Side Pulling a Crane Hoist: Safety Implications and Remedies

Hazards are ever-present in the steel plant environment, and a heightened awareness and emphasis on safety is a necessary priority for our industry. This monthly column, coordinated by members of the AIST Safety & Health Technology Committee, focuses on procedures and practices to promote a safe working environment for everyone.

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Comments are welcome. If you have questions about this topic or other safety issues, please contact safetyfirst@aist.org. Please include your full name, company name, mailing address and email in all correspondence.

Crane hoists of various types are commonly found in industrial material handling applications. In the steel industry, hoists are a common tool of the trade. Side pulling, also known as side loading, can create an unsafe condition for an operator and is present when a standard hoist is used in a manner other than a vertical lift. Improper use of a hoist due to side pulling poses a significant hazard to operators in more than one way. Injuries from side load events have been known to result in serious injury and even death. A large number of crane-mounted hoists are not equipped with side pull protection. However, methods exist to mitigate this hazard. Hoists are relied upon to lift coil, plate, bar, beams, ingots, scrap metal and equipment, and each application can present a different safety challenge.

Definition of Side Pull

Side pulling is referred to in the industry as side loading and in some situations, hook centering. In general, a side pull event exists when a standard hoist is used in a manner other than a vertical lift. Lifting or placing a load that is not plumb with the hoist is referred to as a side pull. Depending on the type of hoist, side pulling can produce more severe results depending on the orientation of the side pull relative to the hoist body. It is important to make the distinction between side load ratings and load capacity. All hoists are rated for a maximum load capacity and many have some form of overload indication. However, very few hoists include side pull detection as standard equipment.

Side pulling is prohibited by the Occupational Safety and Health Administration (OSHA) regulations and is not recommended by most standard hoist manufacturers.

If side pulling is prohibited because of its inherent safety risk, why would an operator side pull a hoist intentionally? The typical reasons are:

- Operator has limited access to orient the hoist as a vertical lift.
- Convenience and speed of using a hoist before fully centering the hoist over the load.
- Unbalanced load or load shift under special lifts can inherently cause a side pull condition.

Certain applications tend to lend themselves to be more prone to side pulling of the hoist. Here are some examples of such applications:

- Tandem hoist/crane picks.
- Pulling materials from a furnace.
- Unbalanced under-hook lifting device lifted by two hoists.
- Die changing/flipping operation.

Operations that cannot be accomplished without side pulling should be handled with engineered or "built-up" hoists that are specifically designed for such use. It is important to note that a side pull with a specially engineered hoist still is dangerous for the operator, as gravity still will take over and swing a load once it is lifted. However, other dangers due to equipment failure are minimized.

In these applications, operators can side pull a hoist mounted to a variety of crane types such as:

- Overhead crane (top or bottom running).
- Jib crane.
- Gantry crane.
- Boom/telescoping extension crane.

It is possible to side pull in two axes (east–west, north–south). A wire pipe hoist will be used in the following example to define each axis. A wire rope hoist can be side pulled with the drum or against the drum. Pulling against the drum typically can have more compounded implications, but both pose safety risks.

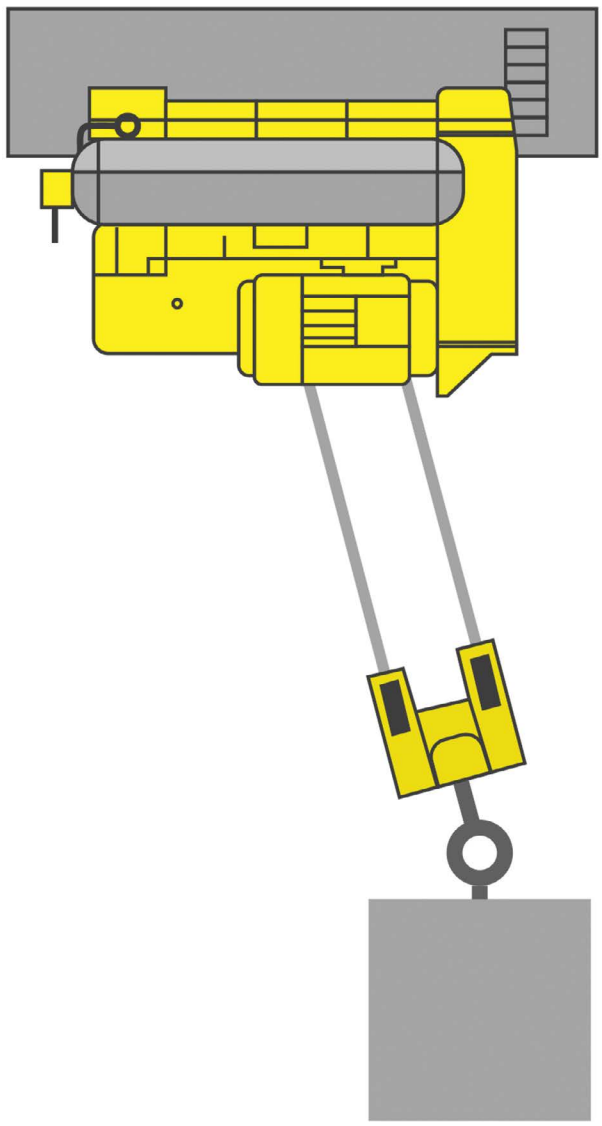
Side Pulling Safety Risks

The safety implications of side pulling fall generally into three categories:

- Personnel injury from a load shift or load swing.
- Damage to the hoist, resulting in an unsafe equipment condition.
- Damage to equipment nearby as a result of load swing, which can also result in an unsafe personnel condition.

Load Swing — When an operator does not center the hoist over the load prior to lifting, gravity will take over once the load has been lifted from its resting place and the load will naturally swing to find its natural level position. This swing can be rather violent and fast. There have been documented cases in which operators lifting heavy dies have been pinned against a wall or column by a load swing or have been swept off their feet and pulled under a swinging load. Also, a load swing can damage another piece of equipment nearby, rendering other potential safety issues. This kind of hazard can occur with a wire rope hoist or a chain hoist.

Figure 1



Hoist side pull illustration.

Damage to Hoist

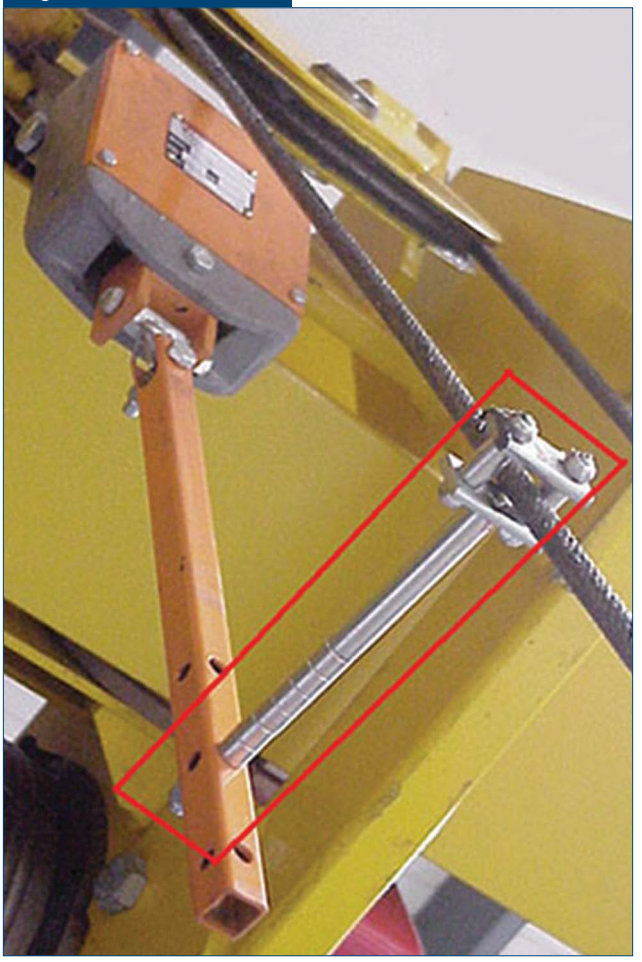
Damage to equipment can trigger a safety risk by compromising the hoist's features. This is where the type of hoist makes a difference.

Chain hoists inherently are not as susceptible to hoist damage resulting in an unsafe condition from a side pull. However, wire rope hoists are much more affected by a side pull event. Wire rope hoists are also widely used in the steel industry, especially under high load capacity in mills and processing centers. An explanation of why a wire rope hoist is more susceptible may shed light on the importance of side pull detection methods.

Wire rope hoists are either of the single-reeved or double-reeved type. The drum of the wire rope hoist is machined with grooves, known as drum lands, in which the wire rope rests during winding/unwinding or lifting/lowering. Many of the hoists currently on the market have partial-depth drum lands and utilize a rope guide over the wire rope to keep the wire rope in the lands. What is referred to as engineered hoist often includes full depth drum lands, so there is no need for a rope guide. Because of these lands, side pulling against the drum or across the lands is much more problematic than with the drum or in the same direction as the winding action.

When side pulling is excessive, the wire rope wants to pull out of and across the drum lands. This will often break the rope guide. Once the rope guide is damaged, it can no longer do its job of keeping the

Figure 2



Mechanical side pull detector.

wire rope in the land. The winding and unwinding is not controlled and the wire rope may not fall back into the land and will get knotted. With a full-depth land, side pulling puts the wire rope in contact with the sharp upper edge of the machined drum land and will prematurely wear the wire rope, damaging strands of wire in the twisted braid. Both conditions just stated may result in a loss of hoist control and limit the load capacity of the wire rope. This is a dangerous condition because the operator may not know that the wire rope has been compromised. The only valid action is to take the hoist out of service and have an inspection performed.

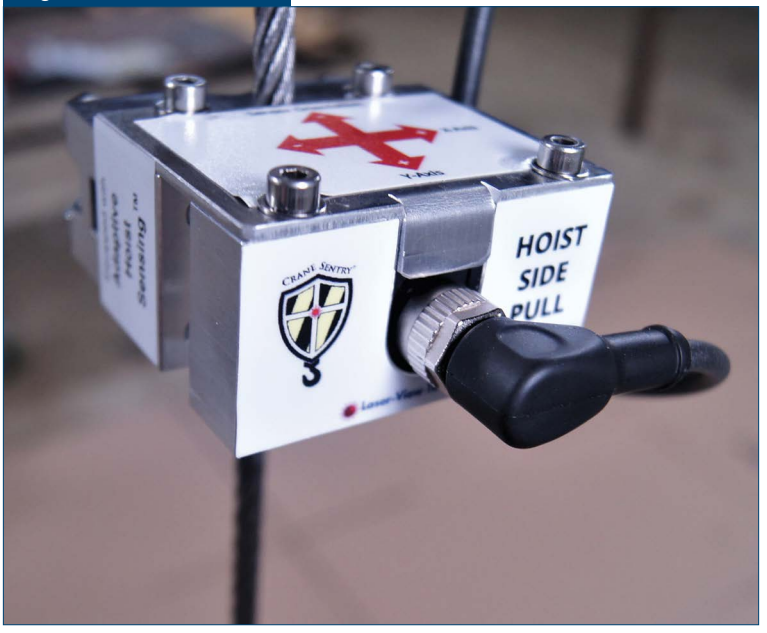
Methods of Detection

Wire Rope Hoist — Methods of detection exist that can be installed on new hoists and retrofitted to existing hoists. These are typically of two categories: mechanical methods and non-contact methods. It is important to note that detection methods are different on various types of hoists. There are three common categories:

- Single-reeved hoist (includes a dead end or fixed end of the wire rope).
- Dual-reeved with an equalizer sheave.
- Dual-reeved with an equalizer bar.

Mechanical methods typically consist of placing a mechanical guide around the wire rope (see Fig. 2). The body of the sensor hangs from the hoist and includes a microswitch. The arm is attached to the wire rope and moves with the rope as the wire rope angle shifts. This can be applied to the dead end or to the side of the equalizer sheave. Any side pull at the load block will manifest itself as an angle change at the dead end or at the equalizer sheave. This type of system is discrete (on/off) and is mechanically set by adjusting the position of the internal microswitch. There typically is not a display of the actual angle. Such a system can only monitor one axis of side pull and will not provide protection in both axes. Relay outputs are used to alert an operator of a side pull condition or disable a hoist.

Figure 3



Non-contact multi-axis side pull detector mounted to wire rope.

Non-contact methods of detection exist and offer advantages to traditional methods. Although mounting to the wire rope is a necessity, this method is referred to as non-contact because the sensing principle does not rely on physical contact to activate the sensor. A common method of non-contact side pull detection is to monitor the angle of the wire rope (see Fig. 3). The

sensors are typically compact in size and lightweight. It can be mounted to the dead end of the wire rope, to the side of the equalize sheave, or to the dead end of the rope on the equalizer bar. This sensor is a two-axis sensor and there are no moving parts to wear or adjust. Sensors like this commonly have a control package that are mounted on the hoist body. The control package evaluates the sensor's signal and provides the control algorithm and the relay output as the alarm that can also be used to alert an operator or disable the hoist. One of the key benefits of a non-contact sensor is that a single axis, two independent axes or an omnidirectional condition can be monitored. Omnidirectional means that a side pull in any combination of X or Y axis can be detected. This adds to the layer of safety that a side pull detector provides.

Chain Hoist

Chain hoists have not typically been monitored for side pull. As mentioned earlier in this article, the issue with chain hoists is usually more of a personnel safety concern because of a shifting load. Chain hoists are either lug mounted, in which the hoist is fixed to a trolley, or hanging, in which the body of the chain hoist hangs on a hook. Being that the chain moves continuously, a sensor cannot be mounted to the chain. This makes the logistics of monitoring a chain hoist more difficult, but not impossible. Methods to monitor side pull of a chain hoist involve the angle of the load block itself.

Side Pull Detection System

Key Characteristics — For a steel producer that needs to maintain safe operation of hoists, it is important that a hoist side pull detection system have key characteristics that will promote safety:

- Know the angle: This is not an absolute requirement, but a nice feature to have so that the actual angle can be seen when the limits are set for the first time.
- Zero feature: The sensor on a wire rope hoist will never sit perfectly plumb. The sensor should be zeroed out.
- Set alarm limits: The ability to set alarm limits is crucial.
- Alarm output: The ability to enable/disable a hoist motion via a relay contact is a must. The ability to also provide an audible or visual indication to operators is important so that they understand and learn from their mistakes.
- Dual axes capability: Side pulling is just as dangerous in both axes, so the ability to measure two axes is important for personnel safety.

Expectations

To minimize the possibility of an accident, investing in a side pull detection for a hoist is a responsible investment. There should be several expectations:

- Limit ability to operate hoist in a side pull condition.
- Adjust operator behavior and awareness via audible or visual indicators so that they do not intentionally side pull.
- Promote the modification of production processes in line with safe hoist practices. When a side pull detector disables a host too frequently and starts affecting production, this provides an opportunity to adjust production processes to minimize the need to side pull.

Conclusion

Side pulling is a common practice that occurs frequently and is often tolerated. However, this is also a well-known cause of damage to hoists and injury to personnel, sometimes resulting in death. Many hoists do not have any form of side pull protection. OSHA prohibits the practice of using cranes and hoists to pull or drag a load sideways. Most hoist manufacturers do not rate their standard hoists for side pull either. Methods exist for mitigating hoist side pull conditions with detection equipment that can be retrofitted to existing hoists or supplied on new equipment. Detection methods are valuable for stopping a side pull condition and helping operators change their behavior to avoid this improper usage of hoists.

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