LIFTING DEVICE

DEVICE NAME: CDF Pit Steel Scintillator Lifting Fixture

ENGINEERING NOTE NUMBER: #57

DRAWING NUMBER: 2563.2-MD-324037

APPLICABLE STANDARD: Aluminum Association Standards

RATED LOAD: 775#

TEST LOAD: 990#

TEST LOAD PERCENT: >125%

LAST LOAD TEST DATE: 9/8/93

COLOR: Aluminum

STRESS CALCULATIONS:

Done by: James F. Brusoe

Date: 4-13-93

Reviewed by: Zhijing Tang

Date: 4-14-93

REMARKS: Load test conducted at MAB on 9/8/93. Deflections were minimal. This beam could take a larger load but it is not required for the purpose it was designed for.

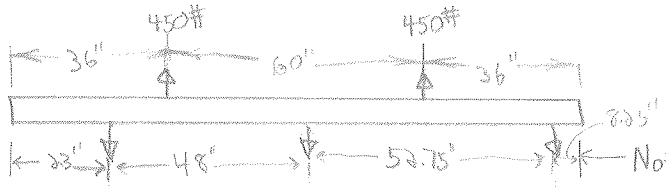
IDENTIFICATION:

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

James Brusoe X2885

Calculations For Bending Stress In Beam

Load Used For Calculations: 900 lbs (about 126.7% of working load)

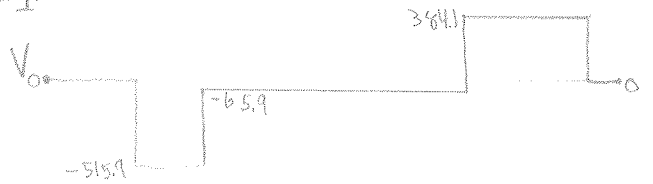


Note: These supports positioned for worse cases.

CASE 1: 515.9 # 384.1 # Note: This case represents end loading. Middle pick up point is ignored.

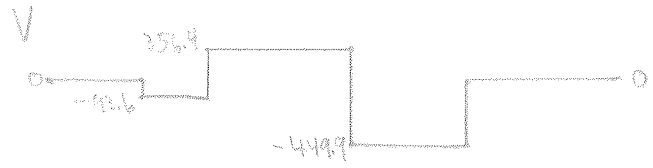
CASE 2: 93.6# 806.3# Note: This case represents central loading. 93.6# side loading necessary for equilibr.

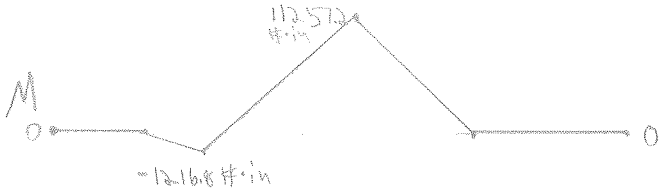
CASE 1:



Maximum Bending moment produced in Case 1 is 10660.7 #·in

CASE 2:

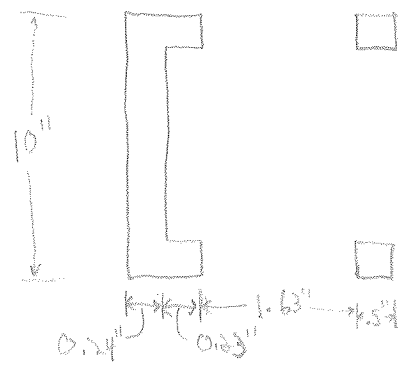




Maximum bending moment produced in Case 2 is 112572 #·in

James Brusoe

New Moment of Inertia due to cut-out regions:



Moment of Inertia due solely to the web:

$$I = \frac{1}{12} bh^3 = \frac{1}{12}(0.24)10^3$$
$$= 20 \text{ in}^4$$

Moment for calculation: 112572 #·in
mult. by 3 F.S = 337716 #·in

$$\sigma = \frac{Mc}{I} = \frac{337716 \text{ \#}\cdot\text{in} \cdot 5\text{in}}{20 \text{ in}^4} = 8442.9 \text{ psi}$$

$\sigma_{max} = 17{,}000$ psi (non-welded aluminum) $\Rightarrow$ SAFE

James Bruce

SHEAR CALCULATIONS

BOLTS

Maximum forseeable load on a bolt is 806.3# taken from a worst-case scenario (diagrammed on bending stress page). This could only happen if the other bolt in the pair failed.

1/2" diameter steel bolt
5/16" head height
3/4" head width

$\tau_{allow} = 0.40\, F_y = 0.40(36{,}000\,psi)$

$\underline{\tau_{allow} = 14{,}400\,psi}$

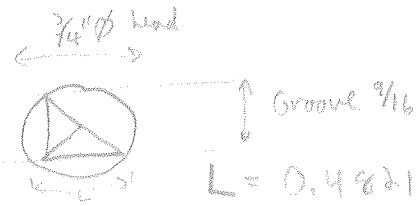
Area of shear $= 2Lh = 2(0.48)\frac{5}{16} = 0.300\,in^2$

$\tau = \frac{V}{A} = \frac{806.3\#}{0.300\,in^2} = 2687.7\,psi$

$F.S. = 3 \Rightarrow \underline{\tau_{actual} = 8063.1\,psi}$

SAFE

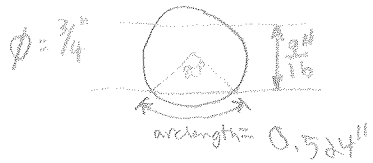
Calculation for L in above calc:



$L = 0.4821$ (Using sine law)

PLATES

Area of shear



shear Area = arclength · plate thickness · 2

$= 0.524'' \cdot 0.5'' \cdot 2 = 0.524\,in^2$

$\underline{\tau_{allow} = 14{,}400\,psi}$

$\underline{\tau_{actual}} = \frac{V}{A} \cdot 3FS = \frac{806.3\#}{0.524\,in^2} \cdot 3 = \underline{4616.2\,psi}$

SAFE

BEAM

Shear Area is along edges of plate

Plate is 15.25" x 2.5"

Beam is ave. 0.424" thick

$\Rightarrow A = (2(15.25) + 2(2.5)) \cdot 0.424 = 15.052$

$\underline{\tau_{allow} = 20{,}000\,psi}$

$\underline{\tau_{actual}} = \frac{V}{A} \cdot 3FS = \frac{806.3}{15.052} \cdot 3 = \underline{160.7\,psi}$

SAFE

BENDING STRESS OF PLATE

FROM ROARK'S FORMULAS FOR STRESS & STRAIN

Loading is uniform over small concentric circle of radius r_0

Simply supported edges

$$\text{Max } \sigma = \frac{3W}{2\pi t^2}\left[(1+\nu)\ln\frac{2b}{\pi r_0'} + \beta\right]$$

where $r_0' = \sqrt{1.6r_0^2 + t^2} - 0.675t$

Size of hole	$a = 4.75''$, $b = 1.63''$
Thickness of plate	$t = 0.5''$
Circle radius (radius of bolt head)	$r_0 = 3/8''$
Load	$W = 806.3$ #
Poisson's ratio for steel	$\nu = 0.3$
ratio number from Roark's	$\beta = 1.000$

$$r_0' = \sqrt{1.6\left(\tfrac{3}{8}\right)^2 + (0.5)^2} - 0.675(0.5)$$

$$r_0' = 0.827$$

Note: The r_0 value of 3/8" is conservative since there is actually 2 bolts sharing the load.

$$\sigma = \frac{3 \cdot 806.3}{2\pi(0.5)^2}\left[(1+0.3)\ln\frac{2(1.63)}{\pi(0.827)} + 1\right]$$

$$\sigma = 1994.2 \text{ psi} \cdot 3 \text{ FS}$$

$$\sigma = 5982.7 \text{ psi}$$

$$\sigma_{allow} = 27{,}000 \text{ psi} \quad \underline{\underline{\text{SAFE}}}$$

Note on April 19, '93: Hole beneath plate has been extended to 7 1/4" long. This will not change the above calculation, since a is only used to look up β in a table, and the value from the table using the new a value is the same.

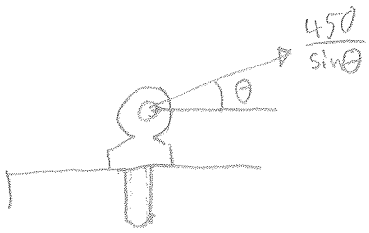
James Brusoe

EYEBOLT CALCULATIONS

Maximum working load from catalog: 2600 lbs.

Vertical load in this application: 450 lbs

NOTE: The factor of safety of 3 has already been included in the catalog's load number.



shear: $\tau_{allow} = 0.40 F_y$ (see photocopy)

$\tau_{allow} = 14{,}400$ psi

$$\tau = \frac{V}{A} = \frac{450 \frac{\cos\theta}{\sin\theta}}{\pi (0.25)^2} \cdot 3 \text{ F.S.}$$

$$\tan\theta = \frac{450 \cdot 3}{14{,}400\, \pi\, (0.25)^2}$$

$\theta = 25.5°$ minimum angle for a F.S. of 3

$\Downarrow$

$\theta > 26°$

Table A.6
Allowable Stresses for BRIDGE and Similar Type Structures

6061—T6, —T651, —T6510, —T6511 Extrusions, Sheet and Plate, Standard Structural Shapes, Rolled Rod and Bar, Drawn Tube, Pipe

6351-T5 Extrusions

Type of Stress	Type of Member or Component	Spec. No.	Allowable Stress, ksi	
TENSION, axial, net section	Any tension member	1	17	10①
TENSION IN BEAMS, extreme fiber, net section	Rectangular tubes, structural shapes bent about strong axis	2	17	10①
	Round or oval tubes	3	21	12①
	Shapes bent about weak axis rectangular bars, plates	4	25	14①
BEARING	On rivets and bolts	5	30	16①
	On flat surfaces and pins and on bolts in slotted holes	6	20	11①

			Allowable Stress, ksi, Slenderness ≤ S_1	Slenderness Limit, S_1	Allowable Stress, ksi Slenderness Between S_1 and S_2	Slenderness Limit, S_2	Allowable Stress, ksi Slenderness ≥ S_2
COMPRESSION IN COLUMNS, axial, gross section	All columns	7	17	$\frac{L}{r} = 8.0$	$17.9-0.112\frac{L}{r}$	$\frac{L}{r} = 66$	$\frac{45{,}000}{(L/r)^2}$
			11①	$\frac{L}{r} = 62$①	$17.9-0.112\frac{L}{r}$	$\frac{L}{r} = 66$	$\frac{45{,}000}{(L/r)^2}$
COMPRESSION IN COMPONENTS OF COLUMNS, gross section	Outstanding flanges and legs	8	17	$\frac{b}{t} = 5.0$	$20.5-0.70\frac{b}{t}$	$\frac{b}{t} = 12$	$\frac{1{,}740}{(b/t)^2}$
			11①	— — —	11①	$\frac{b}{t} = 13$①	$\frac{1{,}740}{(b/t)^2}$
	Flat plates with both edges supported	9	17	$\frac{b}{t} = 16$	$20.5-0.22\frac{b}{t}$	$\frac{b}{t} = 33$	$\frac{430}{(b/t)}$
			11①	— — —	11①	$\frac{b}{t} = 39$①	$\frac{430}{(b/t)}$
	Curved plates supported on both edges, walls of round or oval tubes	10	17	$\frac{R}{t} = 13$	$19.6-0.71\sqrt{\frac{R}{t}}$	$\frac{R}{t} = 141$	$\frac{2{,}800}{(R/t)(1+\sqrt{R/t}/35)^2}$
			11①	$\frac{R}{t} = 5.2$①	$12.0-0.44\sqrt{\frac{R}{t}}$	$\frac{R}{t} = 290$	$\frac{2{,}800}{(R/t)(1+\sqrt{R/t}/35)^2}$
COMPRESSION IN BEAMS, extreme fiber, gross section	Single web beams bent about strong axis	11	19	$\frac{L_b}{r_y} = 21$	$21.3-0.111\frac{L_b}{r_y}$	$\frac{L_b}{r_y} = 79$	$\frac{78{,}000}{(L_b/r_y)^2}$
			11①	— — —	11①	$\frac{L_b}{r_y} = 84$①	$\frac{78{,}000}{(L_b/r_y)^2}$
	Round or oval tubes	12	22	$\frac{R_b}{t} = 29$	$35.0-2.4\sqrt{\frac{R_b}{t}}$	$\frac{R_b}{t} = 83$	Same as Specification No. 10 (See Par. 3.4.12)
			12.5①	$\frac{R_b}{t} = 50$①	[illegible]	[illegible]	Same as Specification No. 10 (See Par. 3.4.12)
	Solid rectangular beams	13	25	$\frac{d}{t}\sqrt{\frac{L_b}{d}} = 13$	$36.1-0.83\frac{d}{t}\sqrt{\frac{L_b}{d}}$	$\frac{d}{t}\sqrt{\frac{L_b}{d}} = 29$	$\frac{10{,}200}{(d/t)^2(L_b/d)}$
			14①	$\frac{d}{t}\sqrt{\frac{L_b}{d}} = 27$①	$36.1-0.83\frac{d}{t}\sqrt{\frac{L_b}{d}}$	$\frac{d}{t}\sqrt{\frac{L_b}{d}} = 29$	$\frac{10{,}200}{(d/t)^2(L_b/d)}$
	Rectangular tubes and box sections	14	19	$\frac{L_bS_r}{I_y} = 120$	$21.3-0.21\sqrt{\frac{L_bS_r}{I_y}}$	$\frac{L_bS_r}{I_y} = 1700$	$\frac{21{,}000}{(L_bS_r/I_y)}$
			11①	— — —	11①	$\frac{L_bS_r}{I_y} = 1910$①	$\frac{21{,}000}{(L_bS_r/I_y)}$
COMPRESSION IN COMPONENTS OF BEAMS, (component under uniform compression), gross section	Outstanding flanges	15	19	$\frac{b}{t} = 6.4$	$24.3-0.83\frac{b}{t}$	$\frac{b}{t} = 10$	$\frac{162}{(b/t)}$
			11①	— — —	11①	$\frac{b}{t} = 15$①	$\frac{162}{(b/t)}$
	Flat plates with both edges supported	16	19	$\frac{b}{t} = 20$	$24.3-0.26\frac{b}{t}$	$\frac{b}{t} = 33$	$\frac{520}{(b/t)}$
			11①	— — —	11①	$\frac{b}{t} = 47$①	$\frac{520}{(b/t)}$
COMPRESSION IN COMPONENTS OF BEAMS, (component under bending in own plane), gross section	Flat plates with compression edge free, tension edge supported	17	25	$\frac{b}{t} = 8.8$	$36.1-1.26\frac{b}{t}$	$\frac{b}{t} = 19$	$\frac{4{,}400}{(b/t)^2}$
			14①	$\frac{b}{t} = 18$①	$36.1-1.26\frac{b}{t}$	$\frac{b}{t} = 19$	$\frac{4{,}400}{(b/t)^2}$
	Flat plates with both edges supported	18	25	$\frac{h}{t} = 46$	$36.1-0.24\frac{h}{t}$	$\frac{h}{t} = 75$	$\frac{1{,}350}{(h/t)}$
			14①	— — —	14①	$\frac{h}{t} = 86$①	$\frac{1{,}350}{(h/t)}$
	Flat plates with horizontal stiffener both edges supported	19	25	$\frac{h}{t} = 107$	$36.1-0.104\frac{h}{t}$	$\frac{h}{t} = 173$	$\frac{3{,}100}{(h/t)}$
			14①	— — —	14①	$\frac{h}{t} = 221$①	$\frac{3{,}100}{(h/t)}$
SHEAR IN WEBS, gross section	Unstiffened flat webs	20	11	$\frac{h}{t} = 33$	$13.9-0.089\frac{h}{t}$	$\frac{h}{t} = 65$	$\frac{34{,}000}{(h/t)^2}$
			6.5①	— — —	6.5①	$\frac{h}{t} = 72$①	$\frac{34{,}000}{(h/t)^2}$
	Stiffened flat webs $a_e = a_1\Big/\sqrt{1+0.7(a_1/a_2)^2}$	21	11	— — —	11	$\frac{a_e}{t} = 65$	$\frac{47{,}000}{(a_e/t)^2}$
			6.5①	— — —	6.5①	$\frac{a_e}{t} = 85$①	$\frac{47{,}000}{(a_e/t)^2}$

WHITE BARS apply to nonwelded members and to welded members at locations farther than 1.0 in. from a weld. SHADED BARS apply within 1.0 in. of a weld.

① For all thicknesses with filler alloys 5356 or 5556. With filler alloys 4043, 5554 or 5654 values apply to metal 0.375 in. or less in thickness; for greater thicknesses multiply allowable stresses by 0.8.

② For all thicknesses with filler alloys 5356 or 5556; for metal 0.375 in. or less in thickness with filler alloys 4043, 5554 or 5654.

TABLE 3.3.1a

MINIMUM MECHANICAL PROPERTIES FOR ALUMINUM ALLOYS (See Also Section 3.1)

Values Are Given in Units of ksi (1000 lb/in^2)

Alloy And Temper	Product*	Thickness Range* in.	TENSION F_{tu}† ksi	TENSION F_{ty}† ksi	COMPRESSION F_{cy} ksi	SHEAR F_{su} ksi	SHEAR F_{sy} ksi	BEARING F_{bu} ksi	BEARING F_{by} ksi	Compressive Modulus of Elasticity‡ E ksi
1100-H12	(Sheet, Plate	All	14	11	10	9	6.5	28	18	10,100
-H14	Rolled Rod & Bar)	All	16	14	13	10	8	32	21	10,100
2014-T6	Sheet	0.040-0.249	66	58	59	40	33	125	93	10,900
-T651	Plate	0.250-2.000	67	59	58	40	34	127	94	10,900
-T6,T6510**	Extrusions	All	60	53	52	35	31	114	85	10,900
-T6,T651	Rolled Rod & Bar Drawn Tube	All	65	55	53	38	32	124	88	10,900
Alclad 2014-T6	Sheet	0.025-0.039	63	55	56	38	32	120	88	10,800
-T6	Sheet	0.040-0.249	64	57	58	39	33	122	91	10,800
-T651	Plate	0.250-0.499	64	57	56	39	33	122	91	10,800
3003-H12	Sheet & Plate	0.017-2.000	17	12	10	11	7	34	19	10,100
-H14	Sheet & Plate	0.009-1.000	20	17	14	12	10	40	25	10,100
-H16	Sheet	0.006-0.162	24	21	18	14	12	46	31	10,100
-H18	Sheet	0.006-0.128	27	24	20	15	14	49	34	10,100
3003-H12	Drawn Tube	All	17	12	11	11	7	34	19	10,100
-H14	Drawn Tube	All	20	17	16	12	10	40	25	10,100
-H16	Drawn Tube	All	24	21	19	14	12	46	31	10,100
-H18	Drawn Tube	All	27	24	21	15	14	49	34	10,100
Alclad 3003-H12	Sheet & Plate	0.017-2.000	16	11	9	10	6.5	32	18	10,100
-H14	Sheet & Plate	0.009-1.000	19	16	13	12	9	38	24	10,100
-H16	Sheet	0.006-0.162	23	20	17	14	12	44	30	10,100
-H18	Sheet	0.006-0.128	26	23	19	15	13	47	32	10,100
Alclad 3003-H14	Drawn Tube	0.025-0.259	19	16	15	12	9	38	24	10,100
-H18	Drawn Tube	0.010-0.500	26	23	20	15	13	47	32	10,100
3004-H32	Sheet & Plate	0.017-2.000	28	21	18	17	12	56	36	10,100
-H34	Sheet & Plate	0.009-1.000	32	25	22	19	14	64	40	10,100
-H36	Sheet	0.006-0.162	35	28	25	20	16	70	45	10,100
-H38	Sheet	0.006-0.128	38	31	29	21	18	72	45	10,100
3004-H34	Drawn Tube	0.018-0.450	32	25	24	19	14	64	40	10,100
-H36	Drawn Tube	0.018-0.450	35	28	27	20	16	70	45	10,100
Alclad 3004-H32	Sheet	0.017-0.249	27	20	17	16	12	54	34	10,100
-H34	Sheet	0.009-0.249	31	24	21	18	14	62	38	10,100
-H36	Sheet	0.006-0.162	34	27	24	19	16	68	43	10,100
-H38	Sheet	0.006-0.128	37	30	28	21	17	70	44	10,100
-H14	Sheet & Plate	0.009-0.499	32	26	24	19	15	64	39	10,100
-H16	Sheet	0.006-0.162	35	30	28	20	17	66	45	10,100
-H131, H241, H341	Sheet	0.024-0.050	31	26	22	18	15	62	39	10,100
-H151, H261, H361	Sheet	0.024-0.050	34	30	28	19	17	66	45	10,100
3005-H25	Sheet	0.013-0.050	26	22	20	15	13	49	35	10,100
-H28	Sheet	0.006-0.080	31	27	25	17	16	56	38	10,100
3006-H391	Sheet	0.010-0.050	31	27	27	20	16	60	44	10,100
3105-H25	Sheet	0.013-0.080	23	19	17	14	11	44	28	10,100
5005-H12	Sheet & Plate	0.017-2.000	18	14	13	11	8	34	22	10,100
-H14	Sheet & Plate	0.009-1.000	21	17	15	12	10	40	25	10,100
-H16	Sheet	0.006-0.162	24	20	18	14	12	48	30	10,100
-H32	Sheet & Plate	0.017-2.000	17	12	11	11	7	34	20	10,100
-H34	Sheet & Plate	0.009-1.000	20	15	14	12	8.5	40	24	10,100
-H36	Sheet	0.006-0.162	23	18	16	13	11	48	29	10,100

TABLE 3.3.1a (cont'd)

Alloy And Temper	Product*	Thickness Range* in.	TENSION F_{tu}† ksi	TENSION F_{ty}† ksi	COMPRESSION F_{cy} ksi	SHEAR F_{su} ksi	SHEAR F_{sy} ksi	BEARING F_{bu} ksi	BEARING F_{by} ksi	Compressive Modulus of Elasticity‡ E ksi
5050-H32	Sheet	0.017-0.249	22	16	14	14	9	44	27	10,100
-H34	Sheet	0.009-0.249	25	20	18	15	12	50	32	10,100
-H32	Rolled Rod & Bar† Drawn Tube	All	22	16	15	13	9	44	27	10,100
-H34	Rolled Rod & Bar† Drawn Tube	All	25	20	19	15	12	50	32	10,100
5052-H32	(Sheet & Plate Rolled Rod & Bar Drawn Tube)	All	31	23	21	19	13	60	39	10,200
-H34	(Sheet & Plate Rolled Rod & Bar Drawn Tube)	All	34	26	24	20	15	65	44	10,200
-H36	Sheet	0.006-0.162	37	29	26	22	17	70	46	10,200
5083-H111	Extrusions	up thru 0.500	40	24	21	24	14	78	41	10,400
-H111	Extrusions	0.501 and over	40	24	21	23	14	78	38	10,400
-H321, H116	Sheet & Plate	0.188-1.500	44	31	26	26	18	84	53	10,400
-H321, H116	Plate	1.501-3.000	41	29	24	24	17	78	49	10,400
-H323	Sheet	0.051-0.249	45	34	32	26	20	88	58	10,400
-H343	Sheet	0.051-0.249	50	39	37	29	23	95	66	10,400
5086-H111	Extrusions	up thru 0.500	36	21	18	21	12	70	36	10,400
-H111	Extrusions	0.501 and over	36	21	18	21	12	70	34	10,400
-H112	Plate	0.250-0.499	36	18	17	22	10	72	31	10,400
-H112	Plate	0.500-1.000	35	16	16	21	9	70	28	10,400
-H112	Plate	1.001-2.000	35	14	15	21	8	70	28	10,400
-H112	Plate	2.001-3.000	34	14	15	21	8	68	28	10,400
-H116, H32	(Sheet & Plate Drawn Tube)	All	40	28	26	24	16	78	48	10,400
-H34	(Sheet & Plate Drawn Tube)	All	44	34	32	26	20	84	58	10,400
5154-H38	Sheet	0.006-0.128	45	35	33	24	20	81	56	10,300
5454-H111	Extrusions	up thru 0.500	33	19	16	20	11	64	32	10,400
-H111	Extrusions	0.501 and over	33	19	16	19	11	64	30	10,400
-H112	Extrusions	up thru 5.000	31	12	13	19	7	62	24	10,400
-H32	Sheet & Plate	0.020-2.000	36	26	24	21	15	70	44	10,400
-H34	Sheet & Plate	0.020-1.000	39	29	27	23	17	74	49	10,400
5456-H111	Extrusions	up thru 0.500	42	26	22	25	15	82	44	10,400
-H111	Extrusions	0.501 and over	42	26	22	24	15	82	42	10,400
-H112	Extrusions	up thru 5.00	41	19	20	24	11	82	38	10,400
-H116, H321	Sheet & Plate	0.188-1.250	46	33	27	27	19	87	56	10,400
-H116, H321	Plate	1.251-1.500	44	31	25	25	18	84	53	10,400
-H116, H321	Plate	1.501-3.000	41	29	25	25	17	82	49	10,400
-H323	Sheet	0.051-0.249	48	36	34	28	21	94	61	10,400
-H343	Sheet	0.051-0.249	53	41	39	31	24	101	70	10,400
6005-T5	Extrusions	up thru 0.500	38	35	35	24	20	80	56	10,100
6061-T6,T651	Sheet & Plate	0.010-4.000	42	35	35	27	20	88	58	10,100
-T6, T6510**	Extrusions	up thru 1.000	38	35	35	24	20	80	56	10,100
-T6,T651	Rolled Rod & Bar	up thru 8.000	42	35	35	27	20	88	56	10,100
-T6	Drawn Tube	0.025-0.500	42	35	35	27	20	88	56	10,100
-T6	Pipe	up thru 0.999	42	35	35	27	20	88	56	10,100
-T6	Pipe	over 0.999	38	35	35	24	20	80	56	10,100
6063-T5	Extrusions	up thru 0.500	22	16	16	13	9	46	26	10,100
-T5	Extrusions	over 0.500	21	15	15	12	8.5	44	24	10,100
-T6	Extrusions & Pipe	All	30	25	25	19	14	63	40	10,100
6351-T5	Extrusions	up thru 1.00	38	35	35	24	20	80	56	10,100

*Most product and thickness ranges are taken from The Aluminum Association's 1984 edition of "Aluminum Standards and Data."

†F_{tu} and F_{ty} are minimum specified values (except F_{ty} for 1100-H12, -H14 Rolled Rod and Bar and Drawn Tube, Alclad 3003-H18 Sheet and 5050-H32, -H34 Rolled Rod and Bar); other strength properties are corresponding minimum expected values.

‡Typical values. For deflection calculations an average modulus of elasticity is used; numerically this is 100 ksi lower than the values in this column.

**Values also apply to -T6511 temper.

TABLE 1-1

Specified Minimum Strengths of Certain ASTM Steels

STEEL TYPE	ASTM NO.	S_y, kpsi	S_u, kpsi	SIZE, in. UP TO
Carbon	A36	36	58	8
Carbon	A529	42	60	$\frac{1}{2}$
Low alloy	A572	42	60	6
Low alloy	A572	50	65	2
Stainless	A588	50	70	4
Alloy Q&T	A514	100	110	$2\frac{1}{2}$

engineering literature. Important standards included in this manual are the Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings and the Code of Standard Practice for Steel Buildings and Bridges.

Table 1-1 lists minimum yield strengths S_y and minimum tensile strengths S_u for certain ASTM steels as given in the AISC specifications. In this table, S_y represents either the minimum yield point, if the material has one, or the minimum yield strength.

The ANSI-ASTM standard B483-78 defines *minimum strength* as follows:

> **A2.1** Standard mechanical property limits for the respective size ranges are based on an analysis of data from standard production material and are established at a level [at] which at least 99 percent of the population of values obtained from all standard material in the size range meets the established value.

Many readers may prefer to qualify *minimum* by always using the adjective *ASTM*, as in *ASTM minimum strength*. The unqualified word *minimum* may be misleading, since there is a chance that up to 1 percent of the materials involved may have a strength smaller than the ASTM minimum.

To ensure that materials having these minimum strengths are actually used in the construction, the AISC specification states that:

> Certified mill test reports or certified reports of tests made by the fabricator or a testing laboratory in accordance with ASTM A6 or A568, as applicable, and the governing specification shall constitute sufficient evidence of conformity with one of the ASTM standards. Additionally, the fabricator shall, if requested, provide an affidavit stating that the structural steel furnished meets the requirements of the grade specified.

The language of designers often includes the terms *stress allowables*, *allowable stresses*, or simply *allowables*. These terms refer to reduced values of strengths that are used in design to determine the geometrical dimensions of parts sized according to strength. Finding these reduced values constitutes the first part of the AISC procedure. Let us designate allowable normal stress as σ_{all} and allowable shear stress as τ_{all}. Then the relationship between allowable stresses and specified minimum strengths using the AISC code is specified as:

$$\begin{aligned}
&\text{TENSION} && 0.45S_y \le \sigma_{all} \le 0.60S_y \\
&\text{SHEAR} && \tau_{all} = 0.40S_y \\
&\text{BENDING} && 0.60S_y \le \sigma_{all} \le 0.75S_y \\
&\text{BEARING} && \sigma_{all} = 0.90S_y
\end{aligned} \tag{1-1}$$