Benefits of Student Interns in Infrastructure Management

APWA Annual Congress
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Pat Kennedy, P.E.
Angie Hager, EIT

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154 Square Miles
1880 Miles of Streets
460 Miles of Alleys

3300 Miles of Curbs
800 Structures
51,000 Ped Ramp Locations
Miscellaneous Assets

Asset Management
Components

• Asset Inventory
• Condition Assessment
• Work Program
The Intern Program

Almost 10 Years

Inventory & Condition Assessment of major and minor infrastructure.

The Intern Program

• The Bosses
  – UCD: Dr. Kevin Rens
  – City and County of Denver: Dan Roberts Pat Kennedy Jim Barwick

The Intern Program

• The Students
  Typically 5 – 10 Graduate and Undergraduate
  Predominantly Civil Engineering
Types of Work

- Inventory
- Inspection & Condition Assessment
- Office Work
- Research

Reports, Papers, Theses

Inventory Projects

- Locate
- Identify
- Quantify

Inventory Project Example
Transit Amenities
Inventory Project Example
Transit Amenities

Condition Assessment Projects

- Locate
- Identify
- Quantify
- Condition Inspection

- Used to Prioritize Repairs
- Completed Projects
  - Pavements
  - Alleys x2
  - Curbs
  - Bridges
Office Work

- Data
- Scanning
- Traffic Management Center
- Other

Research

- Infrastructure Condition Assessment
- Deterioration Modeling
- Bridge Deterioration Studies
- Non-Destructive Testing
- Material Properties

M.S. Degree Theses

- Chatchawarn Sathantip
  "Alley Management System for the City and County of Denver, Colorado"

- Michael E. Gogel
  "Inspection and Rating System for Tubular Steel Pedestrian Bridges"

- Benjamin J. Allen
  "Non-Destructive Evaluation of the 6th Avenue Viaduct Using Strain Gauges"

- Irena Kahanek
  "Assessment and Inventory of Minor Infrastructure in Areas with Weak GPS Signals"

- Robinson Usagani
  "Curb and Gutter Data Management System for the City and County of Denver"

- Angela S. Hager
  "Non-Destructive Evaluation of the Westbound Sixth Avenue Viaduct"

- Saeedeh Chavooshi
  "Analysis of Alley Rigid Pavements in the City and County of Denver, Colorado"

- Anne Delmonte
  "Curb and Gutter Data Analysis Using GIS"

- Yvonne Neiman
  "Infrastructure Management Using GIS Technology"

- Carnot Nogueira
  "Application of Non-Destructive Evaluation Techniques in Bridge Inspections as a Tool for Bridge Management Systems"
Journal Publications


Publications in Symposia Proceedings

Publications in Refereed Symposia Proceedings:


• 2006: Rens, K.L and T. Kim “Quebec Bridge Inspection Using Common Nondestructive Testing Techniques” ASCE Structures Congress, St Louis MO.


Inventory and Condition Assessment
Inventory and Condition Assessment

• Alleys; paper forms 2000-2001
Inventory and Condition Assessment

- Alleys; paper forms 2000-2001
- Curbs; back pack 2001-2003

Elements
- Curb and Gutter
- Crossspans
- Sidewalks
- Pedestrian Ramps
- Inlets
- Alley Aprons
- Driveways
Distresses
- Major Cracks
- Minor Cracks
- Heaved
- Settled
- Spalled
- Scaled
- Drainage
- Undermined
- Missing
### Inventory and Condition Assessment

- Alleys; paper forms 2000-2001
- Curbs; back pack 2001-2003
- Street Pavement; PDA 2004-present

### Condition

- Rutting
- Roughness
- Patches
- Potholes
- Alligatoring
- Transverse Cracks
- Longitudinal Cracks
Inventory and Condition Assessment

- Alleys; paper forms 2000-2001
- Curbs; back pack 2001-2003
- Street Pavement; PDA 2004-present
- Alleys Phase II; PDA 2005-present

Condition

- Asphalt
  - Oxidation
  - Exposed Edge
  - Patches/Potholes
  - Transverse Cracks
  - Longitudinal Cracks

- Concrete
  - Broken Panels
  - Faulted Panels
  - Deteriorated Panels
  - Patches
  - Transverse Cracks
  - Longitudinal Cracks
  - Surface Wear

- RAP
  - Overall
  - Potholes
  - Grading
  - Erosion

Inventory and Condition Assessment

- Alleys; paper forms 2000-2001
- Curbs; back pack 2001-2003
- Street Pavement; PDA 2004-present
- Alleys Phase II; PDA 2005-present
- Bridges; Toughbook 2005-present
Inventory and Condition Assessment

- Alleys; paper forms 2000-2001
- Curbs; back pack 2001-2003
- Street Pavement; PDA 2004-present
- Alleys Phase II; PDA 2005-present
- Bridges; Toughbook 2005-present
- Curbs Phase II; Toughbook under design

Team Configuration

- Two Interns per Team
- Training
  - Personal Safety
  - Hardware/Software
  - Procedures/Distress Identification
  - Public Relations
Data Quality

- Consistent with Engineers (accurate)
- Multiple Blind Studies
  - Curbs
  - Alleys
  - Pavement
- Repeatable (precise)

Research

- Longitudinal Cracks in Concrete Alleys
- Fly Ash in Municipal Infrastructure
- NDT of 6th Avenue Viaduct
Research
Saeedeh Chavooshi

“Analysis of Alley Rigid Pavements in the City and County of Denver, Colorado”

LONGITUDINAL CRACK

TRASH TRUCK HYPOTHESIS
THERMAL HYPOTHESIS
Temperature Differential

Max Temp Differential = 44°F

Tension area greater than 500psi = longitudinal crack
Research

Mark Reiner

“The Role of HVFA concrete in the Sustainability of the Urban Build Environment”
H60 Alley Panel

Other HVFA Applications

- Curb
- Manhole & Cover
- Prestress Slab
- Prestress Bridge Girder
Rebound Hammer

Ultrasonic Pulse Velocity (UPV)

Tomography
- Uses UPV methods
- Define Interior Plane
Combined Effect

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\text{Combined Effect} = \frac{\text{HT}}{\text{HT}_{\text{max}}} + \frac{\text{UPV}}{\text{UPV}_{\text{max}}} + \frac{\text{SH}}{\text{SH}_{\text{max}}} + \frac{\text{HS}}{\text{HS}_{\text{max}}} + \frac{\text{VT}}{\text{VT}_{\text{max}}}
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Budget

- Annual Contract (approx $250,000 / year)
- Funding from Multiple Agencies
- Intern Pay Range $10 - $15 per hour
- Alleys: $10 - $20 / Alley
- Streets - $60 / mile
- Curbs - $100 / mile

Benefits

City and County of Denver
- Inexpensive Technical Labor
- Cover a lot of ground quickly
- Infrastructure Management

The Interns
- Flexible Schedule
- College Credit
- Experience
- Future Employment & Networking
- Real World Engineering

The University
- Research Opportunities
- Access to Municipal Resources

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QUESTIONS?

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