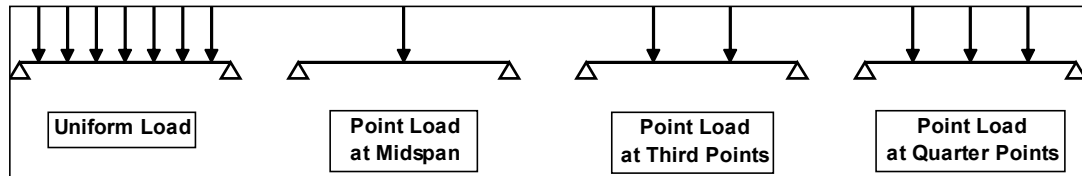


CHRISTIE LITES

ALLOWABLE LOAD DATA

CHRISTIE LITES 16" x 16" TRUSS



Number of Sections	Span ¹ (ft)	Maximum Allowable Point Loads ^{4, 5, 6}								
		Uniform Load ^{2, 3, 4, 6}			Center Point		Third Point		Quarter Point	
		Load (plf)	Total Load (lbs)	Deflection (in)	Load (lbs)	Deflection (in)	Load (lbs)	Deflection (in)	Load (lbs)	Deflection (in)
1	8	820 bc	6560	0.14"	6400	0.21"	2 x 3300	0.21"	3 x 2200	0.21"
		770 tc	6160	0.14"						
2	16	240	3840	0.3"	1920	0.26"	2 x 1430	0.3"	3 x 960	0.3"
3	24	120	2880	0.6"	1900	0.77"	2 x 900	0.77"	3 x 725	0.77"
4	32	60	1920	1.1"	940	0.86"	2 x 700	1.1"	3 x 470	1.1"
5	40	40	1600	1.6"	900	1.64"	2 x 550	1.64"	3 x 400	1.64"
6	48	25	1200	2.26"	600	1.85"	2 x 450	2.26"	3 x 300	2.26"

FOOTNOTES

- 1) Span indicates distance between truss supports.
- 2) Uniform loads shall be distributed evenly across both truss chords and can be applied to either top or bottom chords.
- 3) Values at single span truss labeled "bc" are for uniform loads applied to truss bottom chord. Values at single span truss labeled "tc" are for uniform loads applied to truss top chord.
- 4) Maximum point load that may be applied to truss chords **between** panel points is 250 Lbs at each chord member simultaneously.
- 5) For truss to support indicated loads, point loads shall be hung from truss panel points only. Truss shall be oriented to ensure load is applied at panel points.
- 6) For point loads at intervals not indicated, use equivalent uniform load to determine capacity.
- 7) Loads shown require trusses to be connected at end supports to each chord member (i.e. 4 connections ea end of truss).
- 8) Capacity of additional support structures, components or connections are outside the scope of this analysis.

650 Sussex Boulevard Kingston, Ontario K7M 5A8 (613) 389-1072 **KOHAR
ENGINEERING**

**ADLER METAL WORKS
16 INCH BY 16 INCH LIGHTING TRUSS
STRUCTURAL ANALYSIS**

Prepared by: Rick J. Kohar, P.Eng.

6 February 1998

ADLER METAL WORKS

16 INCH BY 16 INCH LIGHTING TRUSS

STRUCTURAL ANALYSIS

TABLE OF CONTENTS

	Page
1) Design Summary	1
2) Truss Design Geometry	2
3) Beam Area Properties	3
4) Truss Loads and Boundary Conditions	4
5) Truss Deflection Plot	5
6) Truss Maximum Stress Plot	6
7) Close Up of Chord Maximum Stresses	7
8) Top Chord Buckling Calculation	8
9) Close Up of Top & Bottom Brace Stress	10
10) Close Up of Side Brace Stress	11
11) Close Up of End Box & Cross Brace Stress	12
12) Jaw & Eye Bearing Stress Calculation	13
13) Eye Bending/Axial Stress Plot	14
14) Eye Geometry, Loads, & Boundary Cond'ns.	15
15) Jaw Bending/Axial Stress Plot	16
16) Jaw Geometry, Loads, & Boundary Cond'ns.	17
17) Jaw & Eye Rivet Stress Calculation	18
18) Pin Bearing & Shear Stress Calculation	19
19) Definition of "Worst Stress" Displayed in stress plots	20

ADLER METAL WORKS

16 INCH BY 16 INCH LIGHTING TRUSS

DESIGN SUMMARY

A truss, 16" high by 16" deep in cross section, made up of 5 welded sections pinned together to form a total span of 40 feet, has been analyzed with a point load of 1000 pounds force at mid span.

Weld design, and analysis has been carried out in accordance with the American Welding Society's Standard D1.2-90, Structural Welding Code for Aluminum.

In particular section 10.0, of AWS Standard D1.2-90, and the Aluminum Association's Specifications for Aluminum Structures - Construction Manual Series, Section 1 for allowable stresses for bridges, and other similar structures, has been used for the 6061 T6 aluminum.

In summary, the design has been reviewed and found acceptable in the following areas:

- 1) Weld stresses.
- 2) Pin shear and bearing loads
- 3) Member bending, compression and shear loads.
- 4) Member buckling.
- 5) Eye and Jaw Connector Bearing and Axial Stresses


Rick J. Kohar



Professional Engineer
Ontario, Canada



MAIN MENU

Add
Modify
Construct
Files
Inquire
Settings
script

allto mesh
Transfer
Render

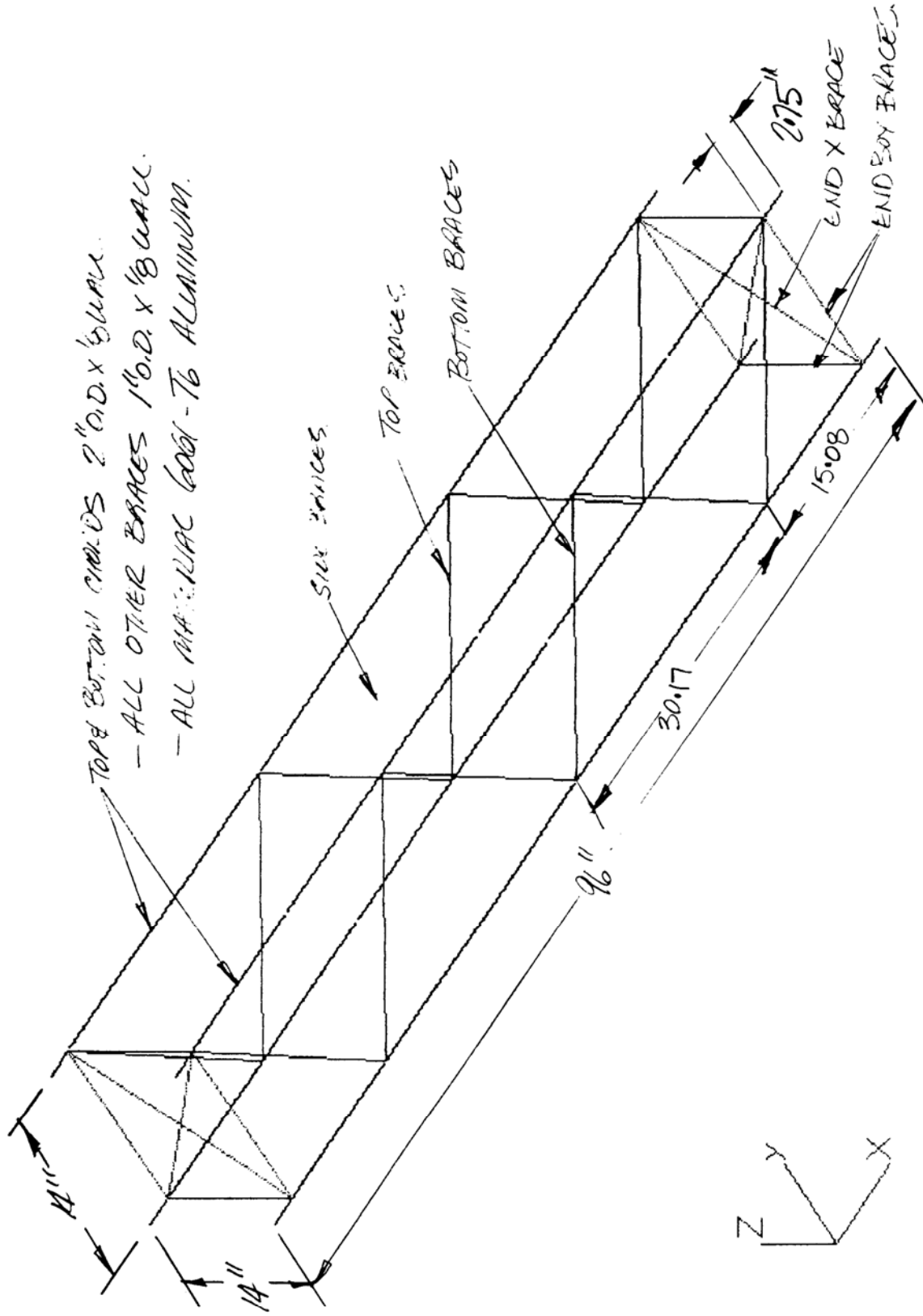
Quit

[Esc]

1Help 2Undo
3Inp 4Snap
5Cur 6Swtc
7Big 8Menu
9Top 0Draw

Data loaded from file: adler20.esd

F2=* S=N C=6 VU=7 L= 0 G= 1 C X=20.5005 Y=-29.999 Z=-35.708



TOP & BOTTOM CHAINS 2" O.D. X 1/8 WALL.
- ALL OTHER BRACES 1" O.D. X 1/8 WALL.
- ALL MATERIAL: 6061-T6 ALUMINUM.

TRUSS DESIGN GEOMETRY

ADUCAL BEAM ADUCAL

5 FEB 96

BEAM AREA PROPERTIES

ID #	DESCR- PTION	AREA A (in ²)	POLAR MOMENT OF INERTIA J (in ⁴)	MOMENT OF INERTIA I ₂ (in ⁴)	MOMENT OF INERTIA I ₃ (in ⁴)	SECTION MODULUS S _x (in ³)	SECTION MODULUS S _y (in ³)	J _p (in ³)
4, 5, 7	1" O.D. X 1/8" WALL.	.344	.068	.034	.034	.067	.067	.136
2, 3, 8	2" O.D. X 1/8" WALL.	.7363	0.650	.325	.325	.325	.325	.650

```

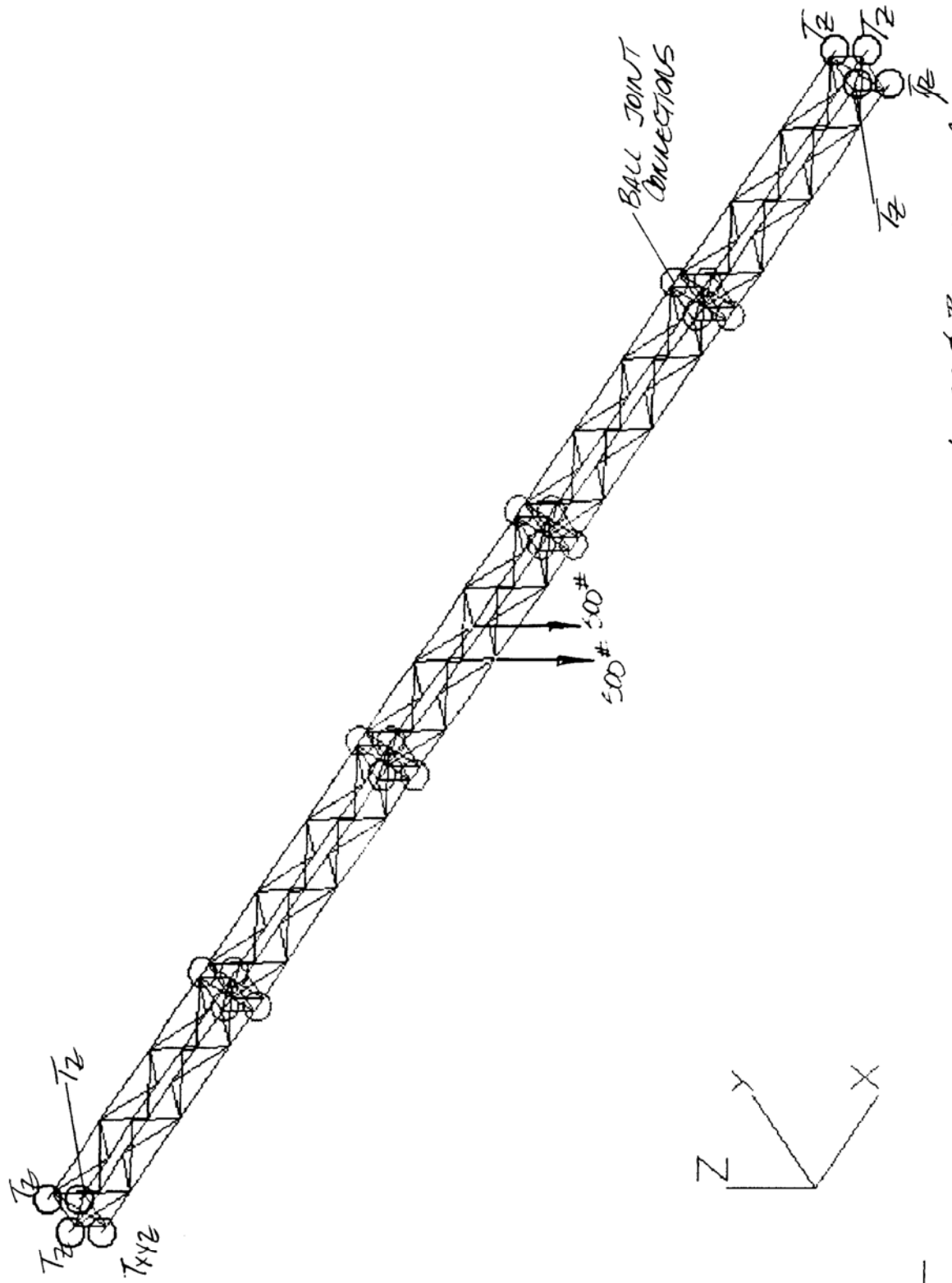
MAIN MENU
Add/Mod
Files
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Settings
-----
anly type
-----
Post
-----
Transfer
Quit
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[Esc]

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```

1Help
2Undo
3Inp
4Snap
5Cur
6Swtc
7Big
8Menu
9Top
0Draw
_

```



Data loaded from file: ADLER23.bed

TRUSS LOADS & BOUNDARY CONDITIONS

BEAM 4.12 File:ADLER23 96/02/06 00:00 LC 1/ 1 Vu= 7 Lo= 45 La= 45 R= -0

GET VAL
Var out

[Esc]

1Help 2Undo
3Inp 4Snap
5Cur 6Swtc
7Big 8Menu
9Top 0Draw

Dither method = Vector: Translation

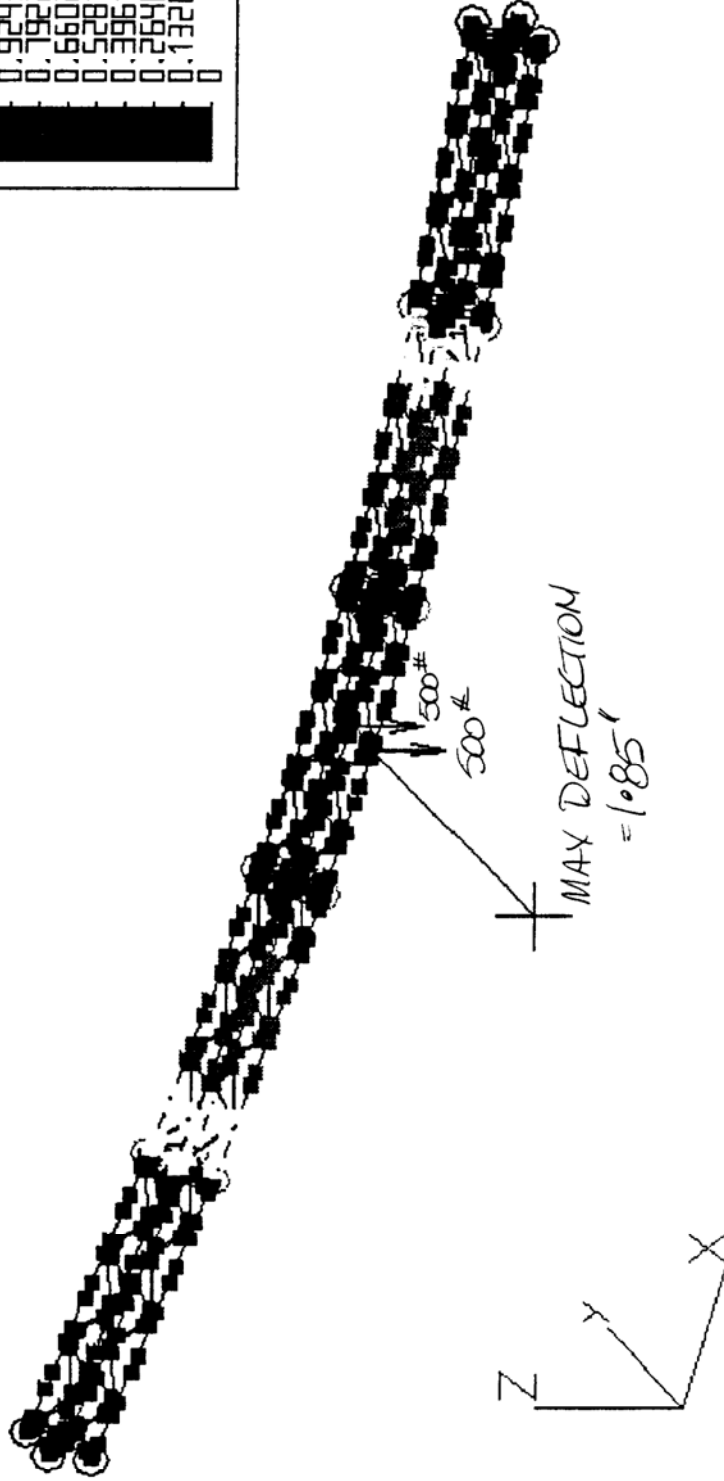
Click on node to get display value at that node.

NODE #25: X=241.363, Y=2.95328, Z=0: Val=1.84538

File:ADLER23 S=N LC 1/ 1 Vu=U2K=170.624 Y=29.7055 Z=-103.20

Displacement

1.84866
1.71661
1.58457
1.45252
1.32047
1.18842
1.05638
0.92433
0.79228
0.66023
0.52819
0.39614
0.26409
0.13204
0



TRUSS DEFLECTION.

GET VAIL
Var out

[Esc]

1Help 2Undo
3Inp 4Snap
5Cur 6Swtc
7Big 8Menu
9Top 0Draw

Dither method = Beam: Worst [Stress]

G1 type=2: #=149

Click on center of front element.

(24) 7.195E+03 (25) 7.516E+03

File:ADLER23 S=N LC 1/ 1 Vu=U2K=160.910 Y=23.4925 Z=-104.11

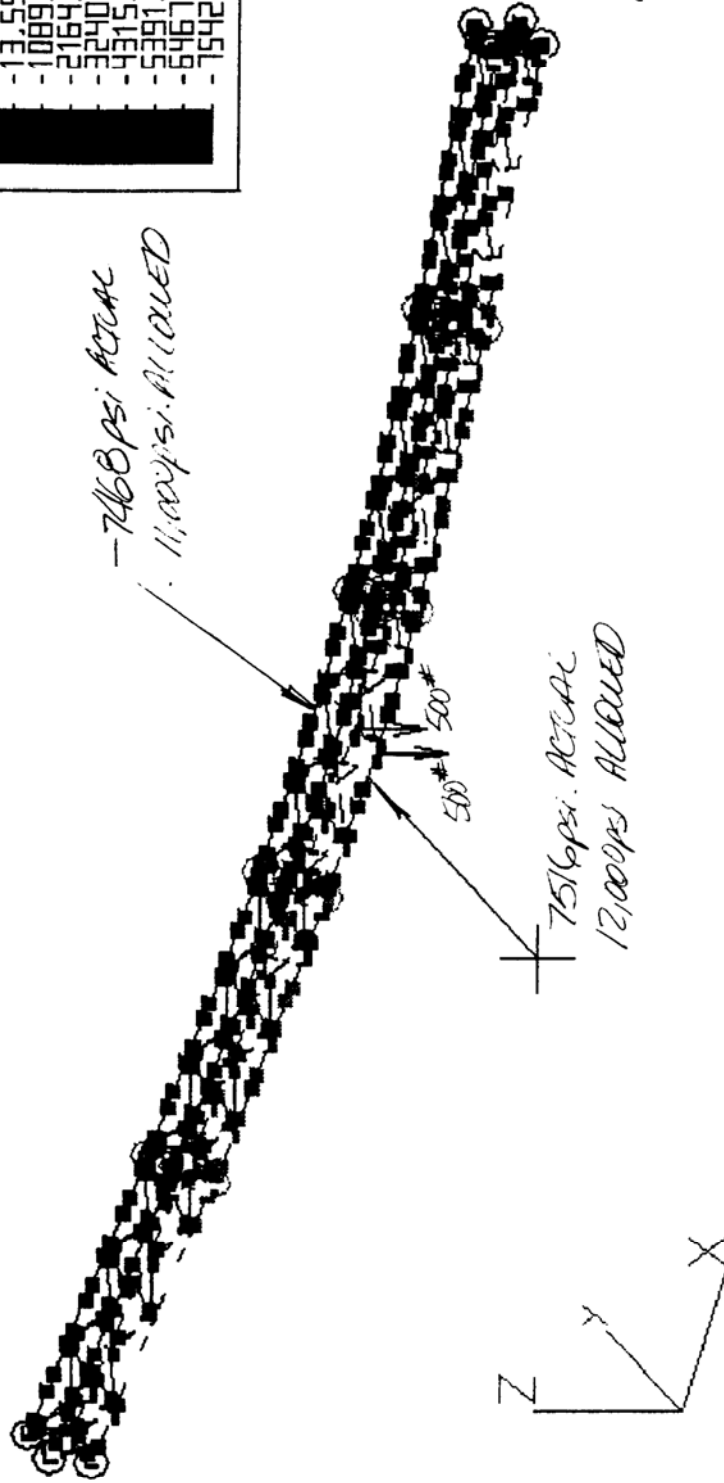
TRUSS MAXIMUM STRESS

OVERVIEW

6

Beam-Truss

7515.62
6440.02
5364.43
4288.83
3213.23
2137.64
1062.04
-13.552
-1089.1
-2164.7
-3240.3
-4315.9
-5391.5
-6467.1
-7542.7



GET VAL
Var out

[Esc]

1Help 2Undo
3Inp 4Snap
5Cur 6Swtc
7Big 8Menu
9Top 0Draw

Other method = Beam: Worst [Stress]
G1 type=2: #=179 Click on center of front element.
(158)-7.442E+03 (159)-7.468E+03
File:ADLER23 S=N LC 1/ 1 Vu=U2=209.621 Y=97.9836 Z=-34.561

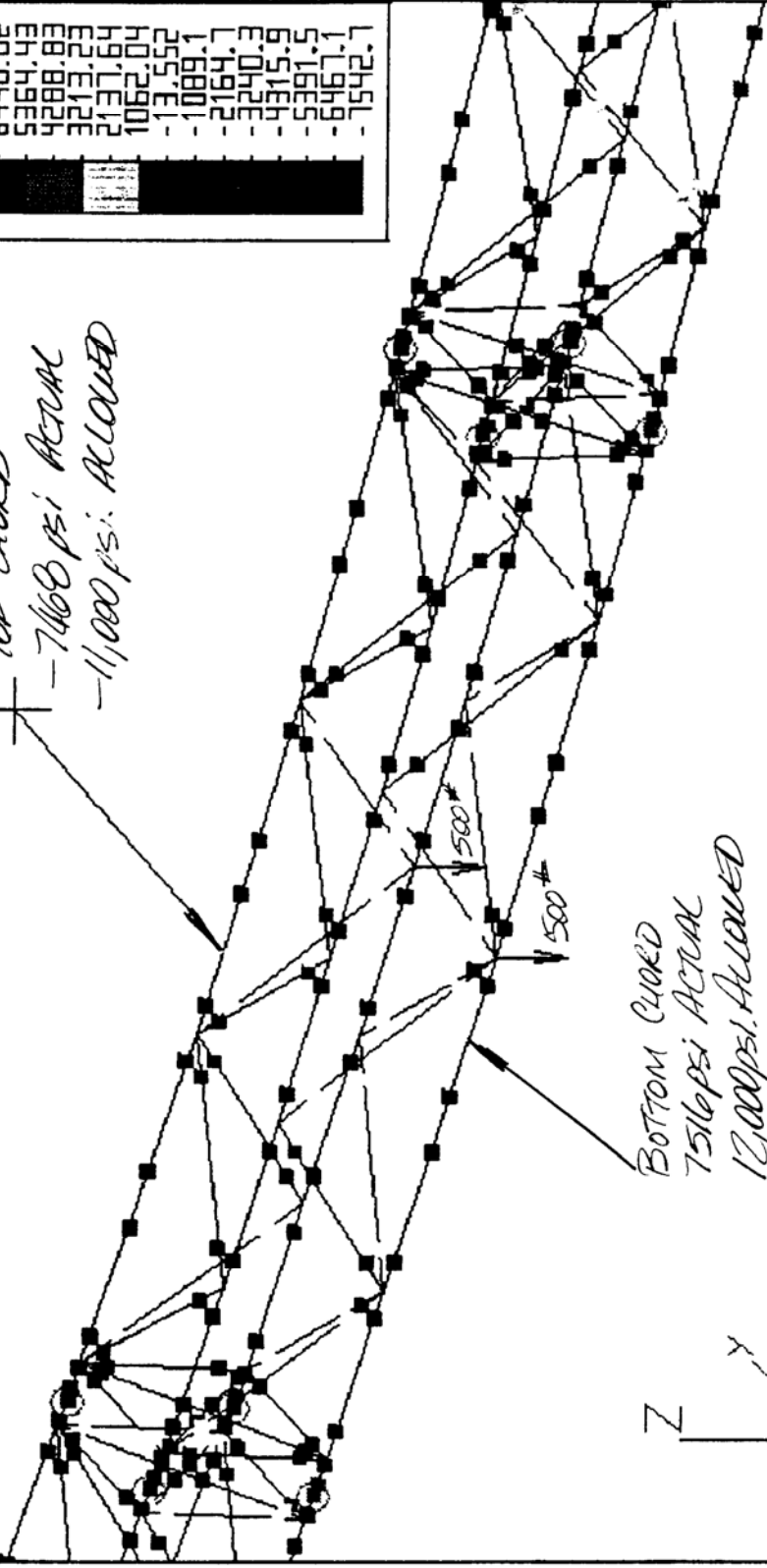
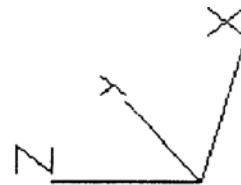
CLOSE UP OF
CHORD MAXIMUM
STRESS

Beam-Truss

7515.62
6440.02
5364.43
4288.83
3213.23
2137.64
1062.04
-13.552
-1089.1
-2164.7
-3240.3
-4315.9
-5391.5
-6467.1
-7542.7

TOP CHORD
-7460 psi ACTUAL
-11,000 psi ALLOWED

BOTTOM CHORD
7516 psi ACTUAL
12,000 psi ALLOWED

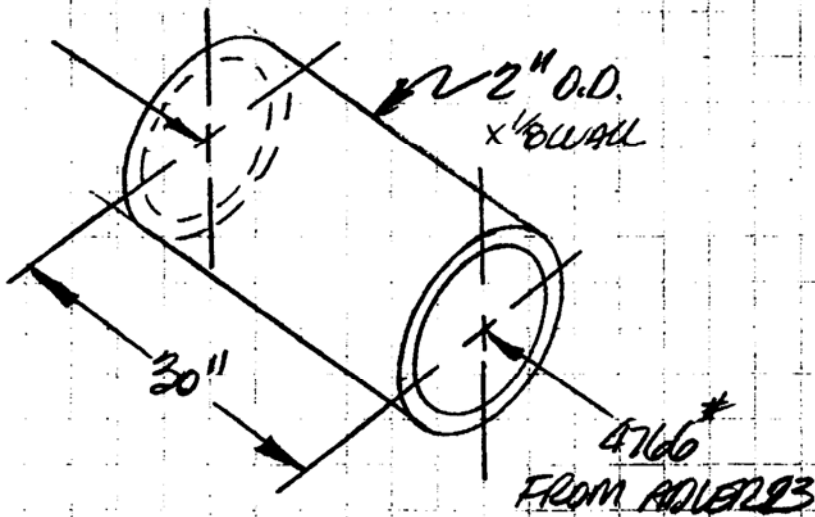


(8)

✓ 5 FEB 96

TOP CHORD BUCKLING CALCULATION

①



$$A = 0.7363 \text{ in}^2$$

$$J = 0.650 \text{ in}^4$$

$$I = 0.325 \text{ in}^4$$

$$Z = 0.325 \text{ in}^4$$

$$K = \sqrt{\frac{d^2 + d_i^2}{16}}$$

$$K = \sqrt{\frac{2^2 + 0.75^2}{16}} = 0.664 \text{ in.}$$

USING EULER METHOD

$$P_{cr} = \frac{n \pi^2 E I}{L^2} \text{ WHERE } n = 1.2 \text{ FOR FIXED-FIXED}$$

$$P_{cr} = \frac{1.2 (\pi^2) (10.3 \times 10^6) (0.325)}{30^2}$$

$$P_{cr} = 44,051 \text{ #}$$

SINCE $P_{cr} > 4766 \text{ # ACTUAL}$

TRY SECANT FORMULA WITH
VARIOUS ECCENTRICITIES

5 FEB 96
②

TOP CHORD BUCKLING (CONT'D)

SECANT FORMULA:
$$\frac{P_{cr}}{A} = \frac{S_y}{1 + \frac{ec}{K^2} \sec \frac{L}{K} \sqrt{\frac{P_{cr}}{4AE}}}$$

WHERE e = ECCENTRICITY, c = DISTANCE FROM CENTER TO OUTER MOST FIBRE

$S_y = 35 \text{ Ksi}$

THEN SOLVING
$$P_{cr} = \frac{S_y A}{1 + \frac{ec}{K^2} \sec \frac{L}{K} \sqrt{\frac{P_{cr}}{4AE}}}$$

$$\Rightarrow P_{cr} = \frac{(35,000)(.7363)}{1 + \frac{e(c)}{(.6644)^2} \left[\cos \left(\frac{30}{.6644} \sqrt{\frac{P_{cr}}{4(.7363 \times 10.3 \times 10^6)}} \right) \right]}$$

SOLVING ITERATIVELY

For $e = \frac{1}{8}'' \Rightarrow P_{cr} = 20,083^*$

$\Rightarrow \text{SAFETY} = \frac{20,083}{4,766} = \boxed{4.21 \text{ TO } 1.}$

For $e = \frac{1}{4}'' \Rightarrow P_{cr} = 16,450^*$

$\Rightarrow \text{SAFETY} = \frac{16,450}{4,766} = \boxed{3.45 \text{ TO } 1.}$

DESIGN IS ACCEPTABLE.

GET VAL

Var out

[Esc]

1Help 2Undo
3Inp 4Snap
5Cur 6Swtc
7Big 8Menu
9Top 0Draw

Other method = Beam: Worst [Stress]

G1 type=2: #=196

(23) 1.318E+03 (65) 1.416E+03

File:ADLER23 S=N LC 1/ 1 Vu=U2K=205.621 Y=60.4599 Z=-37.126

Click on center of front element.

CLOSE (P OF TOP & BOTTOM
BRACE

ADDITIONAL STRESS

6

Beam-Truss

7515.62
6440.02
5364.43
4288.83
3213.23
2137.64
1062.04
-13.552
-1089.1
-2164.7
-3240.3
-4315.9
-5391.5
-6467.1
-7542.7

TOP BRACE

-1006 psi. ACTUAL

-11,004 psi. ALLOWED

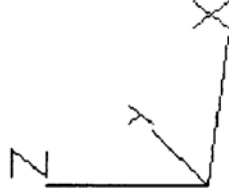
BOTTOM BRACE

1416 psi. ACTUAL

12,000 psi. ALLOWED

500#

500#



GET VAL

Var out

[Esc]

1Help 2Undo
3Inp 4Snap
5Cur 6Swtc
7Big 8Menu
9Top 0Draw

Other method = Beam: Worst [Stress]

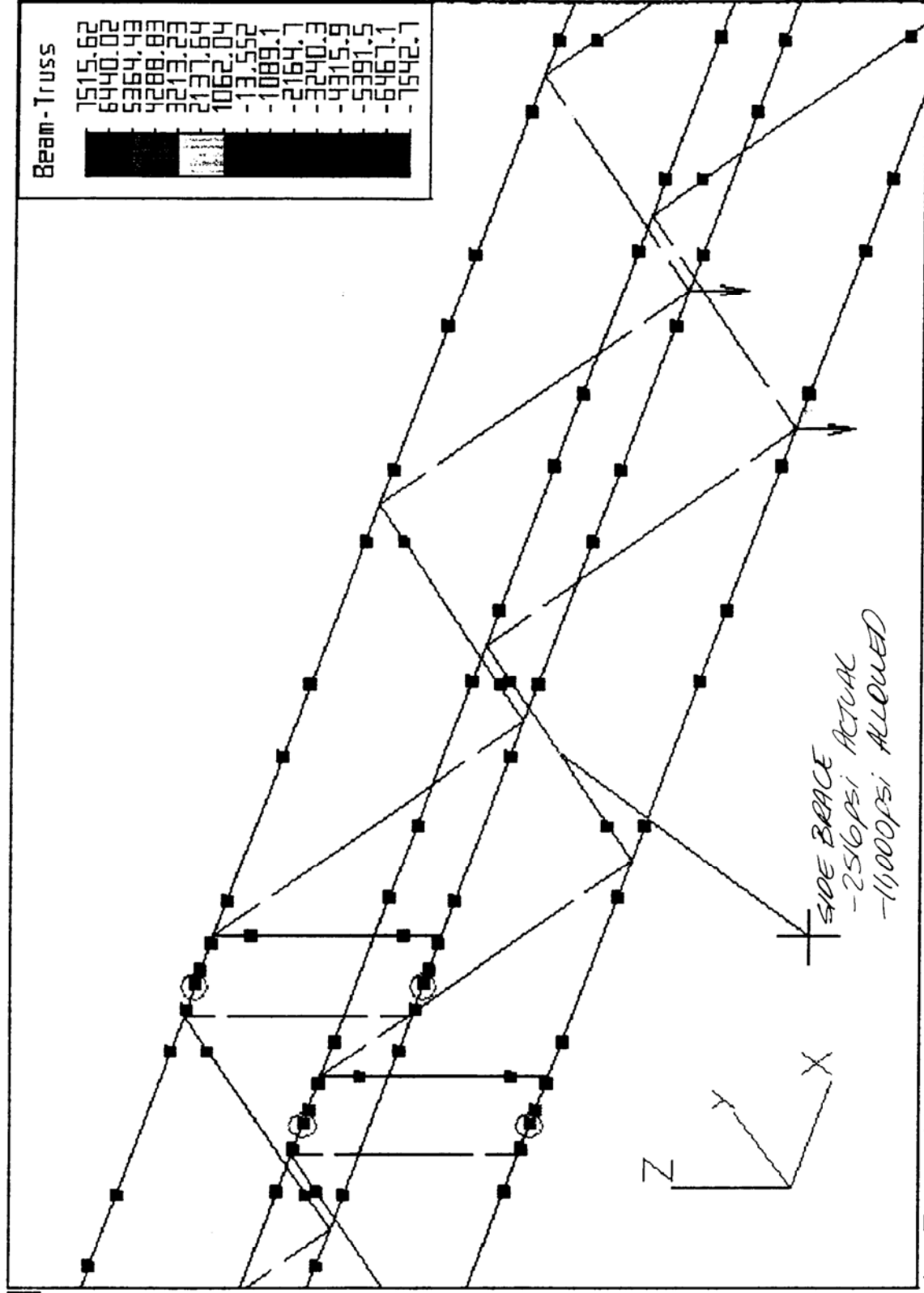
G1 type=2: #=162

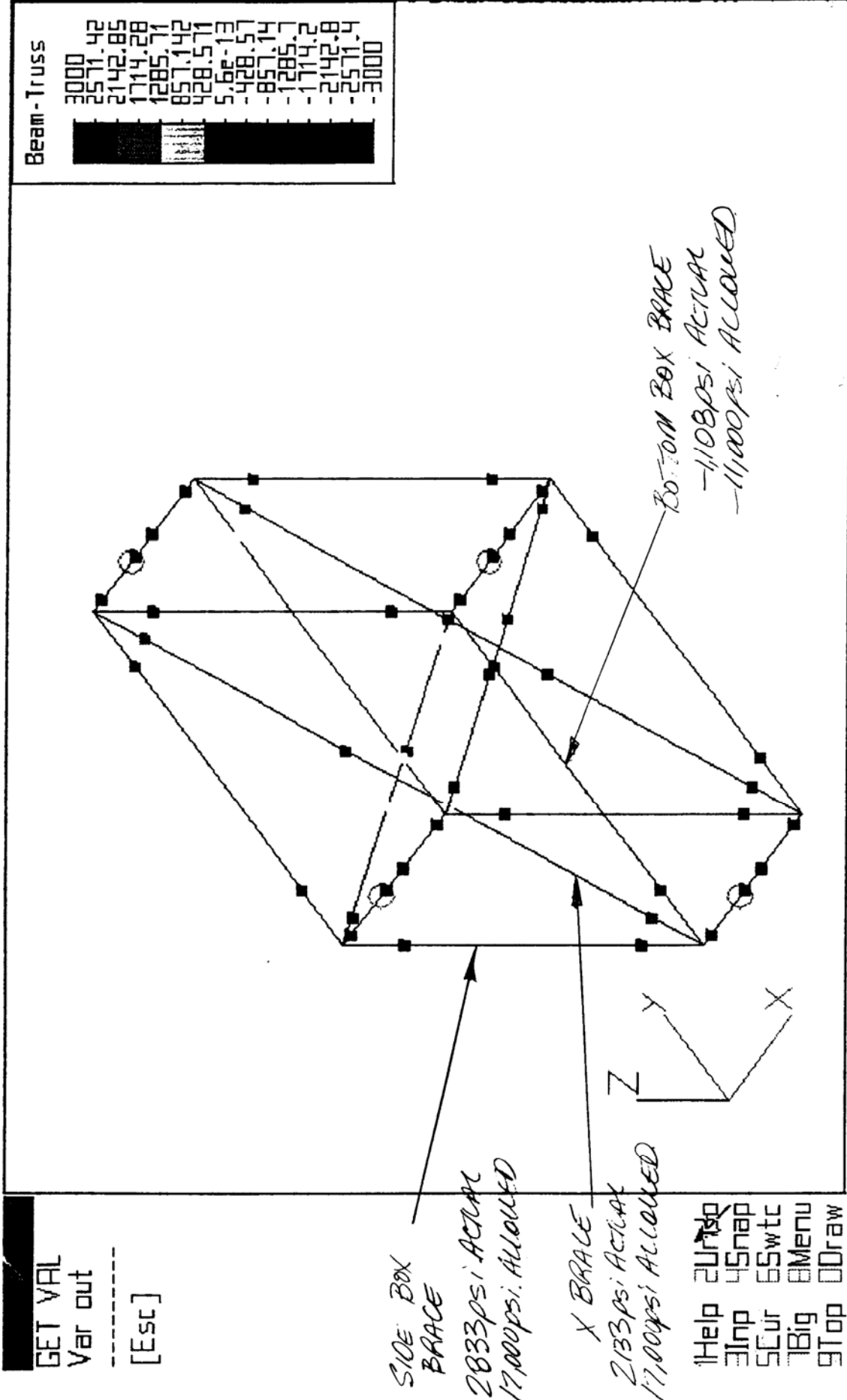
(23)-2.516E+03 (117)-2.196E+03

File:ADLER23 S=N LC 1/ 1 YU=159.361 Y=69.5101 Z=-59.697

Click on center of front element.

CLOSE UP OF SIDE BRACE
MINIMUM STRESS





CLOSE UP OF END,
BOX AND CROSS
BRACE
MEMBER STRESSES

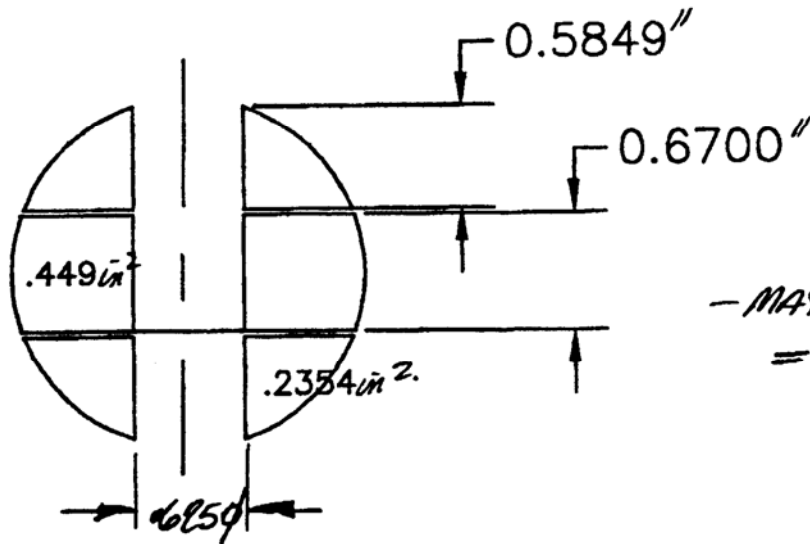
Other method = Beam: Worst [Stress]
Click on center of front element.

[No frills] S=N LC 1/ 1 VU= 7X=137.711 Y=45.4062 Z=-65.269

File:ADLER23

5 FEB 96. ✓

13



JAW & EYE
BEARING STRESSES

- MAXIMUM PIN FORCE
= 3986# FROM ANALYSIS

$$\frac{\text{JAW BEARING STRESS}}{= \frac{3986\#}{2(.5849)(.685)}} = 5,451 \text{ psi} < 20 \text{ KSI FOR 6061-T6}$$

BEARING STRESS
PER AWS

⇒ DESIGN IS O.K.

$$\frac{\text{EYE BEARING STRESS}}{= \frac{3986\#}{(.67)(.685)}} = 9,518 \text{ psi} < 20 \text{ KSI FOR 6061-T6}$$

BEARING STRESS
PER AWS

⇒ DESIGN IS O.K.

GET VAIL

Var out

[Esc]

1Help 2Undo
3Inp 4Snap
5Cur 6Swtc
7Big 8Menu
9Top 0Draw

Dither method = Von Mises [Stress]

Click on node to get display value at that node.

NODE #707: X=22.2129, Y=20.1797, Z=0.67: Val=15972.4

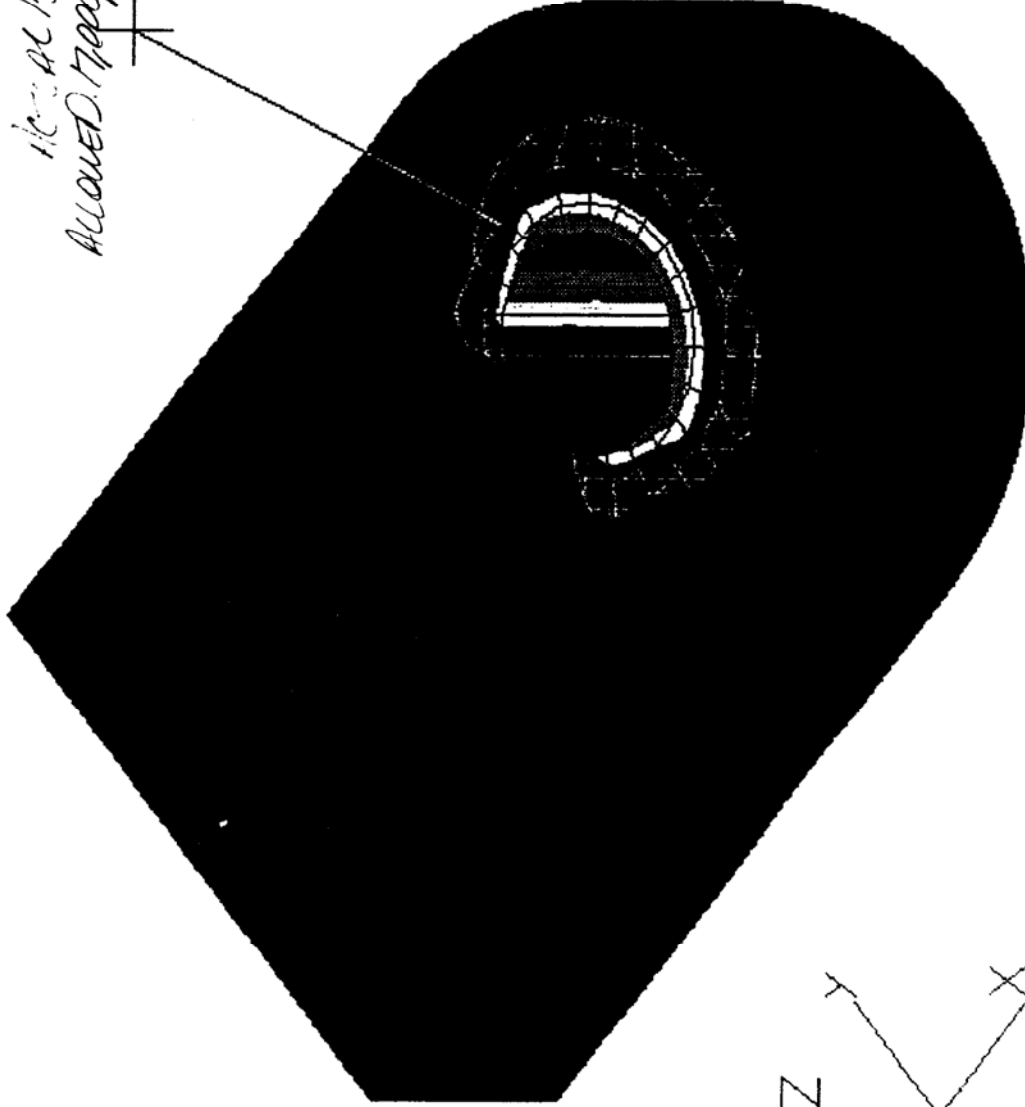
File:EYES S=NLC 1/ 1 Vu= 7 X=21.3529 Y=21.8658 Z=0.36270

64E MAXIMUM BENDING/AXIAL STRESS
WITH 95% BENDING PRESSURE
APPLIED.

Von Mises

16342.4
15221.6
14100.9
12980.2
11859.4
10738.7
9618.00
8497.27
7376.54
6255.81
5135.07
4014.34
2893.61
1772.87
652.147

16342.4
Allowed Stress



DRAW
 Redraw
 Pan
 zoom In
 zoom Out
 Last zm
 Enclose
 --Set w--
 View
 User view
 X perspec
 Define vu
 Jetview
 last vu

 [Esc]

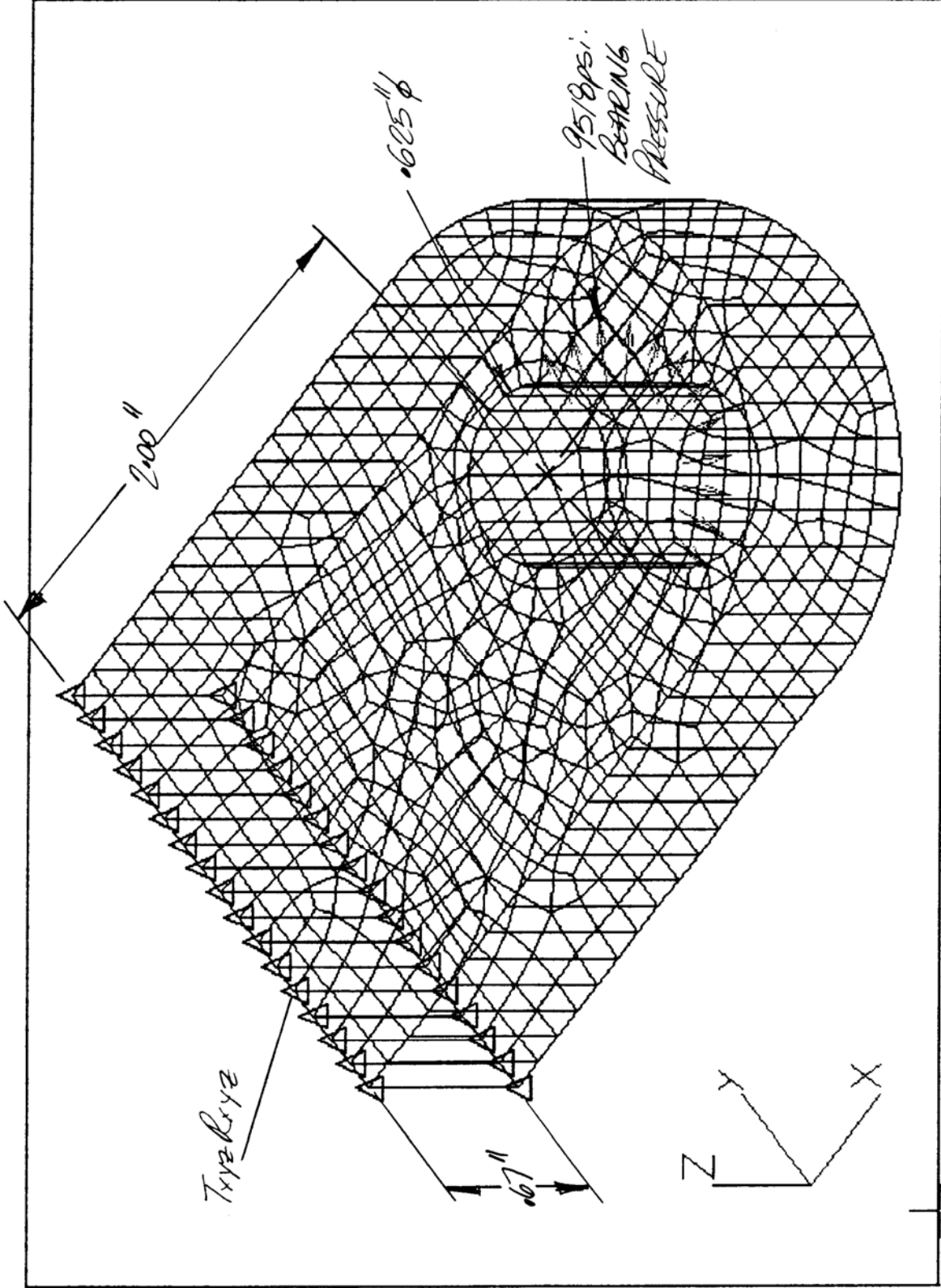
1Help 2Undo
 3Inp 4Snap
 5Cur 6Swtc
 7Big 8Menu
 9Top 0Draw

Select new view.

File:EYEG S=NLC 1/ 1 Vu= 7 X=20.2010 Y=18.2771 Z=-1.3604

EYE GEOMETRY LOADS & BOUNDARY CONDITIONS

15



DRAW
 Redraw
 Pan
 zoom In
 zoom Out
 Last zm
 Enclose
 --Set w--
 View
 User view
 X perspec
 Define vu
 Jetview
 last vu

 [Esc]

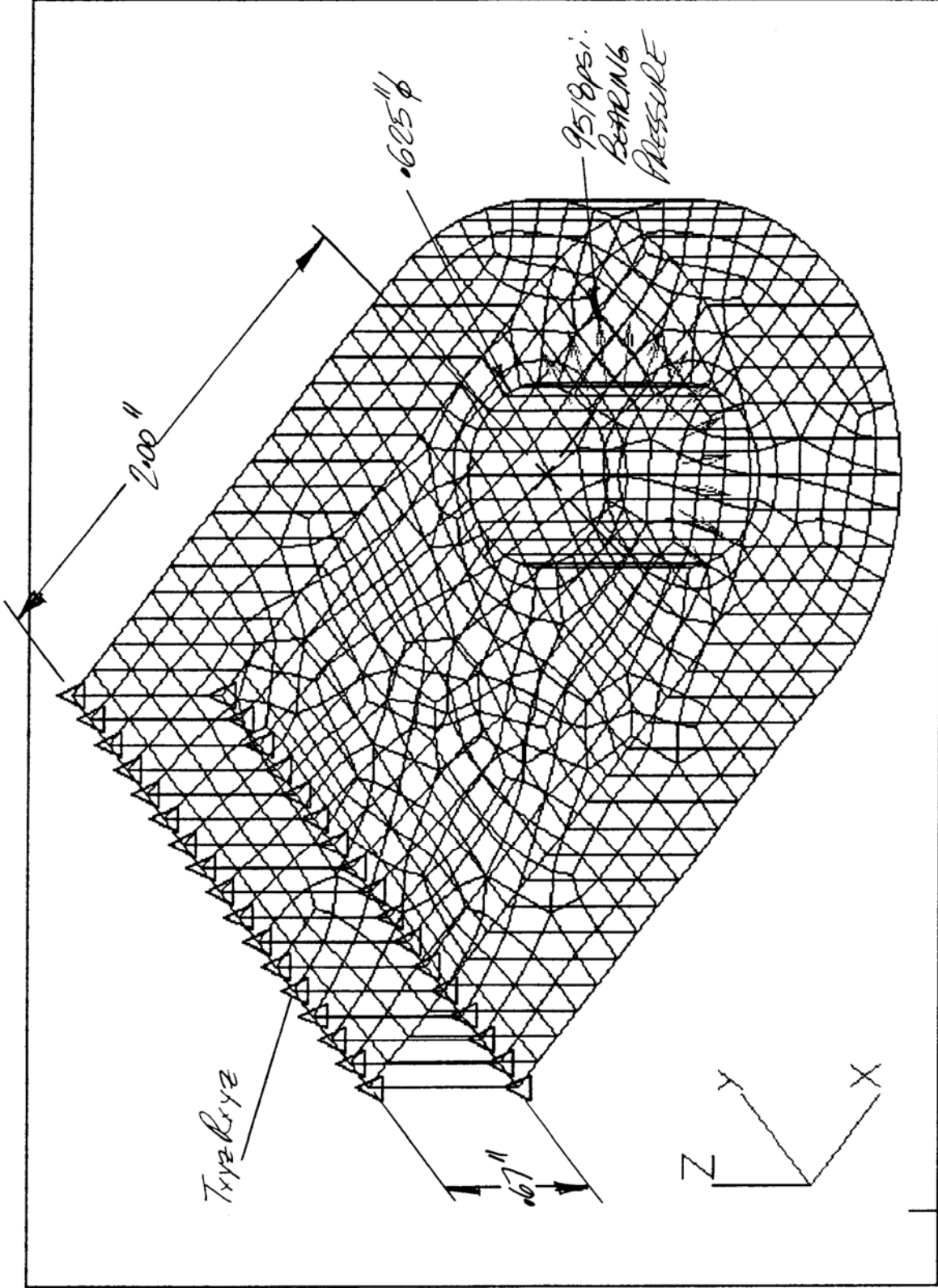
1Help 2Undo
 3Inp 4Snap
 5Cur 6Swtc
 7Big 8Menu
 9Top 0Draw

Select new view.

File:EYEG S=NLC 1/ 1 Vu= 7 X=20.2010 Y=18.2771 Z=-1.3604

EYE GEOMETRY LOADS & BOUNDARY CONDITIONS

15



GET VAL

Var out

[Esc]

1Help 2Undo
3Inp 4Snap
5Cur 6Swtc
7Big 8Menu
9Top 0Draw

Other method = Von Mises [Stress]

Click on node to get display value at that node.

NODE #666: X=6.78895, Y=6.39297, Z=6.70791: Val=16439.5

File:13ADLER9 S=NLC 1/ 1 Vu= 7=4.27673 Y=9.49721 Z=3.69143

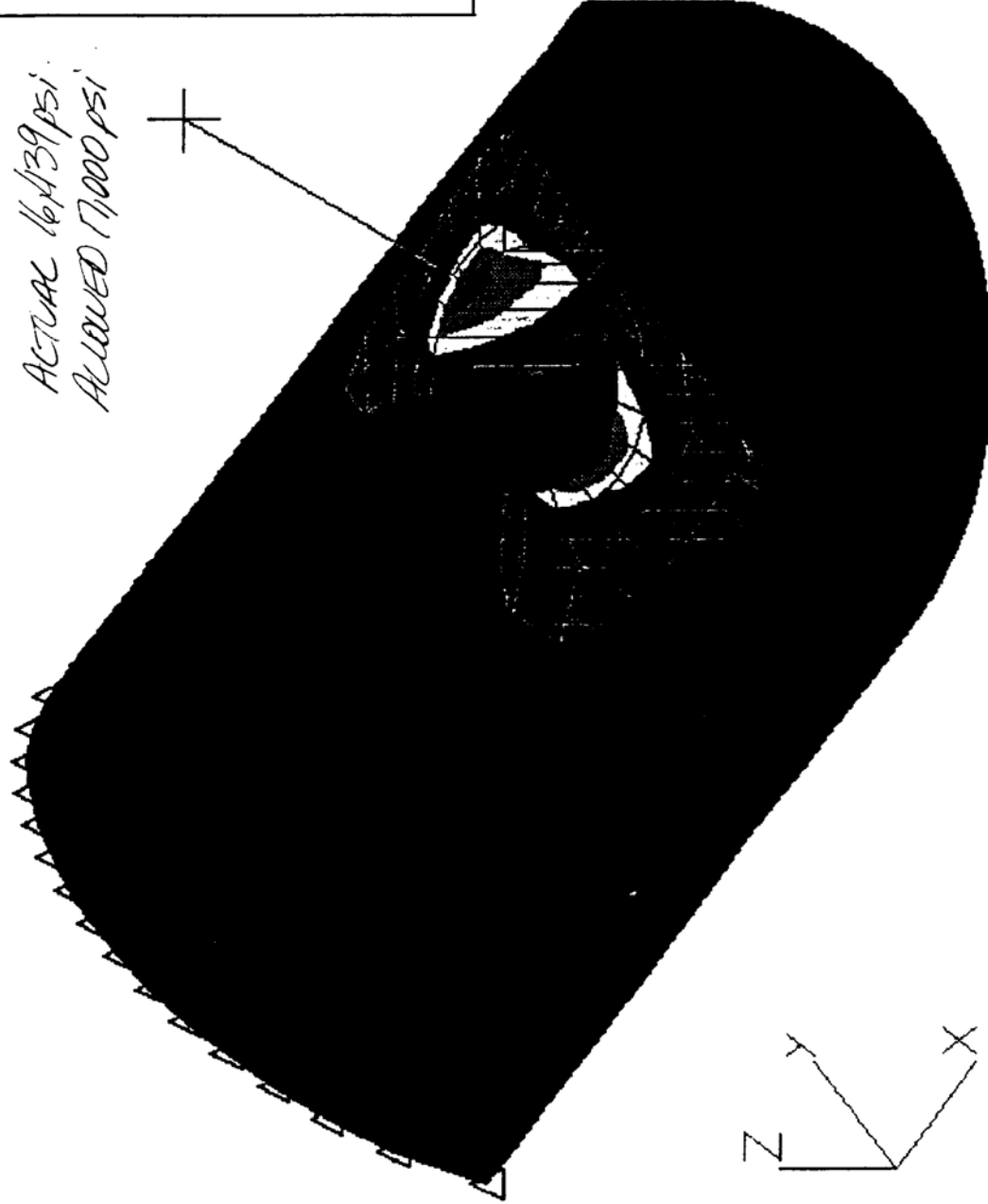
JAW MAXIMUM BENDING AXIAL STRESS
WITH 5451 psi. BEARING
PRESSURE APPLIED

16

ACTUAL 16439 psi.
ALLOWED 17000 psi

Von Mises

17539.1
16299.4
15059.6
13819.8
12580.1
11340.3
10100.5
8860.80
7621.03
6381.26
5141.49
3901.73
2661.96
1422.19
182.428



GET VAR

Var out

[Esc]

1Help 2Undo
3Inp 4Snap
5Cur 6Swtc
7Big 8Menu
9Top 0Draw

Other method = Von Mises [Stress]

Click on node to get display value at that node.

[Auto range] [No frills]

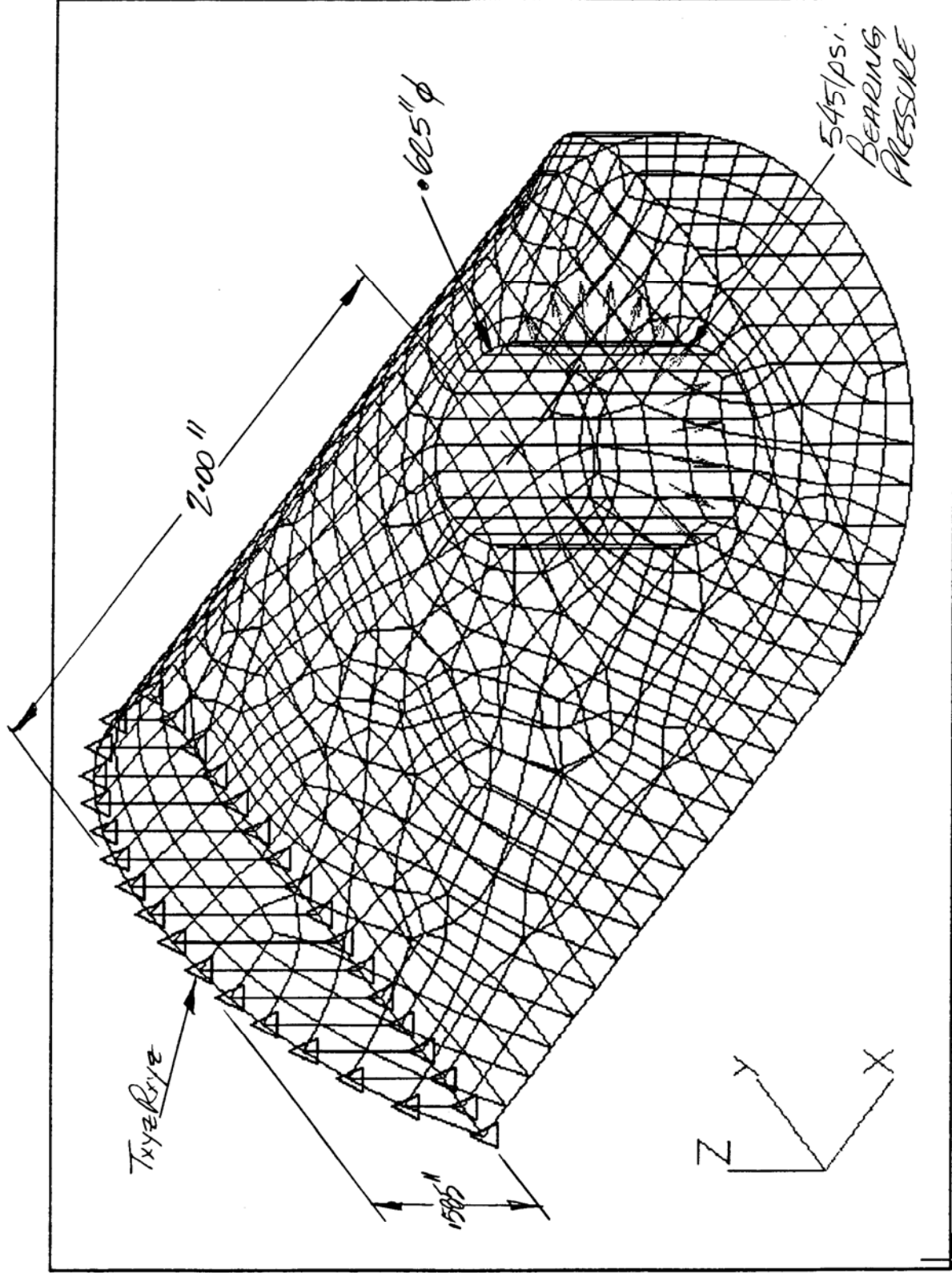
File:13ADLER9

S=N LC

1/ 1

VU= 7=3.10714

Y=6.28027 Z=2.24374



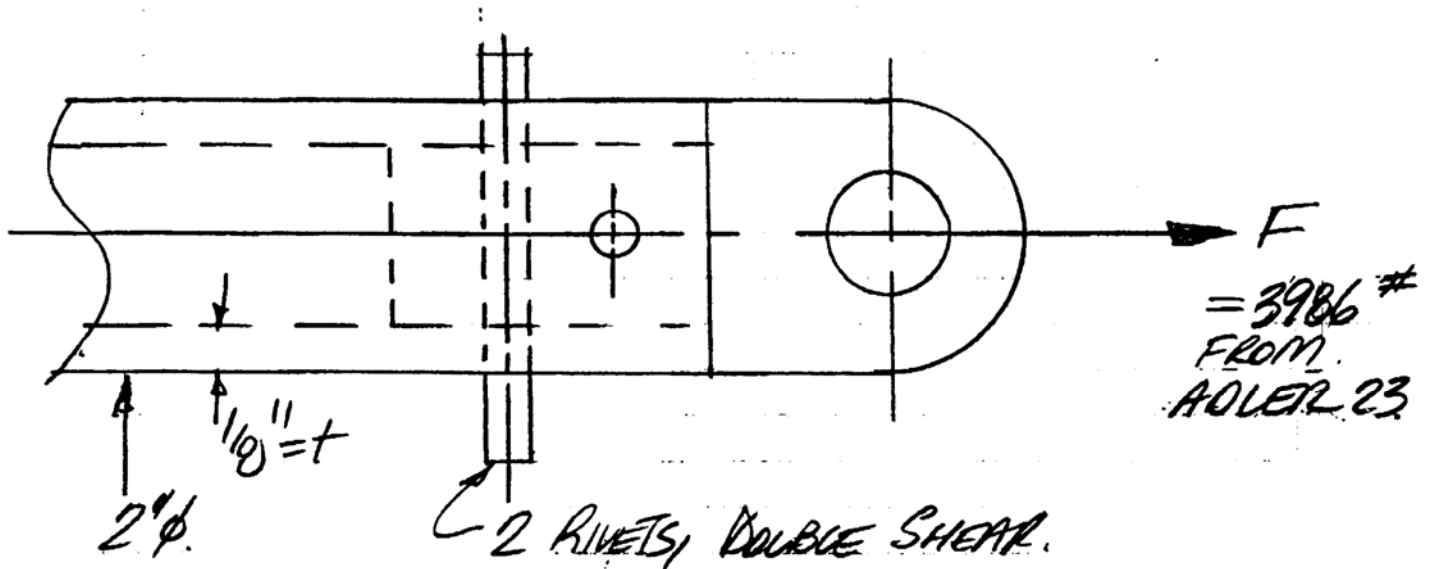
JAW GEOMETRY, LOADS & BOUNDARY CONDITIONS

⑦

AMW

6 FEB 96⁽¹⁸⁾ ✓

JAW EYE RIVET STRESS



— FROM AUS THEN $S_A = 30\text{ KSI}$ FOR 6061-T6
FOR BOLT/RIVET BEARING STRESS

$$\text{BEARING AREA } A_B = 2 \text{ RIVETS} \times 2 \text{ SHEAR} \times t \times d$$
$$= 4td \text{ WHERE } d = \text{RIVET } \phi$$

$$S_A = \frac{F}{A_B} \Rightarrow 30,000 = \frac{3986\#}{4td}$$

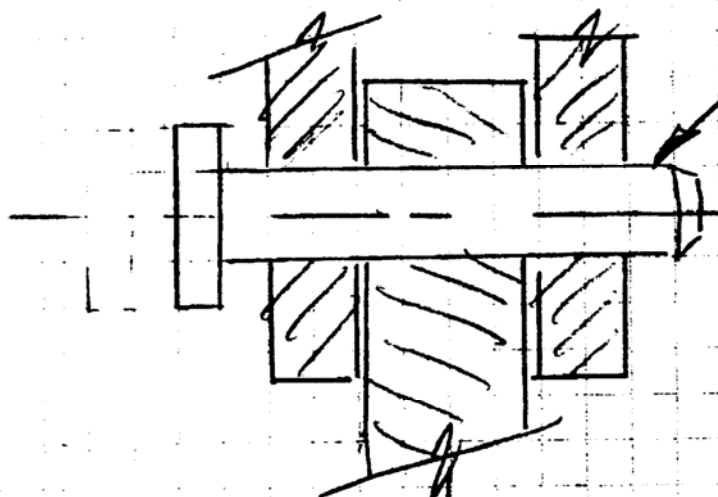
$$d = \frac{3986\#}{(4)(30,000)(t)} \text{ WHERE } t = \frac{1}{8}"$$

THEN RIVET $\phi \Rightarrow d = 0.2657"$ MINIMUM.

@ 30,000psi AUS ALLOWABLE BEARING STRESS

AMU.

2 FEB 96 ✓

PIN BEARING & SHEAR STRESSES

5/8" ϕ
 - SHE 1018-20 STEEL
 ANNEALED
 $S_{UT} = 60 \text{ KSI}$
 $S_y = 40 \text{ KSI}$
 $S_{sy} = 23.01 \text{ KSI}$

$F = 3986 \text{ lb}$ FROM ADVERT 23

$$A_{pin} = \frac{\pi (5/8)^2}{4} = 0.3068 \text{ in}^2$$

$$\text{PIN SHEAR STRESS} = \frac{F}{2A} = \frac{3986 \text{ psi}}{2(0.3068)}$$

$$\tau_{pin} = 6,496 \text{ psi} < \text{ALLS ALLOWABLE FOR } > 10^7 \text{ CYCLES}$$

$$\text{STATIC} = (0.57)(24 \text{ KSI}) = 13.68 \text{ PSI}$$

\therefore PIN SHEAR DESIGN IS O.K.

BEARING STRESSES ARE SAME AS JAW & EYE

& ALLS ALLOWS 24 KSI FOR $> 10^7$ CYCLES FOR STEEL

& JAW BEARING STRESS = 5,451 PSI STATIC

& EYE BEARING STRESS = 9,518 PSI STATIC.

\therefore PIN DESIGN IS ACCEPTABLE.

BEAM TRUSS

- 1) P/A
- 2) M2/S2
- 3) M3/S3
- *#) Worst
- 4) r1 axf
- 5) r2 shf
- 6) r3 shf
- 7) m1 tor
- 8) m2 mom
- 9) m3 mom

Size

[Esc]

HELP

P/A, M2/S2, M3/S3, Worst, R1, R2, R3, M1, M2, M3: '*' indicates beam/truss stress/force method.

Worst = (sign of P/A)(ABS(P/A)+ABS(M2/S2)+ABS(M3/S3))

P/A = Axial stress. "positive value (+)": tensile stress. "negative value (-)" = compressive stress.

M2/S2 = Bending stress due to bending moment M2. S2 = Sectional modulus w.r.t. local 2-axis of beam cross-section.

M3/S3 = Bending stress due to bending moment M3. S3 = Sectional modulus w.r.t. local 3-axis of beam cross-section.

R1, R2, R3 are forces in the local 1, 2 and 3 directions. M1, M2, M3 are moments about the local 1, 2 and 3 axis.

DEFINITION OF THE SYMBOLS

P = axial force.

- Help
- Undo
- Inp
- Snap
- Cur
- Swtc
- Big
- Menu
- Top
- Draw