Acoustical Considerations for Mixed-Use Wood-Frame Buildings

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Acoustics are just one aspect of building performance and must be considered in combination with requirements such as fire protection, structural systems and energy efficiency. To determine an optimal design solution, it is critically important to understand how the design and detailing for each individual system affects the others. Specifically, in addition to meeting the appropriate acoustical rating(s), the assemblies chosen must achieve the required fire ratings and accommodate the structural and energy needs of the project. Understanding the effects of each performance area enables the design team to more easily navigate the decisions and trade-offs required when evaluating different assembly options.

University of Washington West Campus Student Housing – Phase One
For this student housing project, the acoustical engineer recommended a strategic combination of staggered stud and double stud walls to minimize sound transmission.
Mahlum Architects; photo Benjamin Benschneider

Multi-Family Housing Acoustical Expectations

As with any issue of building performance, the acoustics of a mixed-use wood-frame structure can be designed to meet or exceed minimal requirements, depending on the expectations of the developer, buyers and tenants.

In residential buildings, the *International Building Code* (IBC) provides a minimum design requirement for unit-to-unit acoustical protection between floors. It requires a Sound Transmission Class (STC) rating or Impact Insulation Class (IIC) rating of 50, unless the "Authority Having Jurisdiction" has its own more stringent requirement, which is rarely the case. The *International Residential Code* (IRC) requires a minimum design separation of STC 45 for townhouses.

For wood-frame mixed-use buildings, Section 1207 of the 2012 IBC includes the following:

1207.1 Scope. This section shall apply to common interior walls, partitions and floor/ceiling assemblies between adjacent dwelling units or between dwelling units and adjacent public areas such as halls, corridors, stairs or service areas.

1207.2 Airborne sound. Walls, partitions and floor/ceiling assemblies separating dwelling units from each other or from public or service areas shall have a sound transmission class (STC) of not less than 50 (45 if field tested) for air-borne noise when tested in accordance with ASTM E 90. Penetrations or openings in construction assemblies for piping; electrical devices; recessed cabinets; bathtubs; soffits; or heating, ventilating or exhaust ducts shall be sealed, lined, insulated or otherwise treated to maintain the required ratings. This requirement shall not apply to dwelling unit entrance doors; however, such doors shall be tight fitting to the frame and sill.

1207.3 Structure-borne sound. Floor/ceiling assemblies between dwelling units or between a dwelling unit and a public or service area within the structure shall have an impact insulation class (IIC) rating of not less than 50 (45 if field tested) when tested in accordance with ASTM E 492*(09)*.

This minimum requirement is the same for entry level housing, market rate housing and luxury housing, whether it is dorms, apartments or condominiums. Beyond that, it is the responsibility of the design team to develop an acoustical design that meets owner/developer/renter expectations for the project.

The current standard for acoustical detailing dates back to 1963. The FHA/HUD *Noise Control in Multi-Family Housing* document of that year suggested three levels of acoustical isolation: entry level, market rate and luxury housing. Table 1 provides suggested separations between different units in a project based on the acoustical expectation of these three different multi-family housing markets.

TABLE 1
Acoustical Isolation Between Units – Airborne (STC) / Impact (IIC)

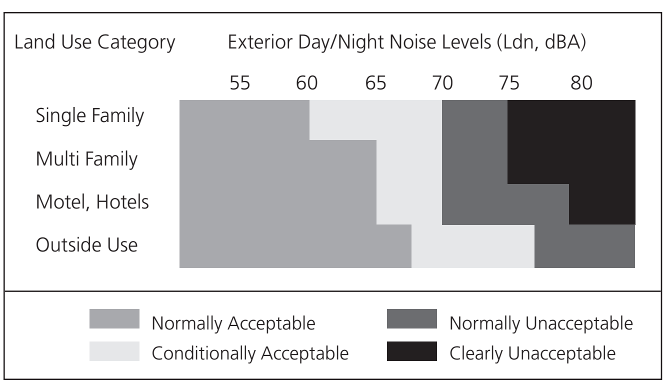
Class Designation	Airborne Sound Isolation (STC)	Floor Ceiling Impact Isolation (IIC)
Entry level	50	50
Market rate	55	55
Luxury	60	60

Exterior-to-Unit

The level of exterior noise is what determines the acoustical requirements of a building's exterior wall. However, the 2012 IBC does not include acoustic requirements for exterior walls. Older versions of the *Uniform Building Code* required exterior noise levels be controlled to 45 Ldn (day/night sound level) inside the unit unless, again, the "Authority Having Jurisdiction" has more restrictive requirements. In all but the loudest environments, housing will typically be found in an area with an Ldn of 80 or quieter. Therefore, it would be reasonable to design exterior walls with the capacity to reduce noise levels by 35 Ldn or less.

Land use compatibility tables similar to Table 2 below help define the appropriate levels of noise intrusion from outside use areas (such as back yards and balconies) in different types of housing. Ldn maps are commonly found in a municipality's general plan. If Ldn maps are not available, acoustical measurements can be taken to help calculate/predict what the noise levels will be just outside the building.

TABLE 2
Land Use Compatibility Acoustical Matrix – Model Noise Ordinance



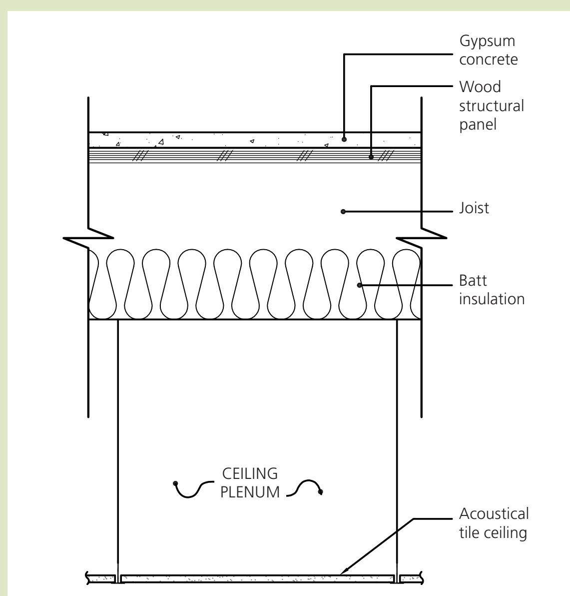
State of California General Plan Guidelines, 1987

Window and door systems are typically the controlling factor for exterior to interior acoustical isolation. Terms like OITC (Outside Inside Transmission Class) for windows may be used. This is a metric that helps select the noise blocking ability or transmission class of a system from the outside to inside. For areas that are louder than 60 Ldn, the windows will typically have to be kept closed to meet the 45 Ldn interior noise level. If fresh air or air changes are required per the project's housing code, then mechanical ventilation or some type of acoustical air transfer system will be required.

Retail-to-Unit (Mixed-Use)

In a mixed-use project, consideration must be given to the acoustics between all of the adjacent spaces—not just dwelling unit to dwelling unit. Acoustical separation between residential and other occupancies can be a significant challenge and this condition is not addressed in the IRC or IBC, though it is starting to be addressed in green building codes such as the *California Green Building Standards Code* (CALGreen). Figure 1 shows a typical floor/ceiling detail between a lower floor restaurant or bar with residential units above. This is a poor performing configuration for acoustics, with an STC of less than 35.

FIGURE 1
Although common between restaurants or bars and the apartments above, the configuration shown in this detail may lead to noise complaints by apartment occupants.



Vocabulary

Current building codes do not reference the most recent acoustical ASTM standards due to the lag in the code adoption cycle. Designers need to carefully review the code and determine which acoustical standard needs to be applied. For example, some jurisdictions call for STC ratings, some allow a Field Test (FSTC) and some call for Noise Isolation Class (NIC) or Apparent Sound Transmission Class (ASTC). This is all dependent on the building code year and associated reference standard. While many of the definitions are similar, some take into account the total experience of how sound gets from one space to the next while others look just at the partition and others still consider the experience but normalized to a standard room. The following definitions, grouped by topic, can help:

Noise Reduction (NR)
The difference in sound pressure level between any two points along the path of sound propagation.

Transmission Loss (TL)
A measurement, in decibels (dB), of how much sound energy is reduced by transmission through materials.

Noise Isolation Class (NIC)
A single-number rating derived from the measured value of noise reduction between two enclosed spaces that are connected by one or more paths. The NIC is not adjusted or normalized to a standard reverberation time.

Flanking Paths
Indirect paths through which sound energy can bypass constructions and seriously degrade the transmission loss (TL) rating of that construction. Example flanking paths are open ceiling plenums and attics, continuous side walls and floors, air duct and pipe penetrations, joist and crawl spaces. Flanking paths can be prevented by careful design of all connections, penetrations and adjacent framing systems.

Sound Transmission Class (STC)
A single-number rating which describes how much sound a wall or floor/ceiling construction will block from one room to the next. STC is applied to situations where speech or office noise constitutes the main sound problem. To determine the rating, an active loudspeaker is placed on one side of the partition and sound levels are measured on both sides. The difference in levels shows how much sound can be blocked by the partition. The higher the rating, the better the sound insulation properties. This is a laboratory test in a controlled acoustical environment.

Apparent Sound Transmission Class (ASTC)
A single-number rating derived from the measured value of apparent transmission loss data. The apparent sound transmission class provides a measure of the sound reduction provided by the complete building system, including flanking paths, and is normalized for the receiving room acoustical absorption so it can be compared to a standard room.

Field Sound Transmission Class (FSTC)
A single-number rating which quantifies the sound insulation properties of a partition as measured in the field in the absence of flanking paths.

Impact Insulation Class (IIC)
A single-number rating which describes how much noise created by footfalls/impact on a floor through a ceiling. This is a laboratory test in a controlled acoustical environment. A standardized testing device generates the impact sound by dropping five hammers, which impart a known energy into the floor/ceiling construction. In the receiving room below, the resulting sound pressure level is measured in frequency bandwidths comparable to those used in sound transmission loss measurements. Increasing IIC values correspond to improved impact noise dampening qualities.

Field Impact Insulation Class (FIIC)
A single-number rating which quantifies the property of a floor/ceiling construction to reduce footfall-generated noise as measured in the field.

Apparent Impact Insulation Class (AIIC)
A single-number rating which quantifies the property of a floor/ceiling construction to reduce the apparent impact transmission loss data. The apparent impact insulation class provides a measure of the impact sound reduction provided by the complete floor/ceiling system, including flanking paths.

A-Weighted Sound Level (Noise Level)
A term for the A-weighted sound pressure level. A-weighting is a frequency weighting commonly used to measure the loudness or "noisiness" of sounds. A-weighting filters the microphone signal in a manner which better correlates with the sensation of the human ear. The sound level is obtained by use of a standard sound level meter and is expressed in decibels. Sometimes the unit of sound level is written as dBA.

Day/Night Sound Level (Ldn)
A descriptor established by the Environmental Protection Agency (EPA) for the 24-hour average A-weighted noise level. Sound levels during the hours from 10:00 p.m. to 7:00 a.m., hours in which people are more sensitive to noise, are penalized 10 decibels (dB). A 10 dB increase in sound level is perceived by most people to be twice as loud.

Community Noise Equivalent Level (CNEL)
A descriptor for the 24-hour A-weighted average noise level. The CNEL concept accounts for the increased acoustical sensitivity of people to noise during the evening and nighttime hours. Sound levels during the hours from 7:00 p.m. to 10:00 p.m. are penalized 5 dB; sound levels during the hours from 10:00 p.m. to 7:00 a.m. are penalized 10 dB. A 10 dB increase in sound level is perceived by most people to be twice as loud.

Outdoor-Indoor Transmission Class (OITC)
A standard used for indicating the rate of transmission of sound between outdoor and indoor spaces in a structure. It is based on the *ASTM E-1332 Standard Classification for the Determination of Outdoor-Indoor Transmission Class*. An alternative similar standard for determining the rate of acoustic isolation of a separation between spaces is Sound Transmission Class (STC). While STC is based on a noise spectrum targeting speech sounds, OITC utilizes a source noise spectrum that considers frequencies down to 80 Hertz (or Hz, such as aircraft/rail/truck traffic) and is weighted more to lower frequencies.

FIGURE 2

Typical Outlet Box

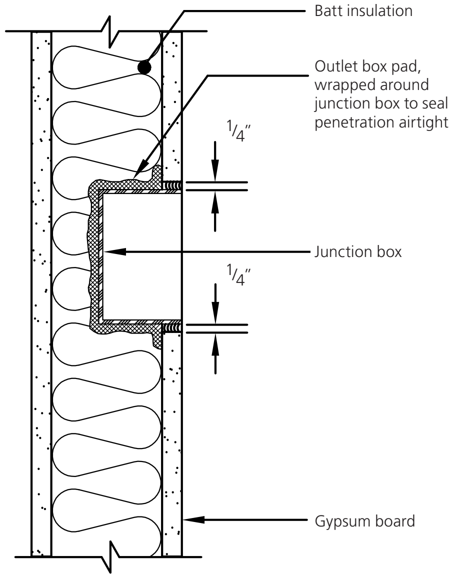
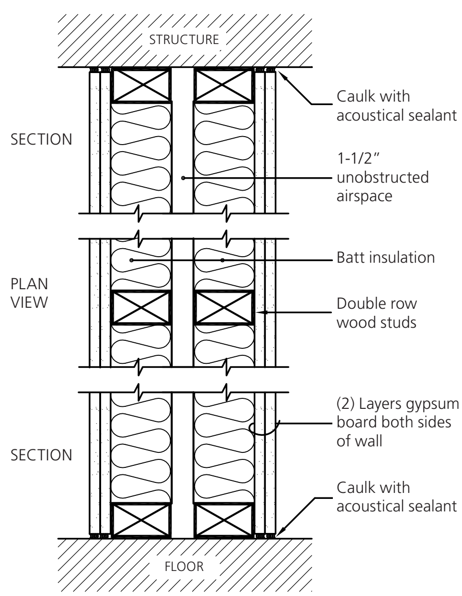


FIGURE 3

STC 63 Party Wall



Air Tight and Insulated

Two things are always assumed in acoustical detailing. First, the cavity is insulated with batt insulation. Second, it is sealed air tight. If the partition is a resilient system, it needs to be sealed with acoustical caulk to maintain the flexibility and resiliency of that acoustical solution. Acoustical caulk does not set with time; it acts as a skin over the finishing but is still flexible below the skin. If the partition is not resilient, such as a double stud or staggered stud wall, it needs to be sealed air tight. This can be achieved by floating a topping slab under the base of the gypsum board, by lapping the joints in the corner and taping, or with fire caulking/sealant. It is important to seal all holes, recessed light fixtures, plumbing penetrations and outlet boxes (see Figure 2). Wherever air can flow, sound can travel. For large openings like outlet boxes, the box must be sealed air tight with an acoustical or fire putty sheet from the wall cavity side prior to gypsum board installation. Then the void between the gypsum board and the outlet box is caulked and sealed air tight after the gypsum board has been installed.

Walls

Sound isolation can be accomplished in two ways. One is to use partitions with a high mass (75 pounds per square foot, psf, or greater) or to use low mass systems (2 to 5 psf) separated by air spaces of 3 to 6 inches.

The goal in party walls or exterior walls is to keep other people's noise out of, and your noise in, the unit. In lightweight wood structures, this is achieved by separating the materials with an air space (e.g., stud or joist construction).

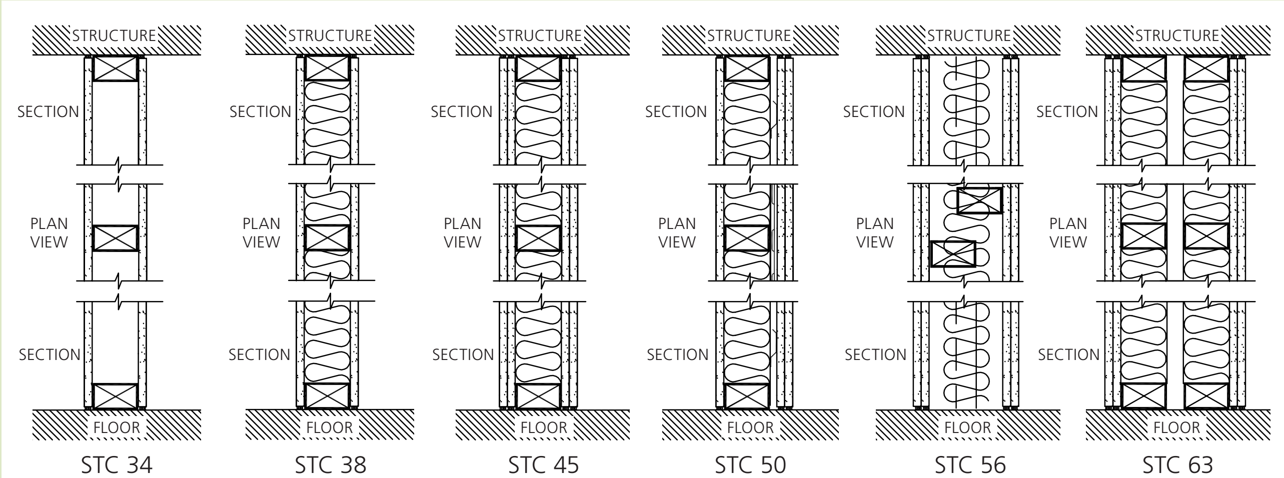
As discussed above, the more expensive the unit, the higher the STC rating is expected to be. However, in most cases, a designer will choose different techniques within the same project based on occupant needs in order to meet acoustical objectives in a way that is also cost effective.

In wood-frame construction, the most effective wall in terms of acoustical performance is a double stud wall. As shown in Figure 3, this wall can achieve a rating of approximately STC 63 when insulated with batt insulation and covered with two layers of gypsum wallboard on the outside faces of the studs. STC 63 is the highest rating possible unless rooms and spaces are detailed like a studio with floating floors, etc.

After double stud construction, the next best framing solutions are staggered stud and then single stud construction (see Figure 4). Acoustically, a single stud wall creates a bridging point for sound to be conducted along every stud. This line of contact created by the stud allows sound on one side of the wall to be transferred through the gypsum wallboard into the stud and back out the gypsum wallboard on the other side of the wall. The other source of sound transfer is sound striking the plane of the gypsum wallboard between studs. As sound vibrates this plane, it travels through the cavity and causes the gypsum wallboard on the other side of the stud to vibrate and reradiate the noise.

FIGURE 4

Acoustical Progression in Wood-Framed Walls

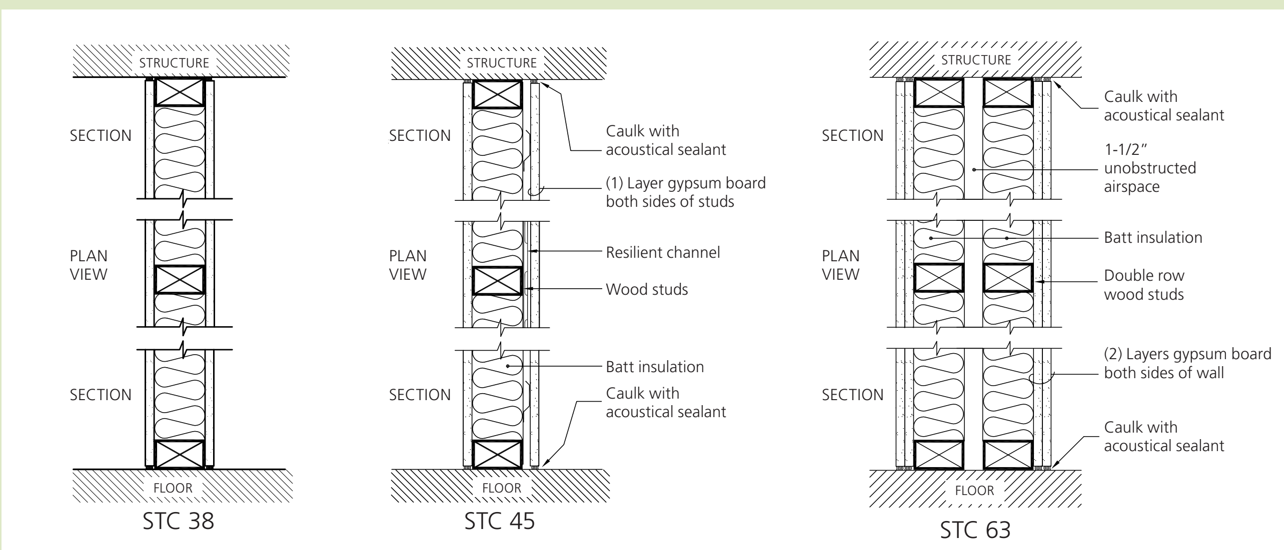


When the gypsum wallboard on one side of the stud is disconnected from the other side in a double or staggered stud wall system, the transmitted sound is reduced and the assembly has a higher STC rating. The advantage of the double stud wall over the staggered stud wall is twofold. The greater the separation between the gypsum wallboard on each face of the wall, the more the noise is reduced and the greater the STC rating becomes. The second advantage is that building utilities can be isolated from the stud system for the unit they serve. If the staggered stud wall has plumbing or electrical run through the cavity, there is greater chance that the studs will be connected together by the utilities, acoustically bridging the two lines of studs. However, if care is taken during construction, a staggered 2x4 stud wall on an 8-inch nominal plate achieves a rating of STC 60 and with a wider double stud system the assembly achieves a rating of STC 63 (assuming batt insulation in each stud cavity and two layers of 5/8-inch gypsum board on both sides of the wall). See Figure 5.

In all cases, the connections at the bottom and top plates (floor and ceiling systems) running between adjacent units in multi-family housing are a flanking path where sound travels through the adjacent structure and is reradiated on the other side.

FIGURE 5

Acoustical Detailing for Wood-Framed Walls



Improvement Factors In Acoustical Isolation Systems

Sheathing

In a light-frame wood building, the mass of the sheathing is just as important as the air space provided by the stud or joist cavity. In acoustical detailing, 5/8-inch-thick type "X" gypsum board is typically required. This material has a mass of 2.2 psf versus 1.6 psf for 1/2-inch-thick gypsum board.

When a shear wall is needed, the standard level of care allows a layer of gypsum board to be replaced acoustically with wood sheathing of equal mass. For example a 7/8-inch thick sheet of wood structural panel has a similar mass to 5/8-inch thick gypsum board panel. When a shear layer is introduced to walls with resilient channels or double stud walls are used, the assembly must be coordinated with applicable fire and structural ratings. However, this is where understanding the impact of the construction type and fire rating affects the acoustical isolation. For example, without understanding the importance of the air space in the wall system, the impact of the order and location of the materials, a wall that commonly separates luxury units could go from STC 63 to STC 48 and not even meet building code requirements. Figure 6 shows that, with the same materials but in a different location, a wall can have an almost 20 STC point swing. Subjectively, this means four times more sound may be transmitted through an improperly constructed wall.

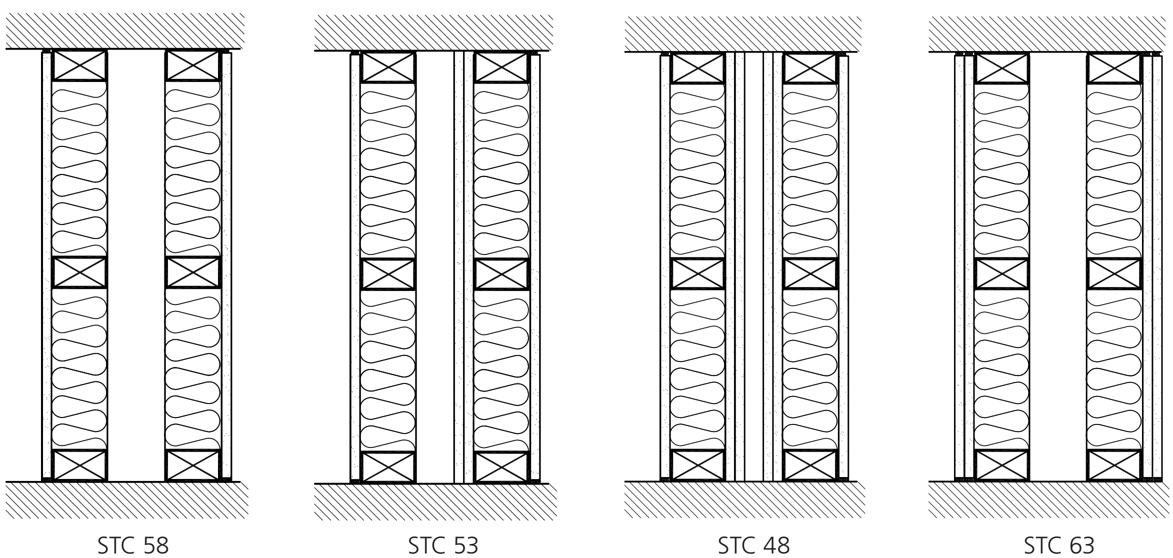
Three factors reduce the potential acoustical isolation:

- First is a smaller air space between the sheathing systems.
- Second is the common resonance of the two thinner wall systems. In this case, the walls radiate at the same frequency, coupling with each other, which reduces the wall system's acoustical effectiveness.
- Third is the air space between the walls. In the case of lot-line walls for townhouses or row housing, the air space is typically sealed air tight. In the case of trapped air, one to two inches of air becomes very stiff, adding to the walls' ability to couple together.

In the past, using multiple layers of gypsum sheathing to increase the mass of the system has been the most common solution to raising the STC rating of the system. A number of laminated gypsum systems have been developed to provide higher acoustical performance than the equivalent thickness of standard gypsum sheathing. In some cases, they have light-gauge sheet metal installed between thinner layers of gypsum. In others, they are simply thinner layers of gypsum glued together. These products use the same principle of constrained layer damping as plywood or laminated glass to increase strength and stiffness over their core materials. The challenge with the new materials is that testing for these specialized or proprietary products has not yet been completed. Further, the testing that has been done

FIGURE 6

Effect of Sheathing Placement on Acoustical Performance (Plan View)



does not correspond to typical wall systems, so a true "apples to apples" review cannot be completed. In the case of shear wall sheathing, mass can be traded out for mass. With the new layered products, they are often changing stiffness properties in addition to mass; therefore, the two products are not always interchangeable.

Insulation

The most cost-effective acoustical improvement to a sound isolation system is the addition of batt insulation or any open cell foam system to the stud or joist cavity. Batt or open cell insulation reduces the sound that makes it into the stud cavity in the same manner as sound absorption works in a room. While closed cell spray foams have higher R-values and offer improved building envelope energy performance by sealing the partition and improving air tightness, the closed cells do not allow the vibrating air molecules to interact with the insulation product so the sound attenuation is less. It is this interaction that helps reduce the sound.

Laboratory tests have shown that the cavity should be at least half-way filled to achieve a measurable improvement and that placement of the insulation does not have an impact providing it doesn't interfere with a resilient wall or floor/ceiling system. In single stud walls, a single stud bay is filled; for staggered or double stud wall systems, insulation is only acoustically needed in one of the stud bays.

In some cases, the "Authority Having Jurisdiction" does not require blocking when a wall system is filled with mineral wool or rock wool insulation as a form of draft stop.

Resilient Connections

When double or staggered stud construction is not possible, decoupling the sheathing from the framing provides a similar form of isolation. Decoupling happens when the framing system functions like a spring. The spring system deforms as sound strikes the gypsum wallboard. As the spring or resilient system expands back to its original shape, it converts some of the acoustical energy from the sound into mechanical energy so there is not as much acoustical energy to transfer through the framing system.

Resilient systems come in different forms including:

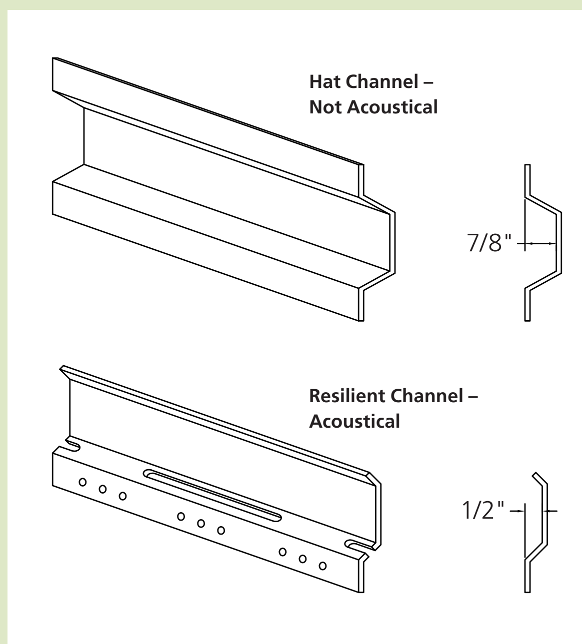
- Fiberboard sheathing systems
- Special metal channels
- Vibration isolators

Fiberboard is often used in acoustic assemblies. Many years ago the product was tested in an acoustical laboratory. The system tested had the fiberboard glued to the framing system and the gypsum board glued to the fiberboard. In that condition, the fiberboard functions as a resilient system. However, as soon as mechanical fasteners are introduced into the installation process, any benefit provided by the fiberboard is compromised by the fastening system. The mechanical fasteners allow acoustical energy that strikes the finish sheathing to be transferred into the framing system and then radiate from the other side of the partition. Having the mechanical fastening system "short circuit" the resilient system is not limited to fiberboard systems and is an installation concern for all resilient systems.

Metal channel systems are attached perpendicular to the primary framing system. The installation of the secondary metal channel framing system changes the acoustical path from a line source connection (gypsum wallboard to the entire length of the framing system) to a lattice connection of the cross points where the two systems connect. This in itself reduces the transfer path of the acoustical energy from one side of the framing system to the other. If the lattice connection is coupled with an isolation or resilient component, the transfer of acoustical energy is further minimized.

There are several manufacturers of resilient channels and their products vary widely in quality. It is worth doing some research and/or performance testing before making a selection. As a general rule, hat channels are significantly inferior to resilient channels since they are not free to move and achieve dissipation of the sound energy (Figure 7).

FIGURE 7
Metal Channels Found in Wood Framing



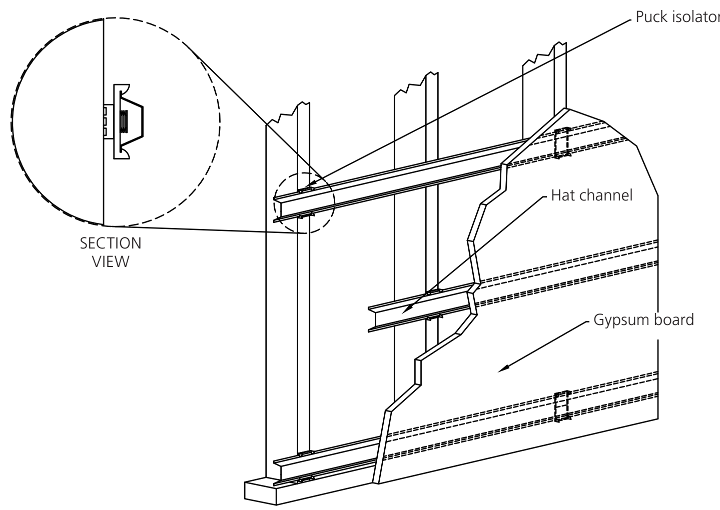
An article in Sound and Vibration magazine[1] discusses the tested performance of different resilient channel products and the common installation errors that impact actual performance of the assembly. For example, the most common error is in the location of the screws used to attach the gypsum sheathing to the resilient channels. If the drywall screws are too long or line up with the framing system, they'll clamp the channel between the framing and gypsum sheathing, defeating the goal of decoupling the sheathing from the framing. If the vibrations are not decoupled from framing, sound will transfer from one space to the next.

The basic design is a metal channel bent into three sections: a flange about 1-1/2 inches wide (where the gypsum board is attached), a section about 1/2-inch tall (with long slots routed into it to provide spring), and a third flange about 5/8-inch wide where the channel is attached to the joist or stud.

A newer resilient system is a rubber (puck) isolator with an attached metal clip (Figure 8). Typically the rubber isolator is attached to the framing system at about four feet on center or every third framing member. This spacing further reduces the number of contact points. After the isolators are attached to the framing system, a standard metal hat channel is installed into the framing clip. The system (isolator, hat channel and a single layer of 5/8-inch gypsum board) is more than two inches deep. This reduces the potential issue with fasteners (discussed above) since drywall screws are rarely if ever this long.

FIGURE 8

Acoustical "Puck Isolator" Wall Detail (Isometric View)



[1]Sound and Vibration, December 2002, http://www.sandv.com/downloads/0212lill.pdf

Floor/Ceiling Systems

Everything discussed for walls applies to floor systems. While the main sources of noise complaints relative to walls are televisions or loudspeakers attached to party walls, footfall or impact noise from above can be an issue in multi-story apartment or condominium projects if proper design steps are not taken. Figure 9 captures the range in acoustical performance that can result from different floor/ceiling design layouts. The second major noise complaint is floor squeaks, followed by spring in the floor due to the span or the size of the joists.

In light wood-frame buildings, one effective floor/ceiling option features a base system construction similar to that shown in Figure 10, which consists of the following:

- Gypcrete or light-weight concrete
- Impact isolation matt
- Tongue and groove subfloor (glued and screwed to the joist)
- Joist system (with 6 inches of batt insulation)
- Resilient channel or puck system (resilient system)
- Two layers of 5/8-inch type "X" gypsum board

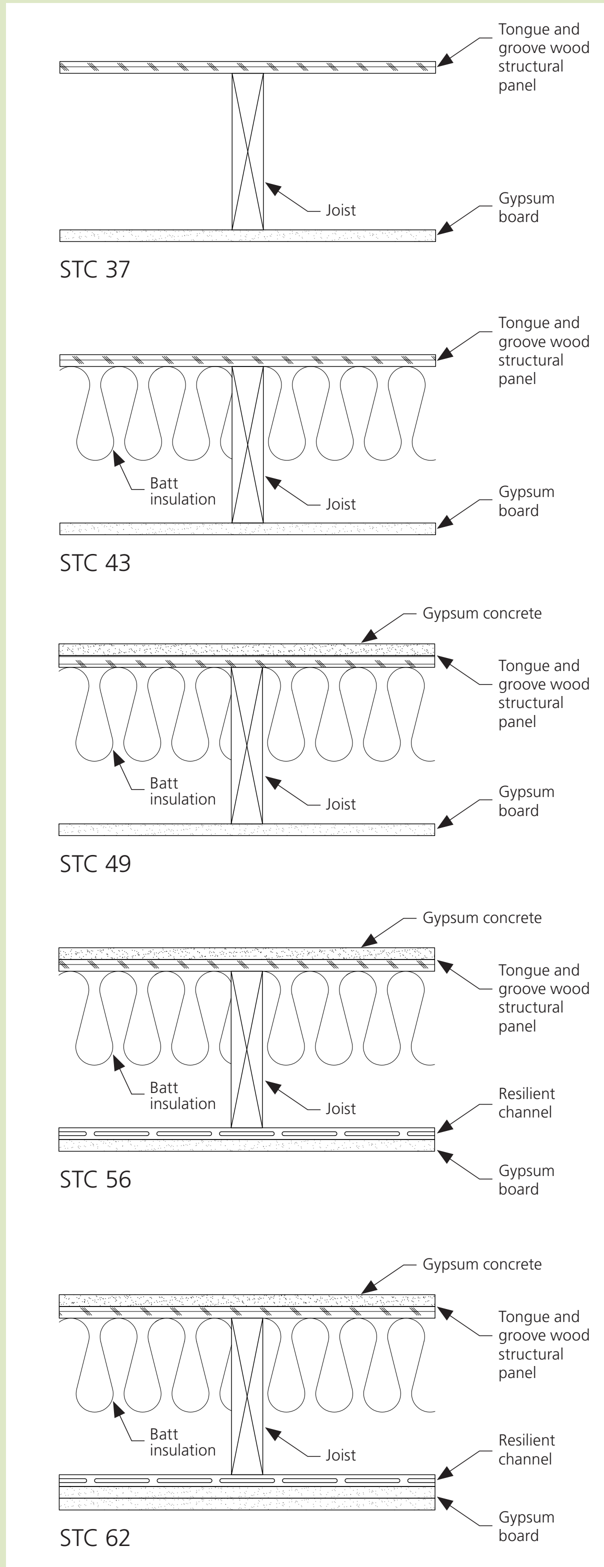
This system has a rating of STC 62, which is the highest rating possible without moving to construction methods found in recording studios. If the intent is to market a project as "luxury," then studio construction may need to be considered.

To achieve a rating of STC 50, both topping with additional mass (such as gypcrete) and a resilient system on the bottom of the joist are required. While some test reports indicate that STC 50 can be met with either the topping mass or the resilient system, research shows that these are exceptions. The test sponsors themselves state that the systems were measured in a laboratory and these results should not be expected in the field.

Installation of resilient systems on the ceiling creates a number of challenges. The perimeter of the gypsum board needs to be held back from the intersecting structure so the gypsum board on the adjacent structure can flex in and out. If gypsum board on the face of the wall is jammed tight to the adjacent framing system (e.g., the joist system) as it is installed, the perimeter of the resilient system will not flex and the acoustical isolation in the lower frequencies will be compromised. Consider the typical installation sequence of gypsum board. First the ceiling is installed, then the walls. The gypsum wallboard is pushed up to the ceiling for a tight seal for finish taping. It is this tight joint that clamps the ceiling gypsum and resilient channels to the underside of the joist; it is no different than having mechanical fasteners screwed through the gypsum board channel and into the framing system.

FIGURE 9

Acoustical Progression in Wood-Framed Floors/Ceilings (Section View)



When resilient systems are used, the gypsum must be held free from the adjacent perimeters, typically by 1/4-inch. This 1/4-inch void needs to be caulked air tight with an acoustical caulk. Acoustical caulk does not harden over time; the surface of the caulk will dry and skin over so it can be painted. If walls are doubling as a fire-resistant assembly and acoustic separation, this may be an area where detailing compromise is needed. Acoustical sealant is excellent for fire-rated partitions and acceptable for use at the perimeter of wall assemblies rated 1-3 hours.

Floor framing systems vary by geographic region and over time. As shown in Figure 11, the acoustical detail is treated the same regardless of the floor framing system.

FIGURE 10

Acoustical Detailing for Wood-Framed Floor Systems

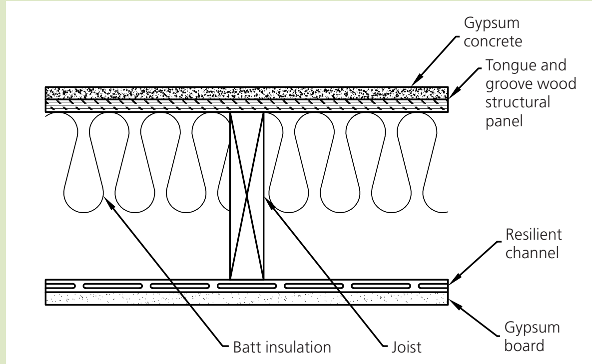


FIGURE 11

Acoustical Joist Systems (Isometric View)

Acoustical detailing is the same regardless of floor framing system

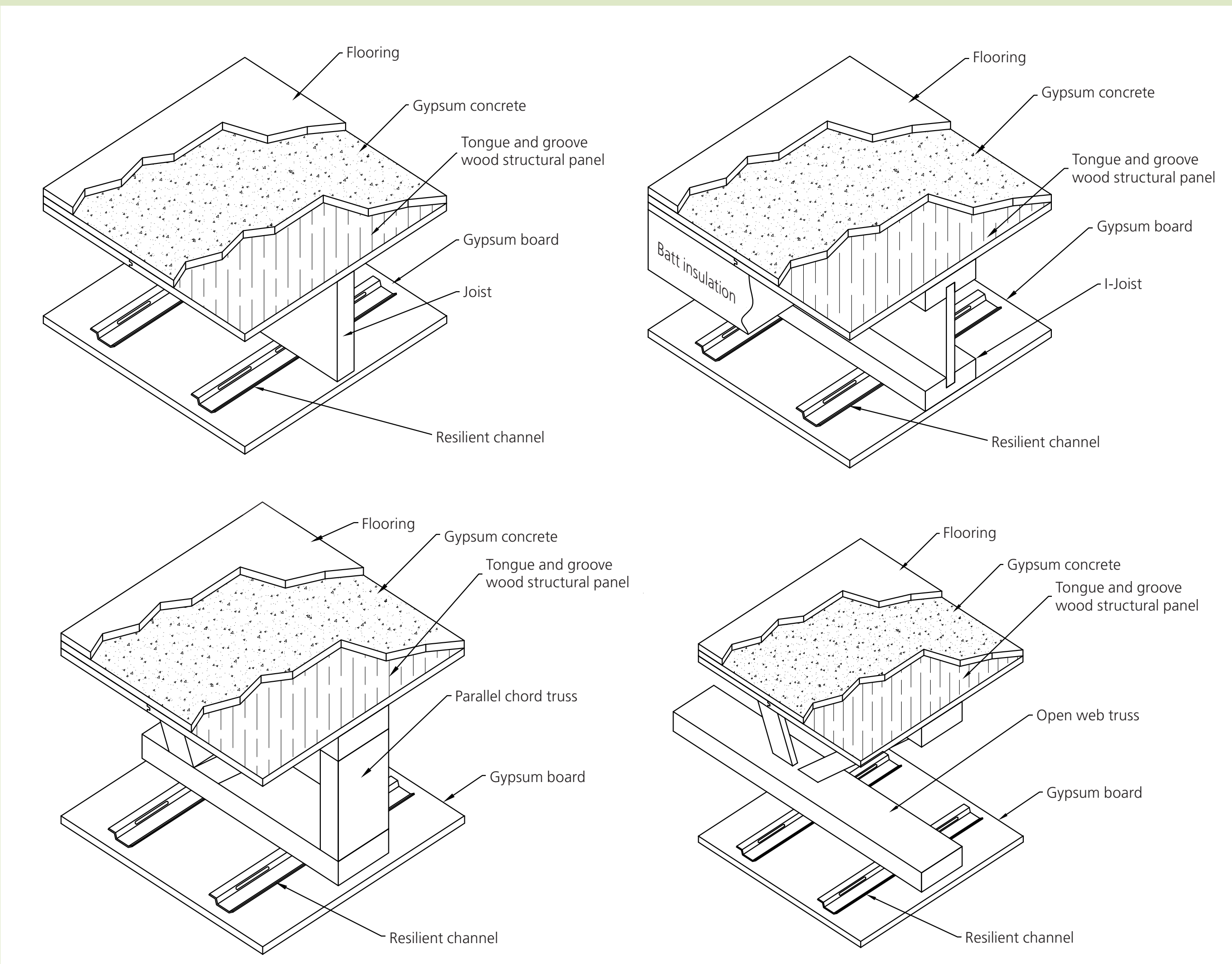
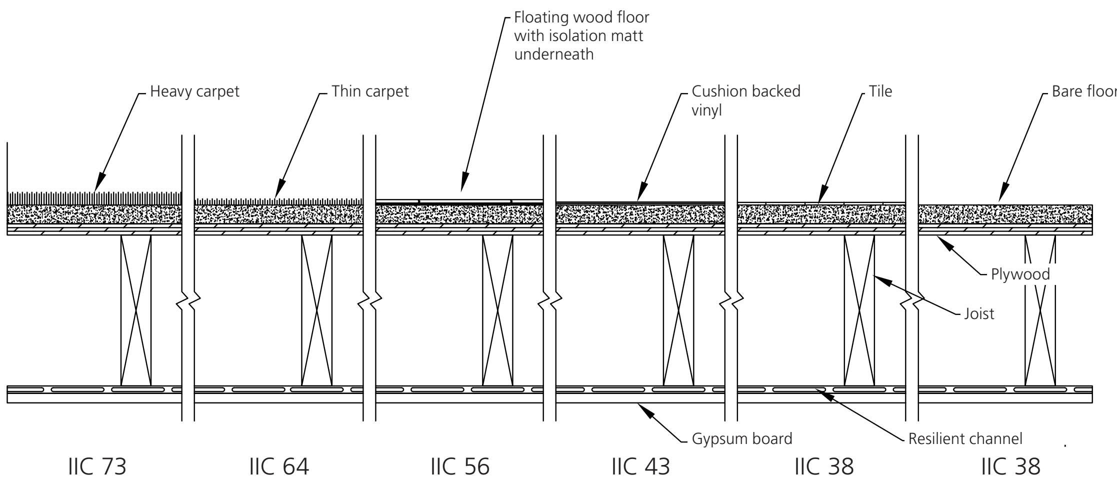


FIGURE 12

Impact Isolation Progression in Wood-Framed Floors/Ceilings (Section View)

Note: For clarity, batt insulation in the joist cavity is not shown



Impact Isolation

The effects of floor finish on the impact isolation are shown in Figure 12. Impact noise can be reduced considerably with the use of soft finishes such as carpet. When carpeting is not practical or desired, the entire finish system must be considered. Floating wood or tile floor systems offer the next best solution. A floating wood floor offers the advantage of an isolation membrane that can be installed beneath the finished wood system. However, placing a resilient isolation mat or buffer under hard finish flooring systems requires coordination. Buffer systems include mats under the topping mass such as foam, cork, or rubber mats made from recycled tires. Each of these buffer materials creates its own set of compromises on the installation process, with the total thickness of the finish floor system being one of the biggest coordination points. Ceramic flooring should meet the requirements of the Ceramic Tile Institute of America (www.ctioa.org).

Down Lights/Duct Work/Exhaust Fans

Acoustical assemblies should not be penetrated by building utilities. Duct work and exhaust fan runs should be enclosed in soffits, not in the joist or stud cavity, where they create holes in the acoustical assembly. If can lights must be used, then fixtures rated for direct insulation contact are required. The cans should be backed and sealed air tight in addition to being caulked/sealed air tight where they contact the gypsum wallboard.

Conclusion

There are many nuances associated with the transfer of sound and acoustical design. The intent of this paper is to introduce the reader to general concepts and design details that need to be considered; however, many essential topics, such as plumbing, mechanical systems and exterior noise control, are beyond the scope of this document. Similarly, it is worthwhile to review the acoustic and fire protection-related detail choices to ensure they are complementary and result in the most efficient overall design. Where acoustic performance is a critical aspect of a project, consider hiring an acoustical consultant as part of the design team. If that is not an option, it is advisable to rely on systems and other solutions that have been independently tested in acoustical testing laboratories. With proper forethought and detailing, it is possible to ensure that mixed-use wood-frame buildings will exceed acoustical performance expectations.

Additional Information:

ICC G2-2010 Guideline for Acoustics – International Code Council

National Council of Acoustical Consultants – www.ncac.com