

## Unit 28: Ties and Anchors

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This course doesn't teach technical rescue.



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Reminder: This course doesn't teach technical rescue.

This course doesn't teach you how to operate in the high angle environment, just how to recognize it.

It does teach some skills for use on non-technical terrain.

It does teach some skills to assist in the warm zone.

Operate under the supervision of trained technical rescue personnel

# Life Safety Rope Systems

- Mainline
  - Supports the load
- Belay
  - Redundant, takes up the load in case of a failure on the mainline portion of the system.
  - Limited slack, limited shock loads.



Life safety rope systems work with:

A mainline, holding the load.

A belay, kept with minimal slack, backup to take the load if there is a failure in the mainline portion of the system.

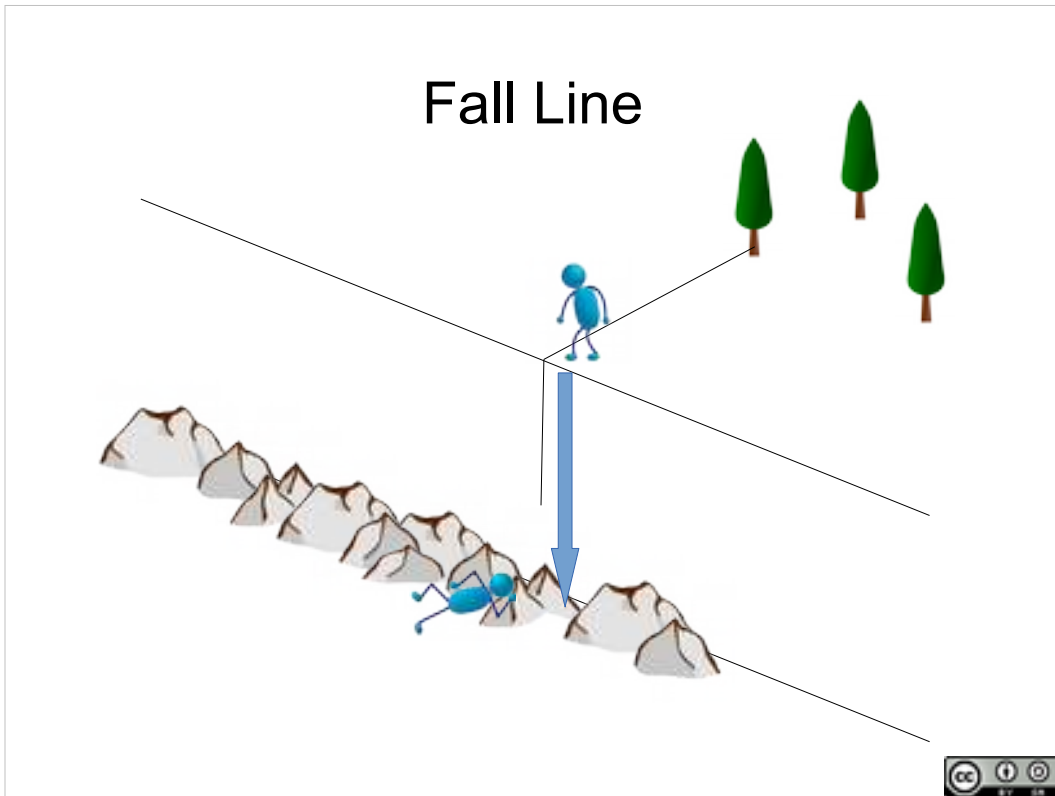
Entirely different from lead climbing systems.

## Some factors in system design

- Loads and Forces
  - System safety factor (10:1 or 15:1)
- Friction
- Anchors
- Fall Line
- Backup/Belay system

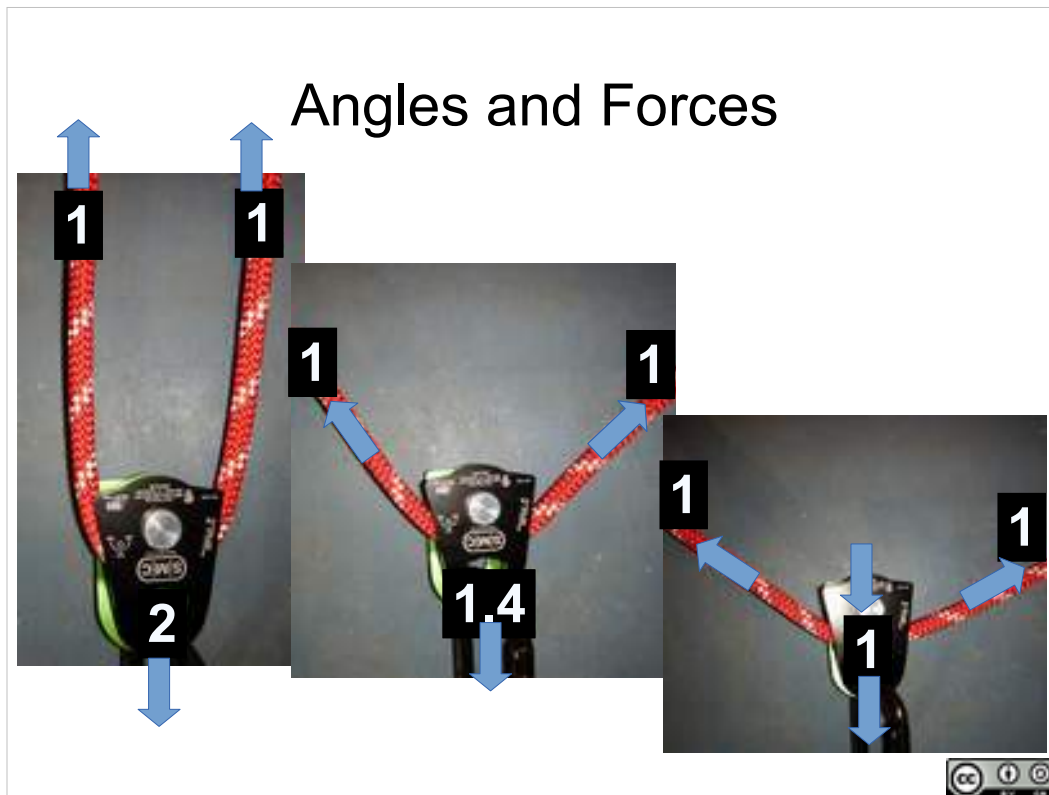


Lets take a very brief look at some of the factors that go into the design of a rope system by a technician.



One concern is the fall line.

Why?



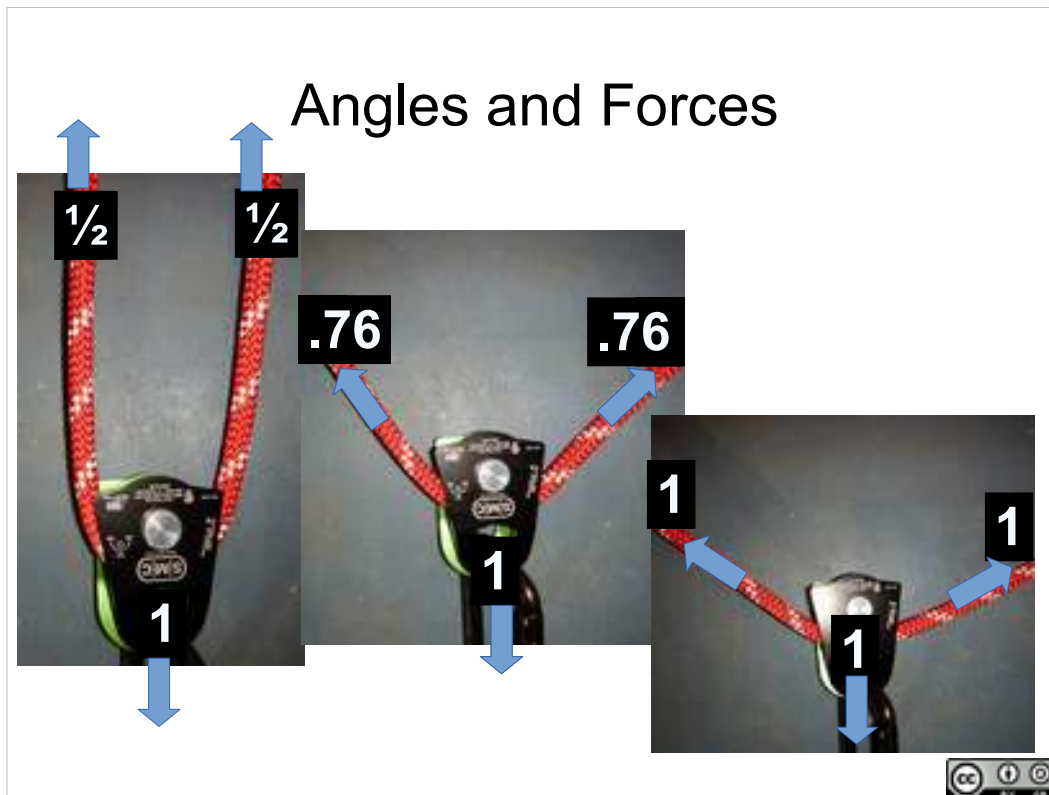
Describe Angles and forces.

0 degrees,  $1+1$  vector sum to 2.

90 degrees,  $1+1$  vector sum to 1.4

120 degrees,  $1+1$  vector sum to 1, beyond that is lower.

Exact numbers don't matter for the purposes of this class (they do matter to the technicians who are rigging systems). But angles are important, can greatly multiply forces. Generally seek to keep angles small (less than 60 degrees).



Describe Angles and forces Looking from the other direction.

Load of 1, on 0 degree pulley, 50% on each leg.  
 Same load, open to 90 degrees, load of 76% on each leg.

Same load, open to 120 degrees, load of 1 on each leg.

Wider than 120 degrees, each leg has load greater than 1.

#### **Demonstration.**

Again, exact numbers don't matter for the purposes of this class, though they are very important for technicians designing systems. Generally, keep angles small, less than 60 degrees.

## Factors in Rescue Efficiency

- Available personnel.
- Terrain.
- Weather.
- Darkness.
- Rope rescuer condition.
- Subject condition.
- Accuracy.
- Speed.



Efficiency of rescue depends on multiple factors.

Knowledge, weather, skills, condition....



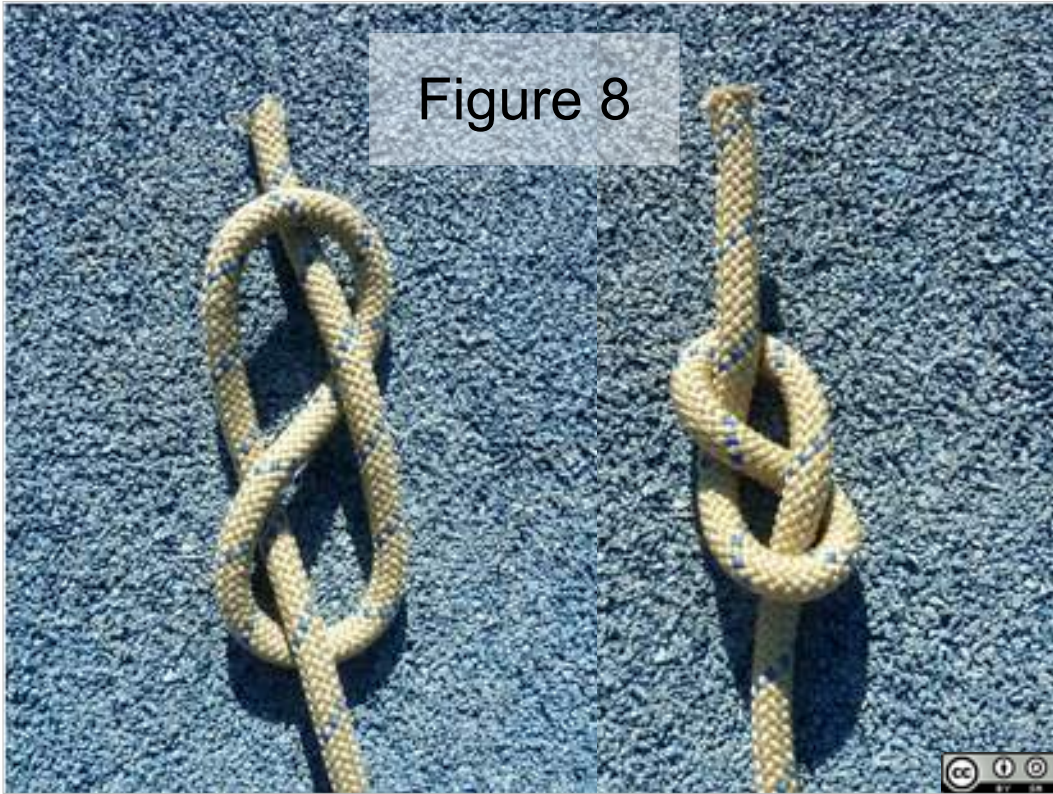
## Practice Ties

- Figure 8 on a bight, with barrel knot safety.
- Figure 8 follow through (tie in), with barrel knot safety.
- Alpine Butterfly
- Double overhand bend.
- Prusik hitch.
- Water knot.
- Square knot.
- Expedient Harness (Swiss seat).
- High strength anchor.



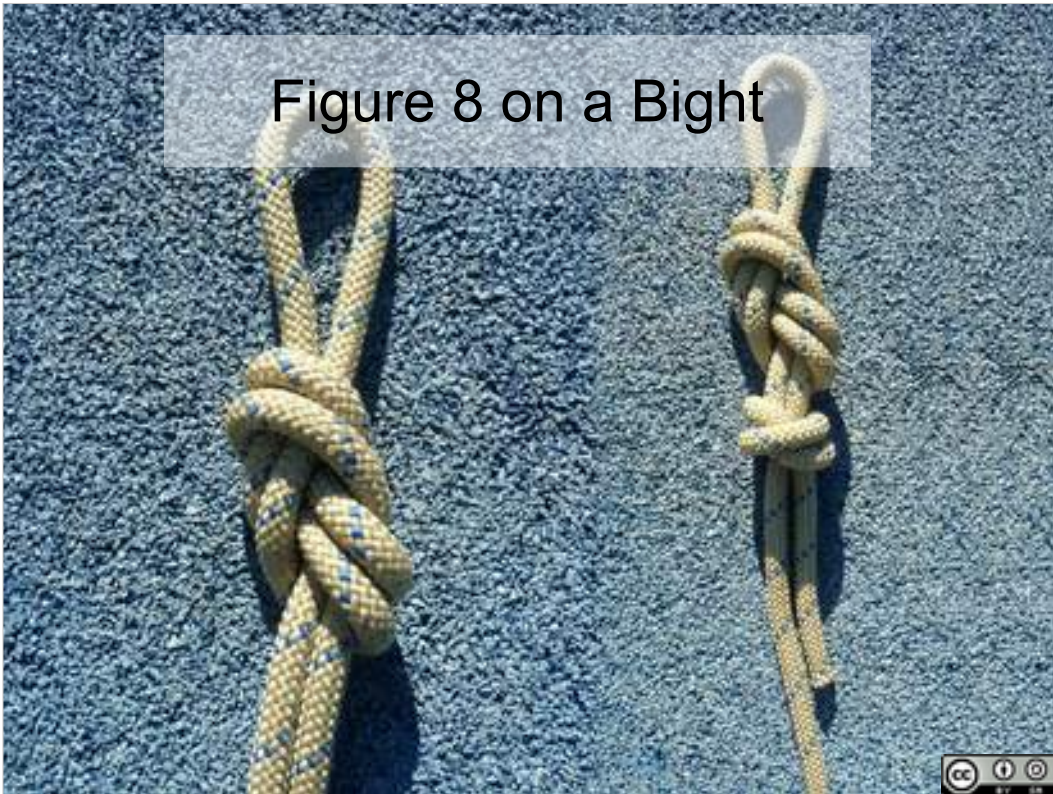
Hand out rope and webbing, demonstrate and have everyone tie each of these ties.

Images of each follow. *[You can use the images while teaching the knots if that is helpful, there are some comments on the knots in the speaker's notes]*



Review: Figure 8 stopper knot.

Foundation life safety knot. Easy to recognize , easy to see that it has been tied correctly.



Review: Figure 8 on a bight.

Reminder: Dress your knots. That is important for their strength.



Review: Barrel knot safety (on a figure 8 on a bight).

Reminder: Make the loop on your figure 8 just large enough for its purpose.



Review: Figure 8 follow through

Exactly the same knot as the figure 8 on a bight, but tied in a follow through (to attach to a harness or some other closed ring).

Starts with a figure 8 in the working end, then pass the working end through the closed ring, then trace the 8.



Figure 8 follow through, finished knot

Exactly the same knot as the figure 8 on a bight, but tied in a follow through (to attach to a harness or some other closed ring).



Double overhand bend.



Alpine Butterfly





Prusik hitch.

Hitch, joins a rope to something.

Prusik hitch slides, but locks when loaded.

Progress capture device.

## Water Knot (Ring Bend)



Water Knot – bend to tie in webbing.



Square knot at the top, with overhand safeties added on the bottom.

Binding Knot.

## Swiss Seat



Used to make a swiss seat, and expedient harness.

Expedient harness.

# Anchors

- Secure
- Redundant
- Equalizing
- Non-Extensible



## Anchors

Describe Selection of materials

Describe Alignment, limitations.



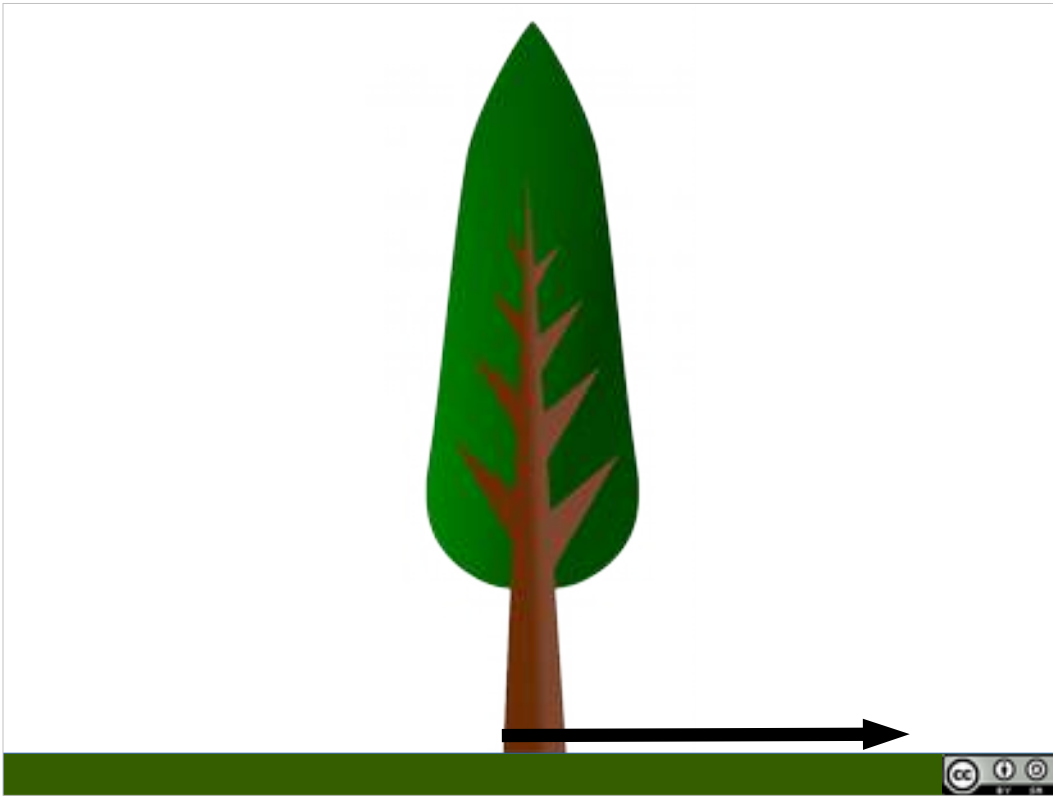
Anchors may be a single point anchor.  
We'll build one sort of single point anchor.

## Multi-Point Anchor



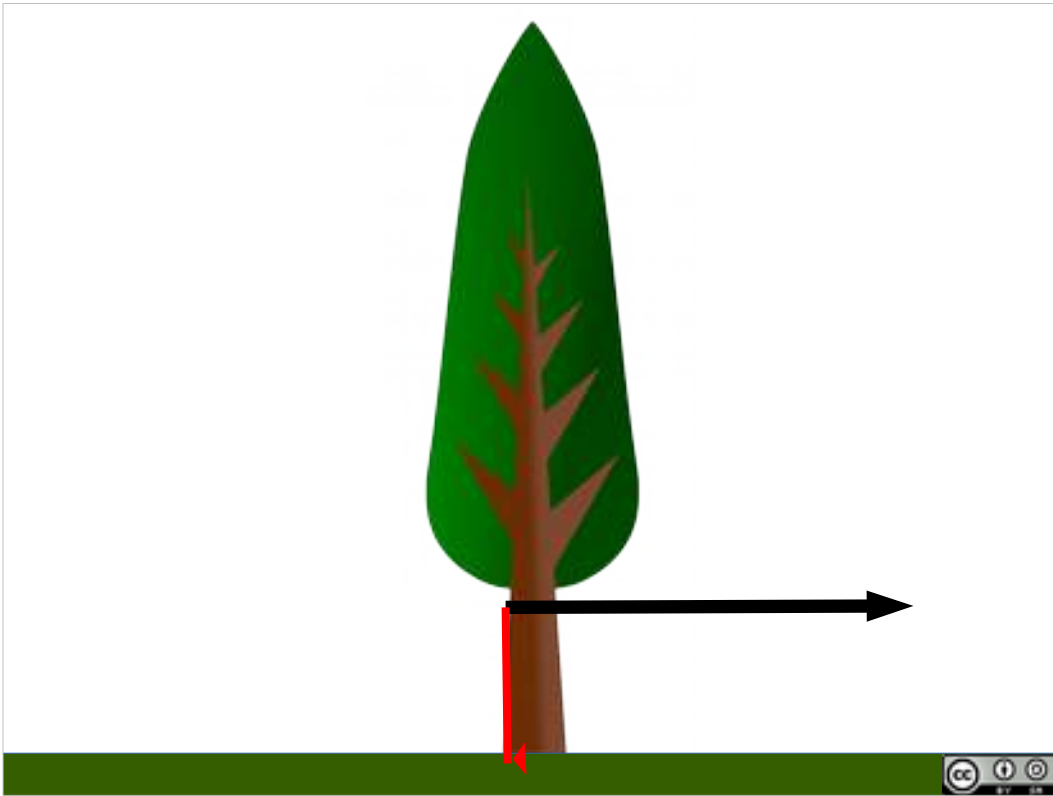
There are also Multi-point anchors.

We won't go into their design.



When anchoring to a tree, anchor low, close to the ground.





Anchoring higher creates a lever and a weaker anchor.

Demonstration.



High Strength Tie-off/Tensionless hitch.

Put edge protection around the anchor.

Precisely three wraps [*See the discussion in "On Rope"*].



High Strength Tie-off/Tensionless hitch.

Put edge protection around the anchor.

Precisely three wraps [*See the discussion in “On Rope”*].

Describe Angles and forces – keep straight through carabener.

Note slight angle in this picture, main line should be straight from anchor.

## Anchor Strap (and tri-link)

Keep Angle  
Small

Tri-link,  
Do Not put  
3 way load on  
a Carabiner

## Team Functions

- Rescue Group Supervisor
- Edge Manager
- Safety
- Belay operator
- Lowering/Haul system operator(s)
- Rescuer/Litter Attendant(s)



Lots of jobs in a rope rescue operation.

Someone in charge.

People filling roles, working as a team.

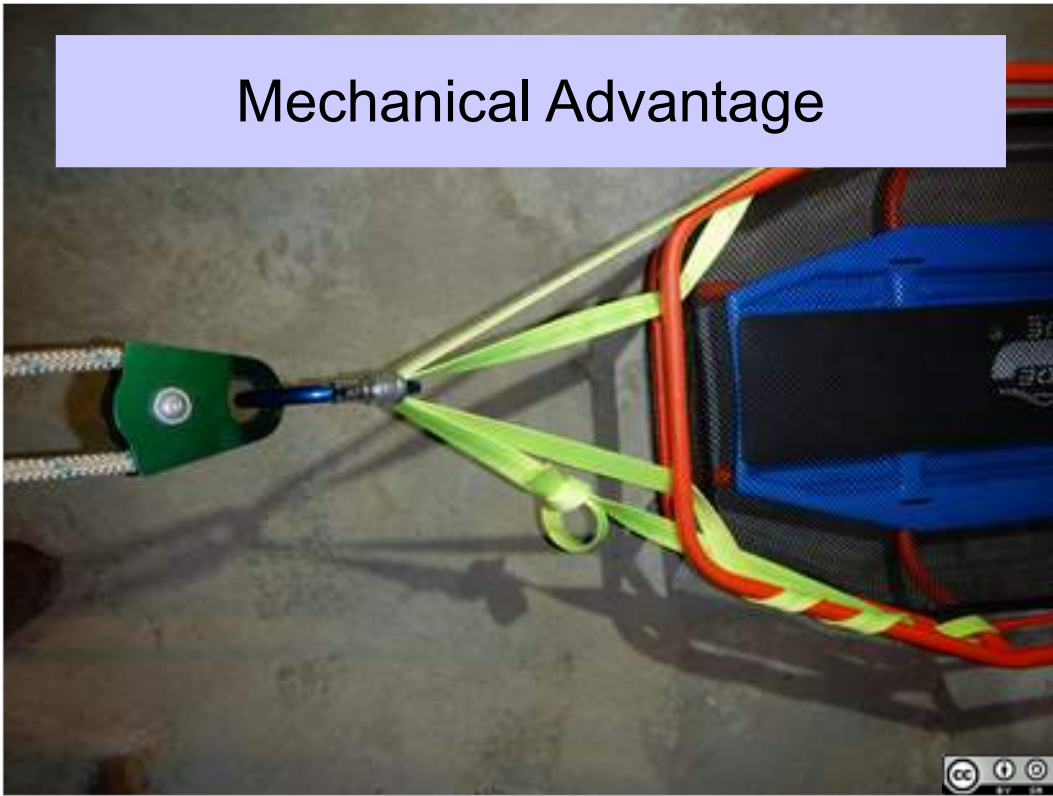
## Haul Systems



Identify team: Edge manager, belay, haul team.

Haul and lower

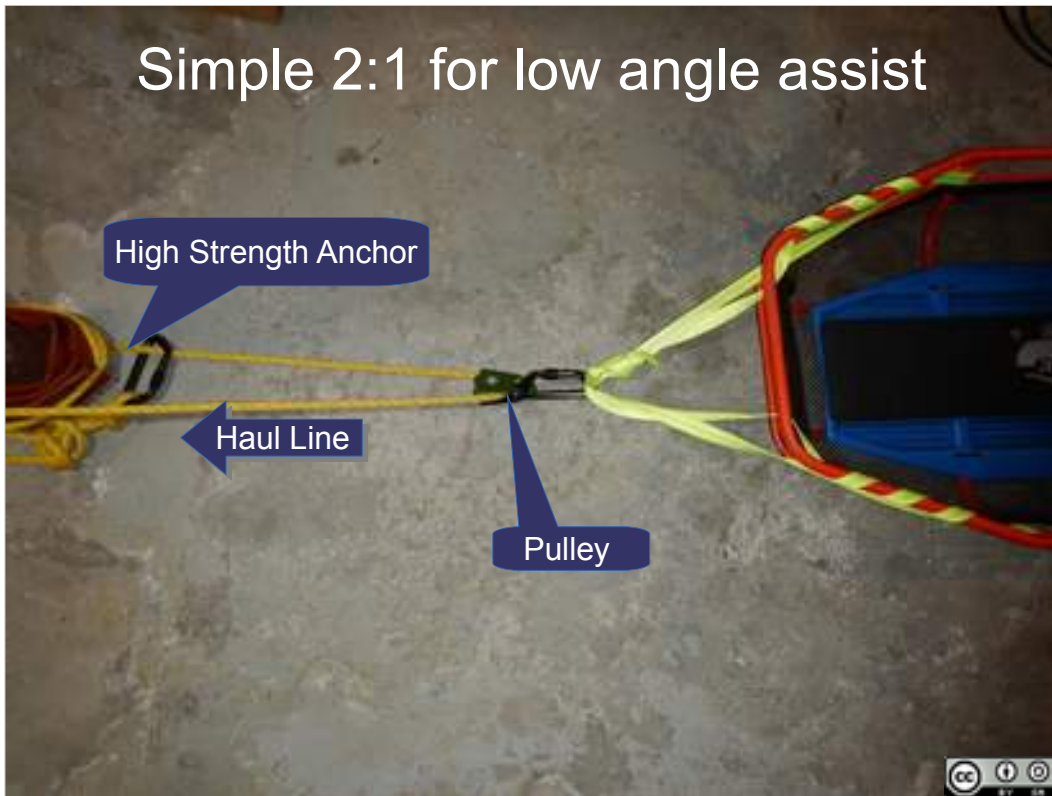
## Mechanical Advantage



Basic mechanical advantage.

Discuss how a pulley works as change of direction, and how a pulley provides mechanical advantage

## Simple 2:1 for low angle assist



## Simple 2:2 pulley on litter for low angle assist

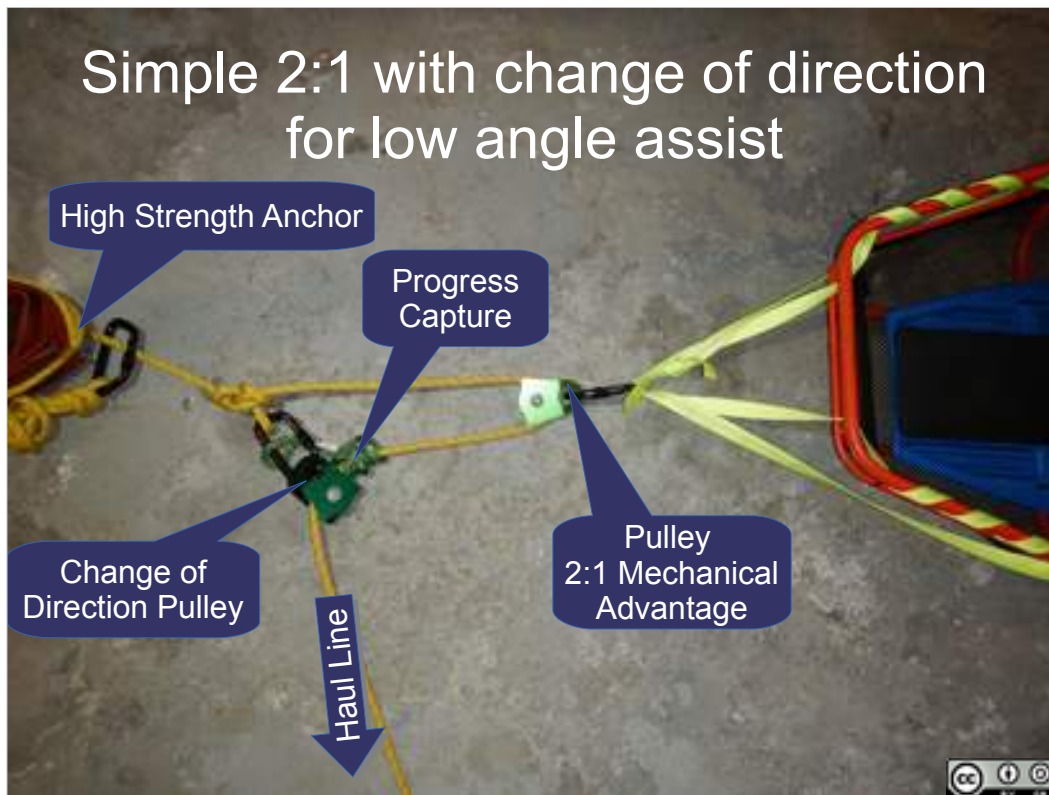


Simple 2:1 with change of direction  
for low angle assist



Add a change of direction pulley to let the haul team work from off the line of haul.

Add a prusik as a progress capture device.



Add a change of direction pulley to let the haul team work from off the line of haul.

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