PROPERTY

COMMENTARY PAPER

Overhead bridge cranes: the unexpected culprit behind some property losses

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Introduction

Industrial operations depend on overhead bridge cranes to lift and move heavy loads. Accidents involving these cranes can cause extensive damage and result in significant property losses. A thorough understanding of the risks is essential for businesses using cranes, as well as insurance underwriters.

Overview of overhead bridge cranes

Overhead bridge cranes are used to lift and transport heavy materials in industrial settings. They operate with a trolley-mounted hoist that traverses on a bridge structure. These cranes can be used in various industries such as construction, manufacturing and logistics. There are multiple types of overhead bridge cranes and they come in different sizes — each with a specific use, such as single girder cranes, double girder cranes and gantry cranes.

Despite the range of benefits in using overhead bridge cranes, they also pose risks and can cause significant property losses or injury when mishandled or improperly maintained.

Common types of bridge cranes

Single girder and double girder cranes

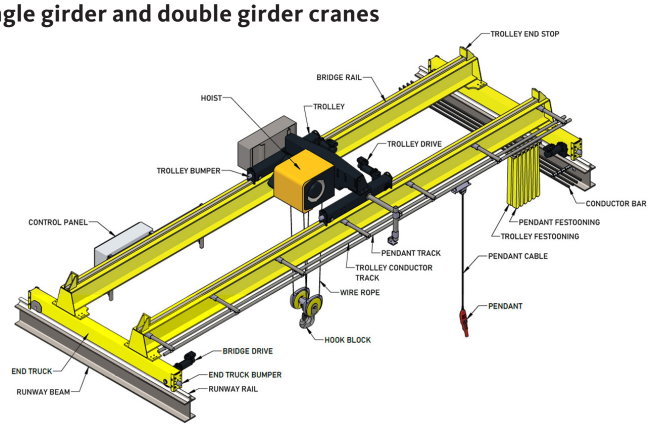


Illustration of a double girder bridge crane curtesy of Tri-State Overhead Crane

Single girder cranes and double girder cranes are two common types of bridge cranes used in industrial settings. The bridge girder is the horizontal beam that serves as the main structural component of an overhead crane. Single girder cranes have only one main beam across the span of the crane, while double girder cranes have two beams.

There are several differences between the two types of cranes. One major difference is their lifting capacity. Double girder cranes generally have a higher lifting capacity and greater stability. This makes them a better choice for industrial settings where heavy loads need to be lifted and moved. In terms of size and weight, single girder cranes are more compact and lightweight. This makes them easier to install and maneuver in tight spaces.

Top running and under running bridge cranes

A top running bridge crane and an under running bridge crane are two different types of overhead cranes. The main difference between the two is the way the bridge runs (or rides) along the crane runway.

In a top running bridge crane, the bridge is supported by rails that are mounted on top of the runway beams. The trolley moves along the top flange of the bridge girder, and the hook and hoist are suspended from the trolley. Top running bridge cranes can be designed for both single and double girder configurations. In contrast, in an under running bridge crane, the bridge travels on the bottom flange of the runway beams, the trolley and the hoist move along the bottom flange of the bridge girder.

One advantage of a top running bridge crane is that it can generally be designed for heavier loads and longer spans than an under running crane. On the other hand, an under running bridge crane may be preferred in situations where there is limited headroom or low ceilings, as they typically require less clearance above the runway beams.

Gantry cranes

A gantry crane is a type of overhead crane that is similar to a top running bridge crane, but instead of being supported by a runway, it is supported by legs that travel on fixed rails or wheels. The legs of a gantry crane can be fixed in place or can be designed to move along the rails, allowing the crane to travel along a linear path.

Gantry cranes are typically used in outdoor applications such as shipping yards, loading docks, and construction sites, where an overhead runway may not be practical or possible. They are also commonly used to service large pieces of equipment, such as airplanes, boats and heavy machinery.

Gantry crane at a construction site

There are different types of gantry cranes available, including single leg gantry cranes, double leg gantry cranes and cantilever gantry cranes. Single leg gantry cranes have one leg that supports the bridge, while double leg gantry cranes have two legs. Cantilever gantry cranes are designed to clear obstacles such as buildings or other structures, and are often used in shipyards and ports.

Monorail cranes

A monorail crane is a type of overhead crane that features a hoist and trolley that runs on a single rail. This rail can be either stationary or moveable and is often suspended from the building structure or ceiling. The monorail crane provides an efficient and cost-effective method of moving materials within a specific area or work zone.

The hoist and trolley system typically consists of a motorized or manually operated hoist, which is mounted on a trolley that runs along the rail. The hoist can be used to lift and lower heavy loads, while the trolley can be used to move the load along the rail.

Causes of property losses caused by overhead bridge cranes

There are several potential causes of property losses caused by overhead bridge cranes, the most common are:

1. **Erection and dismantlement:** improper assembly or disassembly of the crane.
2. **Operator error:** failure to operate the crane safely, monitor loads and surroundings.
3. **Equipment failure:** components wear out, fail or become damaged during use.
4. **Improper maintenance:** inadequate inspections, maintenance, and replacement of worn or defective electrical or mechanical parts.
5. **Design or manufacturing defect.**

Loss examples

Structural design flaw

A temporary overhead crane collapsed in a turbine building of the Arkansas Nuclear One (ANO) plant in Russellville, Arkansas. As a result of the incident, one worker was killed, and eight others were injured. The investigation concluded the following (quote verbatim):

1. The primary cause of the collapse of the temporary overhead crane was a flaw in the structural design of the temporary overhead crane. The structural columns on the north end were not provided with any diagonal braces or lateral ties in the north-south direction at the intermediate header beam level, and thus created instability of the columns. If diagonal braces or lateral ties were provided in the design, this incident would not have occurred.
2. In violation of the OSHA standard, this overhead crane was not load-tested prior to its use in the turbine building.
3. Bigge designed the overhead crane for 100% of the hook load instead of 125% as called for in Entergy's "Material handling program."
4. Entergy's "Material handling program" called for nondestructive tests of welds prior to and after the load test. Welds were not tested.
5. Siemens, Entergy and DP engineering knowingly permitted Bigge to conduct the lift without making sure that Bigge had conducted a load test. Thus, OSHA's standard 1926.1438(b) was violated.

Power plant crane collapse. Image credit OSHA investigative report.

Derailed overhead crane. Picture credit r/CatastrophicFailure reddit group.

Improper rigging

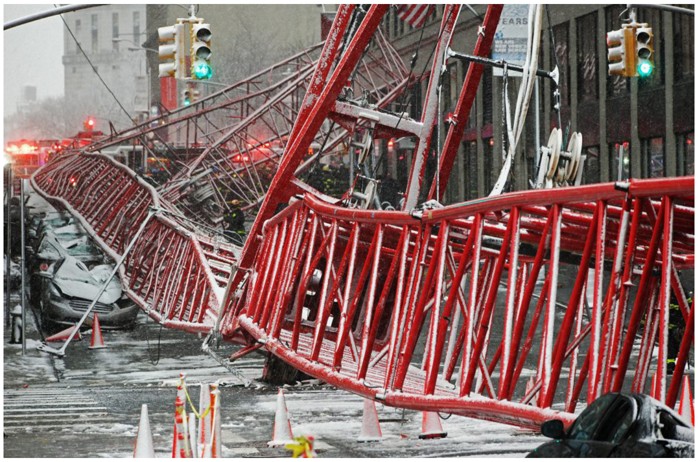
After a 40-ton crane derailed, it was determined that the potential cause was improper rigging. According to a contributor within the reddit r/CatastrophicFailure group, "A metal casting weighing around 35 tons was being lifted and turned over. This was done to enable the other side to be machined. While the piece was being turned, all of the weight transferred to one leg of the chain and one shackle, which caused the shackle to fail. The casting was past its halfway point, which meant it kept on turning as it was only supported at one side, and the momentum was enough to pull one side of the crane off the rails."

Construction site cranes

While cranes typically found at construction sites are not the focus of this commentary, the collapse of construction site cranes can result in large catastrophic events, which can lead to significant injuries or loss of life and even widespread damage to the surrounding area. There are many types of cranes used in construction sites. Some of the most common types include mobile cranes (such as carry deck cranes, crawler cranes, floating cranes, rough terrain cranes, and truck-mounted cranes), tower cranes, overhead cranes, and telescopic cranes. The type of crane used will depend on a variety of factors, including the size and scope of the project, the weight and size of the materials being lifted, and the terrain and conditions of the worksite.

Luffing jib tower crane collapse

In another event, a crane collapsed on the East Side of Manhattan during construction. Seven people were killed while 24 others were injured. According to the investigation report, the crane collapsed because the instructions provided by the manufacturer — regarding the lifting of the stabilizing collar to the ninth floor — were disregarded. A stabilizing collar is designed to anchor the crane to the building. Only half the recommended number of polyester slings (straps) were used to lift the collar, causing the overloaded slings to fail. This resulted in the collar dropping and dislodging two lower-level collars from the building, leaving the crane without any lateral support, which ultimately led to its collapse.



Tribeca crane collapse. Picture credit Milo Hess.

Crawler crane collapse

A crawler crane collapsed on a street in Lower Manhattan's Tribeca neighborhood. The crane, which was almost 600-feet-tall, fell onto nearby buildings, parked cars and pedestrians — killing one person and injuring three others.

The collapse occurred due to high winds that were reportedly stronger than expected, which compromised the crane's stability. The investigation into the incident revealed that a series of errors by the crane operator and other individuals involved in the project had also contributed to the collapse.

Problems with overhead cranes

Common problems with overhead cranes include:

1. Damage or degradation of wire rope - overuse and wear from normal operation, corrosion from exposure to moisture or chemicals, misalignment or damage to sheaves or pulleys, kinks or bends in the rope from improper handling, shock loads and dynamic stresses during use, fatigue and wear from constant flexing, lack of proper lubrication, and improper storage and handling during transportation or downtime.
2. Crane skew and alignment issues - poor initial installation or lack of proper maintenance, wear and tear of the runway, crane wheels, and end trucks, improper loading or uneven weight distribution during operation, overloading beyond the capacity of the crane, misalignment or damage to sheaves or pulleys, inadequate lubrication of moving parts, structural issues with the crane system, environmental factors such as temperature fluctuations and seismic activity.
3. Excessive wear to end truck wheels, girders and wheels - overuse and wear from normal operation, lack of proper lubrication of moving components, contamination from debris or dust, damaged or worn bearings, misalignment between the end truck and the runway, and improper loading or uneven weight distribution during operation.

4. Electrical faults - wear and tear of electrical components due to normal use, moisture or corrosion causing damage to electrical wiring and connections, power surges or voltage fluctuations, improper maintenance of electrical systems, overloading beyond the capacity of the crane, improper grounding, and environmental factors.

5. Problems with the hoist - abrasion, corrosion, and damage to chain links, damaged hooks, electrical faults in the hoist system, wear and tear of hoist components due to normal use, overloading beyond the capacity of the hoist system, and lack of proper lubrication of hoist components.

Tribeca crane collapse. Picture credit Milo Hess.

Forensic investigations

When forensically investigating crane failures, the following steps should be taken:

1. Secure the site and preserve the evidence to prevent further damage or spoliation.
2. Collect all available documentation related to the crane and its operation, including maintenance records, operator logs and inspection reports.
3. Perform a thorough inspection of the crane and its components, including a visual examination and non-destructive testing to identify any potential defects or failures.
4. Interview the crane operator, rigger, site supervisor and crane maintenance personnel.
5. Analyze the evidence gathered during the inspection to identify the root cause of the failure.
6. Determine if the failure was the result of design error, application error, operator error, equipment malfunction, ageing, corrosion, maintenance issues, design defect or other factors.
7. Develop a comprehensive report of the investigation's findings, including recommendations for improvements to prevent similar incidents from occurring in the future.

Mitigating the risk of property losses caused by overhead bridge cranes

To mitigate the risks associated with overhead crane activities, companies can take a few measures to reduce the potential for property loss or injury. These measures include but are not limited to:

1. Regular crane inspections to ensure that the equipment is functioning correctly and identify potential problems before they occur.
2. Continuous training of crane operators to improve their skills and knowledge about crane operation as well as workplace safety.
3. Adequate equipment maintenance and repair to improve equipment reliability.
4. Review of safety procedures and interventions to reduce the frequency of accidents.

Returning cranes to service after disaster events

Steps that could be taken to restore an overhead crane after a fire, smoke or water exposure event (note that specific instructions may vary depending on the situation and regulations) include:

- **Assess the damage:** Before any restoration work can begin, it is important to assess the extent of damage to the crane. This may involve examining the crane for signs of heat damage, corrosion from exposure to water or chemicals, or other types of damage.
- **Professionally clean the crane:** If the crane has been exposed to smoke or water, it will likely need to be thoroughly decontaminated before any restoration work can begin. This may involve using specialized equipment decontamination entities in collaboration with the manufacturer.
- **Repair or replace damaged components:** Once the damage has been assessed, any damaged components will need to be repaired or replaced. This may involve replacing parts that have been heat damaged, corroded or not cost effective to restore.
- **Nondestructive testing** of weld repairs and structural members to verify material properties and integrity are maintained.
- **Test the crane:** After the repairs have been completed, the crane should be thoroughly tested to ensure that it is functioning properly. This may involve running the crane through a series of tests to check its electrical, mechanical, and safety systems.
- **Verify compliance with regulations:** It is important to ensure that the restored crane meets all relevant safety and regulatory requirements. This may involve having the crane inspected by a qualified professional or ensuring that it meets OSHA, CAL/OSHA, or other industry-specific standards.

Summary

Cranes are crucial in industrial operations and pose inherent risks. Understanding and mitigating these risks is essential for businesses in preventing property losses. By conducting regular inspections, providing proper training, and performing adequate maintenance, companies can minimize or even avoid property losses caused by overhead and construction cranes.

Forensic engineers play a crucial role in determining the cause of failure and evaluating recovery options. The engineer typically covers the entire system, including the structure and mechanical components, control system, electrical system, wiring, and human factors. They study data that includes the hydraulic or pneumatic systems, and the loads and stresses placed on the crane.

After the examination, the engineers analyze the gathered data and draw conclusions regarding the root cause(s) of the failure. They can identify design defects or construction errors that may be responsible for the damage. They also check for improper use, maintenance deficiencies, or poor operating practices that could have contributed to the damage.

Lastly, the engineers collaborate with professionals such as lawyers, insurers and other interested parties to ensure a clear understanding of the failure, thus assisting parties to reach informed conclusions on how to repair or prevent a repeat of similar incidents in the future.

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