Banned in the USA? Achieving Accessibility with Unit Pavers

Presenters
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Human Engineering Research Laboratory
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Learning Objectives
1. Know ADA requirements and related guidelines for pedestrian surfaces and the public right of way.
2. Identify characteristics of paver surfaces that most significantly impact accessibility.
3. Understand jurisdictional restrictions on the application of unit pavers.
4. Specify installation and maintenance procedures that promote long-term accessibility.

How Did Pavers Become Pariah?

Advisory R302.7.1 Vertical Alignment.
Pedestrian access route surfaces must be generally planar and smooth...
Surfaces that are heavily textured, rough, or chamfered and paving systems consisting of individual units that cannot be laid in plane will greatly increase rolling resistance and subject pedestrians who use wheelchairs, scooters, and rolling walkers to the stressful and often painful effects of vibration. Such materials should be reserved for borders and decorative accents located outside of or only occasionally crossing the pedestrian access route. Surfaces should be designed, constructed, and maintained according to appropriate industry standards, specifications, and recommendations for best practice.

Smooth paver surfaces are possible when accessibility is considered in design, construction and maintenance.
Why Consider Pavers?

- **Accessibility** - Deliver superior performance when designed, installed and maintained with accessibility in mind
- **Sustainability** - Reduce runoff and improve its quality. Pavers can be made from recycled materials, are recyclable themselves and are available from regional sources.

**Ease of Maintenance** - Deficiencies tend to be localized, and spot repairs can typically be made with minimal manpower, simple tools and common materials.

Why Consider Pavers?

- **Durability** – Paver life often outlasts supporting layers and can be relaid when reconstruction is needed
- **Context** - Pavers made from materials that are ubiquitous and create harmony with buildings and landscape of all styles and periods

Accessibility Requirements

- Federal accessibility laws
  - Architectural Barriers Act (ABAAS, UFAS)
  - Section 504 of the Rehabilitation Act (UFAS)
  - Fair Housing Amendments Act (10 save harbors)
  - Americans with Disabilities Act (2010 ADA Standards)
- State and local laws
  - State human rights laws
  - Local human rights laws
  - Visit-ability
- Building codes (ANSI)
ADA Standards for Transportation Facilities

- DOT’s 2006 ADA Standards
  - Enforceable standard adopted by DOT in 2006
  - Apply to construction and alteration of transportation facilities covered by the ADA

Criteria for:

- Public streets and sidewalks
  - pedestrian access routes
  - street crossings
  - curb ramps
  - blended transitions
  - on-street parking
  - street furniture and other elements

Building Blocks

- Floor or ground surfaces
  - Stable, firm and slip resistant
- Openings
- Changes in level
- Turning space

Openings

http://www.access-board.gov/prowac/nprm.htm
Changes in level

Health Motivation (‘90s)

- WC users experience health consequences related to vibration
  - 60% of WC users report neck pain & discomfort
  - Postural issues are common among WC users

- Vibration Exposure Standards
  (ISO 10326 & 2631)
  - Provide measurement and analysis techniques
  - Provide exposure thresholds
**Related Research**

- **Roadloads (Van Sickle '94, '96, '97, '00, '04)**
  - Developed instrumentation to measure reaction force at caster and propulsion wheels of MWC & recorded data in-lab and in-home & during wheelchair testing.
- **Seating System Influence (DiGiovine 2000 & 2003)**
  - Influence of seating system on comfort and vibration exposure in-lab human trials
- **ICPI/BIA (Wolf, Cooper, Pearlman 2004 & 2007)**
  - Influence of surface features on vibration exposure
- **Suspension (MWC: Kwarcik; PWC: Wolf, 2008)**
  - Influence of suspension system on vibration exposure
- **Influence of Cushion (Pearlman, Garcia & Cooper, 2011)**
  - Characterization of the WC cushion transmissibility
- **Community Vibrations (Pearlman, Garcia & Cooper, 2012)**
  - Evaluation of MWC vibration exposure in the community

**ICPI/BIA Paver Vibration Research**

**Results:**

ICPI/BIA surfaces can result in lower exposure than poured concrete
- Larger bevel \( \rightarrow \) increased accelerations
- 90 deg herringbone better than 45 deg herringbone pattern

**Conclusion:** Surface design important, influential and have measurable effect on vibration exposure to WC riders.

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Concrete</td>
<td>0.45±0.07</td>
<td>0.37±0.08</td>
<td>0.42</td>
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<tr>
<td>Surface 2</td>
<td>0.32±0.06</td>
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<td>Surface 8</td>
<td>0.48±0.06</td>
<td>0.40±0.05</td>
<td>0.47</td>
<td>0.38</td>
</tr>
</tbody>
</table>

**RMS Manual vs. Power Wheelchair**

- **Manual Slope** = 3.57
- **Manual R²** = 0.7385
- **Power Slope** = 1.22
- **Power R²** = 0.48

**Goals of Current Access Board and ICPI/BIA Projects**

1. Characterize relationship between calculated surface roughness, measured vibrations and user-response
2. Develop ‘threshold’ roughness which is both comfortable and safe for users
3. Design a surface roughness measurement device for industry use
4. Promote threshold and relevant measurement techniques through publications and standards
Profile measurement and Roughness Index Calculation

Use IRI as a model (Distance/Distance)

Power wheelchair base

Wheel encoder

IR Laser measurement device measuring vertical distance to ground approximately every 1mm

Simulated Surfaces

<table>
<thead>
<tr>
<th>Surface</th>
<th>Roughness Index (in/ft)</th>
<th>Crack Frequency (in)</th>
<th>Crack Width (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.20</td>
<td>No cracks</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0.29</td>
<td>12</td>
<td>0.80</td>
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<tr>
<td>3</td>
<td>0.36</td>
<td>8</td>
<td>0.80</td>
</tr>
<tr>
<td>4</td>
<td>0.53</td>
<td>12</td>
<td>1.25</td>
</tr>
<tr>
<td>5</td>
<td>0.53</td>
<td>4</td>
<td>1.25</td>
</tr>
<tr>
<td>6</td>
<td>0.64</td>
<td>8</td>
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<td>0.84</td>
<td>8</td>
<td>1.55</td>
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<tr>
<td>8</td>
<td>1.10</td>
<td>4</td>
<td>1.25</td>
</tr>
<tr>
<td>9</td>
<td>1.36</td>
<td>8</td>
<td>2.50</td>
</tr>
</tbody>
</table>

Surfaces

Possible limits

Average RMS Accelerations (m/s²) vs. Engineered Seat RMS

Lower Bound of < 10 min

Middle of 30 min

Middle of 60 min
Questionnaire Results: Rating

- **Questionnaire Results: Rating**
  - **Roughness Index (in/ft)**
  - **Rating**
  - **Perfect 5.0**
  - **Very Good 4.5**
  - **Good 4.0**
  - **Fair 3.5**
  - **Poor 3.0**
  - **Very Poor 2.5**
  - **Impassable 2.0**

- **Questionnaire Results**
  - **% Acceptable**
  - **Average = .90 in/ft**

Deciding on a roughness threshold

- **Limit Description**
  - **Roughness (in/ft)**
  - 75% Acceptable: 0.71
  - 50% Acceptable: 1.12
  - 3.5 Rating: 0.59
  - 2.5 Rating: 1.10
  - Lower limit of <10 min.: 1.28
  - 30 min: 0.91
  - 60 min: 0.58

ADAAG

1. Running slope: 1:20
2. Cross-slope: 1:50
3. Level changes: ¼” or ½” with bevel
4. Surface Roughness
   - “Surfaces should be stable, firm & slip-resistant”
Pathway Measurement Tool (PathMeT)

Asset Management
- Roughness Index
- Lippage/Step Height
- Flatness
- Running Slope
- Cross Slope
- Location (GPS)
- Photograph

Rating Data: Simulated Surfaces

Indoor Subject Rating

<table>
<thead>
<tr>
<th>Rating</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect</td>
<td>75%</td>
</tr>
<tr>
<td>Very Good</td>
<td>50%</td>
</tr>
<tr>
<td>Good</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Fair</td>
<td>Acceptable</td>
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<td>Poor</td>
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<td>Very Poor</td>
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<td>Impassable</td>
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Roughness Index (in/ft)

Community Surface Results

Acceptable

Unacceptable

Recommendations: Joint Width

- Sand joints max. \( \frac{3}{16} \) in.
- Mortar joints max. \( \frac{1}{2} \) in.
- Wider joints permit more of a caster to fall between them
- Consider joint profile
**Recommendations: Chamfer size**

- Edge treatment determines **effective** joint width
- ¼ in. (6 mm) max chamfer or radius

**Recommendations: Bond Pattern**

90° herringbone appears to produce less vibration than 45°, particularly with increasing bevel heights

**Recommendations: Permeable Pavements**

Consider “opening” requirements

Accessibility should be similar to sand-set pavers when joints do not exceed ½ in.

**Recommendations: Installation**

- Observe industry tolerances for all pavement layers
  - Max ± 3/8” (10 mm) in variation from level in 10 ft. (3 m)
  - Max 1/8” (3.2 mm) vertical lippage for square-edged pavers (1/4” [6 mm] for chamfered)
- Compact properly to discourage settling/rutting
Recommendations: Maintenance

• Inspect at least yearly for accessibility issues and repair problems promptly
• Refill joint sand when necessary to maintain interlock
• Remove snow and ice as quickly as possible

For further information including:

• A full set of presentation slides;
• BIA Technical Note 14E, “Accessible Clay Brick Pavements”
• And much more visit www.gobrick.com/aslapavers

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