Special—in this issue:

Designing to Reduce Noise with Precast Concrete

by Allen H. Shiner, P.E., Shiner + Associates, Acoustical Engineers
The prominent A & E firm, Stearns-Roger Corporation, selected prestressed concrete for their Glendale, Colorado, headquarters building. Why? Because it offers “excellent sound attenuation properties.” Also influential were its inherent fire resistance, low maintenance requirements, ready availability, and fast-track construction.

Exterior precast concrete spandrel beams support a long-span double tee floor system. These exposed aggregate spandrel beams are cantilevered as required to accommodate the unusual design. Exterior columns serve as vertical chases for ductwork and piping to supply the perimeter HVAC system.

**Architect/Engineer:** Stearns-Roger Architects, Ltd., Denver, Colorado

**General Contractor:** Stearns-Roger Incorporated, Denver

**Precast Prestressed Concrete:** Rocky Mountain Prestress, Inc., Englewood, Colorado
precast concrete

PRECAST AND PRESTRESSED CONCRETE:

Precast: 6900 LF (2100 m)
spandrels, 4600 LF (1400 m)
columns, 19,000 sq. ft. (1770 m²)
wall panels. Prestressed: 266,500
sq. ft. (24,800 m²) double tees,
4340 LF (1320 m) beams.
Airborne sound

Architectural acoustics seeks to provide a comfortable environment in which desired sounds are clearly heard, and noise is isolated or absorbed. Its importance to tenant satisfaction in all types of buildings cannot be over-estimated.

Good acoustical design uses both absorptive and reflective surfaces, sound barriers, and vibration isolators. Some surfaces must reflect sound so that the loudness will be adequate in all areas where listeners are located. Other surfaces absorb sound to avoid echoes, distortion, and long reverberation. Sound is isolated from rooms where it is not wanted by selected wall and floor-ceiling constructions. Vibrations generated by mechanical equipment must be isolated from the structural frame of the building which might carry them.

Sound barriers (insulation)

Sound insulation involves large reductions of sound from one space to another. This is achieved only by continuous, impervious barriers. If structure-borne sound is involved, layers of resilient material or air space may be introduced into the barrier.

Impact noises

Footsteps, dragged chairs, dropped objects, slammed doors, and plumbing generate impact noises. Structural concrete floors in combination with resilient materials effectively control impact sounds. For example, a carpet and pad over a bare concrete slab will increase impact noise reduction up to 56 points.

Because of the stiffness and density of the material, and the methods generally used in construction and sealing, concrete tends not only to be a better sound insulation barrier, but also to provide fewer openings through which sound may pass. Further, it is highly resistant to impact noise transmission and vibration.

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Airborne sound

Airborne sound travels as pressure waves. When it reaches a wall, floor, or ceiling, it produces vibrations which are radiated to the other side. The sound insulation value of walls and floor-ceiling assemblies is determined by their weight, stiffness, and other vibration-damping characteristics.

Weight is concrete's greatest asset when it is used as a sound insulator. Precast concrete walls, floors, and roofs usually do not need additional treatments in order to provide adequate sound insulation.

If desired, however, greater insulation can be obtained with a resiliently-attached layer of gypsum board or similar material. This helps reduce transmission because of the air space which tends to dissipate sound, and the additional mass of the board. The higher the number, the better the insulation.

Impact noises

Footsteps, dragged chairs, dropped objects, slammed doors, and plumbing generate impact noises. Structural concrete floors in combination with resilient materials effectively control impact sounds. For example, a carpet and pad over a bare concrete slab will increase impact noise reduction up to 56 points.
Efficiency depends on the characteristics of the carpeting and padding — their resilience, thickness, and weight. The combination of good carpeting on resilient padding is much more effective than so-called resilient flooring materials such as linoleum, rubber, asphalt vinyl, and vinyl asbestos, or parquet or strip wood floors applied directly.

Impact sounds may be further reduced by providing an airspace in the structure — for example, by adding a resiliently-mounted plaster or drywall suspended ceiling. Another possibility is a floating floor consisting of a second layer of concrete cast over resilient pads, insulation boards, or mastic.

Sound absorption
A sound wave always loses part of its energy as it hits a surface and bounces off. This occurrence is called sound absorption. A dense, non-porous concrete surface typically absorbs only 1 to 2 percent of sound striking it. Some specially fabricated units with porous concrete surfaces can absorb much more.

The sound absorption of precast concrete can easily be increased with a coating of sprayed-on acoustical material, acoustical tile applied with adhesive, or a suspended ceiling. Most spray-applied fire retardants also absorb sound.

Acceptable sound levels
A certain amount of continuous sound is easily tolerated without becoming noise. In fact, experiment has shown that an absolutely silent room, completely isolated from the sounds of surrounding life and nature, is not a very pleasant place in which to be.

Not all sound need be screened out. For example, in an office or apartment a certain ambient sound level is wanted to assure adequate privacy between spaces. So the level of acceptable sound for different places and activities has been standardized to guide the designer as “preferred noise criteria” (PNC).

Weak links
Doors and windows are often the weak link in an otherwise effective sound barrier. A proper selection of glass will often help. Glass should be mounted with care, both to eliminate noise leaks and to reduce the glass plate vibration.

Sound insulation of a door depends upon its material and construction, and the sealing between door and frame. For best results, adjacent door and window openings should be as far apart as possible, and held to a minimum area. Gaskets, weatherstripping, and raised thresholds serve as excellent thermal as well as acoustical seals.

Acoustical performance can be badly reduced by a small hole, or any other path which allows sound to penetrate or bypass the barrier. Common examples are openings around doors or windows, at electrical outlets, telephone and television connections, and pipe and duct penetrations. If walls do not extend beyond a suspended ceiling to the floor above, sound will travel to the rooms next door.

Starting with the design stage
The design stage is the time to prepare for sound conditioning. The greater the barrier’s sound insulation capacity, the more significant the effect of an unsealed opening in it. Openings for pipes, ducts, etc., should be as small as possible, and sealed airtight. As is usual in precast concrete construction, gaps at the edges of interior precast walls and floors should be sealed with grout or drypack.

Sound leakage often occurs at the intersection between an exterior curtain wall and floor slab. Sealing this gap is essential to the required fire stop between floors, as well as to acoustical integrity. One way to accomplish this is to insert a suitable mineral fiber mat.

Other helpful strategies include expansion or control joints, air gaps, floating floor systems, and full-height and/or double partitions whenever suspended ceilings are used.

Vibration
To prevent vibrations from heavy equipment from reaching other parts of the building, mounting the equipment on a heavy concrete slab on resilient supports is often effective. This treatment provides a low center of gravity to compensate for thrusts such as those generated by large fans.

For equipment with more balanced weight, a second slab may be placed below the mounts, for support and to raise the assembly off the floor for easier cleaning and inspection. This slab in turn may be mounted on pads of precompressed glass fiber or neoprene. The natural frequency of the total load on resilient mounts must be well below the frequency generated by the equipment.

Details available
A more detailed explanation of the points made here is available from PCI. Acoustical Properties of Precast Concrete (JR-198) includes code criteria, design data, examples, and references. Cost is $4, $2 to PCI members.
"Excellent acoustic isolation between apartments," say architects

Developers know that really good soundproofing in multi-family housing attracts and helps hold tenants. In this HUD turnkey project, the Daniel F. Burns Apartments in North Cambridge, Massachusetts, quiet is especially important for the elderly residents. According to the architects, sound-resistant precast concrete walls, ceilings, and floors effectively isolate each apartment from airborne noise as well as noise carried as vibration through the structure itself.

In addition, the use of prestressed hollow-core slabs enabled the designers to achieve the clear-spans which give the apartments their spaciousness, while still holding within the maximum building height requested by the community. Good neighborhood relations were preserved during construction by the speed (199 units in 90 working days) and relative quietness of erection (No impact wrenches or formwork were necessary, except for foundations). Despite the open wall necessitated by balconies, seismic zone 2 requirements were met through vertical post-tensioning of end walls, appropriate connections for intersecting walls, and the diaphragm action of the precast slabs and topping.

Structural Engineer: LeMessurier Associates, Inc., Cambridge
General Contractor: Peabody Construction Company, Braintree, Massachusetts
Precast Prestressed Concrete: San-Vel Concrete Corporation, Littleton, Massachusetts

PRECAST AND PRESTRESSED CONCRETE:
Precast: bearing walls to 28 ft. (8.5 m) long. Prestressed: 22-ft. (6.7 m) balcony slabs, spandrels, parapets, 35-ft. (10.7 m) hollow-core bridge slabs, bridge spandrels.
Precast panels baffle noise in subway station

Precast panels screen mechanical systems both visually and acoustically for the Central Transit Station at Edmonton, Alberta. These panels, with attractive surfaces of native brown stone exposed aggregate, have helped promote public acceptance and use of the rapid transit system.

Twelve types of panels provide wall and column cladding and enclosures for platform and concourse levels. Custom precasting made it easy to incorporate additional acoustical treatments, advertising panels, sprinkler heads, and lighting. Constant moisture seepage from as much as 50 ft. (15.2 m) below grade will not injure these precast units, nor will vandalism or repeated hosing during maintenance.

By using precast concrete elements, the designers minimized the need to close adjacent major streets during construction.

Architect: Donald L. Pinckston, Architect Ltd., Edmonton, Alberta
Structural Engineer: B. W. Brooker Engineering Ltd., Edmonton
General Contractor: Cana Construction, Edmonton
Architectural Precast Concrete: Con-Force Products Ltd., Edmonton

Precast concrete lines walls. Striking shapes at top right are also precast.

Exposed aggregate warms, humanizes.
COVER STORY

Neighbors commend quiet maintenance center

The Lakewood, Colorado, City Maintenance Center is located in a prestigious office/industrial park near a residential development. That meant attractive exteriors and - even more important - containing the sound of heavy vehicles repaired and stored there. Solution: a precast system employing single tees in roof and floor of the maintenance shop, double tees for parking structure and administration building, and precast concrete wall panels for all three. The result: many compliments from residential and commercial neighbors.

Wall panels are exposed aggregate. Boards of random lengths were used to create textured architectural interest on the buttress panels. Long-span single tees provide column-free space for parking and maneuvering road graders and other heavy equipment.

Architect/Engineer: Architects-Engineers West, Inc., Lakewood, Colorado
Construction Manager: Pinkard Construction Company, Lakewood
Precast Prestressed Concrete: Stanley Structures, Denver, Colorado