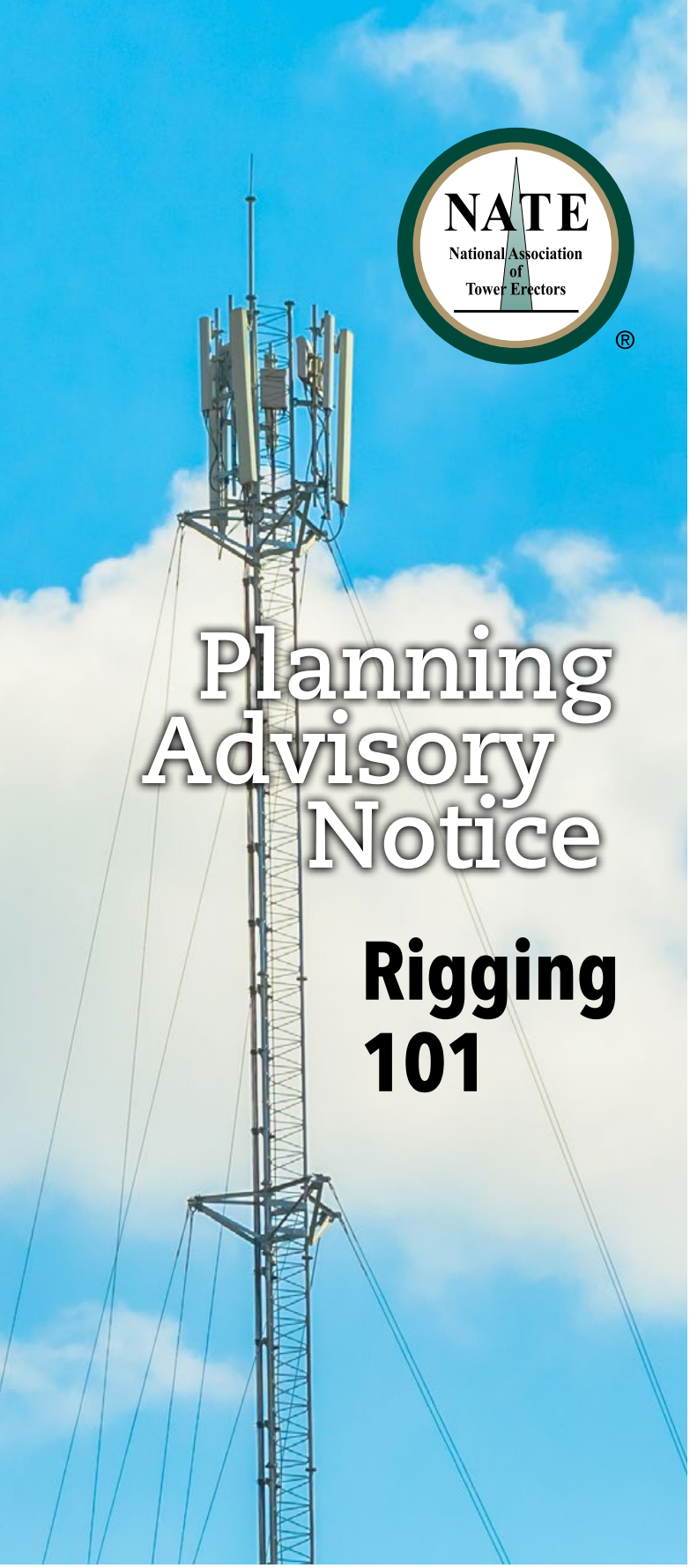


Planning Advisory Notice

Rigging 101

Although the concept of arriving at a tower site and rigging a tower seems like a simple idea, it is not always as simple as one might think. There are a lot of calculations that need to be completed before deciding the size of cable, slings, shackles, blocks, etc. before the rope is ever carried up the tower initially. Below we will cover the calculations that need to be figured out and how to decide on the proper rigging techniques.

The first step is to know what the breaking (nominal) strength of your load line is. Below is a chart from *UniRope.com* that shows the diameter, nominal breaking strength (in tons), and weight per foot of IWRC 6x37 Steel Core Wire Rope:

Rope Diameter (inch)	Nominal Strength (tons)	Weight per Foot
1/4"	3.4	0.12
5/16"	5.2	0.18
3/8"	7.5	0.25
7/16"	10.2	0.34
1/2"	13.3	0.44
9/16"	16.8	0.56
5/8"	20.6	0.69
3/4"	29.4	0.99
7/8"	39.8	1.35
1"	51.7	1.76

For our example today, we are going to use the highlighted 3/8" wire rope. From the chart we can tell that the 3/8" wire rope has a nominal strength of 7.5 tons which equals 15,000 pounds. Now that we know what the wire rope can handle, we have to figure out whether a person will be lifted with it or if it is just going to be materials being lifted. In this example we will assume that someone will NOT be hoisted using this wire rope which means that we need to have a 5:1 safety factor. To calculate the safety factor, we will just take the 15,000 pounds the cable is rated for and divide that by 5 to get the allowable tolerance of the cable to 3,000 pounds WLL (Working Load Limit).

The next step is to calculate the D/d ratio of block sheave and wire rope in pounds. To calculate this,

The members of the **PAN Advisory Group** who are involved in writing and researching each PAN topic include **Scott Kisting** (Vice President, MUTI-Sabre Industries Telecom Services), **John Erichsen** (Principal EET PE, Chairman TIA Committee TR 14), **Craig Snyder** (President, Sioux Falls Tower & Communications), **Stephanie Brewer** (Compliance Coordinator, MUTI-Sabre Industries Telecom Services), and **Kevin Schmidt** (Sioux Falls Tower & Communications).

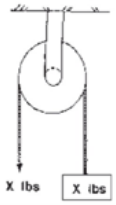
the D/d ratio is the Diameter of the sheave for the block over the diameter of the wire rope. This is calculated by taking the sheave pitch diameter divided by the diameter of the wire rope. The minimum D/d ratio allowed by ANSI B30.16 is a D/d ratio of 16. So to achieve the correct D/d ratio, you would require a 6" block if using 3/8" wire rope. If you take the 6 (diameter of the sheave in the block) /.375 (diameter of the wire rope), you will achieve the minimum 16 D/d ratio. The D/d ratio of 16 will de-rate your system down to 89% of the nominal strength of the wire rope per the McKissick chart (upper right).

D/d RATIO - BLOCKS AND SHEAVES 5

D/d = PITCH DIAMETER OF SHEAVE / DIAMETER OF WIRE ROPE

ASME B30.5:
Crawler, Locomotive and Truck cranes
Boom hoist sheaves: min 15/1
Load hoist sheaves: min 18/1
Load block sheaves: min 16/1

ASME B30.16:
Overhead Hoists
Running sheaves: min 16/1
Non running sheaves: min 12/1



D = SHEAVE PITCH DIAMETER

d = WIRE ROPE DIAMETER

FATIGUE LIFE
Repeated bending and straightening of wire rope causes "fatiguing"

D/d RATIO	RELATIVE FATIGUE OR BENDING LIFE
30	10.0
25	6.5
20	3.8
18	2.9
16	2.1
14	1.5
12	1.1

EFFICIENCY
BENDING ROPE REDUCES IT'S STRENGTH

D/d RATIO	STRENGTH EFFICIENCY COMPARED TO CATALOG STRENGTH IN %
40	95
30	93
20	91
15	89
10	86
8	83
6	79
4	75
2	65
1	50

FOR ADDITIONAL INFORMATION REFER TO ASME B30.5 AND THE CROSBY GENERAL CATALOG

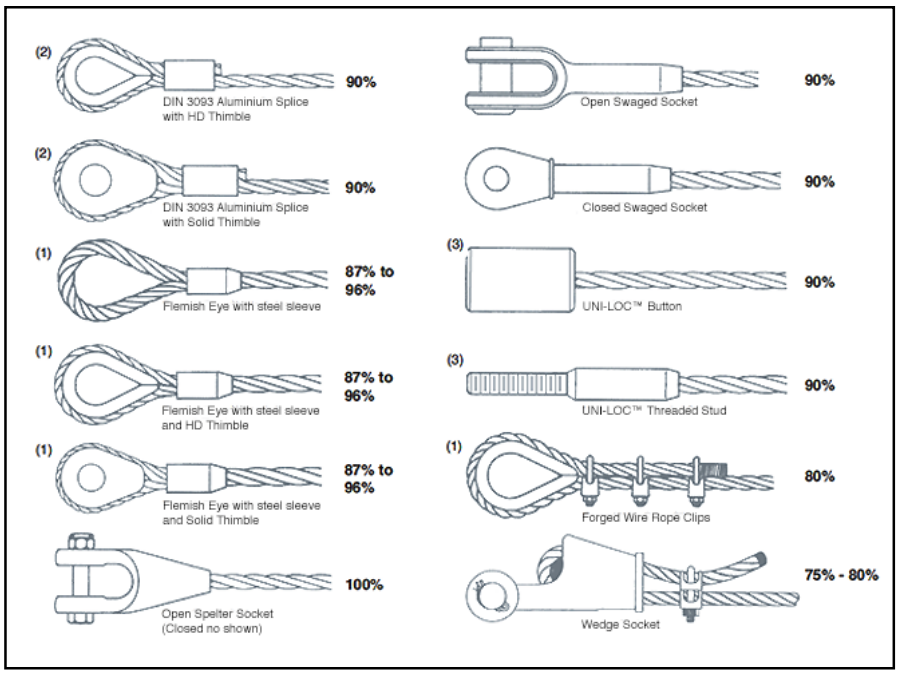
CONTINUED ON NEXT PAGE

The final calculation of the D/d ratio would de-rate the wire rope from the 3,000 pounds down to 2,670 pounds (3,000 lbs x 89% = 2,670 lbs).

The next step is to de-rate the WLL of the load line according to the termination efficiency. The chart (above) reflects the most standard terminations and their efficiencies from UniRope.

For our example we will choose the Crosby Terminator wedge socket which has an 80% termination efficiency. The WLL calculation for the wedge socket would then equal 3,000 lbs x 80% = 2,400 lbs WLL at a safety ratio of 5:1. This now takes precedence over the de-rating of the D/d ratio as it is a lower efficiency which means that we will use the 2,400 lbs as opposed to the 2,670 lbs that we were at previously with the D/d ratio. You always want to use the worst case de-ration while doing the calculations.

The next step is to figure out the required WLL of the top sling and bottom slings (in this example we are using a heel block at the base of the tower and wire rope slings). To calculate the required slings, you must plan on the steel being maxed out (which is 2,400 lbs per the termination efficiency of the wire rope which is the weakest link of the system) X 2. Since the wire rope is going up through the top block then back to the ground you have to double the allowable weight allowed to be picked and also add in the weight of



then choose a 7/16" wire rope sling for the top of the tower which is rated for 6,800 lbs at a 90° angle (Straight) and a 5/16" wire rope sling for the bottom which is rated for 3,400 lbs at a 90° angle.

The next step is figuring out the required shackle sizes for this scenario. For this step, it is all determined by the size of the required slings. For the 7/16" wire rope sling it requires a ½" shackle and for the 3/8" wire rope sling at the bottom of the tower it requires a 7/16" shackle.

Now we have to figure out the required weight of the headache ball. To calculate this you would take (rigging height x cable weight) x overhaul factor. The overhaul factor is a 1.03 for a single parted line using roller bearing sheaves per The Crosby Group. So here it is: (300 x .25) x 1.03 = 77 lbs for your minimum headache ball weight.

WIRE ROPE SLING CAPACITIES (LBS.) - FLEMISH EYE - ANSI B30.9

6 X 19 AND 6 X 37 IMPROVED PLOW STEEL - IWRC 5/1 DESIGN FACTOR

WIRE ROPE SIZE	Crosby Q & T CARBON SHACKLE MINIMUM SHACKLE SIZE FOR A D/d>1 AT LOAD CONNECTION SHACKLE SIZE	VERTICAL (SINGLE LEG)	CHOKER (ANGLE 120)	TWO LEG OR BASKET HITCH (90°)	60 DEGREE SLING ANGLE (60°)	45 DEGREE SLING ANGLE (45°)	30 DEGREE SLING ANGLE (30°)
1/4	5/16	1120	820	2200	1940	1500	1120
5/16	3/8	1740	1260	3400	3000	2400	1740
3/8	7/16	2400	1840	4800	4200	3400	2400
7/16	1/2	3400	2400	6800	5800	4800	3400
1/2	5/8	4400	3200	8800	7600	6200	4400
9/16	5/8	5600	4000	11200	9800	7900	5600
5/8	3/4	6800	5000	13600	11800	9600	6800
3/4	7/8	9800	7200	19600	16900	13600	9800
7/8	1	13200	9600	26400	22800	18600	13200
1	1-1/8	17000	12600	34000	30000	24000	17000
1-1/8	1-1/4	20000	15800	40000	34600	28300	20000
1-1/4	1-3/8	26000	19400	52000	45000	36700	26000
1-3/8	1-1/2	30000	24000	60000	52000	42400	30000

• RATED CAPACITIES BASED ON PIN DIAMETER OR HOOK NO LONGER THAN THE NATURAL EYE WIDTH (1/2 X EYE LENGTH) OR LESS THAN THE NOMINAL SLING DIAMETER

REFER TO ANSI B30.9 FOR FULL DETAILS

HORIZONTAL SLING ANGLES OF LESS THAN 30 DEGREES ARE NOT RECOMMENDED

The final WLL limit of materials is going to be 2,323 lbs that you can still pick safely. This is the de-rating from the termination minus the weight of the headache ball. You could pick this amount all day everyday and be entirely safe per all of the manufacturers specifications.

the steel cable going up and down the tower. This is done by taking the 2,400 lbs WLL x 2 = 4,800 lbs + (600 x .25) = 4,950 lbs on the top sling. The 600 is the length of the wire rope going up and down the tower (300' x 2) and the .25 is the weight per foot of 3/8" wire rope. To calculate the bottom sling is only used to re-direct the wire rope at a 90° angle so it goes from horizontal (from the winch) to vertical (up tower). The minimum WLL of this would have to be 1.41 x the line pull of 2,400 = 3,384 lbs. For these sizes we would

Please remember, this is not including the wear and tear of the equipment and that you have to keep inspecting all of your rigging on a daily basis to ensure that no damage has occurred. This is not rated for a person to ride up. If you are planning on sending someone up on the rigging, you would do the exact same calculations, except you would do them for a 10:1 safety factor as opposed to the 5:1 that we calculated everything for. ■