

Securing Your Home Against Earthquake Damage

The Shelter & Structural Safety chapter lists "Hazard Hunting" as a Tier 1 skill and the shopping list has line items for seismic straps and furniture anchors, but the actual technique has never been written down. FEMA's own data is the reason this matters: falling and shifting objects, not building collapse, is the leading cause of earthquake injury. This guide is how to actually anchor the things in your home.

Everything below depends on finding your studs first

Anchoring hardware, screws, L-brackets, straps, only works if it bites into a wall stud. A screw into drywall or plaster alone will pull straight out under real earthquake force; it isn't a weaker version of a proper anchor, it's decoration that fails when it matters. Studs are typically spaced 16 inches apart, center to center, in most home construction.

To actually use a stud finder: hold it flat against the wall and start it over a spot you're confident is hollow, between where you expect two studs to be, so it calibrates against empty wall rather than a stud. Sweep it horizontally at a slow, steady pace, roughly an inch per second, and keep your other hand off the wall while you do, touching the wall can throw off the reading. When it signals a stud, sweep back over that spot from the other direction to find both edges of it, then mark the midpoint between them as the stud's actual center. If you don't have a stud finder, the knock test works as a backup: tap along the wall and listen for the sound to change from hollow to solid.

Where to start if you can only do one thing

Every item below is worth doing, but they're not equally urgent. Ranked by the actual consequence of skipping it:

1. **The water heater.** A 400+ pound water heater that topples doesn't just make a mess, it can sever its own gas and water connections, creating a fire and flood risk at the same time, in the same moment you're least able to respond to either.
2. **Heavy furniture near beds and exits.** A bookcase or dresser that falls onto a bed, or blocks a doorway, turns a manageable earthquake into a trapped or injured household member.
3. **Everything else on this page:** shelf contents, cabinets, pictures, electronics. Real risks, but lower-consequence than the first two.

Water heater and furnace strapping

Spec	Requirement
Number of straps	At least 2: one in the upper third of the tank, one in the lower third
Lower strap position	At least 4 inches above the water heater's own control panel/gas valve
Strap material	Metal strapping at least 22-gauge steel and 5/8 inch wide, or plumber's tape that fully encircles the tank, not nylon
Anchor hardware	1/4-inch (minimum) lag bolts, at least 1.5 inches of thread penetration into the stud, with a large flat washer between the lag screw and the strap
Gas and water lines	Flexible connectors, not rigid pipe, so the connection can flex slightly with the tank instead of shearing

This isn't just good practice, it's Utah's actual adopted building code (based on the International Residential Code) for exactly this reason: the Wasatch Fault makes water heater strapping a code requirement here, not an optional upgrade. Two straps covers most residential tanks, but the exact cutoff for needing a third strap at mid-height varies by tank size and local jurisdiction; check your specific tank's manufacturer instructions or your local building code rather than assuming two is always enough.

Anchoring furniture: bookcases, dressers, and tall pieces

1. Locate the studs behind where the furniture sits (see above).
2. Use metal L-brackets with screws through the top or back of the piece, or nylon safety straps, either works; what matters is that the hardware reaches a stud, not just the furniture's own backing. Use wood screws long enough to penetrate at least 2 inches into the stud itself, and once installed, pull-test both ends, at the wall and at the furniture, to confirm there's no slack and nothing shifts before trusting the anchor.
3. **Before anchoring through the back of a bookcase**, confirm the back panel is actually solid and securely attached to the sides, top, and bottom. A thin, loosely stapled back panel will tear away from the rest of the piece under load, defeating the anchor.
4. Where two pieces of furniture sit next to each other, connect them to each other in addition to the wall; a linked pair is more stable than two independently anchored pieces.
5. Position anything heavy and unanchored, or anything you haven't gotten to yet, away from beds, sofas, and exit paths, so it can't fall on someone or block the way out.

TVs, electronics, and appliances

- Keep TVs, computers, and microwaves on lower shelves or furniture where practical; lower center of gravity means less energy in a fall.
- A TV needs two separate connections, not one: anchor the furniture itself to a wall stud first, then separately strap the TV to the furniture using the TV's own VESA mount points on the back. Pull-test both connections, at the wall and at the TV, before trusting either one.
- Strap a refrigerator to the wall the same way as a water heater, heavy-gauge strapping into studs, if it isn't already secured by cabinetry on both sides.
- Any gas appliance (range, dryer) should have a flexible connector, not a rigid line, for the same reason as the water heater above.

Keeping shelf and cabinet contents from becoming projectiles

- **Open shelves:** a thin restraint wire, wood dowel, or elastic guardrail across the front of each shelf keeps books and objects from sliding straight off during shaking.
- **Kitchen and bathroom cabinets:** an ordinary childproof latch is built to resist a toddler's grip, not the lateral force of shaking, and some release with the exact same pull motion an earthquake would apply to a swinging door. Use latches specifically sold for earthquake use, push-to-close positive-catch latches or dedicated seismic latches, installed with all the hardware the latch comes with.
- **Pictures and mirrors:** hang with closed hooks rather than open hooks, so the frame can't bounce free during shaking. For smaller or lighter items on shelves, museum putty or earthquake wax holds them in place without permanent hardware.
- **Ceiling fans and pendant lights:** turn off the circuit breaker for the fixture, not just the wall switch, and confirm it's actually dead with a non-contact voltage tester before touching any wiring. Support the fixture with a bracing wire secured to a ceiling joist, and confirm the fixture itself is mounted to a fan-rated electrical box or brace capable of holding at least 50 lbs, not just the drywall around a standard box.

This connects directly to the utility shutoff skill

A strapped water heater with flexible connectors is far less likely to need a gas shutoff in the first place, but knowing how to actually shut off gas, water, and electricity if something does break is a separate skill covered in full in Fire-Starting & Generator Safety. Both matter; this page prevents the damage, that one handles it if prevention wasn't enough.

Sources

- FLASH (Federal Alliance for Safe Homes), securing furniture, appliances, electronics, and belongings before an earthquake: FLASH; FLASH
- Water heater seismic strapping specification (strap placement, lag bolt size, thread penetration): Plumbing & Mechanical
- Utah Residential Code, water heater seismic bracing requirement (adopted 2021 IRC, Section P2801.8): UpCodes; ICC Digital Codes
- Earthquake Country Alliance, "Step 1: Secure Your Space": Earthquake Country Alliance
- Water heater strap material spec: California Seismic Safety Commission
- Stud finder calibration and sweep technique: Bob Vila
- CPSC Anchor It, furniture/TV two-point anchoring and pull-test method: CPSC; FEMA, screw stud-penetration spec: FEMA
- Seismic-rated cabinet latch requirements: FEMA
- Ceiling fan electrical safety and fan-rated box weight requirement: Fine Homebuilding

Basic Knots

Emergency Shelter Basics tells you to secure a tarp ridgeline with a trucker's hitch and stake it out with a taut-line hitch. Other guides across this site mention a clove hitch, a bowline, tying off a line. None of them actually teach the knot itself, they assume you already know it. This guide is that missing skill: seven real knots, with real illustrations and the actual steps, not just the name.

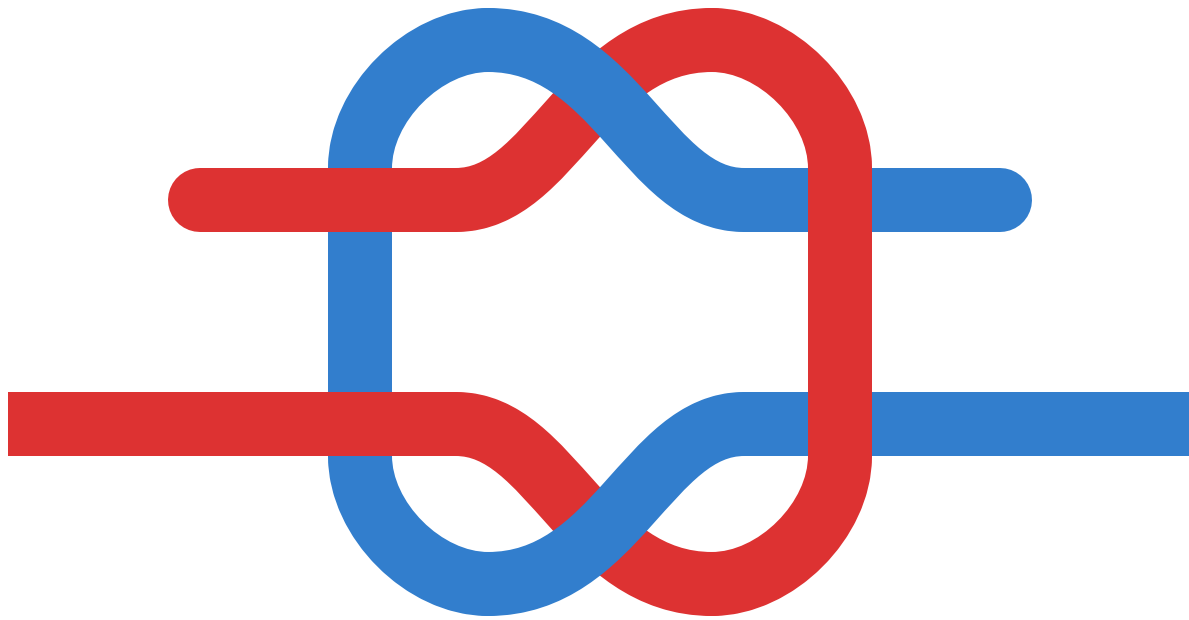
Practice on a real piece of rope before you need one of these for real

Every knot below is simple enough to learn from a picture and a few tries, but "I read the steps once" and "I can tie this in the dark, cold, with my hands shaking" are two different skills. Keep a 3-to-6-foot piece of rope or paracord somewhere you'll actually see it, and tie each of these a few times until your hands remember the pattern without you thinking through the steps.

Square knot (reef knot): binding, not joining

The knot most people already half-know from tying shoelaces or a bandage. It's for binding something closed, cinching a bundle, tying off a bandage, securing a rolled tarp, not for joining two ropes that will bear real load.

1. Hold one rope end in each hand.
2. Cross the right end over the left and tuck it under, then pull both ends to snug the first half.
3. Cross what's now the left end over the right and tuck it under.
4. Pull all four ends (two working ends, two standing ends) to tighten. Done correctly, the two loops that form lie flat and parallel; if they twist into an "S" shape instead, you've tied a granny knot, which slips far more easily, undo it and redo the second cross the other way.



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WARNING

Don't use a square knot to join two ropes under load

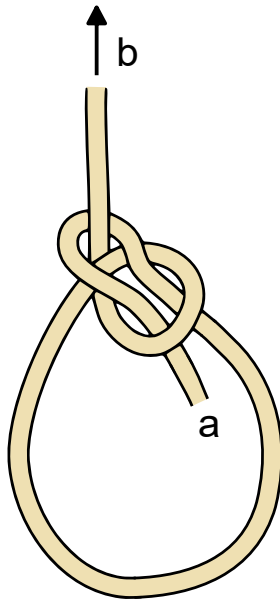
A square (or granny) knot can capsize and slip apart, especially with slippery synthetic rope, wet rope, or two ropes of different diameters, exactly the situation where failure matters most. Use a sheet bend to join two ropes that need to hold real weight.

Bowline: a fixed loop that won't tighten under load

The knot to reach for anytime you need a loop at the end of a rope that stays a fixed size no matter how hard it's pulled, a rescue loop, a loop around a post, the end of a line you're about to throw. Unlike a slip knot, the loop it makes cannot cinch down and choke.

1. Make a small loop in the rope a short distance from the end, the "hole," with the working end coming up through it.
2. Pass the working end up through that loop from underneath, the classic mnemonic: the rabbit comes up out of the hole.
3. Wrap the working end behind the standing part of the rope, around the "tree."
4. Bring the working end back down through the same small loop it started in, the rabbit goes back down the hole.

5. Pull the standing part and the loop's two strands separately to dress the knot, then pull hard on the standing part and the loop together to set it.



Original by Hella, derivative by Tescobar, CC BY-SA 3.0, via Wikimedia Commons.

WARNING

A bowline can work itself loose with no load on it at all

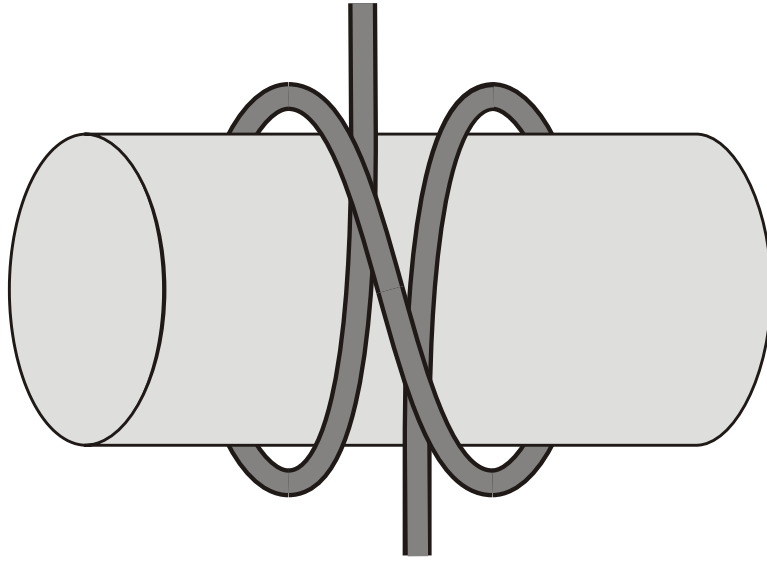
Unlike most knots, a bowline holds fine under steady load but can shake itself undone when the rope is repeatedly slack and jerked with nothing pulling on it, a real, documented weakness, not a myth. For anything safety-critical (a harness, a line someone might actually fall on), finish it with a stopper knot tied in the working end right against the loop, or ask someone at a real climbing or sailing course for the "Yosemite finish."

Clove hitch: quick, adjustable, not fully trustworthy alone

The fast way to start or end a lashing, or to tie a line to a post or pole when you'll want to adjust or untie it again soon. It's not a knot to trust alone for a load that could shift direction or go slack and snap tight again.

1. Wrap the working end around the pole or post once, crossing over itself to form an X on the front.
2. Wrap around the pole a second time, in the same direction, laying the new wrap just to one side of the X.

3. Tuck the working end under that second wrap, passing it through the X you formed in step 1.
4. Pull both ends to snug the hitch tight against the pole.



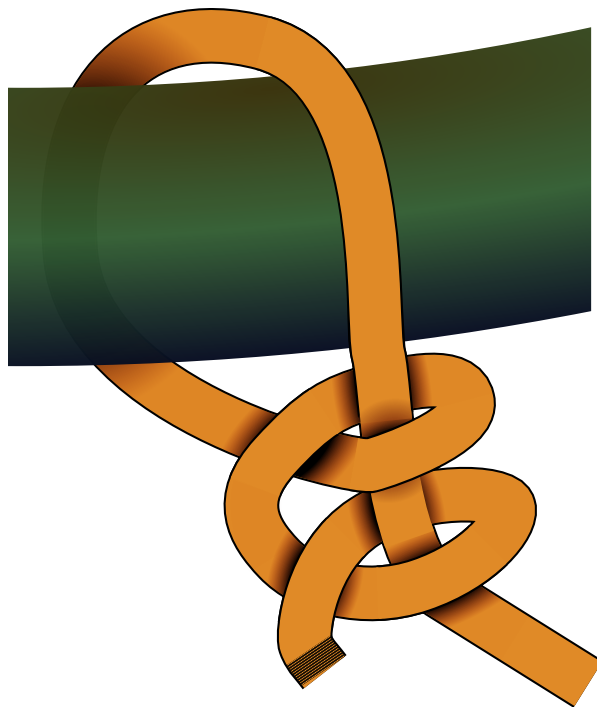
Original by Hella, modified by Luftpirat, CC BY-SA 3.0, via Wikimedia Commons.

For anything that needs to actually hold, a shelter ridgeline, a load you can't watch constantly, back a clove hitch up with a couple of half hitches on the working end, or use two half-hitches from the start instead.

Two half-hitches: securing a line end, plain and reliable

The plain, dependable way to tie a rope's end off to an anchor, a tent stake, a post, a tree, when you want it to actually stay tied. Less adjustable than a clove hitch, more trustworthy.

1. Pass the working end around the anchor.
2. Bring it up and over the standing part, then back through the loop that creates, that's one half-hitch.
3. Repeat the same wrap a second time, right next to the first, that's the second half-hitch.
4. Slide both hitches snug against the anchor and pull the standing part to set them.

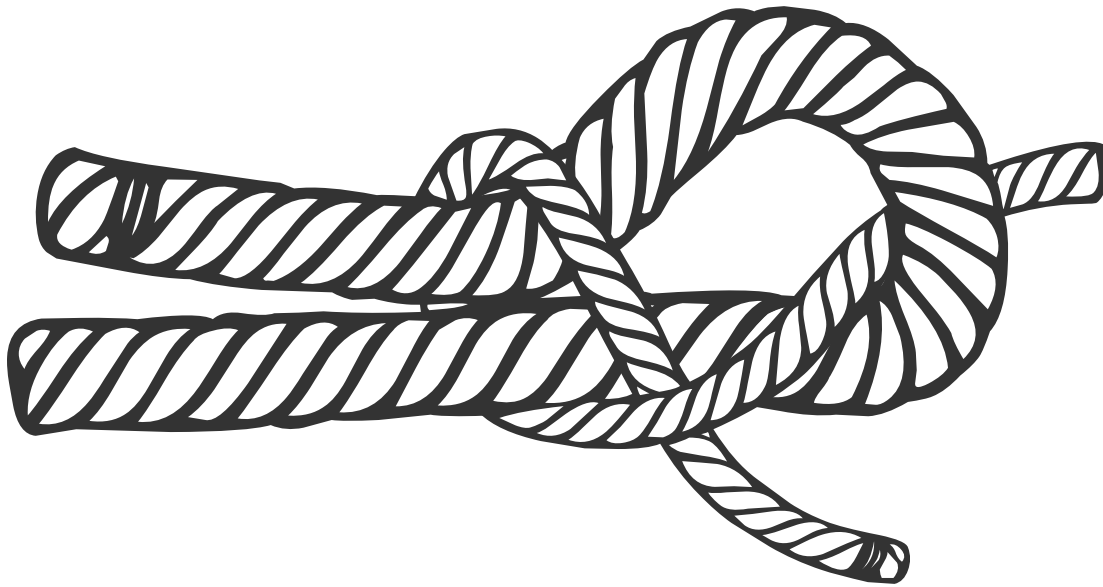


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Sheet bend: joining two ropes of different sizes

The real answer to "how do I tie two ropes together," especially when they're different diameters or materials, exactly the case a square knot fails at. A length of paracord to a length of clothesline, a thin guyline to a thicker ridgeline.

1. Form a bight (a U-shaped fold) in the end of the thicker rope and hold it.
2. Pass the working end of the thinner rope up through that bight.
3. Wrap the thinner rope's working end around behind the entire bight.
4. Tuck the working end under itself, where it first crossed the bight, so both working ends end up on the same side of the finished knot.
5. Pull the thicker rope's bight and the thinner rope's standing part apart to snug it tight.



Lucasbosch, CC BY-SA 3.0, via Wikimedia Commons.

WARNING

A sheet bend can shake loose with no load on it, same weakness as the bowline

If the joined ropes might go slack, tie a double sheet bend instead: identical, but wrap the thinner rope around the bight twice before tucking it, for real security when the size difference between the two ropes is large.

Taut-line hitch: an adjustable knot that grips under load and slides when it's slack

The knot Emergency Shelter Basics uses to stake out a tarp: it holds tension like a fixed knot but slides by hand to re-tension whenever the line stretches or a stake shifts, without ever having to retie it.

1. Wrap the working end around the anchor (a stake, a tree), then around the standing part of the line, moving toward the anchor, twice.
2. Wrap the working end around the standing part one more time, this wrap goes above the first two, closer to the load.
3. Pull the whole hitch snug. Under tension it grips; with the tension released, slide the whole knot along the standing line by hand to lengthen or shorten it, then pull tight again to lock it back in place.



Chris 73, CC BY-SA 3.0, via Wikimedia Commons.

Trucker's hitch: real mechanical advantage for pulling a line drum-tight

The knot that lets one person tension a ridgeline, a tarp, or a load on a roof rack tighter than they could ever pull by hand alone, the same hitch Emergency Shelter Basics uses to tension a tarp ridgeline between two trees.

1. Anchor one end of the line to a fixed point with a bowline or by tying off around it.
2. A few feet from the second anchor point, twist a loop into the standing part of the line, a simple slip loop works, though it can jam under real load; a directional figure-eight-on-a-bight is more secure and still easy to untie afterward.
3. Run the working end around the second anchor point and back through that loop.
4. Pull the working end to draw the line tight, the loop acts as a pulley, giving real (if friction-reduced) mechanical advantage over pulling the line by hand alone.
5. Holding the tension, secure the working end with two half-hitches around the taut lines just below the loop so it can't release.



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Watch it: a full tying sequence is easier to follow in motion than in still steps; Animated Knots by Grog and most outdoor-retailer YouTube channels cover this exact hitch start to finish.

Write your own plan, in one sentence

Reading seven knots once isn't the same as your hands knowing any of them. Finish this sentence with your own real plan:

"This week, I will practice the taut-line hitch until I can tie both, five times each."

Know someone this guide would actually help? Being the person who's ready includes being the person who says something.

Send them this page ›

Sources

- Square/reef knot vs. granny knot, and capsizing failure mode: Wikipedia

- Bowline tying steps and the "rabbit and the tree" mnemonic: NetKnots; loosening-when-slack weakness and the Yosemite finish: Wikipedia
 - Clove hitch tying methods and its need for backup under a shifting load: MasterClass; Wikipedia
 - Two half-hitches technique: Wikipedia
 - Sheet bend tying steps, working-ends-same-side requirement, and the double sheet bend for dissimilar rope sizes: Royal Museums Greenwich; Wikipedia
 - Taut-line hitch wrap sequence and slide-to-adjust mechanism: Wikipedia
 - Trucker's hitch construction, real-world mechanical advantage, and securing the working end: Animated Knots by Grog; Wikipedia
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Working through this from Ready, Set, Ready? Head back to pick your next topic once this one's real.