LIFTING DEVICE

DEVICE NAME: Lab E Chamber Lifting Fixture

ENGINEERING NOTE NUMBER: #49

DRAWING NUMBER:

APPLICABLE STANDARD: Specifications for Aluminum Structures

RATED LOAD: 1120 lbs

TEST LOAD: 1400 lbs

TEST LOAD PERCENT: 125%

LAST LOAD TEST DATE: 7/29/92

COLOR: Aluminum

STRESS CALCULATIONS:

Done by: Donald V. Mitchell

Date: 7-28-92

Reviewed by: Zhijing Tang

Date: 9-1-92

REMARKS:

IDENTIFICATION:

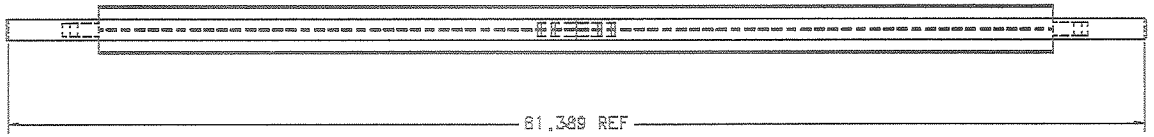
Engineering Note Number & Rated Load Must be Clearly Marked On a Conspicuous Surface.

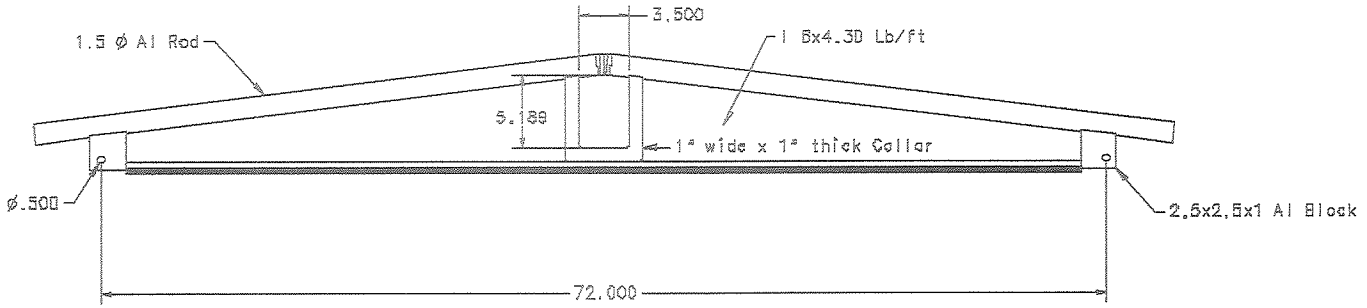
Lab E: Chamber lifting fixture
Rated for 1120 lbs
Load test 7-29-92 @ 1400 lbs
Don Mitchell

Lab E: Chamber Lifting fixture
Rated for 1120 lbs
Load test 7-29-92 @ 1400 lbs
Don Mitchell

ID #49

REV.	DESCRIPTION	DRAWN	DATE
		APPD.	DATE





ITEM NO.	PART NO.	DESCRIPTION OR SIZE	QTY. REQ.

PARTS LIST

UNLESS OTHERWISE SPECIFIED			ORIGINATOR		
FRACTIONS	DECIMAL	ANGLES	DRAWN		
±	±	±	CHECKED		
1. BREAK ALL SHARP EDGES 1/64 MAX.			APPROVED		
2. DO NOT SCALE DWG.			USED ON		
3. DIMENSIONING IN ACCORD WITH ANSI Y14.5 STD'S					
MAX. ALL MACHINED SURFACES			MATERIAL- T6061 - T6 Aluminum		

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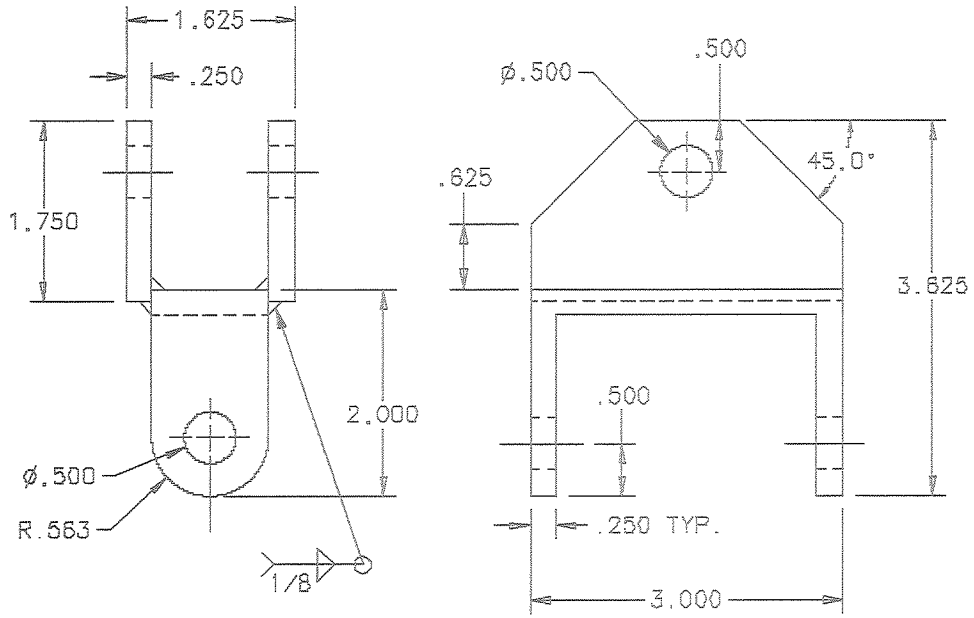
UNITED STATES DEPARTMENT OF ENERGY

LAB E LIFTING FIXTURE

SCALE	DWG SIZE	DRAWING NUMBER	REV.
3/16	C		

IDEAS LEVEL 8.0	USERNAME: DNITCHEL
CAFILE:	

REV.	DESCRIPTION	DRAWN	DATE
		APPD.	DATE



ITEM NO.	PART NO.	DESCRIPTION OR SIZE	QTY. REQ.

PARTS LIST

UNLESS OTHERWISE SPECIFIED			ORIGINATOR		
FRACTIONS	DECIMAL	ANGLES	DRAWN		
±	±	±	CHECKED		
			APPROVED		

1. BREAK ALL SHARP EDGES 1/64 MAX.
2. DO NOT SCALE DWG.
3. DIMENSIONING IN ACCORD WITH ANSI Y14.5 STD'S

MAX. ALL MACHINED SURFACES

USED ON

MATERIAL- A36 Steel

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

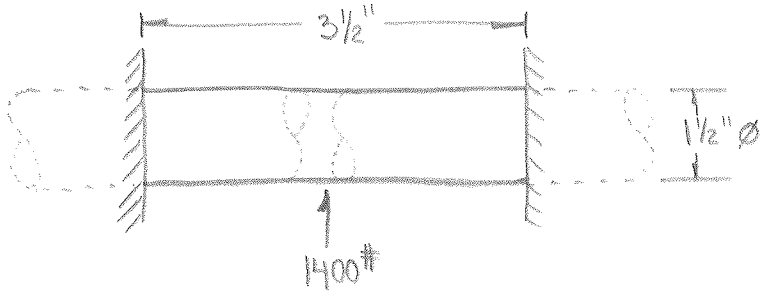
Lab E Lifting Fixture
Pick Point Pin Weldment

SCALE	DWG SIZE	DRAWING NUMBER	REV.
1:1	B		

IDEAS LEVEL 8,0 | USERNAME: DMITCHEL

CADFILE:

LabE: Lifting Fixture	Stress on Aluminum Bar at Crane Pick Point	Don Mitchell x4710 7-28-92



Aluminum T6061-T6

From "Specifications for Aluminum Structures":

allowable stress, $F_b = 24{,}000$ psi

$I = \frac{1}{4}\pi r^4 = \frac{1}{4}\pi(.75)^4 = .2485\ in^4$

$c = .75$ in

$M_x = \frac{FL}{8} = \left(\frac{1400\#}{8}\right)(3.5\,in) = 612.5$ lb-in

$\sigma_{max} = \frac{M_x c}{I} = \frac{(612.5\ in\text{-}lb)(.75\,in)}{.2485\ in^4} = 1{,}848$ psi OK

$\sigma_{max} = 1848$ psi

Shear Stress $= \frac{F}{A} = \frac{1400\#}{1.767\ in^2} = 792.2$ psi OK

$\tau = 792$ psi

Find S_{min}:

With S_{min} known, the smallest aluminum member able to withstand this load without being overstressed can be determined. A comparison between this beam and the actual lifting fixture beam can then be made.

Cantilevered end load:

$M_{max} = (34.25")(700\#) = 23{,}975$ in-lb

$\sigma_{allowable} = F_b = 19{,}000$ psi

$\sigma_{max} = \frac{M_{max}}{S_{min}} \Rightarrow S_{min} = \frac{M_{max}}{\sigma_{max}} = \frac{23{,}975\ in\text{-}lb}{19{,}000\ psi}$

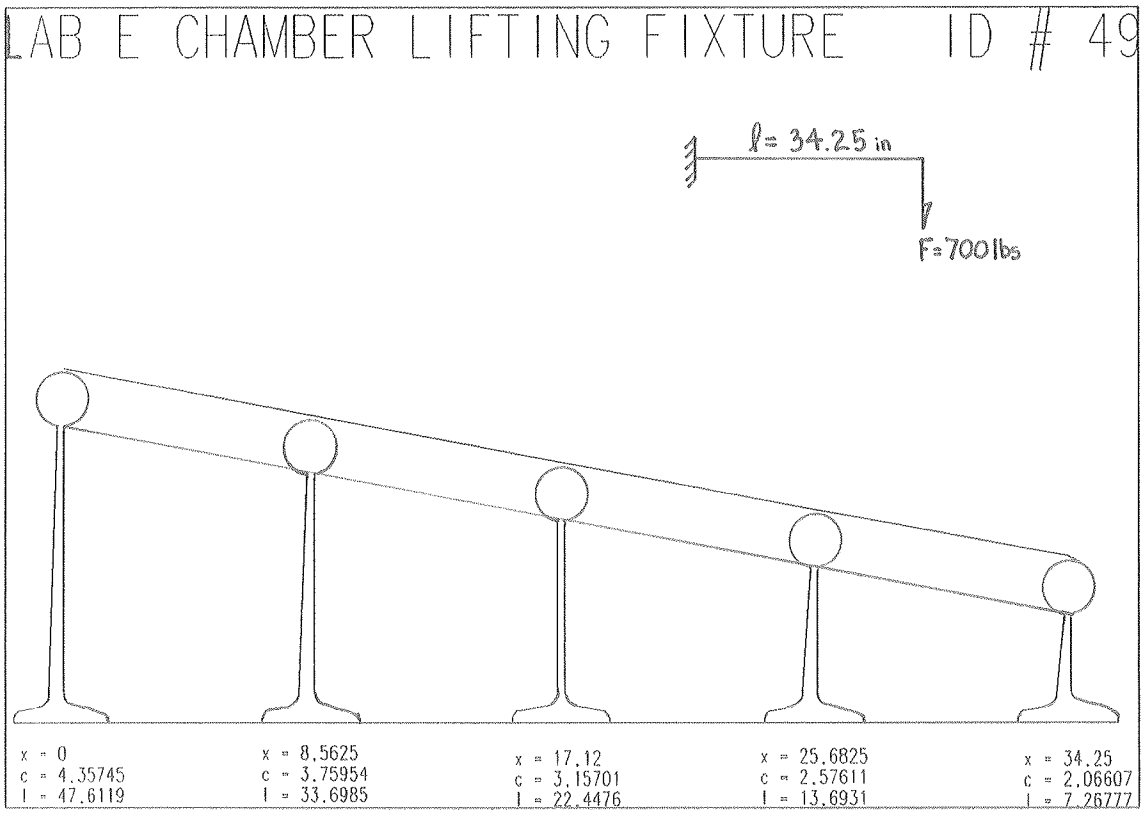
$S_{min} = 1.26\ in^3$

The smallest American Standard I-beam that can be used is a $3'' \times 2.33_{lbs} \times 1.96\#/ft$ w/ $S = 1.68\ in^3$, $I = 2.52\ in^4$

Tapered Beam Stress Analysis
Cantilevered End Load

Don Mitchell
7-29-92
x4710

LAB E Lifting Fixture



junk.mcs

$i := 1 \,..\, 34.25 \cdot 4$

$x_i := .25 \cdot i$

$M_i := F \cdot [x_i - l]$

Load and length of tapered beam:

$F := 700 \ \text{Lbs}$

$l := 34.25 \ \text{in}$

Curve fitted equation to determine distance from neutral axis to extreme fiber:

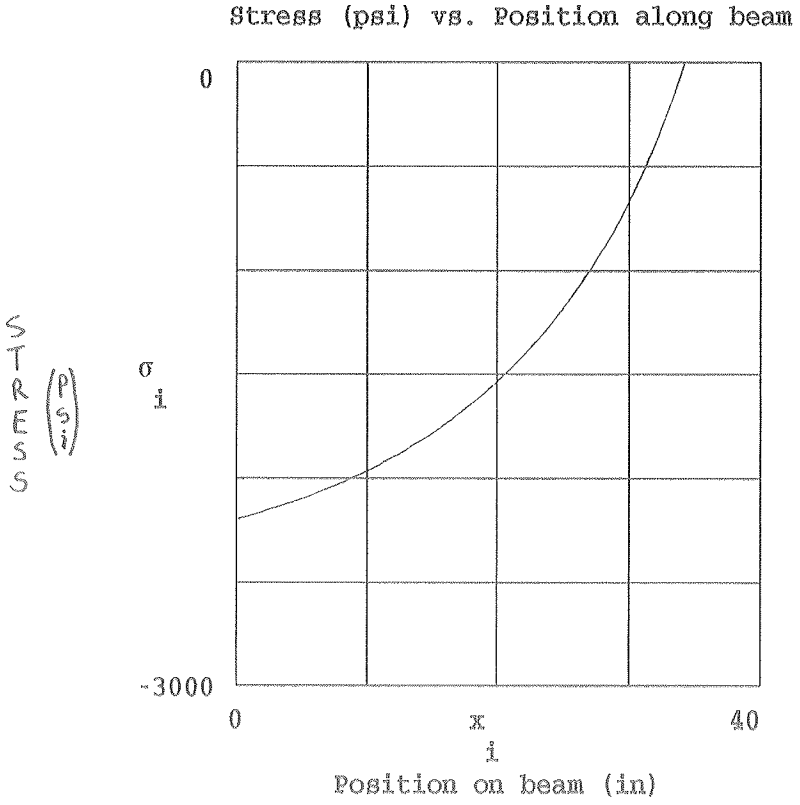
$$c_i := 4.357461 - .06918622 \cdot x_i - .00007126 \cdot x_i^2 - .000002047 \cdot x_i^3 + .000000177 \cdot x_i^4$$

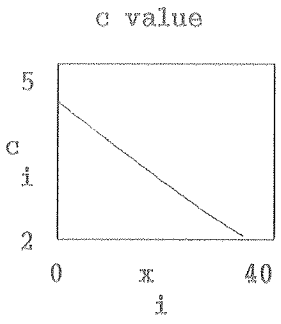
Curve fitted equation to determine the Moment of Inertia for the tapered beam:

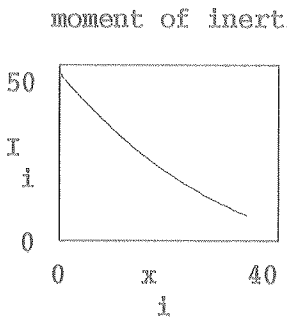
$$I_i := 47.61201 - 1.785776 \cdot x_i + .01909183 \cdot x_i^2 - .00003540131 \cdot x_i^3 - .0000001126073 \cdot x_i^4$$

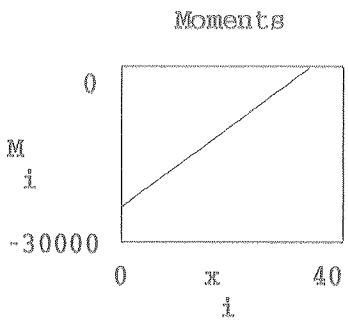
Stress Equation:

$$\sigma_i := \frac{M_i \cdot c_i}{I_i}$$









$\sigma_{max} = |-2,190 \text{ psi}|$

Data Curve Fitting Results

X-Values: X position (length)
Y-Values: Moment of Inertia about the X-X axis

Input Data:

	X	Y
Data point # 1 :	0	47.6139
Data point # 2 :	8.5625	33.6935
Data point # 3 :	17.12	22.4476
Data point # 4 :	25.6875	13.6431
Data point # 5 :	34.25	7.24777

Results:

	Equation	Average % Deviation	Maximum % Deviation
Exponential:	Y = 51.95814 * EXP(-5.442561E-02 * X)	7.64	10.02
Square Root:	Y = 49.84005 + 6.935931 * SQR(X)	11.45	22.05
Logarithmic:	Y = 75.1512 + -18.98659 * Ln(X)	4.37	10.60
Powers:	Not applicable (neg. or 0 X or Y values)	---	
Inverse:	Y = 2.120701 + 291.8705 / X	31.56	42.33
L. Sqrs:	Y = 45.0804 + 1.177028 * X	12.59	35.02
Polynomial:		0.00	0.00

Constant coefficient: 47.61391
1 Degree coefficient: -1.285746
2 Degree coefficient: 1.905181E-02
3 Degree coefficient: -5.946131E-04
4 Degree coefficient: 7.025241E-07

[illegible] FITTING RESULTS

X-Values: [illegible] position (length)
Y-Values: C (distance from neutral axis to extreme fiber

Input Data:

	(X)	(Y)
Data point # 1 :	0	4.35745
Data point # 2 :	8.5625	3.75954
Data point # 3 :	17.12	3.15701
Data point # 4 :	25.6825	2.57611
Data point # 5 :	34.25	2.06607

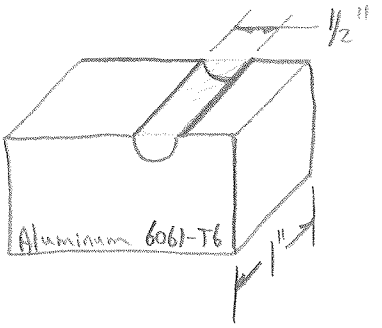
Results:

	Equation	Average % Deviation	Maximum % Deviation
Exponential:	Y = 4.471075 * EXP(-2.184671E-02 * X)	1.98	2.60
Square Root:	Y = 4.564344 + -.3859457 * SQRT(X)	6.55	12.15
Logarithmic:	Y = 6.419871 + -1.200016 * ln(X)	3.58	5.48
Power:	Not applicable (neg. or (0) X or Y-values)	---	---
Inverse:	Y = 1.824152 + 17.55197 / X	6.65	14.01
Linear:	Y = 4.346379 + -.06744459 * X	0.85	1.26
Polynomial:		0.00	0.00

Constant coefficient: 4.357163
1 Degree coefficient:-6.718622E-02
2 Degree coefficient: 7.102704E-05
3 Degree coefficient:-2.047274E-04
4 Degree coefficient: 1.779408E-07

Lab E lifting Fixture | Bearing Stress on Pin Holes | Donald V. Mitchell 7-28-92 x4710

Reference: Specifications for Aluminum Structures



Bearing Area = $(1/2")(1") = 1/2\ in^2$

Load on Pin = 700 #

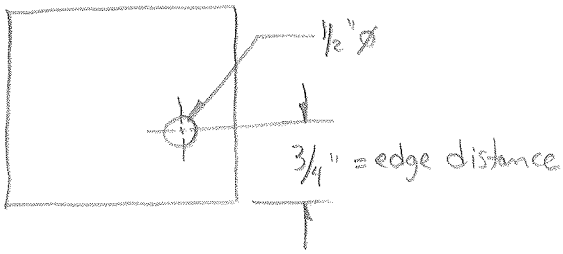
Bearing stress = $\frac{700\ \#}{1/2\ in^2} = 1400\ psi$

Allowable Bearing Stress:

Minimum edge distance should be:

e.d = 2 × nominal diameter

e.d = 2 × 1/2" = 1"



Allowable bearing stress for standard edge distance = 35,000 psi

Reduction factor = $3/4" / 1" = .75$

Allowable bearing stress = $(35{,}000\ psi)(.75) = 26{,}250\ psi$

actual bearing stress = 1400 psi : OK

Absolute Minimum edge distance = (1.5)(hole diameter)

= (1.5)(.5)

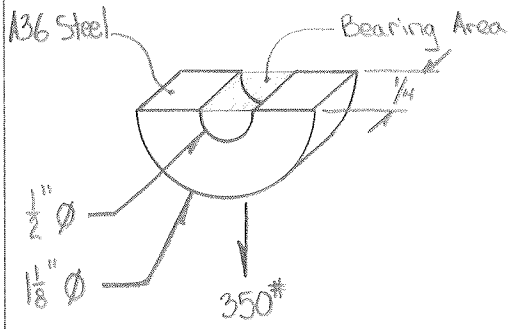
= .75", 3/4"

Shear area of block = $(.56in)(1in) = .56in^2$

Shear stress$_{Block}$ = $\frac{700\#}{.56in^2} = 1250\ psi$

allowable shear stress = 11,000 psi

Lab E: Lifting Fixture	Bearing Stress and min. Edge distance on Steel Connector	Don Mitchell x4710 7-28-92



$$\text{Bearing Area} = \left(\tfrac{1}{4}"\right)\left(1/2"\right) = .125\ in^2$$

$$\text{Bearing Stress} = \frac{F}{A_b} = \frac{350\#}{.125\ in^2} = 2800\ psi$$

From AISC 9th edition:

$$\text{Allowable Bearing Stress} = \frac{L_e F_u}{2d}$$

$$\sigma_b = \frac{(.5")(58\ ksi)}{(2)(.5"\text{ Ø})}$$

$$\sigma_b = 29{,}000\ psi \quad \underline{OK}$$

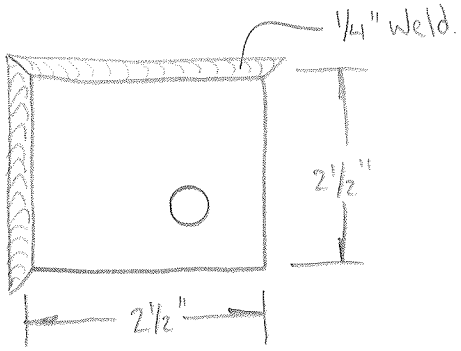
Allowable, Minimum Edge distance: (AISC)

$$L_e = 2P/F_u t = \frac{2(350\#)}{(58000\ psi)(.25\ in)} = .048\ in$$

For an edge distance of 1/2" (as in this case), the maximum load allowable is 3,625 lbs.

WELDS:

A 2 1/2" x 2 1/2" x 1" Aluminum block is mounted at each end of the beam. Ten inches of 1/4" deep weld is used to mount each block. With only 700 lbs supported, 70 lbs/inch of weld is well below the allowable.



BELOW-THE-HOOK LIFTING DEVICE
Engineering Note Cover Page

Lifting Device Numbers:

FNAL Site No.:_____ if applicable Div. Specific No.: #49 if applicable Asset No. _____ if applicable

ASME B30.20 Group: (check one)
- (Group I) Structural and Mechanical Lifting Devices
- Group II Vacuum Lifting Devices
- Group III Magnets, Close Proximity Operated
- Group IV Magnets, Remote Operated

Device Name or Description: SPREADER BAR

Device was: (check all applicable)
- Purchased from a Commercial Lifting Device Manufacturer
  - mfg. name: _____
- ✓ Designed and Built at Fermilab
- Designed by Fermilab and Built by a Vendor
  - Assy drawing number: _____
- Provided by a User or Other Laboratory
- Other. Describe: _____

Engineering Note Prepared by: Don Mitchell Date: 7-23-92

Engineering Note Reviewed by: Zhiying Date: 3-3-2000

Lifting Device Data:

Capacity: 1400 lbs

Fixture Weight: 34 lbs

Service: ✓normal heavy severe (refer to B30.20 for definitions)

Duty Cycle: _____ 8, 16 or 24 hour rating (applicable to groups III, and IV)

Inspections Frequency: _____

Rated Load Test by FNAL (if applicable): Date: 3/14/00 Load: 1680 lbs

Check if Load Test was by Vendor and attach the certificate.

Satisfactory Load Test Witnessed by: JAMES FAGAN 6475

Signature (of Load Test Witness): James Fagan

Notes or Special Information:

Spreader bar to 15ft HDT Drill fixture weight = 1250 lbs
Original calculations used 1400 lbs load. Device to be re-rated to 1400 lbs by testing to 1680 lbs.