

Engineering a Winch-Powered Hatch

by Michael Gabriel

I am the contractor who gets the jobs others avoid. That may be because I'm an engineer by training, a background that's helpful in solving problems. In the following case, the problem that needed solving was basement access (**Figure 1**).

The job at hand was to replace an existing sun-beaten wood deck with a composite deck. Underneath the existing deck were well-constructed concrete walls that enclosed a set of pressure-treated steps leading to a basement door. To gain access to the stairs, several 4-foot-square panels had to be lifted. The homeowners admitted they weren't getting any younger and asked if I could build something that would be easier for them to operate.

Never one to turn down a challenge, I designed and built a hatch that could be raised with the flip of a switch.

Hinging the Hatch

Several decisions had to be made going into the project. Should the hatch be twin doors hinged in the middle, or should it be a single door hinged on a side? Or a single door with a hinge on an end? I ruled out the first two options quickly: Creating a mechanism for twin doors would be too complicated, and hinging the hatch on the side would put part of the lift mechanism in the way of the stairs.

The most practical method seemed to be hinging the hatch on the end. To minimize the clearance required between the deck and the hatch, I located the hinges (ball bearings and 1-inch steel pins) 6 inches in from the end, causing 6 inches of hatch to



Figure 1. Powered by a 12-volt winch, this steel-framed hatch blends flush with the decking, but can be opened with the flick of a switch to provide basement access.



Figure 2. The 1,200-pound hatch pivots on 1-inch steel shafts supported by ball bearings.

rotate down as the larger portion rises above the deck (**Figure 2, page 2**).

My next concern was the structural integrity of the hatch. I felt that a wood structure wouldn't stand up to flexing. Also, I wanted the decking on top of the hatch to blend with the rest of the deck, which meant that clearances had to be kept to a minimum. But the dimensions of a wood-framed hatch would vary seasonally, requiring large clearances that would be hard to mask.

A metal frame would solve both of those problems, so I decided to use 9¼-inch SteelDeck Framing material (Xccent Decking; 800/933-4748, xccentdecking.com). It would make a stiff frame that wouldn't change size with the humidity, and it could be cut with a toothed steel-cutting blade in a circular saw (**Figure 3**).



Figure 3. Steel joists make a frame that doesn't change dimension with the seasons.

Lifting Mechanism

At 6 feet wide and 14 feet 6 inches long, the hatch — decking, frame, and lifting mechanism combined — weighed around 1,200 pounds, a significant load. On top of the weight issue, the existing concrete walls limited the size and placement of the lifting mechanism. One thing I didn't have to worry about, though, was basement egress, as there was already

a code-compliant window for that.

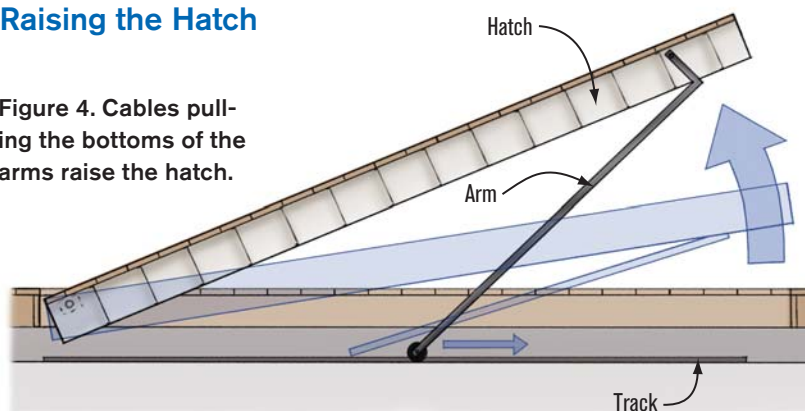
I decided to lift the hatch with a pair of arms composed of doubled 1½-inch-by-2-inch-by-⅛-inch rectangular steel tubing (**Figure 4**). One end of each arm would hinge at the front of the hatch. To the other end of each arm I attached a roller. The rollers would travel on rails affixed to the top of the existing block walls to raise or lower the arms (**Figure 5**,

page 3). When closed, the arms would be close to level, resting just above the rails. To open the hatch, cables pulling on the bottoms of the arms would force the rollers along the rails, standing up the arms, and lifting the hatch.

The major problem with this system was that the confined space in which the arms had to fit meant they'd be nearly parallel to the hatch at the outset. The smaller the angle, the greater the force required to lift the hatch. In the final design, the lift-arm angle was approximately 9 degrees from horizontal, which would require an initial pull of roughly 8,700 pounds to lift the 1,200-pound hatch.

Raising the Hatch

Figure 4. Cables pulling the bottoms of the arms raise the hatch.



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DC-Powered Winch

I chose a 4,000-pound-capacity DC-powered winch from Gorilla Winches (888/657-9997, gorillawinches.com) for operating the hatch (**Figure 6, page 3**). As it is intended for use on an ATV, being outside all the time wouldn't be a problem.



Figure 5. Rollers at the end of the lifting arms travel on tracks made from steel angle. A safety bar placed atop the tracks when the hatch is raised prevents it falling should the cable fail.

I know I just said that 8,700 pounds of pulling power was needed to lift the hatch, and this winch provides less than half that. I overcame the difference with a compound pulley system that lowered the pulling force at the winch to approximately 1,740 pounds (**Figure 7**).

To power the winch, I concealed a 12-volt automotive battery and a 120-volt float charger underneath the deck. The intended purpose of the charger, which I bought at Lowes, is to keep the seldom-used battery topped off. The downside is the hatch can be operated only a couple of cycles within a 48-hour period. In this case, since the hatch would be used only a few times a year, that wasn't a problem.

This was probably the most demanding and challenging project I have built to date, with a fair amount of engineering involved. All the formulas can be found at engineersedge.com, but to use them, you need a basic understanding of material properties and engineering principles. Lacking that, you should get an engineer involved before tackling anything similar. ♦

Michael Gabriel is an engineer-turned-deck-builder in Springfield, Ohio.



Figure 6. A 12-volt winch powered by an automotive battery operates the lift.

Pulley System

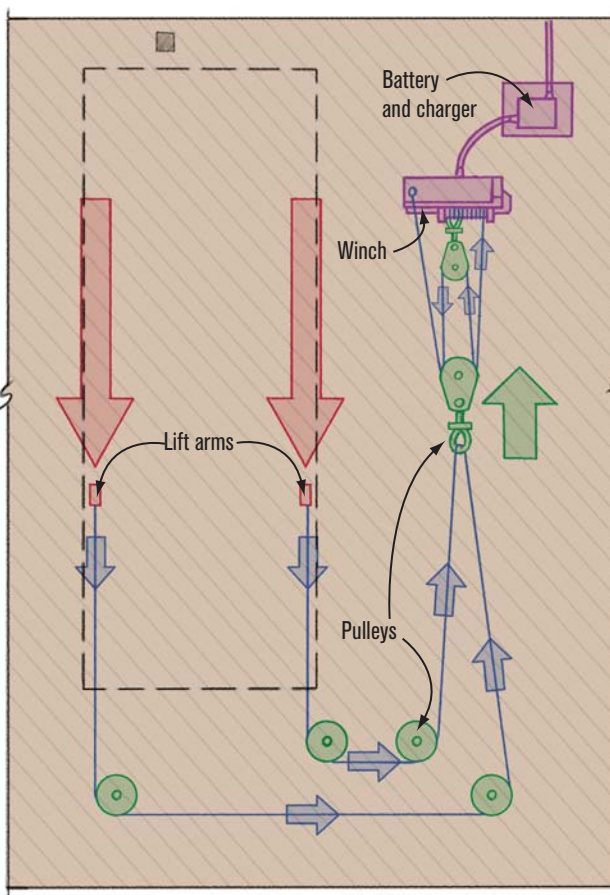


Figure 7. Pulleys control the direction of pull and provide the mechanical advantage that enables the winch to raise the hatch.

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