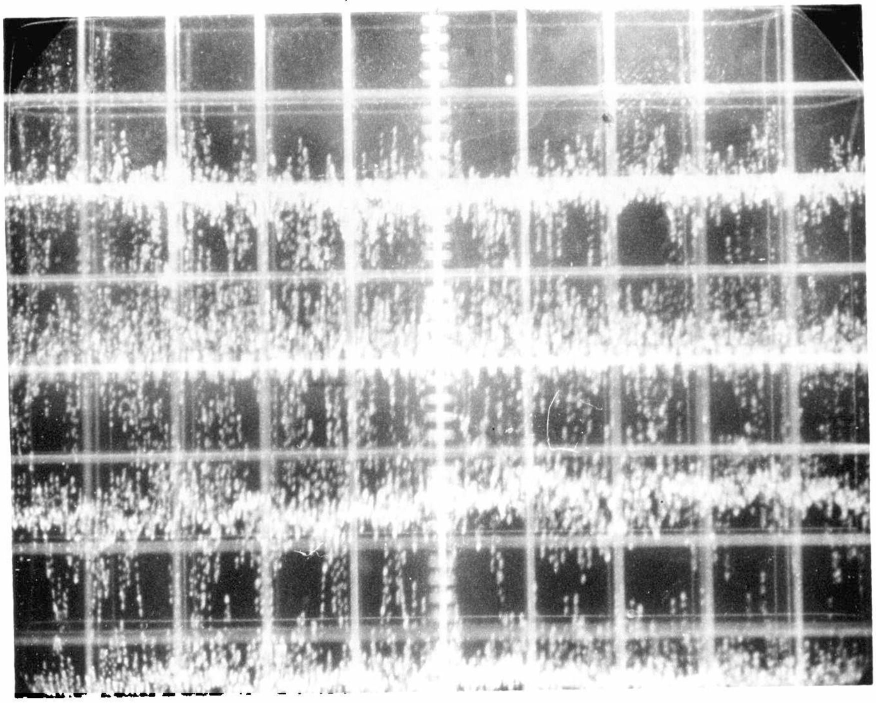


Figure 12

Fast Sweep Oscilloscope Traces

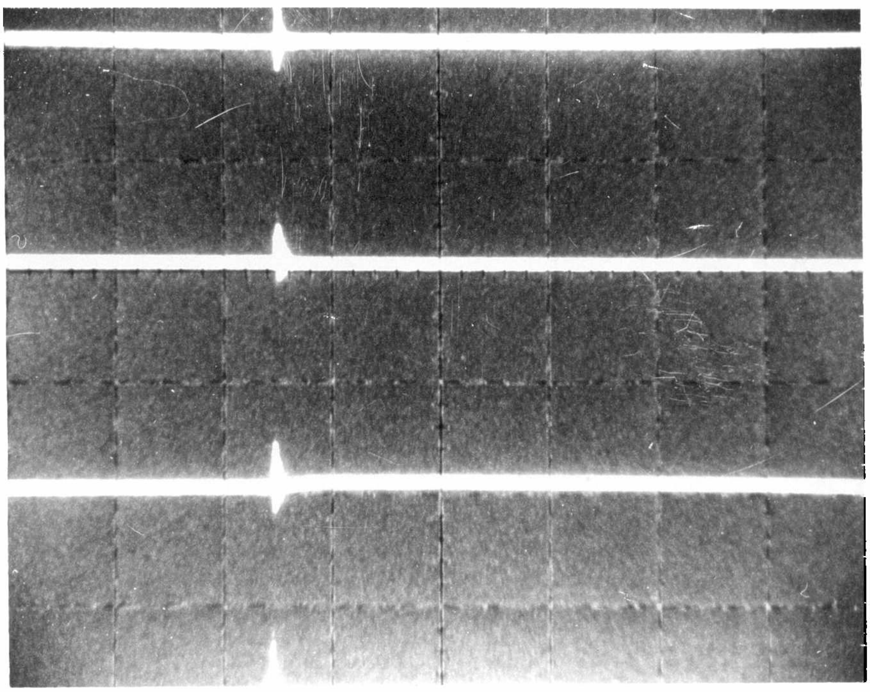


Figure 13

Slow Sweep Oscilloscope Traces

stress in the four stay rods which resisted the tensile load after fracture of the specimen.

CHAPTER VI

SUMMARY OF CONCLUSIONS

(1) The frame is probably safe for a static short-time test at a load of 1,000,000 pounds, but is marginal at this load. For a long-time loading (more than a few minutes), the load should probably be limited to approximately 750,000 pounds because of the possibility of some creep. This latter load would be a very conservative one, and with plates added as indicated below and with further test work, higher permissible loads might be appropriate.

(2) Additional plates should be welded to the exposed portions of the car channels of the upright end members of the frame, both on the inside and the outside of the members. If these plates were one inch in thickness, the section modulus would be increased by more than fifty percent, and long-time loading at 1,000,000 pounds might be appropriate.

(3) The stay rod concept worked very well at 430,000 pounds, and probably will almost to the static capacity of the frame. However, some additional fracture test work should be done at increasingly higher loads to determine more accurately an appropriate maximum load for this type of test.

(4) There was negligible evidence of any tendency toward buckling of the upper horizontal member. There is thus no concern about buckling of either of the horizontal members.

(5) The results of the computer analysis and the experimental work checked very well for the horizontal members and the web, with a maximum discrepancy of only five percent between the two sources of stresses.

For the flexural side of the vertical member, the corresponding discrepancy was about twenty percent for the two most highly stressed points, due at least in part to the deep beam effect of the vertical member.

(6) Eccentricity of the load significantly affects the stress at certain parts of the vertical members, and some procedure to detect and reduce the unbalanced load is desirable for subsequent test work.

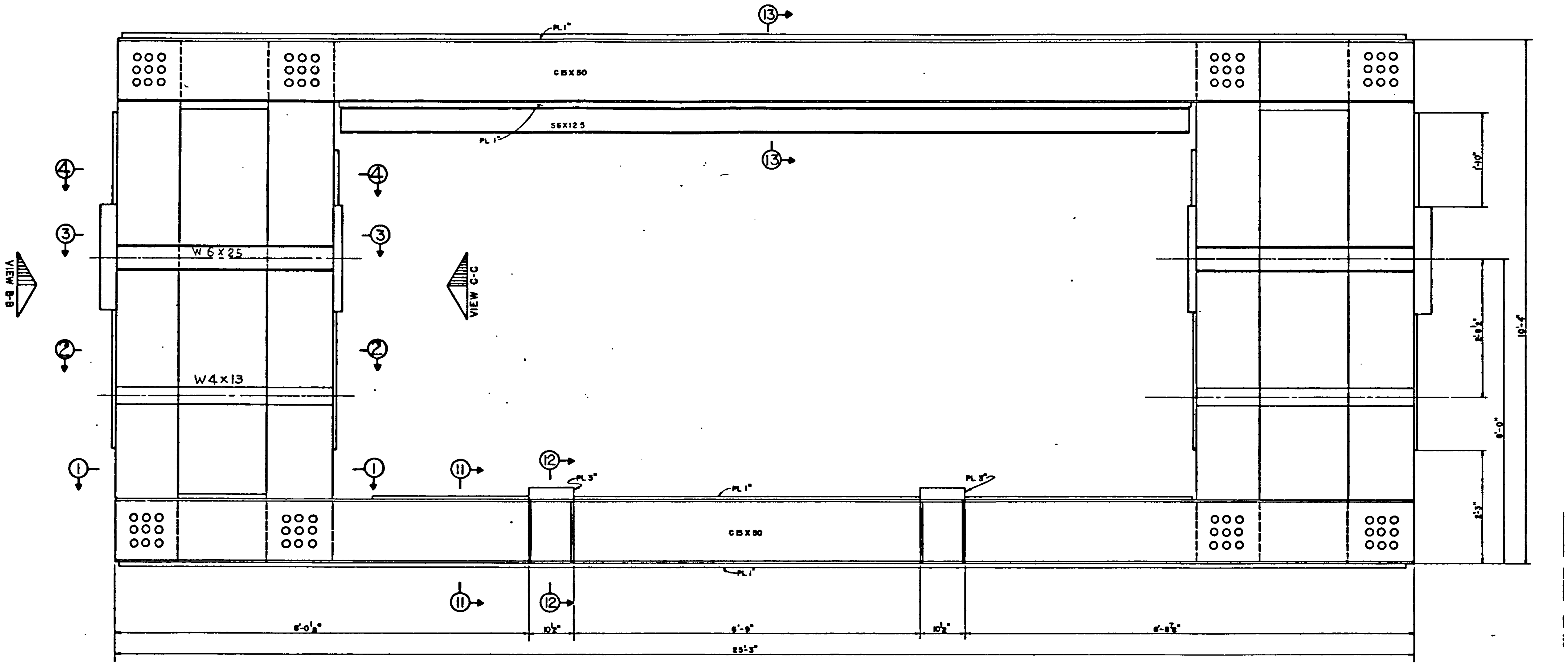
(7) For any significant amount of work with the frame, additional equipment must be added to make its use more convenient. This is especially true for fracture test work. Trolleys to support and permit convenient movement of the rods and pull plates must be added, as well as an automatic system for backing off the nuts on the stay rods. More sophisticated equipment for controlling and measuring the load would also be very helpful.

(8) Further study is needed regarding the shear deformation effect on the stress in the vertical deep beam members.

APPENDICES

APPENDIX A

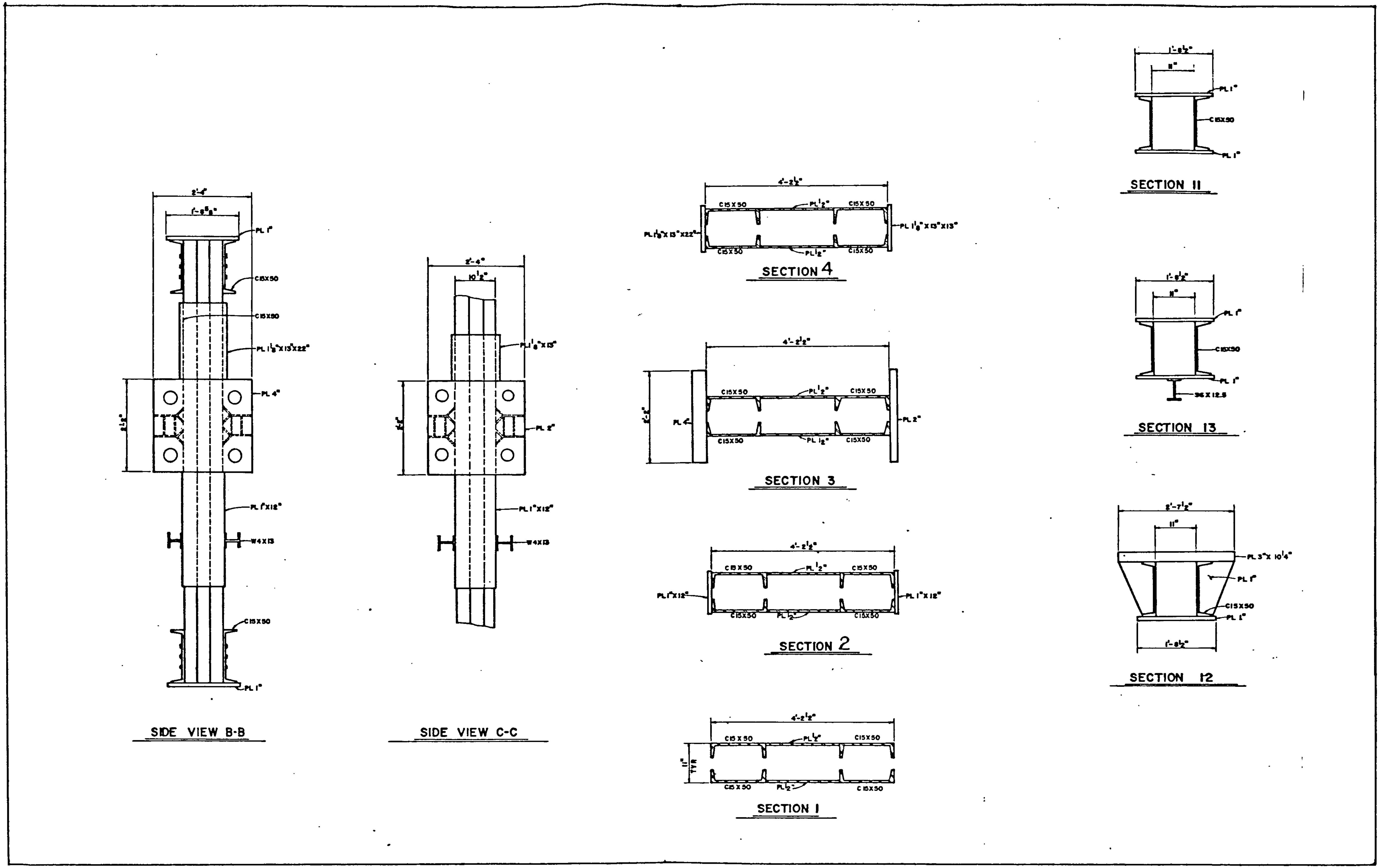
SECTION AND GEOMETRIC PROPERTIES OF TEST FRAME



1000,000 LB. TEST FRAME

DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF HOUSTON

SCALE	DATE	DRAWN BY


SIDE VIEW B-B
SIDE VIEW C-C
SECTION 4
SECTION 3
SECTION 2
SECTION 1
SECTION 11
SECTION 13
SECTION 12

SECTION PROPERTIES

Section Group No.	Moment of Inertia (IN^4)	Section Modulus (IN^3)	Cross Sectional Area (IN^2)	Remarks
1	21,439 *(21,246)	840 *(833)	79.8 *(74.5)	*(Data Based on 3/8" Web Pl.)
2	37,663 *(37,470	1421 *(1413)	103.8 *(98.55)	*(Data Based on 3/8" Web Pl.)
3	134,937	3959	242.5	
4	40,928	1552	109.0	
11	3,432	403	70.4	
12	6,580	496	144.4	
13	3,915	Top: 431 Bottom: 281	74.1	

APPENDIX B

STATIC COMPUTER ANALYSIS

FRAME ANALYSIS
D. M. KIM
FEBRUARY, 1977

OPTION DATA

CARD TYPE	YIELD STRESS KSI	E PSIXE6	G PSIXE6	DESG MATL DENSITY (490) PCF	ENCL MATL DENSITY (150) PCF	AVG WATER DEPTH FT	WATER DENSITY (64) PCF	EQUILIBRIUM CHECK FORCE LBS	EQUILIBRIUM CHECK MOMENT IN-LBS
******	******	******	******	******	******	******	******	******	******
OPTION	36.	30.	12.						

OPTIONS
****

OPTION NUMBER	OPTION SPECIFIED	
1	NO	TRANSVERSE SHEAR DEFORMATIONS CONSIDERED
2	NO	EXECUTE DATA CHECK PROGRAM
3	YES	EXECUTE STRAN PREPROCESSOR PROGRAM
4	NO	PRINT STRAN INPUT DATA FILE
5	YES	EXECUTE STRAN PROGRAM

GEOM DATA

CARD TYPE	Z-COORDINATES MUDLINE FT	Z-COORDINATES DECK FT	OVERTURNING COORDINATES X FT	OVERTURNING COORDINATES Y FT	OVERTURNING COORDINATES Z FT	TRANS STRUCT ORIGIN X FT	TRANS STRUCT ORIGIN Y FT	TRANS STRUCT ORIGIN Z FT	ROTATE STRUCTURE AXES (DEG) ROT STR X AXIS ANGLE/X	ROT STR X AXIS ANGLE/XY	ROT STR Y AXIS ANGLE/X	ROT STR Y AXIS ANGLE/XY
****	******	******	******	******	******	******	******	******	******	******	******	******
GEOM	0.		12.	0.	0.							

JOINT DATA

CARD TYPE	JOINT NO	COORDINATES (FEET) X	Y	Z	COORDINATES (INCH) X	Y	Z	CONN. CODES X	Y	Z	X	Y	Z	LOCATION JOINT	DIST GROUP	REMARKS
JNT	11	1.5	0.	0.0					1							
JNT	51	1.5	0.	5.4					1							
JNT	91	1.5	0.	9.1												
JNT	17	22.5	0.	0.0					1							
JNT	57	22.5	0.	5.4					1							
JNT	97	22.5	0.	9.1												
JNT	12	4.	0.	0.0												
JNT	13	8.	0.	0.0												
JNT	14	12.	0.	0.0												
JNT	15	16.	0.	0.0												
JNT	16	20.	0.	0.0												
JNT	92	4.	0.	9.1												
JNT	93	8.	0.	9.1												
JNT	94	12.	0.	9.1												
JNT	95	16.	0.	9.1												
JNT	96	20.	0.	9.1												
JNT	140	12.	0.	-1.0				1	1	1	1	1	1			D-SPT.
JNT	21	1.5	0.	1.6												
JNT	41	1.5	0.	4.3												
JNT	61	1.5	0.	6.5												
JNT	27	22.5	0.	1.6												
JNT	47	22.5	0.	4.3												
JNT	67	22.5	0.	6.5												

JOINT COORDINATES

INTERNAL JOINT NO	EXTERNAL JOINT NO	COORDINATES (FEET) X	Y	Z	CONN CODES XYZXYZ
1	11	1.500	0.0	0.0	1
2	12	4.000	0.0	0.0	
3	13	8.000	0.0	0.0	
4	14	12.000	0.0	0.0	
5	15	16.000	0.0	0.0	
6	16	20.000	0.0	0.0	
7	17	22.500	0.0	0.0	1
8	21	1.500	0.0	1.600	
9	27	22.500	0.0	1.600	
10	41	1.500	0.0	4.300	
11	47	22.500	0.0	4.300	
12	51	1.500	0.0	5.400	1
13	57	22.500	0.0	5.400	1
14	61	1.500	0.0	6.500	
15	67	22.500	0.0	6.500	
16	91	1.500	0.0	9.100	
17	92	4.000	0.0	9.100	
18	93	8.000	0.0	9.100	
19	94	12.000	0.0	9.100	
20	95	16.000	0.0	9.100	
21	96	20.000	0.0	9.100	
22	97	22.500	0.0	9.100	
23	140	12.000	0.0	-1.000	111111

THIS STRUCTURE HAS 23 JOINTS AND OF THESE 5 ARE SUPPORTS

SPECIAL GROUP PROPERTIES DATA

CARD TYPE	AREA IN**2	IZ IN**4	IY IN**4	IX IN**4	CZ IN	CY IN	GROUP NO
****	************	************	************	************	******	******	****
SPRA	74.55	21246.	21246.	150.	25.5	25.5	1
SPRA	96.55	37470.	37470.	200.	26.5	26.5	2
SPRA	262.50	134937.	134937.	300.	34.1	34.1	3
SPRA	70.4	3432.	3432.	145.	8.5	8.5	11
SPRA	70.4	3915.	3915.	145.	13.9	13.9	13

MEMBER GROUP PROPERTIES DATA

CARD TYPE	GROUP NO	TUBULAR OD-FT	TUBULAR OD-IN	TUBULAR WT-IN	PRIS-SPEC SIZE	PRIS-SPEC TYPE	PRIS-SPEC WGHT	LZ FT	LY FT	KZ	KY	MG RAD IN	CM OR PSI Z	CM OR PSI Y	CATEGORY	SFC MEM	LENGTH RED (IN) FIRST	LENGTH RED (IN) SECOND	INSIGF TUBE
****	****	******	******	******	****	***	******	****	****	****	****	******	*****	*****	*	*	***	***	*
TUBU	100		48.0	3.0															
PRIS	1					SPC		9.	9.						A				
PRIS	2					SPC		9.	9.						A				
PRIS	3					SPC		9.	9.						A				
PRIS	11					SPC		24.	24.						A				
PRIS	13					SPC		24.	24.						A				

MEMBER DATA

CARD TYPE	GROUP NO	JOINT NUMBERS FIRST	SECOND	CONNECTION CODES FIRST	SECOND	CHORD A DEG	LZ FT	LY FT	KZ	KY	MG RAD IN	CM OR Z	PSI Y	CATEGORY	SEC MEM	LENGTH RED (IN) FIRST	SECOND
****	****	******	******	******	******	*******	****	****	****	****	******	*****	*****	*	*	***	***
MEMB	1	11	21														
MEMB	1	17	27														
MEMB	1	61	91														
MEMB	1	67	97														
MEMB	2	21	41														
MEMB	2	27	47														
MEMB	3	41	51														
MEMB	3	51	61														
MEMB	3	47	57														
MEMB	3	57	67														
MEMB	11	11	12														
MEMB	11	12	13														
MEMB	11	13	14														
MEMB	11	14	15														
MEMB	11	15	16														
MEMB	11	16	17														
MEMB	13	91	92														
MEMB	13	92	93														
MEMB	13	93	94														
MEMB	13	94	95														
MEMB	13	95	96														
MEMB	13	96	97														
MEMB	100	14	140														

GROUP PROPERTIES

GROUP NO.	SECTION TYPE	O.D. IN	W.T. IN	AREA IN2	SECT. MODU.-IN3 Y	SECT. MODU.-IN3 Z	FY KSI	CC	IY IN4	IZ IN4	RY IN	RZ IN	IX IN4
1	0.0 SPC 253.68			74.5	633.	833.	36.0	128.3	21246.	21246.	16.9	16.9	150.
2	0.0 SPC 335.34			98.5	1414.	1414.	36.0	128.3	37470.	37470.	19.5	19.5	200.
3	0.0 SPC 825.17			242.5	3957.	3957.	36.0	128.3	134937.	134937.	23.6	23.6	300.
11	0.0 SPC 239.56			70.4	404.	404.	36.0	128.3	3432.	3432.	7.0	7.0	145.
13	0.0 SPC 239.56			70.4	282.	282.	36.0	128.3	3915.	3915.	7.5	7.5	145.
100	TUBULAR	48.000	3.000	424.1	4493.	4493.	36.0	128.3	107831.	107831.	15.9	15.9	215662.

MEMBER PROPERTIES

GROUP NO	MEMBER JOINTS LOW	HIGH	CHORD ANGLE	MGRW IN	S M	C	CM OR PSI Y	Z	LENGTH FT	LY FT	LZ FT	KY	KZ	KL/R Y	KL/R Z	FA KSI	.6FY KSI	FEYY KSI
1																		
	11	21	0.0	0.0	0	A	0.85	0.85	1.6	9.0	9.0	0.80	0.80	5.1	5.1	21.4	21.6	5897.6
	17	27	0.0	0.0	0	A	0.85	0.85	1.6	9.0	9.0	0.80	0.80	5.1	5.1	21.4	21.6	5897.6
	61	91	0.0	0.0	0	A	0.85	0.85	2.6	9.0	9.0	0.80	0.80	5.1	5.1	21.4	21.6	5897.6
	67	97	0.0	0.0	0	A	0.85	0.85	2.6	9.0	9.0	0.80	0.80	5.1	5.1	21.4	21.6	5897.6
2																		
	21	41	0.0	0.0	0	A	0.85	0.85	2.7	9.0	9.0	0.80	0.80	4.4	4.4	21.4	21.6	7868.2
	27	47	0.0	0.0	0	A	0.85	0.85	2.7	9.0	9.0	0.80	0.80	4.4	4.4	21.4	21.6	7868.2
3																		
	41	51	0.0	0.0	0	A	0.85	0.85	1.1	9.0	9.0	0.80	0.80	3.7	3.7	21.5	21.6	11515.1
	51	61	0.0	0.0	0	A	0.85	0.85	1.1	9.0	9.0	0.80	0.80	3.7	3.7	21.5	21.6	11515.1
	47	57	0.0	0.0	0	A	0.85	0.85	1.1	9.0	9.0	0.80	0.80	3.7	3.7	21.5	21.6	11515.1
	57	67	0.0	0.0	0	A	0.85	0.85	1.1	9.0	9.0	0.80	0.80	3.7	3.7	21.5	21.6	11515.1
11																		
	11	12	0.0	0.0	0	A	0.85	0.85	2.5	24.0	24.0	0.80	0.80	33.0	33.0	19.8	21.6	141.9
	12	13	0.0	0.0	0	A	0.85	0.85	4.0	24.0	24.0	0.80	0.80	33.0	33.0	19.8	21.6	141.9
	13	14	0.0	0.0	0	A	0.85	0.85	4.0	24.0	24.0	0.80	0.80	33.0	33.0	19.8	21.6	141.9
	14	15	0.0	0.0	0	A	0.85	0.85	4.0	24.0	24.0	0.80	0.80	33.0	33.0	19.8	21.6	141.9
	15	16	0.0	0.0	0	A	0.85	0.85	4.0	24.0	24.0	0.80	0.80	33.0	33.0	19.8	21.6	141.9
	16	17	0.0	0.0	0	A	0.85	0.85	2.5	24.0	24.0	0.80	0.80	33.0	33.0	19.8	21.6	141.9
13																		
	91	92	0.0	0.0	0	A	0.85	0.85	2.5	24.0	24.0	0.80	0.80	30.9	30.9	19.9	21.6	161.8
	92	93	0.0	0.0	0	A	0.85	0.85	4.0	24.0	24.0	0.80	0.80	30.9	30.9	19.9	21.6	161.8
	93	94	0.0	0.0	0	A	0.85	0.85	4.0	24.0	24.0	0.80	0.80	30.9	30.9	19.9	21.6	161.8
	94	95	0.0	0.0	0	A	0.85	0.85	4.0	24.0	24.0	0.80	0.80	30.9	30.9	19.9	21.6	161.8
	95	96	0.0	0.0	0	A	0.85	0.85	4.0	24.0	24.0	0.80	0.80	30.9	30.9	19.9	21.6	161.8
	96	97	0.0	0.0	0	A	0.85	0.85	2.5	24.0	24.0	0.80	0.80	30.9	30.9	19.9	21.6	161.8
100																		
	14	140	0.0	0.0	0		0.85	0.85	1.0	1.0	1.0	0.80	0.80	0.6	0.6	21.6	21.6	********

MEMBER - GROUP CROSS REFERENCE

MEMBER JOINTS LOW	MEMBER JOINTS HIGH	GROUP NO	REMARKS	MEMBER JOINTS HIGH	MEMBER JOINTS LOW	GROUP NO	GROUP NO	MEMBER JOINTS LOW	MEMBER JOINTS HIGH	MEMBER ID
11	12	11		12	11	11	1	11	21	10008
11	21	1	VERTICAL	13	12	11	1	17	27	70009
12	13	11		14	13	11	1	61	91	140016
13	14	11		15	14	11	1	67	97	150022
14	15	11		16	15	11	2	21	41	80010
14	140	100	VERTICAL	17	16	11	2	27	47	90011
15	16	11		21	11	1	3	41	51	100012
16	17	11		27	17	1	3	47	57	110013
17	27	1	VERTICAL	41	21	2	3	51	61	120014
21	41	2	VERTICAL	47	27	2	3	57	67	130015
27	47	2	VERTICAL	51	41	3	11	11	12	10002
41	51	3	VERTICAL	57	47	3	11	12	13	20003
47	57	3	VERTICAL	61	51	3	11	13	14	30004
51	61	3	VERTICAL	67	57	3	11	14	15	40005
57	67	3	VERTICAL	91	61	1	11	15	16	50006
61	91	1	VERTICAL	92	91	13	11	16	17	60007
67	97	1	VERTICAL	93	92	13	13	91	92	160017
91	92	13		94	93	13	13	92	93	170018
92	93	13		95	94	13	13	93	94	180019
93	94	13		96	95	13	13	94	95	190020
94	95	13		97	67	1	13	95	96	200021
95	96	13		97	96	13	13	96	97	210022
96	97	13		140	14	100	100	14	140	40023

ESTIMATION OF MATERIAL TAKE-OFF

GROUP NO	SECT TYPE	TOTAL LENGTH FT	REDUCED LENGTH FT	REGULAR SECTION WEIGHTS UNIT LB/FT	TOTAL KIP	REDUCED KIP	SPECIAL TUBULAR WEIGHTS UNIT LB/FT	TOTAL KIP	REDUCED KIP	ENCLOSED MATERIAL WEIGHTS UNIT LB/FT	TOTAL KIP	REDUCED KIP	PROP CARD ADDED UNIT LB/FT	TOTAL KIP
1	PRIS	8.4	8.4	253.7	2.1	2.1							0.0	0.0
2	PRIS	5.4	5.4	335.3	1.8	1.8							0.0	0.0
3	PRIS	4.4	4.4	825.2	3.6	3.6							0.0	0.0
11	PRIS	21.0	21.0	239.6	5.0	5.0							0.0	0.0
13	PRIS	21.0	21.0	239.6	5.0	5.0							0.0	0.0
100	TUBU	1.0	1.0	1443.2	1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		TOTAL WEIGHTS			19.1	19.1		0.0	0.0		0.0	0.0		0.0

LISTING OF JOINTS IN EACH CLASSIFICATION BY UNIT

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

UNIT 1

JOINTS ELIMINATED
CLASS 1
12 13 14 15 16 17 27 47 51 57 61 67 91 92 93 94 95
97 140

JOINTS CARRIED OVER
CLASS 4
11 41

UNIT 2

JOINTS ELIMINATED
CLASS 1
21
CLASS 2
11 41

JOINT CLASSIFICATION SUMMARY

UNIT NUMBER	NUMBER OF MEMBERS	NUMBER OF JOINTS	ELIMINATED JOINTS CLASS 1	CLASS 2	CARRY-OVER JOINTS CLASS 3	CLASS 4	JOINTS ELIMINATED	JOINTS CARRY-OVER
1	21	22	20	0	0	2	20	2
2	2	3	1	2	0	0	3	0

ITEM COUNTS

UNITS	JOINTS	SUPPORTS	JT. ADDED FEATURE	MEMBERS	MBR. ADDED FEATURE
2	23	5	0	23	0

LOADING TITLE DATA

CARD TYPE	LOADNG NUMBER	DESCRIPTION OF LOADING
****	****	**
LONG	1	1000 KIPS AT LEFT SIDE
LONG	2	1000 KIPS AT RIGHT SIDE
LONG	3	1000 KIPS AT LEFT SIDE (UNIFORM)
LONG	4	1000 KIPS AT RIGHT SIDE (UNIFORM)

NON-GENERATED LOAD DATA

CARD TYPE	LOADNG NUMBER	JOINTS FIRST OR LDGP	JOINTS SECOND PRCNT	DIRECTION ANGLE/X DEG	X	ANGLE/XY DEG	Y	STD MEMB ANGL	UNIF CONC MOMT	DIST TO LOAD FT	LOAD K K/FT IN-K	LENGTH LOAD FT	FINAL LOAD K/FT	REMARKS
LOAD	1	51			1			STD	CONC		1000.			
LOAD	2	57			1			STD	CONC		-1000.			
LOAD	3	41	51		1			STD	UNIF		455.		455.	
LOAD	3	61	51		1			STD	UNIF		455.		455.	
LOAD	4	47	57		1			STD	UNIF		-455.		-455.	
LOAD	4	67	57		1			STD	UNIF		-455.		-455.	

DEAD, BUOYANT AND VIRTUAL WEIGHT LOADINGS DATA

CARD TYPE	DEAD LONG NO	BUOY LONG NO	LONG NO	C	DIRECTION ANGLE/X	ANGLE/XY	VIRTUAL WEIGHT LOADINGS LONG NO	C	DIRECTION ANGLE/X	ANGLE/XY	LONG NO	C	DIRECTION ANGLE/X	ANGLE/XY	PERCENT DSP WTR (100)	DYNAMIC WGHT NOS FOR JOINT MASSES M11	M22	M33
****	****	****	****	*	******	******	****	*	******	******	****	*	******	******	*****	****	****	****
DBVW	10																	

SUMMARY OF DRVW LOADINGS

GROUP NO	DEAD LONG KIPS	BUOY LONG KIPS	VIRTUAL WEIGHT LOADINGS (KIPS) 1	2	3
1	2.13				
2	1.81				
3	3.63				
11	5.03				
13	5.03				
100	1.44				
TOTAL	19.08				

LOAD COMBINING DATA

CARD TYPE	LOADCN NUMBER	LONG	PERCT	LONG	PERCT	LONG	PERCT	LONG	PERCT	LONG	PERCT	LONG	PERCT	LONG	PERCT	LONG	PERCT	LONG	PERCT
****	****	***	*****	***	*****	***	*****	***	*****	***	*****	***	*****	***	*****	***	*****	***	*****
COMB	1	1		2															
COMB	2	1		2		10													
COMB	3	3		4		10													

LOADING NUMBER AND PERCENT OF LOADING TO BE APPLIED (BLANK MEANS 100 PERCENT)

LOAD CONDITION TITLE DATA

CARD TYPE	LOADCN NUMBER	DESCRIPTION OF LOAD CONDITION
****	****	**
LDCN	1	1000. KIPS LOAD (CONCENT.)
LDCN	2	1000. KIPS LOAD (CONCENT.) & DEAD LOAD
LDCN	3	1000. KIPS LOAD (UNIFORM.) & DEAD LOAD

1 LOAD CONDITION 1 1000. KIPS LOAD (CONCENT.)

LOADING NUMBER	LOADING PERCENT	DESCRIPTION
1	100.0	1000 KIPS AT LEFT SIDE
2	100.0	1000 KIPS AT RIGHT SIDE

NUMBER OF LOADINGS 2
MOMENTS WITH RESPECT TO POINT (X= 12.00 Y= 0.0 Z= 0.0)

LOADING	SHEAR (KIP)				VERTICAL	MOMENT (FT-KIP)				TORQUE
NUMBER	X	Y	VECTOR	ANGLE	KIP	X	Y	OVERTURN	ANGLE	FT-KIP
1	1000.0	0.0	1000.0	0.0	0.0	0.	5400.	5400.	90.0	0.
2	-1000.0	0.0	1000.0	180.0	0.0	0.	-5400.	5400.	-90.0	0.
TOTAL	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.0	0.

2 LOAD CONDITION 2 1000. KIPS LOAD (CONCENT.) & DEAD LOAD

LOADING NUMBER	LOADING PERCENT	DESCRIPTION
1	100.0	1000 KIPS AT LEFT SIDE
2	100.0	1000 KIPS AT RIGHT SIDE
10	100.0	GENERATED DEAD LOADS ON NON-ELIMINATED STRUCTURE MEMBERS

NUMBER OF LOADINGS 3
MOMENTS WITH RESPECT TO POINT (X= 12.00 Y= 0.0 Z= 0.0)

LOADING	SHEAR (KIP)				VERTICAL	MOMENT (FT-KIP)				TORQUE
NUMBER	X	Y	VECTOR	ANGLE	KIP	X	Y	OVERTURN	ANGLE	FT-KIP
1	1000.0	0.0	1000.0	0.0	0.0	0.	5400.	5400.	90.0	0.
2	-1000.0	0.0	1000.0	180.0	0.0	0.	-5400.	5400.	-90.0	0.
10	0.0	0.0	0.0	0.0	-19.1	0.	0.	0.	0.0	0.
TOTAL	0.0	0.0	0.0	0.0	-19.1	0.	0.	0.	0.0	0.

3 LOAD CONDITION 3 1000. KIPS LOAD (UNIFORM.) & DEAD LOAD

LOADING NUMBER	LOADING PERCENT	DESCRIPTION
3	100.0	1000 KIPS AT LEFT SIDE (UNIFORM)
4	100.0	1000 KIPS AT RIGHT SIDE (UNIFORM)
10	100.0	GENERATED DEAD LOADS ON NON-ELIMINATED STRUCTURE MEMBERS

NUMBER OF LOADINGS 3
MOMENTS WITH RESPECT TO POINT (X= 12.00 Y= 0.0 Z= 0.0)

LOADING	SHEAR (KIP)				VERTICAL	MOMENT (FT-KIP)				TORQUE
NUMBER	X	Y	VECTOR	ANGLE	KIP	X	Y	OVERTURN	ANGLE	FT-KIP
3	1001.0	0.0	1001.0	0.0	0.0	0.	5405.	5405.	90.0	0.
4	-1001.0	0.0	1001.0	180.0	0.0	0.	-5405.	5405.	-90.0	0.
10	0.0	0.0	0.0	0.0	-19.1	0.	0.	0.	0.0	0.
TOTAL	0.0	0.0	0.0	0.0	-19.1	0.	0.	0.	0.0	0.

SUMMARY OF LOADINGS AND LOAD CONDITIONS

MOMENTS WITH RESPECT TO POINT (X= 12.00 Y= 0.0 Z= 0.0)

		SHEAR (KIP)				VERTICAL	MOMENT (FT-KIP)				TORQUE
		X	Y	VECTOR	ANGLE	KIP	X	Y	OVERTURN	ANGLE	FT-KIP
LOADNG											
1		1000.0	0.0	1000.0	0.0	0.0	0.	5400.	5400.	90.0	0.
2		-1000.0	0.0	1000.0	180.0	0.0	0.	-5400.	5400.	-90.0	0.
3		1001.0	0.0	1001.0	0.0	0.0	0.	5405.	5405.	90.0	0.
4		-1001.0	0.0	1001.0	180.0	0.0	0.	-5405.	5405.	-90.0	0.
10		0.0	0.0	0.0	0.0	-19.1	0.	0.	0.	0.0	0.
LOADCN											
1	1	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.0	0.
2	2	0.0	0.0	0.0	0.0	-19.1	0.	0.	0.	0.0	0.
3	3	0.0	0.0	0.0	0.0	-19.1	0.	0.	0.	0.0	0.

0 DIAGNOSTIC MESSAGES WERE PRINTED, (ISTOP= 0 CONDITION CODE = 6)

FORCE .GT. 0.0 KIPS MOMENT .GT. 0.0 INCH-KIPS

LOAD CONDITION NUMBER	JOINT NUMBER	FORCE (KIPS) X	FORCE (KIPS) Y	FORCE (KIPS) Z	MOMENT (INCH-KIPS) X	MOMENT (INCH-KIPS) Y	MOMENT (INCH-KIPS) Z
1	11	-0.00	0.0	0.00	0.0	-0.00	0.0
1	12	-0.00	0.0	-0.00	0.0	0.0	0.0
1	13	-0.00	0.0	0.00	0.0	0.00	0.0
1	14	0.00	0.0	-0.00	0.0	-0.00	0.0
1	15	-0.00	0.0	-0.00	0.0	0.00	0.0
1	16	0.00	0.0	-0.00	0.0	0.00	0.0
1	17	0.00	0.0	0.00	0.0	0.00	0.0
1	21	-0.00	0.0	-0.00	0.0	-0.00	0.0
1	27	-0.00	0.0	-0.00	0.0	0.00	0.0
1	41	0.00	0.0	0.00	0.0	0.00	0.0
1	47	0.00	0.0	-0.00	0.0	0.00	0.0
1	51	0.00	0.0	-0.00	0.0	-0.00	0.0
1	57	-0.00	0.0	0.00	0.0	0.00	0.0
1	61	0.00	0.0	-0.00	0.0	0.00	0.0
1	67	-0.00	0.0	0.00	0.0	0.00	0.0
1	91	-0.00	0.0	-0.00	0.0	0.00	0.0
1	92	0.00	0.0	-0.00	0.0	0.00	0.0
1	93	-0.00	0.0	0.00	0.0	0.00	0.0
1	94	0.00	0.0	0.00	0.0	-0.00	0.0
1	95	-0.00	0.0	-0.00	0.0	-0.00	0.0
1	96	-0.00	0.0	-0.00	0.0	0.00	0.0
1	97	0.00	0.0	0.00	0.0	0.00	0.0
2	11	-0.00	0.0	0.00	0.0	-0.00	0.0
2	12	-0.00	0.0	-0.00	0.0	0.00	0.0
2	13	-0.00	0.0	0.00	0.0	0.00	0.0
2	14	0.00	0.0	-0.00	0.0	-0.00	0.0
2	15	0.00	0.0	-0.00	0.0	0.00	0.0
2	16	0.00	0.0	0.00	0.0	-0.00	0.0
2	17	0.00	0.0	-0.00	0.0	0.00	0.0
2	21	0.00	0.0	-0.00	0.0	-0.00	0.0
2	27	-0.00	0.0	-0.00	0.0	0.00	0.0
2	41	0.00	0.0	0.00	0.0	0.00	0.0
2	47	0.00	0.0	-0.00	0.0	0.00	0.0
2	51	0.00	0.0	-0.00	0.0	-0.00	0.0
2	57	0.00	0.0	0.00	0.0	0.00	0.0
2	61	0.00	0.0	-0.00	0.0	0.00	0.0
2	67	-0.00	0.0	0.00	0.0	0.00	0.0
2	91	-0.00	0.0	-0.00	0.0	0.00	0.0
2	92	-0.00	0.0	-0.00	0.0	0.00	0.0
2	93	0.00	0.0	0.00	0.0	0.00	0.0
2	94	-0.00	0.0	0.00	0.0	-0.00	0.0
2	95	0.00	0.0	-0.00	0.0	-0.00	0.0
2	96	-0.00	0.0	-0.00	0.0	0.00	0.0

FORCE .GT. 0.0 KIPS MOMENT .GT. 0.0 INCH-KIPS

LOAD CONDITION NUMBER	JOINT NUMBER	F O R C E %KIPS< X	Y	Z	M O M E N T %INCH-KIPS< X	Y	Z
2	97	-0.00	0.0	0.00	0.0	0.00	0.0
3	11	-0.00	0.0	0.00	0.0	-0.00	0.0
3	12	-0.00	0.0	-0.00	0.0	-0.00	0.0
3	13	-0.00	0.0	0.00	0.0	0.00	0.0
3	14	0.00	0.0	-0.00	0.0	-0.00	0.0
3	15	0.00	0.0	-0.00	0.0	0.00	0.0
3	16	0.00	0.0	0.00	0.0	0.00	0.0
3	17	0.00	0.0	-0.00	0.0	0.00	0.0
3	21	0.00	0.0	-0.00	0.0	-0.00	0.0
3	27	-0.00	0.0	-0.00	0.0	0.00	0.0
3	41	0.00	0.0	0.00	0.0	0.00	0.0
3	47	0.00	0.0	-0.00	0.0	0.00	0.0
3	51	0.00	0.0	-0.00	0.0	-0.00	0.0
3	57	-0.00	0.0	0.00	0.0	0.00	0.0
3	61	0.00	0.0	-0.00	0.0	0.00	0.0
3	67	-0.00	0.0	0.00	0.0	-0.00	0.0
3	91	-0.00	0.0	-0.00	0.0	0.00	0.0
3	92	-0.00	0.0	-0.00	0.0	0.00	0.0
3	93	0.00	0.0	0.00	0.0	0.00	0.0
3	94	0.00	0.0	-0.00	0.0	-0.00	0.0
3	95	-0.00	0.0	0.00	0.0	-0.00	0.0
3	96	0.00	0.0	-0.00	0.0	0.00	0.0
3	97	-0.00	0.0	0.00	0.0	0.00	0.0

JOINT NUMBER	DEFLECTION %INCHES< X	Y	Z	ROTATION %RADIANS< X	Y	Z	REMARKS
11	0.024	0.0	0.038	0.0	0.000597	0.0	
12	0.018	0.0	0.022	0.0	0.000455	0.0	
13	0.009	0.0	0.005	0.0	0.000227	0.0	
14	0.000	0.0	-0.000	0.0	0.000000	0.0	
15	-0.009	0.0	0.005	0.0	-0.000227	0.0	
16	-0.018	0.0	0.022	0.0	-0.000455	0.0	
17	-0.024	0.0	0.038	0.0	-0.000597	0.0	
21	0.035	0.0	0.038	0.0	0.000494	0.0	
27	-0.035	0.0	0.038	0.0	-0.000494	0.0	
41	0.046	0.0	0.038	0.0	0.000093	0.0	
47	-0.046	0.0	0.038	0.0	-0.000093	0.0	
51	0.046	0.0	0.038	0.0	0.000017	0.0	
57	-0.046	0.0	0.038	0.0	-0.000017	0.0	
61	0.046	0.0	0.038	0.0	-0.000054	0.0	
67	-0.046	0.0	0.038	0.0	0.000054	0.0	
91	0.035	0.0	0.038	0.0	-0.000485	0.0	
92	0.027	0.0	0.050	0.0	-0.000369	0.0	
93	0.013	0.0	0.064	0.0	-0.000185	0.0	
94	0.000	0.0	0.066	0.0	0.000000	0.0	
95	-0.013	0.0	0.064	0.0	0.000185	0.0	
96	-0.027	0.0	0.050	0.0	0.000369	0.0	
97	-0.035	0.0	0.038	0.0	0.000485	0.0	
140	0.0	0.0	0.0	0.0	0.0	0.0	

JOINT DEFLECTIONS AND ROTATIONS LOAD CONDITION NUMBER 1

JOINT NUMBER	DEFLECTION %INCHES< X	Y	Z	ROTATION %RADIANS< X	Y	Z	REMARKS
11	0.024	0.0	0.024	0.0	0.000575	0.0	
12	0.019	0.0	0.010	0.0	0.000335	0.0	
13	0.009	0.0	0.001	0.0	0.000060	0.0	
14	0.000	0.0	-0.000	0.0	0.000000	0.0	
15	-0.009	0.0	0.001	0.0	-0.000080	0.0	
16	-0.019	0.0	0.010	0.0	-0.000335	0.0	
17	-0.024	0.0	0.024	0.0	-0.000575	0.0	
21	0.035	0.0	0.024	0.0	0.000464	0.0	
27	-0.035	0.0	0.024	0.0	-0.000464	0.0	
41	0.045	0.0	0.024	0.0	0.000092	0.0	
47	-0.045	0.0	0.024	0.0	-0.000092	0.0	
51	0.046	0.0	0.024	0.0	0.000017	0.0	
57	-0.046	0.0	0.024	0.0	-0.000017	0.0	
61	0.046	0.0	0.024	0.0	-0.000054	0.0	
67	-0.046	0.0	0.024	0.0	0.000054	0.0	
91	0.035	0.0	0.024	0.0	-0.000477	0.0	
92	0.027	0.0	0.036	0.0	-0.000346	0.0	
93	0.013	0.0	0.048	0.0	-0.000163	0.0	
94	0.000	0.0	0.052	0.0	0.000000	0.0	
95	-0.013	0.0	0.048	0.0	0.000163	0.0	
96	-0.027	0.0	0.036	0.0	0.000346	0.0	
97	-0.035	0.0	0.024	0.0	0.000477	0.0	
140	0.0	0.0	0.0	0.0	0.0	0.0	

JOINT NUMBER	DEFLECTION %INCHES< X	Y	Z	ROTATION %RADIANS< X	Y	Z	REMARKS
11	0.024	0.0	0.024	0.0	0.000572	0.0	
12	0.019	0.0	0.010	0.0	0.000334	0.0	
13	0.009	0.0	0.001	0.0	0.000079	0.0	
14	0.000	0.0	-0.000	0.0	0.000000	0.0	
15	-0.009	0.0	0.001	0.0	-0.000079	0.0	
16	-0.019	0.0	0.010	0.0	-0.000334	0.0	
17	-0.024	0.0	0.024	0.0	-0.000572	0.0	
21	0.035	0.0	0.024	0.0	0.000461	0.0	
27	-0.035	0.0	0.024	0.0	-0.000461	0.0	
41	0.045	0.0	0.024	0.0	0.000089	0.0	
47	-0.045	0.0	0.024	0.0	-0.000089	0.0	
51	0.046	0.0	0.024	0.0	0.000018	0.0	
57	-0.046	0.0	0.024	0.0	-0.000018	0.0	
61	0.046	0.0	0.024	0.0	-0.000050	0.0	
67	-0.046	0.0	0.024	0.0	0.000050	0.0	
91	0.035	0.0	0.024	0.0	-0.000474	0.0	
92	0.027	0.0	0.036	0.0	-0.000343	0.0	
93	0.013	0.0	0.046	0.0	-0.000162	0.0	
94	0.000	0.0	0.052	0.0	0.000000	0.0	
95	-0.013	0.0	0.048	0.0	0.000162	0.0	
96	-0.027	0.0	0.036	0.0	0.000343	0.0	
97	-0.035	0.0	0.024	0.0	0.000474	0.0	
140	0.0	0.0	0.0	0.0	0.0	0.0	

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CARD TYPE	PILE GROUP NO.	NO. OF PILES	REACTIONS AT FIRST JOINT	SECOND JOINT	MOVED TO THIRD JOINT	PILE IDEN
****	**	**	******	******	******	******
SUPT	1	1			140	C

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LOAD COND NO.	DEFLECTIONS INCHES AXIAL	DX OR DZ	DY	VECTOR	ANGLE	TORSIONAL	ROTATIONS RADIANS RX OR RZ	RY	VECTOR	ANGLE	AXIS SYSTEM
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

SUPPORT DEFLECTIONS AND ROTATIONS PILE C THIRD JOINT NUMBER 146 PAGE 8

LOAD COND NO.	AXIAL FORCE KIPS	SHEAR FORCE KIPS FX OR FZ	FY	VECTOR	ANGLE	EST. KS KIPS/IN	TORSIONAL MOMENT IN-KIPS	BENDING MOMENT INCH-KIPS MX OR MZ	MY	VECTOR	ANGLE	EST. KM IN-K/RAD
1	0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	0.0
2	19.1	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	0.0
3	19.1	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	0.0

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SUPPORT REACTIONS PILE C THIRD JOINT NUMBER 140 PAGE 9

PILE IDEN	THIRD JOINT NUMBER	AXIAL FORCE KIPS	SHEAR FORCE KIPS FX OR FZ	FY	VECTOR	ANGLE	EST. KS KIPS/IN	TORSIONAL MOMENT IN-KIPS	BENDING MOMENT INCH-KIPS MX OR MZ	MY	VECTOR	ANGLE	EST. KR IN-K/RAD
C	140	0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	0.0
TOTALS		0.0	-0.0	0.0	0.0		0.0	0.0	0.0	-0.0	0.0		0.0
AVERAGE		0.0	-0.0	0.0	0.0		0.0	0.0	0.0	-0.0	0.0		0.0

PILE IDEN	THIRD JOINT NUMBER	AXIAL FORCE KIPS	SHEAR FORCE KIPS FX OR FZ	FY	VECTOR	ANGLE	EST. KS KIPS/IN	TORSIONAL MOMENT IN-KIPS	BENDING MOMENT INCH-KIPS MX OR MZ	MY	VECTOR	ANGLE	EST. KM IN-K/RAD
C	140	19.1	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	0.0
TOTALS		19.1	-0.0	0.0	0.0		0.0	0.0	0.0	-0.0	0.0		0.0
AVERAGE		19.1	-0.0	0.0	0.0		0.0	0.0	0.0	-0.0	0.0		0.0

PILE IDEN	THIRD JOINT NUMBER	AXIAL FORCE KIPS	SHEAR FORCE KIPS FX OR FZ	FY	VECTOR	ANGLE	EST. KS KIPS/IN	TORSIONAL MOMENT IN-KIPS	BENDING MOMENT INCH-KIPS MX OR MZ	MY	VECTOR	ANGLE	EST. KR IN-K/RAD
C	140	19.1	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	0.0
TOTALS		19.1	-0.0	0.0	0.0		0.0	0.0	0.0	-0.0	0.0		0.0
AVERAGE		19.1	-0.0	0.0	0.0		0.0	0.0	0.0	-0.0	0.0		0.0

SUPPORT REACTIONS LOAD CONDITION 3

LOAD COND NO	JOINT NUMBER	FORCES KIPS FX	FY	FZ	MOMENTS INCH-KIPS MX	MY	MZ	REMARKS
1	11	0.0	0.0	0.0	0.0	0.0	0.0	
1	17	0.0	0.0	0.0	0.0	0.0	0.0	
1	51	0.0	0.0	0.0	0.0	0.0	0.0	
1	57	0.0	0.0	0.0	0.0	0.0	0.0	
1	140	-0.0	0.0	0.0	0.0	-0.0	0.0	
2	11	0.0	0.0	0.0	0.0	0.0	0.0	
2	17	0.0	0.0	0.0	0.0	0.0	0.0	
2	51	0.0	0.0	0.0	0.0	0.0	0.0	
2	57	0.0	-0.0	0.0	0.0	0.0	0.0	
2	140	-0.0	0.0	19.1	0.0	-0.0	0.0	
3	11	0.0	0.0	0.0	0.0	0.0	0.0	
3	17	0.0	0.0	0.0	0.0	0.0	0.0	
3	51	0.0	0.0	0.0	0.0	0.0	0.0	
3	57	0.0	0.0	0.0	0.0	0.0	0.0	
3	140	-0.0	0.0	19.1	0.0	-0.0	0.0	

LOAD COND NO	VERTICAL FORCE KIPS	S H E A R F O R C E KIPS FX	FY	VECTOR	ANGLE DEG
1	0.0	-0.0	0.0	0.0	180.0
2	19.1	-0.0	0.0	0.0	180.0
3	19.1	-0.0	0.0	0.0	180.0

SUMMATION OF REACTIONS - STANDARD AXIS SYSTEM

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CARD                 PERCENTAGE OF YIELD STRESS TO BE USED FOR EACH LOAD CONDITION
TYPE     1     2     3
oooo  ooooo ooooo ooooo ooooo ooooo ooooo ooooo ooooo ooooo ooooo ooooo ooooo ooooo ooooo ooooo

STRS   60.   60.   60.
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80

GROUP NO	MEMBER JOINTS LOW	MEMBER JOINTS HIGH	LOAD COND NO	DIST FT	FORCES (KIPS) AXIAL FX	FORCES (KIPS) SHEAR FY	FORCES (KIPS) SHEAR FZ	MOMENTS (IN-KIPS) TORSIONAL MX	MOMENTS (IN-KIPS) BENDING MY	MOMENTS (IN-KIPS) BENDING MZ	STRESSES (KSI) AXIAL X	STRESSES (KSI) BENDING Y	STRESSES (KSI) BENDING Z	STRESSES (KSI) COMBINED
1	11	21	1	0.0	-0.00	-406.92	0.0	0.0	0.0	-486.0	0.00	0.0	0.59	0.59
				0.8	-0.00	-406.92	0.0	0.0	0.0	3416.5	0.00	0.0	4.10	4.10
				1.6	-0.00	-406.92	0.0	0.0	0.0	7324.9	0.00	0.0	5.79	8.79
1	11	21	2	0.0	6.30	-409.97	0.0	0.0	0.0	-919.4	-0.08	0.0	-1.10	-1.19
				0.8	6.10	-409.97	0.0	0.0	0.0	3016.3	-0.08	0.0	-3.62	-3.70
				1.6	5.90	-409.97	0.0	0.0	0.0	6952.0	-0.09	0.0	-8.34	-8.42
1	11	21	3	0.0	6.30	-410.39	0.0	0.0	0.0	-917.6	-0.08	0.0	-1.10	-1.19
				0.8	6.10	-410.39	0.0	0.0	0.0	3022.2	-0.08	0.0	-3.63	-3.71
				1.6	5.90	-410.39	0.0	0.0	0.0	6961.9	-0.08	0.0	-8.36	-8.43
1	17	27	1	0.0	0.00	406.92	0.0	0.0	0.0	486.0	-0.00	0.0	-0.59	-0.59
				0.8	0.00	406.92	0.0	0.0	0.0	-3416.5	-0.00	0.0	-4.10	-4.10
				1.6	0.00	406.92	0.0	0.0	0.0	-7324.9	-0.00	0.0	-8.79	-8.79
1	17	27	2	0.0	6.30	409.97	0.0	0.0	0.0	919.4	-0.08	0.0	-1.10	-1.19
				0.8	6.10	409.97	0.0	0.0	0.0	-3016.3	-0.08	0.0	-3.62	-3.70
				1.6	5.90	409.97	0.0	0.0	0.0	-6952.0	-0.09	0.0	-8.34	-8.42
1	17	27	3	0.0	6.30	410.39	0.0	0.0	0.0	917.6	-0.08	0.0	-1.10	-1.19
				0.8	6.10	410.39	0.0	0.0	0.0	-3022.2	-0.08	0.0	-3.63	-3.71
				1.6	5.90	410.39	0.0	0.0	0.0	-6961.9	-0.08	0.0	-8.36	-8.43
1	61	91	1	0.0	-0.00	593.08	0.0	0.0	0.0	18051.9	0.00	0.0	21.67	21.67
				1.3	-0.00	593.08	0.0	0.0	0.0	8799.9	0.00	0.0	10.56	10.56
				2.6	-0.00	593.08	0.0	0.0	0.0	-452.1	0.00	0.0	0.54	0.54
1	61	91	2	0.0	3.17	590.03	0.0	0.0	0.0	17854.3	-0.04	0.0	-21.43	-21.46
				1.3	2.85	590.03	0.0	0.0	0.0	8653.8	-0.04	0.0	-10.39	-10.42
				2.6	2.52	590.03	0.0	0.0	0.0	-548.6	-0.03	0.0	-0.66	-0.69
1	61	91	3	0.0	3.17	590.61	0.0	0.0	0.0	17879.7	-0.04	0.0	-21.46	-21.50
				1.3	2.85	590.61	0.0	0.0	0.0	8666.2	-0.04	0.0	-10.40	-10.44
				2.6	2.52	590.61	0.0	0.0	0.0	-547.3	-0.03	0.0	-0.66	-0.69
1	67	97	1	0.0	0.00	-593.08	0.0	0.0	0.0	-18051.9	-0.00	0.0	-21.67	-21.67
				1.3	0.00	-593.08	0.0	0.0	0.0	-8799.9	-0.00	0.0	-10.56	-10.56
				2.6	0.00	-593.08	0.0	0.0	0.0	452.1	-0.00	0.0	-0.54	-0.54
1	67	97	2	0.0	3.17	-590.03	0.0	0.0	0.0	-17854.3	-0.04	0.0	-21.43	-21.46
				1.3	2.85	-590.03	0.0	0.0	0.0	-8653.8	-0.04	0.0	-10.39	-10.42
				2.6	2.52	-590.03	0.0	0.0	0.0	548.6	-0.03	0.0	-0.66	-0.69
1	67	97	3	0.0	3.17	-590.61	0.0	0.0	0.0	-17879.7	-0.04	0.0	-21.46	-21.50
				1.3	2.85	-590.61	0.0	0.0	0.0	-8666.2	-0.04	0.0	-10.40	-10.44
				2.6	2.52	-590.61	0.0	0.0	0.0	547.3	-0.03	0.0	-0.66	-0.69
2	21	41	1	0.0	-0.00	-406.92	0.0	0.0	0.0	7324.9	0.00	0.0	5.18	5.18
				1.3	-0.00	-406.92	0.0	0.0	0.0	13917.1	0.00	0.0	9.84	9.84
				2.7	-0.00	-406.92	0.0	0.0	0.0	20509.2	0.00	0.0	14.50	14.50
2	21	41	2	0.0	5.90	-409.97	0.0	0.0	0.0	6952.0	-0.06	0.0	-4.92	-4.98
				1.3	5.44	-409.97	0.0	0.0	0.0	13593.5	-0.06	0.0	-9.61	-9.67
				2.7	4.99	-409.97	0.0	0.0	0.0	20235.1	-0.05	0.0	-14.31	-14.36
2	21	41	3	0.0	5.90	-410.39	0.0	0.0	0.0	6961.9	-0.06	0.0	-4.92	-4.98
				1.3	5.44	-410.39	0.0	0.0	0.0	13610.2	-0.06	0.0	-9.63	-9.68

GROUP NO	MEMBER JOINTS LOW	HIGH	LOAD COND NO	DIST FT	FORCES (KIPS) AXIAL FX	SHEAR FY	SHEAR FZ	MOMENTS (IN-KIPS) TORSIONAL MX	BENDING MY	BENDING MZ	STRESSES (KSI) AXIAL X	BENDING Y	BENDING Z	COMBINED
2	21	41	3	2.7	4.99	-410.39	0.0	0.0	0.0	20258.6	-0.05	0.0	-14.33	-14.38
2	27	47	1	0.0	0.00	406.92	0.0	0.0	0.0	-7324.9	-0.00	0.0	-5.18	-5.18
				1.3	0.00	406.92	0.0	0.0	0.0	-13917.1	-0.00	0.0	-9.84	-9.84
				2.7	0.00	406.92	0.0	0.0	0.0	-20509.2	-0.00	0.0	-14.50	-14.50
2	27	47	2	0.0	5.90	409.97	0.0	0.0	0.0	-6952.0	-0.06	0.0	-4.92	-4.98
				1.3	5.44	409.97	0.0	0.0	0.0	-13594.5	-0.06	0.0	-9.61	-9.67
				2.7	4.99	409.97	0.0	0.0	0.0	-20235.1	-0.05	0.0	-14.31	-14.36
2	27	47	3	0.0	5.90	410.39	0.0	0.0	0.0	-6961.9	-0.06	0.0	-4.92	-4.98
				1.3	5.44	410.39	0.0	0.0	0.0	-13610.2	-0.06	0.0	-9.63	-9.66
				2.7	4.99	410.39	0.0	0.0	0.0	-20258.6	-0.05	0.0	-14.33	-14.38
3	41	51	1	0.0	-0.00	-406.92	0.0	0.0	0.0	20509.2	0.00	0.0	5.18	5.18
				0.6	-0.00	-406.92	0.0	0.0	0.0	23194.9	0.00	0.0	5.86	5.86
				1.1	-0.00	-406.92	0.0	0.0	0.0	25880.6	0.00	0.0	6.54	6.54
3	41	51	2	0.0	4.99	-409.97	0.0	0.0	0.0	20235.1	-0.02	0.0	-5.11	-5.13
				0.6	4.54	-409.97	0.0	0.0	0.0	22940.9	-0.02	0.0	-5.80	-5.82
				1.1	4.08	-409.97	0.0	0.0	0.0	25646.7	-0.02	0.0	-6.48	-6.50
3	41	51	3	0.0	4.99	-410.39	0.0	0.0	0.0	20258.6	-0.02	0.0	-5.12	-5.14
				0.6	4.54	-160.14	0.0	0.0	0.0	22141.3	-0.02	0.0	-5.60	-5.61
				1.1	4.08	90.11	0.0	0.0	0.0	22372.4	-0.02	0.0	-5.65	-5.67
3	47	57	1	0.0	0.00	406.92	0.0	0.0	0.0	-20509.2	-0.00	0.0	-5.18	-5.18
				0.6	0.00	406.92	0.0	0.0	0.0	-23194.9	-0.00	0.0	-5.86	-5.86
				1.1	0.00	406.92	0.0	0.0	0.0	-25880.6	-0.00	0.0	-6.54	-6.54
3	47	57	2	0.0	4.99	409.97	0.0	0.0	0.0	-20235.1	-0.02	0.0	-5.11	-5.13
				0.6	4.54	409.97	0.0	0.0	0.0	-22940.9	-0.02	0.0	-5.80	-5.82
				1.1	4.08	409.97	0.0	0.0	0.0	-25646.7	-0.02	0.0	-6.48	-6.50
3	47	57	3	0.0	4.99	410.39	0.0	0.0	0.0	-20258.6	-0.02	0.0	-5.12	-5.14
				0.6	4.54	160.14	0.0	0.0	0.0	-22141.3	-0.02	0.0	-5.60	-5.61
				1.1	4.08	-90.11	0.0	0.0	0.0	-22372.4	-0.02	0.0	-5.65	-5.67
3	51	61	1	0.0	-0.00	593.08	0.0	0.0	0.0	25880.6	0.00	0.0	6.54	6.54
				0.6	-0.00	593.08	0.0	0.0	0.0	21966.3	0.00	0.0	5.55	5.55
				1.1	-0.00	593.08	0.0	0.0	0.0	18052.0	0.00	0.0	4.56	4.56
3	51	61	2	0.0	4.08	590.03	0.0	0.0	0.0	25646.7	-0.02	0.0	-6.48	-6.50
				0.6	3.63	590.03	0.0	0.0	0.0	21752.5	-0.01	0.0	-5.50	-5.51
				1.1	3.17	590.03	0.0	0.0	0.0	17858.3	-0.01	0.0	-4.51	-4.53
3	51	61	3	0.0	4.08	90.11	0.0	0.0	0.0	22372.4	-0.02	0.0	-5.65	-5.67
				0.6	3.63	340.36	0.0	0.0	0.0	20051.9	-0.01	0.0	-5.29	-5.31
				1.1	3.17	590.61	0.0	0.0	0.0	17879.7	-0.01	0.0	-4.52	-4.53
3	57	67	1	0.0	0.00	-593.09	0.0	0.0	0.0	-25880.6	-0.00	0.0	-6.54	-6.54
				0.6	0.00	-593.09	0.0	0.0	0.0	-21966.3	-0.00	0.0	-5.55	-5.55
				1.1	0.00	-593.08	0.0	0.0	0.0	-18052.0	-0.00	0.0	-4.56	-4.56
3	57	67	2	0.0	4.08	-590.03	0.0	0.0	0.0	-25646.7	-0.02	0.0	-6.48	-6.50
				0.6	3.63	-590.03	0.0	0.0	0.0	-21752.5	-0.01	0.0	-5.50	-5.51
				1.1	3.17	-590.03	0.0	0.0	0.0	-17858.3	-0.01	0.0	-4.51	-4.53
3	57	67	3	0.0	4.08	-90.11	0.0	0.0	0.0	-22372.4	-0.02	0.0	-5.65	-5.67

GROUP NO	MEMBER JOINTS LOW	MEMBER JOINTS HIGH	LOAD COND NO	DIST FT	FORCES (KIPS) AXIAL FX	SHEAR FY	SHEAR FZ	MOMENTS (IN-KIPS) TORSIONAL MX	BENDING MY	BENDING MZ	STRESSES (KSI) AXIAL X	BENDING Y	BENDING Z	COMBINED
3	57	67	3	0.6	3.63	-340.34	0.0	0.0	0.0	-20951.9	-0.01	0.0	-5.29	-5.31
				1.1	3.17	-590.61	0.0	0.0	0.0	-17679.7	-0.01	0.0	-4.52	-4.53
11	11	12	1	0.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
				1.3	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
				2.5	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
11	11	12	2	0.0	409.97	0.0	-6.30	0.0	919.4	0.0	-5.82	-2.28	0.0	-8.10
				1.3	409.97	0.0	-6.60	0.0	820.6	0.0	-5.82	-2.04	0.0	-7.86
				2.5	409.97	0.0	-6.90	0.0	721.4	0.0	-5.82	-1.79	0.0	-7.61
11	11	12	3	0.0	410.39	0.0	-6.30	0.0	917.6	0.0	-5.83	-2.27	0.0	-8.10
				1.3	410.39	0.0	-6.60	0.0	820.8	0.0	-5.83	-2.03	0.0	-7.86
				2.5	410.39	0.0	-6.90	0.0	719.6	0.0	-5.83	-1.78	0.0	-7.61
11	12	13	1	0.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
				2.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
				4.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
11	12	13	2	0.0	409.97	0.0	-6.90	0.0	721.4	0.0	-5.82	-1.79	0.0	-7.61
				2.0	409.97	0.0	-7.38	0.0	550.0	0.0	-5.82	-1.36	0.0	-7.19
				4.0	409.97	0.0	-7.86	0.0	367.1	0.0	-5.82	-0.91	0.0	-6.73
11	12	13	3	0.0	410.39	0.0	-6.90	0.0	719.6	0.0	-5.83	-1.78	0.0	-7.61
				2.0	410.39	0.0	-7.38	0.0	548.2	0.0	-5.83	-1.36	0.0	-7.19
				4.0	410.39	0.0	-7.86	0.0	365.3	0.0	-5.83	-0.90	0.0	-6.73
11	13	14	1	0.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
				2.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
				4.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
11	13	14	2	0.0	409.97	0.0	-7.86	0.0	367.1	0.0	-5.82	-0.91	0.0	-6.73
				2.0	409.97	0.0	-8.34	0.0	172.8	0.0	-5.82	-0.43	0.0	-6.25
				4.0	409.97	0.0	-8.82	0.0	-33.1	0.0	-5.82	-0.08	0.0	-5.91
11	13	14	3	0.0	410.39	0.0	-7.86	0.0	365.3	0.0	-5.83	-0.90	0.0	-6.73
				2.0	410.39	0.0	-8.34	0.0	171.0	0.0	-5.83	-0.42	0.0	-6.25
				4.0	410.39	0.0	-8.82	0.0	-34.9	0.0	-5.83	-0.09	0.0	-5.92
11	14	15	1	0.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
				2.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
				4.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
11	14	15	2	0.0	409.97	0.0	8.82	0.0	-33.1	0.0	-5.82	-0.08	0.0	-5.91
				2.0	409.97	0.0	8.34	0.0	172.8	0.0	-5.82	-0.43	0.0	-6.25
				4.0	409.97	0.0	7.86	0.0	367.1	0.0	-5.82	-0.91	0.0	-6.73
11	14	15	3	0.0	410.39	0.0	8.82	0.0	-34.9	0.0	-5.83	-0.09	0.0	-5.92
				2.0	410.39	0.0	8.34	0.0	171.0	0.0	-5.83	-0.42	0.0	-6.25
				4.0	410.39	0.0	7.86	0.0	365.3	0.0	-5.63	-0.90	0.0	-6.73
11	15	16	1	0.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
				2.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.79	-1.21	0.0	-6.99
				4.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.79	-1.21	0.0	-6.99
11	15	16	2	0.0	409.97	0.0	7.86	0.0	367.1	0.0	-5.82	-0.91	0.0	-6.73
				2.0	409.97	0.0	7.38	0.0	550.0	0.0	-5.82	-1.36	0.0	-7.19
				4.0	409.97	0.0	6.90	0.0	721.4	0.0	-5.82	-1.79	0.0	-7.61

GROUP NO	MEMBER JOINTS LOW	MEMBER JOINTS HIGH	LOAD COND NO	DIST FT	FORCES (KIPS) AXIAL FX	SHEAR FY	SHEAR FZ	MOMENTS (IN-KIPS) TORSIONAL MX	BENDING MY	BENDING MZ	STRESSES (KSI) AXIAL X	BENDING Y	Z	COMBINED
11	15	16	3	0.0	410.39	0.0	7.86	0.0	365.3	0.0	-5.83	-0.90	0.0	-6.73
				2.0	410.39	0.0	7.38	0.0	546.2	0.0	-5.83	-1.36	0.0	-7.19
				4.0	410.39	0.0	6.90	0.0	719.6	0.0	-5.83	-1.78	0.0	-7.61
11	16	17	1	0.0	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
				1.3	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
				2.5	406.92	0.0	0.00	0.0	488.0	0.0	-5.78	-1.21	0.0	-6.99
11	16	17	2	0.0	409.97	0.0	6.90	0.0	721.4	0.0	-5.82	-1.79	0.0	-7.61
				1.3	409.97	0.0	6.60	0.0	822.6	0.0	-5.82	-2.04	0.0	-7.86
				2.5	409.97	0.0	6.30	0.0	919.4	0.0	-5.82	-2.28	0.0	-8.10
11	16	17	3	0.0	410.39	0.0	6.90	0.0	719.6	0.0	-5.83	-1.78	0.0	-7.61
				1.3	410.39	0.0	6.60	0.0	820.8	0.0	-5.83	-2.03	0.0	-7.86
				2.5	410.39	0.0	6.30	0.0	917.6	0.0	-5.83	-2.27	0.0	-8.10
13	91	92	1	0.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				1.3	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				2.5	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
13	91	92	2	0.0	590.03	0.0	2.52	0.0	-550.6	0.0	-8.38	-1.95	0.0	-10.34
				1.3	590.03	0.0	2.22	0.0	-515.1	0.0	-8.38	-1.83	0.0	-10.21
				2.5	590.03	0.0	1.92	0.0	-484.2	0.0	-8.38	-1.72	0.0	-10.10
13	91	92	3	0.0	590.61	0.0	2.52	0.0	-547.3	0.0	-8.39	-1.94	0.0	-10.33
				1.3	590.61	0.0	2.22	0.0	-511.8	0.0	-8.39	-1.82	0.0	-10.21
				2.5	590.61	0.0	1.92	0.0	-480.8	0.0	-8.39	-1.71	0.0	-10.10
13	92	93	1	0.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				2.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				4.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
13	92	93	2	0.0	590.03	0.0	1.92	0.0	-484.2	0.0	-8.38	-1.72	0.0	-10.10
				2.0	590.03	0.0	1.44	0.0	-443.9	0.0	-8.38	-1.58	0.0	-9.96
				4.0	590.03	0.0	0.96	0.0	-415.2	0.0	-8.38	-1.47	0.0	-9.86
13	92	93	3	0.0	590.61	0.0	1.92	0.0	-480.8	0.0	-8.39	-1.71	0.0	-10.10
				2.0	590.61	0.0	1.44	0.0	-440.6	0.0	-8.39	-1.56	0.0	-9.95
				4.0	590.61	0.0	0.96	0.0	-411.8	0.0	-8.39	-1.46	0.0	-9.85
13	93	94	1	0.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				2.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				4.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
13	93	94	2	0.0	590.03	0.0	0.96	0.0	-415.2	0.0	-8.38	-1.47	0.0	-9.86
				2.0	590.03	0.0	0.48	0.0	-397.9	0.0	-8.38	-1.41	0.0	-9.79
				4.0	590.03	0.0	-0.00	0.0	-392.2	0.0	-8.38	-1.39	0.0	-9.77
13	93	94	3	0.0	590.61	0.0	0.96	0.0	-411.8	0.0	-8.39	-1.46	0.0	-9.85
				2.0	590.61	0.0	0.48	0.0	-394.6	0.0	-8.39	-1.40	0.0	-9.79
				4.0	590.61	0.0	-0.00	0.0	-388.8	0.0	-8.39	-1.38	0.0	-9.77
13	94	95	1	0.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				2.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				4.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
13	94	95	2	0.0	590.03	0.0	-0.00	0.0	-392.2	0.0	-8.38	-1.39	0.0	-9.77
				2.0	590.03	0.0	-0.48	0.0	-397.9	0.0	-8.38	-1.41	0.0	-9.79

GROUP	MEMBER JOINTS		LOAD COND	DIST	F O R C E S %KIPS<			M O M E N T S %IN-KIPS<			S T R E S S E S %KSI<			
NO	LOW	HIGH	NO	FT	AXIAL FX	SHEAR FY	SHEAR FZ	TORSIONAL MX	BENDING MY	BENDING MZ	AXIAL X	BENDING Y	BENDING Z	COMBINED
13	94	95	2	4.0	590.03	0.0	-0.96	0.0	-415.2	0.0	-8.38	-1.47	0.0	-9.86
13	94	95	3	0.0	590.61	0.0	-0.00	0.0	-388.8	0.0	-8.39	-1.38	0.0	-9.77
				2.0	590.61	0.0	-0.48	0.0	-394.5	0.0	-8.39	-1.40	0.0	-9.79
				4.0	590.61	0.0	-0.96	0.0	-411.8	0.0	-8.39	-1.46	0.0	-9.85
13	95	96	1	0.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				2.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				4.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
13	95	96	2	0.0	590.03	0.0	-0.96	0.0	-415.2	0.0	-8.38	-1.47	0.0	-9.86
				2.0	590.03	0.0	-1.44	0.0	-443.9	0.0	-8.38	-1.58	0.0	-9.96
				4.0	590.03	0.0	-1.92	0.0	-484.2	0.0	-8.38	-1.72	0.0	-10.10
13	95	96	3	0.0	590.61	0.0	-0.96	0.0	-411.8	0.0	-8.39	-1.46	0.0	-9.85
				2.0	590.61	0.0	-1.44	0.0	-440.5	0.0	-8.39	-1.56	0.0	-9.95
				4.0	590.61	0.0	-1.92	0.0	-480.8	0.0	-8.39	-1.71	0.0	-10.10
13	96	97	1	0.0	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				1.3	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
				2.5	593.08	0.0	-0.00	0.0	-452.0	0.0	-8.42	-1.60	0.0	-10.03
13	96	97	2	0.0	590.03	0.0	-1.92	0.0	-484.2	0.0	-8.38	-1.72	0.0	-10.10
				1.3	590.03	0.0	-2.22	0.0	-515.1	0.0	-8.38	-1.83	0.0	-10.21
				2.5	590.03	0.0	-2.52	0.0	-550.6	0.0	-8.38	-1.95	0.0	-10.34
13	96	97	3	0.0	590.61	0.0	-1.92	0.0	-480.8	0.0	-8.39	-1.71	0.0	-10.10
				1.3	590.61	0.0	-2.22	0.0	-511.8	0.0	-8.39	-1.82	0.0	-10.21
				2.5	590.61	0.0	-2.52	0.0	-547.3	0.0	-8.39	-1.94	0.0	-10.33
100	14	140	1	0.0	0.00	-0.00	0.0	0.0	0.0	0.0	-0.00	0.0	-0.00	-0.00
				1.0	0.00	-0.00	0.0	0.0	0.0	0.0	-0.00	0.0	-0.00	-0.00
100	14	140	2	0.0	17.63	-0.00	0.0	0.0	0.0	0.0	-0.04	0.0	-0.00	-0.04
				1.0	19.08	-0.00	0.0	0.0	0.0	0.0	-0.04	0.0	-0.00	-0.04
100	14	140	3	0.0	17.63	-0.00	0.0	0.0	0.0	0.0	-0.04	0.0	-0.00	-0.04
				1.0	19.08	-0.00	0.0	0.0	0.0	0.0	-0.04	0.0	-0.00	-0.04

0 DIAGNOSTIC MESSAGES WERE PRINTED IN THE FIRST PART OF POST PROCESSOR

APPENDIX C

TABULATION OF STATIC STRESSES

Load (Kips)	Gage 2 Gage Reading	Gage 2 Net Strain	Gage 3 Gage Reading	Gage 3 Net Strain	Gage 4 Gage Reading	Gage 4 Net Strain
0	0	0	0	0	0	0
50	-31	-31	-10	-10	-57	-57
100	-60	-60	-20	-20	-108	-108
153	-84	-84	-29	-29	-165	-165
201	-108	-108	-38	-38	-214	-214
302.4	-164	-164	-58	-58	-320	-320
400	-218	-218	-76	-76	-426	-426
After Break Zero (430 Kips)	+10	+10	+14	+14	+6	+6
500	-280	-290	-94	-108	-524	-530
600	-315	-325	-72	-86	-549	-555
700	-370	-380	-97	-111	-602	-608
800	-434	-444	-133	-147	-673	-679
900	-480	-490	-156	-170	-746	-752
980	-522	-532	-188	-202	-846	-852
Stress for 1000 Kips	-16.29ksi		-6.18 ksi		-26.08 ksi	

Basic Strain Gage Readings and Stress for 1000 Kips

Load (kips)	Gage 5 Gage Reading	Gage 5 Net Strain	Gage 7 Gage Reading	Gage 7 Net Strain	Gage 8 Gage Reading	Gage 8 Net Strain
0	0	0	0	0	0	0
50	-27	-27	-9	-9	0	0
100	-54	-54	-14	-14	-20	-20
153	-91	-91	-20	-20	-24	-24
201	-115	-115	-23	-23	-34	-34
302.4	-173	-173	-31	-31	-61	-61
400	-223	-223	-41	-41	-86	-86
Zero After Break (430 Kips)	+36	+36	+6	+6	+8	+8
500	-268	-304	-48	-54	-110	-118
600	-325	-361	-37	-43	-100	-108
700	-356	-392	-47	-53	-126	-134
800	-380	-416	-56	-62	-162	-170
900	-448	-484	-61	-67	-192	-200
980	-478	-514	-63	-69	-230	-238
Stress for 1000 Kips	-15.73 ksi		-2.11 ksi		-7.29 ksi	

Basic Strain Gage Readings and Stress for 1000 Kips

Load (Kips)	Gage 9 Gage Reading	Gage 9 Net Strain	Gage 10 Gage Reading	Gage 10 Net Strain	Gage 11 Gage Reading	Gage 11 Net Strain
0	0	0	0	0	0	0
50	+18	+18	-24	-24	-20	-20
100	+46	+46	-65	-65	-44	-44
153	+73	+73	-86	-86	-69	-69
201	+88	+88	-110	-110	-90	-90
302.4	+130	+130	-167	-167	-141	-141
400	+167	+167	-225	-225	-193	-193
Zero After Break (430 Kips)	-60	-60	0	0	+8	+8
500	+198	+258	-281	-281	-249	-257
600	+198	+258	-288	-288	-264	-272
700	+242	+302	-330	-330	-322	-330
800	+290	+350	-376	-376	-389	-397
900	+346	+406	-418	-418	-465	-473
980	+403	+463	-459	-459	-539	-547
Stress for 1000 Kips	Gages 9 and 10 are a Two-Element Rosette---computed shear stress from gage readings 10.85 ksi				-16.74 ksi	

Basic Strain Gage Readings and Stress for 1000 Kips

Load (Kips)	Gage 12 Gage Reading	Gage 12 Net Strain	Gage 19 Gage Reading	Gage 19 Net Strain
0	-18448	0	+5100	0
50	-17848	+600	+5100	0
100	-17950	+498	+5098	-2
153	-17973	+475	+5095	-5
201	-17980	+468	+5090	-10
302.4	-17690	+758	+5090	-10
400	-18090	+358	+5090	-10
Zero After Break (430 Kips)	-17964	+484	+5122	+22
500	-18082	-118	+5090	-10
600	-17751	+213	+5070	-30
700	-17742	+222	+5068	-32
800	-17762	+202	+5060	-40
900	-17773	+191	+5052	-48
980	-17773	+191	+5042	-58
Stress for 1000 Kips	+5.73 ksi		-1.74 ksi	

Basic Strain Gage Readings and Stress for 1000 Kips

Load (Kips)	Gage 13 Gage Reading	Gage 13 Net Strain	Gage 14 Gage Reading	Gage 14 Net Strain	Gage 15 Gage Reading	Gage 15 Net Strain
0	+1520	0	0	0	-70	0
50	+1509	-11	+7	+7	-74	-4
100	+1509	-11	+18	+18	-56	-14
153	+1496	-24	+25	+25	-59	-11
201	+1488	-32	+38	+38	-51	-19
302.4	+1479	-41	+42	+42	-52	-18
400	+1474	-46	+68	+68	-52	-18
Zero After Break (430 Kips)	+1536	+16	+10	+10	-50	+20
500	+1458	-78	+70	+60	-48	-2
600	+1442	-94	+95	+85	-44	-6
700	+1424	-112	+90	+80	-50	0
800	+1417	-119	+94	+84	-57	-7
900	+1410	-126	+96	+86	-50	0
980	+1410	-126	+104	+94	-52	-2

Stress for 1000 Kips

Gages 13, 14, and 15 are a Three-Element Rosette.
Minimum principal stress: -8.0 ksi
Maximum principal stress: +0.6 ksi

Basic Strain Gage Readings and Stress for 1000 Kips

Load (Kips)	Gage 16 Gage Reading	Gage 16 Net Strain	Gage 17 Gage Reading	Gage 17 Net Strain	Gage 18 Gage Reading	Gage 18 Net Strain
0	0	0	0	0	0	0
50	-13	-13	-3	-3	+7	+7
100	-30	-30	+3	+3	+17	+17
153	-52	-52	-9	-9	+28	+28
201	-69	-69	-7	-7	+44	+44
302.4	-115	-115	-14	-14	+68	+68
400	-150	-150	-11	-11	+86	+86
Zero After Break (430 Kips)	+8	+8	+17	+17	-9	-9
500	-183	-191	-18	-35	+88	+97
600	-234	-242	-20	-37	+126	+135
700	-268	-276	-28	-45	+142	+151
800	-294	-302	-36	-53	+176	+185
900	-322	-330	-40	-57	+201	+210
980	-358	-366	-42	-59	+240	+249

Stress for 1000 Kips

Gages 16, 17, and 18 are the three elements of a rosette.
Minimum principal stress: -8.8 ksi
Maximum principal stress: +7.8 ksi

Basic Strain Gage Readings and Stress for 1000 Kips

Load (Kips)	Gage 22 Gage Reading	Gage 22 Net Strain	Gage 23 Gage Reading	Gage 23 Net Strain	Gage 24 Gage Reading	Gage 24 Net Strain
0	0	0	-2500	0	+1700	0
50	-23	-23	-2503	-3	+1685	-15
100	-33	-33	-2455	-45	+1681	-19
153	-26	-26	-2493	-7	+1660	-40
201	-33	-33	-2487	-13	+1650	-50
302.4	-55	-55	-2487	-13	+1650	-50
400	-70	-70	-2472	-28	+1602	-98
Zero After Break (430 Kips)	+16	+16	-2508	+8	+1690	-10
500	-78	-94	-2473	-35	+1574	-116
600	-110	-126	-2458	-50	+1520	-170
700	-120	-136	-2447	-61	+1486	-204
800	-130	-146	-2450	-58	+1450	-204
900	-145	-161	-2447	-61	+1410	-280
980	-153	-169	-2447	-61	+1363	-327

Stress for 1000 Kips: Gages 22, 23, and 24 are the three elements of a rosette.
Minimum principal stress: -26.0 ksi
Maximum principal stress: -8.0 ksi

Basic Strain Gage Readings and Stress for 1000 Kips

Load (Kips)	Gage 21 Gage Reading	Gage 21 Net Strain	Gage 27 Gage Reading	Gage 27 Net Strain	Gage 34 Gage Reading	Gage 34 Net Strain
0	-2700	0	+500	0	-100	0
50	-2723	-23	+473	-27	-115	-15
100	-2734	-35	+444	-56	-133	-33
153	-2746	-46	+403	-97	-148	-48
201	-2757	-57	+368	-132	-164	-64
302.4	-2793	-93	+308	-192	-190	-90
400	-2820	-120	+240	-260	-213	-113
Zero After Break (430 Kips)	-2697	+3	+500	0	-104	-4
500	-2838	-141	+141	-319	-240	-136
600	-2885	-188	+95	-405	-263	-159
700	-2915	-218	+36	-464	-277	-173
800	-2948	-251	-50	-550	-310	-206
900	-2974	-277	-120	-620	-352	-248
980	-3000	-3-3	-200	-700	-342	-238
Stress for 1000 Kips	-9.28 ksi		-21.4 ksi		-7.29 ksi	

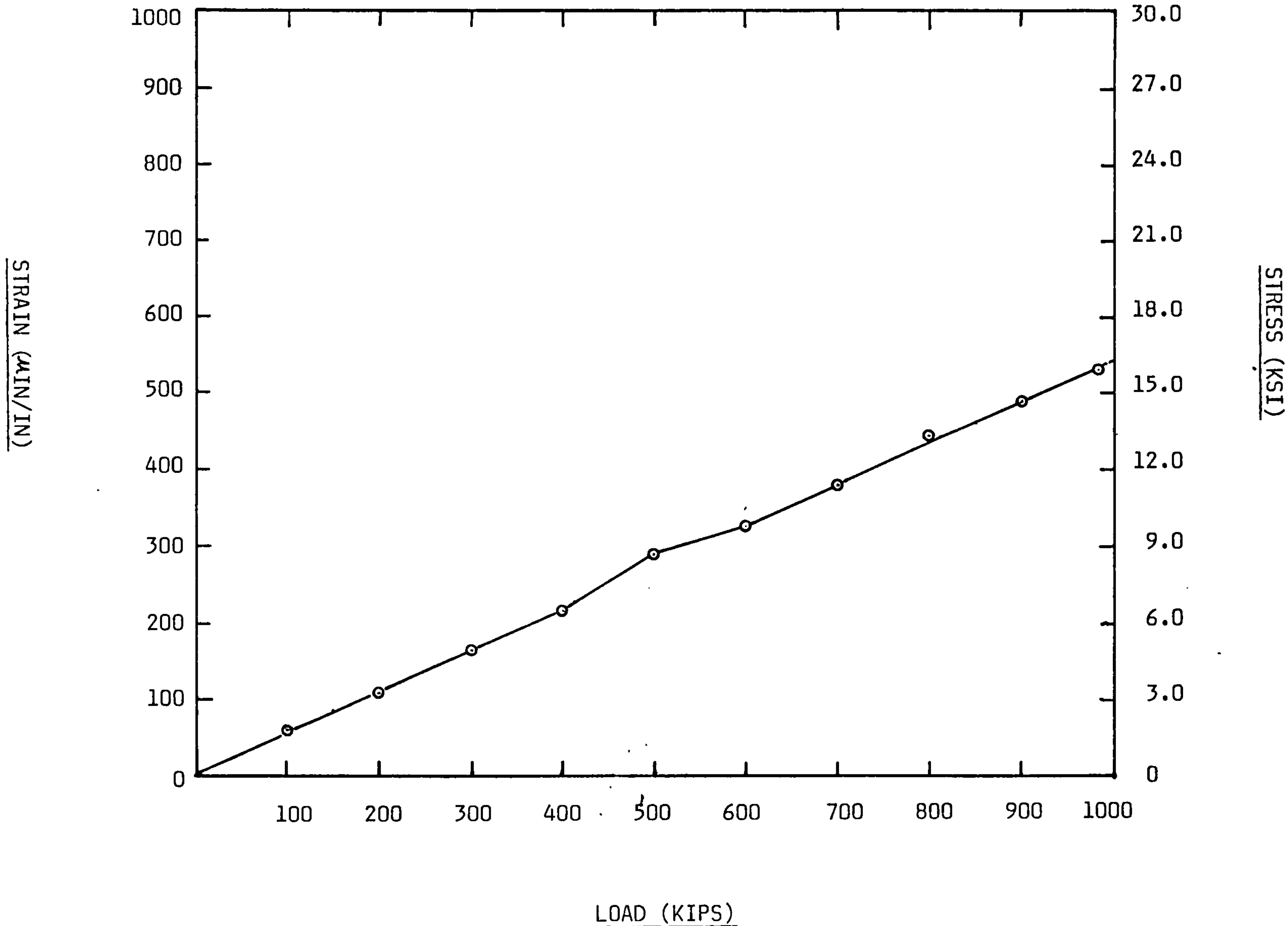
Basic Strain Gage Readings and Stress for 1000 Kips

	Gage 25		Gage 26		Gage 32	
Load (Kips)	Gage Reading	Net Strain	Gage Reading	Net Strain	Gage Reading	Net Strain
0	-600	0	0	0	+1000	0
50	-617	-17	0	0	+993	-7
100	-623	-23	-20	-20	+988	-12
153	-625	-25	-16	-16	+986	-14
201	-642	-42	-26	-26	+977	-23
302.4	-668	-68	-32	-32	+958	-42
400	-693	-93	-33	-33	+936	-64
Zero After Break (430 Kips)	-587	-13	-21	-21	+920	-80
500	-713	-126	-45	-24	+833	-87
600	-770	-183	-67	-46	+804	-116
700	-803	-216	-75	-54	+777	-143
800	-847	-260	-82	-61	+760	-160
900	-891	-304	-87	-66	+734	-286
980	-935	-348	-100	-79	+705	-215
Stress for 1000 Kips	-10.65 ksi		-2.42 ksi		-6.58 ksi	

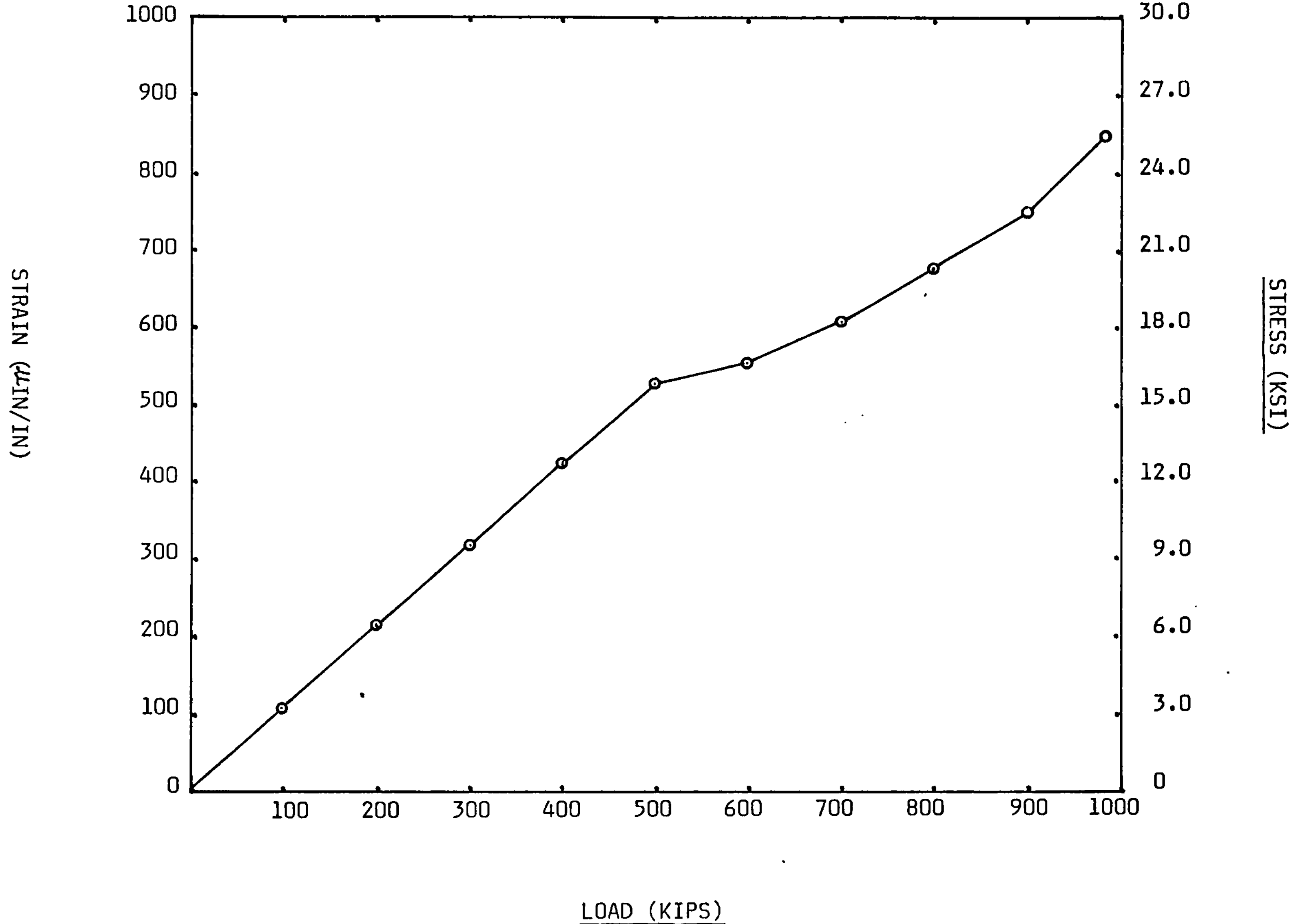
Basic Strain Gage Readings and Stress for 1000 Kips

APPENDIX D

STRESS VERSUS LOAD CURVES

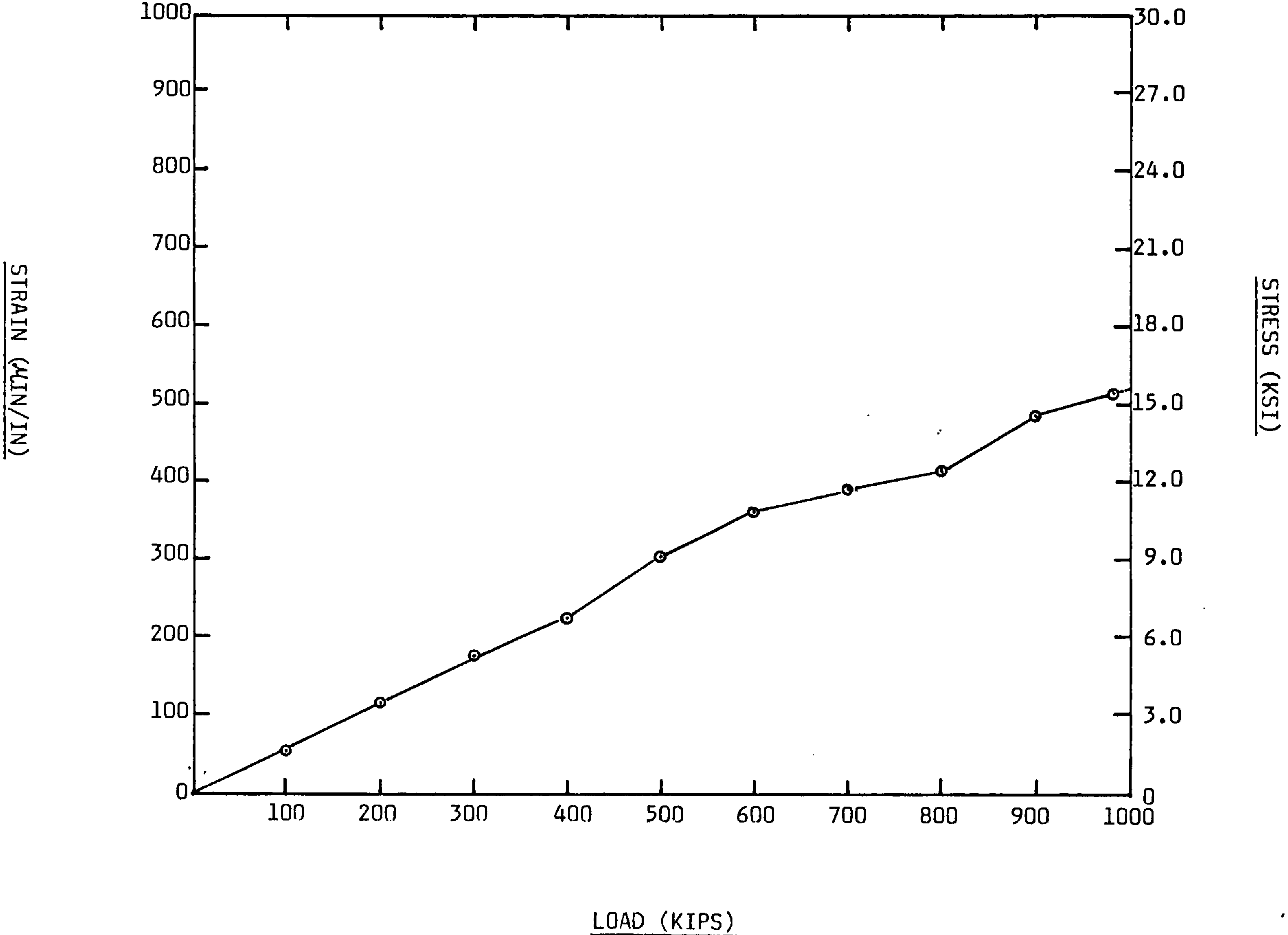

STRAIN (µIN/IN)
0
100
200
300
400
500
600
700
800
900
1000
STRESS (KSI)
0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
27.0
30.0
100
200
300
400
500
600
700
800
900
1000
LOAD (KIPS)

GAGE NO. 2

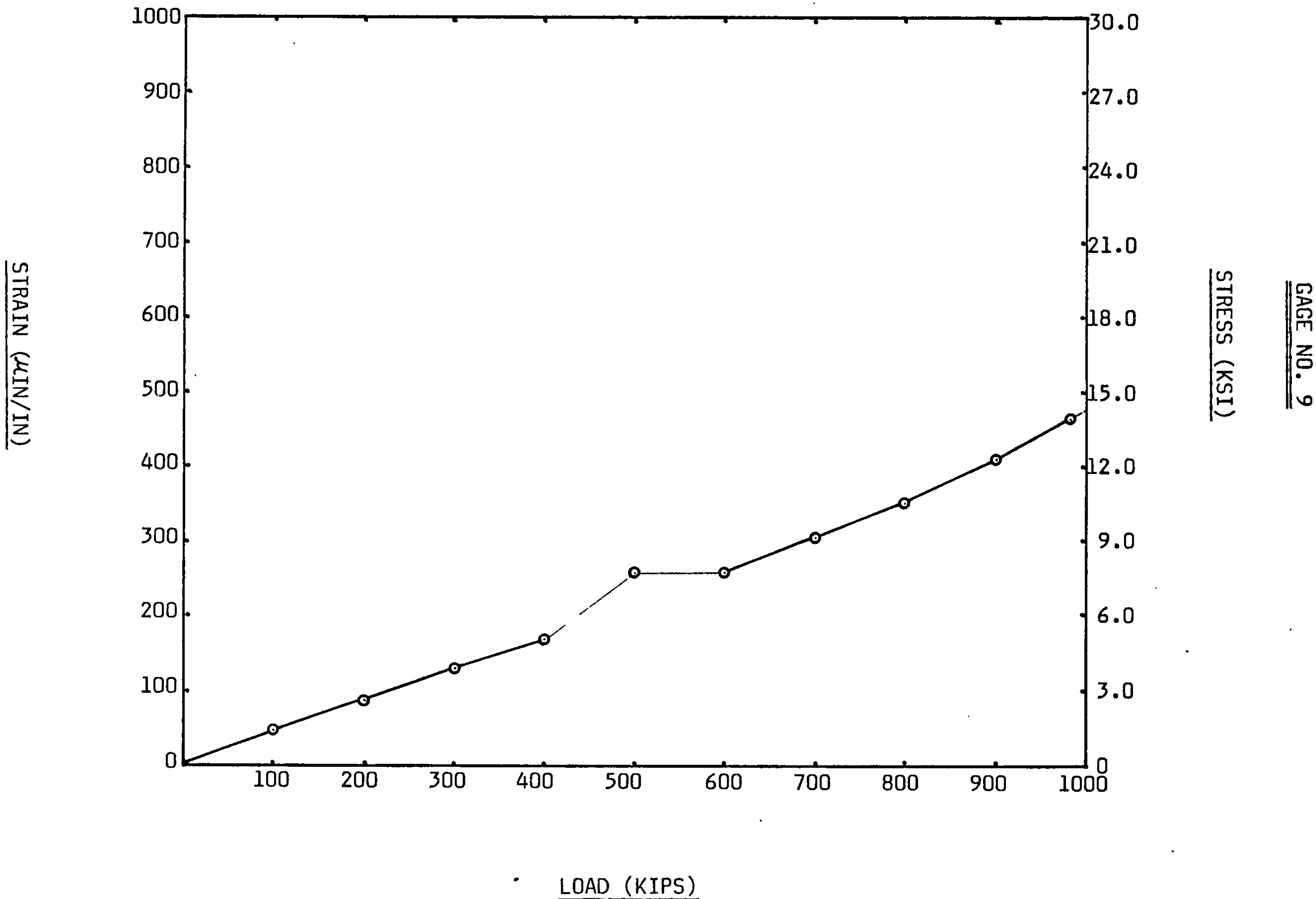


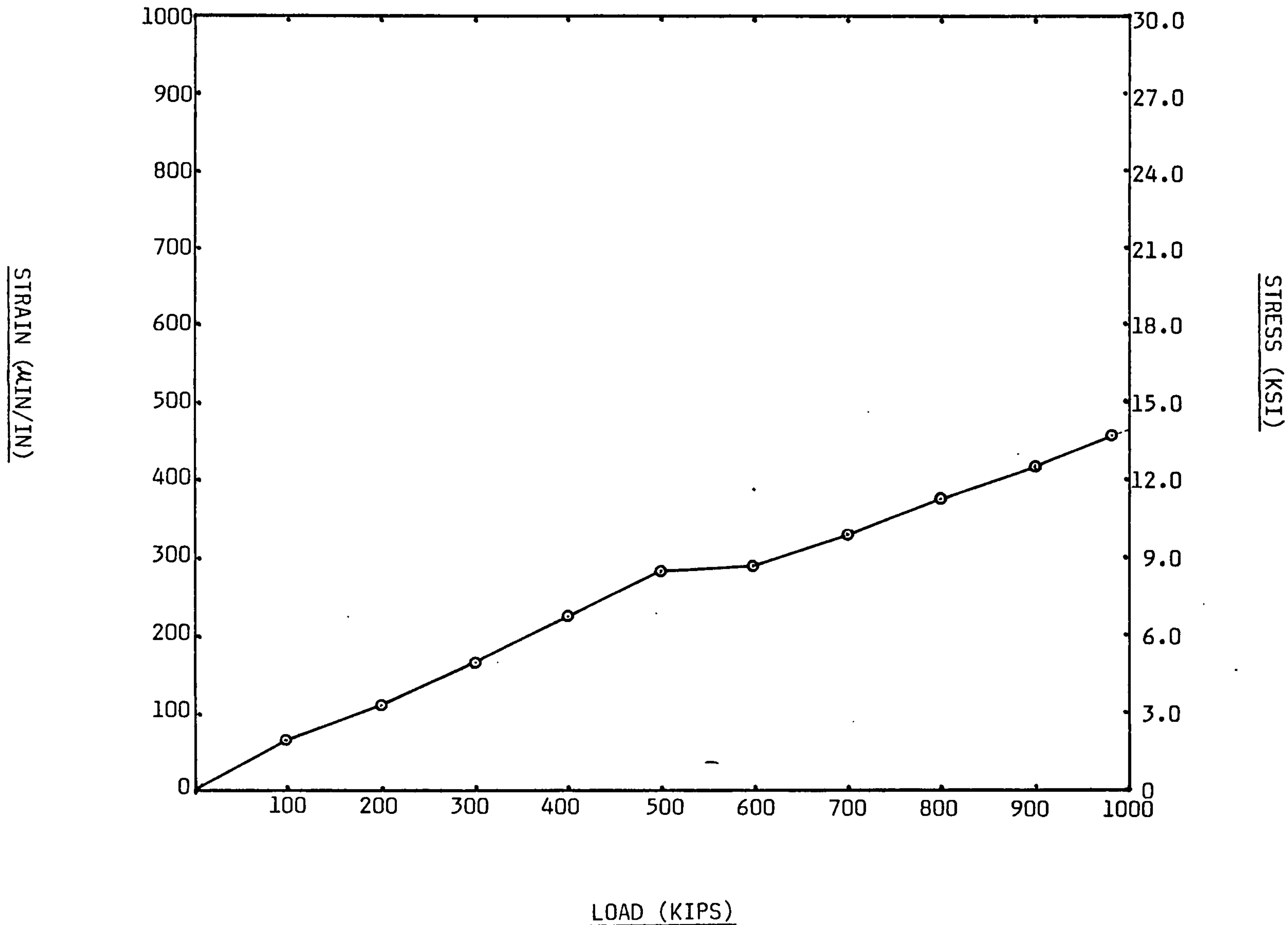
1000
900
800
700
600
500
400
300
200
100
0
STRAIN (μIN/IN)
100
200
300
400
500
600
700
800
900
1000
LOAD (KIPS)
30.0
27.0
24.0
21.0
18.0
15.0
12.0
9.0
6.0
3.0
0
STRESS (KSI)

GAGE NO. 4

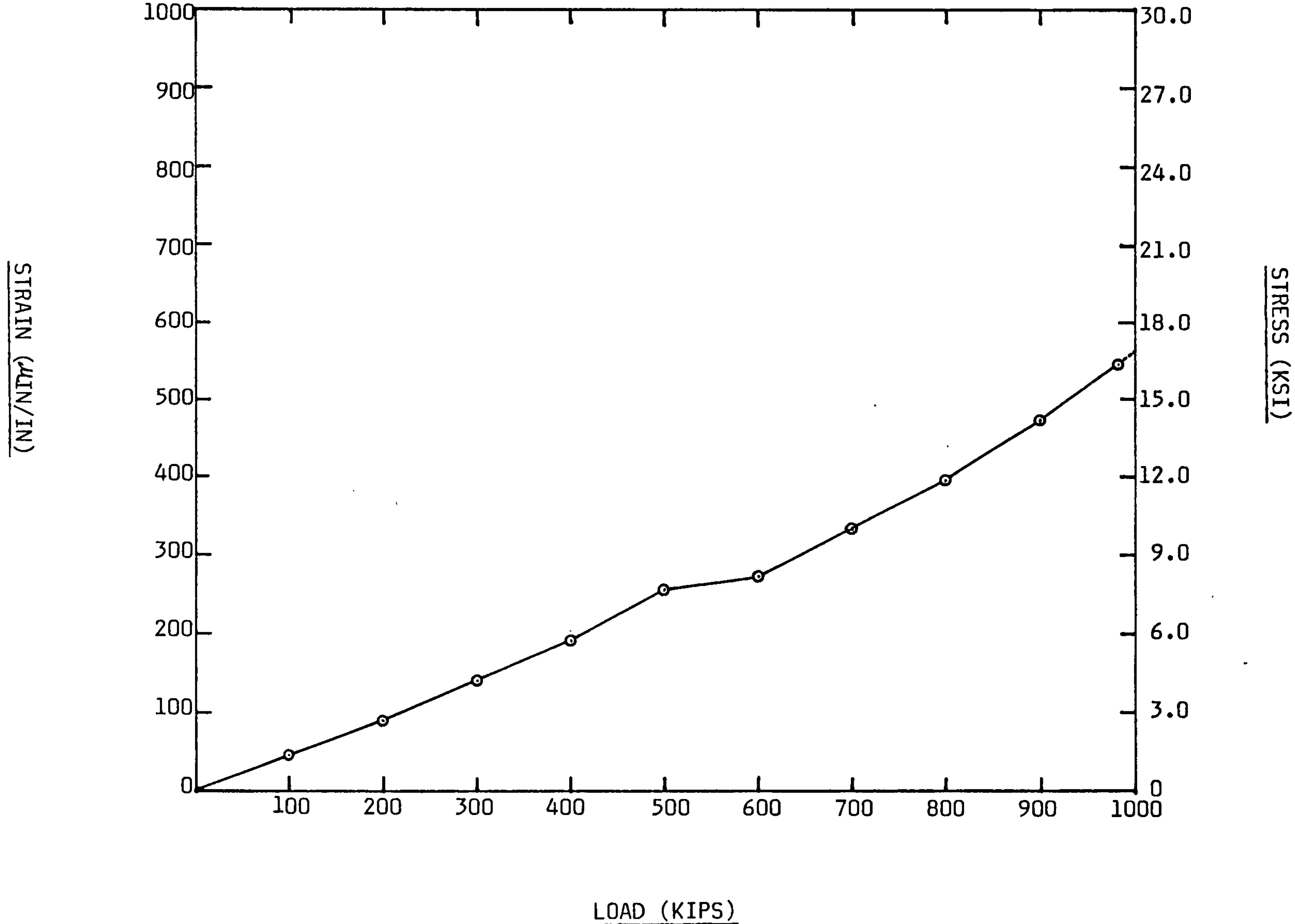

STRAIN (μIN/IN)
1000
900
800
700
600
500
400
300
200
100
0
STRESS (KSI)
30.0
27.0
24.0
21.0
18.0
15.0
12.0
9.0
6.0
3.0
0
100
200
300
400
500
600
700
800
900
1000
LOAD (KIPS)

GAGE NO. 5

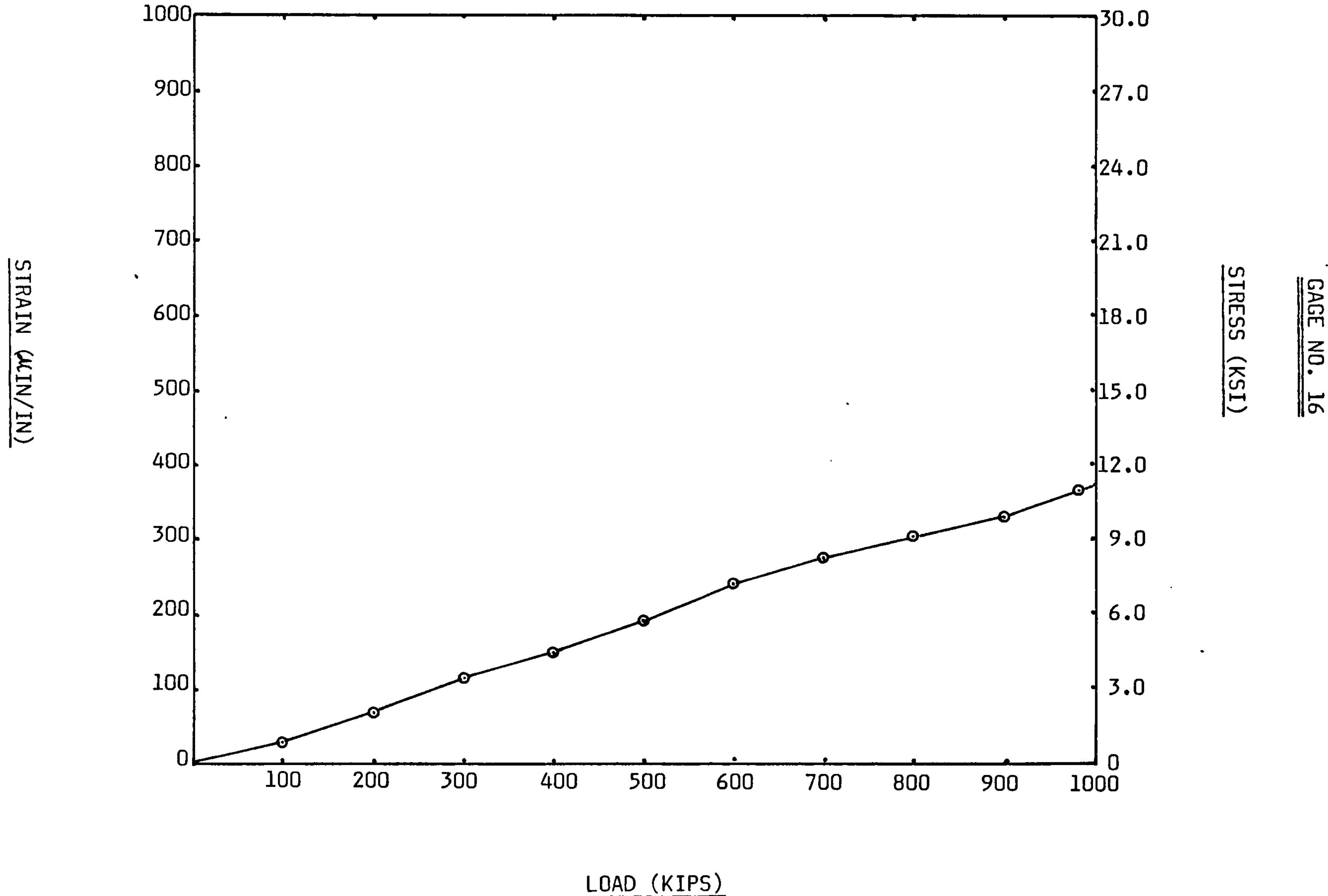

STRAIN (μIN/IN)
STRESS (KSI)
GAGE NO. 9
LOAD (KIPS)
0
100
200
300
400
500
600
700
800
900
1000
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
27.0
30.0

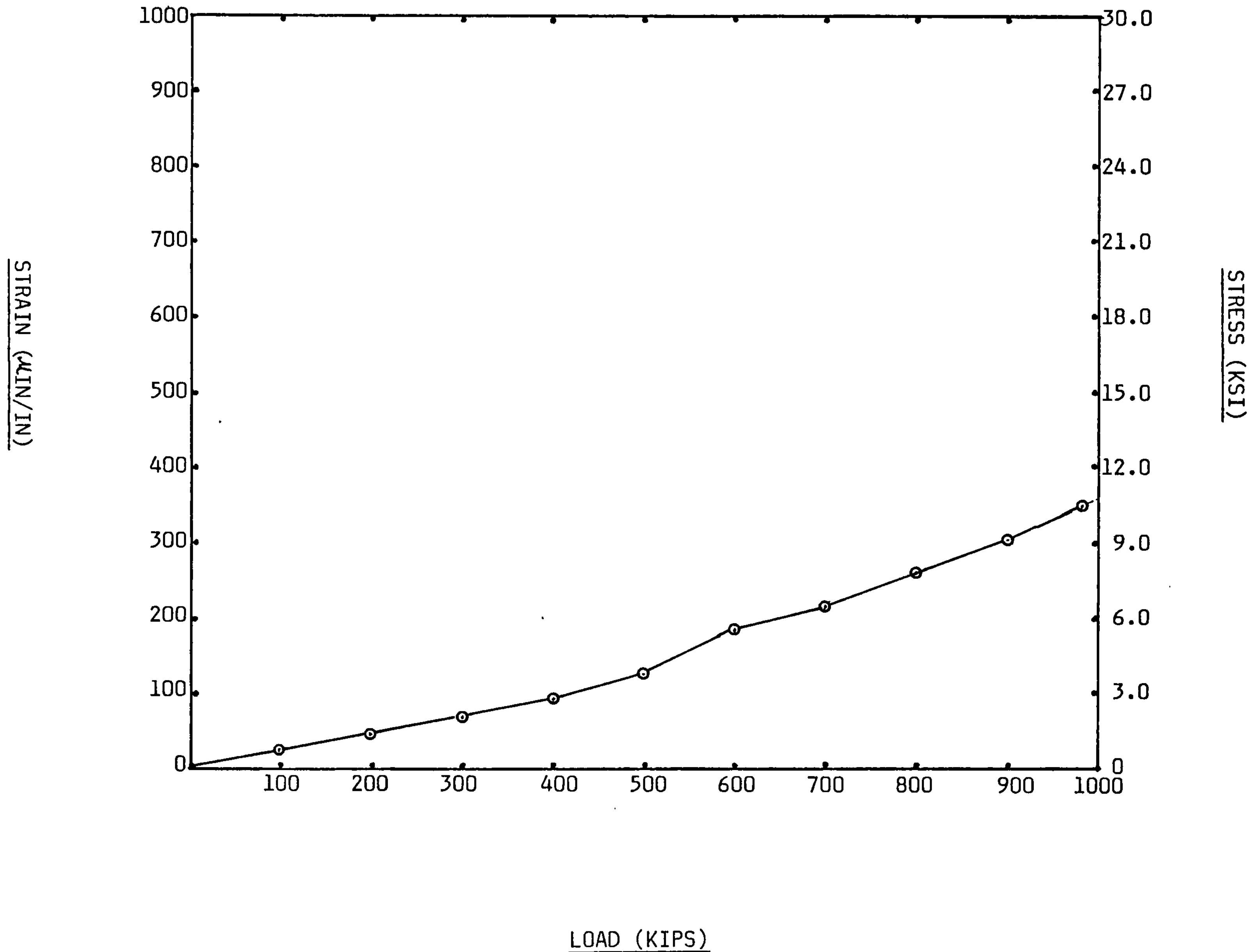

STRAIN (μIN/IN)
0
100
200
300
400
500
600
700
800
900
1000
STRESS (KSI)
0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
27.0
30.0
100
200
300
400
500
600
700
800
900
1000
LOAD (KIPS)

GAGE NO. 10


STRAIN (μIN/IN)
STRESS (KSI)
LOAD (KIPS)
0
100
200
300
400
500
600
700
800
900
1000
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
27.0
30.0

GAGE NO. 11


STRAIN (μIN/IN)
1000
900
800
700
600
500
400
300
200
100
0
100
200
300
400
500
600
700
800
900
1000
LOAD (KIPS)
30.0
27.0
24.0
21.0
18.0
15.0
12.0
9.0
6.0
3.0
0
STRESS (KSI)
GAGE NO. 16


STRAIN (μIN/IN)
STRESS (KSI)
LOAD (KIPS)
0
100
200
300
400
500
600
700
800
900
1000
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
27.0
30.0

GAGE NO. 25

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