Wood Specification: Acoustics

For centuries, wood has been the material of choice for architects and designers intent upon delivering the highest quality of acoustic performance. From a violin to an entire concert hall, wood plays a role in delivering memorable acoustical experiences. Wood produces sound by direct striking and it amplifies or absorbs sound waves that originate from other bodies. For these reasons, wood is an ideal material for musical instruments and other acoustic applications, including architectural ones.

Why Acoustic Performance Adds Value

- Architects and designers have a responsibility to design functional and safe environments. It is very difficult, if not impossible, to meet these goals without considering acoustics. Moreover, it is extremely challenging to deal retroactively with poor acoustic environments. Doing so can severely impact a building's value.
- Privacy is a major issue for building occupants. Designers must provide for adequate levels of sound insulation. Acoustical problems arise when sound transmits through the structure or when reverberation occurs via hard reflective surfaces. Sometimes fire safety design features can have deleterious effects on sound transmission because of the requirements for hard, non-combustible materials, wall and floor penetrations, etc.
- Post-occupancy evaluations of buildings have revealed that poor acoustic performance is a common problem in buildings with large areas of hard, acoustically reflective surfaces. Such surfaces are frequently found in green buildings where the use of absorbent surfaces is often minimized due to indoor air quality concerns.
- Wood is not as acoustically lively as other surfaces and can offer acoustically absorptive qualities. Generally, a wood-finished building is not as noisy as a complete steel or concrete structure.
- Most green building rating systems do not recognize the importance of acoustic performance.

Richmond Olympic Oval Roof

How to Include Acoustic Performance in Design

- Acoustics are integral to the functioning of almost every type of indoor environment, from open offices to worship centers. Some building environments can even become dangerously loud and therefore unsafe for the occupants. In order to effectively address these issues, building acoustics should be considered in the design phase.
- Optimal acoustic design must consider a wide range of factors, such as building location and orientation, planning and location of sound-sensitive functions, adequate insulation of partitions, insulation or spatial separation of noisy mechanical equipment, and measures to enhance audibility.
- To determine the effects of a material's surface on the acoustics, the acoustic absorption and scattering properties of the material's surface are measured. Any unabsorbed sound energy is reflected back into the space. Not only does the amount of sound energy reflected by a surface affect the sound field, but where the energy is reflected to is also a major factor. The extent to which sound energy is scattered over a defined area, relative to absorption, is of importance to acousticians.

Terminology

Sound Transmission Class: determined in accordance with American Society for Testing and Materials' ASTM E 413 Standard Classification for Rating Sound Insulation.

Impact Insulation Class: calculated according to American Society for Testing and Materials' ASTM E 989 Standard Classification for Determination of Impact Insulation Class.

Post-occupancy evaluation: involves systematic evaluation of opinion about buildings in use, from the perspective of the people who use them. It assesses how well buildings match users' needs, and it identifies ways to improve building design and performance, and fitness for purpose.

Resources

www.acoustics.com: provides a comprehensive range of resources including a database of products, design guides, and best practices.

What to Ask Suppliers

- Acquire Sound Transmission Class and Impact Insulation Class ratings for key components and assemblies, and for any potential interior finishes used as acoustical controls.
- Learn about any synergistic environmental benefits, such as indoor air quality performance and whether the product is certified by a third-party forest certification system.

Procedure

- Consider ambient noise issues during schematic design: site the building, and the zone spaces within the building, to provide occupants with protection from undesirable outside noise.
- Specify in the contract documents an appropriate Sound Transmission Class rating of perimeter walls in terms of response to external noise levels.
- Provide noise attenuation of the structural systems and implement measures to insulate primary spaces from impact noise.
- Mitigate acoustical problems associated with mechanical equipment, and mitigate noise and vibration associated with plumbing systems.
- Specify acoustical controls to meet the acoustical privacy requirements.
- Specify measures to meet speech intelligibility requirements for the various spaces and activities.
- If in doubt about any acoustical issue, retain the services of a qualified acoustics expert.

Standards and Best Practices for Acoustic Design in Buildings

Building codes used in the United States generally require sound isolation for multiple occupancy dwelling units. A Sound Transmission Class (STC) of not less than 50 is commonly specified. However, it is recognized that sounds may still be audible, though speech not understood, on the other side of a wall insulated to STC 50. For this reason, an STC of 60 is recommended in sensitive areas. Canadian research has identified the following sound-insulation objectives for multi-family buildings.

- Inter-unit walls and floors: Sound Transmission Class 55 or higher
- Inter-unit "hard" floors: Impact Insulation Class 55 or higher
- Inter-unit carpeted floors: Impact Insulation Class 65 or higher

Sources:International Building Code (Model Code), Chapter 12.
Burrows, J. and Craig, B. 2005. Sound Control in Multi-Family Wood-Frame Buildings. (http://www.soundivide.com/uploads/content_file/multi-family_sound-control-en-277.pdf)

University of Washington

In 2012, the University of Washington in Seattle added nearly 1,700 student housing beds by constructing three residential halls and two apartment buildings, all of which include five stories of wood-frame construction over two stories of concrete. Designed by Mahlum Architects and winner of a recent WoodWorks Wood Design Award, the 668,800-square-foot project is the first of four phases planned to add much-needed student housing to the urban campus.

"Acoustics are important for any multifamily housing project, but especially for student housing," says Anne Schopf, FAIA, a design partner with Mahlum. "Mitigation measures must be weighed against budget, which is why we brought in experts from Seattle-based SSA Acoustics for the design of this project."

Because they knew single stud walls would not provide adequate performance, SSA recommended staggered stud walls between residential units. Since there is no rigid connection between the gypsum board on each side (except at the plate), a staggered stud wall performs better than a single stud wall. Double stud walls perform better than a staggered stud design because plates are separated by an air space, so they used double stud walls between residential units and common spaces (e.g., lounges, staircases, and elevators) and service areas.

In the floor/ceiling assembly, they paid careful attention to the installation of resilient channels, which are often one of the main causes of failed floor/ceiling assemblies from an acoustical standpoint. In fact, there is a difference of 8 to 10 IIC and STC points between assemblies with resilient channels versus those without.

Channel installation has fairly straightforward requirements; for example, screws for the gypsum board should never touch the framing behind the resilient channel.

"We used enhanced acoustical walls between rooms in the same unit," says Mohamed Ait Allaoua, managing partner of SSA Acoustics. "Although not a typical approach in multifamily buildings, this is important in student housing projects where people within a relatively small space have different needs—if one student wants to watch TV in the living room, for example, while another is studying in the bedroom."