

How TOWER CRANES Work

Tower cranes are a common fixture at any major construction site. They're pretty hard to miss.. they often rise hundreds of feet into the air, and can reach out just as far. The construction crew uses the tower crane to lift steel, concrete, large tools - like acetylene torches and generators, and a wide variety of other building materials.

When you look at one of these cranes, what it can do seems nearly impossible: Why doesn't it tip over? How can such a long boom lift so much weight? How is it able to grow taller as the building grows taller? If you have ever wondered about how tower cranes work, then this article is for you. Here, you will find out the answers to all of these questions and more!



Parts of a Tower Crane

All tower cranes consist of the same basic parts:

1. The **base** is bolted to a large concrete pad that supports the crane.
2. The base connects to the **mast** (or **tower**), which gives the tower crane its height.
3. Attached to the top of the mast is the **slewing unit** (large ring-gear and motor) that allows the crane to rotate.
4. Attached to the slewing unit is the **jib** (or boom), the **machinery arm**, the **counterweights**
5. and, the **Operators Cab**

On top of the **slewing unit** are three parts:



- 1) The long horizontal **jib** (or **working arm**), which is the portion of the crane that carries the load. A trolley runs along the jib to move the load in and out from the crane's center:



- 2) The shorter horizontal **machinery arm**, which contains the crane's motors and electronics as well as the large concrete counterweights:



The **machinery arm** contains the **winch motor** that lifts the load, along with the control electronics that drive it and the cable drum, as shown here: →



The **motors** that drive the slewing unit are located above the unit's large rotational gear: →



3) and, The operators cab...



Now, it would be a pretty big problem if one of these things fell over on a jobsite. Let's find out what keeps these massive structures standing upright.

Why Don't They Fall Over?

When you look at a tall tower crane, the whole thing seems outrageous -- why don't these structures fall over, especially since they have **no support wires** of any kind?

The first element of the tower crane's stability is a large **concrete pad** that the construction company pours several weeks before the crane arrives. This pad typically measures 30 feet by 30 feet by 4 feet (10 x 10 x 1.3 meters) and weighs 400,000 pounds (182,000 kg). These are the pad measurements for the crane shown here.

Large **anchor bolts** embedded deep into this pad support the base of the crane:



The mast rises from this firm foundation. The mast is a large, **lattice structure**, typically 10 feet (3.2 meters) square. The triangulated cross-members structure gives the mast the strength to remain upright.

So these cranes are essentially bolted / anchored to the ground to ensure their stability. In the next section, you will learn how tower cranes "grow."

How Do They Grow?

Tower cranes arrive at the construction site on 10 to 12 tractor-trailer rigs.

The crew uses a **mobile crane** to first assemble a 40-foot (12-m) mast that consists of two vertical mast sections and the slewing gear.

Then the jib and the machinery sections are assembled.

The mobile crane then places these horizontal members on the pre-assembled mast sections.

The **counterweights** are then added.



To rise to its maximum height, the crane *grows* itself one mast section at a time! The crew uses a **top climber** or **climbing frame** that fits between the slewing unit and the top of the mast. Here is the process:

- a) The crew hangs a weight on the jib to balance the counterweight.
- b) The crew detaches the slewing unit from the top of the mast. Large hydraulic rams in the top climber push the slewing unit up 20 feet (6 m).
- c) The crane operator uses the crane to lift another 20-foot mast section into the gap opened by the climbing frame. Once bolted in place, the crane is 20 feet taller!



Once the building is finished and it is time for the crane to come down, the process is reversed -- the crane disassembles its own mast and then mobile cranes disassemble the rest.

How Much Weight Can They Lift?

A typical tower crane has the following specifications:

1. **Maximum unsupported height** - 265 feet (80 meters)
The crane can have a total height much greater than 265 feet if it is tied into the building as the building rises around the crane.
2. **Maximum reach** - 230 feet (70 meters)
3. **Maximum lifting power** - 19.8 tons (18 metric tons)
4. **Counterweights** - 20 tons (16.3 metric tons)

The maximum load that the crane can lift is 18 metric tons (39,690 pounds), but the crane cannot lift that much weight if the load is positioned at the end of the jib. The closer the load is positioned to the mast (center of rotation), the more weight the crane can lift safely.

Alternatively, the crane may be rated as having capacity of 300 tonne-meters. The **300 tonne-meter** rating tells you the relationship. For example, if the operator positions the load 30 meters (100 feet) from the mast, the crane can lift a maximum of 10.1 tonnes (ie. 300 tonne divided by 30 meters).

The crane uses two **limit switches** to make sure that the operator does not *overload* the crane:

- a) The **maximum load** limit switch monitors the pull on the cable and makes sure that the load does not exceed 18 tonnes.
- b) The **load moment** limit switch makes sure that the operator does not exceed the tonne-meter rating of the crane as the load moves out on the jib. A **cat head assembly** in the slewing unit can measure the amount of collapse in the jib and sense when an overload condition occurs.

Renting a Tower Crane

Most construction companies rent their tower cranes from another company.

This separate organization would mobilize the crane to the jobsite, assemble it and charge a monthly fee while the crane is on the site.

The typical fee for **installation and disassembly** runs around US\$60,000. This price includes shipping the crane to the site, renting the mobile crane used to assemble the tower crane, the cost of the crew that handles the assembly, etc.

A typical **monthly rental fee** for a 150-foot-tall tower crane is approximately US\$15,000, with an additional charge to rent the climbing frame and extra mast sections.