How Studies of Crane Accidents and Trends Lead to A Safer Work Environment

Jim D. Wiethorn, P.E.
Principal/Chairman

Engineering
Study Development

• A Topic of Great Interest
  • Always intrigued by cranes
  • Grew up in the construction industry
  • Search for guidelines (instructions) on crane lifts

• 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

Mobile Crane Operations

Who is Responsible

1970 - 1998

By:
Assistant General Manager
Construction Safety Association of Ontario
74 Victoria Street
Toronto, Ontario M5C 2A5
Telephone: (416) 566-1501

Revised: September 1986

Construction Safety Association of Ontario
Crane Safety on Construction Sites

ASCE Manuals and Reports on Engineering Practice No. 93

First Publication in the United States
Dealing with Duties & Responsibilities

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

1998 - 2007
Mobile and Locomotive Cranes

Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

ASME B30.5-2007
(Revision of ASME B30.5-2004)

Duties & Responsibilities

2007 - Present

Current National Consensus Standard

www.conexpoconagg.com
Primary Parties

Zones Of Responsibilities

Rigging Function
Operator
Management/Lift Director
Responsibility Flow Chart

Site Supervisor -> Lift Director

Crane Owner/User/Service Provider

- Crane Operator
- Riggers

Signalperson
Develop Study Issues

- Haag Engineering – Crane Accidents
- Subject Matter Experts
  - Industry Consultants
  - ASME B30 Committee Members
  - NCCCO Committee Members
  - SC&RA Members
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

- **Highway/Road & Bridge Construction**
  - Often lifts have to be done at night
  - More critical lifts-dual crane picks
  - Unprepared crane ways-continuous movement native soil
  - Tight fits-complicated
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
  - Numerous adjustments are made that are industry specific

• **Residential Construction**
  - No qualified riggers – lack of rigging/lifting experience
  - Operator is often brought into the lift-held to a higher standard
Crane Study Categories

• Marine Industry
  – 24-Hour operations
  – Multiple blind lifts during operations
  – General idea of weights but not known until lifted
  – Often lifting off barges

• Mining Industry
  – Maintenance-Potential chemical exposure
  – Unknown ability of riggers
  – Equipment can remain idle for a long period of time
Crane Study Categories

- **Arborists/Logging Industry**
  - Follows different standard-ANSI Z133
  - Unknown weights and control of load
  - Unknown rigging ability of climber
  - Access to the load

- **Agriculture Industry**
  - No qualified riggers – lack of rigging/lifting experience
  - Weight of load seldom known
  - Site obstructions-power lines
Crane Study Categories

• **Oilfield-Land Base Industry**
  – Maintenance Issues
  – Availability of qualified operators
  – Multiple types of lifts-equipment
  – 24-Hour operations

• **Oilfield-Offshore Industry**
  – Maintenance/Exposure Issues
  – Sufficiently trained riggers
  – Dynamic loading and offloading boats
  – 24-Hour operations
Peer Review Process

• Establish working relationship with recognized university/organization

• MIT/Haag Development
  – Core case style and procedures
  – Guidelines for acceptable level of data input
  – Initiate study
  – Added Marine as a four category
• 1987-2011: Nearing 700 crane accidents
• Crane accidents in 49 of 50 States and Internationally-
  Africa-Brazil-Canada-Puerto Rico-Turks & Caicos-Virgin
  Islands
• Crane Types
  – Tower
  – Mobile
  – Bridge
  – Hydraulic
  – Cableway
  – Derrick
  – Pedestal
  – Gantry
  – MEGA
  – Launching Girders
  – Other
Analysis of Crane and Lifting Accidents in North America from 2004 to 2010

by

Ray Addison King

B.S. Architectural Engineering
The University of Texas at Austin, 2011

SUBMITTED TO THE DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ENGINEERING IN CIVIL AND ENVIRONMENTAL ENGINEERING AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY JUNE 2012

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Signature of Author: ____________________________
Department of Civil and Environmental Engineering
May 11, 2012

Certified by: ________________________________
John A. Ochsnerstorf
Associate Professor of Building Technology and Civil and Environmental Engineering
Thesis Supervisor

Accepted by: ________________________________
Heidi M. Neif
Chair, Departmental Committee for Graduate Students

Preliminary Study
Ray King
MIT Thesis-2012
Jobs Received vs. Jobs Completed

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

Year: 1983 to 2013
Values range from 0 to 80.
Study Breakdown by Section

- Statistical Data of Crane Use
- Collateral Damage and Injuries/Deaths
- Responsibilities
- Causes of Accidents
Statistical Data - All Categories

1983-2013
### Crane Study Basis-Cases/Category

- **1983 - 2013**
- **716 Crane Accidents**
- **507 Accidents Categorized**

<table>
<thead>
<tr>
<th>Category</th>
<th>CASES</th>
<th>%</th>
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<td>9</td>
<td>1.8</td>
</tr>
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<td>Arborist/Logging</td>
<td>7</td>
<td>1.4</td>
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<td>31</td>
<td>6.1</td>
</tr>
<tr>
<td>Oilfield-Offshore Industry</td>
<td>17</td>
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<td>Agriculture Industry</td>
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<td><strong>TOTAL</strong></td>
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## Crane Study Basis - Deaths/Category

- **507 Accidents Categorized**

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<td>1.4</td>
</tr>
<tr>
<td>Oilfield-Land Base Industry</td>
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<td>7.5</td>
</tr>
<tr>
<td>Oilfield-Offshore Industry</td>
<td>2</td>
<td>1.4</td>
</tr>
<tr>
<td>Agriculture Industry</td>
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<td>0.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>147</strong></td>
<td></td>
</tr>
</tbody>
</table>
## Crane Study Basis-Deaths/Trade

- **507 Accidents Categorized**
  - Ironworker: 24, 16.3%
  - Management: 10, 6.8%
  - Oiler: 1, 0.7%
  - Operator: 38, 25.9%
  - Other Field Personnel: 51, 34.7%
  - Pedestrian/Bystander: 3, 2.0%
  - Rigger: 20, 13.6%
  - Signal Person: 0, 0.0%

**TOTAL**: 147
**Crane Study Basis-Injuries/Category**

- **507 Accidents Categorized**
  
<table>
<thead>
<tr>
<th>Category</th>
<th># Injuries</th>
<th>%</th>
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<tbody>
<tr>
<td>Commercial Construction -</td>
<td>95</td>
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<td>Residential Construction -</td>
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<td>4.3</td>
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<td>4.3</td>
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<tr>
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<td>3</td>
<td>1.4</td>
</tr>
<tr>
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<td>1.4</td>
</tr>
<tr>
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<tr>
<td>Oilfield-Offshore Industry -</td>
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<td>4.3</td>
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<tr>
<td>Agriculture Industry -</td>
<td>0</td>
<td>0.0</td>
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<td><strong>TOTAL</strong></td>
<td><strong>209</strong></td>
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</tr>
</tbody>
</table>
## Crane Study Basis-Injuries/Trade

- **507 Accidents Categorized**
  - Ironworker - 50 injuries, 17.6%
  - Management - 5 injuries, 1.8%
  - Oiler - 1 injury, 0.4%
  - Operator - 29 injuries, 10.2%
  - Other Field Personnel - 82 injuries, 28.9%
  - Pedestrian/Bystander - 14 injuries, 4.9%
  - Rigger - 94 injuries, 33.1%
  - Signal Person - 9 injuries, 3.2%
  - **TOTAL** - 284

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# Breakdown by Crane Types

<table>
<thead>
<tr>
<th>Crane Type</th>
<th>Percentage</th>
<th>Rank</th>
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</thead>
<tbody>
<tr>
<td>Tower</td>
<td>8.5%</td>
<td>(3)</td>
</tr>
<tr>
<td>Mobile-Lattice</td>
<td>36.3%</td>
<td>(2)</td>
</tr>
<tr>
<td>Bridge</td>
<td>4.4%</td>
<td>(4)</td>
</tr>
<tr>
<td>Mobile-Hydraulic</td>
<td>41.0%</td>
<td>(1)</td>
</tr>
<tr>
<td>Cableway</td>
<td>0.3%</td>
<td></td>
</tr>
<tr>
<td>Derrick</td>
<td>0.9%</td>
<td></td>
</tr>
<tr>
<td>Pedestal</td>
<td>1.6%</td>
<td></td>
</tr>
<tr>
<td>Gantry</td>
<td>0.6%</td>
<td></td>
</tr>
<tr>
<td>MEGA</td>
<td>0.9%</td>
<td></td>
</tr>
<tr>
<td>Launching Girder</td>
<td>0.6%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4.7%</td>
<td></td>
</tr>
</tbody>
</table>
Responsibilities

- Site Supervisor 14.6% (4)
- Lift Director 19.8% (3)
- Rigger 22.5% (2)
- Operator 25.7% (1)
- Service Provider 2.9%
- Owner/User 4.9%
- Signal Person 1.9%
- Other 2.1%
- Manufacturer 5.6%
Failure Modes

- Operator Aids: 3.8%
- Mechanical Problems: 22.1% (2)
- Crane Stability: 19.2% (3)
- Attached Load: 16.7% (4)
- Crane Operation: 15.8%
- Rigging: 32.5% (1)
- Jib Displacement: 1.3%
- Crane Travel: 3.8%
- Engineering Issues: 1.9%
- Wind: 5.7%
- Boom Impact: 2.2%
- Signals: 3.2%
- A/D: 7.9%
- Wrong Weight: 5.0%
- Power Line Contact: 6.0%
Critical Lifts

- Site Controls: 26.7 % (2)
- Rigging: 11.1 % (4)
- Wrong Weight: 6.7 %
- Plan Issues (Changes): 37.8 % (1)
- Operator: 15.6 % (3)
- Weather: 2.2 %
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
# Overall Comparison - Crane Types By Industry

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ALL JOBS</th>
<th>COMMERCIAL</th>
<th>INDUSTRIAL</th>
<th>HIGHWAY</th>
<th>RESIDENTIAL</th>
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<tbody>
<tr>
<td>Tower</td>
<td>27</td>
<td>24</td>
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<td>1</td>
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<tr>
<td>Mob-Lat</td>
<td>115</td>
<td>55</td>
<td>46</td>
<td>14</td>
<td>-</td>
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<tr>
<td>Bridge</td>
<td>14</td>
<td>-</td>
<td>14</td>
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<td>Mob-Hy</td>
<td>130</td>
<td>42</td>
<td>53</td>
<td>16</td>
<td>18</td>
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<tr>
<td>Cableway</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
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<tr>
<td>Derrick</td>
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<td>-</td>
<td>3</td>
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<td>Pedestal</td>
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<td>Gantry</td>
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<td>MEGA</td>
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<td>15</td>
<td>2</td>
<td>12</td>
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## Overall Comparison - %

<table>
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<th>RESIDENTIAL</th>
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<td>71.4</td>
<td>51.5</td>
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<td><strong>15.2</strong></td>
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</tr>
</tbody>
</table>
Findings: Commercial

• The highest occurrence of accidents were associated with:
  – Rigging
  – External engineering design
  – Improper signals
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

- Elevated number of accidents associated with operator errors
  - Reduce number of operators permitted to operate the crane
  - Operator Training in accordance with ASME & OSHA requirements-National Certification Program
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
  - 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
Findings: Residential

- Lack of lift planning experience resulted in elevated accidents associated with the Lift Director and Rigging
- Instability of the load after being lifted confirmed problematic issues with rigging
- Unknown weights or wrong weights similarly were associated with rigging
Future Work

- Preliminary study: Haag/MIT was issued in June 2012 covering approximately 100 crane accidents
- Procedures established by MIT will be implemented into the first comprehensive study covering nearly 700 crane accidents in March 2013
- The Haag Crane study will be updated and issued annually every March
Future Work

• The study will be re-formatted for specific year of occurrence rather than when analyzed.
• Trends will be examined to study the effectiveness of training and certification
  – Crane Operator Certification
  – Signal Person Certification
  – Rigger Certification
Future Work

• Ultimately the Lift Director Certification currently under development will be evaluated on an annual basis

• Critical problematic issues will be submitted to OSHA and ASME for consideration in future standards