For professional engineers in private practice

DECEMBER 2013

CANADIAN CONSULTING engineer

ENVIRONMENT 3
University of Waterloo

GROWTH SPURT
Toronto's New Skyscrapers

UNDER PRESSURE
Liability and Engineers

www.canadianconsultingengineer.com

By Brian Chapnik, PhD, P.Eng,
HGC Engineering

Here are four scenarios where building design has to be specially adjusted to overcome acoustical problems with HVAC equipment.

HVAC and Noise

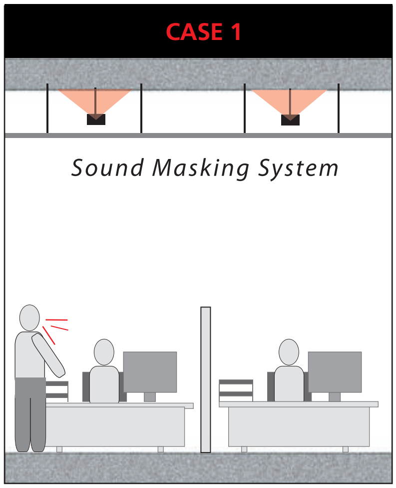
When reviewing HVAC systems in a building, the acoustical engineer is typically faced with some common design aspects that need to be considered: the sound insulation value of the walls and floor-ceiling assemblies of the mechanical room; the noise transmitted through ventilation ductwork; and ensuring that appropriate vibration isolation devices are applied on installed source equipment.

There are, however, more unusual cases in which the design of the HVAC system may have other less obvious impacts on the design of the building.

CASE 1 | Quiet or Silent Distribution Systems

In most commercial buildings, conditioned air is distributed on tenant floors through ductwork, with airflows regulated by adjustable or variable terminal devices. Air moving through these devices creates a certain amount of "bland" background sound. The sound, referred to as "masking" sound or colloquially as "white noise," generally has some beneficial effect, as a minimal amount of steady background sound is essential to creating a comfortable acoustical environment that allows for privacy of speech and freedom from distraction due to occasional spurious noises.

Some newer HVAC systems do not rely on ductwork distribution to deliver conditioned air. In the context of green building (LEED) designs, for example, convection-based systems such as passive chilled beams or other radiant finned-tube water distribution systems may be installed to provide heating and/or cooling. With no forced convection elements, these systems are generally silent and thus do not produce the bland steady background sound needed for masking. While these systems may achieve energy-efficiency objectives, they can require that consideration be given to providing electronic sound masking. This technology essentially consists of loudspeakers installed in a grid-like pattern in or above the ceiling, and a method of controlling their output to produce "white noise" at specifically engineered volume levels.



Similarly, some new office buildings have raised flooring throughout, which can be configured as a sealed supply-air plenum for distributing conditioned air. While the air from the plenum is released from terminal diffusers set into the access floor, the pressure in the plenum is so low that any sound produced by the diffusers is negligible. Thus except at locations near the building core where the compartment unit that pressurizes the plenum is typically located, background sound levels generated by the HVAC system tend to be very low. Again, such designs often require consideration of supplementary electronic systems for sound masking.

In both of the above cases there are additional complexities that may arise when a local air-conditioning device (e.g. a fan coil unit) is installed in one area of the floor, as the masking sound generated in that area is noticeably different than in other locations on the floor. However, the technology of electronic sound masking systems has improved to the point where it can readily address such complexities, incorporating computer-based algorithms for loudspeaker placement and wireless-based equalization to achieve consistent coverage throughout.

CASE 2 | Common General Exhaust Systems

In most hotels and some residential condominiums, exhaust air from the washrooms is evacuated through a common duct riser. This collected exhaust air is sometimes passed through a heat-recovery ventilator to reclaim some of the heat energy that would otherwise be lost by evacuating the riser directly outdoors, thereby achieving LEED performance targets.

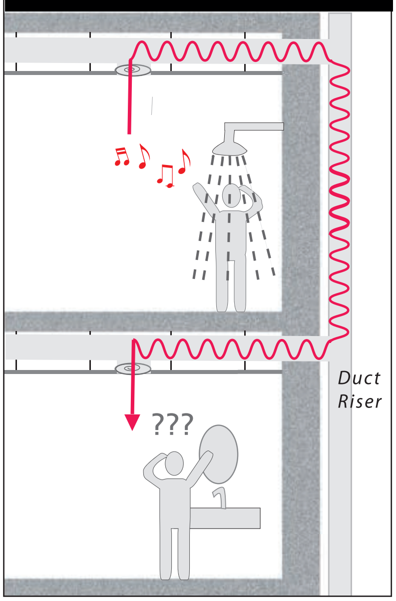
The exhaust grille in each washroom is connected to the common exhaust riser, creating a path through which sound may be transmitted between the spaces. In some situations, sound transferred via this path can be significant; past acoustic field testing of some of these conditions has indicated effective sound transmission class (STC) values that are approxi-

continued on page 18

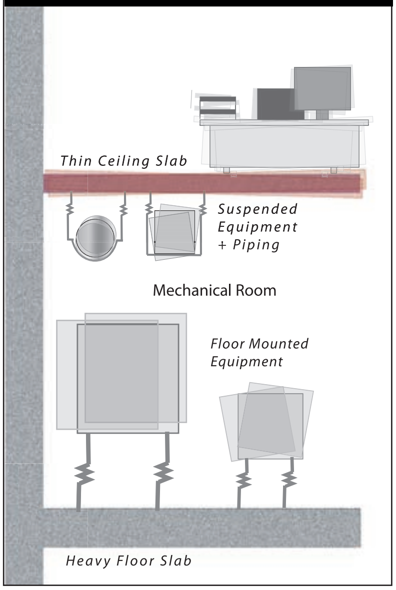
mately 10 points lower than the relevant building code requirement, with voices and other ambient sounds being clearly communicated through the exhaust grilles.

This issue is typically resolved by introducing some acoustically lined ductwork between the exhaust grilles and the vertical duct riser. This treated ductwork may take several different forms, including rigid ductwork with a neoprene-coated fibreglass blanket fastened to the inside of the duct walls, flexible metal ductwork with perforated walls and acoustic material behind, or flexible non-metallic ductwork with acoustic material wrapped around it. However, if not carefully implemented, these measures can lead to excessive restrictions of the airflow, resulting in washrooms not being adequately ventilated. While this difficulty can sometimes be overcome by including an additional "booster" fan behind the exhaust grille, small washroom exhaust fans are generally not designed for operating under any significant restrictions, and noisy operation can result. The overall net energy efficiency is also reduced. Careful consideration in design is required to achieve an optimal solution from all perspectives.

CASE 2



CASE 3



CASE 3 | Lightweight Ceiling Structures

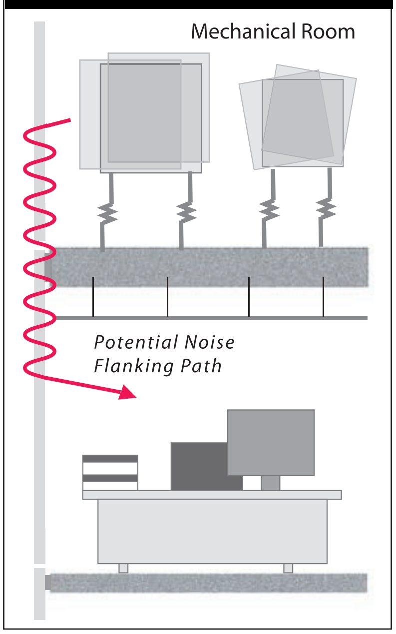
Generally, mechanical room floors are designed to be somewhat heavier than other floors in a building to support the increased loads associated with the equipment. The more robust floors also allow better vibration isolation between the equipment and the structure, using standard springs or other isolation mounts.

However, it is less common for the ceiling of a mechanical space to be upgraded structurally, despite the fact that some heavy equipment and piping may be suspended. Even good vibration isolators installed between the relatively lightweight ceiling and the suspended equipment or piping may not be sufficient to prevent transmitted vibrations from being perceptible on the floor above, as the effectiveness of the isolators is reduced by the dynamic reactivity of the structure. In some cases, the ceiling structure is considered inadequate to support heavy piping loads, and the pipes must be supported on independent stands back down to the floor. In these instances, noise/vibration from the pipes may be transmitted into the floor, and it is less straightforward to ensure that good vibration isolation is achieved. Additional isolation pads are sometimes included below the base plate of the support stands, a solution which can be expensive when there is a significant amount of lateral offset piping to be supported. The pipe stands also create obstacles within the mechanical room, making access for maintenance and repairs more difficult.

CASE 4 | Curtain Wall Buildings

In the past, noisy mechanical rooms for HVAC equipment generally included heavy concrete floors, sometimes with a secondary isolated slab above the structural slab, and masonry walls. In recent years, however, the amount of glazing in the building envelope has been increasing, so that even smaller institutional and commercial buildings include glass cur-

CASE 4



tain wall features. These features often extend into the mechanical and electrical room areas that contain noisy equipment.

High noise levels can easily excite a glass curtain wall, and the resulting vibrations can be transmitted through the curtain wall system to adjacent

continued on page 23

provide proper acoustic isolation and silencing for the generator intake and exhaust," Farkas explains. Features such as a floating floor, an acoustically insulated ceiling and walls, and mechanical services suspended from the slab above using spring isolators, helped to further reduce the noise level.

Farkas is confident that developers will continue to push residential towers ever higher. When they do, he expects that residential projects will have to embrace features traditionally reserved for commercial buildings. "The use of a mid-level mechanical room, which was used in the Trump tower, allows developers to consider staged occupancy, where the time lapse between the first and last occupancy dates might evolve from months to years. Depending on market conditions, a developer with plans for a 150-storey tower could build the first 75 storeys, place a mechanical room at that level, occupy the first part of the building, and resume construction at a later date," he says.

The Council on Tall Buildings and Urban Habitat is equally as optimistic that developers will continue to scrape the sky. "The need to create efficient, high-density districts for people to live and work is pushing skylines higher," the group concludes in a recent annual report. "There is no evidence that those factors will subside any time soon." **CCE**

John G. Smith is the president of Word-Smith Media in Ajax, Ont.

---

continued from page 18

areas "flanking" the floor system. In some cases, it is possible to protect the exterior wall with an additional internal partition located right behind it, designed to block noise. However, installing a large wall has a cost and it can create aesthetic issues. It can also create condensation concerns depending on the thermal design of the building envelope.

Some curtain wall suppliers have developed alternative solutions, in which the curtain wall elements immediately above the mechanical room floor slab are framed and supported independently of those below, with an isolation joint between. Such solutions tend to be more cost effective overall, although they may not be 100% effective in all cases, and supplementary treatments may still be needed in very noisy areas.

The above cases outline several areas in which special acoustical considerations may be warranted during the design of a building HVAC system. These considerations often arise from initiatives presented by a multi-disciplinary design team to achieve LEED green building goals related to energy efficiency, sustainability, or reduced subsystem costs, or to achieve a desired modern design aesthetic. However the design implications related to acoustics (and the costs to address the resulting issues) are not often well understood. Fortunately, it is more and more common to include an acoustical engineer on the multi-disciplinary team, to seek out and address these issues during design and help to develop the most appropriate and cost-effective solutions. **CCE**

Brian Chapnik, Ph.D., P.Eng., is a principal acoustical engineer with HGC Engineering of Mississauga, Ont. He has been involved in the design of HVAC systems in commercial, residential, and institutional buildings throughout Canada. www.hgcengineering.com.