# Investigation of the July 19, 2016 Crane Collapse during Pile Driving for New Tappan Zee Bridge over Hudson River, Rockland County, NY

U.S. Department of Labor
Occupational Safety and Health Administration
Directorate of Construction

January 2017

# Report

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Cover page photo was taken from Thornton Tomasetti’s inspection report.

## 1. Introduction

On July 19, 2016, at around noontime, a Manitowoc MLC300 crawler crane engaged in driving piles for the construction of a new bridge suddenly collapsed and fell over the existing Tappan Zee Bridge in New York. The new bridge was being constructed adjacent to the existing bridge. The crane was equipped with the movable counterweight system known as VPC-MAX. Piles were driven for the construction of a pier for the New Tappan Zee Bridge over New York's Hudson River. The incident occurred on the Rockland County side. The 256 foot-long boom of the crane fell over the existing bridge (north and southbound lanes of Interstate I-87/I-287), see figure 1. Fortunately no vehicle was hit by the falling boom. The southbound lanes of the existing bridge sustained some structural damage. Traffic on the existing bridge was closed following the incident, and traffic was diverted for several hours. Northbound lanes were however reopened in the evening, and the southbound lanes were reopened later. There were no serious injuries reported, although four people were treated for minor injuries.

The OSHA Regional Administrator, Region II in New York, requested the Directorate of Construction (DOC), OSHA National Office, in Washington, D.C. to provide engineering assistance in its investigation of the incident. There was considerable media attention to the incident and it was the subject of prolonged discussion on TV. One structural engineer from DOC visited the site to examine the failed crane and vibratory hammer, and to obtain construction documents. Two safety compliance officers from the Tarrytown Area Office were also present during the visit.

Taken from WestchesterNews

**Fig. 1 – View of the fallen crane across the river and existing bridge**

## 2. Description of the Project

In 2013, the New York State Thruway Authority began construction of the New Tappan Zee Bridge, to replace the existing Tappan Zee Bridge over New York's Hudson River, connecting Rockland County and Westchester County in New York. The existing Tappan Zee Bridge opened in 1955, is 3.1-miles long and carries seven lanes of Interstate I-87/I-287/NY Thruway traffic.

The replacement Tappan Zee Bridge, see figure 2, is a twin cable-stayed bridge with separate structure for the westbound and eastbound bridge. Each bridge structure will have four lanes for general traffic along with designated bus lanes. The new bridge is constructed north and close to the existing bridge. The new bridge is scheduled for completion in 2018. The project construction cost is approximately $4 billion.

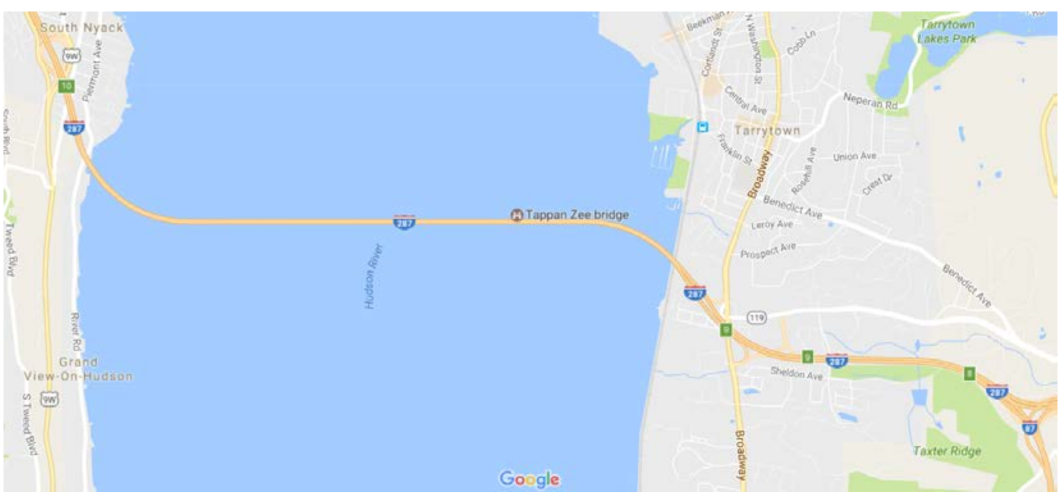
The new bridge is designed and being constructed by Tappan Zee Constructors, LLC (TZC), a consortium of companies formed to build the bridge. The four companies included in the consortium are: Fluor Corporation, Irving, TX; American Bridge, Coraopolis, PA; Granite Construction Inc., Watsonville, CA; and Traylor Bros. Inc., Evansville, IN.

From the New NY Bridge website http://www.newnybridge.com/
**Fig. 2 – Architectural Rendering of the New Bridge**

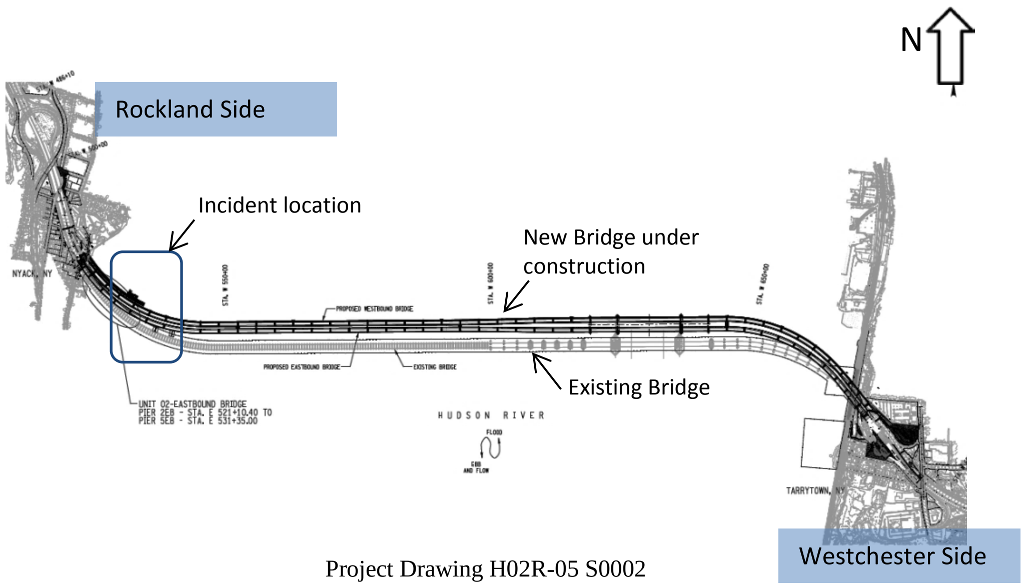
The location map, key plan and project photos are shown in figures 3 to 8. The new eastbound bridge is between the existing bridge and the new westbound bridge. The new bridge, 3.1 miles long, has more than 40 piers each for eastbound and westbound bridges. The crane collapse occurred on the eastbound bridge in Rockland County while driving a pile for pier #4EB. The foundation plan for new eastbound bridge between piers 2B and 5EB are shown below. The piers were spaced approximately 350± ft. apart, see figure 9. The deck for the westbound bridge was already completed in this section, see figure 5.

The pier 4EB consisted of 14 steel piles of 36" outside diameter, 1¼" wall thickness and of 50 ksi grade steel. The piles are numbered 1 to 14. Pile #1 is the southern-most pile; see figure xx, where the incident occurred. The pile cap was designed as cast-in-place concrete 73 feet long, 28 feet wide and 8 feet thick, see figures 10 to 13. The pile was designed to be driven to 210± ft. below the pile cap (see figures 12 and 13). The pile consisted of two sections. First, the bottom section, 155 feet long was to be driven and then it was to be spliced to the top section, 75 feet long, and then the combined pile was to be driven to the required depth. To accommodate the 14 piles, a floating cofferdam was constructed.

The TZC pile driving computations for pier 4B assumed a MLC 300 crane and ICE 66 vibratory hammer. However, TZC decided to use a J&M Model 66 (manufactured by J&M Foundation Equipment, LLC. and is believed to be equivalent to an ICE 66), with 2 adjustable clamps, to drive the piles at the pier 4EB. Besides J&M 66, TZC had used other vibratory hammer models as well in this project. TZC had multiple cranes, as many as 50, at the construction site. TZC decided to use a recently purchased MLC 300 crane with VPC-MAX to drive the piles for the pier 4EB with J&M Model 66 vibratory hammer. The new MLC 300 crane had driven fewer than 30 piles since TZC purchased it. MLC 300 was the only crane equipped with VPC-MAX at the entire site.




Taken from Google maps
**Fig. 3 – Location Map**




Project Drawing H02R-05 S0002

**Fig. 4 – Key Plan**


Taken from the New NY Bridge website http://www.newnybridge.com/photo/

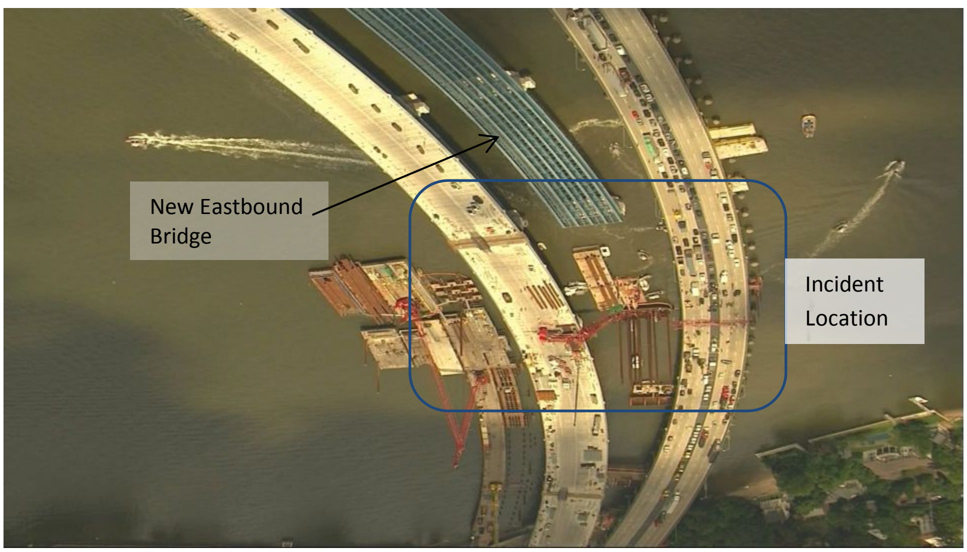
**Fig. 5 – Project progress photo** (June 24, 2016)


Taken from the New NY Bridge website
http://www.newnybridge.com/webcam/

**Fig. 6 – Project progress at the Main Span**

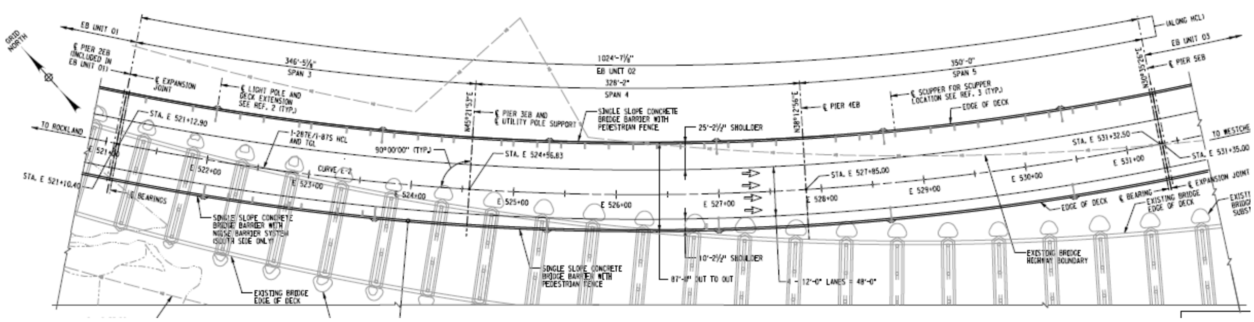

Taken from the New NY Bridge website
http://www.newnybridge.com/webcam/

**Fig. 7 – Project progress at the Rockland side, where the incident occurred.**



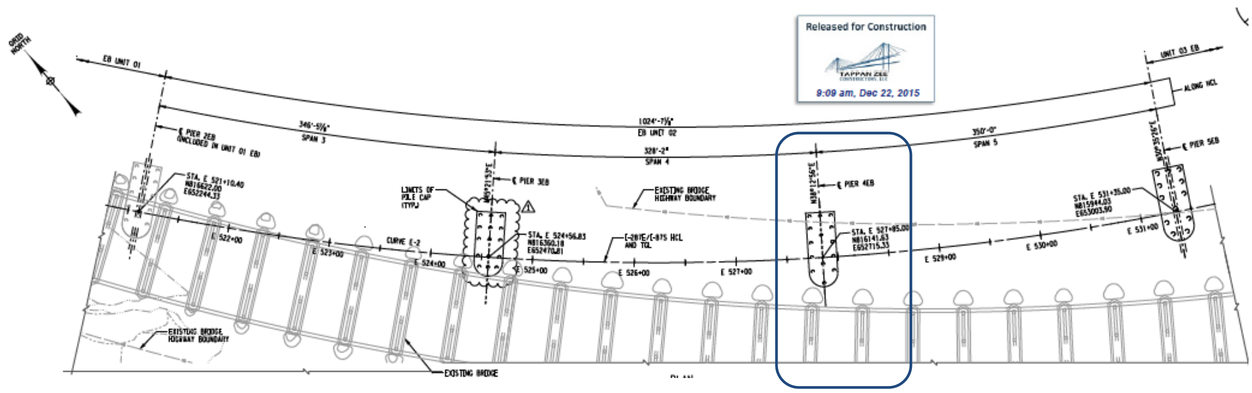

Taken from WestchesterNews

**Fig. 8 – Rockland Side of the Bridge on the day of the incident**



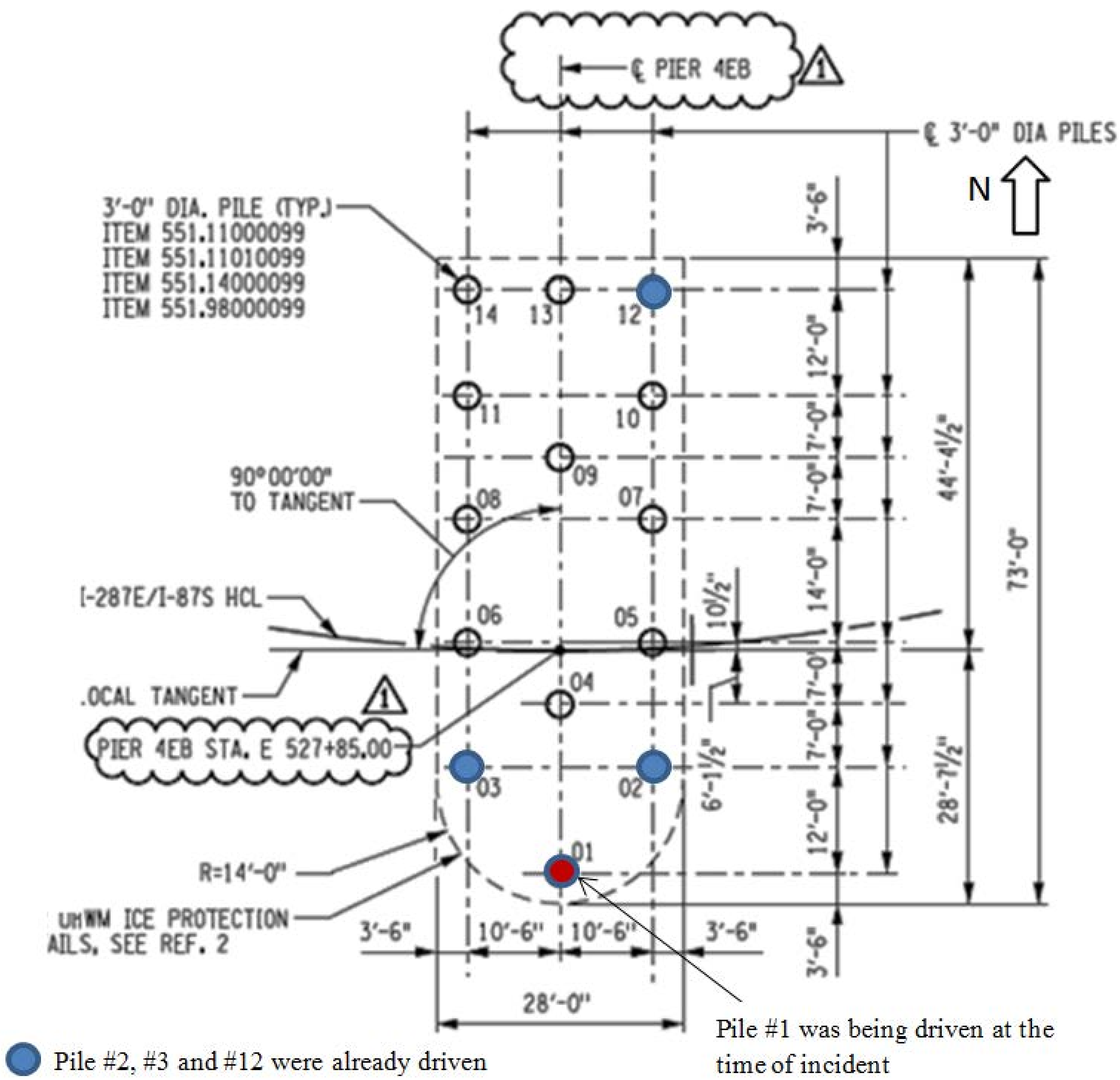
From Project Drawing H02R-05 S100

**Fig. 9 – Eastbound Bridge Plan**




From Project Drawing H02R-05 S102

**Fig. 10 – Eastbound Bridge Foundation Plan**

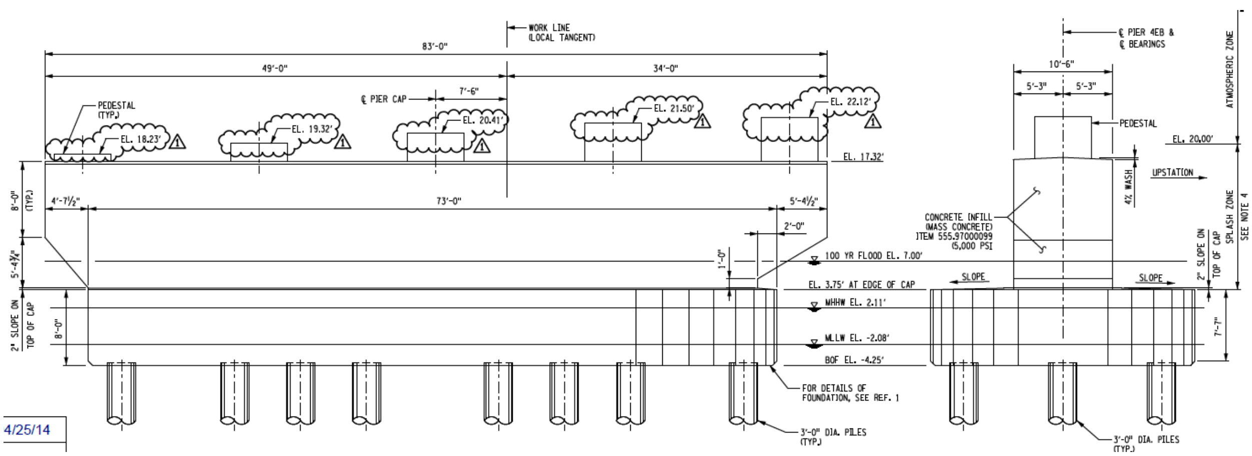



From Project Drawing H02R-05 S102

**Fig. 11 – Pile Layout Plan Pier 4EB**

| PILE SCHEDULE PIER 4EB | | | | | |
|---|---|---|---|---|---|
| PIPE PILE DESIGNATION | OUTER DIAMETER (IN) | WALL THICKNESS (IN) | STEEL GRADE (KSI) | APPROXIMATE TIP ELEVATION (FT) | TENSION (T) OR COMPRESSION (C) PILES |
| P04 EB-01 | 36 | 1.25 | 50 | -214.0 | C |
| P04 EB-02 | 36 | 1.25 | 50 | -217.0 | C |
| P04 EB-03 | 36 | 1.25 | 50 | -211.0 | C |
| P04 EB-04 | 36 | 1.25 | 50 | -214.0 | C |
| P04 EB-05 | 36 | 1.25 | 50 | -218.0 | C |
| P04 EB-06 | 36 | 1.25 | 50 | -211.0 | C |
| P04 EB-07 | 36 | 1.25 | 50 | -221.0 | C |
| P04 EB-08 | 36 | 1.25 | 50 | -211.0 | C |
| P04 EB-09 | 36 | 1.25 | 50 | -216.0 | C |
| P04 EB-10 | 36 | 1.25 | 50 | -222.0 | C |
| P04 EB-11 | 36 | 1.25 | 50 | -212.0 | C |
| P04 EB-12 | 36 | 1.25 | 50 | -223.0 | T |
| P04 EB-13 | 36 | 1.25 | 50 | -218.0 | C |
| P04 EB-14 | 36 | 1.25 | 50 | -213.0 | T |

From Project Drawing H02R-05 S103
**Fig. 12 – Pile Schedule Pier 4EB**

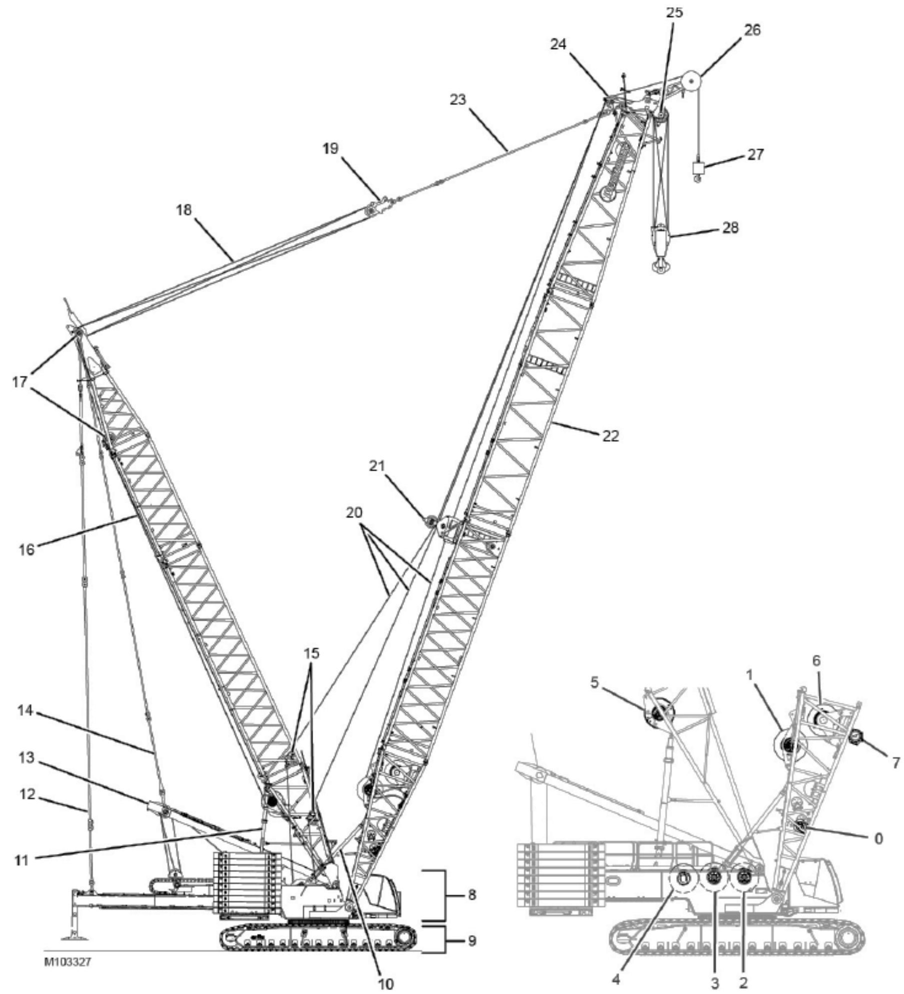


From Project Drawing H02R-05 S303
**Fig. 13 – Pier 4B Sections**

## 3. <u>Description of Crane, Geotechnical details, Cofferdam and Vibratory Hammer</u>

<u>Crane</u>

The crane that was involved in the incident and collapsed was a Manitowoc MLC300 crawler crane (S/N 605541) with VPC-MAX (S/N 605826), see figure 14. The manufacturer provided the crane manual for this investigation. The crane was rigged with a 256 foot-long boom (B60:500), per drawing 81023382 (see Appendix), and a 98-foot M10:503 lattice mast, per mast rigging drawing 81025690 (see Appendix). The crane was equipped with a Series 2 counterweight of 386,000 pounds VPC (Variable Position Counterweight). At the time of the incident, the radius of the boom was 135 feet and the capacity was 146,000 pounds per load chart 9432-A (see Appendix).




| Item | Description | Item | Description | Item | Description |
|---|---|---|---|---|---|
| 0 | Drum 0 (rigging winch) | 12 | Counterweight Straps | 24 | Boom Top Wire Rope Guide |
| 1 | Drum 1 (main hoist) | 13 | Live Mast | 25 | Lower Boom Point |
| 2 | Drum 2 (auxiliary front hoist) | 14 | Mast Straps | 26 | Upper Boom Point |
| 3 | Drum 3 (auxiliary rear hoist) | 15 | Load Drum Wire Rope Guides | 27 | Load Block |
| 4 | Drum 4 (mast hoist) | 16 | #503 Fixed Mast | 28 | Hook-and-Weight Ball |
| 5 | Drum 5 (Boom hoist) | 17 | Boom Hoist Wire Rope Guides | | |
| 6 | Drum 6 (luffing or auxiliary hoist) | 18 | Boom Hoist Wire Rope Reeving | | |
| 7 | Drum 7 (tagline) | 19 | Equalizer | | |
| 8 | Upperworks | 20 | Load Lines | | |
| 9 | Lowerworks | 21 | Load Drum Wire Rope Guides | | |
| 10 | Physical Boom Stop | 22 | #500 Boom | | |
| 11 | Physical Mast Stop | 23 | Boom Straps | | |

Taken from Crane manual
**Fig. 14 – Crane details**

Soil conditions and pile depth

Soil borings were performed at the construction site in April 2012. Test boring log data in the vicinity of pier 4EB were provided by TZC. Two boring logs, located approximately 150 feet around pier 4EB, the mud line indicated to be seven feet below the water line. The river bed floor consisted of a layer of very soft (WR/WH) organic silty clay soils (OH) with very low or negligible bearing capacities. The soil in this area was easily penetrated by rods with a zero blow under the weight of the rods or with the weight of the rods plus the weight of the hammer. Based on the boring logs, the organic silty clay was approximately 30 feet deep at one location and piles could be driven into this layer of very soft soil under its own self-weight. The sub-surface investigation indicated medium stiff to very stiff soils consisting of clayey silt, silty clay and sand for the next 30 feet. Below this level, there were alternating layers of stiff soils and very soft soils, until hard rock was reached.

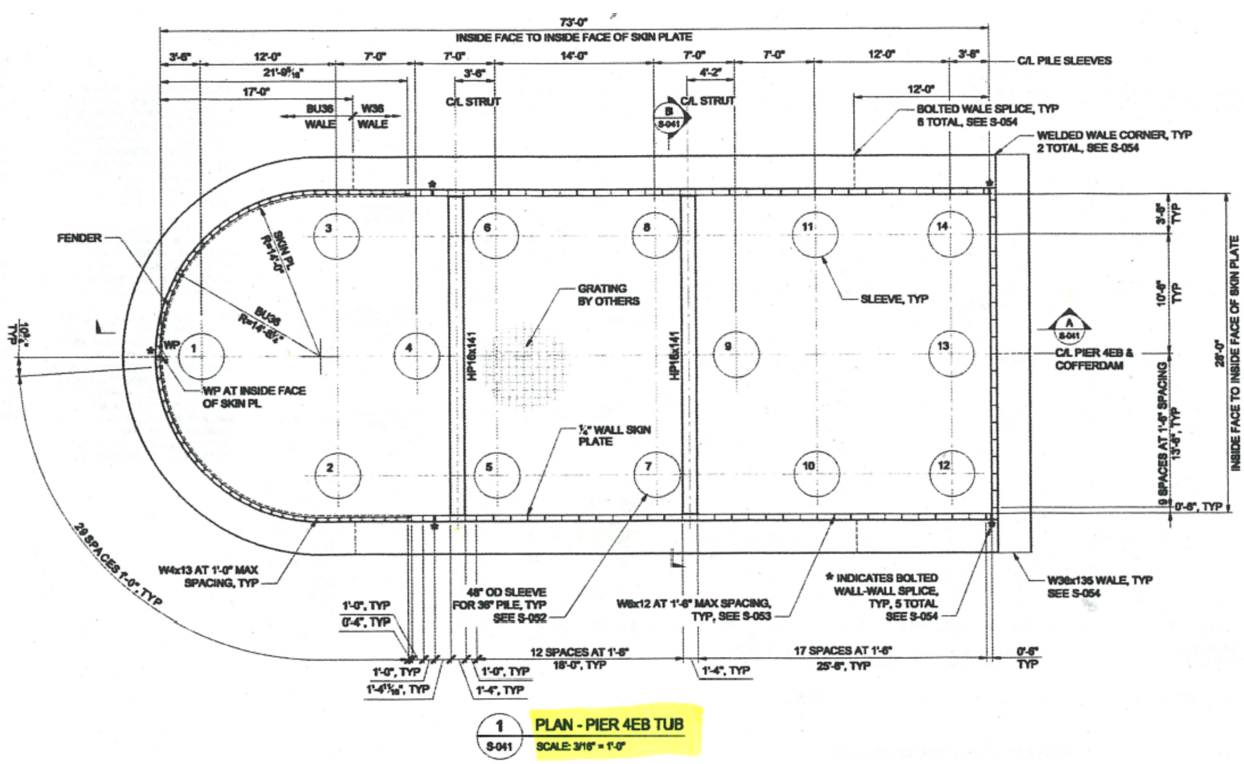
The steel open-end pipe piles were designed to be driven to an approximate tip elevation of -214 feet. The bottom of the pile cap was -4.25 feet. Given the in-situ soil condition, both vibratory and hydraulic hammers were selected for the pile installation. The bottom section of the pile, 155 feet, was to be driven with a vibratory hammer; then, the top section, 75 feet long, was to be spliced; and the combined pile was to be driven to the final depth with a hydraulic hammer.

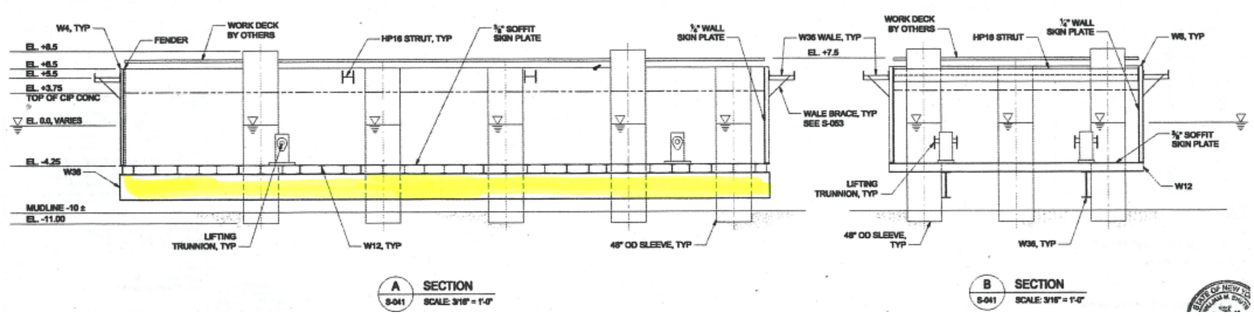
Initially, all the piles (14 piles, 155 feet long) in pier 4EB were driven under its self-weight to the bottom of the surface muddy layer of the river bed floor, approximately 50 feet from the top of cofferdam. Installation templates were used to guide the pile in to position. On the day of the incident, before the driving began, all the piles were self-standing into the muddy river bed floor. Pile #1 had been driven approximately 32 feet into the muddy river bed floor under its own self weight. The pile installation logs indicated that the mud line was measured to be at a depth of approximately 10 feet below the water line.

On the day of the incident, TZC planned to drive the piles in pier 4EB further into the soil with a vibratory hammer. The piling started around 8 a.m. and pile # 2, 3, and 12 were successfully vibratory driven approximately 120 feet into the soil. Then the contractor placed the hammer on pile #1 and pile driving continued. In a course of five to six minutes of driving the pile, the vibratory hammer came out of the pile.

Floating cofferdam

Cofferdams were designed as a floating structure in this project, see figure 15. The floating cofferdams were prefabricated at an off-site location. The floating cofferdams consisted of thin shells which were braced with wales and struts. Steel pipe sleeves were installed at the floating structure to guide pile driving through the bottom of the floating cofferdams. Once at the site, the floating cofferdam was lowered into the water to a designated elevation. After the location of the floating cofferdam was secured, the steel pipe piles were placed in the sleeves. The floating cofferdam method used in this project required the floating cofferdam to be properly located and secured with specific horizontal and vertical tolerances. During the pile installation, floating stability of the coffer dam was to be checked within the specific tolerances.






From Project Drawing S041

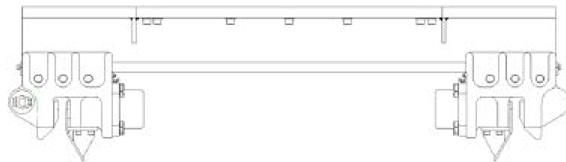
**Fig. 15 – Floating cofferdam Plan and Sections**

## Vibratory Hammer

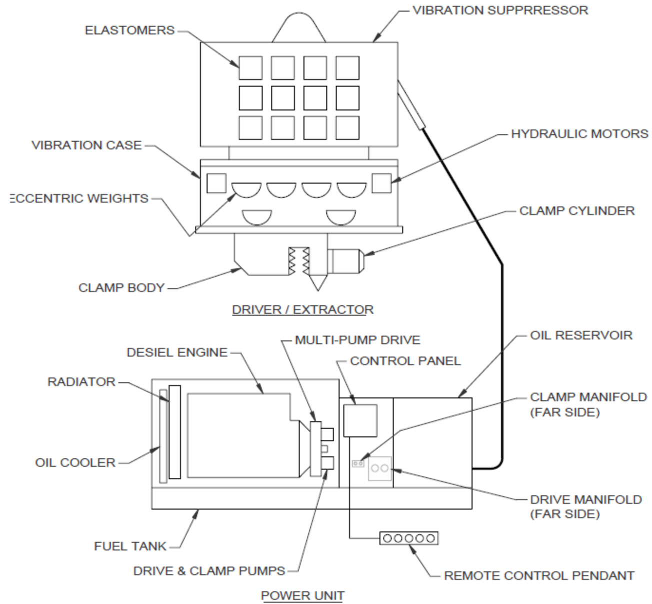
The vibratory hammer in use was J&M model 66 hydraulic vibratory Driver/Extractor, manufactured by J&M Foundation Equipment, LLC., with model 800G power unit, see figure 16. J&M used to manufacture vibratory equipment for ICE **(**International Construction Equipment, Inc.) and were partners till around 2000. Around 2000, J&M split away from ICE and started manufacturing on their own. Currently J&M is owned by APE (American Piledriving Equipment). J&M model 66 is believed to be an ICE 66 equivalent vibratory hammer. The principles of operation of the vibratory hammer are shown in Figure 16 as well. The vibratory hammer consists of three major components, Vibration suppressor; Vibration case with eccentric weights and hydraulic motors; and Clamp.

Vibration suppressor is on the top of the hammer, which serves as an isolated bias weight. It is isolated from oscillation by 12 rubber elastomers and acts as a net downward load helping the driving efficiency by increasing the penetration rate of the pile. This driver in the middle consists of six counter rotating weights. The horizontal components of the centrifugal force generated as a result of rotating masses cancel each other. As a result, a sinusoidal dynamic vertical force is produced on the pile and helps to drive the pile. A 12-foot-long caisson beam with hydraulic clamps was used to attach the vibrator to the pile at the bottom of the hammer. Hydraulic hoses connected the power unit to the hydraulic motors on the vibrator. The above description has been taken from the J&M vibratory hammer material publicly available on the web.

J&M vibratory hammer 66



Caisson Beam




Vibratory Hammer details

**Fig. 16 – Vibratory Hammer**

## 4. Description of the Incident

The incident occurred on the eastbound bridge, Rockland side, while driving pile #1 for the pier 4EB. Pile #1, 155 feet long, 36 inches diameter, was being driven with a vibratory hammer J&M 66 using Manitowoc MLC300 with VPC-MAX crane. A schematic sketch with crane, hammer and pile is shown in figure 17 below. The crane was stationed on the newly constructed westbound bridge. The crawlers were placed on long wooden cribbing and were oriented parallel to the new bridge. The centerline of the south crawler was about 6 ft. from the edge of the new bridge deck. The crane was operating at a radius of 135 feet at the time of the incident.

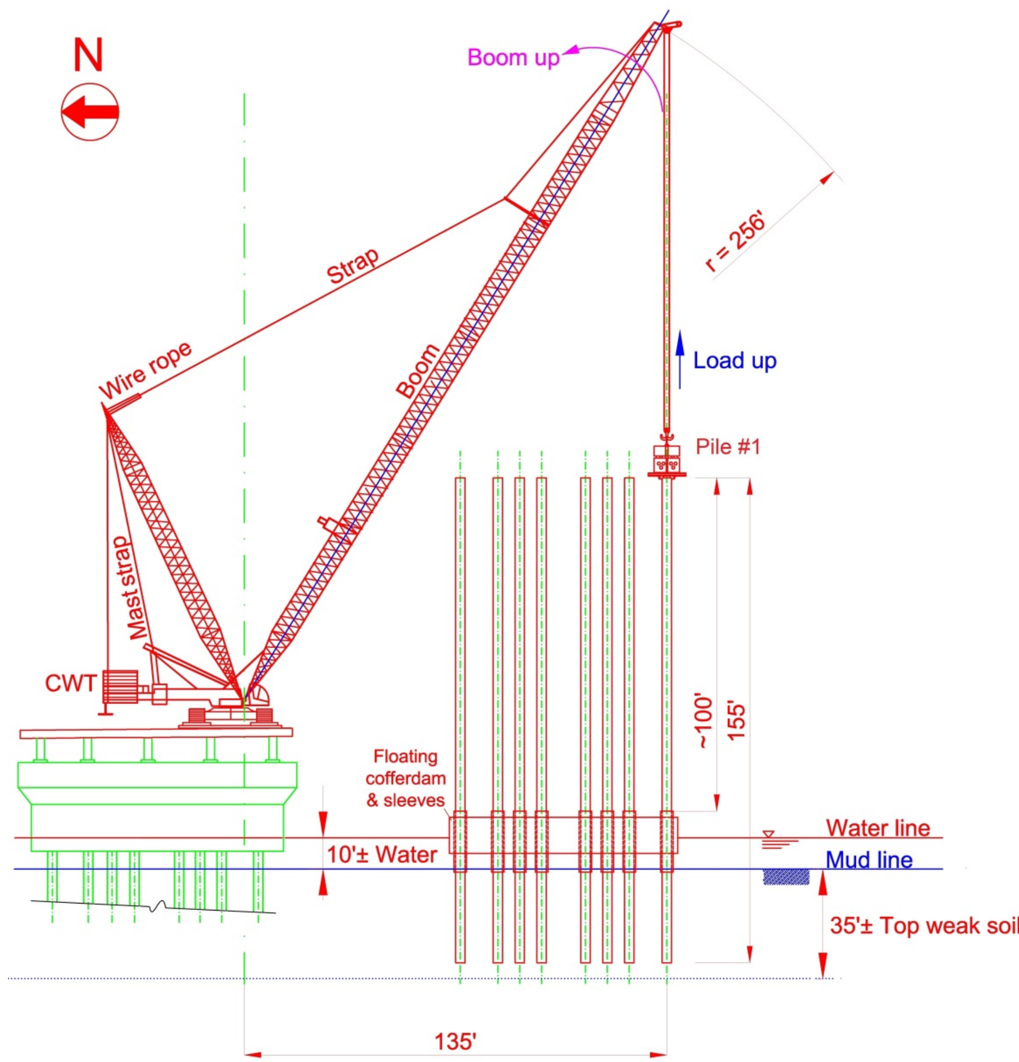
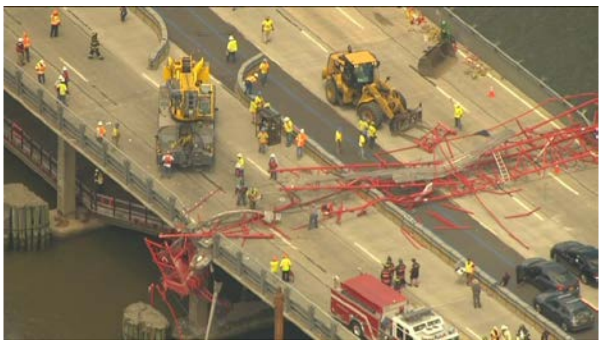



**Fig. 17 - Sketch of crane, hammer and pile at the time of incident**

The 155-foot-long pile weighed 73,285 lbs. and the J&M 66 hammer, rigging and hook block weighed 33,933 lbs. Thus the total load on the crane was 107, 218 lbs. From the load chart, the capacity of the crane at a radius of 135 ft. was 146,000 lbs. The water depth was 10± ft. and the top of the cofferdam was 10± above the water.

In pier 4EB, out of the 14 piles, three piles were already driven. The crew started the pile-driving in the morning. After completing the three piles, the crew started driving pile #1. During pile driving and extraction of pile #1, the hammer got released from the pile, and then the crane collapsed. The crane fell hitting the upright standing pilings of the new bridge and fell over the existing bridge. The vibratory hammer with caisson beam attachment fell into the water. Collapse photos are shown in figures 18 to 27.

After the incident, TZC had retained Thornton Tomasetti, New York, NY as their consultant and Thornton Tomasetti provided OSHA their inspection report, which included site photos and videos.



Taken from WestchesterNews
**Fig. 18 – Shows crane collapsed onto the existing bridge**


**Fig. 19 - Shows the collapsed crane, piles and cofferdam**


**Fig. 20 – Shows the collapsed crane**


**Fig. 21 – Shows the collapsed crane**


Taken from Thornton Tomasetti inspection report

**Fig. 22 – Shows the collapsed crane**


**Fig. 23 – Shows the collapsed crane**


**Fig. 24 –Collapsed crane, piles and cofferdam**


**Fig. 25 – Collapsed crane with counterweight**


**Fig. 26 - Vibratory Hammer recovered from water**


Taken from Thornton Tomasetti inspection report

**Fig. 27 - Vibratory Hammer recovered from water**
(Note: one clamp missing)

## 5. Discussion

The piles consisted of 36" O.D steel pipe, consisting of upper and lower sections. The lower section was approximately 155 feet long. The pipe was placed inside a 4 ft. outside diameter sleeve approximately 20 ft. long. There was an approximately 5" annular space between the piles and the sleeve that provided a maximum tilt of ¼" per foot.

The pile #1 where the incident occurred was the fourth pile of pier 04EB to be driven into the river bed on the day of the incident (see figure 11 for the layout of the piles of the pier 04EB). In the morning, piles # 2, 3, and 12 were successfully driven into the soil using the same set of crane and vibratory hammer. There were reports of leaks in the hydraulic hoses connected to the vibratory hammer in the morning of the day of the incident. The vibratory hammer was lowered to the platform for examination, but no substantial leaks were detected - although some hoses were observed to be “oily.” Repairs were therefore considered to be unwarranted, though it is believed that the issue of the leak, and the basis and source of earlier reports of the leak, were never fully settled. The vibratory hammer, therefore, continued to be employed to drive the piles without ascertaining the veracity of the earlier news of the leaks. It is the industry practice to replace the hoses immediately.

There are two key participants in driving the piles. First is the operator of the remote control pendant of the vibratory hammer, who is stationed on top of the platform. His functions, among other things, are to turn on and off the vibratory hammer’s engine, and to turn on and off the vibratory hammer’s clamp that provides the grip of the hammer onto the pile. The second key player is the crane operator, who operates the crane within the parameters set by the crane manufacturer with respect to radius of the boom, and the magnitude of the load comprising the dead load of the pile, vibratory hammer, rigging, block, etc. The crane operator places the vibratory hammer onto the pile, and drives the pile into the soil in a plumbed manner. In the event that the pile becomes skewed in one or two orthogonal directions, the crane operator extracts the pile to the extent necessary to re-drive the pile and correct the pile’s plumbness.

A review of the video taken by the on-site surveillance camera indicated that the vibratory hammer remained on top of the pile #1 for no more than approximately six minutes before the incident occurred. For the first three minutes, the pile was driven down into the soil followed by another three minutes when the pile was being gradually extracted. Immediately before the incident, the tip of the pile was approximately at the same elevation as it was when the vibratory hammer was placed in the beginning. The crane operator extracted the pile by the same amount as he drove it into the soil earlier; after a little pause, there was a sudden release of the vibratory hammer in a trajectory motion consistent with the boom-up action instead of a load-up motion. These six minutes of activity can be seen from the surveillance camera frames shown below (see figures 28 to 32). More frames from the surveillance camera are shown in the Appendix.


(shows that the Hammer was not attached to the pile at 11:49:42 a.m.)

**Fig. 28 – Surveillance Camera frame**


(Pile driving is already in progress.)

**Fig. 29 – Surveillance Camera frame**


(Pile driving in progress)

**Fig. 30 – Surveillance Camera frame**


(Shows Pile extraction.)

**Fig. 31 – Surveillance Camera frame**


(Vibratory hammer released and swinging towards the boom at 11:57:47 a.m.)

**Fig. 32 – Surveillance Camera frame**

It is not understood why the crane operator suddenly switched from the load-up to boom-up mode. It is suspected that the pile got stuck either in the sleeve or in the muddy soil, and the crane operator acted to free it by booming up. With the sudden release of the load, the mast of the crane failed, followed by the boom failure. The sequence of the crane failure shown in the appendix was prepared by Manitowoc, the crane manufacturer.

The crane was equipped with a data logger. The hook load, mast strap load, boom up/down operation, hoist up/down operation, and other information are provided in the data logger. For each second, there are more than ten lines of entry, and the data logger file provided by Manitowoc contained more than 398,000 lines of entry. A plot of approximately five minutes of data, preceding the time at which the hook load and mast strap load became zero, is shown in the plot below (see figure 33). The plot is for duration of 4 minutes and 28 seconds (The data logger time from 7:17:25 AM to 7:21:53 AM). The date and time in the data logger did not correspond to local date or Eastern Standard Time. The plot was provided by the crane manufacturer. Selected entries within the 4 min. 28 sec. duration is shown in the Appendix.

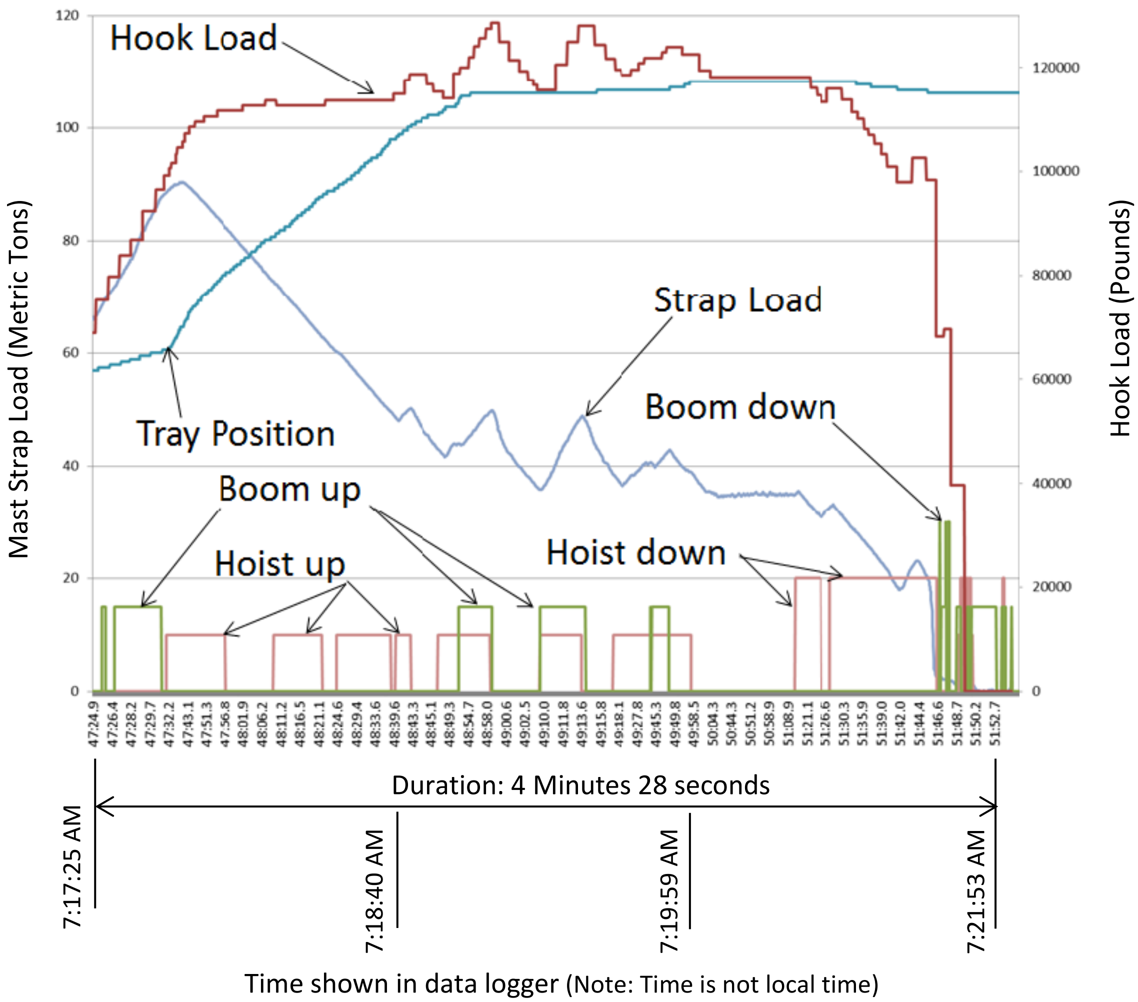



**Fig. 33 – Data logger information at time of incident**

Post-incident examination of the top three feet of the pile indicated indentations on the south and north tips where the grip cylinder and the bearing plates of the vibratory hammer were clamping the pile. The mark on the south side is a significantly deep groove indentation measuring half the thickness of the pile wall. On the north side there are scratching marks, but not deep gouging as observed on the south side, see figures 34 to 37. This appeared to be consistent with the boom-up action by the crane operator, as it will exert higher force on the south side compared to the north side. An additional reason for the deep gouging on the south side of the pipe is the fact that the grip cylinder had a flat contact surface with the pipe. This caused a large concentrated force where the cylinder contacted the pipe, resulting in permanent deformation of the pipe. The vibratory hammer clamp and the removable bearing plate are shown in figures 38 to 41. The replaceable "Fixed Jaw Plate" part from J&M manual is shown in figure 42.

Metallurgical testing on the vibratory hammer, pile ends and crane were being conducted by LPI, Inc., Consulting Engineers, under the guidance of Thornton Tomasetti. The testing was ongoing and their report was not available as of January 18, 2017. Manitowoc did some non-destructive testing of the crane, and their report was provided.

**Fig. 34 – Cut piece from pile #1**

**Fig. 35 – Mark on the north side of pile #1**

**Fig. 36 – Deep indentation on the south side of pile #1**

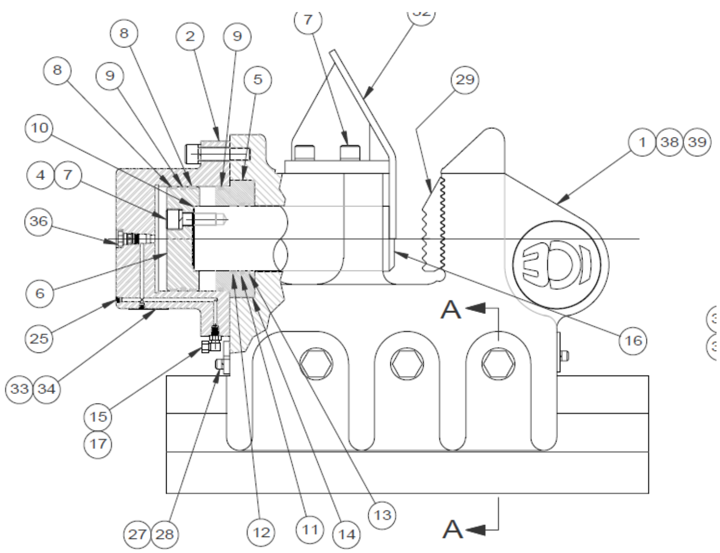
**Fig. 37 – Deep indentation on the south side of pile #1**

**Fig. 38 – Vibratory hammer Clamp**

**Fig. 39 – Close-up of Clamp removable bearing plate**

**Fig. 40 – Close-up of removable bearing plate**

**Fig. 41 – Close-up of corroded removable bearing plate**



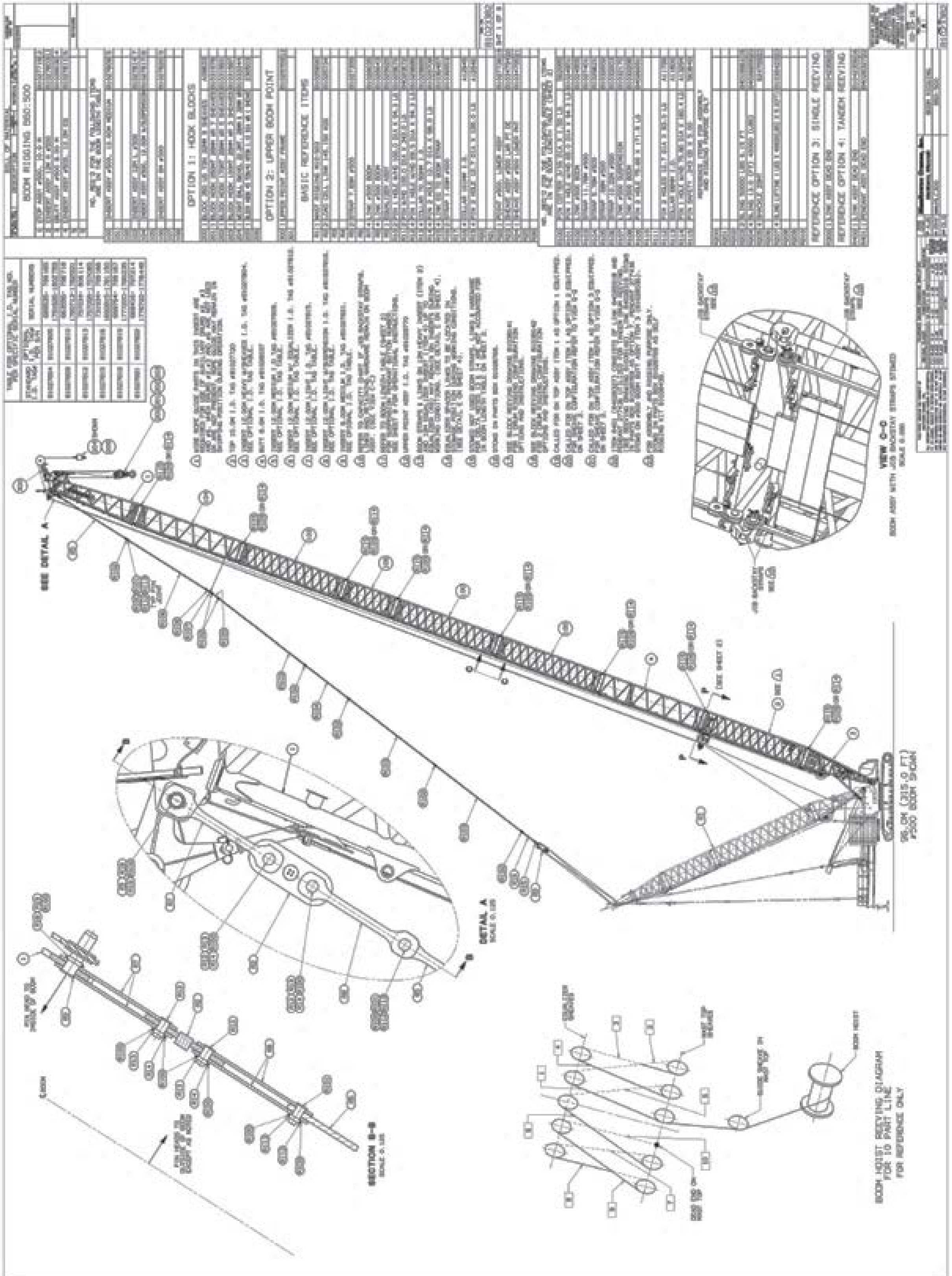

Note: see the teeth on the jaw plate marked 29

**Fig. 42 – Removable fixed jaw plate from J&M manual**

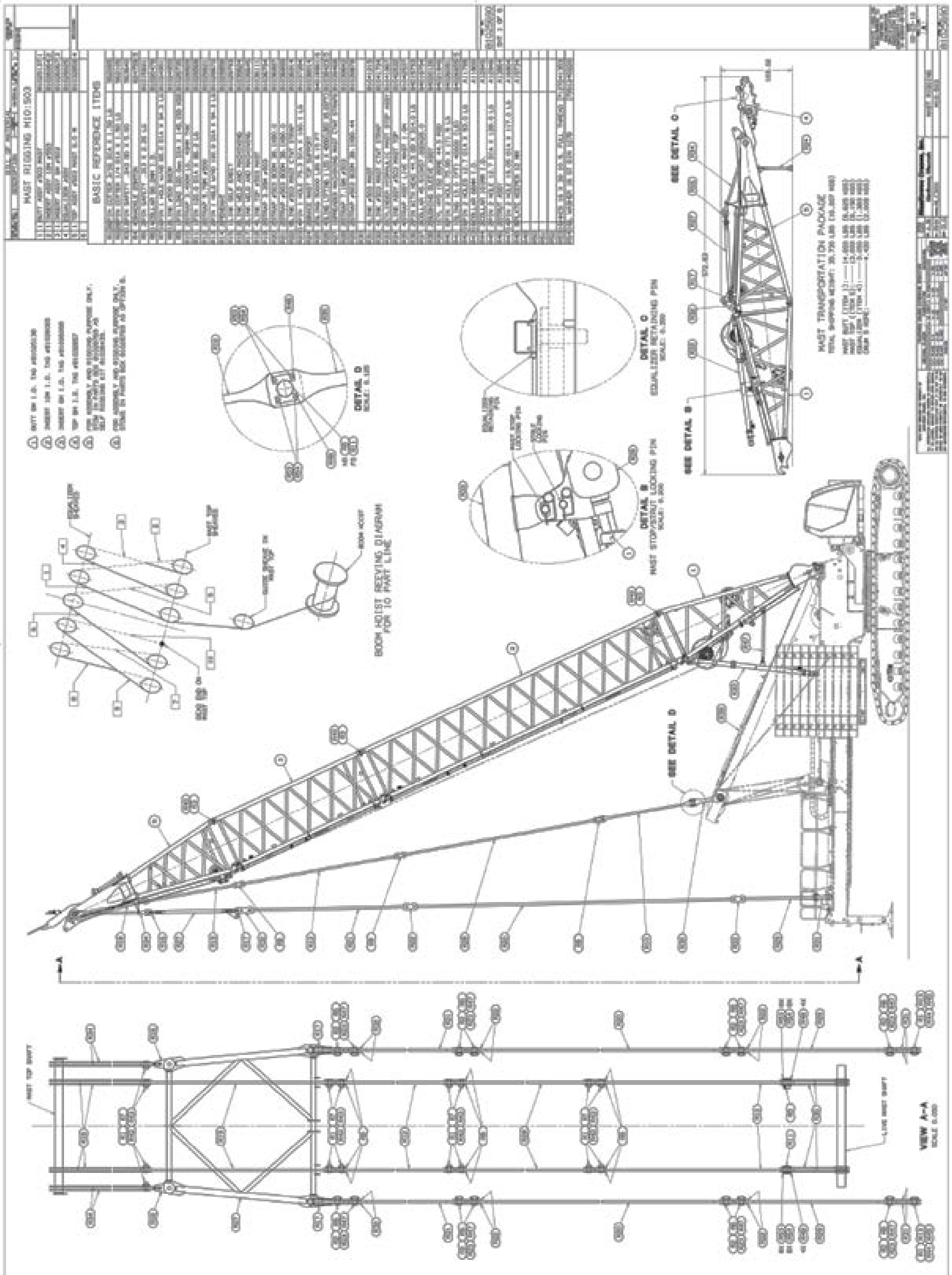
## Conclusions

1. The collapse of the crane occurred when the crane operator inadvertently or purposely raised the boom (boom-up) in order to further extract the pile during the plumbing procedure. Minutes earlier, the crane operator had successfully extracted the pile a few feet by raising the load (load-up), but it is believed that, for some unknown reason, he could no longer raise the pile, and therefore resorted to "boom-up." The boom-up suddenly released the vibratory hammer and resulted in a chain reaction failure of the crane mast followed by the breakup of the crane boom when it struck the standing piles on its way down. The boom eventually fell over the lanes of the existing Tappan Zee Bridge. This incident had the potential of catastrophic consequences.
2. Tappan Zee Bridge Constructors, LLC used a corroded and damaged bearing plate located against the clamping cylinder on the vibratory hammer - a deviation from the standard industry practice.
3. Tappan Zee Bridge Constructors, LLC violated the generally accepted industry standard (ANSI A10.19) since the capacity of the crane was significantly lower than the required capacity of five times the load of the pile and the vibratory hammer during pile extraction. However, during the pile driving, the load was within the crane capacity.
4. Tappan Zee Bridge Constructors, LLC proceeded to use the vibratory hammer without entirely resolving the issue of the oil leaks in the hydraulic hoses. This issue was raised at the beginning of the morning shift on the day of the incident but it persisted to varying degrees throughout the morning.
5. The bearing plate of the clamp did not contain jawed teeth as required by the vibratory hammer manufacturer.
6. It is believed that the Tappan Zee Bridge constructors, LLC operated the vibratory hammer without possessing its operating manual. Tappan Zee Bridge Constructors, LLC could not produce the manual to OSHA in spite of repeated requests from OSHA.

# APPENDIX



**Crane Boom drawing**




**Crane Mast drawing**

# MLC300
# VPC-MAX S-2

ASME B30.5

Manitowoc

B60

386,000 lb

360°

**255.9 ft**

| ft | ° | ft | 34.8 ft lb | 48.0 ft lb |
|---|---|---|---|---|
| 32 | 84.7 | 261.6 | 324,700 | 324,700 |
| 34 | 84.3 | 261.4 | 324,700 | 324,700 |
| 36 | 83.8 | 261.2 | 324,700 | 324,700 |
| 38 | 83.4 | 260.9 | 324,700 | 324,700 |
| 40 | 82.9 | 260.7 | 324,700 | 324,700 |
| 45 | 81.8 | 259.9 | 324,700 | 324,700 |
| 50 | 80.7 | 259.1 | 324,700 | 324,700 |
| 55 | 79.5 | 258.1 | 324,700 | 324,700 |
| 60 | 78.4 | 257.1 | 321,300 | 324,700 |
| 65 | 77.2 | 255.9 | 290,400 | 324,700 |
| 70 | 76.1 | 254.7 | 264,400 | 324,700 |
| 75 | 74.9 | 253.3 | 242,000 | 318,700 |
| 80 | 73.8 | 251.8 | 222,600 | 292,800 |
| 85 | 72.6 | 250.3 | 205,600 | 270,400 |
| 90 | 71.4 | 248.5 | 190,600 | 250,900 |
| 95 | 70.2 | 246.7 | 177,300 | 233,600 |
| 100 | 69.0 | 244.8 | 165,400 | 218,400 |
| 105 | 67.8 | 242.7 | 154,600 | 204,700 |
| 110 | 66.6 | 240.5 | 144,900 | 192,500 |
| 115 | 65.3 | 238.2 | 136,100 | 181,400 |
| 120 | 64.1 | 235.8 | 128,000 | 171,300 |
| 125 | 62.8 | 233.2 | 120,600 | 162,100 |
| 130 | 61.6 | 230.5 | 113,700 | 153,700 |
| 135 | 60.3 | 227.6 | 107,400 | 146,000 |
| 140 | 59.0 | 224.6 | 101,600 | 138,800 |
| 145 | 57.6 | 221.4 | 96,200 | 132,200 |
| 150 | 56.3 | 218.0 | 91,100 | 126,100 |
| 155 | 54.9 | 214.5 | 86,400 | 120,400 |
| 160 | 53.5 | 210.8 | 82,000 | 115,100 |
| 165 | 52.1 | 206.9 | 77,800 | 110,100 |
| 170 | 50.7 | 202.8 | 73,900 | 105,400 |
| 175 | 49.2 | 198.5 | 70,200 | 101,000 |
| 180 | 47.7 | 193.9 | 66,800 | 96,900 |
| 185 | 46.1 | 189.1 | 63,500 | 93,000 |
| 190 | 44.5 | 184.0 | 60,400 | 89,300 |
| 195 | 42.9 | 178.6 | 57,400 | 85,800 |
| 200 | 41.2 | 172.9 | 54,600 | 82,500 |
| 210 | 37.6 | 160.4 | 49,400 | 76,400 |
| 220 | 33.7 | 146.0 | 44,600 | 70,800 |
| 230 | 29.3 | 129.1 | 40,200 | 65,700 |
| 240 | 24.1 | 108.5 | 36,200 | 61,100 |
| 250 | 17.6 | 81.1 | 32,400 | 56,700 |

**275.6 ft**

| ft | ° | ft | 34.8 ft lb | 48.0 ft lb |
|---|---|---|---|---|
| 34 | 84.7 | 281.2 | 275,800 | 275,800 |
| 36 | 84.3 | 281.0 | 275,800 | 275,800 |
| 38 | 83.9 | 280.8 | 275,800 | 275,800 |
| 40 | 83.4 | 280.5 | 275,800 | 275,800 |
| 45 | 82.4 | 279.8 | 275,800 | 275,800 |
| 50 | 81.3 | 279.1 | 275,800 | 275,800 |
| 55 | 80.3 | 278.2 | 275,800 | 275,800 |
| 60 | 79.2 | 277.2 | 275,800 | 275,800 |
| 65 | 78.2 | 276.1 | 275,800 | 275,800 |
| 70 | 77.1 | 275.0 | 275,400 | 275,800 |
| 75 | 76.0 | 273.7 | 250,700 | 275,800 |
| 80 | 75.0 | 272.4 | 229,600 | 275,800 |
| 85 | 73.9 | 270.9 | 211,400 | 268,900 |
| 90 | 72.8 | 269.3 | 195,500 | 249,300 |
| 95 | 71.7 | 267.7 | 181,500 | 232,100 |
| 100 | 70.6 | 265.9 | 169,100 | 216,800 |
| 105 | 69.5 | 264.0 | 158,000 | 203,200 |
| 110 | 68.3 | 262.0 | 148,000 | 190,900 |
| 115 | 67.2 | 259.9 | 139,000 | 179,800 |
| 120 | 66.1 | 257.6 | 130,800 | 169,700 |
| 125 | 64.9 | 255.3 | 123,300 | 160,500 |
| 130 | 63.8 | 252.8 | 116,400 | 152,100 |
| 135 | 62.6 | 250.2 | 110,100 | 144,400 |
| 140 | 61.4 | 247.4 | 104,300 | 137,200 |
| 145 | 60.2 | 244.6 | 98,900 | 130,600 |
| 150 | 59.0 | 241.5 | 94,000 | 124,500 |
| 155 | 57.8 | 238.4 | 89,300 | 118,800 |
| 160 | 56.5 | 235.0 | 85,000 | 113,400 |
| 165 | 55.3 | 231.6 | 80,900 | 108,400 |
| 170 | 54.0 | 227.9 | 77,100 | 103,800 |
| 175 | 52.7 | 224.1 | 73,500 | 99,400 |
| 180 | 51.3 | 220.1 | 70,100 | 95,200 |
| 185 | 50.0 | 215.9 | 67,000 | 91,300 |
| 190 | 48.6 | 211.4 | 63,700 | 87,600 |
| 195 | 47.2 | 206.8 | 60,600 | 84,200 |
| 200 | 45.7 | 201.9 | 57,700 | 80,900 |
| 210 | 42.7 | 191.4 | 52,200 | 74,700 |
| 220 | 39.5 | 179.6 | 47,300 | 69,200 |
| 230 | 36.0 | 166.3 | 42,700 | 64,100 |
| 240 | 32.2 | 151.2 | 38,500 | 59,500 |
| 250 | 28.0 | 133.4 | 34,600 | 55,200 |
| 260 | 23.0 | 111.7 | 31,000 | 51,300 |
| 270 | 16.7 | 82.9 | 27,600 | 47,600 |

**9432-A**, 2016-02-29
6/9

**S/N: 605826**

**Manitowoc Cranes**
Manitowoc, Wisconsin 54220 U.S.A.

**Load Chart for the crane**

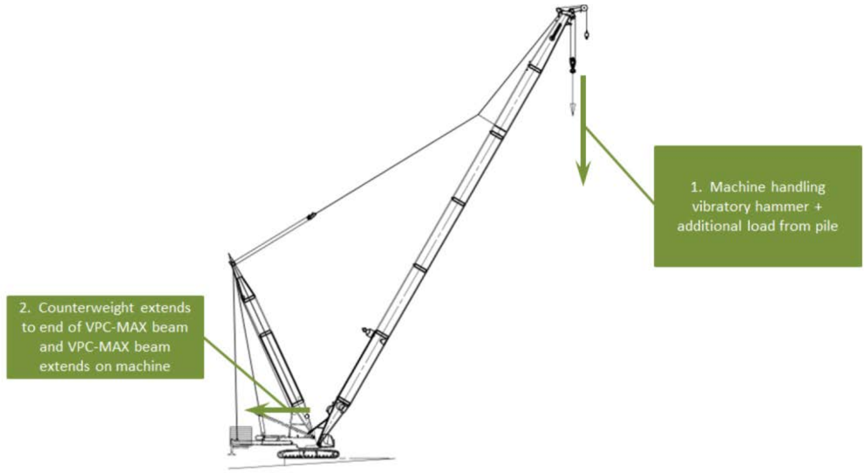



**Figure 4:** Lifted Load

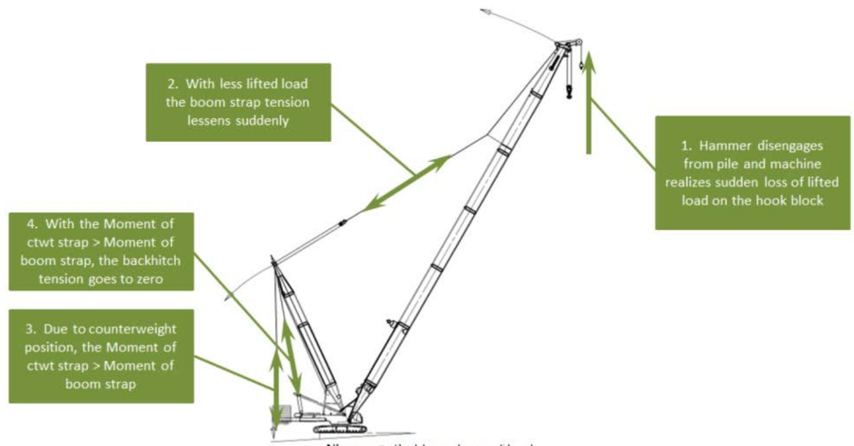



**Figure 5:** Sudden release of load

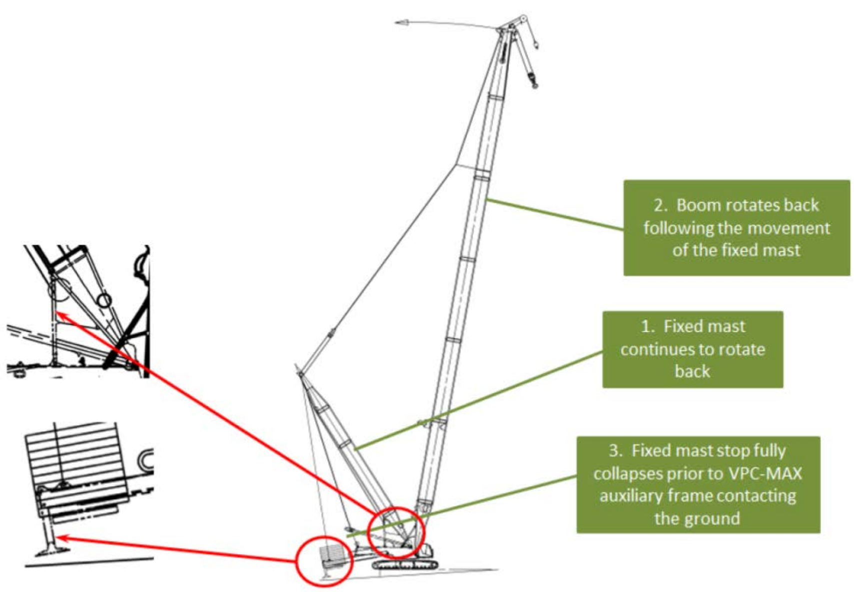



**Figure 6:** Backward motion of boom and lattice mast

**Sequence of failure of the crane, prepared by Manitowoc, the crane manufacturer**

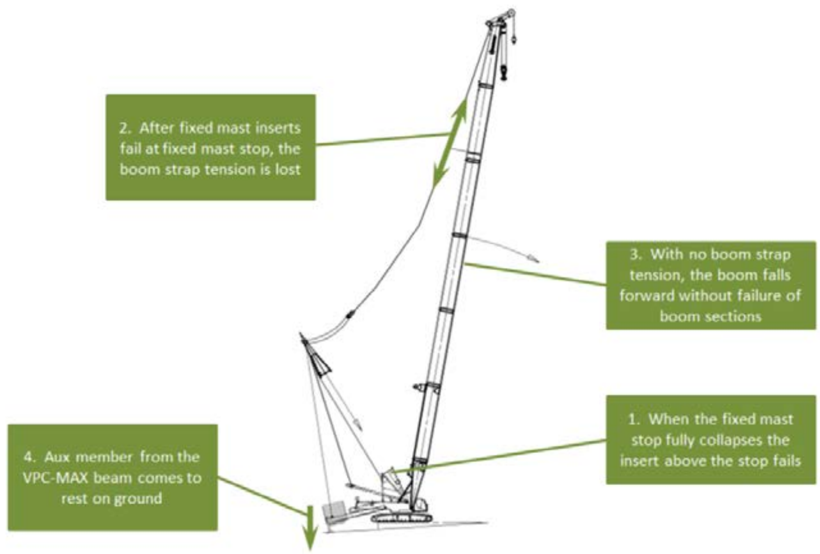



**Figure 7:** Mast failure

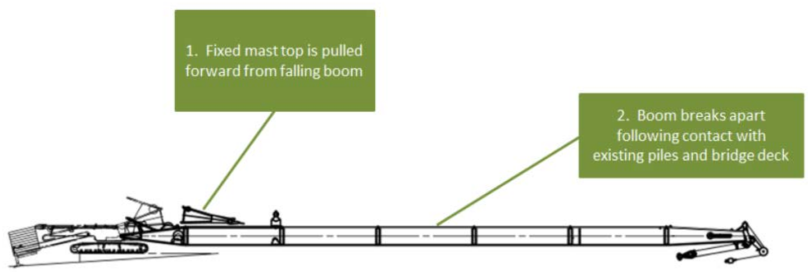



**Figure 8:** Final resting place

**Sequence of failure of the crane, prepared by Manitowoc, the crane manufacturer**

| Time | Boom Angle (°) | Hook Load Lower (lbs) | Hook Load Upper (lbs) | Capacity Lower (lbs) | Capacity Upper (lbs) | Radius Lower (ft) | Radius Upper (ft) | Tray Position (cm) | Beam Position (cm) | Mast Strap (mt) | Drum 1 | Drum 1 | Drum 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/02/2014 07:17:25 AM | 59.3 | 68900 | 2400 | 140462 | 30000 | 138.5 | 145.7 | 298 | 271 | 65.6 | | 0 | |
| 12/02/2014 07:17:51 AM | 58.8 | 109500 | 2400 | 137857 | 30000 | 139.8 | 146.7 | 432 | 271 | 86.8 | Hoist Up | 0 | |
| 12/02/2014 07:18:40 AM | 59.3 | 113600 | 2400 | 140462 | 30000 | 138.8 | 145.7 | 708 | 271 | 49.1 | | 0 | |
| 12/02/2014 07:18:40 AM | 59.3 | 114800 | 2400 | 140462 | 30000 | 138.8 | 145.7 | 708 | 271 | 49.1 | | 0 | |
| 12/02/2014 07:18:40 AM | 59.3 | 114800 | 2400 | 140462 | 30000 | 138.8 | 145.7 | 708 | 271 | 48.5 | Hoist Up | 0 | |
| 12/02/2014 07:18:40 AM | 59.3 | 114800 | 2400 | 140462 | 30000 | 138.8 | 145.7 | 713 | 271 | 48.5 | Hoist Up | 0 | |
| 12/02/2014 07:18:43 AM | 59.3 | 118700 | 2400 | 140462 | 30000 | 138.8 | 145.7 | 730 | 271 | 50.2 | Hoist Up | 0 | |
| 12/02/2014 07:18:46 AM | 59.3 | 115300 | 2400 | 140462 | 30000 | 138.8 | 145.7 | 751 | 271 | 43.1 | | 0 | |
| 12/02/2014 07:18:46 AM | 59.3 | 115300 | 2400 | 140462 | 30000 | 138.8 | 145.7 | 751 | 271 | 43.1 | | 0 | |
| 12/02/2014 07:18:47 AM | 59.3 | 115300 | 2400 | 140462 | 30000 | 138.8 | 145.7 | 751 | 271 | 43 | Hoist Up | 0 | |
| 12/02/2014 07:18:47 AM | 59.3 | 115300 | 2400 | 140462 | 30000 | 138.8 | 145.7 | 751 | 271 | 42.9 | Hoist Up | 0 | |
| 12/02/2014 07:18:51 AM | 59.3 | 118800 | 2400 | 141015 | 30000 | 137.5 | 144.4 | 776 | 271 | 44 | Hoist Up | 0 | |
| 12/02/2014 07:18:59 AM | 59.3 | 127400 | 2400 | 141569 | 30000 | 138.5 | 144.7 | 791 | 271 | 49.6 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:18:59 AM | 59.3 | 127400 | 2400 | 141569 | 30000 | 138.5 | 144.7 | 791 | 271 | 49.6 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:18:59 AM | 59.3 | 127400 | 2400 | 141569 | 30000 | 138.5 | 144.7 | 791 | 271 | 49.7 | | 1 | Boom Up |
| 12/02/2014 07:18:59 AM | 59.3 | 128600 | 2400 | 141569 | 30000 | 138.5 | 144.7 | 791 | 271 | 49.9 | | 0 | |
| 12/02/2014 07:19:06 AM | 59.8 | 115600 | 2400 | 143785 | 30000 | 137.1 | 143.7 | 791 | 271 | 36 | | 0 | |
| 12/02/2014 07:19:07 AM | 59.8 | 115600 | 2400 | 143785 | 30000 | 137.1 | 143.7 | 791 | 271 | 35.9 | | 0 | |
| 12/02/2014 07:19:07 AM | 59.8 | 115600 | 2400 | 143785 | 30000 | 137.1 | 143.7 | 791 | 271 | 35.9 | | 0 | |
| 12/02/2014 07:19:08 AM | 59.8 | 115600 | 2400 | 143785 | 30000 | 137.1 | 143.7 | 791 | 271 | 35.9 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:19:08 AM | 59.8 | 115600 | 2400 | 143785 | 30000 | 137.1 | 143.7 | 791 | 271 | 36 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:19:14 AM | 59.8 | 128100 | 2400 | 143231 | 30000 | 137.1 | 143.7 | 791 | 271 | 48.7 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:19:14 AM | 59.8 | 128100 | 2400 | 143231 | 30000 | 137.1 | 143.7 | 791 | 271 | 48.9 | | 1 | Boom Up |
| 12/02/2014 07:19:14 AM | 59.8 | 128100 | 2400 | 142677 | 30000 | 137.1 | 143.7 | 791 | 271 | 48.3 | | 1 | Boom Up |
| 12/02/2014 07:19:14 AM | 59.8 | 128100 | 2400 | 142677 | 30000 | 137.1 | 143.7 | 791 | 271 | 48.1 | | 1 | Boom Up |
| 12/02/2014 07:19:14 AM | 59.8 | 128100 | 2400 | 142677 | 30000 | 137.1 | 143.7 | 791 | 271 | 48 | | 1 | Boom Up |
| 12/02/2014 07:19:15 AM | 59.8 | 128100 | 2400 | 142677 | 30000 | 137.1 | 143.7 | 791 | 271 | 48 | | 0 | |
| 12/02/2014 07:19:17 AM | 59.8 | 121700 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 38.6 | | 0 | |
| 12/02/2014 07:19:17 AM | 59.8 | 121700 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 38.5 | Hoist Up | 0 | |
| 12/02/2014 07:19:17 AM | 59.8 | 121700 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 38.4 | Hoist Up | 0 | |
| 12/02/2014 07:19:42 AM | 59.8 | 121800 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 40.7 | Hoist Up | 0 | |
| 12/02/2014 07:19:42 AM | 59.8 | 121800 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 40.7 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:19:42 AM | 59.8 | 121800 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 40.7 | Hoist Up | 0 | |
| 12/02/2014 07:19:42 AM | 59.8 | 121800 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 40.6 | Hoist Up | 0 | |
| 12/02/2014 07:19:43 AM | 59.8 | 121800 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 40.6 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:19:49 AM | 59.8 | 124000 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 42.6 | Hoist Up | 1 | Boom Up |

**Data logger information**

| Time | Boom Angle (°) | Hook Load Lower (lbs) | Hook Load Upper (lbs) | Capacity Lower (lbs) | Capacity Upper (lbs) | Radius Lower (ft) | Radius Upper (ft) | Tray Position (cm) | Beam Position (cm) | Mast Strap (mt) | Drum 1 | Drum 1 | Drum 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/02/2014 07:19:49 AM | 59.8 | 124000 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 42.7 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:19:49 AM | 59.8 | 124000 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 42.7 | Hoist Up | 0 | |
| 12/02/2014 07:19:49 AM | 59.8 | 124000 | 2400 | 144338 | 30000 | 135.8 | 142.7 | 791 | 276 | 42.9 | Hoist Up | 0 | |
| 12/02/2014 07:19:57 AM | 59.8 | 122500 | 2400 | 145446 | 30000 | 135.8 | 142.7 | 791 | 291 | 39 | Hoist Up | 0 | |
| 12/02/2014 07:19:58 AM | 59.8 | 122500 | 2400 | 145446 | 30000 | 135.8 | 142.7 | 791 | 291 | 39 | Hoist Up | 0 | |
| 12/02/2014 07:19:58 AM | 59.8 | 122500 | 2400 | 145446 | 30000 | 135.8 | 142.7 | 791 | 291 | 38.9 | | 0 | |
| 12/02/2014 07:19:58 AM | 59.8 | 122500 | 2400 | 145446 | 30000 | 135.8 | 142.7 | 791 | 291 | 38.8 | | 0 | |
| 12/02/2014 07:21:18 AM | 60.3 | 118100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 291 | 35 | | 0 | |
| 12/02/2014 07:21:19 AM | 60.3 | 118100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 291 | 35 | | 0 | |
| 12/02/2014 07:21:19 AM | 60.3 | 118100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 291 | 35.1 | Hoist Down | 0 | |
| 12/02/2014 07:21:26 AM | 60.3 | 114600 | 2400 | 146592 | 30000 | 134.8 | 141.7 | 791 | 291 | 30.9 | Hoist Down | 0 | |
| 12/02/2014 07:21:26 AM | 60.3 | 114600 | 2400 | 146592 | 30000 | 134.8 | 141.7 | 791 | 291 | 30.9 | Hoist Down | 0 | |
| 12/02/2014 07:21:26 AM | 60.3 | 113300 | 2400 | 146592 | 30000 | 134.8 | 141.7 | 791 | 291 | 30.9 | | 0 | |
| 12/02/2014 07:21:27 AM | 60.3 | 115800 | 2400 | 147185 | 30000 | 134.8 | 140.7 | 791 | 291 | 32.6 | | 0 | |
| 12/02/2014 07:21:27 AM | 60.3 | 115800 | 2400 | 147185 | 30000 | 134.8 | 140.7 | 791 | 291 | 32.6 | | 0 | |
| 12/02/2014 07:21:27 AM | 60.3 | 115800 | 2400 | 147185 | 30000 | 134.8 | 140.7 | 791 | 291 | 32.7 | Hoist Down | 0 | |
| 12/02/2014 07:21:46 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.6 | Hoist Down | 0 | |
| 12/02/2014 07:21:47 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.6 | Hoist Down | 0 | |
| 12/02/2014 07:21:47 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.5 | | 0 | |
| 12/02/2014 07:21:47 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.6 | | 0 | |
| 12/02/2014 07:21:47 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.5 | | 0 | |
| 12/02/2014 07:21:47 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.6 | | 0 | |
| 12/02/2014 07:21:47 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.5 | | 0 | |
| 12/02/2014 07:21:47 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.5 | | 2 | Boom Down |
| 12/02/2014 07:21:47 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.5 | | 2 | Boom Down |
| 12/02/2014 07:21:47 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.5 | | 0 | |
| 12/02/2014 07:21:47 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.5 | | 0 | |
| 12/02/2014 07:21:47 AM | 60.3 | 68100 | 2400 | 145446 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.5 | | 1 | Boom Up |
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 134.8 | 141.7 | 791 | 271 | 2.1 | | 1 | Boom Up |
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 140.4 | 141.7 | 791 | 271 | 2.1 | | 1 | Boom Up |
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 140.4 | 147.6 | 791 | 271 | 2.1 | | 1 | Boom Up |
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 140.4 | 147.6 | 791 | 271 | 2.1 | | 2 | Boom Down |
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 140.4 | 147.6 | 791 | 271 | 2.1 | | 1 | Boom Up |
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 140.4 | 147.6 | 791 | 271 | 2.1 | | 0 | |
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 140.4 | 147.6 | 791 | 271 | 2 | | 0 | |
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 140.4 | 147.6 | 791 | 271 | 1.9 | | 0 | |

**Data logger information**

| Time | Boom Angle (°) | Hook Load Lower (lbs) | Hook Load Upper (lbs) | Capacity Lower (lbs) | Capacity Upper (lbs) | Radius Lower (ft) | Radius Upper (ft) | Tray Position (cm) | Beam Position (cm) | Mast Strap (mt) | Drum 1 | Drum 1 | Drum 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 140.4 | 147.6 | 791 | 271 | 1.9 | | 2 | Boom Down |
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 140.4 | 147.6 | 791 | 271 | 1.8 | | 2 | Boom Down |
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 140.4 | 147.6 | 791 | 271 | 1.9 | | 2 | Boom Down |
| 12/02/2014 07:21:48 AM | 58.8 | 69600 | 2400 | 137857 | 30000 | 140.4 | 147.6 | 791 | 271 | 1.9 | | 2 | Boom Down |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.3 | | 0 | |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.4 | | 0 | |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.4 | | 0 | |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.4 | | 1 | Boom Up |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.4 | | 1 | Boom Up |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.4 | | 1 | Boom Up |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.4 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.4 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.4 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.4 | Hoist Up | 1 | Boom Up |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.4 | | 1 | Boom Up |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.4 | Hoist Down | 0 | |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.5 | Hoist Down | 0 | |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.6 | Hoist Down | 0 | |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.6 | Hoist Down | 0 | |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.6 | | 0 | |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.6 | Hoist Up | 0 | |
| 12/02/2014 07:21:49 AM | 58.1 | 39700 | 2400 | 134557 | 30000 | 143 | 150.3 | 791 | 271 | 1.6 | | 0 | |
| 12/02/2014 07:21:49 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.6 | Hoist Down | 0 | |
| 12/02/2014 07:21:49 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.6 | | 1 | Boom Up |
| 12/02/2014 07:21:49 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.6 | | 1 | Boom Up |
| 12/02/2014 07:21:49 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.5 | | 1 | Boom Up |
| 12/02/2014 07:21:50 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.5 | | 1 | Boom Up |
| 12/02/2014 07:21:50 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.5 | Hoist Down | 1 | Boom Up |
| 12/02/2014 07:21:50 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.5 | Hoist Down | 1 | Boom Up |
| 12/02/2014 07:21:50 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.5 | | 0 | |
| 12/02/2014 07:21:50 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.5 | | 0 | |
| 12/02/2014 07:21:50 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.4 | Hoist Down | 0 | |
| 12/02/2014 07:21:50 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.3 | Hoist Down | 0 | |
| 12/02/2014 07:21:50 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.3 | Hoist Down | 0 | |
| 12/02/2014 07:21:50 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.3 | | 1 | Boom Up |
| 12/02/2014 07:21:50 AM | 60.5 | 0 | 2400 | 147185 | 30000 | 133.9 | 140.7 | 791 | 271 | 1.2 | | 1 | Boom Up |

**Data logger information**


**Surveillance Camera video frames extracted** (shows day of the incident with time)


**Surveillance Camera video frames extracted** (shows day of the incident with time)