Safety Added Through Utilization of Rope Access Techniques during Bridge Inspections

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This presentation is not a training, and is intended for informational purposes only.

Please seek proper training before beginning any climbing activities.
1. Intro to Advanced Climbing Systems
2. SPRAT Research and Drop Tests
3. UAS Overview
4. William Natcher Bridge Case Study
5. Lessons Learned
6. Future of Rope Access and UAS
Industrial Rope Access Trade Association (IRATA) 2014 Report

- Major injuries: 0
- Reportable injury rate: 64 per 100,000 workers
- Non-reportable: 2-4 per 1,000 workers
Why Research?

- Balance:
  - Fall Distance
  - Force

Diagram showing the relationship between fall distance, force, and safety factors.
Rock Exoctica enForcer Load Cell

Calibrated with analog scale: +/- 5lbs
Drop Test: Static – Full Length - Goblin

https://youtu.be/OwLfWY0f3bY
Drop Test: Static – Cinched - Vector

https://youtu.be/jLzoWz2lkA8
Drop Test: Shock Pack – Cinched – Goblin

https://youtu.be/7W-rUSeh2Do
Results

Average Drop Test Forces

- **Tests**: 1700 LBF
- **Dynamic**: 2100 LBF
- **Static**: 3500 LBF
- **Shock Pack**: 1400 LBF

Red line indicates 900 lbs threshold.
No significant correlation between device type & length of rope to force result

Dynamic rope & shock absorber reduce force

Limiting to 900lbs was not achieved

CAMP has indicated double legs may not allow Goblin to slip
Topcon Falcon 8

DJI Inspire 2

DJI Phantom 4
General Uses: UAS

- **Structural Inspections**
  - Bridges
  - Buildings
  - High-Mast
  - Turbines

- **Post-Disaster**
  - Rescue
  - Construction Monitoring, Volumetric Take-Offs

- **3D Models & Point Cloud Surveys**

- **Structural Health Monitoring**

- **Thermal Imaging, FLIR**
Prescreen: Safety – Efficiency - Thorough

- Initial investigation with UAS
- In-depth, hands-on investigation with rope access
- Complete record of all flights

UAS Screening

UAS Supported Inspector
Live UAS Support

https://youtu.be/jxtAU9Wg2u0
At 10 feet
Phantom 4

At 10 feet
Phantom 4

At 40 feet
Inspire 2

At 40 feet
Inspire 2
Point cloud model for measuring
Thermal Imaging

Bridge Decks

Concrete Delamination
Equipment ascent

https://youtu.be/U066oRc-vic
Case Study: William Natcher Bridge

Cable scan

https://youtu.be/-G1TFH_qQ0U
Defect find

https://youtu.be/NlnTUjnHdV8
Case Study: William Natcher Bridge

Rope access investigation

https://youtu.be/6UsWI2C39fo
Case Study: William Natcher Bridge

- New Finding Discovered with UAV
- Inspector sent in via rope to investigate
Case Study: William Natcher Bridge

At 30 feet
Inspire 2
Case Study: William Natcher Bridge

- 3D model for health monitoring
- Known cracks mapped
- Then captured in model
Case Study: William Natcher Bridge

- Summary of Findings
  - 1/8” crack detectable at 30ft in HDPE
Case Study: William Natcher Bridge

- Summary of Findings
  - Verification of detection
    - 100% of cable connections rappelled
    - 25% of cable lengths rappelled
    - UAS captured deficiencies at connections
    - UAS detected 1 new crack along cable body
Case Study: William Natcher Bridge

- Summary of Findings
  - Efficiency
    - UAS: 8 minutes per cable
    - Rope Access: 45 minutes per cable + initial setup
Lessons Learned: Limitations

- Wind & Vortex Shedding
- Inspector verification hands on
- Tight girder spacing tricky
- Trusses tricky
- GPS interference
Lessons Learned: Limitations

- Battery life in cold conditions
  - Inspire won’t take off if battery is < 50°
  - Falcon 8 averaged 9 mins of flight time
  - Inspect in warm weather!
Future Opportunities

- Research for policy development
  - Probability of detection, validation
  - Cameras for enhanced detection, FLIR, etc.
- Preprogrammed flight paths
- Machine learning and inspection algorithms

https://www.youtube.com/watch?v=u9o5QN9jw-c
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