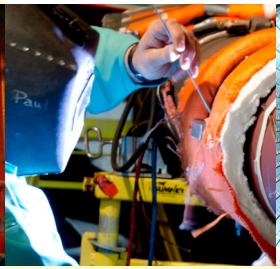
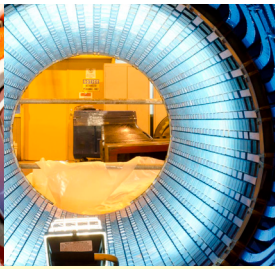
THE OUTAGE EXPERT
PROCESS, HABITS, CULTURE

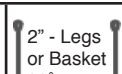
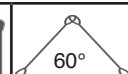
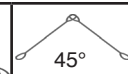
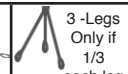




RIGGING
STUFF THAT WORKS

SLING CAPACITIES

MECHANICAL SPLICE IN POUNDS

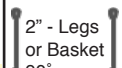
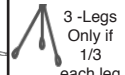
DESIGN FACTOR 5:1

Size in inches	 1.00 VERTICAL	 .75 CHOKER	 2" - Legs or Basket 90° 2.00	 60° 1.73	 45° 1.41	 30° 1.00	 3 -Legs Only if 1/3 each leg 2.60	Size in mm	
1/4	1,300	960	2,600	2,200	1,820	1,300	3,300	6.4	Wire Rope
5/16	2,000	1,480	4,000	3,400	2,800	2,000	5,100	8.0	
3/8	2,800	2,200	5,600	5,000	4,000	2,800	7,400	9.6	
7/16	3,800	2,800	7,600	6,800	5,400	3,800	10,000	11.0	
1/2	5,000	3,800	10,000	8,800	7,200	5,000	13,200	13.0	
9/16	6,400	4,800	12,800	11,000	9,000	6,400	16,500	14.0	
5/8	7,800	5,800	15,600	13,600	11,000	7,800	20,000	16.0	
3/4	11,200	8,200	22,400	19,400	15,800	11,200	29,100	19.0	
7/8	15,200	11,200	30,400	26,000	22,000	15,200	39,000	22.0	
1	19,600	14,400	39,200	34,000	28,000	19,600	51,000	25.4	
1-1/8	24,000	18,000	48,000	42,000	34,000	24,000	62,000	28.5	
1-1/4	30,000	22,500	60,000	52,000	42,000	30,000	76,000	32.0	
		MULTIPLIER -->		1.00	.75	.60	<-- MULTIPLIER		

Formula to find sling length - Total distance between pick points x Multiplier = Sling Length

SLING CAPACITIES

DESIGN FACTOR 5:1 - CHAIN 4:1 WEB 5:1 ROUND 5:1

	Size or Code	 1.00 VERTICAL	.80 CHOKER	 2" - Legs or Basket 90° 2.00	 60° 1.73	 45° 1.41	 30° 1.00	 3 -Legs Only if 1/3 each leg 2.60	Diameter or Width	
Chain G - 8	9/32	3,500	2,800	7,000	6,100	4,900	3,500	9,150	7 mm	Chain G - 8
	3/8	7,100	5,680	14,200	12,300	10,000	7,100	18,450	10 mm	
	1/2	12,000	9,600	24,000	20,800	17,000	12,000	31,200	13 mm	
	5/8	18,100	14,480	36,200	31,300	25,600	18,100	46,950	16 mm	
Web Eye & Eye	1-9-1	1,600	1,280	3,200	2,770	2,260	1,600	4,150	1"	Web Eye & Eye
	1-9-2	3,200	2,560	6,400	5,540	4,452	3,200	8,310	2"	
	1-9-3	4,800	3,840	9,600	8,320	6,780	4,800	12,480	3"	
	1-9-4	6,400	5,120	12,800	11,090	9,040	6,400	16,630	4"	
	2-9-3	8,800	7,1200	17,760	15,390	12,540	8,880	23,080	3"	
	2-9-4	11,520	9,210	23,040	19,960	16,270	11,520	29,940	4"	
Polyester Round	EN30	2,600	2,100	5,200	4,500	3,600	2,600	6,750	1"	Polyester Round
	EN60	5,300	4,200	10,600	9,100	7,500	5,300	13,650	1"	
	EN90	8,400	6,700	16,800	14,500	11,800	8,400	21,750	1.5"	
	EN120	10,600	8,500	21,200	18,300	14,900	10,600	27,450	1.5"	
	EN150	13,200	10,600	26,400	22,800	18,600	13,200	34,200	2"	
	EN180	16,800	13,400	33,600	29,100	23,700	16,800	43,650	2"	

RIGGING HARDWARE CAPACITIES

FORGED STEEL

Size in inches	Shldr Eye Bolt 5:1 Vertical	Shldr Eye Bolt 5:1 45 deg.	Turnbuckle 5:1 Eye or Jaw	Master Link 5:1	Shackle 6:1 SPAnchor	Wire Rope Clip Min# clips	Wire Rope Clip Turnback in inches	Wire Rope Clip Torque in ft. lbs.
1/4	500	125	500	-	1,000	2	4.75	15
5/16	800	200	800	-	1,500	2	5.25	30
3/8	1,200	300	1,200	-	2,000	2	6.50	45
7/16	-	-	-	-	3,000	2	7.00	65
1/2	2,200	550	2,200	4,920	4,000	3	11.50	65
9/16	-	-	-	-	-	3	12.00	95
5/8	3,500	875	3,500	6,600	6,500	3	12.00	95
3/4	5,200	1,300	5,200	10,320	9,500	4	18.00	130
7/8	7,200	1,800	7,200	-	13,000	4	19.00	225
1	10,000	2,500	10,000	24,360	17,000	5	26.00	225
1-1/8	-	-	-	-	19,000	6	34.00	225
1-1/4	15,200	3,800	15,200	35,160	24,000	7	44.00	360

Flat Shackle 5:1	Web Eye Width Inches
6,500	1-2
9,000	3
12,000	4
17,000	5

Swivel Hoist Rings 5:1

Size	WLL
3/8	1,000
1/2	2,500
5/8	4,000
3/4	5,000
7/8	8,000
1	10,000

COEFFICIENTS OF FRICTION

Concrete on Concrete	.65	Continuous lubricated	
Metal on Concrete	.60	Surface	.15
Wood on concrete	.45	Steel on steel	.10
Wood on metal	.30	Load on wheels	.05

D/d Ratios

30:1 = .94	8:1 = .83
20:1 = .92	5:1 = .77
15:1 = .89	2:1 = .65
10:1 = .86	1:1 = .50

LOAD WEIGHTS - CALCULATING

Materials and Liquids - Pounds / cu. ft.			
Aluminum	165	Iron Casting 450	
Asbestos	153	Lead 708	
Asphalt	81	Lumber - Fir 32	
Brass	524	Lumber - Oak 62	
Brick	120	Lumber - RR Ties 50	
Bronze	534	Oil, Motor 58	
Coal	56	Paper 58	
Concrete, Reinf.	150	Portland Cement 94	
Crushed Rock	85	River Sand 120	
Diesel	52	Rubber 94	
Dry Earth, Loose	75	Steel 480	
Gasoline	45	Water 63	
Glass	162	Zinc 437	

Pounds / sq. ft.	
Steel Plate	
• 1/8”	5
• 1/4”	10
• 1/2”	20
• 1”	40
Aluminum Plate	
• 1/8”	1.75
• 1/4”	3.50
Lumber	
• 3/4” Fir	2
• 3/4” Oak	4

Pounds / gal	
Steel Plate	
• 1/8”	5
• 1/4”	10

- 7.5 gallons of liquid to a cubic foot
- 27 cubic feet to a cubic yard
- 2,000 lbs = 1 U.S ton

Formulas and Information

- H = Height
- W = Width
- L = Length
- d = diameter
- r = 1/2 diameter
- π = 3.2 (approx)
- Area of square or rectangle = LW
- Vol. of cube = HWL
- Area of circle = πr^2
- Circumference = π d
- The area of a circle is approx 8-% of its diameter squared (diameter x diameter)
- Load weight (to estimate) --> Volume in cu. ft x 500 lbs x density factor .02, .05, .10, .20, .30 etc

RIGGING HARDWARE CAPACITIES

FORGED STEEL

Size in inches	Shldr Eye Bolt 5:1 Vertical	Shldr Eye Bolt 5:1 45 deg.	Turnbuckle 5:1 Eye or Jaw	Master Link 5:1	Shackle 6:1 SPAnchor	Wire Rope Clip Min# clips	Wire Rope Clip Turnback in inches	Wire Rope Clip Torque in ft. lbs.
1/4	500	125	500	-	1,000	2	4.75	15
5/16	800	200	800	-	1,500	2	5.25	30
3/8	1,200	300	1,200	-	2,000	2	6.50	45
7/16	-	-	-	-	3,000	2	7.00	65
1/2	2,200	550	2,200	4,920	4,000	3	11.50	65
9/16	-	-	-	-	-	3	12.00	95
5/8	3,500	875	3,500	6,600	6,500	3	12.00	95
3/4	5,200	1,300	5,200	10,320	9,500	4	18.00	130
7/8	7,200	1,800	7,200	-	13,000	4	19.00	225
1	10,000	2,500	10,000	24,360	17,000	5	26.00	225
1-1/8	-	-	-	-	19,000	6	34.00	225
1-1/4	15,200	3,800	15,200	35,160	24,000	7	44.00	360

Flat Shackle 5:1	Web Eye Width Inches
6,500	1-2
9,000	3
12,000	4
17,000	5

Swivel Hoist Rings 5:1

Size	WLL
3/8	1,000
1/2	2,500
5/8	4,000
3/4	5,000
7/8	8,000
1	10,000

COEFFICIENTS OF FRICTION

Concrete on Concrete	.65	Continuous lubricated	
Metal on Concrete	.60	Surface	.15
Wood on concrete	.45	Steel on steel	.10
Wood on metal	.30	Load on wheels	.05

D/d Ratios

30:1 = .94	8:1 = .83
20:1 = .92	5:1 = .77
15:1 = .89	2:1 = .65
10:1 = .86	1:1 = .50

LOAD WEIGHTS - CALCULATING

Materials and Liquids - Pounds / cu. ft.			
Aluminum	165	Iron Casting 450	
Asbestos	153	Lead 708	
Asphalt	81	Lumber - Fir 32	
Brass	524	Lumber - Oak 62	
Brick	120	Lumber - RR Ties 50	
Bronze	534	Oil, Motor 58	
Coal	56	Paper 58	
Concrete, Reinf.	150	Portland Cement 94	
Crushed Rock	85	River Sand 120	
Diesel	52	Rubber 94	
Dry Earth, Loose	75	Steel 480	
Gasoline	45	Water 63	
Glass	162	Zinc 437	

Pounds / sq. ft.	
Steel Plate	
• 1/8”	5
• 1/4”	10
• 1/2”	20
• 1”	40
Aluminum Plate	
• 1/8”	1.75
• 1/4”	3.50
Lumber	
• 3/4” Fir	2
• 3/4” Oak	4

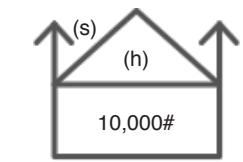
Pounds / gal	
Steel Plate	
• 1/8”	5
• 1/4”	10

- 7.5 gallons of liquid to a cubic foot
- 27 cubic feet to a cubic yard
- 2,000 lbs = 1 U.S ton

Formulas and Information

- H = Height
- W = Width
- L = Length
- d = diameter
- r = 1/2 diameter
- π = 3.2 (approx)
- Area of square or rectangle = LW
- Vol. of cube = HWL
- Area of circle = πr^2
- Circumference = π d
- The area of a circle is approx 8-% of its diameter squared (diameter x diameter)
- Load weight (to estimate) --> Volume in cu. ft x 500 lbs x density factor .02, .05, .10, .20, .30 etc

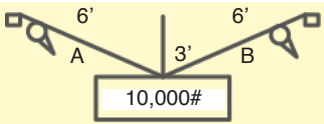
LOAD FACTORS & WEIGHT DISTRIBUTIONS



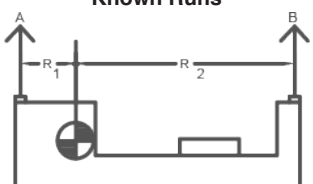
Tension in s = $\frac{\text{length s}}{\text{lengtg h}}$ x share load wt. $\quad \frac{s}{h}$ = Load Factor

Tension in A = $\frac{6}{3}$ x 4,000

Tension in A = 8,000 #

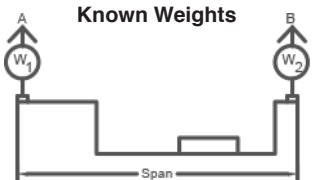


Known Runs



Share of Load Wt. @ A	Share of Load Wt. @ B	Legend
$R_1 + R_2 = TS$ $\frac{R_2}{TS} = P$ P x W = Share of Load Wt @ A	$R_1 + R_2 = TS$ $\frac{R_1}{TS} = P$ P x W = Share of Load Wt @ B	R_1 = Run, Side 1 R_2 = Run, Side 2 TS = Total Span P = Percentage W = Weight of Load

Known Weights

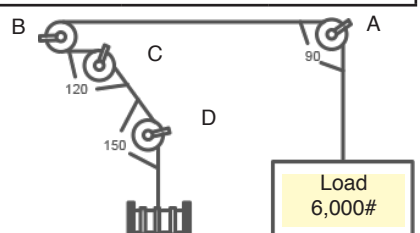


CG in Feet From A	CG in Feet From B	Legend
$W_1 + W_2 = TW$ $\frac{W_2}{TW} = P$ P x S = CG in ft. from A	$W_1 + W_2 = TW$ $\frac{W_1}{TW} = P$ P x S = CG in ft. from B	W_1 = Weight at A W_2 = Weight at B TW = Total Weight P = Percentage S = Span

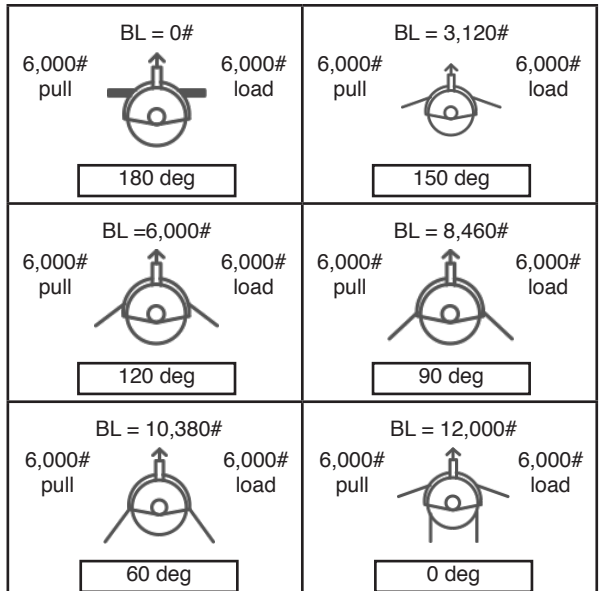
BLOCK & FAIRLEAD LOADING

Angle full included	Block Factor	Line Pull in lbs.	Block Load in lbs.
180	0.00	6,000	0
150	0.52	6,000	3,120
120	1.00	6,000	6,000
90	1.41	6,000	8,460
60	1.73	6,000	10,380
0	2.00	6,000	12,000
Formula	Block Factor x Line Pull = Block Load		

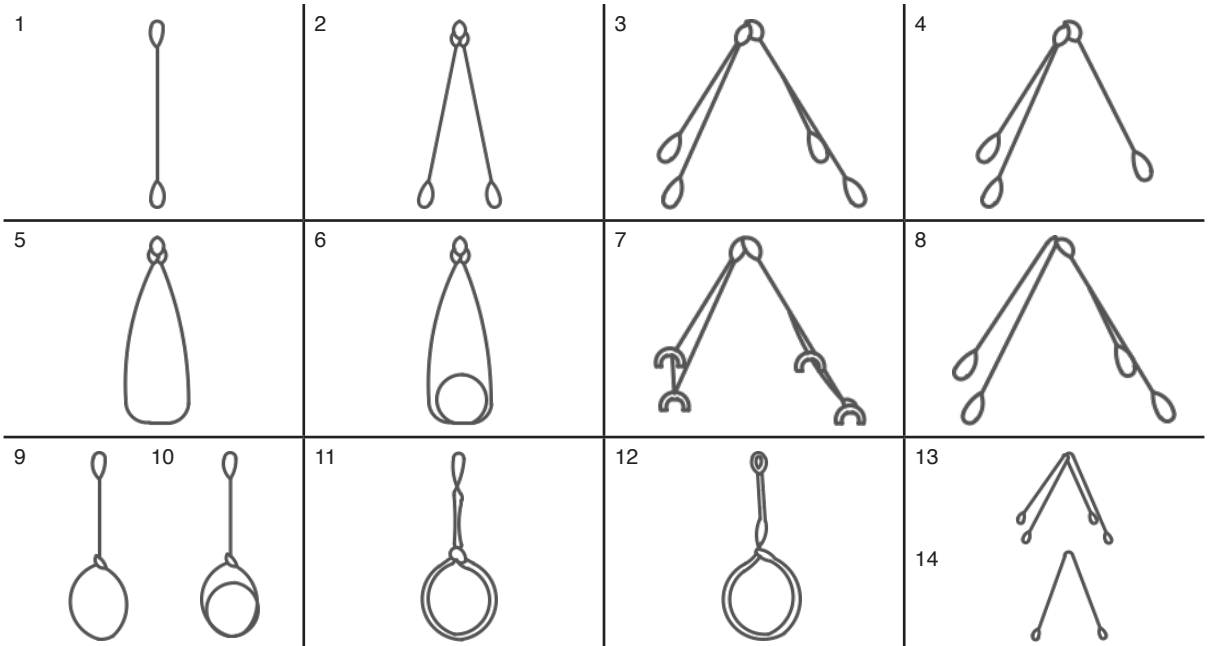
Assume frictionless system:
A = 8,460
B = 12,000
C = 6,000
D = 3,120



EXAMPLE



HITCH TYPES



#	Hitch Type	Up Down/ CG	Leg Loading	Load Control	#
1	Single Vertical	Above	One	Poor	1
2	2 - Leg Bridle	Above	Two	Average	2
3	4 - Leg Bridle	Both	Two	Excellent	3
4	3 - Leg Bridle	Both	Three	Excellent	4
5	Single Wrap Basket	Both*	Two	Average	5
6	Double Wrap Basket	Both*	Two	Good	6
7	Two Single Baskets	Both**	Four	Poor	7
8	Inverted Basket & 2 - Leg Br	Both	Four	Excellent	8
9	Single Wrap Choker	Both*	Single	Average	9
10	Double Wrap Choker	Both*	Single	Good	10
11	Double Choker Bight - Up	Both*	Two	Good	11
12	Double Choker Eyes - Up	Both*	Two	Poor	12
13	Double Inverted Baskets	Above	Four	Poor	13
14	Single Inverted Baskets	Above	Two	Poor	14

* [never use a single hitch below CG]

**[compunds loading at pick points]

LENGHT: HEIGHT: RUN							
Angle in Degrees	Ratio Columns			Angle in Degrees	Ratio Columns		
	Length	Height	Run		Length	Height	Run
46	1.390	1.00	0.966	23	2.559	1.00	2.356
45	1.414	1.00	1.000	22	2.670	1.00	2.475
44	1.440	1.00	1.036	21	2.790	1.00	2.605
43	1.466	1.00	1.072	20	2.924	1.00	2.748
42	1.495	1.00	1.111	19	3.072	1.00	2.904
41	1.524	1.00	1.150	18	3.236	1.00	3.078
40	1.555	1.00	1.192	17	3.420	1.00	3.271
39	1.589	1.00	1.235	16	3.628	1.00	3.487
38	1.624	1.00	1.280	15	3.861	1.00	3.729
37	1.662	1.00	1.327	14	3.134	1.00	4.011
36	1.701	1.00	1.376	13	4.445	1.00	4.332
35	1.742	1.00	1.426	12	4.810	1.00	4.701
34	1.788	1.00	1.483	11	5.241	1.00	5.145
33	1.836	1.00	1.540	10	5.747	1.00	5.659
32	1.887	1.00	1.600	9	6.393	1.00	6.314
31	1.942	1.00	1.664	8	7.185	1.00	7.115
30	2.000	1.00	1.732	7	8.206	1.00	8.144
29	2.063	1.00	1.804	6	9.567	1.00	9.514
28	2.130	1.00	1.881	5	11.490	1.00	11.446
27	2.203	1.00	1.963	4	14.336	1.00	14.301
26	2.281	1.00	2.050	3	19.107	1.00	19.081
25	2.364	1.00	2.146	2	28.654	1.00	28.636
24	2.459	1.00	2.246	1	57.299	1.00	57.290

LENGHT: HEIGHT: RUN							
Angle in Degrees	Ratio Columns			Angle in Degrees	Ratio Columns		
	Length	Height	Run		Length	Height	Run
90	1.0000	1.00	0.000	68	1.079	1.00	0.404
89	1.0002	1.00	0.017	67	1.086	1.00	0.425
88	1.0006	1.00	0.035	66	1.095	1.00	0.445
87	1.001	1.00	0.052	65	1.104	1.00	0.467
86	1.002	1.00	0.070	64	1.113	1.00	0.488
85	1.004	1.00	0.088	63	1.122	1.00	0.510
84	1.006	1.00	0.105	62	1.133	1.00	0.532
83	1.008	1.00	0.123	61	1.143	1.00	0.554
82	1.010	1.00	0.141	60	1.155	1.00	0.578
81	1.013	1.00	0.158	59	1.167	1.00	0.601
80	1.015	1.00	0.176	58	1.179	1.00	0.625
79	1.019	1.00	0.194	57	1.192	1.00	0.649
78	1.022	1.00	0.213	56	1.206	1.00	0.675
77	1.026	1.00	0.231	55	1.221	1.00	0.700
76	1.031	1.00	0.249	54	1.236	1.00	0.727
75	1.035	1.00	0.268	53	1.252	1.00	0.754
74	1.040	1.00	0.287	52	1.269	1.00	0.781
73	1.046	1.00	0.306	51	1.287	1.00	0.810
72	1.052	1.00	0.325	50	1.305	1.00	0.839
71	1.058	1.00	0.344	49	1.325	1.00	0.869
70	1.064	1.00	0.363	48	1.346	1.00	0.900
69	1.071	1.00	0.384	47	1.367	1.00	0.933