Building a 100’ Monkey Bridge

Revised 3/24/2017

Description: A monkey bridge is made up of three heavy ropes, one footrope and two handrails. The three ropes are held apart from each other at a comfortable distance by small diameter rope stringers, and supported above the ground by A-frames. The major advantages of a monkey bridge over other types are its ease of construction, its ability to span long distances, and its light weight for a given length. Its primary disadvantage is the difficulty of crossing it without falling off, particularly for longer spans and spans that are not adequately tensioned. A large monkey bridge must include a safety system because of the fall risk inherent in its design.

We built the monkey bridge shown in these photos in June, 2014, at High Point State Park in Sussex, NJ. The site was a small gorge located adjacent to the Appalachian Trail about ½ mile from the nearest trailhead. The gorge was about 100’ feet wide, 25’ deep, and one side of the gorge was much steeper and higher than the other. There were many mature trees at the site. We had limited manpower, but lots of time to build the bridge. Because of these circumstances, our design and process differed somewhat from how a larger group might approach building the bridge on a different site. We point out these differences as they appear in the following pages.

Design Considerations

Safety: A fall from a large monkey bridge could kill, so large monkey bridges need a safety system. Smaller bridges may not need a safety system, but you should have a designated person responsible for safety and a safe operating procedure for all monkey bridges regardless of size.

Materials: Exact sizes and quantities of material will depend on the span of your bridge and other design choices. For small monkey bridges we recommend at least ¾" diameter rope for the footrope and at least ½" diameter rope for the handrails. For large bridges, we use 1¼" footropes and ¾" handrails. You will also need sacking to protect the footrope where it crosses each a-frame and attaches to natural anchors. We recommend using a block and tackle to tension the bridge, though this can be done less satisfactorily by manpower alone on small bridges. We do not recommend using come-alongs or other mechanical winches for tensioning the bridge as it is too easy to over-tension the ropeway.

Site Selection and Anchors: You will have to design the bridge's length of span and anchors to fit your site. If you are starting out, it is easiest to build the bridge on flat ground. As you gain experience you will find it more fun and challenging to bridge across obstacles. If possible choose a site with natural anchors that you can tie off the bridge to. Well chosen natural anchors are safer than built anchor systems, and they will save you time during construction.

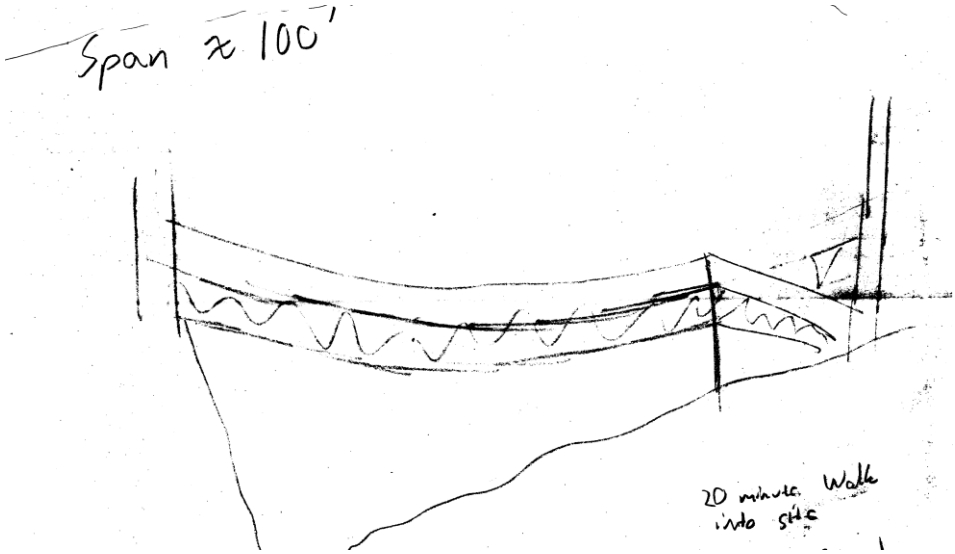
Span: As the bridge's span increases, so does the amount that the ropeway sags in the span. Sag will be most severe when a person is at the middle of the bridge's span. Excessive sag will make the bridge difficult to cross. The amount of sag in the bridge is also a function of the tension in the ropeway. You can reduce sag by pulling more tension on the ropeway, but if you pull too much tension you will dangerously overstress the bridge. The minimum allowable sag in your bridge when loaded should be 5% of the span's length. Thus, a 100' span must have room to sag at least 5'. If building on level ground, you must increase the height of your a-frames as the span increases to keep the middle of the span from touching the ground when the bridge is used.

Manpower: The bridge in the following photos was built by two people over the course of a day, but the bridge is easier and faster to build with a larger group. If your troop has several patrols, assign each one to work on a different subassembly of the bridge (Ropeway, a-frames, and anchors) so that work can proceed on several fronts simultaneously.

Longevity: If you intend for your bridge to see heavy or long term use (such as at a summer camp or camporee) it should to be more sturdily built than a bridge that you build at a troop meeting or weekend campout. For hard use bridges you should use interlocking stringers, and you should incorporate tackles into the ropeway so that you can easily take up tension as the bridge stretches in use. Built anchor systems will be problematic for large bridges that see heavy or long term use, so it is well worth finding a site where you can use natural anchors.

Plans

Building a monkey bridge is a straightforward project, so we only made a rough sketch and a few notes before building the bridge in these photos. We were working at a remote site, so a detailed materials list was more important than normal.



BEC Rope Bridge

- Walkway 100', 3' spacing for stringer pairs
- 2 × 18', 1 × 10' spars, shaved
- 2 × 150' × 3/4" ropes
- 10 × 10' × 1/4" ropes
- 20 × 15' × 1/4" ropes
- 10 × 20' × 1/4" ropes
- 5 × scrap canvas
- Harness + Helmet × 2
- Rabbit Ears
- Pack Frame
- Shovel
- Axe
- Tapers
- Handy Billy + Slings

Notes

- [redacted] @ 12'
- an spars.
- No slings @ either end
- All tensioning w/ Handy Billy

Building the Ropeway

We used a 150’ piece of 1¼” manila rope for the footrope. The two handrails are each 150’ pieces of ¾” manila. The footrope and handrails are connected by stringers made of ¼” manila rope. When a person crosses a completed monkey bridge, most of their weight goes into the footrope. The stringers transfer some of this load to the handrails. They also keep the handrails at a user friendly distance from the footrope. Here, the handrails are spaced about 4’ out from each side of the footrope, and stringers are attached to the footrope every two feet. The stringers are tied to the footrope with a larks head knot and tied to each handrail with a two-half-hitches and roundturn. We attached stringers to the middle 100’ of the large ropes, and left 25’ on each end for attaching the bridge to its anchorages. Even a small bridge needs at least 15’ of rope on each end, 10’ to run from the a-frame to the anchor and 5’ or more to tie off.

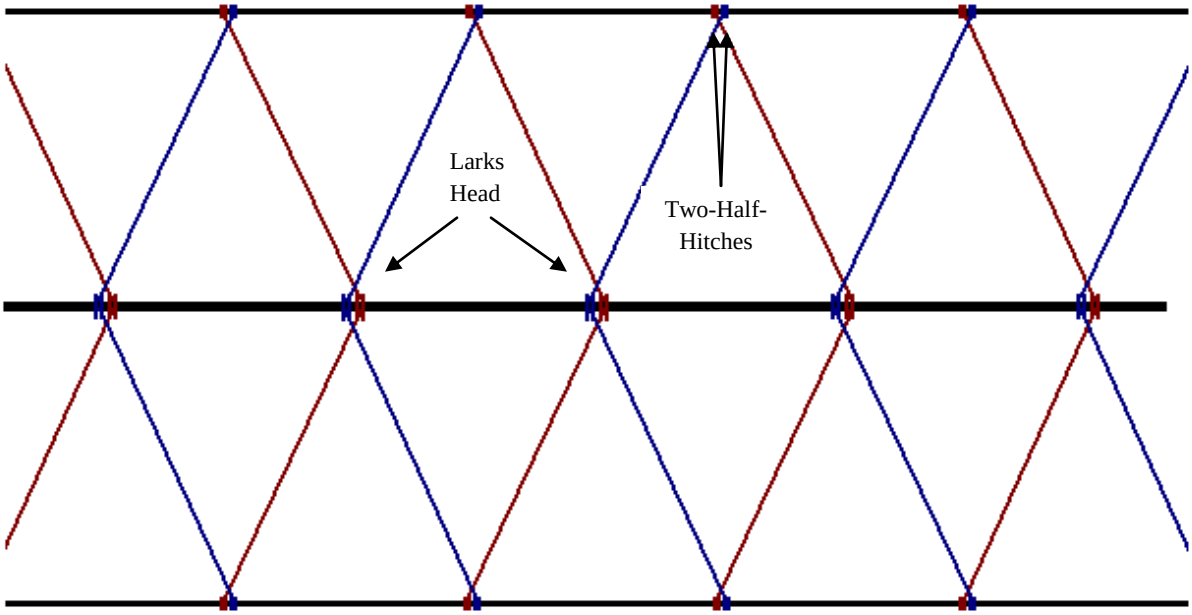
We store our completed ropeway on a spool and reuse it for many bridges. As a consequence, we built it with a system of interlocking stringers to connect the footropes and handrail. This is a superior design to the straight stringers used on most monkey bridges, but requires more time and materials to construct.

Stringer Designs for a Monkey Bridge

The monkey bridge in the sketch below uses straight stringers. This is the stringer design shown in BSA publications. The middle of each stringer is connected to the footrope with a larks head or clove hitch, and each end is clove hitched to a handrail. The stringers are usually spaced 3’ or 4’ apart. This design is easy to construct and uses less rope than interlocking stringers. It is a good choice for a bridge that will see limited use, but we have found it problematic on bridges that see heavy use because the stringers will easily shift out of position along the handrails and footrope.

From Pioneering Merit Badge Pamphlet (Adolph Peschke, 1993 ed.)

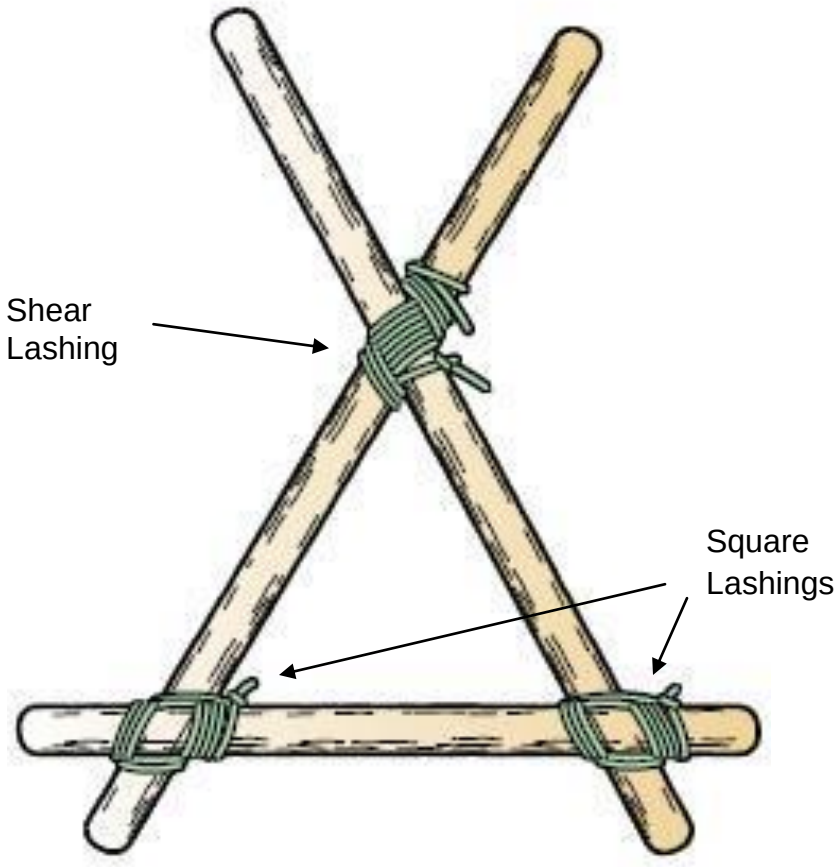
The following sketch shows a birds’ eye view of the ropeway of a monkey bridge built with interlocking stringers. Built this way, each stringer interlocks with its neighbors so that they hold each other in position when placed under strain. We generally space the stringer pairs 2’to 2½’ apart on the footrope and use a 10’ length of ¼” manila rope for each stringer. We attach the center of each stringer to the footrope with a larks head knot (Quicker to tie than a clove hitch) and tie the ends of the stringers to each handrail with a two-half-hitches and round turn (Holds a little better than a clove hitch). For a given stringer spacing, bridges built this way require twice as many ¼” stringer ropes as a straight stringer bridge, but they hold up better in use, such as if you are building a monkey bridge for a camporee, summer camp, or other hard use,



Lashing the A-Frames

The monkey bridge's ropeway is held above the ground by triangular a-frames. The ropeway will sag when you use the bridge, so the a-frames must be tall enough to keep the middle of ropeway off of the ground when it is carrying a person. A longer span will require taller a-frames. Because of the uneven terrain at this site we only needed an a-frame at one end of this bridge, but monkey bridges built on level ground will require an a-frame at each end.

We used 18' upright spars for the legs of the a-frame. We started by laying them parallel to each other and tying them together with a shear lashing 12' above the butts of the spars. We then spread the butts of the upright spars 9' apart. Spreading the legs apart further tightens the shear lashing. Secure the legs at this distance by tying a 10' ledger spar between the butts using square lashings. This sequence is the best way to build the a-frame because it lets you use a shear lashing for the upper lashing on the a-frame. The upper lashing is a critical lashing in the structure because it must support the heavily strained footrope. The shear lashing is well suited for this task because it has more wrapping turns than a square or diagonal lashing, and is thus stronger and more resistant to slipping down on the spars.



From Pioneering Merit Badge Pamphlet (BSA, 2006 ed.)

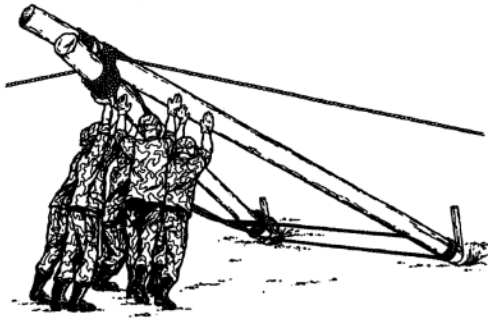
Prepping the A-Frames

After lashing the a-frame together you must prepare it for use in a monkey bridge. The photo below shows the top of the a-frame shortly before we stood it up. Attach two 25’ or longer guy lines of ½” manila rope to the top of each leg. These will hold up the A-frame while you are finishing the bridge. Take a piece of canvas sacking and lash it into the crotch of the a-frame. This prevents the footrope from being abraded against the spars when the bridge is in use. For this bridge, we laid out the ropeway and placed it through the a-frame before erecting it. This makes the a-frame heavier and harder to stand up. We did this because we were shorthanded and would need to raise the a-frame with a block and tackle anyway. When working with a crew large enough to raise the a-frame by hand, we find it easier to put the ropeway through the a-frame after standing it up.

Erecting the A-Frame(s)

Now you need to stand up the a-frames at each end of the bridge and hold them in place with guy lines. Before you stand up the a-frame you need to dig a 6” or so deep hole for each leg to set into. The holes are critical. They prevent the legs from slipping forward while you are standing the a-frames up, and, once the bridge is in use, they prevent the bottom of the a-frame from kicking out and collapsing the bridge. You also need to make or find four anchors for your guy lines. We were able to find saplings to tie off to, but if you are working in an area without natural anchors you will need to drive heavy stakes. We use 36” stakes of hardwoods or 1” rebar driven at least 16” deep. Tent pegs won’t cut it.

A crew of five to seven scouts can erect an a-frame up to 20’ tall by hand by proceeding as in the illustration below. Proceed carefully, and make sure that everyone has an escape route picked out in case things go wrong. Make sure that you have some way of preventing the butts of the a-frame from sliding forward as you stand it up.



From FM 5-125 (Dept. of Defense, 1995)

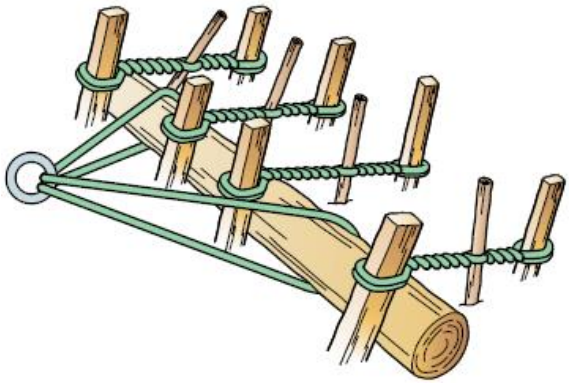
We were shorthanded, so we pulled the a-frame up using the block and tackle that we brought with us to tension the ropeway. A larger group could do the job more quickly by hand.

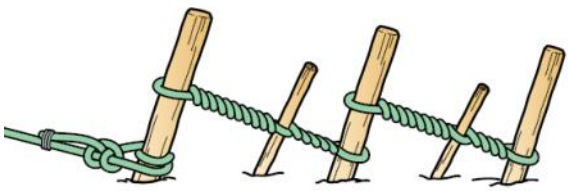
Anchorages

Each end of the bridge needs a sturdy anchor for you to secure the ropeway to. A natural anchor is your best choice. Mature healthy trees make the best natural anchors. Large slab sided boulders deeply embedded in the ground will also work. Avoid using dead or injured trees for anchors. Their root structure may have hidden rot even if the trunk appears sound. Put sacking on the anchor before tying off to it to protect the tree and the ropes from abrading each other.

A single stake, no matter how large, cannot take the strain from the ropeway of even a small monkey bridge, so, if natural anchors are unavailable at your building site you will need to build anchor systems. An anchor system distributes strain across multiple stakes. A log and stake anchor system and 1-1-1 anchor system are shown below. 3’ or longer clear grained hardwood spars with pointed tips and chamfered striking faces make the best wooden stakes. Drive them at least 2’ deep, and use a large wooden mallet to extend their life. For a more durable alternative, use 36” lengths of 1” rebar, which drive easily with a metal sledge.

In our experience, even a well built anchor system will give you trouble with heavy forces and sustained use, so we avoid them whenever we can.





From Pioneering Merit Badge Pamphlet (BSA, 2006 ed.)

Tensioning the Footrope

Pull the footrope as tight as possible by hand and then use a block and tackle to finish the job. On this bridge we removed the tackle after pulling tension, but if the bridge will see a lot of use, you can integrate the tackle into the bridge's design so that you can easily tighten up the bridge as it sags in use (This will require much sturdier rigging than that shown below.). The tackle is worth using even with large groups of Scouts because it allows the Scouts pulling tension to stand out of the way of the Scouts tying off to the anchorage. We do not recommend using come-alongs or other similar tools to tension your bridge, as it is too easy to over-tension the ropeway. Remember that under load the bridge should sag an amount equal to at least 5% of its span. Tensioning the footrope does a great deal to stabilize and secure the a-frame(s).

The block and tackle that we used to set up this bridge uses ¾" rope and has a 10' draw. It is rigged to advantage, and gives a mechanical advantage of 4. The block tied to the anchorage has a swivel hook (not pictured), which makes it easy to keep the falls of the tackle from twisting during use.

Attaching and Tensioning the Handrails

Tensioning the footrope puts a downward force on the a-frames and greatly stabilizes them. It is now safe to climb up the a-frames to attach and tension the bridge's handrails. Start working at the far end of the bridge (opposite from where you were just pulling tension in the footrope). Attach each handrail to the a-frame by lashing it on using a square lashing, and then secure the end of each handrail to your anchorage. Be careful that the bridge's stringers are properly aligned while you are doing this. Return to the near side of the bridge and repeat the process. It will be more difficult here because you will need to hold tension in the main span of the handrails while simultaneously tying off. A small block and tackle that you can take up the a-frame with you makes this job a lot easier, but is by no means necessary.

We have seen many small monkey bridges where the handrails are attached to the a-frames by clove hitching the handrails to the a-frame. We prefer to lash the handrails in place for several reasons. First, it is easier to pull high tension in the handrails when they are lashed. Second, the handrails are easier to re-tension when lashed in place. Third, clove hitching the handrails disturbs stringer alignment in a bridge with a prefabricated ropeway. This is difficult to correct if your ropeway uses interlocking stringers.

Installing the Safety System

A bridge of this one's size (100' span, 25ft maximum height above ground) cannot be operated safely without some sort of fall protection system. We lash in two additional ¾" ropes that run above each handrail for the whole length of the bridge. These are installed, anchored, and tensioned the same way as the handrails. Folks crossing the bridge can now harness up and clip into both lines with rabbit ears (The orange webbing in the second picture). You must use two safety lines because users will have to unclip from one line at a time to get past the a-frame(s).

You need to have at least two sets of harnesses and rabbit ears in case someone needs help in the middle of the bridge. This bridge is able to safely support three adults, but it is good practice to only allow one person to cross the main span at a time, as one person's movements can throw off another's balance.

Finishing Up

Your monkey Bridge is now complete. Before putting anyone across it double check all of the knots and lashings for safety. Keep a close watch on your bridge while it is in use for emergent safety issues. For safety, only one person should be on the bridge's span at any time.

As the bridge is used the ropeway will stretch and bed in to the a-frames causing the bridge to lose tension. This is shown in the second photo below. If you have to re-tension, start with the footrope and then move to the handrails. You can tension the footrope from the ground using the block and tackle. For the handrails, one person will need to go up the near a-frame to pull tension through the handrail lashings while a second adjusts the knots at the anchorage.