Architecture and Acoustic Design in Green Buildings

Indian GBC
Green Building Congress 2011
New Delhi, India
20 October 2011

Objective:

Understand why IEQ – “Acoustic Comfort” is important in buildings, and should be included in codes, standards, and design guidelines

Observations:

1. Buildings are designed, constructed, and operated primarily for the purpose of providing healthy and productive spaces for “People” to work and live.

2. “Acoustic Comfort” means providing an acoustic environment that is conducive to speech intelligibility, speech privacy, low distractions and annoyance, and concentration where appropriate.

3. Current approaches to building design and construction are not meeting the occupants IEQ – Acoustic needs (CBE).

Outline

1. Architecture & Acoustics - Global
   - Building Use and Acoustic Needs
   - Design Practice for Acoustics - USA
   - Space Design to meet Acoustic Needs
   - Closed and Open Spaces
   - Conference Rooms
   - Building IEQ-Acoustics - Global
   - PCF: Surveys of Occupant Satisfaction
   - CBE Survey Results
   - Green Building Rating Systems
   - GBC and Acoustic Requirements
   - USA Green Rating Systems
   - India Green Rating System

Acoustic Standards Development

ASA: Acoustical Society of America, elected Fellow 1999
- Member TCA Technical Committee on Architectural Acoustics
- Member ASTM Committee E05 on Environmental Acoustics
- Member ASTM Committee E02 on Biological Effects of Sound
- Member TCA Technical Committee on Architectural Acoustics

ASTM: ASTM International
- Member Committee E05 on Environmental Acoustics
- Member Committee E02 on Biological Effects of Sound

ASHRAE: American Society of Heating, Refrigerating, and Air-Conditioning Engineers
- Member TC11 Technical Committee on Indoor Environment
- Member TC11 Technical Committee on Physiology and Human Environment

AES: Audio Engineering Society
- Member TC2: Acoustics and Audio Equipment

ANSI: American National Standards Institute
- Member TC20 Technical Advisory Group on Audio and Musical Instruments

ISO: International Organization for Standardization
- Member TC220: Building Environment Design - Indoor Acoustic Environment

USGBC: US Green Building Council
- Member: Judges - Masters - Expert - Auditors

Publications & Presentations (since 1995):
- Over 80 publications in 30 journals, trade magazines and conference proceedings
- Over 100 seminars on Architectural Acoustics in 18 countries
- Invited lecturer at 18 universities in 6 countries.

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1. Architecture & Acoustics - Global

Office Buildings

<table>
<thead>
<tr>
<th>Building Use and Acoustic Needs</th>
<th>Intelligibility within</th>
<th>Privacy between</th>
<th>Sound Quality</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Office</td>
<td>high</td>
<td>high</td>
<td>medium</td>
<td>high</td>
</tr>
<tr>
<td>Conference</td>
<td>high</td>
<td>high</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>Open Plan</td>
<td>medium</td>
<td>medium</td>
<td>low</td>
<td>high to low</td>
</tr>
<tr>
<td>Call Center</td>
<td>low</td>
<td>low</td>
<td>low</td>
<td>medium</td>
</tr>
</tbody>
</table>

2. Design Practice for Acoustics - USA

Open Plan Design

<table>
<thead>
<tr>
<th>Confidential Privacy</th>
<th>Management Office</th>
<th>HR Office</th>
<th>Legal Office</th>
<th>Conference Room</th>
</tr>
</thead>
</table>

Education Buildings

<table>
<thead>
<tr>
<th>Building Use and Acoustic Needs</th>
<th>Intelligibility within</th>
<th>Privacy between</th>
<th>Sound Quality</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom</td>
<td>high</td>
<td>low</td>
<td>medium</td>
<td>high</td>
</tr>
<tr>
<td>Lecture Hall</td>
<td>high</td>
<td>low</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>Cafeteria</td>
<td>medium</td>
<td>low</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Assembly Rm</td>
<td>medium</td>
<td>low</td>
<td>medium</td>
<td>low</td>
</tr>
</tbody>
</table>

2. Design Practice for Acoustics - USA

Office

Closed Plan Design

- High Intelligibility within
- High Privacy between

For walls to ceiling, confidential privacy

Balanced Design

A: Absorb reflected sound w/med NRC ceiling
   * .70 to .55 NRC
B: Block direct sound w/partition & ceiling
   * min. 35 STC wall & 35 CAC ceiling
   * pref. 45 STC wall & 40 CAC ceiling
C: Cover speech intrusion w/masking sound
   * Masking @ 43 dBA

ASMI standards C62, E86, E1404, E1371 (manufacturer standards)
2. Design Practice for Acoustics - USA

Office

Productivity

open plan design

• Knowledge Worker
• Administrative
• Clerical
• Call Center
• Teaming

Office

Open Plan Design

No Privacy
Clerical

Low Privacy
Administrative

Normal Privacy
Professional

Office – Knowledge Worker

Open Plan Design

balanced design

For knowledge workers, non-intrusive privacy

A: Absorb reflected sound w/ high AC ceiling
   210 AC - 170 AC

B: Block direct sound w/ divider
   72 in. - 60 in. high, landscape layout

C: Cover speech intrusion w/ masking sound
   Masking @ 48 dBA

ASTM standards: E1111, E1113, E1371 (measurements standards)

Office

Productivity

Call Center Design

Armstrong
2. Design Practice for Acoustics - USA

Office – Call Center

- Low Intelligibility/Privacy, within adjacent
- Reduced distant distractions

For call center workers, low distractions from a distance

A: Absorb distant sound w/ high NRC ceiling
   0.95 NRC ~ 0.60 NRC

B: Not Blocking direct sound w/ low divider,
   but use 0.70 NRC landscape furniture

C: Cover speech intrusion w/ masking sound
   Masking @ 48 – 46 dBA

Call Center Design

Balanced Design

Architecture & Acoustics:

2. Design Practice for Acoustics - USA

Education - Classroom

Hearing speech is not sufficient .... It must be understood!

For Speech to be Intelligible we must:

1. Design for Sound Clarity w/ Architecture and Acoustics
2. Protect Sound Clarity w/ Mechanical System Design

2. Design Practice for Acoustics - USA

Education

Sound Clarity – RT

Sound Clarity Factors:
1. Direct sound has clarity
2. Want 'early' reflections
3. Don't want 'late' reflections
4. Don't want echoes

Architecture & Acoustics:
1. Size of room
2. Shape of room
3. Surface treatment

Controlling Sound Reflections:
1. Acoustical ceiling tile
2. Sound absorbing wall elements
3. Sound absorbing 'space' elements
4. Carpet

Education - Classroom

Protecting Clarity w/ low Background Noise

Controlling Noise:
1. Environmental – Walls, exterior and interior
2. Heating/Ventilation – Mechanical Design
3. Room noise (activity) – Sound Absorption

ANSI S12.00 P L, BGN = 35 dBA max. (design standard)
3. Building IEQ and Acoustics - Global

POE all USA and Australia Bldgs

Summary - Occupant Satisfaction 2011

Average Score by Category

- General Satisfaction
- Building Health
- Office Layout
- Office Productivity
- Thermal Comfort
- Air Quality
- Lighting
- Acoustic Quality
- Ownership and Maintenance

USA (N=53635)
Australia (N=3891)

3. Building IEQ and Acoustics - Global

POE all USA and all LEED USA Bldgs

Summary - Occupant Satisfaction 2011

Average Score by Category

- USA (N=53635)
- LEED USA (N=9492)

3. Building IEQ and Acoustics - Global

POE all LEED USA Buildings

Summary - Occupant Satisfaction 2011

Average Score by Category

- Platinum LEED USA (N=122)
- Silver LEED USA (N=87)

3. Building IEQ and Acoustics - Global

4. Green Building Rating Systems

GBC and Acoustic Requirements

LEED Rating Systems

LEED - Market Sector Rating Systems

- LEED - NC
- LEED for New Construction
- LEED for Operable Façades
- LEED for Existing Buildings
- LEED for Commercial Interiors

- LEED - EB
- LEED for Existing Buildings
- LEED for Commercial Interiors
- LEED for Core & Shell

- LEED - CI
- LEED for Commercial Interiors
- LEED for Core & Shell

- LEED - CS
- LEED for Commercial Interiors
- LEED for Core & Shell

- LEED - H
- LEED for Homes

- LEED - M
- LEED for Mattress

- LEED - ND
- LEED for Neighborhood Development

- LEED - R
- LEED for Retail

- LEED - SR
- LEED for School

- LEED - SC
- LEED for Student Housing

- LEED - T
- LEED for Retail

- LEED - R2C
- LEED for Residential

- LEED - N
- LEED for Neighborhood

- LEED - I
- LEED for Interiors
4. Green Building Rating Systems

Materials and IEQ - Acoustical LEED Credit Areas

<table>
<thead>
<tr>
<th>Sustainable Sites</th>
<th>Water Efficiency</th>
<th>Energy &amp; Atmosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>18%</td>
<td>6%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Materials & Resources 20%

Acoustical products:
- Recycled content
- Product is recyclable
- Low VOC emissions
- Made from renewable feedstock
- Design for safety
- Design for disassembly
- Increases energy efficiency
- Positive carbon footprint

OFFICE: Innovation Credits - Acoustics

<table>
<thead>
<tr>
<th>Total Points</th>
<th>Acoustic Points</th>
<th>Acoustic Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI/GBI</td>
<td>1000</td>
<td>22</td>
</tr>
<tr>
<td>LEED2009</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>CHPS</td>
<td>85</td>
<td>3</td>
</tr>
<tr>
<td>BREEAM</td>
<td>85</td>
<td>3*</td>
</tr>
<tr>
<td>CASBEE</td>
<td>20</td>
<td>5*</td>
</tr>
<tr>
<td>Green Star</td>
<td>146</td>
<td>2</td>
</tr>
</tbody>
</table>

Table. Acoustic credits as a percent of the overall credits available for sustainable design.
4. Green Building Rating Systems

OFFICE: Innovation Credits - Acoustics

**LEED 2011 For India**

**ID Credit 1: Innovation in Design**

**LEED Points**

1 point

**Earned**

To provide clients new and creative ideas or improve in areas which are exceptional for the LEED 2011 for India Rating System. The unique innovation or performance must be documented through a LEED Project Credit Application.

**Requirements**

Credit may be awarded through any combination of the innovation in Design and Energy Performance goal within the LEED Rating System.

**Getting Started**

Identify the following as a strategy:

- The use of innovative design tools
- The proposed integrated design approach
- The proposed solutions in innovative concepts
- The design approach (example) is not used for requirements.