Construction and Management of Sidewalks and Recreational Trails

David K. Hein, P.Eng., M.ASCE

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David K. Hein, P.Eng.

- Over 35 years of experience in the design, evaluation and management of pavements
- Responsible for transportation asset management practice
- Extensively involved with ASCE
  - T&DI Board of Governors, President, 2018
  - Chair of:
    - Interlocking Concrete Pavement Committee
    - Permeable Pavement Committee
    - Large Element Paving Slab Standards Committee (new)
    - Engineering Standards for the Smart City Committee (new)
  - Teaching and training through pavement related webinars

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Learning Outcomes

- Understand the key mechanisms of sidewalk and recreational trail performance and how to build them to last
- Be able to identify design and construction features that may negatively impact the performance of the assets
- Understanding maintenance and rehabilitation needs and techniques
- Methods and means to complete condition assessments
- Maintenance and rehabilitation needs and procedures
- How to ensure compliance with national and local ordinances and requirements
- How to minimize liability due to trip and slip hazards

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Introduction

- There are more than 1.6 million km (1 million miles) of sidewalk in North America
- Replacement cost > $150 billion
- About 15 to 20 percent requires major rehabilitation or replacement
- Cost of > $ 20 billion

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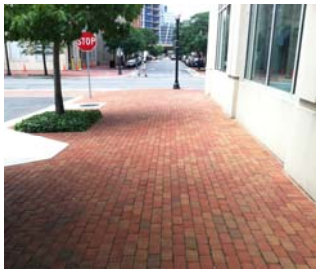
Use and Benefits of Sidewalks and Trails

- Improved Public Safety
  - Enables communities to improve safety including pedestrians, cyclists and motorists
- Environment and Health
  - Connections between streets, parking lots and buildings will help to reduce vehicle trips, encourage walking and bicycling and reduce sedentary life-styles
- Quality of Life
  - Makes community more inviting
  - Fosters resident interaction
  - Improves pedestrian experience
  - More use by aging population



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Use and Benefits of Sidewalks and Trails

- Economic Benefits
  - Good design encourages business investment
  - Increase in property values
  - Attract new business
- Environmental Benefits
  - Enhance stormwater runoff management
  - Improve air and water quality
  - Reduce heat island effect for pedestrians
  - Reduce noise

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Primary Functions

- Provide a safe and durable surface for the public
- Continuous access to desired destination
- Separate vehicles, bicycles and pedestrians
- Accessibility for users with disabilities
- Unobstructed access
- Drainage away from buildings in urban areas
- Access for winter maintenance

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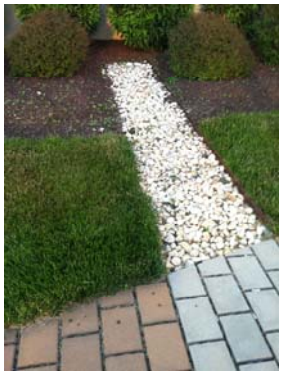
Secondary Functions

- Accommodate lighting, utilities and vegetation
- Improved accessibility for visually and mobility impaired
- Enhance the environment
- Support drainage



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Planning and Design

- Service life depends on a variety of factors:
  - Environmental conditions
  - Materials
  - Design standards
  - Construction quality
  - Maintenance standards and actions
- Typical expected service life:
  - Concrete – 80 years
  - Interlocking Concrete Paving Stones or Bricks – 80 years
  - Asphalt – 40 years

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Planning and Design

- Sidewalks should be designed for all users
- Characteristics and have significant impact on disabled
  - Longitudinal and transverse grade
  - Surface type
  - Curb ramps
  - Surface texture, i.e. navigational features for visually impaired
- U.S. Access Board has guidelines (http://www.access-board.gov)

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Typical Location Selection Criteria

- Near transit or bus routes
- Access for elderly and persons with disabilities
- Continuity of sidewalk/trail
- Addition of new facilities (schools, parks, sport complexes)
- Pedestrian generators (library, hospital, shopping mall, etc.)
- High vehicle/pedestrian/bike interaction
- Population density
- Type of roadway, width, presence of shoulders

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Sidewalk Functional Design

- Design for disabled
- Separation from the traffic flow (minimum offset)
- Geometric design
  - Width (1.8 m recommended, 1.5 m min.)
  - Crossfall 2%; Grade (8% max)
  - Vertical clearance (2 m min)
- Ramp layout
- Design details
  - Lighting
  - Placement of appurtenances
  - Cross walks

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Sidewalk Width

- Depends on right-of-way available
- Use of the facility
- Minimum width = 1.5 m (5 ft)
- Ideal width = 1.8 m (6 ft), minimum width for adult to pass a person pushing a baby carriage or wheelchair

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Sidewalk Materials

- Most sidewalks within the public right of way in North America are exposed concrete
- Asphalt concrete followed by interlocking concrete pavers or bricks are also common
- Other “enhanced” treatment include:
  - Granite setts
  - Large format pavers
  - Recycled plastic units
  - Combinations of the above
- Life-cycle costs should be considered when choosing the appropriate surface for a particular application

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Poured Concrete

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Asphalt
05 23 2011 01:28
Porous
Asphalt
Walk

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Exposed Aggregate Concrete with Basalt Insets

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Recycled Products

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Sidewalk Management

- Planning
  - Usage
  - Improvements in safety and convenience
- Design
  - Functionality
  - Life-cycle costs
  - Aesthetics
- Maintenance
  - Summer
  - Winter

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Depressed Sidewalk at Crossing

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Concrete Curb Ramp with Tactile Surface Inlay

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Sidewalk Engineering Design

- Material type selection
  - Concrete
  - Asphalt concrete
  - Interlocking concrete pavers
  - Other?
- Design standards
- Use of tree root barriers to reduce sidewalk heaves
- Material quality
- Construction quality (QC/QA)
- Edge Restraints for pavers and granite setts

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Construction

- General recommendations
  - Do not relax "pavement standards" sidewalks are important
  - On-site inspectors are key for the successful installation
- Keep records of construction
- Subgrade
  - **Uniformly** compacted minimum 95 percent standard Proctor
- Base
  - Granular minimum 100 mm (4 in), increase to 150 mm (6 in) for driveways and 200 mm (8 in) for weak or frost susceptible soils
  - Concrete or asphalt in some designs
- Select proper materials and mix designs
- Reduce heaving by increasing depth and sloping towards the curb

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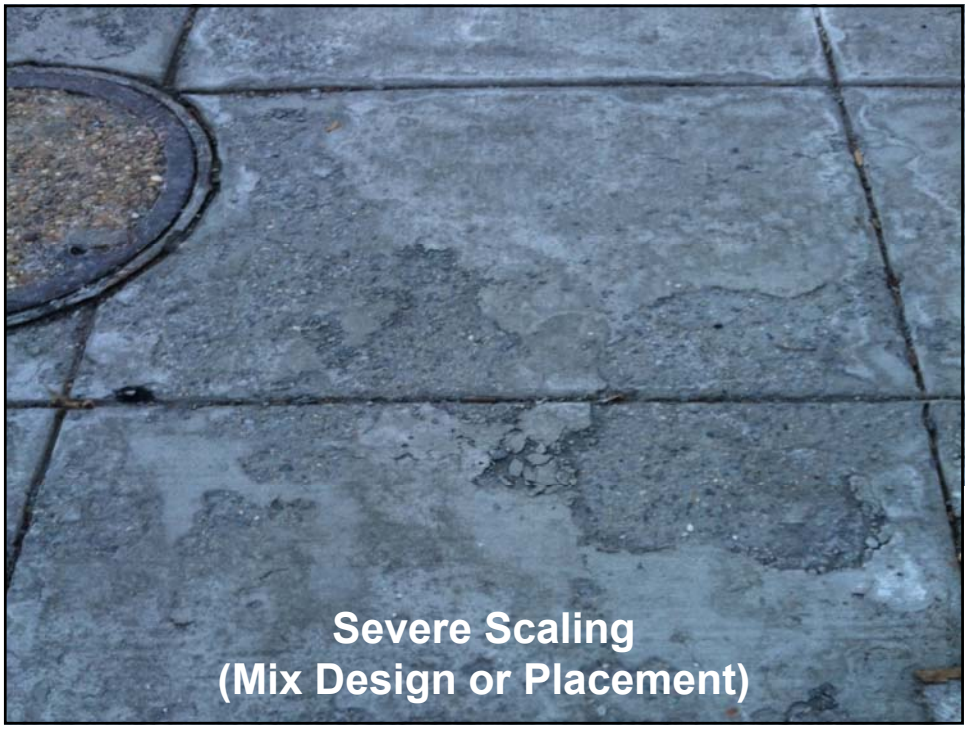
Severe Scaling
(Mix Design or Placement)

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Poor Quality Concrete (Freeze/Thaw)

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Construction of PCC Sidewalks

- Thickness 100 mm (4 in) minimum, 150 mm (6 in) for driveways, 175-225 mm (7 to 9 in) for commercial and industrial driveways
- Compressive Strength, 30 MPa (4,000 psi)
- Air content of 4 to 8 percent depending on aggregate size
- Air dry 1 month before de-icing salts are applied
- Do not place on frozen subgrade or base
- Joints (use them), maximum 24 times thickness
- Isolation joints placed adjacent to rigid structures
- Control joints max width of 5 mm (1/4 in), ½ of slab depth

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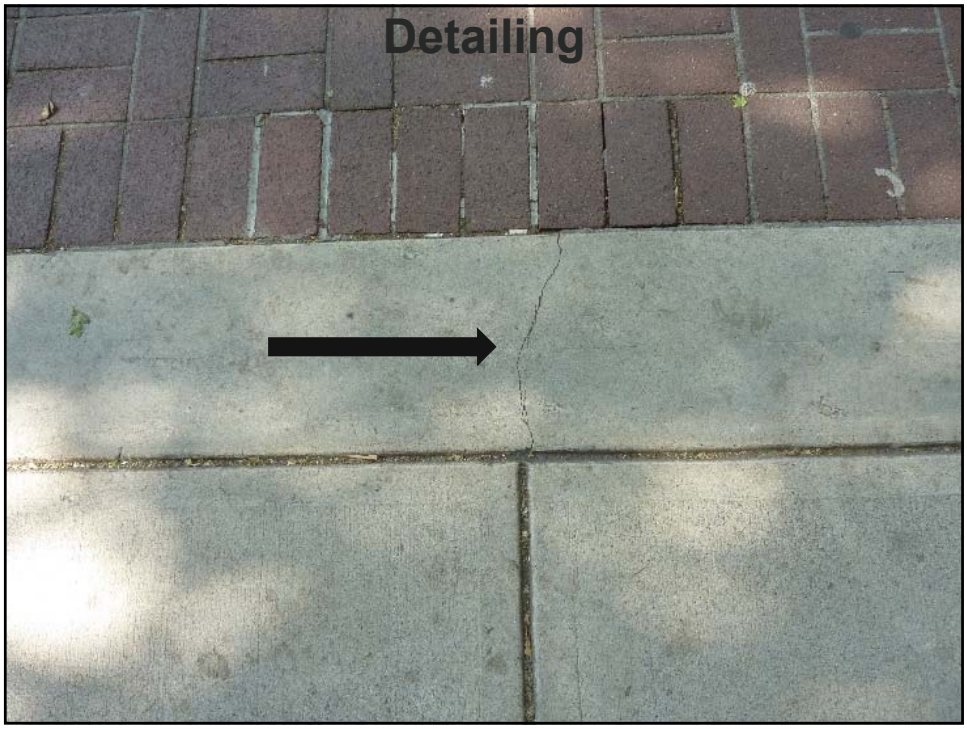

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Construction of Asphalt Sidewalks/Trails

- Recommended use of Performance Graded Asphalt
- Increase depth at commercial driveways
- A good base is important

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Asphalt Details

- Asphalt cement content of 5 to 7 percent
- Performance Graded asphalt suitable for location
- Air voids of 2.5 to 5 percent
- Maximum aggregate size of 12 mm (1/2 in)
- Place using mechanical spreader
- Base should extend 150 mm (6 in) wider than surface
- Ensure good base compaction
- Stable slopes
- Adequate drainage

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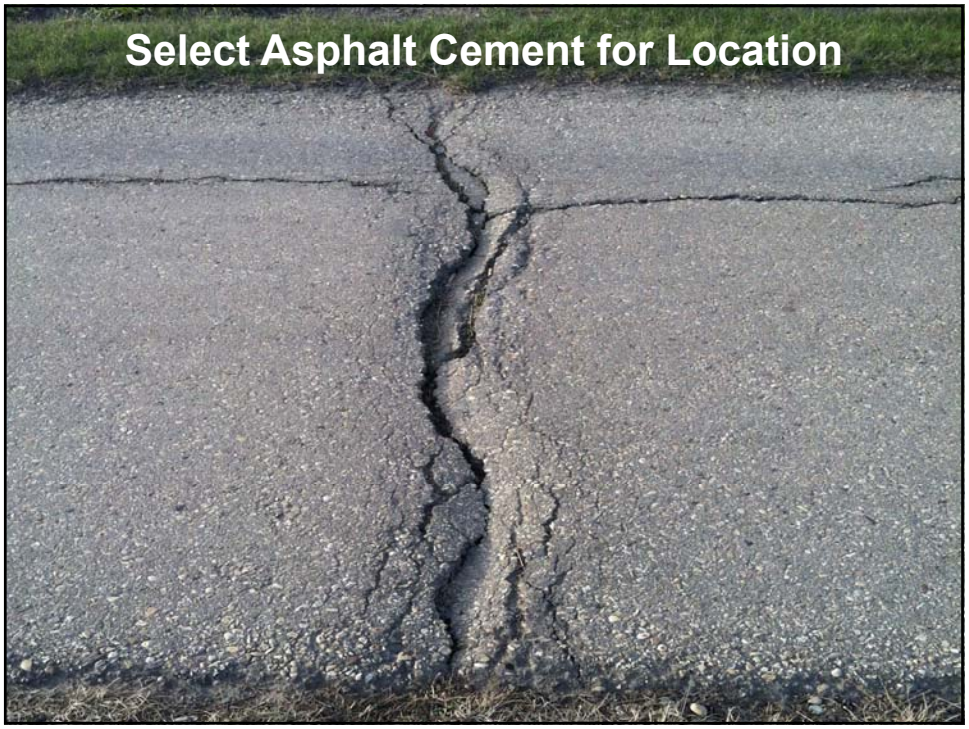

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Construction of Interlocking Concrete Pavement

- Designed as flexible pavement over base
- Need a good edge-restraint
- Joint sand plays important structural role
- Store extra pavers for future maintenance and repair
- Geotextile placed on top of base to reduce loss of fines
- Specify pavers to meet requirements of:
  - ASTM C936
  - CSA A231.2

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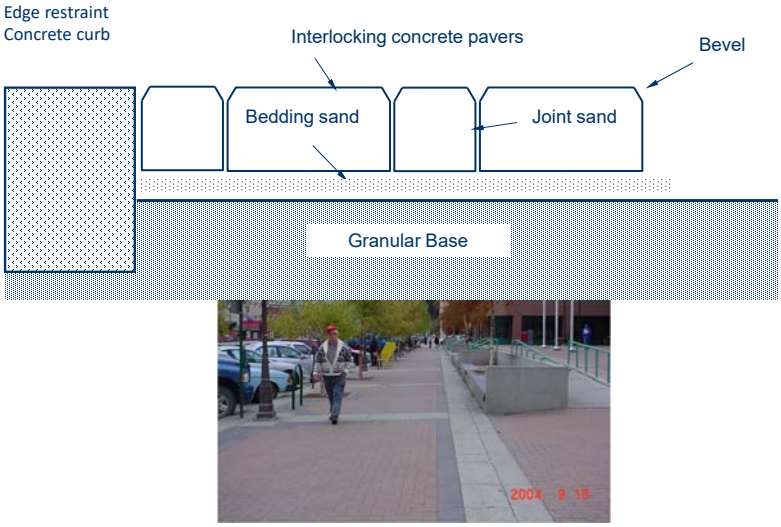
Construction of ICP



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Use Soldier Course at Material Interfaces

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If Not Possible, Detail Correctly

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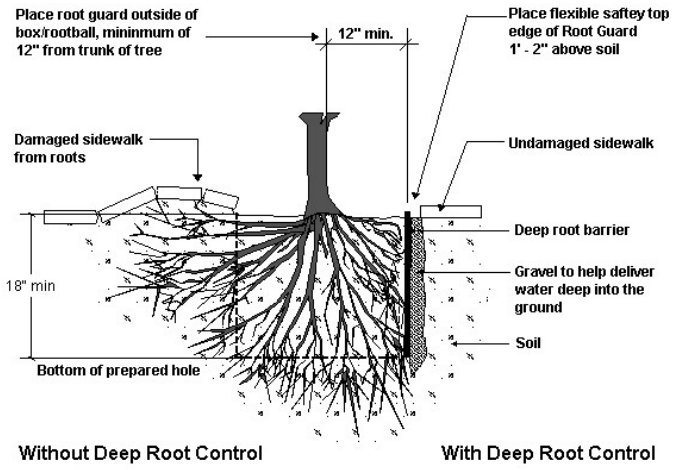
Dealing with Tree Roots



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Dealing with Tree Roots (Barriers)




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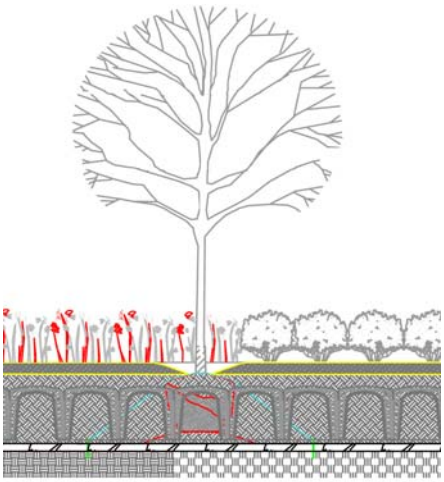
Dealing with Tree Roots (Accommodate)

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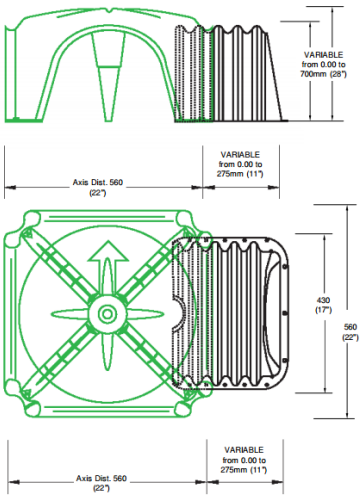
Dealing with Tree Roots (Accommodate)



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Distress Modes

- Similar to Roadways
- Smaller Scale
- Fewer Distresses
  - Modes include:
    - Cracking
    - Material or system failure
    - Settlement/heave or other distortion

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Condition Rating - 0

- Non-existent, significant deterioration with missing sections, complete reconstruction necessary

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Condition Rating – 2 (Poor)

- Significant deterioration, missing sections, potential for trip and fall hazards, complete reconstruction necessary

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Condition Rating – 4 (Fair)

- Many distresses present, major sections require reconstruction

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Condition Rating – 6 (Good)

- Some distressed areas, cracked slabs, uneven surface, potential for trip hazard. Repairs could include slab jacking, localized panel replacement and grinding for trip hazards

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Condition Rating – 8 (Very Good)

- Occasional cracked slabs or uneven surface, slab jacking or grinding to address possible trip hazards

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Condition Rating – 10 (Excellent)

- No significant distress present

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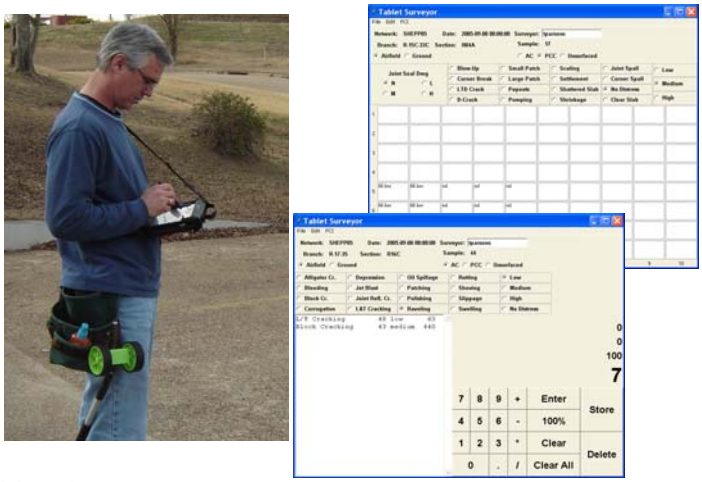
Data Collection Methods

- Manual based on visual survey and table data recording



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Data Collection Methods

- Video based on small survey vehicle and cameras

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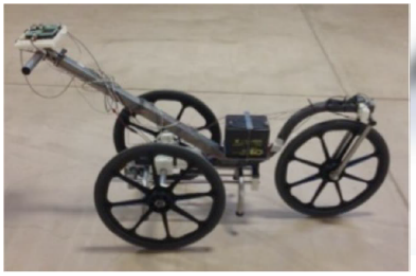
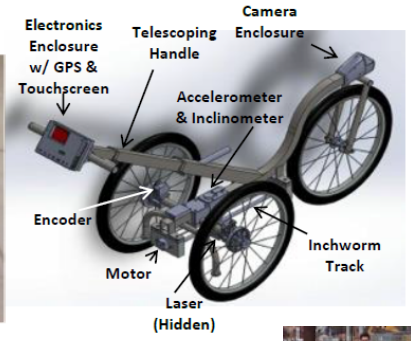
Data Collection Methods

- Walking multi-purpose survey device (PathMeT)





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Maintenance

- Larger focus on sidewalk maintenance recently
  - Desire to maintain a good aesthetic appearance
  - Consideration of liability due to slip and trip hazards
  - Focus on compliance with disability acts
- Realization of the real value of the assets and backlog liability
- Life-cycle cost management
- Development of formal maintenance and rehabilitation plans

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Maintenance

- Inventory
  - Past design information
- Condition Assessment
  - Update regularly
  - Track past deficiencies and problems
- Prioritize
- Fix

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Maintenance Practices

- Localized reconstruction
- Grinding
- Asphalt wedges/fillets
- Asphalt patching
- Asphalt overlay
- Slab jacking
- Loss of edge restraint (Pavers)
- Debonding (Mortared Brick)

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Grinding of “Patterned” Concrete

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Sidewalk Repairs by Cement Mortar

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Slab Jacking

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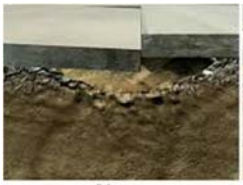
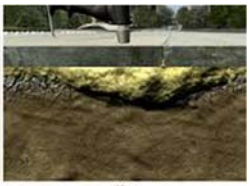
Slab Jacking





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Compliance with Disability Acts

Department of Justice
September 15, 2010

2010 ADA Standards for Accessible Design

Introduction

The Department of Justice published revised regulations for Titles II and III of the Americans with Disabilities Act of 1990 "ADA" in the *Federal Register* on September 15, 2010. These regulations adopted revised, enforceable accessibility standards called the 2010 ADA Standards for Accessible Design "2010 Standards" or "Standards". The 2010 Standards set minimum requirements – both scoping and technical – for newly designed and constructed or altered State and local government facilities, public accommodations, and commercial facilities to be readily accessible to and usable by individuals with disabilities.

Adoption of the 2010 Standards also establishes a revised reference point for Title II entities that choose to make structural changes to existing facilities to meet their program accessibility requirements; and it establishes a similar reference for Title III entities undertaking readily achievable barrier removal.

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Compliance with Disability Acts

BRAILLE | LARGE PRINT | AUDIO | ONLINE | TRAINING

CATEGORIES

- BRAILLE
- LARGE PRINT
- ACCESSIBLE PDF
- MOBILE & WEBSITE ACCESSIBILITY
- OTHER FORMATS
- ACCESSIBILITY LEGISLATION
- GENERAL

How will the 2016 AODA (Accessibility for Ontarians with Disabilities Act) deadline affect my business?

The purpose of the AODA (Accessibility for Ontarians with Disabilities Act) 2005 is to benefit all Ontarians by developing, implementing, and enforcing accessibility standards in order to achieve accessibility for Ontarians with disabilities. On June 3, 2011, the Ontario government released the final AODA Integrated Accessibility Standards regulation. The Ontario Government has definitely attempted to inform the public about accessibility laws and standards, but comprehending and applying the standards can be confusing and cumbersome.

When it involves communicating accessibly with your customers there are certain requirements that must be met by **January 1, 2016**, which will impact your organization.

Why is this date so important?

Under the Intergrated Accessibility Standards Regulation of AODA, private and not-for-profit organizations with 50+ employees who operate in Ontario must ensure they arrange for and provide **accessible formats and communication supports** for goods and services to people with disabilities.

AODA
Accessibility for Ontarians with Disabilities Act

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Desired Features

- Provide a safe pedestrian environment
- Provide comfortable accessibility for disabled users
- Document features and conditions
- Develop deficiency list
- Prioritize
- Manage and improve to meet needs

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Asset Inventory – Pedestrian Access Routes

- Need to know what you own or need to manage
- Identify asset categories

- Inlets
- Manholes
- Valve boxes
- Grates
- Crosswalks
- Median/Islands
- Ped Signals
- Ramps
- Trees
- Driveways
- Call boxes
- Fire hydrants
- Electrical boxes
- Trash cans
- Parking meters
- Bus stops
- Benches
- Traffic signals
- Street lights
- Subway stations
- Mail boxes
- Tree pits
- Planters
- Bollards
- Bicycle racks
- Signs
- Sidewalks
- Media boxes
- Awnings/canopies
- Street cafes
- Stairs/landings
- Hazard lights
- Speed control devices
- Lanes
- Curb/gutter
- Guardrail

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General Data Collection Methods

- Observation – Visual review to collect data such as asset type, material, delineation, mounting, orientation, etc.
- Imagery – Digital images to record condition and be used for other assessments
- Manual – Tape measure or rule to assess length, width and height
- Slope – Uses digital level to measure running and/or cross slope
- Contrast – Uses luminance meter to collect contrast data
- Sound – Measure ambient sound and signals
- Physical Location – GPS to determine coordinates to sub-meter accuracy

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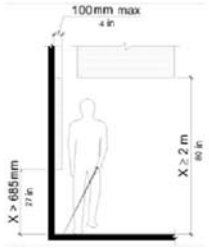
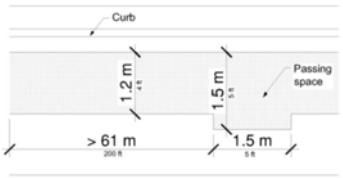
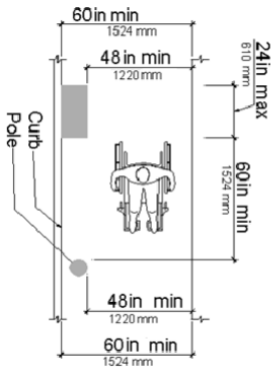
Pedestrian Access Route

- Sidewalks and other pedestrian circulation paths located in the public right-of-way
- Street crossings
- Medians and refuge islands







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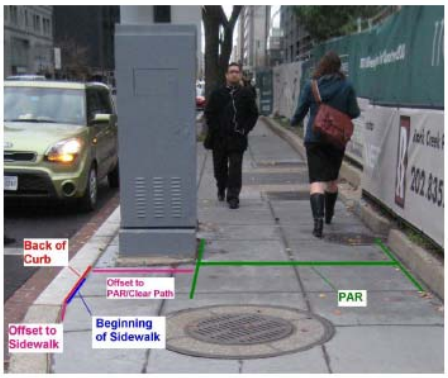
Sidewalks

- Total width
- Clear width
- Offset from curb
- Grade
- Cross-slope
- Material
- Stability of surface
- Slip resistance
- Trip hazard
- Surface openings



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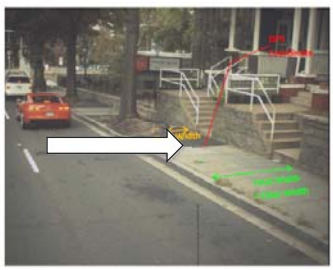
Common Obstructions

- Trees/roots
- Fences
- Utilities
- Bush/shrubs
- Drops
- Retaining walls
- Media boxes, trash bins
- Bus stops
- Path or sidewalk features



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ASTM Standard for Pathway Roughness

Standard Practice for Computing Pathway Roughness Index from Longitudinal Profile Measurements

1. Scope

1.1 This practice covers the mathematical processing of longitudinal profile measurements to produce a pedestrian pathway roughness statistic called the Pathway Roughness Index (PRI).

1.2 The intent is to provide a standard practice for computing and reporting an estimate of pathway roughness for sidewalks and other pedestrian surfaces.

1.3 This practice is based on an algorithm developed at the Human Engineering Research Laboratories sponsored by Access Board grants H133E070024 and H133N110011 and reported in a Transportation Research Board (TRB) paper(1).

1.4 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use.*

3.1.1.1.1 *Discussion*—Elevation measurements may be taken statically, as with rod and level (see Test Method E1364) or dynamically using a rolling inclinometer (see Test Method E2133)

3.1.1.2 *traveled surface roughness*—the deviations of a surface from a true planar surface with characteristics dimensions that affect vehicle dynamics, ride quality, dynamic loads, and drainage, for example, longitudinal profile, transverse profile, and cross slope.

3.1.1.3 *wave number*, *n*—the inverse of wavelength.

3.1.1.3.1 *Discussion*—Wave number, sometimes called spatial frequency, typically has units of cycle/m or cycle/ft.

3.1.2 *Definitions of Terms Specific to This Standard:*

3.1.2.1 *Pathway Roughness Index (PRI)*, *n*—an index computed from a longitudinal profile measurement using a standard 70 mm (2.5in.)

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Conclusions

- Sidewalks are important part of municipal infrastructure
- Safety is important
- Use the same care as when dealing with pavements
- There are benefits in having a good sidewalk management
- Design for people with disabilities

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