A Guide to Green Building Acoustics

Many buildings are now designed to meet the Leadership in Energy and Environmental Design (LEED) certification. LEED certified buildings tend to be designed by LEED accredited architects and other design professionals. As acoustic consultants, we are often asked to demonstrate our green credentials, and to submit evidence of our LEED experience. For most types of buildings, there are no specific acoustic requirements relating to LEED. However, there are acoustical performance criteria given in the LEED requirement for Schools for New Construction & Major Renovations. This guide aims to illustrate how BKL's acoustic design fits into green buildings and the LEED certification process.

BKL Consultants in Acoustics

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A recent survey of green buildings (mostly in the United States) indicated that the main drawbacks from the users perspective were poor acoustics (privacy and room acoustics deficiencies) and ventilation issues. BKL's efforts in Green Building design are tailored to provide acoustical recommendations that complement the building design and keep the buildings in which we are involved from the negative columns of future surveys of this nature.

Acoustic Design of Buildings

In general, we consider the acoustic performance of a space to be determined by the background noise in the space (NC, PNC, RC), the noise isolation from adjacent spaces (STC, NIC) and from the exterior (OITC), and the room acoustics (reverberation time, speech intelligibility). We control these acoustic parameters by providing sufficient attenuation to the HVAC systems, by designing appropriate room boundaries, and by selecting suitable room finishes.

LEED for Schools

LEED recommends that the Reverberation Time (RT) and Impact Insulation Class (IIC) in classrooms and other core learning spaces in schools are designed to meet the minimum acoustic performance requirements of ANSI Standard S12.60 - 2002 “Acoustical Performance Criteria, Design Requirements and Guidelines for Schools”.

LEED also recommends that the walls enclosing learning spaces meet the Sound Transmission Class (STC) requirements of the ANSI Standard, with the exception of windows, that must meet a minimum STC rating of 35.

The recommended maximum background noise levels in classrooms and other primary learning spaces should not exceed 40dBA (1 point) or 35dBA (2 points). Alternatively, background levels can be designed to achieve an RC level of 32 (1 point) or 27 (2 points) - as defined in Chapter 47 of the 2003 HVAC Applications ASHRAE Handbook.

Green Buildings

The LEED rating system considers the use of sustainable sites, the efficient use of water, energy efficiency and emissions to atmosphere, the use of materials and resources, the indoor environmental quality, and innovation in the design process. These green goals often result in significant acoustic challenges related to:

- Natural ventilation - to promote better air quality, and lower energy consumption
- Radiant cooling - to reduce cooling costs and costs of moving air
- Use of green materials

Natural Ventilation

Natural ventilation often requires large openings in the building envelope which can let in noise from traffic, aircraft and other environmental noise. Natural ventilation may also result in more openness between interior spaces which can lead to a loss of acoustic privacy.

Naturally ventilated buildings can be better designed acoustically by the use of air paths that are sound attenuated by labyrinths, lined elbows and silencers. However, these can reduce air-flow so much that traditional fans are required to overcome air resistance. This increases the cost and reduces the "green" initiative by requiring more energy.

Acoustically attenuated openings in the building envelope and acoustically attenuated passive stack systems have been successfully used in the design of naturally ventilated buildings. However, the buildings have to be designed around the requirements of both the ventilation system and the acoustic design. This includes site orientation and space planning. The ventilation systems can significantly affect both the internal and external appearance of the buildings.

Radiant Heating/Cooling

Passive heating/cooling uses concrete walls and floors to absorb heat during the day and to release it at night. Active systems provide greater control by incorporating cooling coils in the slabs to transfer heat to a central cooling system or from a central heating system. Airflow and its associated noise is consequently reduced.

Both passive and active systems require bare concrete surfaces for heating and cooling. Therefore they cannot be covered with the thermal insulation that results from an acoustic ceiling, or with any substantial amount of sound absorbing insulation. Hence, the surfaces available for acoustic treatment are limited, and this can reduce the room acoustic quality. Speech privacy in open plan offices is often significantly affected. Once a building is designed in this way, there is little possibility of acoustic remedy. Hanging baffles and absorbent screens can help the situation to some degree. However, the use of wall panels and ceiling panels is still preferred as the primary method of acoustic control.

Green Materials

Green materials are those that do not present any potential health hazards, and contain a proportion of recycled material, or at least can be recycled at the end of their useful lifetime.

Many acoustic finishes are fibrous and contain glass-fibre. Although there is little evidence to suggest that glass fibre acoustic insulation is hazardous to health, all fibrous materials tend to be viewed suspiciously, and some health care and education facilities demand that no glass-fibre based materials are used in new construction projects.

Glass-fibre based products are often recommended as duct-lining to control HVAC noise, and cross-talk noise transmission via ducts. Glass-fibre ceiling tiles and acoustic panels are generally proposed to control reverberation and encourage good speech intelligibility.

It is possible to use alternative materials such as "packless" silencers in HVAC systems, paper or wood-based products, and cotton or wool fibre based products, which have recently been made available. However, these products tend to be more expensive, have unknown life-spans, and may present other issues in relation to fire-retardation and the potential for mould growth.

Green Roofs

Green roofs are acoustically beneficial to buildings. They increase the mass of the roof, thereby improving sound isolation through the roof, they increase the damping of the roof and thereby reduce panel resonances. Therefore, green roofs are particularly beneficial for buildings close to airports or other elevated noise sources.

BKL Green Building Projects

We have worked on a number of green buildings where the building management system has dictated the use of exposed ceilings in classrooms and labs, and on other green buildings incorporating natural ventilation and energy saving features. These include:

- Richmond Olympic Speed Skating Oval - Cannon Design
- UBC ICICS/CS Expansion - Hotson Bakker Boniface Haden Architects
- SFU Technology and Sciences Complex (TASC1) - Stantec Architecture
- SFU TASC2 - Chernoff Thomson Architects
- SFU Arts and Social Sciences Complex (ASSC1) - Busby Perkins & Will Architects
- UBC Continuing Education - Hotson Bakker Boniface Architects
- UBC Biodiversity Building - Patkau Architects
- Telus William Farrell Atrium - Busby Perkins & Will Architects
- BC Gas (now Terasen) Operations Centre - MCM Architects
- VanDusen Botanical Gardens facilities renewal - Busby, Perkins & Will Architects

Conclusions

Green design initiatives should be introduced carefully, and should be fully co-ordinated with the acoustic requirements for the project. Design decisions need to be made in full knowledge of the trade-offs being made, so that poor acoustics, or the cost of reinstating satisfactory acoustic performance does not come as a surprise. For these reasons an acoustical consultant needs to be engaged early in the concept stages of a Green Building Project so that the acoustical design issues can be identified and addressed while the overall design is still at a stage to accommodate them.