HOW HYDRAULIC TRUCK CRANES WORK

Heavy rains spawned by Hurricane Danny flooded many parts of Charlotte, NC. Flood waters rose so quickly in Little Sugar Creek that the underpinnings of a train trestle collapsed, bringing a diesel locomotive crashing down into the creek. As you might imagine, a 412,000-pound (186,880-kg) locomotive is not easily lifted. After the waters receded, emergency teams brought in three large hydraulic truck cranes -- one 500-ton, one 300-ton and one 175-ton -- to lift the train out of the creek bed and back onto the train tracks.

Hydraulic truck cranes can lift thousands of pounds using the simple concept of transmitting forces from point to point through a fluid.

Hydraulic cranes are very simple by design but can perform Herculean tasks that would otherwise seem impossible. In a matter of minutes, these machines are able to raise multi-ton bridge beams on highways, heavy equipment in factories and even lift beachfront houses onto pilings. Hydraulic truck cranes are also used to lift killer whales like Shamu out of water tanks when places like Sea World ship the whales to new destinations.

When watching a hydraulic truck crane in action, it s hard to believe just how much weight it s moving because it deals with these multi-ton objects with relative ease. Hydraulic truck cranes vary in lifting power. It s easy to tell how much a particular hydraulic truck crane can lift just by the name of it:

A 40-ton crane can lift 40 tons (80,000 lb or 36,287 kg).

Here you will learn how these cranes are able to lift thousands of pounds using hydraulics, and we ll climb into the cab to show you just how these machines are operated.

CONSOLIDATED - DECKRANE
Vancouver - Canada
www.deckrane.com

It s All About Hydraulics

The hydraulic crane is based on a simple concept -- the transmission of forces from point to point through a fluid. Most hydraulic machines use some sort of incompressible fluid, a fluid that is at its maximum density. Oil is the most commonly used incompressible fluid for hydraulic machines, including hydraulic cranes. In a simple hydraulic system, when a piston pushes down on the oil, the oil transmits all of the original force to another piston, which is driven up.

In a simple hydraulic system, when one piston is pushed down, another piston is pushed up.

A hydraulic pump creates the pressure that moves the pistons. Pressure in a hydraulic system is created by one of two types of hydraulic pumps:

Variable-displacement pump
Gear pump

Most hydraulic truck cranes use two-gear pumps that have a pair of inter-meshing gears to pressurize the hydraulic oil. When pressure needs to increase, the operator pushes the foot throttle to run the pump faster. In a gear pump, the only way to get high pressure is to run the engine at full power.

A 70-ton hydraulic truck crane uses a 12.7-L diesel engine that generates up to 365 horse-power. The engine is connected to three two-gear pumps, including:

Main pump - This pump operates the piston rod that raises and lowers the boom, as well as the hydraulic telescoping sections that extend the boom. The main pump is able to generate 3,500 pounds per square inch (psi) of pressure. It generates more pressure than the other two pumps because it is responsible for moving much more weight.

Pilot pressure counterweight pump - A hydraulic truck crane uses counterweights on the back of the cab to keep it from tipping over. These are added and removed by a hydraulic lift that has its own pump. The counterweight gear pump can generate 1,400 psi.

Steering/outrigger pump - One pump controls the steering and the outriggers. The outriggers are used to stabilize the truck during lifting operations. Because steering and outrigger operation are not performed simultaneously, they run off of the same pump. This pump generates 1,600 psi.

In the next section, you ll see how the hydraulic system acts on the other parts of the hydraulic truck crane.

Parts of a Hydraulic Truck Crane

Although everything on the truck begins and ends with the hydraulic system, there s more to a hydraulic truck crane than the hydraulics. There are many components involved in lifting a load. Here are the basic parts of every hydraulic truck crane:

Boom
Jib
Rotex gear
Outriggers
Counterweights
Reinforced-steel cable
Hook

The most recognizable part of any crane is the **boom**. This is the steel arm of the crane that holds the load. Rising up from just behind the operator s cab, the boom is the essential piece of a crane, allowing the machine to raise loads to heights of several dozen feet.

Most hydraulic truck cranes have a boom that has several telescoping sections.

For instance, a 70-ton Link-Belt hydraulic truck crane has a boom with three telescoping sections. This particular boom has a length of 127 feet (38.7 meters).

Some booms are equipped with a **jib**, which is the lattice structure attached to the end of the boom. On the 70-ton hydraulic truck crane, the jib is 67 feet (20.4 m) long, giving the crane a total length of 194 feet (59.1 m).

As the load is lifted, the sections telescope out to the desired height.

Basic Equipment

Some basic equipment on a hydraulic truck crane:

Boom - The large arm mainly responsible for lifting
Counterweights - Multi-ton weights placed on the back of the cab to prevent the crane from tipping during lifts
Two-gear pump - Hydraulic pump system that uses two rotating gears to pressurize oil
Jib - Lattice structure that extends out of the boom
Outriggers - Supports that keep the crane balanced
Rotex gear - Large gear under the cab that allows the boom to be rotated
Load Moment Indicator - Array of lights (and/or indicators) located in the cab just above the operator s eye level; flashes if crane s lifting limits are reached

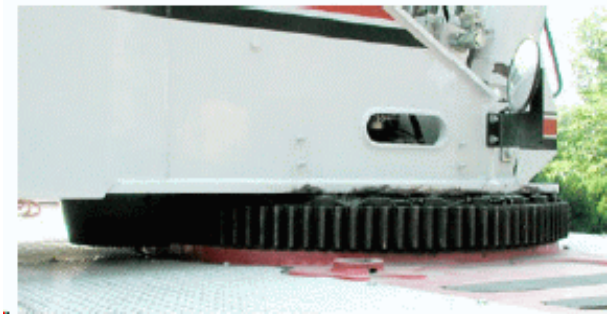
Reinforced-steel cable lines run from a winch just behind the operator s cab, extending up and over the the boom and jib. Each line (single-part) is capable of holding a maximum load of 14,000 pounds (6,350 kg).

So, a 70-ton hydraulic truck can use up to 10 cable parts-of-lines (multiple part) for a total of 140,000 pounds (63,503 kg), or 70 tons. The lines run up the boom and jib and attach to a 285-pound (129 kg) metal ball that keeps the lines pulled taut when no load is attached to the hook.

The large metal ball attached to the hook keeps the cable taut when there is no load on the hook.

To maneuver the load, the boom has to be able to move right and left, as well as up and down. Underneath the operator s cab is a **Rotex gear** on a turntable bearing that turns at 2 revolutions per minute (rpm). It is driven by a bidirectional, hydraulic motor mounted on the cab and housed in a metal cover to prevent injuries. The rotation is controlled by a foot-operated, hydraulic pedal in the cab.

The large gear under the cab is the Rotex gear, which allows the cab to swivel and move the boom from side to side.



Hydraulic truck cranes are used to lift heavy loads to tall heights, and it s important that the truck be completely stable during the lifting operation. The tires don t offer the stability needed, so the truck employs **outriggers** that act as balances to keep the crane from leaning too much to one side or the other. The outriggers use hydraulics to lift the entire truck, tires and all, off the ground. The outriggers are comprised of the beam, which is the leg of the outrigger, and the pad, which is the foot. Sometimes, "floats" are placed under the pad to dissipate the force of the crane and the load over concrete or pavement. Floats are usually wood planks that are lined up to create a base that is larger than the pad itself.

The outriggers keep the crane balanced during a lift. The inset shows all outriggers extended.

The outriggers are only one mechanism used to balance the crane during lifting operations. There are also detachable counterweights that can be placed on the back of the crane on the underside of the cab. These counterweights prevent the crane from tipping forward during operation. The amount of counterweight needed for a particular lift is determined by the weight of the load, the radius of the boom and the boom s angle during operation. The 70-ton Link-Belt truck crane has counterweights that come in 4,000-pound (1,814-kg) sections. Counterweights are only used during lifts; they have to be removed before the truck can be driven.

CONSOLIDATED - DECKRANE
Vancouver - Canada
www.deckrane.com

In the Operator s Seat

In the previous two sections, you learned how the hydraulics and other pieces of equipment on the hydraulic truck crane work. All of this equipment is controlled by the operator inside the cab, which is located on top of the deck. Crane operators use several control mechanisms to raise and lower the boom, rotate the cab and boom, wind and unwind the winch and control other peripheral equipment.

The crane is operated by hydraulic joysticks and foot pedals.

The 70-ton Link-Belt hydraulic truck crane has two basic types of controls for maneuvering a load:

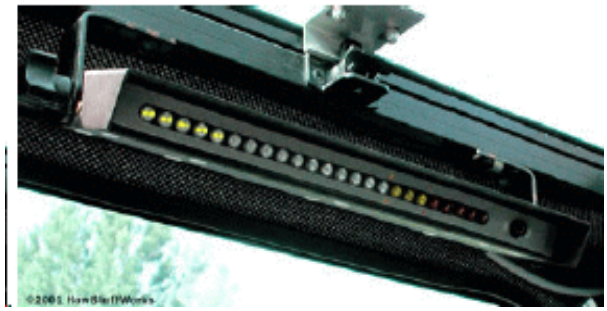
Joysticks - There are two joysticks in the cab. One controls left-to-right movement of the boom, and the other controls forward and aft movement.
Foot pedals - These pedals are responsible for retracting and extending the telescoping sections of the boom. They also control the amount of pressure being generated by the pump.

Joy sticks and foot pedals are connected to hydraulic hoses that connect various hydraulic rams to **spool valves**. The spool valve is connected to the hydraulic pump via a third hose that is placed between the two hoses that run from the spool valve to the hydraulic ram. When a joystick is pushed in one direction, it causes the valve to shut off one of the hydraulic hoses leading to the ram and open the other. Which way the joystick is pushed determines whether the piston in the hydraulic ram slides in or out.

The spool-valve system lets the crane operator control the hydraulic pistons.

Prior to any lift, the operator enters data into a computer inside the cab, including the weight of the object to be lifted and the height to which it is to be lifted. This computer serves as the operator s backup, warning the operator if the crane is being pushed beyond its capability. Using a binder of charts in the cab, the operator also determines the angle of lift and the radius of the boom. Once all of this is entered, the computer can track the progress of the lift and warn the driver if the crane is nearing its limitations. If the boom is lifted too high for the load amount, a series of lights just above the inside of the front window will begin to light up. These lights are the warning lights for the **Load Moment Indicator (LMI)**

If the operator tries to lift a load too heavy (or in some other way off the chart), the Load Moment Indicator will light up.



There are at least two other people that may be required to perform a lift properly, including the **oiler** and the **signalman**. The oiler is responsible for making sure that all of the crane s parts are in place and secured prior to any lift. He or she also acts as a spotter during a lift to ensure that the lift is being performed properly. The signalman, as the name suggests, gives hand signals to the operator during the lift to make sure the load is being maneuvered correctly.

Hydraulic truck cranes provide brute strength to move objects, machines and even large animals that would otherwise be very difficult to budge. Using a very simple principle of hydraulics, these machines move thousands of pounds with relative ease, making them an essential component of most construction projects and a great example of the power of basic physics.

You can see some photos of these machines at work by going to our website at ***www.deckrane.com*** and clicking on services and then on photos