Crane Accidents:
A Study of Causes and Trends to Create a Safer Work Environment
1983-2013

Jim D. Wiethorn, P.E.
Principal/Chairman
Dallas, Texas
Miller Park
Milwaukee, Wisconsin
Hoover Dam ByPass

Cableway System
Hoover Dam ByPass

Nevada
Study Development

• Develop a Known Basic Parameter
  • Duties & Responsibilities of Crane Lifts
  • Apply current standards over the entire study
    • Track Changes/Improvements/Problematic Areas
• Develop Study Issues-Subject Matter Experts
• Develop Peer Reviewed Process-Authentication
• Have an Adequate Size Data Bank
Duties & Responsibilities

- Where It Began-

- Iron Workers - 1960's
  - International Association of Bridge, Structural and Ornamental Iron Workers
Publications by Don Dickie

• Don Dickie - 1970 - 1998
Mobile Crane Accidents

September 1986

Mobile Crane Operations
Who is Responsible
Crane Safety on Construction Sites

ASCE Manuals and Reports on Engineering Practice No. 93

First Publication in the United States Specifically Dealing with Duties & Responsibilities

ASCE Manuals and Reports on Engineering Practice No. 93
Published: 1998

1998 - 2007
Primary Parties

ASCE 93 Zones Of Responsibilities
Duties & Responsibilities

2007 - Present

Current National Consensus Standard
Responsibility Flow Chart

- Site Supervisor
- Lift Director
- Crane Owner/User/Service Provider
- Signalperson
- Crane Operator
- Riggers
Study Development Sources

• Haag Engineering - Crane Accidents
  • Through December 2013 - 716 Assignments
  • Currently through February 201 - 904 Assignments

• Subject Matter Experts
  • Industry Consultants
  • ASME B30 Committee/Sub-Committee Members
  • NCCCO Committee Members
  • SC&RA Members
10 - Crane Study Categories

• Commercial Construction
  • Work with multiple users on a site
  • Almost Exclusive use of tower cranes
  • Consistent lifting but with different loads/radii
  • Lifts are often made in tight quarters-multiple workers
  • Multiple ranges of lifts: General, Production & Critical

• Highway/Road & Bridge Construction
  • Often lifts have to be done at night
  • More critical lifts-dual crane picks
  • Unprepared crane ways-continuous crane movement-native soil
  • Tight fits-complicated
  • Multiple Random Power Lines Over Roads
Crane Study Categories

• **Industrial/Manufacturing**
  - Greatest number of “certified” operators
    - First to controls gets to operate the crane
  - Continuous use 24/7 - maintenance is problematic
  - Usually consistent or identical lifts
    - Moving product from one point to another
  - Irregular or complicated center-of-gravity calculations/lifting-piping

• **Residential Construction**
  - No qualified riggers - lack of rigging/lifting experience
  - Operator is often brought into the lift-held to a higher standard
  - Workers Do Not Understand Load Drift
  - Lack of Tag Lines
Crane Study Categories

• **Marine Industry**
  • 24-Hour operations
  • Multiple blind lifts during operations
  • General idea of weights but not known until lifted
  • Lifting off barges and ships

• **Mining Industry**
  • Maintenance-Potential chemical exposure
  • Unknown ability of riggers
  • Equipment can remain idle for a long period of time between uses
  • Multiple Shifts/Operators of a Single Unit
Crane Study Categories

• Arborists/Logging Industry
  • Follows different standard-ANSI Z133
  • Unknown weights and control of load
  • Unknown rigging ability of climber who is also the Lift Director
  • Logging-24/7 repetitive operations

• Agriculture Industry
  • No qualified riggers - lack of rigging/lifting experience
  • Weight of load seldom known
  • Site obstructions-power lines
  • Creative uses of rigging
Oilfield-Land Base Industry
- Maintenance Issues - Remote areas
- Availability of qualified operators
- Multiple types of lifts with multiple companies
- 24-Hour operations

Oilfield-Offshore Industry
- Maintenance/Exposure Issues
- Equipment idle for long periods of time
- Sufficiently trained riggers
- Dynamic loading and offloading boats
- 24-Hour operations
Study Breakdown by Section

• Statistical Data
  • Background/Crane Use

• Collateral Data
  • Damage Costs and Injuries/Deaths

• Responsibilities of Parties
  • Current B30.5 Guidelines

• Causes of Accidents
  • 14 Distinct Types of Accidents & Their Causes
Statistical Data
Data Bank

• 1983-2015: 716 (904) crane accidents-507 (600) Categorized

• Crane accidents in 49 of 50 States and Internationally-South Africa-Brazil-Canada-Puerto Rico-Turks & Caicos-Virgin Islands, Grand Bahama Island

• Crane Types
  • Tower
  • Mobile
  • Bridge
  • Hydraulic
  • Cableway
  • Derrick
  • Pedestal
  • Gantry
  • MEGA
  • Launching Girders
  • Other
Jobs Received vs. Jobs Completed

- Sum of #Jobs Cat
- Sum of #Jobs RCVD

Data points from 1985 to 2013 showing trends in jobs received and completed.
Crane Study Basis-Cases/Category

• 1983 - 2013
• 716 Crane Accidents

• 507 Accidents Categorized
  • Commercial Construction - 192 37.9
  • Industrial/Manufacturing - 141 27.8
  • Highway Construction - 57 11.2
  • Residential Construction - 19 3.7
  • Marine Industry - 33 6.5
  • Mining Industry - 9 1.8
  • Arborist/Logging - 7 1.4
  • Oilfield-Land Base Industry - 31 6.1
  • Oilfield-Offshore Industry - 17 3.4
  • Agriculture Industry - 1 0.2
  TOTAL 507
## Breakdown by Crane Types

<table>
<thead>
<tr>
<th>Crane Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile-Hydraulic</td>
<td>32.1 %</td>
</tr>
<tr>
<td>Track Lattice</td>
<td>20.1 %</td>
</tr>
<tr>
<td>Tower Crane</td>
<td>11.4 %</td>
</tr>
<tr>
<td>Mobile-Lattice</td>
<td>10.8 %</td>
</tr>
<tr>
<td>Mobile RT</td>
<td>8.3 %</td>
</tr>
<tr>
<td>Overhead</td>
<td>4.7 %</td>
</tr>
<tr>
<td>Special Crane</td>
<td>3.6 %</td>
</tr>
<tr>
<td>Gantry</td>
<td>1.0 %</td>
</tr>
<tr>
<td>MEGA</td>
<td>1.0 %</td>
</tr>
<tr>
<td>Derrick</td>
<td>0.2 %</td>
</tr>
<tr>
<td>Other</td>
<td>0.4 %</td>
</tr>
</tbody>
</table>
Total Number of Accidents By Month
Collateral Data
## Crane Study Basis-Deaths/Category

<table>
<thead>
<tr>
<th>Category</th>
<th># Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Construction</td>
<td>55</td>
</tr>
<tr>
<td>Highway Construction</td>
<td>32</td>
</tr>
<tr>
<td>Industrial/Manufacturing</td>
<td>29</td>
</tr>
<tr>
<td>Oilfield-Land Base Industry</td>
<td>11</td>
</tr>
<tr>
<td>Marine Industry</td>
<td>10</td>
</tr>
<tr>
<td>Residential Construction</td>
<td>3</td>
</tr>
<tr>
<td>Mining Industry</td>
<td>3</td>
</tr>
<tr>
<td>Arborist/Logging</td>
<td>2</td>
</tr>
<tr>
<td>Oilfield-Offshore Industry</td>
<td>2</td>
</tr>
<tr>
<td>Agriculture Industry</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>147</strong></td>
</tr>
</tbody>
</table>
Crane Study Basis-Deaths/Trade

- 507 Accidents Categorized
  - Other Field Personnel - 51
  - Operator - 38
  - Ironworker - 24
  - Rigger - 20
  - Management - 10
  - Pedestrian/Bystander - 3
  - Oiler - 1
  - Signal Person - 0

  TOTAL 147
<table>
<thead>
<tr>
<th>Industry Type</th>
<th># Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Construction</td>
<td>118</td>
</tr>
<tr>
<td>Industrial/Manufacturing</td>
<td>80</td>
</tr>
<tr>
<td>Highway Construction</td>
<td>29</td>
</tr>
<tr>
<td>Oilfield-Land Base Industry</td>
<td>13</td>
</tr>
<tr>
<td>Oilfield-Offshore Industry</td>
<td>13</td>
</tr>
<tr>
<td>Residential Construction</td>
<td>10</td>
</tr>
<tr>
<td>Marine Industry</td>
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</tr>
<tr>
<td>Mining Industry</td>
<td>3</td>
</tr>
<tr>
<td>Arborist/Logging</td>
<td>3</td>
</tr>
<tr>
<td>Agriculture Industry</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>281</strong></td>
</tr>
</tbody>
</table>
Crane Study Basis-Injuries/Trade

- 507 Accidents Categorized

<table>
<thead>
<tr>
<th>Role</th>
<th># Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigger</td>
<td>91</td>
</tr>
<tr>
<td>Other Field Personnel</td>
<td>82</td>
</tr>
<tr>
<td>Ironworker</td>
<td>50</td>
</tr>
<tr>
<td>Operator</td>
<td>29</td>
</tr>
<tr>
<td>Pedestrian/Bystander</td>
<td>14</td>
</tr>
<tr>
<td>Signal Person</td>
<td>9</td>
</tr>
<tr>
<td>Management</td>
<td>5</td>
</tr>
<tr>
<td>Oiler</td>
<td>1</td>
</tr>
</tbody>
</table>

**TOTAL** 281
Load vs No Load On-The-Hook

- **Load On-The-Hook**
  - 356 Incidents  70.2%

- **No Load On-The-Hook**
  - 151 Incidents  29.8%
Total Deaths/Injuries By Industry
Total Deaths/Injuries By Trade

<table>
<thead>
<tr>
<th>Trade</th>
<th>Deaths</th>
<th>Inj</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIG</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>OFP</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>IW</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>OFER</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>PED/BY</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>SIG</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>MANG</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>OIL</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

Red: Deaths  
Blue: Inj
Estimated Property / Equipment Damage By Crane Size

- $50,000,000.00
- $100,000,000.00
- $150,000,000.00
- $200,000,000.00
- $250,000,000.00
- $300,000,000.00
- $350,000,000.00
- $400,000,000.00
- $450,000,000.00
- $500,000,000.00

Crane Size: Less Than 2 Tons, 2-14 Tons, 15-99 Tons, 100-199 Tons, 200-299 Tons, 300-599 Tons, Greater Than 600 Tons

Graph showing estimated property and equipment damage by crane size.
Responsibilities of Parties
Parties Involved With Lifts

- Site Supervisor
- Lift Director
- Rigger
- Operator
- Service Provider
- Owner/User
- Signal Person
- Other
- Crane Manufacturer
- Manufacturer of Load
- Maintenance/Inspection Personnel
Quantifying Contribution to Incident

- The responsible parties were categorized as either “primary” or “secondary”.

- A PRIMARY responsible party has been defined as a party who failed in their responsibility in such a way that, without their breach of responsibility, the accident would not have occurred.

- A SECONDARY responsible party has been defined as a party whose breach of responsibility exacerbated the accident, but it would have occurred regardless due to other factors.
Typical Responsibility Assessment
Jack Breslin Center
Michigan State University
**Breslin Area**

- Dual pick and carry with a load using 2-4100’s
- Operators would pick up the long span truss and travel to its designated location for placement.
- Hand signals were used rather than radios. One person gave the signal to the operator and the spotter on the roof; who in turn transfer the signal to the opposite side of the stadium to the other spotter; who then signaled the crane operator on the other side of the stadium
- There was no directional guidance or speed control for the operators to follow
Crane A travels faster than Crane B and does not travel parallel; but rather gets further away.
Operator drops load as he begins to tip
Load strikes seating; Crane A boom rebounds
As load falls, it pulls Crane B into ring the beam.
Boom impacts ring beam and buckles
First boom rebounds and shears chords.
Breslin Center - Dual Pick

Type of Lift/Operation: Critical

Noted Deficiencies:
- Lack of control line for parallel dual crane travel.
- Lack of station markers for uniform travel control.
- Lack of hardwired communication between operators.
- Lack of compacted crane-way for level travel.

Responsibilities:
- Primary: Lift Director
- Secondary: Operator
<table>
<thead>
<tr>
<th>Role</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator</td>
<td>27.4 %</td>
</tr>
<tr>
<td>Lift Director</td>
<td>24.9 %</td>
</tr>
<tr>
<td>Rigger</td>
<td>21.3 %</td>
</tr>
<tr>
<td>Site Supervisor</td>
<td>16.8 %</td>
</tr>
<tr>
<td>Mechanical/Maintenance</td>
<td>6.1 %</td>
</tr>
<tr>
<td>Crane Manufacturer</td>
<td>5.7 %</td>
</tr>
<tr>
<td>Owner/User</td>
<td>4.1 %</td>
</tr>
<tr>
<td>Other</td>
<td>4.1 %</td>
</tr>
<tr>
<td>Manufacturer of Load</td>
<td>2.2 %</td>
</tr>
<tr>
<td>Signal Person</td>
<td>1.9 %</td>
</tr>
<tr>
<td>Service Provider</td>
<td>1.6 %</td>
</tr>
</tbody>
</table>
OPERATOR RESPONSIBILITY TREND-1987-2013

TREND LINE
Secondary Responsible (All Incidents)

- Operator 3.9 %
- Lift Director 3.6 %
- Rigger 3.4 %
- Site Supervisor 1.6 %
- Service Provider 1.6 %
- Signal Person 0.8 %
- Mechanical/Maintenance 0.4 %
- Owner/User 0.4 %
- Other 0.2 %
- Crane Manufacturer 0.0 %
- Manufacturer of Load 0.0 %
Responsible Parties (All Incidents)
Mobile Hydraulic Crane Incidents

Responsible Parties (Mobile Hydraulic Crane Incidents)

- Primarily Responsible Party (% of Mobile Hydraulic Crane Incidents)
- Secondarily Responsible Party (% of Mobile Hydraulic Crane Incidents)
Tower Crane Incidents

Responsible Parties (Tower Crane Incidents)

- Crane Manufacturer
- Crane Operator
- Lift Director
- Manufacturer of Load/Lifting...
- Mechanical/Maintenance Issue
- Other
- Owner/User
- Rigger
- Service Provider
- Signal Person
- Site Supervisor

- Primarily Responsible Party (% of Tower Crane Incidents)
- Secondarily Responsible Party (% of Tower Crane Incidents)
Causes of Accidents
Accident Types

- Crane Overturn 18.5%
- Boom Collapse 18.5%
- Crane Travel/De-Railed 15.8%
- Unstable/Dropped/Lost Load 10.1%
- Rigging Failure 5.9%
- Power Line Contact 4.1%
- Boom/Jib Dropped 3.9%
- Assembly/Disassembly 3.4%
- Landed Load Stability 2.4%
- Two Block 1.8%
- Trip/Slip/Fall/Jump From Crane 1.6%
- Signaling 1.4%
- Personnel Basket Failure 0.8%
- Slewing Assembly Failure 0.6%
- ***Worker Contact 33.9%
<table>
<thead>
<tr>
<th>Cause</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional Load Suddenly Applied</td>
<td>4%</td>
</tr>
<tr>
<td>Crane Out Of Level</td>
<td>4%</td>
</tr>
<tr>
<td>Wrong Weight-Operator</td>
<td>8%</td>
</tr>
<tr>
<td>Crane Struck By Other Equipment</td>
<td>1%</td>
</tr>
<tr>
<td>Foundation Failure</td>
<td>3%</td>
</tr>
<tr>
<td>Improper A/D Procedures</td>
<td>6%</td>
</tr>
<tr>
<td>Insufficient-Removed CW</td>
<td>4%</td>
</tr>
<tr>
<td>Lifting Device Failed</td>
<td>1%</td>
</tr>
<tr>
<td>Lost Load-Stability</td>
<td>3%</td>
</tr>
<tr>
<td>Maintenance Issue</td>
<td>1%</td>
</tr>
<tr>
<td>Manufacturing Defect</td>
<td>3%</td>
</tr>
<tr>
<td>No Out-Boom Extended-No Load</td>
<td>2%</td>
</tr>
<tr>
<td>Op/Aid Turned Off/Disconnected</td>
<td>3%</td>
</tr>
<tr>
<td>Outrigger Failure-Soil</td>
<td>1%</td>
</tr>
<tr>
<td>Outrigger Failure-Structural</td>
<td>4%</td>
</tr>
<tr>
<td>Outriggers Not Extended</td>
<td>10%</td>
</tr>
<tr>
<td>Overload</td>
<td>49%</td>
</tr>
<tr>
<td>Pulling A Load-Lateral Load At Tip</td>
<td>2%</td>
</tr>
<tr>
<td>Soil Failure/Trench/Slope</td>
<td>7%</td>
</tr>
<tr>
<td>Signals</td>
<td>3%</td>
</tr>
<tr>
<td>Swing-Dynamic Loading</td>
<td>4%</td>
</tr>
<tr>
<td>Traveling The Crane-Drive/Rail</td>
<td>6%</td>
</tr>
<tr>
<td>Traveling w/Suspended Load</td>
<td>2%</td>
</tr>
<tr>
<td>Wind</td>
<td>6%</td>
</tr>
<tr>
<td>Wrong Set-Up-Mode-A2B</td>
<td>4%</td>
</tr>
<tr>
<td>Wrong Weight-By Others</td>
<td>9%</td>
</tr>
<tr>
<td>Wrong Weight-Not Known</td>
<td>6%</td>
</tr>
<tr>
<td>Mat Displacement</td>
<td>2%</td>
</tr>
<tr>
<td>Overridden-A2B</td>
<td>7%</td>
</tr>
<tr>
<td>Structural Failure</td>
<td>2%</td>
</tr>
<tr>
<td>Upper Not Locked-Rotates</td>
<td>3%</td>
</tr>
<tr>
<td>Use By An Unauthorized Person</td>
<td>1%</td>
</tr>
<tr>
<td>Wrong Weight-Demolition</td>
<td>4%</td>
</tr>
<tr>
<td>Wrong Wt-Fluids/Matls in Load</td>
<td>3%</td>
</tr>
<tr>
<td>Altered Or Damaged A2B</td>
<td>1%</td>
</tr>
<tr>
<td>Stuck Load</td>
<td>1%</td>
</tr>
</tbody>
</table>
Boom Collapse Causes

- Boom Impact: 9.3%
- Dynamic Loading: 7.0%
- Foundation Design: 1.2%
- High Boom-Into Backstops: 9.3%
- Maintenance Issue: 7.0%
- Manufacturing Defect: 9.3%
- Operational Aid Turned Off/Disc: 17.4%
  - Overload: 29.1%
- Overridden LMI or A2B: 7.0%
- Prior Damage/Repair To Boom/Jib: 10.5%
- Side Loaded: 18.6%
- Structural Failure: 11.6%
- Stuck Load: 5.8%
- Wind Loading-Boom/Tower: 14.0%
- Wrong Weight - Demolition: 4.7%
- Abuse-Lack of Maint.: 3.5%
- Additional Load is Suddenly Applied: 1.2%
- Altered Or Damaged A2B: 1.2%
- Crane Was Rigged Improperly: 1.2%
- Dynamic Loading: 7.0%
- Failure at Landed Load: 1.2%
- Tie-In Design: 2.3%
- Wrong Setup-Mode - LMI: 2.3%
- Wrong Weight - By Others: 4.7%
- Wrong Weight - Not Known: 2.3%
- Wrong Weight - Operator: 2.3%
- Wrong Weight - Fluids/Mats In Load: 1.2%
- Wind Loading-Load: 1.2%
Use of Study to Improve Safety

- Identify those accident topics in each industry which are most problematic
- Implement internal lift planning and/or operational procedures
- Identify corresponding areas of certification or training trends
94% of all Crane Accidents Had Some Type of Human Intervention.

Therefore, training and educating personnel involved in lifts of their responsibilities is paramount.
Findings: Commercial

- The highest occurrence of accidents were associated with:
  - Unknown or wrong weight
  - Overriding or turning off the LMI
  - Rigging
  - External engineering design
  - Improper signals-Tower crane incidences
Engineering Issues

• Weight/Stability Calculations-Demolition
• Special Application-Field Changes-Speed
• Design Change/Refurbish-Other than OEM
• Tower Crane Base Design
• Tower Crane Floor Tie-In
• Shop-Built Crane
Findings: Industrial/Manufacturing

• Elevated number of accidents associated with operator errors in manufacturing
  • Reduce number of operators permitted to operate the crane
  • Operator Training in accordance with ASME & OSHA requirements-National Certification Program
• Complex shapes with unknown center-of-gravities in Industrial lifts
Findings: Highway/Road & Bridge

• Almost 50% of the accidents occurred with no load on the hook
  • The majority of the “no-load” accidents were associated with crane movement with poor or substandard preparation
  • Largest number of critical lift accidents
  • Secondary issues were crane movement on the site associated with power line contact
  • Third factor was A/D
Findings: Highway/Road & Bridge

- Significant number of complex and critical lifts corresponded to the highest percentage of Site Supervisor responsibilities.
- Highest number of accidents with the boom striking stationary objects and collapsing.
- Greater number of deaths than injuries per incident.
- Demolition and erection of long span girders - Lateral Torsional Buckling.
  - >140 feet - PLAN YOUR PICK POINTS
Findings: Residential

• Lack of lift planning experience resulted in elevated accidents associated with the Lift Director and Rigging
• Workers lack of understanding of load drift-use of tag lines
• Instability of the load after being lifted confirmed problematic issues with rigging
• Lack of experience field personnel often required the operator to rig and direct the lift
Findings: Marine

• Boom close proximity to side of the ship resulted in multiple buckled booms
• Multiple objects are rigged for each lift-dislodged/falling portions of the load
• Most lifts are in the blind-multiple workers trying to control/place/pick load
• Workers touching or close proximity to load
Findings: Logging/Arborist

• Unknown weights—all estimates or best guess resulting in overturn

• Climber controls the operation (Lift Director)
  • Rigs the load that has unknown c.g.
  • Location of the cut determines the weight of the load
  • Once the tree is cut, the crane cannot release the load

• Lifting workers with the crane
Tip of the Iceberg

- Database provides nearly endless combinations of information
- Tailored charts can be produced to specific to Industries, Crane Types, Crane Sizes, Lift Types, Accident Types, Type of Collateral Issues, and many more
- Retrieve information about specific planned lifts to better understand potential issues and prepare better safety plans and lift plans
- Production of White Papers, Trends and Articles resulting from study data
Tower Crane Life Expectancy

An Examination of Recent Trends to Establish Age Limits - January 2015
Age of Cranes at Time of Incidents

- Range from 0 to 92 years old
- Average age is 16.9 years
- Median age is 14 years
- Data confirmed there is no correlation between crane age and accidents
Wind vs Tower Cranes

What Really Happens?

Tower cranes can lift loads to heights that conventional cranes cannot approach. Their lack of visual support (foundations) is outweighed by their ability to reach long distances at great heights. Since they are best suited for operating at great heights, concerns about high winds, particularly since lowering them to lower elevations cannot be done easily. To overcome this perceived disadvantage, tower cranes are designed to swing (weatherwise) with the wind, thereby minimizing the profiles exposed to the wind pressure. However, unlike conventional single vertical towers, tower cranes have additional built-in characteristics which provide additional resilience to wind effects.

In out-of-service configuration, the tower leans slightly toward the counterweight side of the tower. When a tower crane is in service, the rope relays and align with the path of the wind. Wind forces must be quite strong to overcome this initial lean, and push the tower back to vertical. With increasing wind pressure, the tower will ultimately lean opposite the counterweights, and with greater wind forces component members can experience loads exceeding their ultimate strengths.

This unique wind resistant design feature can be reduced or even eliminated by erroneous human interventions. During our years of examining tower crane failures, too often we have determined that operators, owners, and even management personnel have intervened in ways which lead to the ultimate demise of tower cranes. Their well-intentioned actions led directly to zone failure. One repeated mistake derives from the myth that high winds will cause the tower crane to spin velocity and cause failure of the crane. Delivering this myth, operators apply one brake to slow the rotation during high wind events. One operator interviewed explained that he was taught to apply a single brake prior to the tower crane in anticipation of high winds for this very purpose. Similarly, inadvertent applications of the brake prior to high winds have occurred.

In 2003 during construction of FedEx Forum in Memphis, Tennessee, a severe thunderstorm was approaching the city and emergency procedures included disconnecting the three tower crane operators to take their cranes out of service and lock them. One of the operators left the cab and began execution without manually disengaging the elevating brake. When he reached the base of the tower and retracted the power, the spring loaded brakes un lethally set. Reported wind speeds were on the order of 100 mph, and the tower crane that was restrained could not weatherize. The involved tower crane base experienced distortion, but did not fail. Additionally, the tower was leaning about 40 feet. After the event, we found that the two properly prepared tower cranes had weatherized and the damaged unit had not.

In 2012 as Hurricane Sandy approached New York City, workers prepared a lifting tower crane near the top of a 10-story building. Examination revealed four safety anchoring lines which someone had used to tie-off while inverting lower section to raise the crane height. The four lines were secured on two scaffold beams, and the crane remained secure to the outrigger beam. Two of the lines were wrapped around the outrigger beam, and one was cut and pulled from the crane. The crane’s weight had caused the lines to stretch and pull, effectively weakening the upper from rotating. During high winds, the tower could not weatherize because the lines restrained rotation. As wind speeds increased, frontal winds blew against the lifting boom and ultimately pushed it over the rear of the upper.

Perhaps the primary issue with companies’ leaking tower cranes is the owner’s desire to have the crane company prominently displayed at the source job of the tower crane. Tower cranes, often being the tallest structure on a construction project, are the preferred choice for advertising the project, developer or construction company. They become billboards in the sky. Around almost any site, there will be signs naming the general contractor in addition to the manufacturer. If a crane fails, the wind effects on tower cranes are reduced drastically when users simply follow the manufacturer’s recommendations and instructions when it comes to installing signs.

In most cases, the manufacturer calls for signs to be limited to 32 sq. ft. and to be placed in only specific locations. Incorrectly placed signs, and signs larger than the manufacturer recommends, increase the wind impact area and can have dire consequences. Operation of the crane can be affected, and crane control is difficult in low wind conditions. In extreme cases, the crane will not weatherize due to the wind area.
Thank you!

jwiethorn@haaggglobal.com