Urban Acoustics
Presented By:

Thorburn Associates
ACoustical, Technology, AND Lighting Design

Design Professionals

Acoustics
Room Acoustics
Sound Isolation
Mechanical Noise
Vibration Isolation
Environmental Noise

Technology
Audio Video Systems
Telepresence
Sound Masking/Paging
Structured Cabling
Security

Lighting
Lighting Design
Fixture Layout
Fixture Specification
Controls
Daylighting

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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Urban Acoustics

Steve(n) Thorburn, PE, LEED AP, CTS-I, CTS-D, Thorburn Associates

As with any issue of building performance, the acoustics of a mixed-use wood-frame structure can be designed to meet or far exceed minimal requirements. It is the responsibility of the design team to determine acoustical expectations for the project and meet them within the available budget.

Through the use of case studies, this fast-paced, interactive session will explore how multi-story wood systems can be used to meet acoustical privacy goals. Discussion will focus on the detailing and construction of units, and how consideration of the construction process can help keep acoustical costs down.

With the objective of providing implementable solutions, the session will include construction details and photos showing what has and hasn’t worked in actual buildings.

WoodWorks
Learning Objectives

At the end of this program, participants will be able to:

- Evaluate the acoustical impact of ICC Building Code vs. Residential Expectations
- Develop cost effective / acoustically centric space planning ideas for wood frame design
- Produce practical and constructible acoustical isolation detailing for wood frame design
- Identify common acoustical compromises during construction

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The Building Code

Acoustical Expectations

Luxury? Market Rate? Entry Level?

FHA Rules of Thumb from 1962

NOTE THIS IS NOT A CODE, IT HAS BECOME the DE FACTO STANDARD BUT NOT CODE

Entry Level Housing
STC 50 / IIC 50 (STC/IIC 48)*

Market Rate Housing
STC 55 / IIC 55 (STC/IIC 52)*

Luxury Rate Housing
STC 60+ / IIC 60+ (STC/IIC 55)*

IIC 60+ very hard to achieve with wood or tile surfaces

* Actual 1962 values - adjust when IBC set “50” as minimum

ICC G2 2010 Guideline for Acoustics

STILL NOT A CODE, IT IS FROM THE ICC – FROM WHAT APPEARS TO BE A RESEARCH PAPER FROM THE INTERNET!

Acceptable Performance
“Grade B Performance”
55 / 52
(Laboratory / Field)
Airborne - STC / NNIC
Impact - IIC / NISR

Preferred Performance
“Grade A Performance”
60 / 57
(Laboratory / Field)
Airborne - STC / NNIC
Impact - IIC / NISR
**Land Use Compatibility For Community Noise**

<table>
<thead>
<tr>
<th>Land Use Category</th>
<th>Exterior Day/Night Noise Levels (Ldn, dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55  60  65  70  75  80</td>
</tr>
<tr>
<td>Single Family</td>
<td>![Diagram]</td>
</tr>
<tr>
<td>Multi Family</td>
<td>![Diagram]</td>
</tr>
<tr>
<td>Motel, Hotels</td>
<td>![Diagram]</td>
</tr>
<tr>
<td>Outside Use</td>
<td>![Diagram]</td>
</tr>
</tbody>
</table>

**Exterior to Interior**

**Mixed Use – Bar to Housing**

**Commercial to Residential**

BEFORE

GET RID OF THE PROBLEM
Commercial to Residential

Not Addressed by Building Code
- Implied at 45 dBA/Ldn
  (Interior Noise Criterion)
- Enforced as Nuisance Complaints

Urban Acoustics
Vocabulary

Terms (They Are Changing!)

<table>
<thead>
<tr>
<th>General</th>
<th>Sound</th>
<th>Impact</th>
<th>Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR</td>
<td>STC</td>
<td>IIC</td>
<td></td>
</tr>
<tr>
<td>dBA</td>
<td>FSTC</td>
<td>FIIC</td>
<td></td>
</tr>
<tr>
<td>Ldn</td>
<td>NIC</td>
<td>AIIC</td>
<td></td>
</tr>
<tr>
<td>CNEL</td>
<td>ASTC</td>
<td>NNIC</td>
<td></td>
</tr>
<tr>
<td>OITC</td>
<td></td>
<td>NISR</td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td></td>
<td></td>
<td>NRC</td>
</tr>
</tbody>
</table>
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Acoustical Wall Systems

Acoustical Detailing – The Givens

- Walls are Full Height (Deck to Deck)
- Insulated (Unfaced Batt) In all Stud or Joist Cavities
- Sealed Air Tight
- Floor Sheeting Is Glued and Screwed

Wall Progression – Sound Isolation

STC 34  STC 38  STC 45

STC 50  STC 63  STC 49
Metal Channels

Hat Channels Are **Not** Acoustical Channels

Resilient Channels Are Acoustical Channels

Resilient Channel Comparison

Puck Resilient Isolator

Lot Line Wall – Sound Isolation

STC-63  STC-48  STC-53  STC-58
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Acoustical Floor / Ceiling Systems
Sound and Impact

Floor Systems

STC 37

Floor Systems

STC 43

Floor Systems

STC 49
Floor Systems – Topping Slab

Gypcrete or Light Weigh Concrete

Floor Systems

STC 56

Floor Systems

STC 62

Floor Systems

Batt insulation not show for clarity
Floor Systems

Batt insulation not shown for clarity
Impact Isolation

- Impact noise changes as it travels in the building.
- Impact noise is best controlled at the source.

Effects of Floor Covering on Impact Isolation

<table>
<thead>
<tr>
<th>Floor Covering</th>
<th>IIC 73</th>
<th>IIC 64</th>
<th>IIC 56</th>
<th>IIC 43</th>
<th>IIC 32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Carpet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thin Carpet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceramic Backed Vinyl</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plywood Joint</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gypsum Board</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resilient Channel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

STC 56

Batt insulation not show for clarity

Cross-Laminated Timber

About CrossLam

Cross Laminated Timber have many of the benefits that other building materials just don't have:
- Up to 6 times lighter than concrete

We Need More Test Data

In absence of test data we compare to known acoustical systems

ACOUSTICALLY STILL REALLY NEW
Cross-Laminated Timber

**Table 3**

<table>
<thead>
<tr>
<th>Number of Layers</th>
<th>Thickness in. (mm)</th>
<th>Area Mass lb./ft² (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2.16 (60)</td>
<td>6.14 (38)</td>
</tr>
<tr>
<td>5</td>
<td>4.61 (117)</td>
<td>11.98 (38.3)</td>
</tr>
<tr>
<td>7</td>
<td>7.87 (200)</td>
<td>28.40 (180)</td>
</tr>
<tr>
<td>7</td>
<td>7.95 (202)</td>
<td>28.60 (181)</td>
</tr>
<tr>
<td>8</td>
<td>9.76 (246)</td>
<td>25.40 (124)</td>
</tr>
<tr>
<td>10</td>
<td>12.40 (320)</td>
<td>32.77 (180)</td>
</tr>
</tbody>
</table>

"Volume generally assumed for the density of hardened concrete is 150 lb./ft³ (2400 kg/m³)"  

**McGraw-Hill Encyclopedia of Science and Technology.**

6 inch thick 20 lb./ft³. CLT  
Same Mass as 1.6 inch thick Concrete  
Based on Acoustics  
Mass Law STC Rating about 38 STC

Cross-Laminated Timber

**Table 4**

<table>
<thead>
<tr>
<th>Number of Layers</th>
<th>Thickness in. (mm)</th>
<th>Assembly Type</th>
<th>STC</th>
<th>IIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3.74 - 4.53 (95-115)</td>
<td>Wall</td>
<td>32-34</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>5.31 (135)</td>
<td>Floor</td>
<td>39</td>
<td>23</td>
</tr>
<tr>
<td>7</td>
<td>5.75 (146)</td>
<td>Floor</td>
<td>39</td>
<td>24</td>
</tr>
</tbody>
</table>

Measured on field bare CLT wall and floor (Hsu, 2013b)

<table>
<thead>
<tr>
<th>Number of Layers</th>
<th>Thickness in. (mm)</th>
<th>Assembly Type</th>
<th>FSTC</th>
<th>FIIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4.13 (105)</td>
<td>Wall</td>
<td>28</td>
<td>N/A</td>
</tr>
<tr>
<td>7</td>
<td>8.19 (208)</td>
<td>Floor</td>
<td>N/A</td>
<td>25</td>
</tr>
</tbody>
</table>

70+ IIC 35

Cross-Laminated Timber

70+ IIC 35
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Leaks - Doors and Windows

Leaks: Where air can flow... so will sound.

Air Tight Seal

Insulation
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Other Issues to Consider

Acoustical Fiction!
- Fiber Board

Acoustical Fiction!
- Trapped Channel

Plumbing Isolation
OMG! THIS IS VERY BAD! DO NOT BELIEVE THE INTERNET!
When it comes to Acoustics

Only Believe Real Laboratory

Test Data or Someone you Pay

and can Sue!

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This concludes The American Institute of Architects Continuing Education Systems Course

Steve(n) Thorburn, PE, LEED AP
Thorburn Associates Inc.
SJT@TA-Inc.com

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Credits

- California Noise Control Office – Green Book (out of print)
- USG – Acoustics Collection of STC test reports (out of print)
- FHA – Multifamily housing (out of print)
- EPA – Levels document (out of print)
- USG Handbook for Gypsum Board Installation
- ICC G2 2010 Guideline for Acoustics
- Clark Dietrich Metal Framing -- www.clarkdietrich.com/
- PAC International, Inc. (Risc-1 Isolator) - http://www.pac-intl.com/
- Gyp-Crete -http://www.maxxon.com/
- Ceramic Tile Institute of America -- http://www.ctiaa.org/
- Mullins Acoustics -- http://mullinsacoustics.com/
- Lilly Acoustics -- http://www.jglacoustics.com/
- WoodWorks.org
- Cross-Laminated Timber Handbook

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Thank You!!!
Steve(n) Thorburn, PE, LEED AP
sjt@TA-Inc.com

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ACOUSTICAL, TECHNOLOGY, AND LIGHTING DESIGN