Innovative Approach to Airfield Pavement Inspections and Distress Identification at OAK

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Overview

• APMS Evolution
• Challenges
• Case Study (Oakland) and Innovations
• Benefits and Next Steps
Pavement Management Concept

Data Collection

Define Inventory

Condition / Analysis

Philosophies/Strategies

Rehabilitation Needs ($) and Timing

10-Year CIP
CIP Year
- No CIP
- Year 1 (2012)
- Year 2 (2013)
- Year 3 (2014)
- Year 4 (2015)
- Year 5 (2016)
- Year 6 (2017)
- Year 7 (2018)
- Year 8 (2019)
- Year 9 (2020)
- Year 10 (2021)

6/4/2015
Airport Pavement Management

• Airport Changes:
  ▪ Reduced airport staff available for escorts
  ▪ Shifting escort ‘burden’ to consultants
  ▪ Reduced available time on airfield pavement

• Can we get a bigger return on investment for time spent in field?
Airport Pavement Management

- Service Provider Changes: change in philosophy
Evolution of APMS Data Collection

- **Statistical** based sampling: Manual with paper
- **Statistical** based sampling: Manual with handheld / GPS
- **Statistical** based sampling: Video with manual processing
- **Map Cracking and PCI**: Manual with GPS (GAPEMS)
- **Map Cracking and PCI**: 3D Imaging / GPS with semi-automated processing
Equipment

• 3D Imagery

- PCI to meet FAA
- Level of processing - prioritize to your needs
- 100% mapping
**Technology – 3D Imagery**

**SYSTEM SPECIFICATIONS**
- Number of laser profiles: 2
- Sampling rate: 5600 profiles/s or 11200 profiles/s
- Vehicle speed: 0 to 100 km/h
- Profile spacing: 1 to 5 mm (adjustable)
- Transversal field of view: 4 m
- Transversal accuracy: 1 mm
- Transversal resolution: 4096 points/profile
- Depth range of operation:
  - 250 mm (adjustable)
  - Depth accuracy: 0.5 mm
- Laser profiler dimensions:
  - 428 mm (h) x 265 mm (l) x 139 mm (w)
- Weight: 10 kg
- Power consumption (max):
  - 150W at 120/240VAC

**High Definition 3D Imagery**
Challenges

• Fitting a roadway solution to an airfield (Context)
• Not cost competitive with traditional approach (Automation)
Runway (12-16 passes)

Roadway (1 pass per lane)
Automation

- ASTM D5340
- Different than typical roadway / State Highway requirements
Oakland – Case Study

- 10 million passengers/year
- 556,000 tons Cargo
- RW12-30 = 10,000ft
- Asphalt
- 1 weekly closure Monday 1:30am-6:00am
INNOVATIONS
# High-Speed Data Collection

<table>
<thead>
<tr>
<th>Method</th>
<th>Yield</th>
<th>Time in field</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>25% Sample</td>
<td>12 hours**</td>
<td>2 walking 1 escort 1 other vehicle towing light plant</td>
</tr>
<tr>
<td>Video</td>
<td>100%</td>
<td>2 hours</td>
<td>1 escort 2 in van</td>
</tr>
</tbody>
</table>

** At Oakland, this is 3 separate Monday closures

** Video – Less Time, Higher Yield
Context

- ArcGIS Integration
- Viewing images as ‘aerial’ with ability to zoom to see individual image from 3D vehicle
- Portable to the client
Products
### Automation

- **Not for all airports…**

<table>
<thead>
<tr>
<th>Method</th>
<th>Field Cost</th>
<th>Post-Processing</th>
<th>Operational Impact</th>
<th>Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>12 hours x 3 people</td>
<td>negligible</td>
<td>high</td>
<td>36 person-hours</td>
</tr>
<tr>
<td>Video</td>
<td>2 hours x 2 people -Mob/demob -Equipment Fee</td>
<td>Image processing Distress / PCI (100% compared to 20% sample)</td>
<td>negligible</td>
<td>60 person-hours plus video related costs</td>
</tr>
</tbody>
</table>

- **Why automate?** Video cost can be 2x more in dollars
Automation

- Test cases –
  - Manual review to develop the baseline distress
  - Models developed and applied
## Automation

### Distress

<table>
<thead>
<tr>
<th>Distress</th>
<th>Runway 12-30</th>
<th></th>
<th>Runway 15-33</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pass 1</td>
<td>Pass 2</td>
<td>Pass 1</td>
<td>Pass 2</td>
</tr>
<tr>
<td>Linear / Transverse Cracking</td>
<td>291</td>
<td>260</td>
<td>121</td>
<td>43</td>
</tr>
<tr>
<td>Patching</td>
<td>111</td>
<td>39</td>
<td>80</td>
<td>81</td>
</tr>
<tr>
<td>Alligator Cracking</td>
<td>6</td>
<td>16</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Weathering</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Block Cracking</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>29</td>
</tr>
<tr>
<td>Total Distress Samples</td>
<td>409</td>
<td>320</td>
<td>230</td>
<td>165</td>
</tr>
<tr>
<td>Total Images</td>
<td>396</td>
<td>396</td>
<td>127</td>
<td>127</td>
</tr>
</tbody>
</table>

### Model AUC

<table>
<thead>
<tr>
<th>Distress</th>
<th>Model AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear / Transverse Cracking</td>
<td>0.96</td>
</tr>
<tr>
<td>Patching</td>
<td>0.91</td>
</tr>
<tr>
<td>Alligator Cracking</td>
<td>0.67</td>
</tr>
<tr>
<td>Weathering</td>
<td>0.97</td>
</tr>
<tr>
<td>Block Cracking</td>
<td>0.78</td>
</tr>
</tbody>
</table>
Benefits to OAK

• Minimum disruptions to Airport Operations
• 100% coverage - PCI + Maintenance Plan (Enhanced APMS)
• Improved geospatial accuracy of distress – used by Port Ops and Maintenance (Work order management integration)
• Images of condition in 2015
• Data accessibility to the Port
Going Forward

• Efficiency Improvement
  ▪ Improving coverage in data collection (driving paths, laser span)
  ▪ Image stitching of non-linear features (already improved at San Bernardino on Aprons)
  ▪ Automation of airfield distresses

• Cost Reduction