Big Data on Crane Runway Analysis and Repair

23rd Annual Crane Symposium

Presented By: Mike Falk, Mike Young and Gabriel Monroy
Evolution of Scan Data

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Evolution of Scan Data

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Crane Bays – Short & Wide

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Runway Structure Elevation View

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Crane Bridge Deflection – Elevation View

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There are two main types of High Definition Scanners:
- Pulse-based scanners
- Phase-based scanners
**Laser Scanner Specs**

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**Technical Data**

- **Laser Class**: 1
- **Beam Divergence**: < 0.3 mrad
- **Beam Diameter**: approx. 3.5 mm (at 0.1 m distance)
- **Range**: 197.3 m (unambiguity interval)
- **Minimum Distance**: 0.3 m
- **Resolution Range**: 0.1 mm
- **Data Acquisition Rate**: Max. 1,024 million pixel/sec.
- **Linearity Error**: ± 1 mm
- **Range Noise**: black 14 %, grey 37 %, white 80 %
- **Range Noise, 10 m**: 0.5 mm rms, 0.4 mm rms, 0.3 mm rms
- **Range Noise, 25 m**: 1.0 mm rms, 0.6 mm rms, 0.5 mm rms
- **Range Noise, 50 m**: 2.7 mm rms, 1.2 mm rms, 0.8 mm rms
- **Range Noise, 100 m**: 10 mm rms, 5.8 mm rms, 2.6 mm rms
- **Temperature Drift**: negligible

**Definition Unit**

- **Vertical Field of View**: 180°
- **Horizontal Field of View**: 10°
- **Vertical Resolution**: 0.00001°
- **Horizontal Resolution**: 0.00001°
- **Vertical Accuracy**: ± 0.007 mm
- **Horizontal Accuracy**: ± 0.007 mm
- **Rotation Speed**: max. 60 rpm (2000 rpm)

**Scan Duration**

- **Angular Resolution**:
  - **Linear**: ± 0.29 min, ± 0.32 min, ± 0.34 min
  - **Angular**: ± 0.29 min, ± 0.32 min, ± 0.34 min
- **Scan Duration**:
  - **Linear**: 1 km, 2 km, 3 km
  - **Angular**: 5 km, 10 km, 20 km

**Scan Quality**

- **High**: 5 km, 10 km
- **Ultra High**: 20 km, 50 km
- **Ultra High**: 100 km, 200 km

**Scan Coverage**

- **Linear**: 1 km, 2 km, 3 km
- **Angular**: 5 km, 10 km, 20 km

**Scan Resolution**

- **High**: 5 km, 10 km
- **Ultra High**: 20 km, 50 km
- **Ultra High**: 100 km, 200 km
Elevated Runway—Tall Identification of:
- Clearances
- Tolerances
- Obstructions
- Conditions
What's Important

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Elevated Runway—Tall
Identification of:
• Clearances
• Tolerances
• Obstructions
• Conditions
• Utilities
• Operational Hazards
What’s Important

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Elevated Runway—Tall
Develop Erection Procedures:
• Crane & Equipment Positioning
• Obstructions
• Swing Radius
• Height/Reach
• Conditions
• Operational Hazards
What’s Important

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Elevated Runway—Tall Design Aid:
- Structural Component ID
- Framing member ID
- Use to form as-built condition
- Too many points to map
- Operational Hazards
What’s Important

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Elevated Runway—Tall
- Before and After
What’s Important

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Match elevation between new and existing
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What’s Important
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As-built survey for structural maintenance
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RAIL SEPARATION
Supplemental Information
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HOT RAIL ALIGNMENT
COLUMN PLUMBNESS
GIRDER CAMBER
GIRDER ROLL
North Crane - After Traveling South

Diagonal Dimensions:
AC = 76' 5"
BD = 76' 3 13/16"

Side Dimensions:
AB = 74' 7 1/4"
BC = 16' 4 3/8"
CD = 74' 6 13/16"
AD = 16' 5 3/16"

Prior to survey, North Crane traveled south from far north end in excess of three bays.

Notes:
1. This drawing represents data acquired at the McNary Dam by Falk PLI on 7/21/2015.
2. Units are in feet and inches.
3. Crane was surveyed between #8 and #9 Turbines.
<table>
<thead>
<tr>
<th></th>
<th><strong>Optics</strong></th>
<th><strong>Rail Riders</strong></th>
<th><strong>Laser Scanners</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access</strong></td>
<td>Multiple methods may be used. Vertical measurements may require man lifts</td>
<td>Physical contact with rail, need access to rail. Requires additional access for girder and column.</td>
<td>Can be positioned from the crane or from the ground</td>
</tr>
<tr>
<td><strong>Line of sight</strong></td>
<td>Mandatory may require man lifts or harnesses</td>
<td>Not needed due to physical contact</td>
<td>Can be positioned anywhere to increase line of sight to features being measured, no tie-off needed</td>
</tr>
<tr>
<td></td>
<td>Line of sight from ground.</td>
<td>Line of sight from ground or girder.</td>
<td></td>
</tr>
<tr>
<td><strong>Alignment</strong></td>
<td>Assumed centerline or offset</td>
<td>Assumes measured rail position. Requires additional work for analysis.</td>
<td>Centerline of crane bay is based upon the column line split at the ends of the bay on the ground</td>
</tr>
<tr>
<td><strong>Type of Surveys</strong></td>
<td>Rail &amp; Girder Alignment and Elevation, Column Plumb, Crane Square/Deflection</td>
<td>Rail Alignment Only. Column and girder measurements require additional survey.</td>
<td>Rail &amp; Girder Alignment and Elevation, Girder Camber/Roll, Column Plumbs, Clearances and Clash Detection, Crane Square/Deflection</td>
</tr>
<tr>
<td><strong>Operations</strong></td>
<td>Requires Shutdown/LOTO Requires OSHA tie-off</td>
<td>Requires Shutdown/LOTO Requires OSHA tie-off.</td>
<td>Can be performed during normal operations</td>
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</tbody>
</table>
Contact Information

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Crane Rail Span
Centerline of Rail to Face of Column
Proposed Rail Alignment
Girder Roll and Girder Elevation
Column Plumbness
Hot Rail Horizontal Alignment