

# BUILD A CUSTOM CANOPY

A step-by-step guide to building a weather-tested cover that protects your boat from the elements and lets you work onboard sheltered in relative comfort.

STORY AND PHOTOS BY SUSAN CANFIELD

ILLUSTRATIONS BY GUY DRINKWALTER

## Tools

- Tape measure, 3m & 15m (10' & 50')
- Chalk line
- Colored chalk sticks
- Permanent markers
- Tubing bender, 3/4"
- Tubing cutter
- Drill, 12V 9mm (3/8") cordless
- Drill bit, 5.5mm (7/32")
- Tap, 1/4"-28
- Screwdriver, phillips
- Socket wrench with 12mm (1/2") deep socket
- Stepladder
- Torpedo level
- String
- Knife
- Lead sinker

If you live in an area where boating is a seasonal activity, covering your boat for the winter should be a no-brainer. A good cover pays for itself by preventing damage that occurs when a boat is left uncovered: gel-coat weathering and cracks, deck leaks and delamination, water-stained interiors, corrosion, mildew and rot. Most often, a winter cover is tightly fitted to the boat to keep the cover material from flogging itself to death in high winds. Often, you can't work on the topsides when the cover is fitted or move around on deck freely. Ventilation under a winter cover is usually limited at best.

Before starting phase two of my 22-year-old boat's ongoing overhaul, I built a working cover frame that allows unfettered access and excellent ventilation. It's shrinkwrapped extended canopy is tall enough that I can work anywhere on deck (reinstalling deck fittings and varnishing)



(top) When it comes to a weatherproof working cover, it doesn't get much better than this. (bottom) White shrink-wrap was my cover of choice. It lets in plenty of light, provides shade from the hot summer sun, and sloughs off rain and snow. If I want to work at night, I can clip a couple of lights to the cover frame and the white shrinkwrap becomes a big lampshade. Note the wood blocks positioned under each vertical support.



and wide enough for access to the caprails (varnishing) and topsides (paint touch-up).

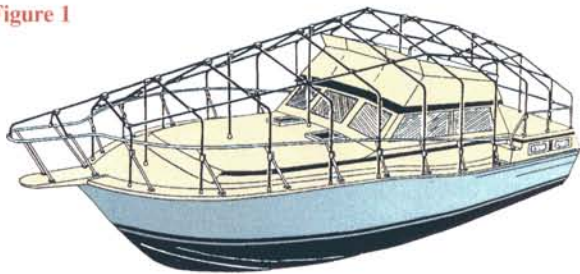
Having used the Kover Klamp (KK) framing system to support my boat's winter cover for many years, I knew I could build an extended-canopy frame using the same components. The greater challenge was to make the new frame freestanding, since I'd removed my boat's lifeline stanchions during overhaul. In the end, I accomplished both objectives. The extended canopy, in particular, is a great improvement over the standard boat cover frame and one well

worth the additional complexity and expense involved. A freestanding frame, on the other hand, is rarely needed and adds considerable expense. It also requires alternative anchor points (in lieu of lifeline and/or handrail stanchions) so that the frame can be secured to the deck.

The standard KK boat cover frame (**Figure 1**) uses 19mm (3/4") electrical conduit (EMT) held in place with patented steel clamps (**Figure 2**). It's like Tinker Toys on steroids! While a KK frame costs more than one made of wood, it's far easier to work with, stores compactly and is



Figure 1



The standard Kover Klamp cover frame is anchored to a boat's life-line stanchions or deck railings.

Figure 2



Kover Klamps are designed to hold 19mm (3/4") ID electrical conduit (EMT) at any desired angle. A rubber tab between the clamp's two metal plates grips the conduit, a single bolt locks everything in place. Assembly is easy with a socket wrench.

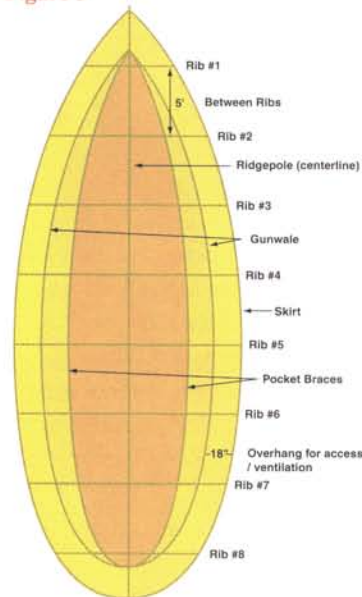
certainly economical in the long run.

If a standard frame meets your needs, you can simply refer to the KK website ([www.koverklampframes.com](http://www.koverklampframes.com)), their printed materials and the instructional video included with their boat cover kits. If you're interested in building an extended-canopy frame, that may or may not be free-standing, a "how-to" guide is provided below.

## Design

Weather must be the first consideration when developing a design and choosing materials for a boat cover. On Chesapeake Bay, where I live (and boat), winds typically range from calm to 15 knots. Violent thunderstorms can produce wind gusts of up to about 50 knots. Fortunately, hurricanes are infrequent. One winter, we may get 1.8m (6') of snow, the next virtually none. I chose a frame design (60° slope) and cover material (shrinkwrap) that readily shed snow and ice. In the event winds over 50

Figure 3



knots are forecast, I'm prepared to remove the cover.

Determine the length of your frame's

The author's 12m (40') extended-canopy frame (overhead view). Rib #1 is aft of the bow, rib #8 is 30cm (12") forward of the stern. Pocket braces keep the ribs parallel with each other and prevent the cover material from pocketing between ribs. The pocket braces extend from the first to last rib, halfway between the ridgepole and the bend of the rib legs.

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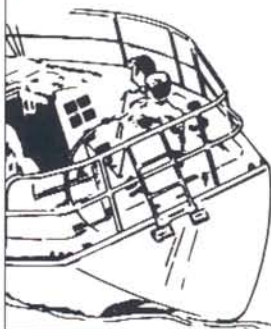


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**Figure 4**

Rib spacing and spans. The author's canopy frame is 12m (40') long; her boat's length on deck is 11.2m (37') (CL=Centerline).

Station#	Distance	Distance	Plus 18"
	From Bow	CL-Gunwale	Overhang
1	1'	25"	43"
2	6'	44"	62"
3	11'	61"	79"
4	16'	68"	86"
5	21'	68"	86"
6	26'	66"	84"
7	31'	55"	73"
8	36'	32"	50"

extended canopy. Verify your boat's overall length on deck (LOD), typically listed in the manufacturer's specifications, by taking your own measurements. Then add the desired overhang at bow and stern. Example: since my boat's LOD is 11.2m (37'), and I wanted its working cover to extend 45cm (18") beyond the gunwales, my canopy frame needed to be 12m (40') long.

Determine the number of ribs, their spacing and spans. How many ribs will be needed to support the canopy? If the canopy's vertical supports will be anchored to the deck

stanchions or railings, rib spacing must correspond. If adjacent stanchions are more than 1.5m (5') apart, however, add a floating rib in the middle. If the frame must support heavy snow and/or ice, space the ribs at shorter intervals. My frame, for example, is freestanding with ribs 1.5m (5') apart (**Figure 3**). Measure the distance between gunwales at each rib station. Divide by two to obtain the centerline-to-gunwale distance, and

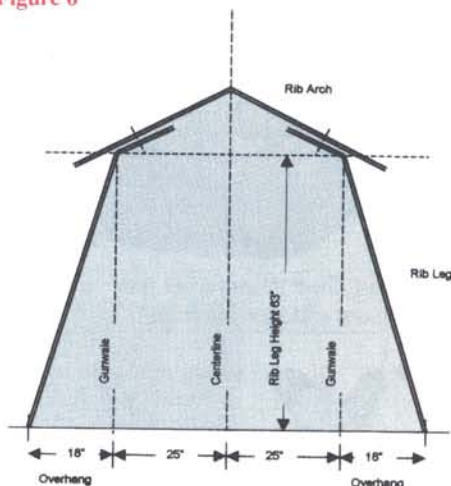
then add the desired amount of overhang. Record your calculations as shown in **Figure 4**.

Determine the desired rib leg height. Don't make your cover frame any taller than it needs to be as height creates windage, a disadvantage when the winds blow. Since I'm 160cm (63") tall, a rib leg height of 1.6m (63") makes it easy for me to move about on deck.

## Construction

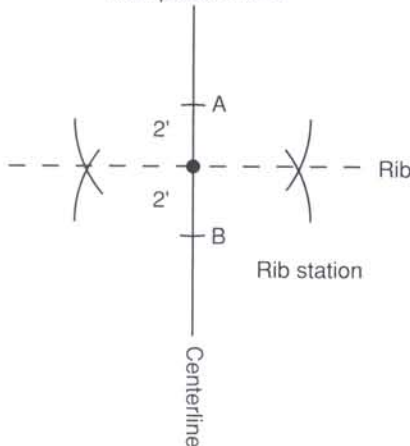
An extended-canopy frame is far easier to build on a level surface than on deck. Lacking a suitable paved area near my boat, I used a neighborhood tennis court during the off-season. But I then had to disassemble, move and reassemble the frame at my boat. Fortunately, the disassembled frame and all its components could be transported by car in a single trip.

Draw the canopy frame in overhead view. Using a chalk line (fluorescent colors work best), mark the centerline of your canopy frame on a level paved surface. With a tape measure and colored chalk, mark each rib station along the centerline. Next, draw each rib perpendicular to the centerline (**Figure 5**). Put an "X" at the appropriate centerline-to-gunwale plus overhang distance in both (port and starboard) directions along each rib. Use the chalk line to mark the canopy's skirt. Connect the X's at the end of each rib moving from bow to stern, then back along the opposite

**Figure 6**

Rib Construction: Place two rib legs on your chalked pattern. Align the rib arch with its center on the pattern's centerline with the rib legs. Mark and cut the conduit where the arch and legs overlap (about 20cm/8" above the bend). The measurements given here are for rib #1 in the author's frame.

**Figure 6** Equal distance arcs drawn from points A & B



To accurately draw each rib perpendicular to the centerline, first draw short intersecting arcs using a string and chalk that are equidistant from two points along the centerline. These points must be equidistant from and on opposite sides of each rib station. Finally, draw the perpendicular line (rib) so that it extends through the rib station and intersecting arcs.

side.

Assemble the longitudinal elements. Connect lengths of EMT with KK couplings (standard EMT couplings lack the strength needed for frame construction) to form the ridgepole. With the tubing fully seated in the coupling, drill and tap the conduit to accept the setscrews (6mm x 1.0mm). If you don't have a metric bit and tap, you can use a 7/32" bit and a 1/4"-28 tap. Ensure that all the setscrews face in the same direction so they can be oriented away from the cover.

If you're building a freestanding structure, you'll need to separate the assembled canopy frame into self-supporting modules for installation on deck. I separated my boat's canopy frame into five self-supporting sections: three-legged bow and stern sections, and three four-legged rib pairs (2-3, 4-5, 6-7). Ensure that your ridgepole's couplings fall where needed. If your frame's vertical supports will clamp to deck stanchions and/or railings, coupling location is not an issue.

With the ridgepole (and couplings as appropriate) correctly positioned on your pattern, use a broad



tipped 12mm (1/2") permanent marker to mark each rib station, circling the EMT. Assemble both pocket braces in the same fashion, however, you needn't mark the rib stations. Don't worry about cutting the ridgepole and pocket braces to their proper length; just set them aside for now.

Next, assemble the canopy's skirt. Bend and connect lengths of EMT to conform to your pattern. Remember to position the couplings for modular installation if you're building a freestanding frame. Drill and tap the tubing at couplings. Finally, with the assembled skirt lying on your pattern, use the broad-tipped marker to indicate where each rib leg should land.

Draw the rib patterns. In a clear area, use your chalk line to make a straight line longer than your canopy's longest rib span including overhangs. This is the baseline used for rib construction. Starting in the center of the baseline and working in both directions, mark the center-line-to-gunwale (without overhang) distance for rib #1. Next, draw lines perpendicular to the baseline at the center point and gunwale distances. Then mark your desired rib leg height above each gunwale, and desired overhangs along the baseline (Figure 6).

Assemble the ribs. Using a separate length of EMT for each rib arch, mark the center and bend 60°. Using a separate length of EMT for each rib leg, mark the desired height and bend as needed to fit your pattern (approximately 50°). Placed a pair of rib legs on your chalked pattern as shown in Figure 6. Then align a rib arch with its center mark on the pattern's centerline with the rib legs. Mark and cut the EMT where the rib arch and rib legs overlap (about 20cm/8" above the bend).

Join the rib segments; drill and tap for the setscrews. Again, ensure that the screw heads face inward so they won't poke holes in the cover. Repeat this process for each rib. Use a permanent marker to draw lines around

each rib halfway between its center and the bend in each leg. These are reference marks for the pocket braces that will be fit later.



(above) Frame assembly on deck requires a minimum of tools (from left): torpedo level, tubing cutter, tap wrench, Phillips screwdriver and socket wrench with 12mm (1/2") deep socket. A canvas waist apron provides pockets for carrying clamps, slide locks, hand tools and a marking pen. (right) The Kover Klamp framing system includes (clockwise from left): protection pads, plastic plugs, rubber tips, slide locks, couplings and patented clamps.

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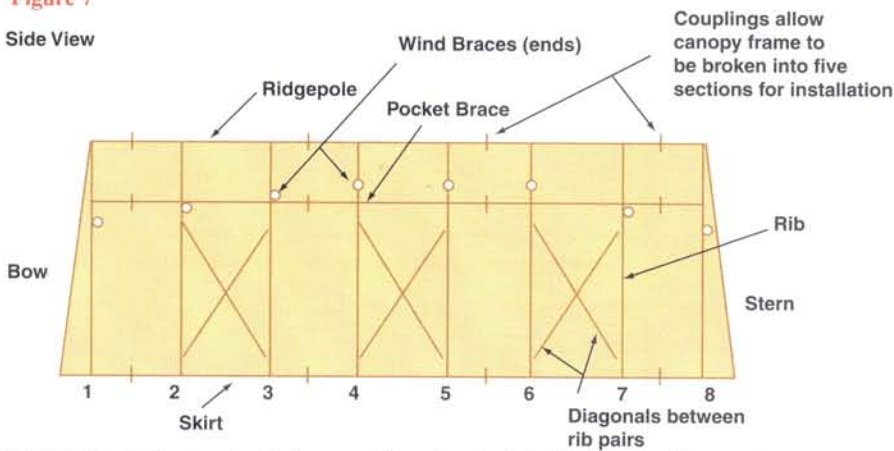
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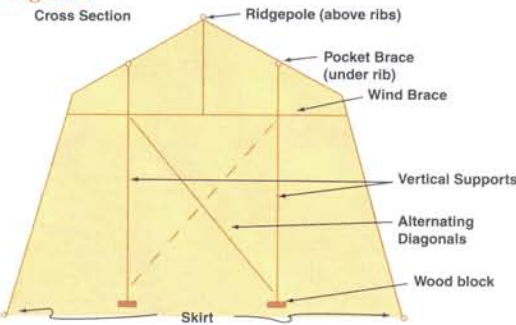
**Figure 7**

Side View



(above) The author's extended-canopy frame breaks into five freestanding sections, as shown below, for modular installation on deck. (below) Extended-canopy frame with freestanding supports (cross section view). Frame and canopy tie-downs are not shown.

**Figure 8**



tubing over the line for chafe protection. Make sure your knots are large enough to prevent the tie-down loops from being pulled back through the EMT. I used 4.7mm (3/16") line that has a breaking strength of 544kg (1,200lb) and added a rolling hitch above each bowline.

### Assembly

Assemble the canopy frame. Position rib #1; clamp the end of each leg inside the skirt. Use temporary diagonals to keep the rib vertical. Try to fit the clamps in a consistent way. Repeat the process for the next rib. Once two ribs are standing, fit the appropriate ridgepole segment above the ribs; ensure that the ribs are plumb. As you assemble the canopy

frame, cut and fit diagonal supports as appropriate (**Figure 7**). If all four diagonal braces for a rib pair are cut to the same length, they'll be interchangeable on reassembly.

After clamping the ribs, ridgepole and diagonal supports in place, clamp the pocket braces under the ribs. Bend and fit the bow and stern legs and attach them to the ridgepole. Drill and tap for the setscrews. Next, install a wind brace at each rib to prevent the canopy from deforming in high winds. Use a slide lock inside each clamp to prevent it from slipping inward. If your frame is to be freestanding, you'll also need to fit a compression post on the centerline between each rib and its wind brace. A post is not needed if the rib has just one vertical support.

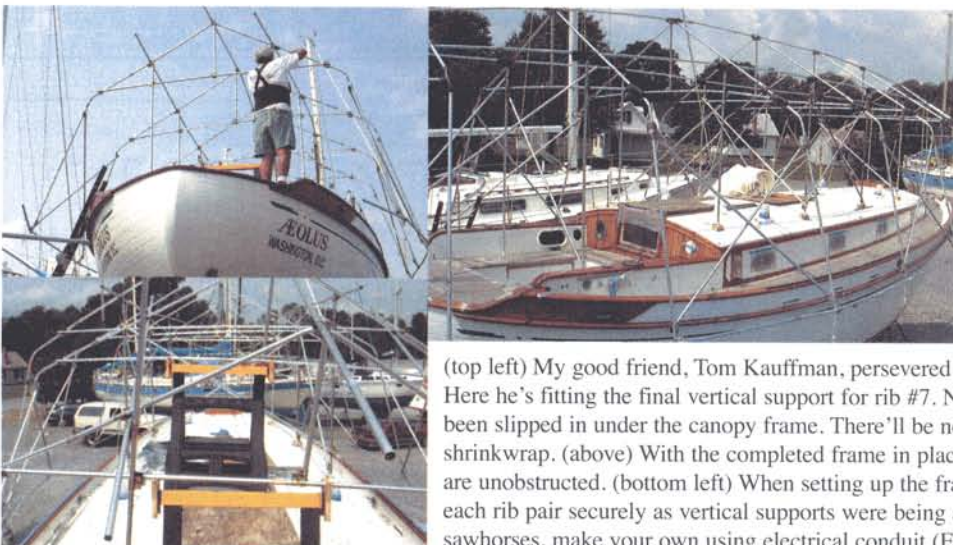
### Labeling

Before disassembling your canopy frame, clearly label its various segments. The KK people sell color-coded and numbered waterproof labels for this purpose. Take pictures and/or notes for reassembly.

### Set Up

If the canopy's vertical supports clamp to deck stanchions and/or railings, disassemble the ridgepole, pocket braces and skirt. Don't disassemble the ribs. Fit plastic end plugs and protective rubber tips at one end of two lengths of EMT; clamp the tubing to opposing stanchions (rubber tips down). Clamp the appropriate rib to the vertical supports and adjust rib height as desired. Repeat this process until all the ribs have been clamped in place. Fit the canopy's ridgepole, pocket braces and skirt. Then mark, bend, cut and clamp each vertical support (**Figure 8**).

If you're building alongside your boat, it's time to run a tie-down line through each rib. Otherwise, wait until you reassemble the frame for installation on your boat. A one-ounce lead sinker on a string can be used to fish the line through each rib. Before tying a bowline in both ends of each tie-down (where they exit the conduit), slip a length of clear plastic



(top left) My good friend, Tom Kauffman, persevered throughout my frame-building project. Here he's fitting the final vertical support for rib #7. Notice how the ladder on the left has been slipped in under the canopy frame. There'll be no need to cut an access door in the shrinkwrap. (above) With the completed frame in place, the foredeck, side decks and cockpit are unobstructed. (bottom left) When setting up the frame on deck, we used sawhorses to hold each rib pair securely as vertical supports were being attached. If you don't own suitable sawhorses, make your own using electrical conduit (EMT), Kover Klamps and rubber tips.





(top) Using a single piece of shrinkwrap, Dan Hughes (left) and Mike Myers of Gem Polishing, Deale, Maryland, covered the frame in just two hours. (middle) Kover Klamp's reusable protection pads are made of a heavy-duty non-absorbent, non-chafing material. Corner snaps make the pads easy to fit or remove if clamp adjustments need to be made. Waterproof,

color-coded and numbered labels, like the one seen here, simplify frame reassembly. (bottom) With the cover in place, the author makes final adjustments to the lines securing the frame to the boat. Tie down lines run inside each rib and under the boat's keel. Clear plastic tubing protects the line from chafe as it exits from the bottom of the rib.

Bending the vertical supports to conform to the rib arches enhances frame rigidity and prevents cover punctures. Install the wind braces. Don't forget to label the vertical supports prior to disassembly.

If your frame is free standing, separate the pre-assembled canopy into modules as discussed above. Lift the center module into position on deck. I found it helpful to pre-position two sawhorses (each fitted with pipe holders) on deck. The wind braces of each rib pair rest on the sawhorses while vertical supports (with plastic plugs and rubber tips fitted at their lower ends) loosely clamp to the pocket braces and wind brace at

each rib. Slip a KK slide lock onto each support. After lifting the canopy to the desired height and extending the vertical supports, tighten each vertical's upper clamp. Position the slide lock immediately beneath the upper clamp and tighten both setscrews. Then tighten the lower clamp. Repeat this process for each vertical support. When the center section has been leveled at the proper height, mark and cut each vertical support above the pocket brace. Install cross bracing between all four verticals supporting the center module. Finally, secure the center module in place by running tensioned lines to cleats, perforated toerails and/or bulwark scuppers.

Repeat this process with the next module, building outward from the center. As each module is lifted to the proper level, connect the ridgepole, pocket braces and skirt (in that order). Install diagonal cross braces athwartship between vertical supports. Install diagonal braces longitudinally as

**Figure 10** Cost of materials. (Kover Klamp components are in red)


Frame Component	Quantity	Price	Total
Clamps (5/pack)	33	19.99	659.67
Couplings (5/pack)	8	6.99	55.92
Slide locks (5/pack)	6	7.25	43.50
Plastic end plugs (25/pack)	1	5.50	5.50
Rubber tips (5/pack)	3	4.95	14.85
Protection pads (2/pack)	11	6.50	71.50
Electrical conduit (EMT)	100	2.19	219.00
19mm (3/4") x 3m (10')			
Line, 4.7mm (3/16") braided (152m/500' spool)	1	110.00	110.00
Plastic tubing, 6mm (1/4") ID /foot	6	.14	.84
<b>TOTAL COST</b>			<b>US\$1180.78</b>

warranted by local weather conditions. Install tie-downs to anchor the frame modules on deck to cleats,

perforated toerails, caprail scuppers, etc. These lines must be tensioned whenever the boat is left unattended.

With all extended-canopy frames, run a tie-down line under the keel between each rib's tie-down loops. These lines too must be tensioned whenever the boat is left unattended.

## Time Line

How long does it take to construct and set up an extended-canopy frame? Under optimum conditions (fair weather, all tools and materials at hand, a paved area adjacent to the boat and two assistants), I'd estimate two to three days for a 12m (40') canopy. Subsequent set ups, where no cutting or fitting is needed, would take one to two days. Cost is directly related to a frame's size and complexity (**Figures 9 and 10**). Caution: Kover Klamps, like Tinker Toys, are addictive. Once you discover how handy they can be, you'll want to use them to build a temporary garage, workshop or greenhouse. Then you'll have to buy more when it's time to cover the boat again. 

About the author: Susan Canfield is a NAMS-certified, SAMS-accredited marine surveyor in Annapolis, Maryland. A frequent DIY contributor, she also teaches marine surveying at WoodenBoat School in Brooklin, Maine.

**Figure 9** Materials required for the author's 12mLx4.4mWx2.7mH (40'Lx14.4'Wx9'H) boat cover frame. Extended-canopy components are highlighted in blue, those unique to the freestanding support structure in red.

Structural Element	Lengths	Couplings	Clamps	Slide Locks	End Plugs	Rubber Tips	Pads
Ridgepole	6	5	8	0	0	0	0
Ribs	8	0	0	0	0	0	0
Rib Legs	16	16	0	0	0	0	0
Pocket Braces	8	8	16	0	0	0	0
Wind Braces	8	0	16	0	6	0	16
Skirt	8	8	18	0	0	0	0
Diagonals/Canopy	12	0	24	0	0	0	0
Vertical Supports	14	0	28	14	14	14	0
Center Posts	0	0	12	0	0	0	6
Diagonals/V. Supports	20	0	40	0	0	0	0
<b>TOTALS</b>	<b>100</b>	<b>37</b>	<b>16</b>	<b>20</b>	<b>14</b>	<b>14</b>	<b>22</b>