

New York-New Jersey Trail Conference

RIGGING HANDBOOK





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Introduction

A safe day on the trail begins before you arrive for trail work, continues while traveling to the work site, during your tasks, and after you leave. Your safety, the safety of coworkers, and the safety of the public is your highest priority. It is your responsibility to work safely, be aware of your surroundings, the risks involved, and any unsafe situations should they arise.

Rigging is a special part of trail building meant to bring efficiency, and environmental impact reduction to work sites. It is also an extremely dangerous activity. This document provides the groundwork for a safe day rigging on the trail working with the Trail Conference (TC). The following also applies when training, working, and staying at the Welch Education Center.

1. General Worksite Safety Responsibilities

1. Knowing
 - a. The responsibilities set forth in this document
 - b. Emergency Response Plans
 - c. Escape routes
 - d. The location of first aid and sting kits
 - e. Leave No Trace Principles (p.3 safety handbook)
 - f. Environmental Protection Principles (p.3 safety handbook)
2. Identifying
 - a. Unsafe conditions
 - b. The presence of the general public passing into worksite
3. Reporting/announcing
 - a. Unsafe conditions
 - b. The presence of the general public passing into work site
4. Recording
 - a. Job Hazard Analysis (JHA) reports
 - b. Accidents
 - c. Injuries
 - d. All required information in all required safety documents (see safety handbook Appendix)
5. Maintaining and Inspecting
 - a. Job site
 - b. First aid kits
 - c. Tools (hand tools, power tools, machinery, and rigging equipment)
 - d. Personal Protective Equipment

Field Safety Officer Responsibilities:

1. Know Emergency Response Plan and take lead in an Emergency situation
2. Compliance with TC and host agency environmental, health, and safety policy
3. Lead Tailgate Safety Meetings
4. Coordinate compliance of the Environmental Protection Responsibilities (p.3)
5. Insure first aid kits are stocked and at the work site
6. Insure that Volunteer Information Forms are at the worksite
7. Be aware of special medical issues of volunteers and location of emergency medicine (inhaler/epi pen, etc.)



2. Rules for Rigging

A. OSHA safety guidelines (1926.251.xx) will be adhered to for:

1. ALL Grip Hoist winches
2. High lines, aka: Slack Line, Sky Line, Sky Wire

OSHA safety guidelines:

1. 1926.251(a)(1): Rigging equipment . . . shall be **inspected prior to use** on each shift and as necessary during its use to ensure that it is safe. **Defective rigging equipment shall be removed from service.**
2. 1926.251(a)(2)(i): Has permanently affixed and **legible identification markings**. . . that indicate the recommended **safe working load [SWL]**
3. 1926.251(a)(2)(ii): Not be loaded in excess of its recommended [SWL]
4. 1926.251(a)(2)(iii): Not be used without affixed, legible identification markings, required by paragraph (a)(2)(i) of this section
5. 1926.251(a)(3): Rigging equipment, when not in use, shall be removed from the immediate work area so as not to present a hazard to employees
6. 1926.251(b)(3): Job or shop hooks and links, or makeshift fasteners, formed from bolts, rods, etc., or other such attachments, shall not be used
7. 1926.251(c)(3): Wire rope shall not be secured by knots, except on scraper haul back lines
8. 1926.251(c)(6): **Slings shall not** be shortened with knots or bolts or other makeshift devices
9. 1926.251(c)(7): Sling legs shall **not** be kinked
10. 1926.251(c)(8): Slings in a basket hitch shall have the loads **balanced** to prevent slippage
11. 1926.251(c)(10): Hands or fingers shall not be placed between the sling and its load while the sling is being tightened around the load
12. 1926.251(c)(11): Shock loading is prohibited
13. 1915.113(b)(2): Loads shall be applied to the **throat** of the hook since loading the point overstresses and bends or springs the hook.
14. There are no OSHA regulations for gates over the throat of hooks, but NYNJTC REQUIRES a **gate** be used, or a wire be fashioned to the hook to act as a gate
 - a. In lieu of a hook without a gate, a shackle should be used instead
 - b. OSHA gate interpretation: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=25276
15. Setting spar blocks
 - a. 1917.119(c): Portable Metal Ladders must meet ANSI A14.2-1990 safety requirements
 - b. Neither the ladder standard (29 CFR 1926, subpart X) nor the fall protection standard (29 CFR 1926, subpart M) requires fall protection for workers while working on portable ladders (https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=23870)
 - c. Nevertheless, when setting a spar higher than your height (pretty much any situation), climbers **MUST** use a fall arrest system
 - i. Under §1926.502(d)(16)(iii), a personal fall arrest system must limit an employee's free fall to not more than six feet.
 - ii. 1926.502(d)(9) Lanyards and vertical lifelines shall have a minimum breaking strength of 5,000 pounds
 - iii. 1926.502(d)(16)(ii) limit maximum arresting force on an employee to 1,800 pounds (8 kN) when used with a body harness;



- iv. 1926.502(d)(16)(iii) be rigged such that an employee can neither free fall more than 6 feet (1.8 m), nor contact any lower level;
- v. 1926.502(d)(16)(v) If the system is used by an employee having a combined tool and body weight of 310 pounds (140 kg) or more, then the employer must appropriately modify the criteria and protocols
- d. Maintain full control while climbing or descending ladders
 - i. ladder use must include both hands and feet 1926.1053(b)(22)
 - ii. attach a hand-line to harness, then remove to use for raising/lowering sling and block for spar set up

ADDITIONAL RIGGING RULES:

- 16. All high line loads must be secured with a "belay" rope:
 - a. Use static ropes, preferably with a SWL that maintains a safety factor of five
 - b. Knots to use for load attachment (p.13)
 - i. Bowline on a Bight
 - ii. Figure 8 Follow Through
 - c. Knots must be untied at the end of the day, retied when needed:
 - i. to ensure even wear, and extend rope life
 - ii. to ensure knots don't bind
 - iii. to ensure everyone is familiar with these two 'safe' knots
 - d. Knot must be tied to a separate clevis/shackle on the load end
 - i. the shackle then attached to a load sling itself
 - ii. or attached to another shackle on the load sling
 - iii. NEVER ATTACH belay shackle to the load hook
- 17. Port-A-Wrap or sling and shackle belay system:
 - a. Must be attached to an anchor (large tree or immovable rock)
 - i. preferably close to the spar closest to the winch
 - ii. or the spar itself
 - b. Attach PAW to sling that is attached to aforementioned anchor (ai,ii)
 - i. Use (choker(girth hitch) or basket) and a clevis shackle
 - ii. Leave room to stand clear "v-of-death" while PAW is in use
 - c. Must be properly used with proper rope and SWL- varies with series
- 18. Sling labels on anchor and spar trees must face outward from trees so they are legible
- 19. Slings with worn-out or illegible sling labels must be retired from use
- 20. ALWAYS read sling, shackle, and block labels to obey SWL
- 21. STAY OUT OF THE "BIGHT," or "V of Death" (i.e. below any part of the high line)
- 22. Stay away from underneath the load
- 23. Uphill pulls using a motorized winch must also have belay
- 24. Do NOT modify ANY grip hoist handle ("control levers")
 - a. Do NOT make them longer
 - b. Do NOT use pipe instead of the factory handle
 - c. Do NOT put wood inside the hollow factory handle
 - d. Do NOT use larger handles on smaller grip hoists
 - i. the 1 ton handle (28 in) shall NOT be used for the 3/4 ton hoist
 - ii. the 2 ton (45 in) shall NOT be used on the 1 nor 3/4 ton



EVERY rigger MUST know:

1. Know the SWL of each part in a rigging system
2. Anchor to Spar wire angles should NOT exceed 20 degrees from horizontal
3. High lines above the load should NOT be tensioned beyond 6 degrees from horizontal
4. 1 ton TU-17 Griphoist simple system highline loads should NOT exceed 400 lbs!
 1. Rock will be assumed to be 200 lbs/ft³ (160-190, dark colored rocks heavier)
 2. Lift rocks +/-1.25ft x 1.25ft x 1.25ft rock = 2 ft³
5. 2 ton TU-28 Griphoist simple system highline loads should NOT exceed 800 lbs!
 1. Rock will be assumed to be 200 lbs/ ft³ (160-190, dark colored rocks heavier)
 2. Lift rocks +/-1.5ft x 1.5ft x 1.5ft rock = 4 ft³

3. Understanding Labels

Safe Working Load (SWL)

The SWL is the limit of the load to be supported by the item in question. This can be gathered from item's label. The SWL may also be labeled: the Rated Capacity, Normal Working Load, Working Load Limit, Max Rated Load, and Rated Load Value. Typically, the SWL is calculated by testing products to determine their Minimum Breaking Strength (MBS), then dividing this by a "failure safety factor" of five times. In other words, the MBS/5=SWL. In some cases the safety factor may be higher or lower than 5.

SWL RULES:

1. SWL Safe working loads are NOT to be exceeded.
2. All rigging equipment must have SWL labels. Labels with "CE" = metric (1 metric ton = 2,200 lbs)
3. Ropes typically do not have SWL labels, but are rated, know the rating.

APPROXIMATE Rope SWL Examples (know manufacture's actual SWL!)

Type of Rope	SWL (lbs) no knot	SWL (lbs) with knot
Orange Poly Rope	4,080 (2 tons)	2,040
Red Poly Rope	3,260 (1.5 tons)	1,630
Blue Poly Rope	2,000 (1 ton)	1,000
White Poly (3/8")	100 (0.05 tons)	50
White climbing 7/16"	7,500	3,750
White Muletape, flat kevlar	360 (0.18 tons)	180

Dynamic Ropes = colorful = ~7-8% stretch

Static Ropes = not colorful = ~3% stretch

Knot Safety

It is safest to assume that the SWL of a rope with a knot is 50% of the rope's SWL

Knot Type	% of Rope Strength
Bowline	55-74
Figure Eight	66-77
Clove Hitch	58-68
Overhand	45
2 Half-Hitches	75
Rewoven Figure 8	50

SWL for Wire: see table under #5 below



5. Safe and Acceptable Rigging Arrangement- SAARA

SAARA- SWL

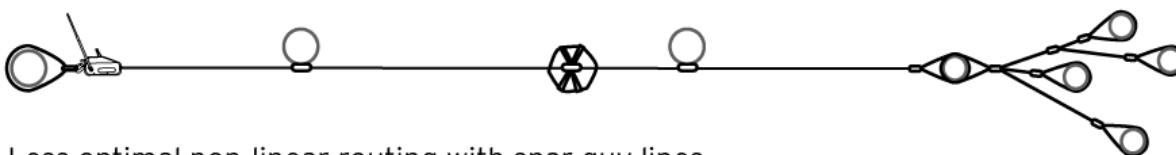
Note: these SWL and MBS numbers may change with time, see manufacture's label and documentation for current data	Minimum Breaking Strength	Failure Safety Factor = MBS/SWL	Rated Capacity- WLL or SWL	Power stroke effort/ movement forward	Slack stroke effort/ movement reverse
Winch TU-17, 1 ton	10,000	5	2,000		
Shear Pins TU-17, 1 ton	3,000	150%	2,000		
Control lever 28 in				80 lb/2 in	40 lb/2.4 in
Winch Wire for TU-17- 5/16 (4x26)	10,000	5	2,000		
Campbell block FOR WINCH rope 4x26, 5/16 = 3 in diam sheave [use 5 inch for angles less than 90]	20,000	5	4,000 (min 1.5-2x rope WLL)		
Black Rat			3,520		
Winch TU-28, 2 ton	20,000	5	4,000		
Shear Pins TU-28, 2 ton	6,000	150%	4,000		
Control lever 45 in				119 lb/2.2 in	44 lb/2.8 in
Winch Wire for TU-28-7/16 (4x26)	20,000	5	4,000		
Campbell block FOR WINCH rope 4x26, 5/16 = 4.5 in diam sheave [use 7 inch for angles less than 90]	40,000	5	8,000 (min 1.5-2x rope WLL)		
Big Red					
Highline wire- 5/16 wire 6x19	10,000	5	2,000		
Highline wire- 3/8 wire 6x19	14,000	5	2,800		
Highline wire- 7/16 wire 6x19	19,000	5	3,800		
Highline wire- 1/2 wire 6x19	25,000	5	5,000		
Amsteel Blue - 5/16	12,300	5	2,740		
Amsteel Blue - 3/8	17,600	5	3,920		
Amsteel Blue - 7/16	21,500	5	4,780		
Amsteel Blue - 1/2	30,600	5	6,800		
Amsteel Blue - 9/16	36,500	5	8,100		
Sling 2 in x 6 ft- (must match or exceed winch WLL) Yellow, endless , choker(weakest)	16,500	5	3,300		
Sling 3 in x 6 ft- (must match or exceed winch WLL) Yellow, eye-eye , choker(weakest)	12,500	5	2,500		
Shackle-3/4" Campbell	57,000	6	9,500		
Trees-spars/anchors	unknown	5	unknown		
Port-A-Wrap 601LN Nickel plated steel (up to 3/4" rope)	50,000	10*	2,000		
Sauerman for 3/8 wire			4,000		
Sauerman for 1/2 wire			7,000		
Sauerman for 5/8 wire			11,000		

- MBS- Minimum Breaking Strength- usually 5xSWL, sometimes 4, 6, 10; 3 for DOT
- Rated Capacity, aka: working load limit (WLL), safe working load (SWL), normal working load (NWL), max rated load, rated load value...
- Usually, not always, for wire, swl tons = rope diameter x rope diameter x 8 (5/16x5/16x8=200/256=0.78 tons. NOTE, this is lower than the 1 ton rating of 5/16 wire for use with TU-17. The factory rope MBS is 10,000, making SWL 2,000)
- Use of Saurman Grip reduces SWL of wire rope by
- Use of U wire rope clips reduces SWL of wire rope by
- *10 is usually the Safety Factor for arboricultural rigging

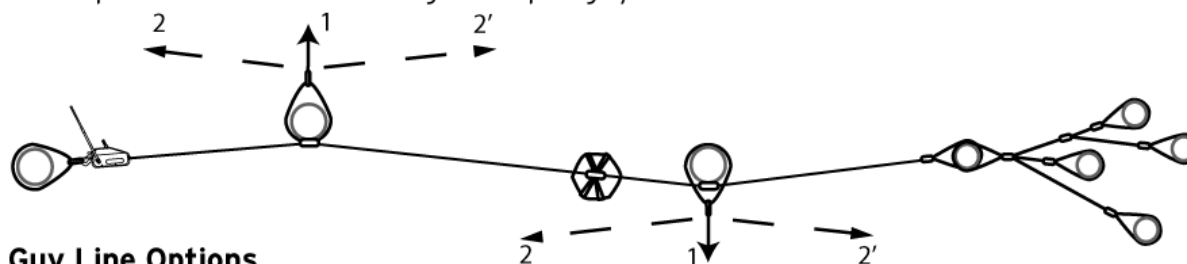
IMPORTANT: Sheave Block Diameter for angles less than 90 degrees = 16 times rope diameter for 4x26 (winch rope); 18-20 for 6x19 (common slack/high-line wire)...these are for vertical pulls where the lines are parallel, smaller blocks can be used for angles of 90 or more. For Amsteel Blue Rope = sheave block diameter must be 8 times the diameter of the line.

SAARA-Alignment

Best set-up is straight/linear



Less optimal non-linear routing with spar guy lines



Guy Line Options

*near spar block height for non linear routing (and/or smaller trees)

1 = one guy line (best if opposite horizontal R Force (not shown))

2, 2' = two lines (preferably parallel/in-line to opposite high zline)

3 = all three 1, 2, 2'

SAARA-Anchor to Spar Angles

Anchor ● to Spar ○ angles should be as low as possible-- not much over 20 degrees

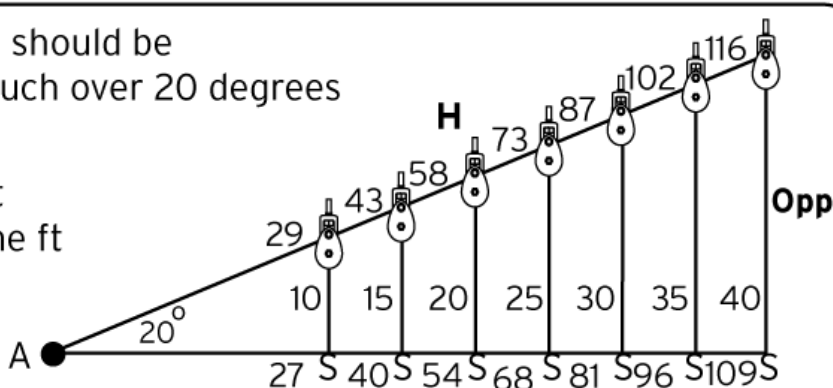
H = Opp/sin 20

H = anchor to spar line ft

Opp = ground to block line ft

*Note- this shows LEVEL

Anchor and Spar tree bases "S".
Different A and S height (on hills)
will change the Angle and Opp.



SAARA-Anchor to Spar Angles

Anchor ● to Spar Block ○ angles should be as low as possible-- not much over 20 degrees

$$\theta \text{ degrees} = \tan^{-1} (\text{Opp} / \text{Adj})$$

H = Anchor to Spar Block B line ft

Opp = Spar ground S to Block B line ft

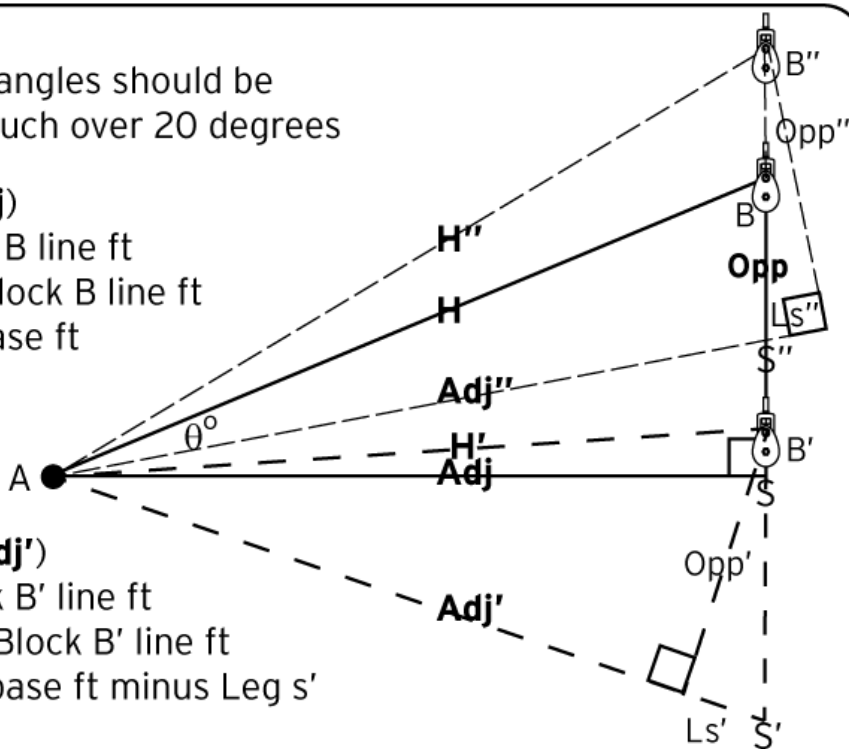
Adj = Anchor to Spar S base ft

$$\theta' \text{ degrees} = \tan^{-1} (\text{Opp}' / \text{Adj}')$$

H' = Anchor to Spar Block B' line ft

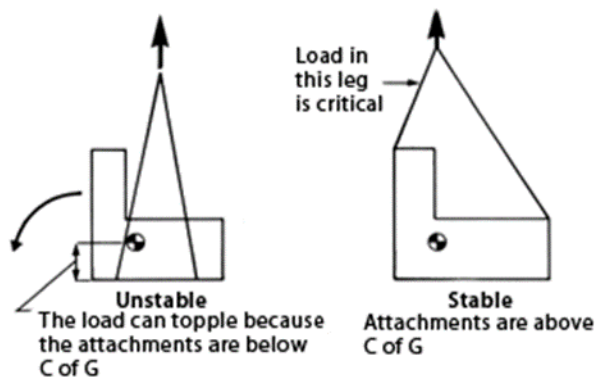
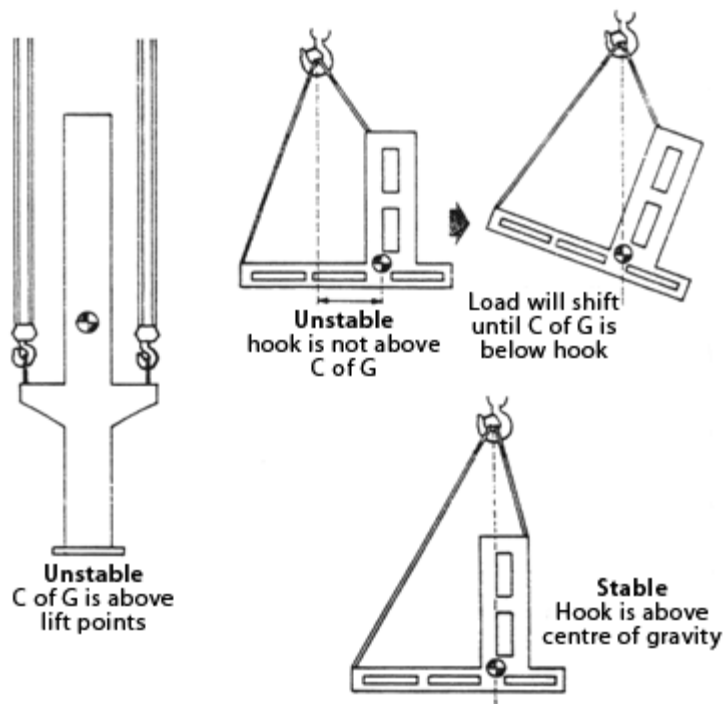
Opp' = Spar ground S' to Block B' line ft

Adj' = Anchor to Spar S' base ft minus Leg s'



8. Load Balance

1. Ensure load is well wrapped and secure within sling(s).
 - i. Any sign of slippage requires rapidly lowering the load and re-wrapping
2. Ensure load is balanced.
 - i. Loads should be hung in a manner that puts the center of gravity (CG) DIRECTLY below the load block hook (and beneath the lowest point of attachment)
 - ii. Loads may shift when first lifted to swing CG under hook. If they hang in a manner that causes the *hook to tilt* the load must be re-wrapped

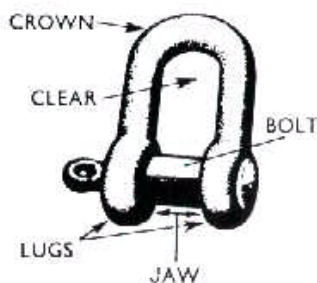


Objects balance around their center of gravity, a point at which we can imagine all the object's weight is centered or concentrated. Suspended objects will move so their center of gravity is below the point of support.

Estimate CG location, lift the load with the hook over CG, then correct the estimate by moving the hook, load and sling suspension. In addition, support the load ABOVE the CG because it will move itself as low as possible below the point of support.

9. Load Attachment

1. When using shackles to lift loads ensure force is directed ONLY from bolt to crown. Side loading reduces the SWL significantly.



2. ADD packing (washers) to ensure shackle does not shift.



Incorrect - Eye splice may cut running line



Correct - Use thimbles in the eyes

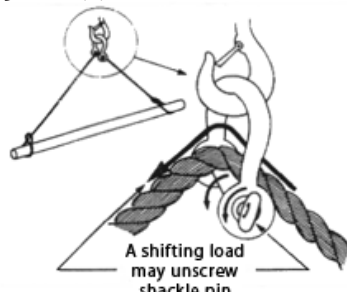
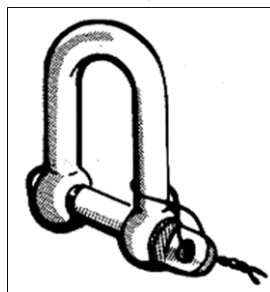


Incorrect - Shackle pin in contact with running line can work loose

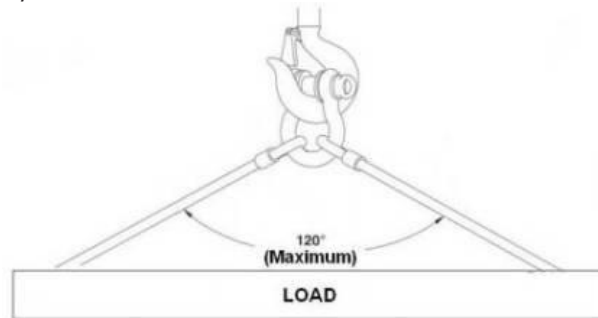


Correct - Shackle pin cannot turn

3. ADD mousing (wire) to shackle pin if shifting is suspected to occur.



4. Do not surpass 120° on shackle, beyond this it is considered a side-load, and the SWL is reduced significantly.



Symmetrical Loading of Shackles

5. To prevent opening up the hook and damage to rope eyes when two or more rope eyes, use a shackle (pin on hook (packed if needed), rope eyes to the shackle).

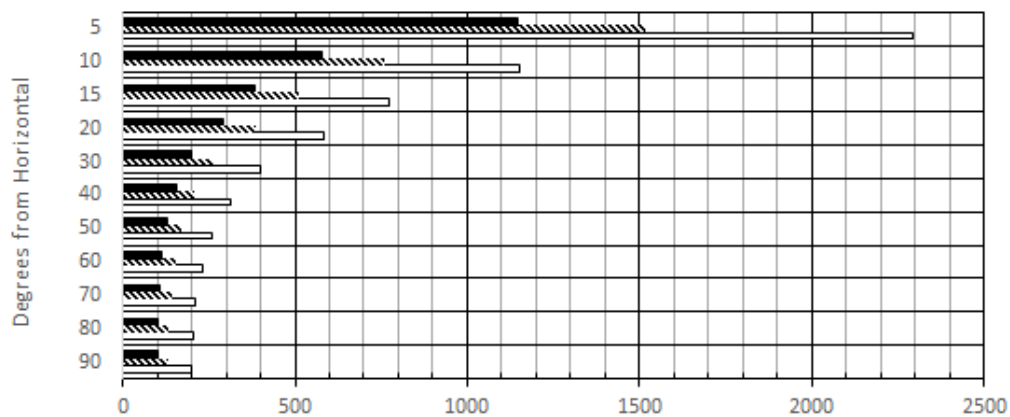


10. Load Slings

Supporting 400-800 lb rocks will be tolerated by slings with a SWL of 2500 or more, meaning most slings and configurations.

Slings can be cut by repeated dragging and wrapping. Capacities are based on nylon webbing having breaking strengths of 8000 pounds per inch of webbing width and Dacron (Polyester) having a breaking strength of 5000 pounds per inch of webbing width. The capacities are also based on a 5:1 factor of safety, assuming that the end fittings are of adequate strength.

LOAD SUPPORT PER ANGLE AND NUMBER OF SLINGS FOR 400 LB LOAD

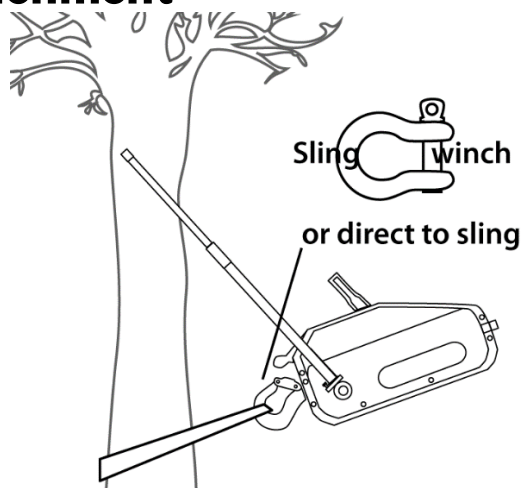


	90	80	70	60	50	40	30	20	15	10	5
■ 1 sling leg of 4, 25% lbs of 400 supported	100	102	106	115	131	156	200	292	386	576	1147
▨ 1 sling leg of 3, 33% lbs of 400 supported	132	134	140	152	172	205	264	386	510	760	1515
□ 1 sling leg of 2, 50% lbs of 400 supported	200	203	213	231	261	311	400	585	773	1152	2295

Tension on Sling Leg (lbs)

Sling Tension = (Load weight/#sling legs)/sinθ from horizontal

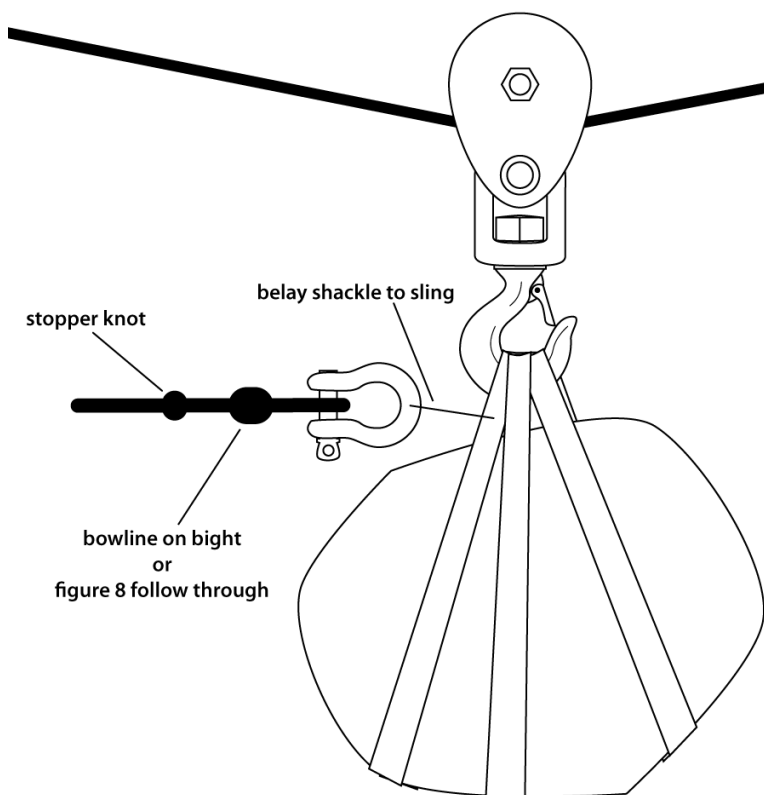
11. Anchor attachment



Using a shackle minimizes wear on the sling from wire rope

12. Belaying

Belay lines are attached to loads to assure they travel a controlled path, and don't run away.



Acceptable belay knots:

1. Figure eight
 - a. Easy to check, hard to open
 - b. Should be secured around the standing end using a stopper knot
 - i. Ashley Stopper
 - ii. Double Overhand knot/stopper
 - c. Tie in "Flat" form, then tighten
 - d. The two outermost turns are brought in snug against the ropes they enclose
 - e. As a result these turns finish on the other side of the turns they accompany
2. Bowline on a bight
 - a. Easy to check, easy to untie
 - b. Loose unless actively loaded/pulled on
 - c. Pass the tail outside the loop and under the collar to form a Yosemite Tie-off
 - d. IMPORTANT: fasten the tail with a stopper knot to the adjoining loop or the standing end
 - i. Ashley Stopper
 - ii. Double Overhand knot/stopper

3. Terms:

- a. Bight: a bend or arc where ropes do not cross
 - i. Sometimes used to finish knots for easy untying
 - ii. "knots on the bight" are tied without use of the working end
- b. Dressing: arranging a knot to:
 - i. improve performance, and/or strength
 - ii. lower jamming/binding potential
- c. Hitch: a knot to attach a rope to something, a shackle in our case
- d. Loop: a full circle passing the working end over itself
- e. Standing end (or standing part): not active in knot tying or opposite of the working end
- f. Working end: (or working part) active in knot tying, opposite the standing end

Knots

Bowline on a bight

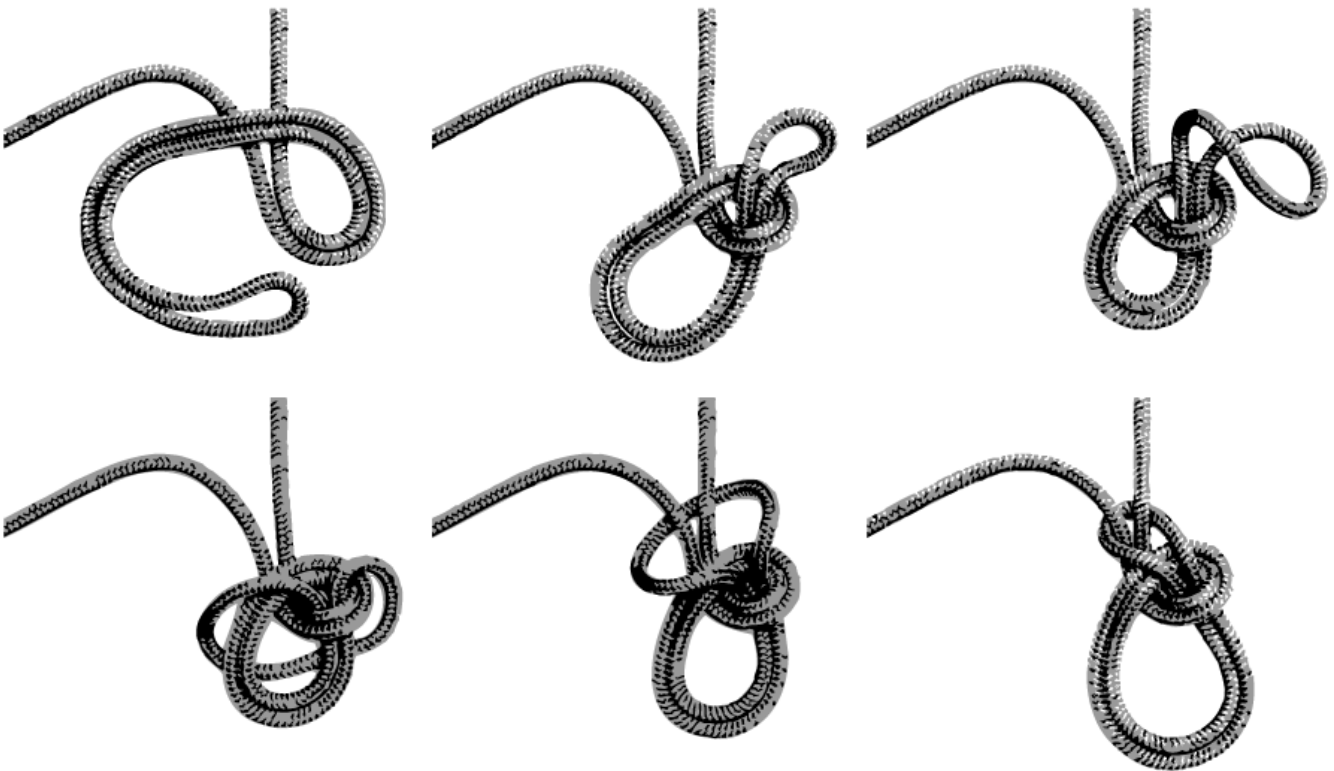
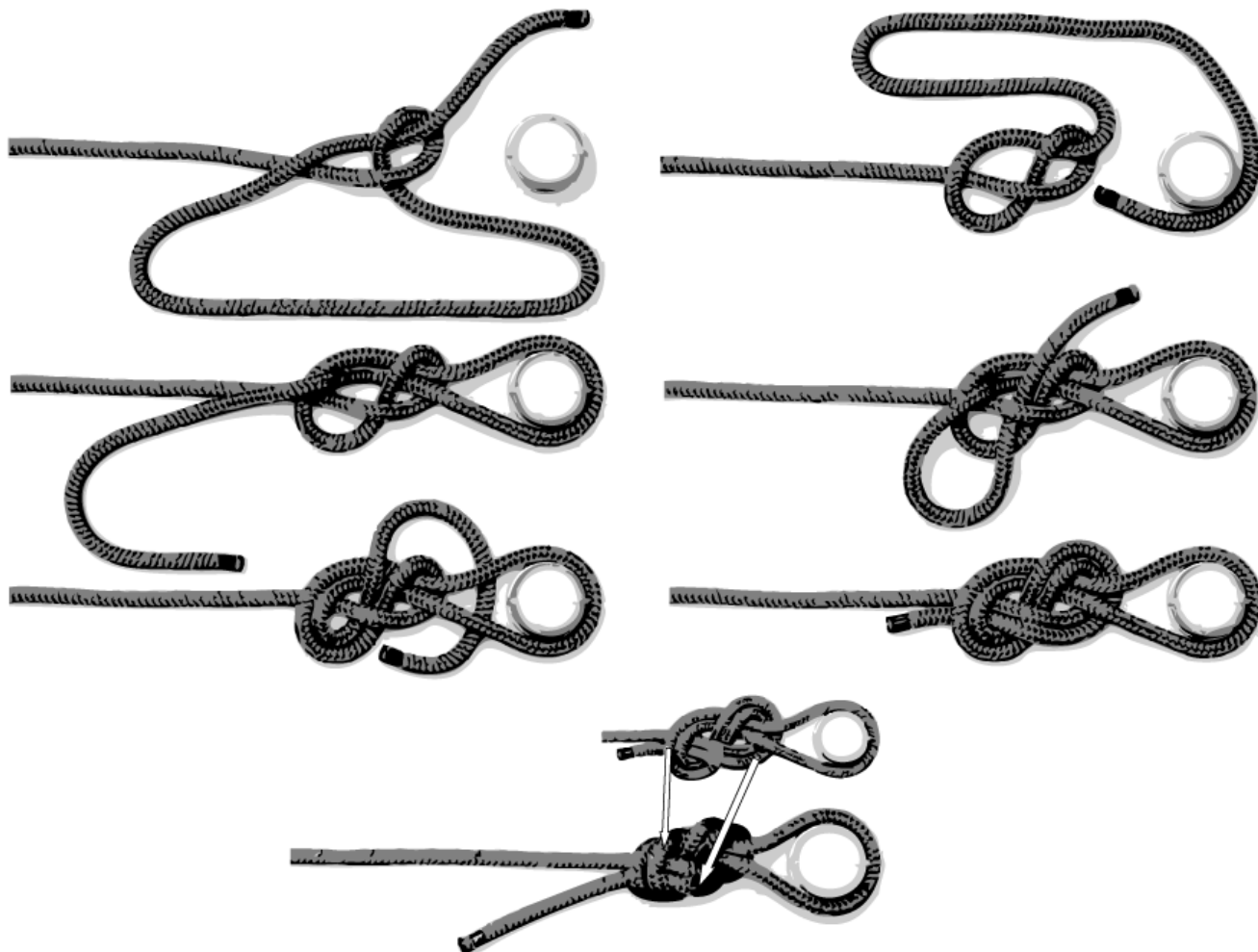


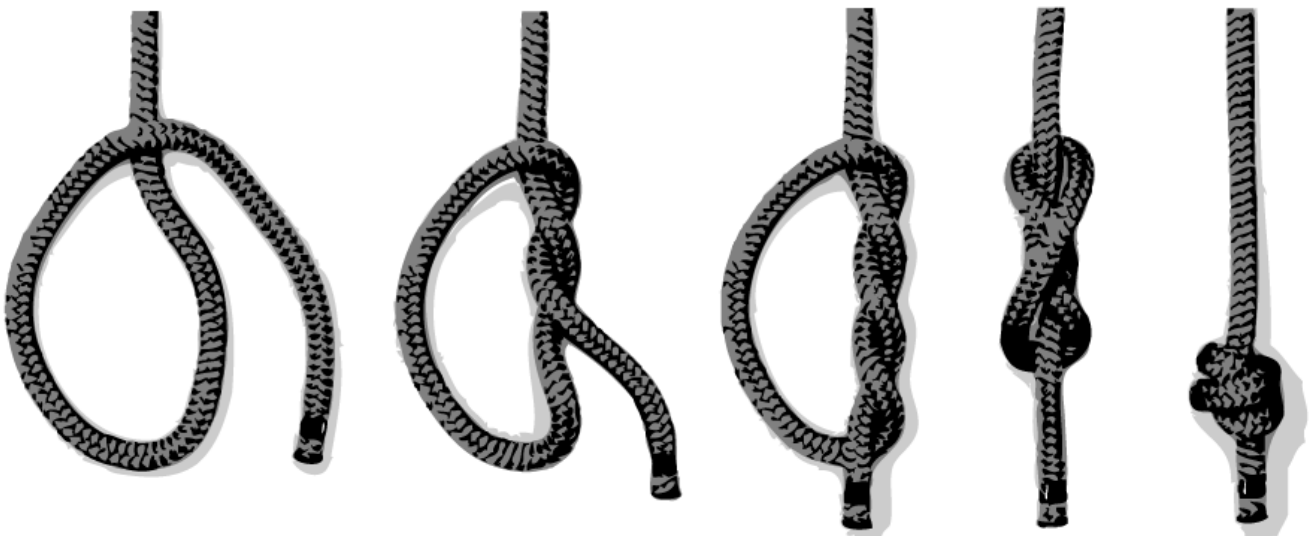
Figure 8 follow through



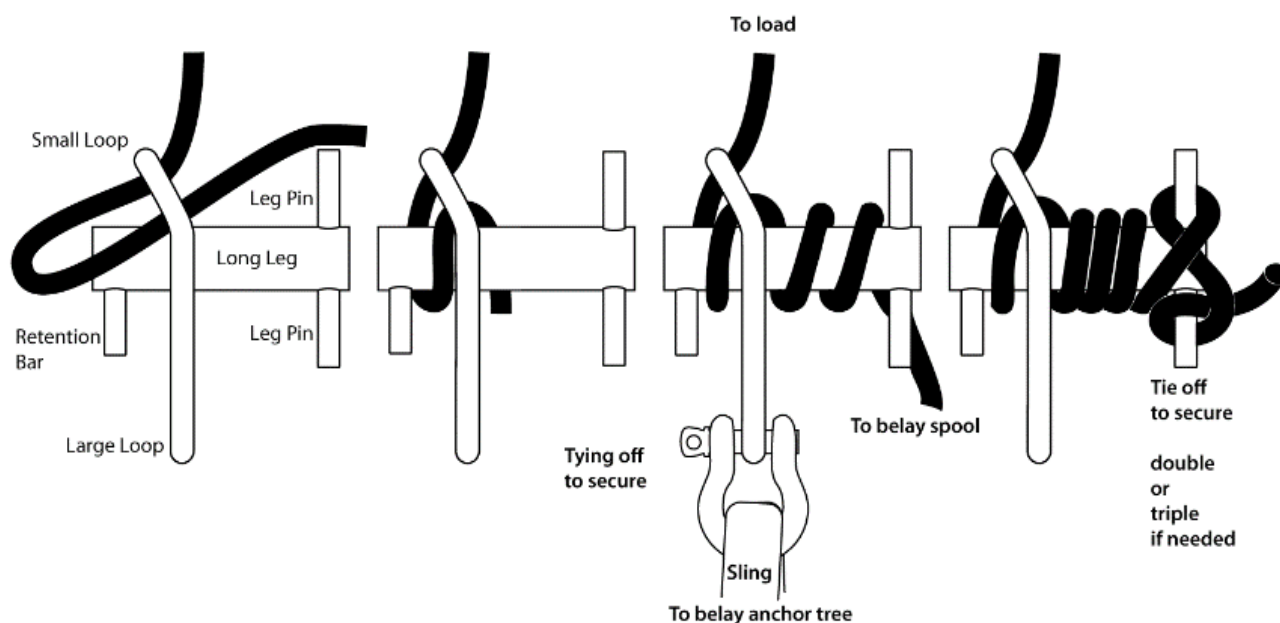
Ashley stopper



Double overhand stopper



13. Port-A-Wrap



14. Call and Response

Clear communication operating a high line system is mandatory to ensure those operating the system, and those working in the area, know what is taking place. Use walkie talkies and/or hand gestures to ensure clear communication between operators.

Calls are made at a volume 'everyone' can hear, and repeated in response by others.

TENSION or SLACK WINCH-REPEAT
 ROCK ON THE LINE or NO ROCK -REPEAT
 HOLD or SLACK BELAY- REPEAT

15. Equipment Maintenance

It is important to keep equipment out of the dirt and as clean as possible to ensure a long life.

1. Wire Rope
 - Clean with wire brushes and oil annually or as needed
2. Ropes and slings (including Amsteel Blue)
 - Wash with clean water or non detergent soap (ivory) annually or as needed
3. Blocks
 - Clean with wire brushes and grease sheaves annually or as needed
4. Griphoists
 - Lubricate with gear oil every use



- Oil Bath monthly or as needed
- Full brake down and service annually or as needed

Equipment Retirement

Retire any rigging equipment if it shows:

- a. Wear below normal (wearing thin, decreasing in thickness or size)
- b. Degradation, including rust
- c. Cracks
- d. Missing Original Equipment or parts
- e. Signs of bending outside of factory design

Retire Fiber Rope:

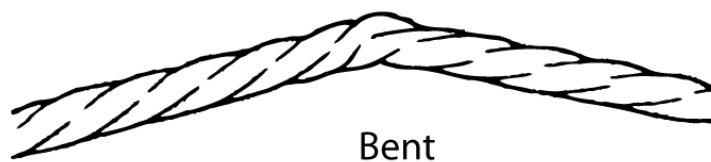
- a. When sheath degradation is apparent
- b. The core is visible or coming through sheath
- c. The sheath is punctured or glazed from friction
- d. Consider retiring regularly used ropes after 5-10 years of use, unless "a" is a factor

Sling retirement:

- a. If you see red (fibers though the outer yellow or white), it's dead
- b. If you can no longer read SWL label or label no longer exists

Wire retirement:

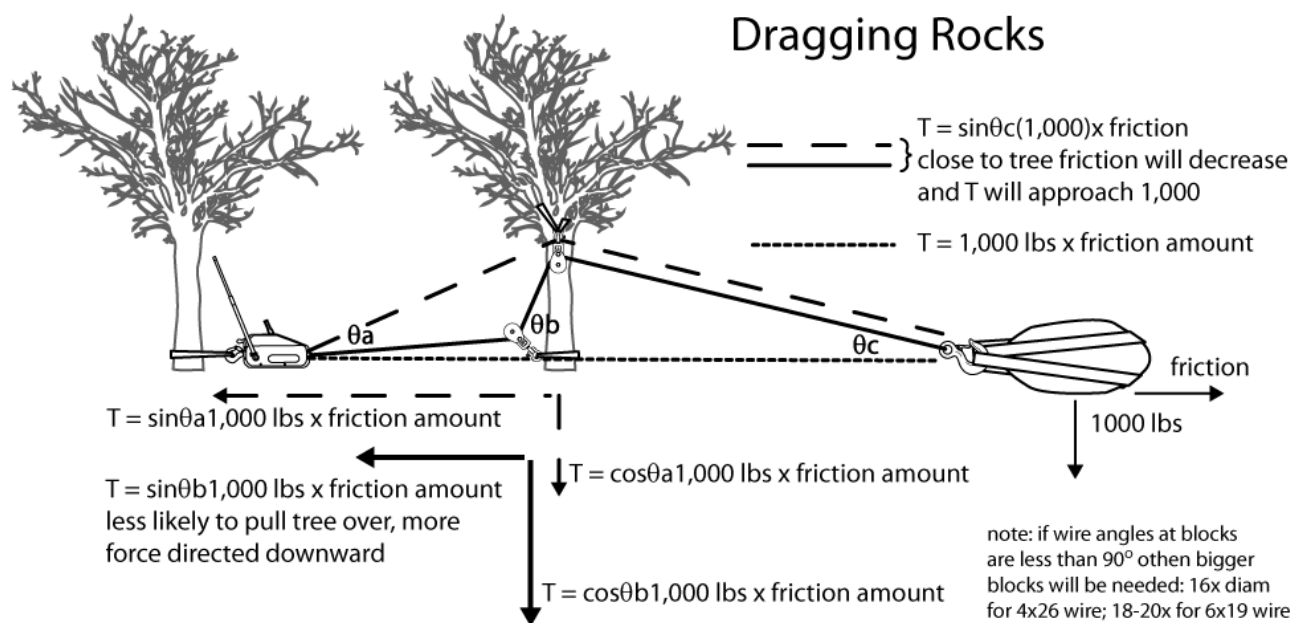
- a. If it no longer feeds through winch
- b. If thimbles are no longer in place or ends are compromised
- c. If any strands are broken or frayed



16. Alternate set-ups

1. **Twin tramway**- for heavy loads in need of two lines
 - a. Set up parallel lines
 - b. Use opposite side of spar trees
 - c. Use alternate anchors if possible
 - d. Two blocks/pulleys on the same load
 - e. Two grip hoists operated in unison
2. **Double-ended tramway**- for long runs to make lifting load faster
 - a. Two grip hoists
 - b. At opposite anchors
3. **Multi-stage tramway**- for long or angled runs, with mid-air transfer
 - a. First line is lower
 - b. Second line is slacked to meet first lower line
 - c. Load is transferred from first to second line
4. **Motorized**- for uphill transport
 - a. Use a high quality and reliable brand
 - b. Stay within the manufacture's SWL tension rating and pulling capacity
 - c. Consider erring on the side of safety by increasing the safety factor to 8 or more

17. Dragging



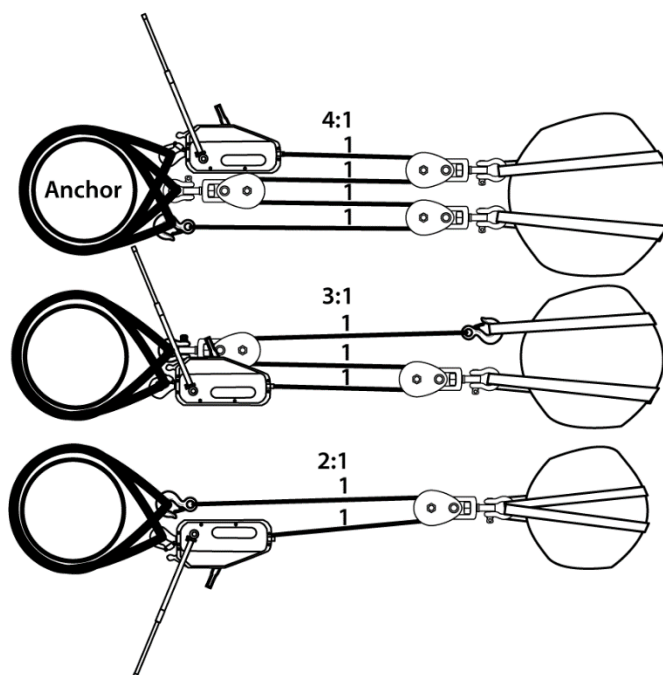
Dragging tricks and tips to reduce friction

- Change sling bight on rock to spin rock rather than drag straight ahead
- Put the sling bight below the front of the rock for more frontal lift

- Put the sling bight in the rear of the rock to flip the rock
- Put the rock on a two rock bar railroad track
- NEVER drag a rock downhill or across a steep slope without a belay

18. Mechanical Advantage

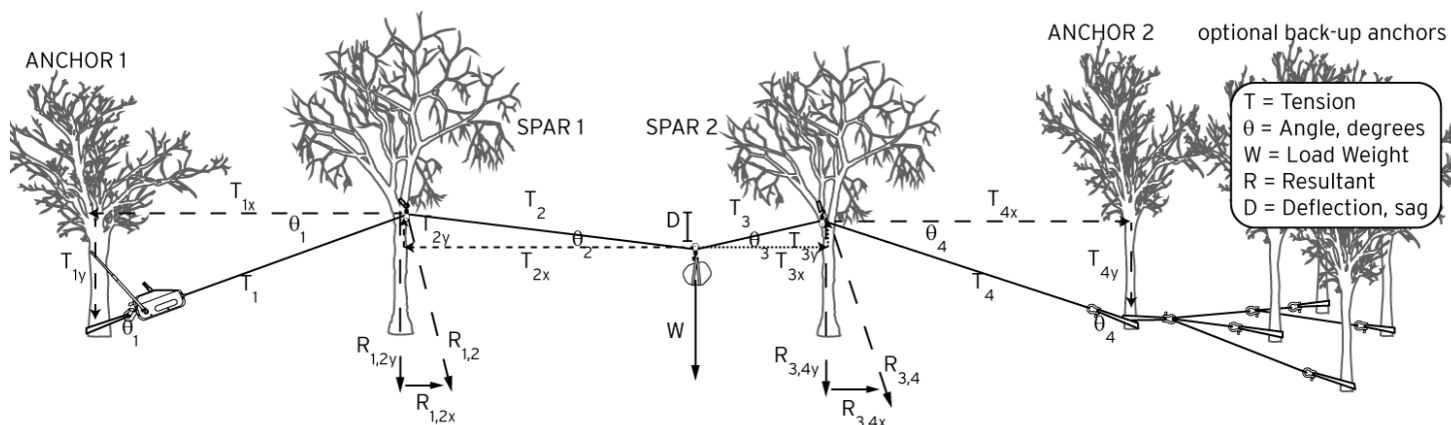
1. Normal highline rigging involves 1 : 1 pulls with no “mechanical advantage.”
2. The configurations in the image below will make lifting and dragging easier.
 - a. If done as shown, with nearly parallel arrangements, then the advantages will be as shown, less any friction from the line/pulley.
 - b. For example, 400 lbs becomes:
 - i. ~200 with 2:1 ($400/2$)
 - ii. ~133 with 3:1 ($400/3$)
 - iii. ~100 with 4:1 ($400/4$)
 - c. Advantage will still be gained with less than a parallel arrangement, for example, another nearby anchor at 10, 20, or 40 degrees away, but as degrees increase, advantage decrease



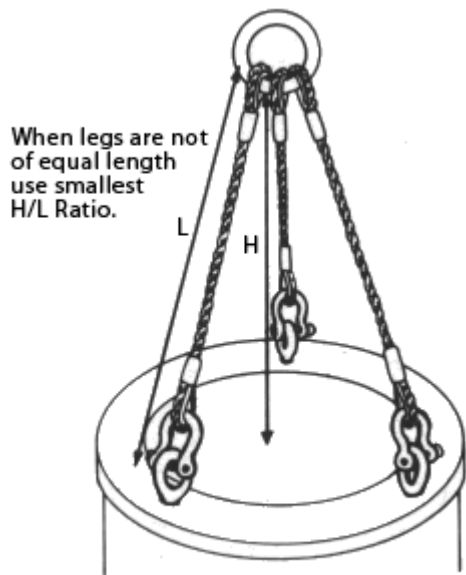
18. Math to know

It is not required to know the math involved in ensuring a rigging system does not exceed the rated capacity of any part of that system, but it helps to understand resultant forces and

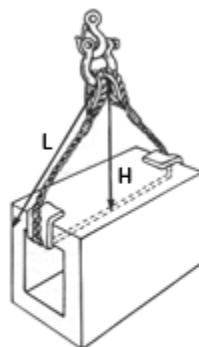
tensions that are the result of physical Laws, mainly Newton's third law and its relation to tension and trigonometry.



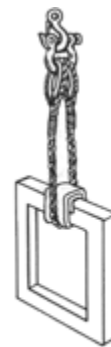
$T_2 = W / \sin\theta_2 + ((\cos\theta_2 / \cos\theta_3) \times \sin\theta_3)$			
$T_3 = (W - T_2 \sin\theta_2) / \sin\theta_3$			
$T_1^2 = (T_2 \sin\theta_2 / \sin\theta_1)^2 + (T_2 \cos\theta_2 / \cos\theta_1)^2$			
$T_4^2 = (T_3 \sin\theta_3 / \sin\theta_4)^2 + (T_3 \cos\theta_3 / \cos\theta_4)^2$			
Solve for the load (T2 then T3), then T1 or T4			
$T_{1y} = \text{upward force on anchor 1 sling} = T_1 \sin\theta_1$			
$T_{4y} = \text{upward force on anchor 2 sling} = T_4 \sin\theta_4$			
$R_{1y} = \text{downward force on spar 1} = T_1 \cos\theta_1 + T_2 \cos\theta_2$			
$R_{4y} = \text{downward force on spar 2} = T_4 \cos\theta_4 + T_3 \cos\theta_3$			



$$SWL = S.W.L. \text{ (of single vertical hitch)} \times \frac{H}{L} \times 3$$



Inclined Legs
S.W.L. = S.W.L.
(of single vertical hitch)
 $\times H \times 2$



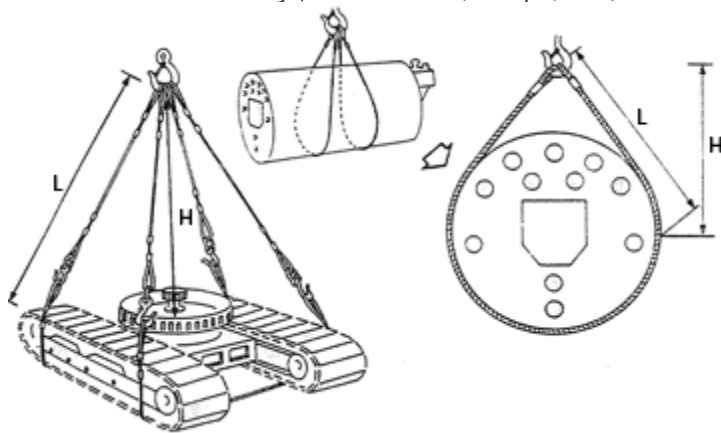
Vertical Legs
S.W.L. = S.W.L.
(of single vertical
hitch) $\times 2$

Single Basket Hitch

For vertical legs,
SWL = SWL (of rope) $\times 2$
For inclined legs,
SWL = SWL (of rope) $\times H/L \times 2$

Double Basket Hitch

For vertical legs, SWL = SWL (of rope) $\times 4$
For inclined legs, SWL = SWL (of rope) $\times H/L \times 4$



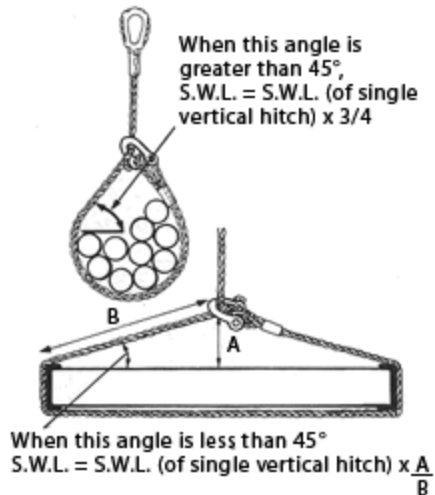
Double-Wrap Basket Hitch

Depending on the conjurations, the safe working loads are the same as for the single basket hitch or the double basket hitch.



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Single Choker Hitch

For sling angles of 45°

$$SWL = SWL \text{ (of rope)} \times \frac{3}{4}$$

Sling angles of less than 45° are not recommended; however, if they must be used, the formula is:

$$SWL = SWL \text{ (of rope)} \times \frac{A}{B}$$

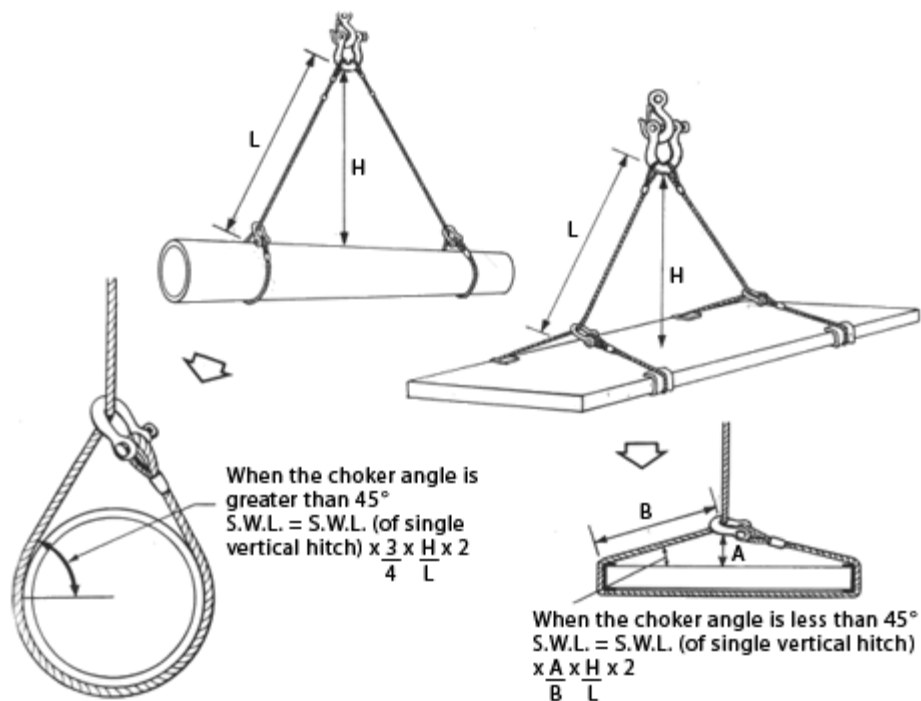
Double Choker Hitch

For sling angles of 45° or more (formed by the choker),

$$SWL = SWL \text{ (of rope)} \times \frac{3}{4} \times \frac{H}{L} \times 2.$$

Sling angles of less than 45° (formed by the choker) are not recommended; however, if they must be used, the formula is:

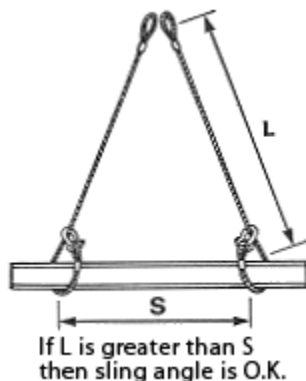
$$SWL = SWL \text{ (of rope)} \times \frac{A}{B} \times \frac{H}{L} \times 2.$$



Double-Wrap Choker Hitch

Depending on the configuration, the safe working loads are the same as for the single choker hitch or double choker hitch.

Ensure that the sling angle is always greater than 45 degrees. To make sure that the angle is adequate once a load is rigged, check that the horizontal distance between the attachment points on the load is less than the length of the shortest sling leg. If this is the case, then the angle is greater than 60 degrees.



When using choker hitches, do not force the eye down toward the load once tension is applied; rope damage will result.