# Using a Boat Lift Hoist to Tilt Over an HDX-5106 Tower

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INTRODUCTION:

I installed a TRX-100HD raising fixture for my US Tower HDX-5106 106 foot crank up tower. It came with a Fulton K-2550 hand winch. This winch worked OK for raising the tower, but it was a real athletic event to turn the supplied 11 inch crank handle the needed 1000+ turns, requiring both hands. Tilting the tower over routinely caused the brake to overheat and squeal very loudly, requiring frequent "rest periods". The tiny brake pads and the mechanism for activating them made me very nervous.

It seemed like a no-brainer to replace the winch with a Fulton KW-3000 worm drive winch. Because of the worm drive, there was no brake issue. Theoretically, it had a 2X mechanical advantage over the K-2550. However, this was basically canceled out by the additional friction of the worm. The worm must have enough friction to hold the tower, therefore, the effort is at least doubled. The worm gear had a serious problem with overheating, especially if I turned the crank with an electric drill. This could be alleviated to some extent by thoroughly greasing it, but this was difficult because there were no zerk fittings. After using this winch for a few years, it started to make squealing noises during its final trip upward. After coaxing the tower into the upright position, I decided that this winch would never be used again.

A MOTORIZED TILT OVER WINCH:

I did a rough calculation of the amount of force on the tilt over cable, which has a 4:1 mechanical advantage due to pulleys. The tower weighs something like 4000 lbs, plus I had a 7 foot heavy duty mast, a "small" prop pitch rotator, and the 200+ lb MonstIR antenna. My calculations worked out to over 4000 lbs cable tension. If this is true, it would explain why the previous winches seemed over loaded. In searching for a winch, it seemed like most motorized winches topped out at 2500 or so lbs. Repurposing what I call a "jeep winch" was summarily ruled out because they are not designed for this application, and there are issues with braking and duty cycle, and there is the need for a big battery. They are designed to get your jeep out of a hole, not gradually lower it into a hole, and the hole is not 50 feet deep. The brake is designed to hold the jeep, not for controlled descent. I love to repurpose things, but you have to be very careful about unintended consequences.

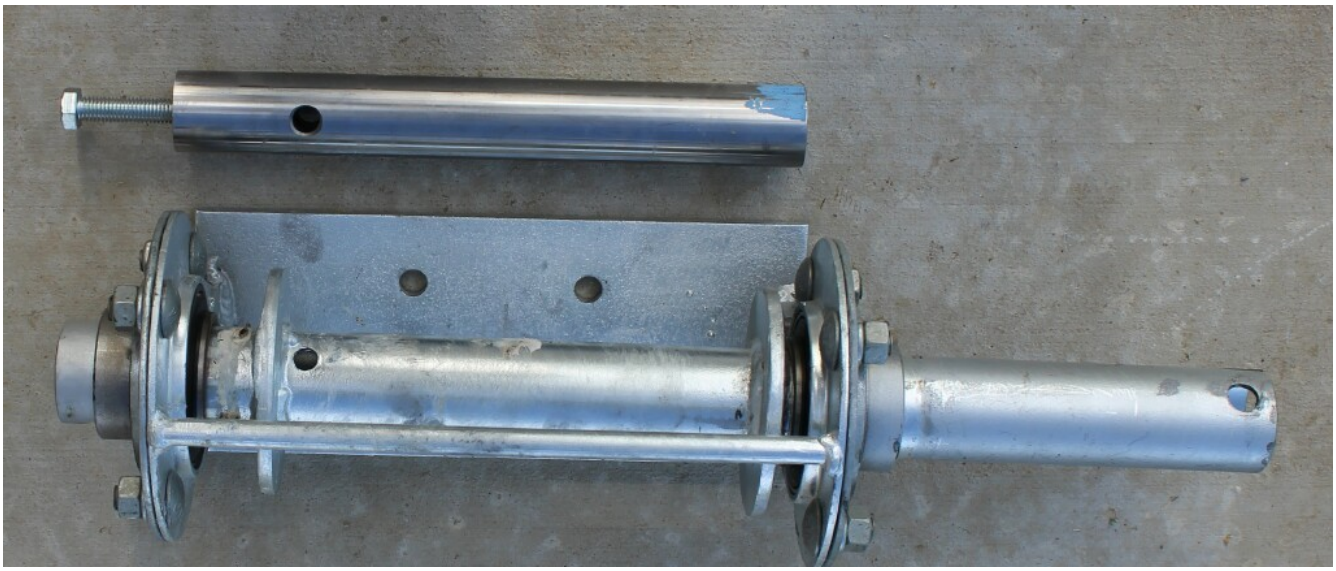
The breakthrough came when I saw W4ABC's site:

http://www.w4abc.com/drive.html

After extensively studying this site, I decided to contact Ricky at Lunmar Boat Lifts:

http://lunmarboatlifts.com/

They offer two "drive drums" which wind up the cable, 4 inch and 6 inch. It turned out that my tower had about 50 feet of 5/16 cable, and the 6 inch size was not adequate. Ricky had their shop make me a custom 9 inch drive drum. This accommodates 50 feet of cable in 3 layers.

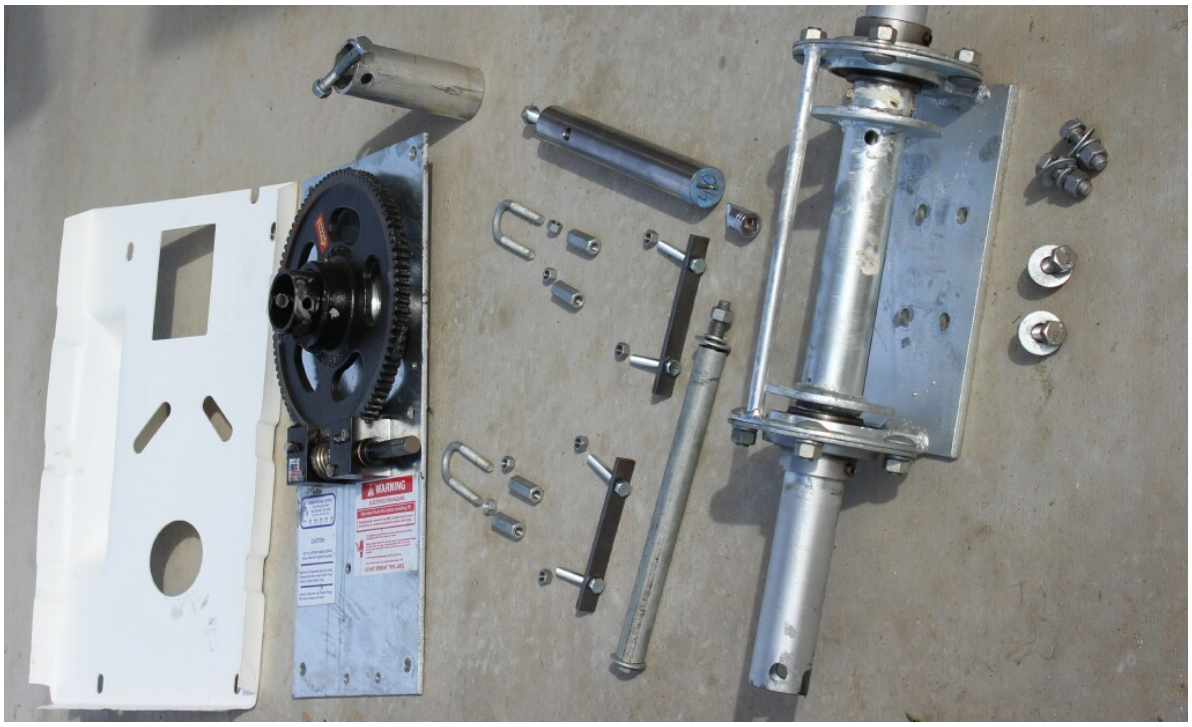


The cable winds around a shaft that has an OD of 1.9 inches and an ID of 1.715 inches, which is "coincidentally" the same size as trade size "1 ½ inch" schedule 40 water pipe. Hopefully, it was structural steel not just water pipe. I calculated 30,000 psi of stress at 4000 lbs cable tension. This would challenge even some decent grades of steel, so I decided to insert a 40 mm solid steel bar into the center of the shaft to reinforce it. 40 mm just happens to be a perfect fit inside schedule 40, allowing for the internal weld line. A 1 foot bar cost about $30 at McMaster Carr (shown in the above photo above the drive drum, with blue paint on the end). Below is another view of the 40 mm bar.

The drive drum has a hole drilled next to the flange on the left (visible in previous phtot). You are supposed to insert the end of the cable and snake it out the end of the shaft and put a cable clamp on the end of it. Rather than do this, I drilled a ½ inch diameter hole through the 40 mm bar that lined up with the hole in the drive drum. I also drilled another hole through the end of the bar (along the axis) that joined up with the other hole. This hole was threaded for a ½-13 bolt. The bolt is threaded through the hole until it presses up against the cable and holds it in place. When tightening this bolt, the rod is held from rotating by using a so-called "drag link socket" (available from Grainger for about $8) which is like a big screwdriver attachment for a socket wrench. I machined a slot for this tool in the opposite end of the 40 mm bar using a milling machine. The photo below shows the cable inserted into the hole and the bolt threaded into the end hole.

The photo below shows how the drag link socket fits into the slot on the other end of the 40 mm bar.

The following figure shows most of the kit of parts to be installed on the tower. Left to right: the inner winch cover, the worm drive gear plate, above that, the shaft adapter, the hardware for the antitorque shaft, then the antitorque shaft itself, the drive drum, and its mounting hardware. Note shown is the outer winch cover, the pulley and belt, the motor and its electrical harness. This is a 6500 lb rated winch that comes with a 1 HP motor. It takes about 15 minutes to raise or lower the tower with this, which is fine with me. I don't want any sudden movements. The approximate price of this system is $1,500 with shipping. Notice how the massive ring gear and worm drive completely dwarfs the KW3000 winch.



We started by drilling four ½ inch mounting holes in the existing TR-100HD winch mounting plate. The existing 3/8 inch holes held the original winch. The photo below shows the winch mounting plate on the TRX-100H with the four new ½ inch holes for the drive drum. The are also four existing 3/8 inch holes for the old winch.

Here is what the drive drum looks like when mounted:

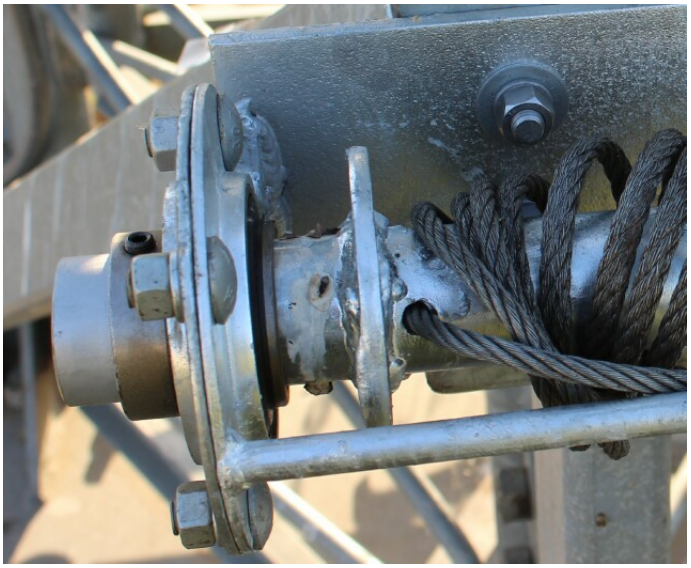
Next the inner cover was mounted as shown below:

Then the 40 mm bar was inserted.  The cable set screw is viable on the end.

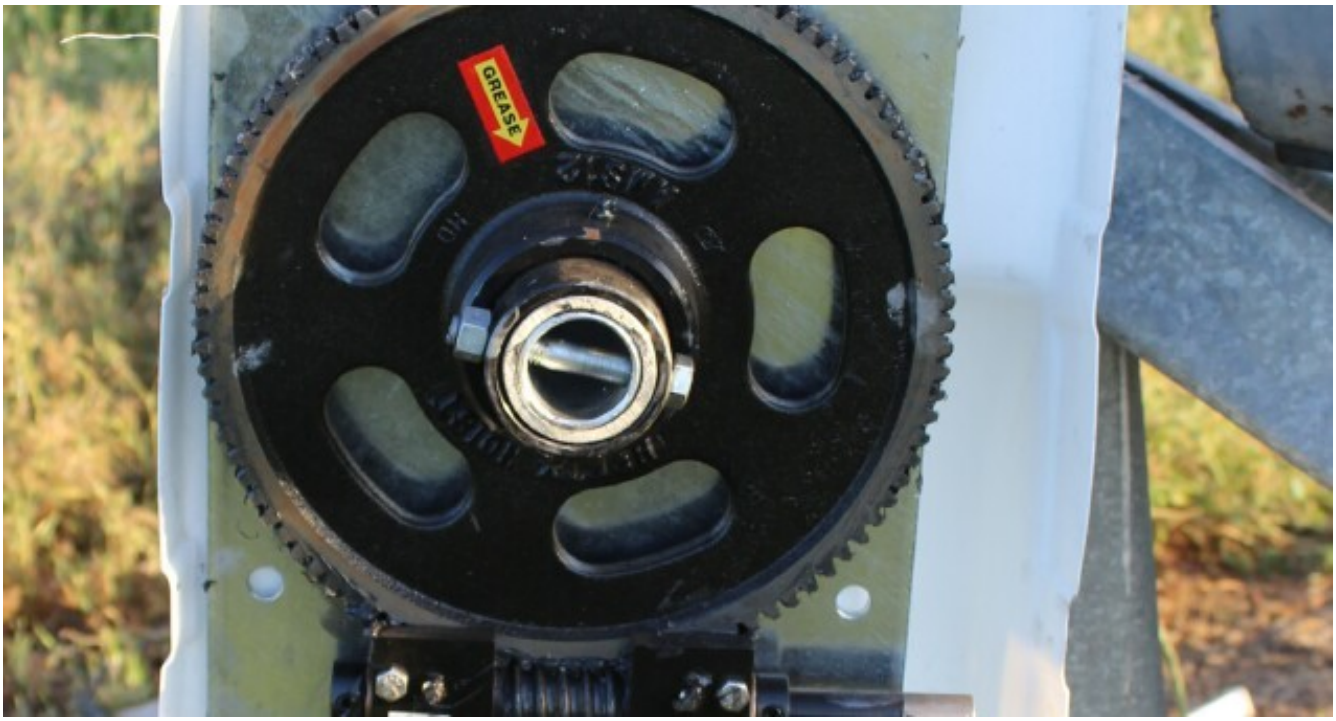
Then the shaft adapter from 1.9 inches to 2 inches was installed.

Then the worm gear plate was installed.

Then the cable is inserted and the clamping bolt is tightened.

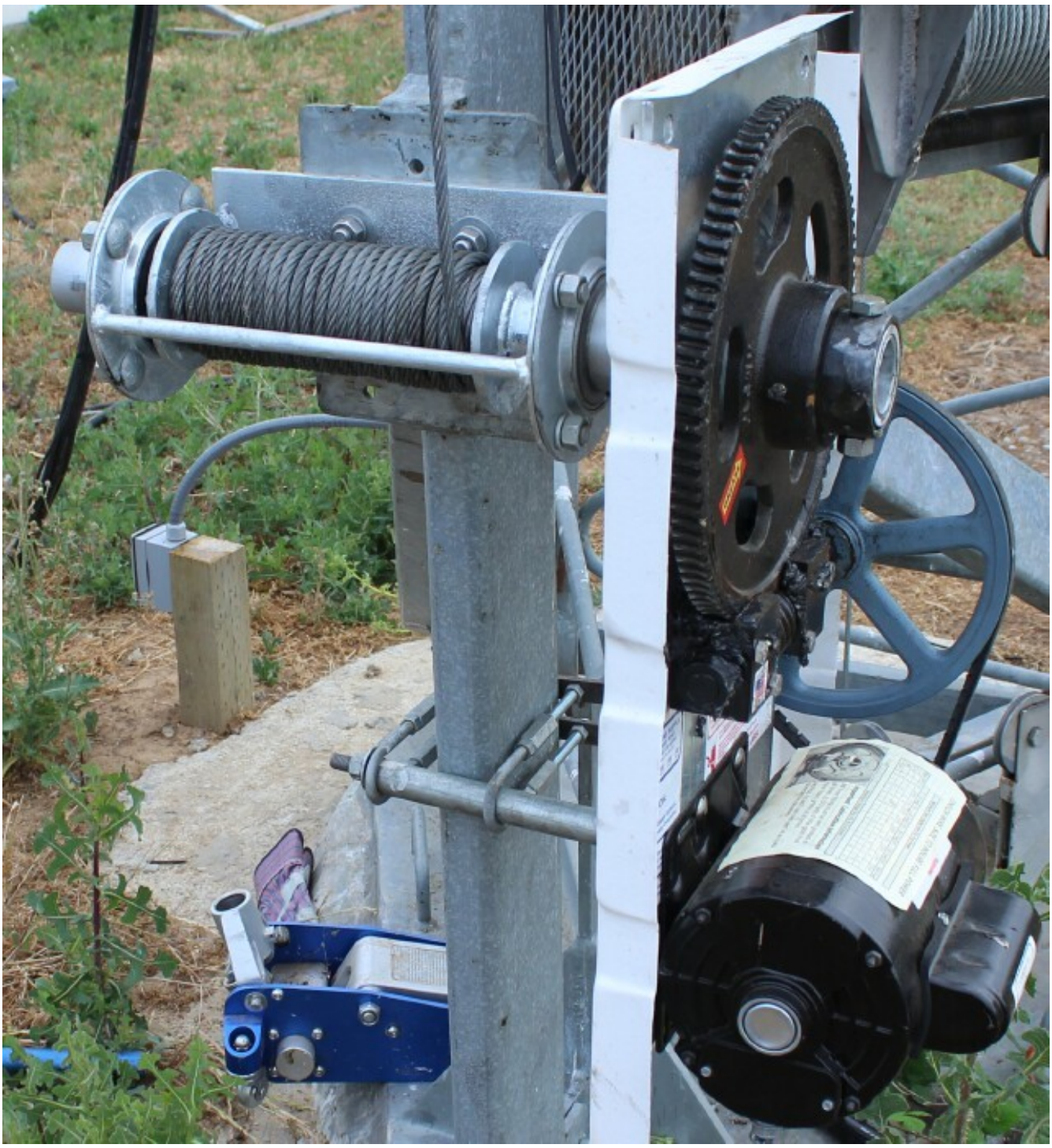


Now the shaft bolt can be installed.




Next the anti-torque bar is clamped to the 2x6 steel beam of the TR-100HD.

Here we have installed the motor, pulley and belt, and wound up the cable on the drum. The blue floor jack visible (lower left) is used to assist tilting over the tower far enough to reach the tipping point. Upon raising, it is used to provide a soft landing to upright position.



Here is a wider view showing the TR-100HD fixture, which the boat industry calls a “davit”.

Here is a photo of the electrical harness, with up down switch and GFCI.


Here we have installed the outer cover to make the system weatherproof:

The photo below shows the complete winch ready for duty.