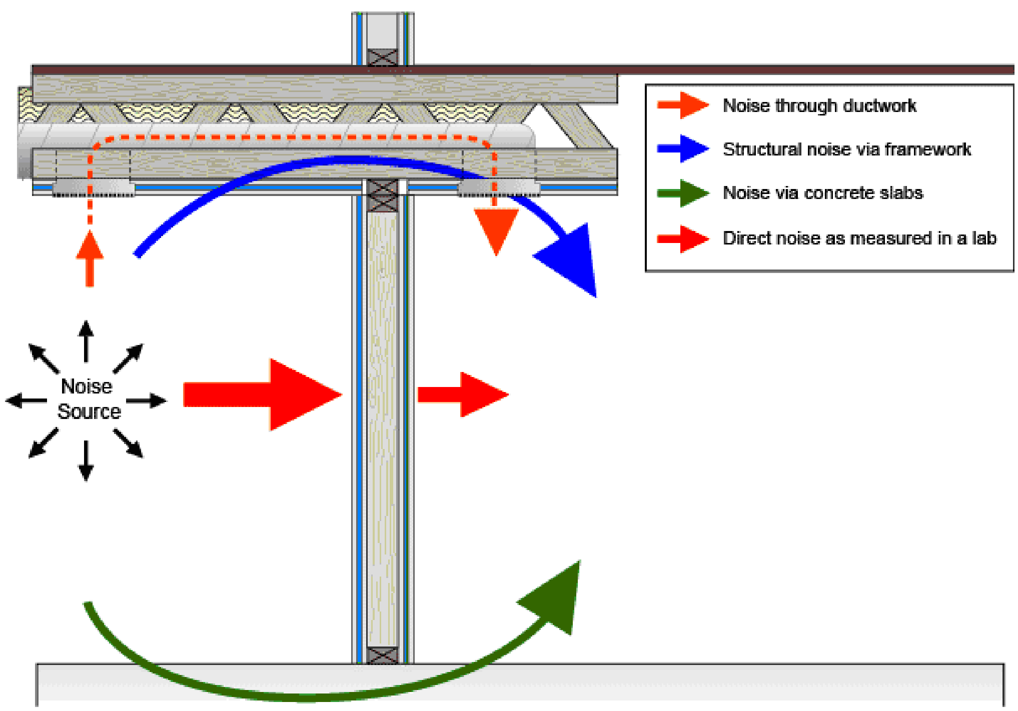
Understanding Flanking Noise

One of the least talked about aspects of sound isolation is something called flanking noise. What is flanking noise? Flanking noise is noise reaching a room by an indirect path. For example noise reaching the room above your home theater from some route other than through your ceiling, noise reaching the next room by a route other than through the wall, and so on.

Part 1: What is flanking noise?

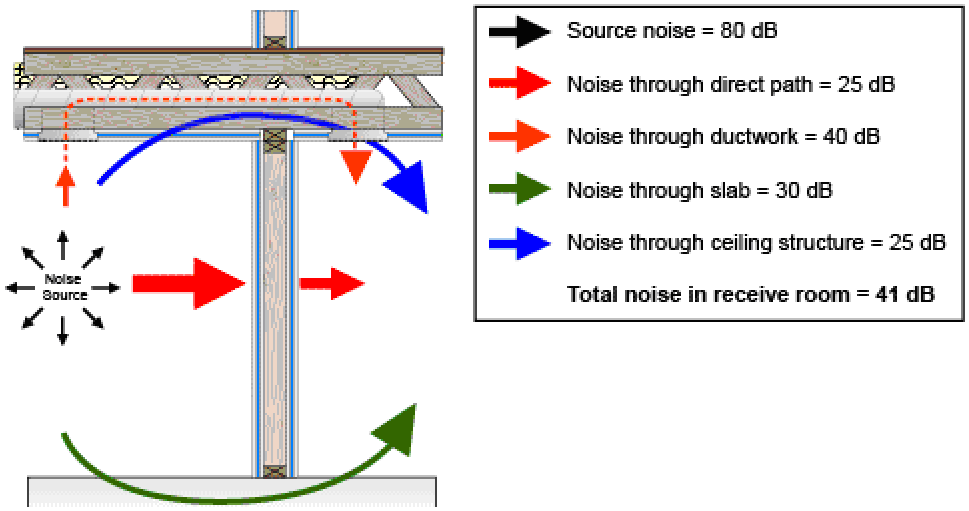
To visualize what flanking noise is, take a look at this sketch:



The red arrows in the sketch above are direct noise, noise passing through the wall into the next room. The orange, blue, and green arrows reflect noise that can make it into the next room via paths not related to the wall. Noise coming from these paths is called "flanking noise."

Here in the real world, flanking noise can spoil even the best-executed wall or floor/ceiling installation if prudence in planning is not exhibited.

Part 2: Understanding the importance of flanking noise



Imagine the scenario above. You have a single wood stud wall with 2 layers 5/8”on the source side and 2 layers ½” on the receiving side with an acoustic glue in between layers.

That wall will stop about 55 dB of sound over much of the vocal range, which would mean that 80dB of source noise would become 25dB on the other side of the wall. 25 decibels of sound would pass through the wall.

If 40 dB of sound passes through the ductwork, however, then the net sound reduction isn’t 55dB anymore, it is only 40dB. If noise makes it through other paths as well, the net sound isolation may fall even further. In the hypothetical case above, the net noise reduction falls from the 55dB potential of the wall to just 39 dB - all because of flanking noise.

No partition can ever perform better than the level of flanking noise.

In the scenario above, no modification you can make to the wall will help improve sound isolation. This is because it isn’t the wall that is failing, it is the ductwork.

The only way to improve the sound isolation is to improve the ductwork. Imagine that you improved the wall by adding 10 more layers of visco elastic glue and drywall… you will still have 41dB of noise in the receive room because that is how much noise is making it through the ductwork + concrete slab, etc.

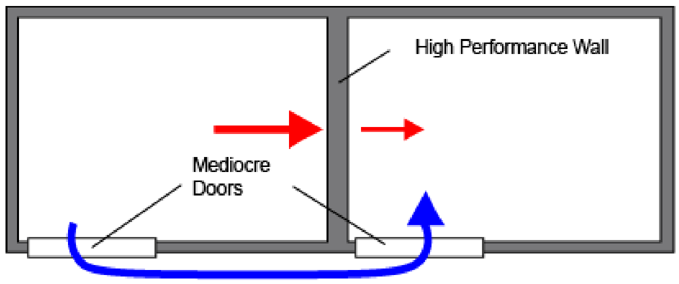
Laboratory measurements vs. the real world.

Laboratory tests are immensely valuable because they are done in standardized ways, in certified labs that meet various requirements, and allow us to compare the sound-stopping potential of different walls. But in laboratories great effort is made to minimize flanking noise, and as a result (at least in many cases) the results reflect just the performance of the wall, with no flanking noise effects at all. It is therefore reasonable to consider laboratory results as reflecting the potential of a given construction, and not what that construction is certain to yield. If seal quality is good, and if flanking noise is suppressed, then you can most definitely attain laboratory results in your home or construction. If these things are not tended to, however, performance will be less.

Part 3: Potential flanking path sources & how to deal with them

In this section, we will take a look at some of the many things that can cause the performance of sound-isolation partitions to suffer. These are things that can compromise an otherwise excellent design.

a) Doors



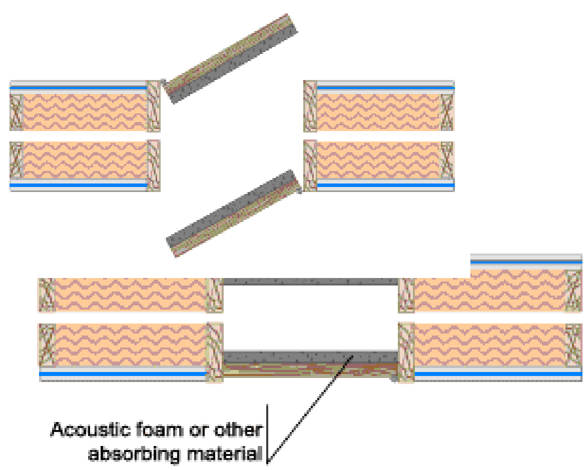
If you have to stop sound from going from one room to the next, and a door connects the two rooms, the door is very likely to be the weak link. In other words, more sound is likely to come through the door than through any high quality wall.

Even in situations where a door doesn't directly connect two rooms, doors can be problematic. Sound going out one door, down a hall, and in another door to the neighboring room can often exceed the sound going through a high quality wall connecting the two rooms.

Specialized acoustic doors

Various manufacturers offer specialty, engineered acoustic doors with elaborate seal systems and other goodies that allow performance to be much higher than normal doors.

We advise you to not just look at STC ratings, but to ask the manufacturers for transmission loss data at lower frequencies as well.



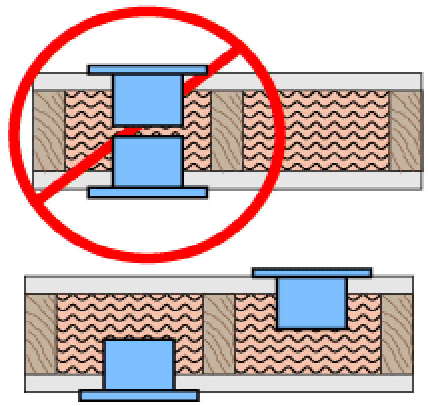
Communicating doors

If a door directly connects two rooms, the best option is a communicating doors system - two doors that form an "airlock" between the two rooms. This configuration yields higher performance than any conceivable single door, and it also grants us the most tolerance of somewhat compromised seal quality. Still, seal quality is critical, even for communicating doors. It is completely reasonable to consider two heavy communicating doors preferable to any realistic single door, engineered or not. If you opt for communicating doors, it is a great idea to put some type of sound absorption in the cavity between the two doors. Cloth-wrapped rigid fiberglass or acoustic foam are two excellent choices.

Upgrading a door

Whether you select for a DIY solid core choice or communicating doors, the addition of acoustic glue + mass in the form of a sheet of MDF, plywood, etc., can increase the performance of your door considerably. This benefits doors by damping the resonances that typically limit the STC of these assemblies.

b) Mass and seal quality



Some simple and low-cost guidelines that will help you get good performance out of your doors are these

1. Use heavy solid-core interior slab mounted in an exterior jamb. Mass is one of the key components of any sound isolation scheme, and it's important in doors as well. The solid core contributes mass, and the exterior jamb has weather-strip all around for a reasonable seal. Do not use hollow core doors where sound isolation is important under any circumstances.

2. Concentrate on ensuring that seal quality is good. Specialized seals should be considered when performance is critical. Whatever route you take, you must ensure that seal quality is very good.

c) Electrical outlets

Electrical, media and light switch outlets as well as plumbing can cause sound isolation problems as well. These all create physical penetrations in the wall. Ensure you use intumescent Putty in behind all such outlets and opening edges. To avoid compromising sound isolation with electrical outlets, follow these basic guidelines:

1. Never put outlets back to back, always put them in separate stud cavities
2. Seal the outlets edges with n acoustic Sealant
3. Use insulation in the wall (something you should do if you care about sound isolation anyway). Insulation helps absorb sound as it travels from one outlet box to another.

d) Ductwork

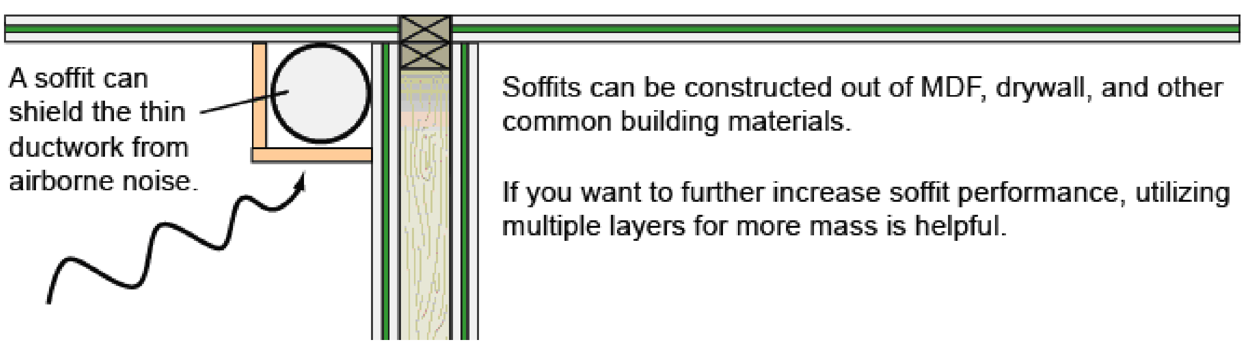
Ductwork can be problematic for the simple reason that it can provide a direct air path for sound to travel. There are many products available for taming sound coming through ducts. Among these are:

1. Duct Liner is your ally: Used lined ductwork (insulated ductwork). Lined ductwork contains sound absorbing material inside the duct to help destroy sound as it bounces it ways down the “tunnel” created by the duct. Also consider "flex duct" which is flexible and insulated. INSULATION MUST BE INSIDE THE DUCT TO BE EFFECTIVE IN THIS MANNER.

2. Long, complex paths are ideal: Ideally the duct path from where you will be making some noise to where you need it to be quiet would contain bends and be as long as possible. This creates a more complex path for the sound to travel, gives the duct liner more distance/time to do its work. 90 or 180 degree bends in lined duct can be helpful as they force airborne sound to interact with the duct liner more extensively. Flex ducts within a joist cavity should at least have a serpentine "S" shape.

3. Flex duct can be useful: Use flexible duct, but only in areas where the duct will not be exposed to direct sound. Flexible duct over some part of the path will break the structural path that the duct provides. Ducts can radiate sound traveling through the air they contain, but they can also radiate sound that they carry in their thin metal shells.

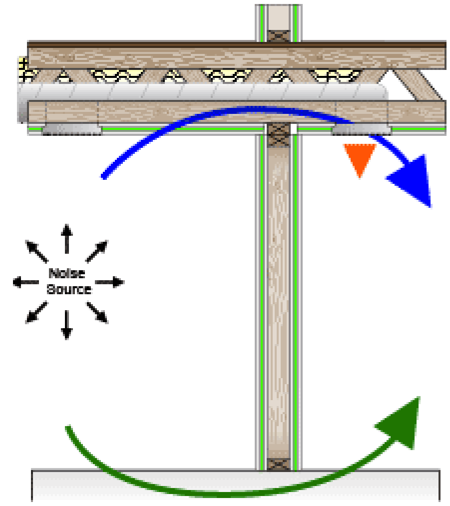
4. Use soffits to cover ductwork exposed to sound: If ductwork has to be exposed to sound, it is very preferable to cover it with a soffit. If there is no way to avoid having ductwork exposed to direct sound, round duct will perform better than rectangular duct, and coating the duct with a viscoelastic material will also help. Thin metal ducts are little barrier to airborne sound and therefore they should be exposed as little as possible.



5. Coating a duct: Preparing a duct with a visco elastic coating can help mitigate structural sound, but in general this shouldn’t be considered as valuable as lining the duct.

6. Exposed duct downstream is not a good sound barrier: Sound can pass out of thin metal ducts as easily as it can pass into them so if a critical area elsewhere in your construction must have ductwork exposed to the air, make sure the joints in that ductwork are sealed with an acoustic Seal, and also consider coating the ductwork with a dense viscoelastic coating such to reduce noise transmission. Even more extensive measures can be taken if need be, such as covering exposed duct with mass loaded vinyl or insulation + vinyl barrier.

e) Structure-borne noise



Noise can travel as mechanical vibration through the structure of your construction - studs, joists, subfloors, walls - to remote locations where the vibration can stimulate wall, ceiling and floor panels to create noise. Structural noise can be controlled in a variety of ways.

Among these are:

1. When you can, make one critical room different than the rest of the house.

2. If there is one room in your construction where noise will need to be contained more than others, it is helpful to make that room a different design than the other rooms. This is helpful because low frequency resonance points are the weakest link of any wall, and it is at these frequencies that sound can most easily enter the structure. Upon traveling through the structure to another place in the house, if the resonances are the same (i.e., if the construction is the same) then the same resonances in remote walls is again easily stimulated.

3. In situations where low frequency noise can be heard many rooms away from the source, structural noise is the culprit. Often, the worst cases are when all the walls in a building are the same. Changing the low frequency resonance behavior of a wall can be accomplished by any of the following:

- ✓ Use a fundamentally different wall design like staggered or double studs
- ✓ Use resilient decoupling such as sound clips or channel on the studs has limited effect
- ✓ Use an effective damping material such as a visco elastic glue on the walls between drywall sheets
- ✓ Use a 1 3/8” approved multi layer engineered Sound Proofing Drywall

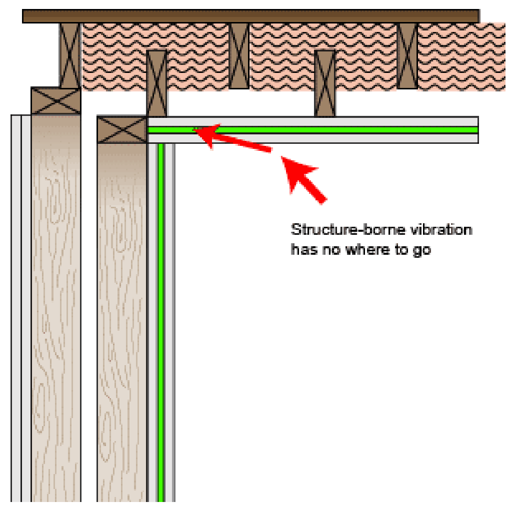
Note: Just adding a second layer of drywall or a layer of soundboard will not accomplish this goal

Mechanical decoupling can help

The use of modern sound clips, or constructions such as staggered or double studs can be effective by keeping sound vibration from reaching the structure in the first place. That is how these systems are effective - they provide breaks that keep drywall on the inside of a room from being in mechanical contact with the rest of the structure.

The ability, however, of decoupling schemes to reduce structure-borne sound is just like their ability to reduce airborne sound: they are effective only at frequencies well above their primary low frequency resonance. At and around this resonance, they will WORSEN the situation for both airborne and structure-borne noise, not help it. That is the nature of the beast when it comes to decoupling.

Since most walls are not decoupled, the construction of a decoupled wall usually meets the criteria above for non-homogenous construction as well. Decoupling options include room within a room, furring channel, staggered studs, sound clips, closed cell polyethylene foam and other options.



By far the most effective form of decoupling is the "room within a room," where double rows of studs are utilized in combination with separate ceiling joists to create a situation where almost no mechanical connection exists between the room and the rest of the structure.

Structure-borne noise is reduced, as there is no mechanical path from noise to the main structure of the construction.

Viscoelastic damping can help

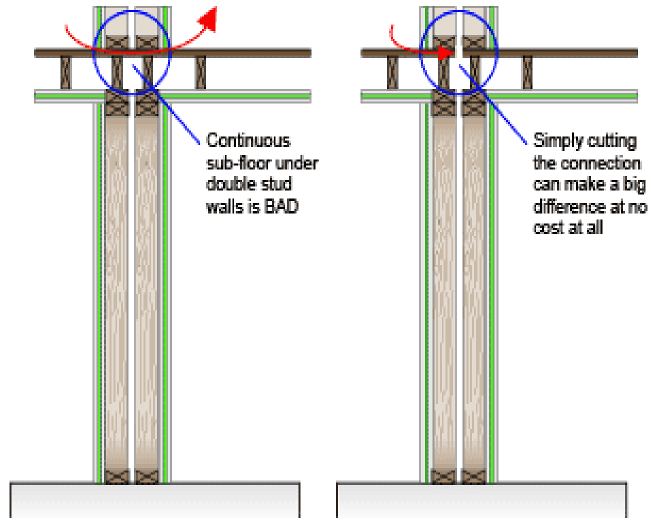
Viscoelastic damping materials such as Sound Proofing Drywall systems can contribute greatly to reducing structure-borne noise. This is because damping, by definition, is energy dissipation. As energy travels along an undamped structure, very little of it is dissipated, and it can travel great distances. When energy travels over a highly damped structure on the other hand, the energy is quickly dissipated - the damping materials convert the energy to heat.

The use of such products in a structure can dissipate structure-borne noise faster than undamped structures. Quite simply, the noise cannot travel far enough through a very well damped structure to cause disturbance at long distances. Unlike decoupling, the effect of damping is not frequency dependent.

The best choice is, as always, a combination of damping and decoupling. For example, the low frequency resonance of a heavily damped double stud wall is so much less severe than a conventional double stud wall that this problem can be simply disregarded.

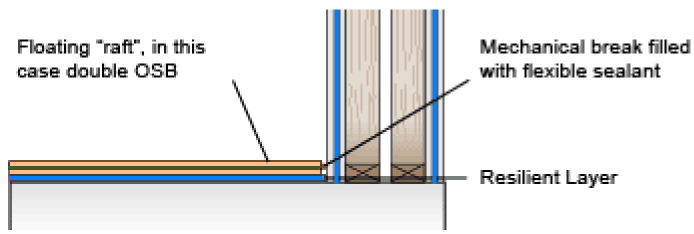
Structural breaks can help

While we can't list every opportunity for minimizing structural connections, but we hope that the diagram here illustrates the point.



Floating floors can help. The use of floating floors can help mitigate flanking noise via structural paths as well. A floating floor is a floor that has a surface "floating" on top of some type of resilient layer. The floating surface may be wood, multiple layers of wood, gypsum concrete, or various other materials such as Sound Proofing Wood. The resilient layer comes in many forms, from rigid fiberglass to rubber mats, from to other elaborate engineered systems.

It is wise to leave a mechanical break between the floating element and the neighboring structure, as shown here.



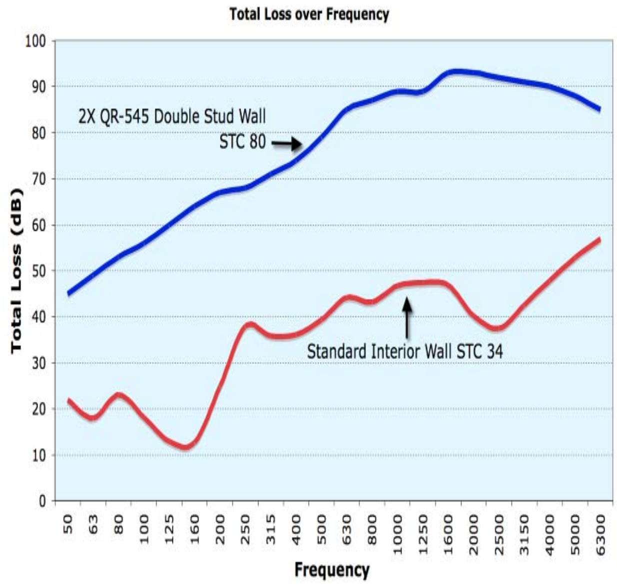
A floating floor can be extremely expensive, and if you are attempting to soundproof a basement room you should consider sound-treating the concrete floor via creation of a floating floor only after prudent measures have been taken on the walls, ceiling, ductwork, doors, etc. While concrete slabs can be flanking problems, typically they limit only the highest performance walls, and a reasonably good wall can be built without elaborate and often extremely expensive floating floors. But remember, for the highest level of performance that slab will have to be dealt with. Upgrades of some type to the floor of a 2nd level room are compulsory for good quality sound isolation.

Structural Noise Summary

The comments above will get you started on the right track with your plan. It's not necessary to take every possible step in many cases, but if an ultimate level of performance is to be attained, then a very involved design is necessary.

f) Seal quality and other direct air leaks

Last, but by no means least, is seal quality and other small air cracks directly connecting two rooms because where ever air can travel, so can sound. Even the smallest seal failure can have catastrophic consequences to a high performance partition, proper caulking practice is critical.



Poor seal quality will make a poor performer out of any partition, even one of the best possible walls like a Sound Proofing Drywall damped double stud wall. In fact, very poor seal quality will drag the performance of even the best walls down from the stratosphere to the level of the wall in a cheap motel.

For this reason special attention should be paid to any physical penetrations within a wall including light switches, media and phone outlets and plumbing. Acoustically engineered Putty helps to substantially mitigate sound transmission in these areas.

If your walls are not very well sealed, all the Sound Proofing products in the world won't do you any good. The graph below illustrates the effect of seal quality on a variety of walls.

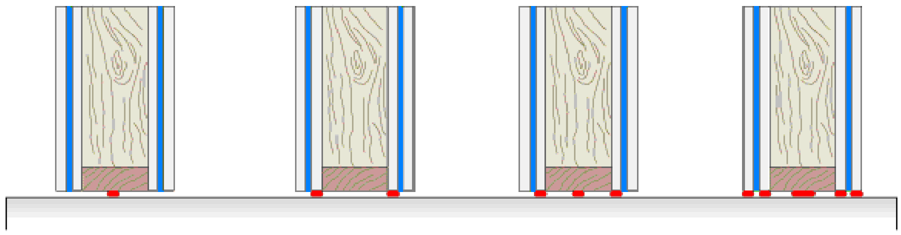
■ 1 3/8" Sound Proofing Drywall Double Stud Wall, STC 80

■ Standard Wood Single Stud Wall, STC 36

As this chart shows, the huge performance gains that modern sound isolation technology can deliver are completely lost if seal quality is poor.

Do I need a specialized acoustic sealant and putty? You should strive to use an acoustic sealant and putty because they have been designed to be flexible, and to remain flexible and never dry. Flexibility prevents the seals from cracking over time and is an important component.

How should I use the caulk?



Bad
Sealant under frame only. Sound can easily enter and exit the wall cavities

Good
A good start for remodeling jobs where you are adding drywall to an existing wall

Very Good
Beads under drywall to keep sound from leaking into the cavity, and under frame for redundancy

Perfect
A heavy bead under the walls plates plus a bead under *each* drywall layer

You should strive for multiple caulk layers on partitions where sound isolation is critical. This helps ensure that a quality seal is attained by "doubling up" on seals - if one layer has compromised quality, it is backed up by the other layers.

Many different sealant patterns can be utilized with success. And 10 perfect seals aren't much better than 2 perfect seals (one on each side of the wall), BUT (and that's a big but) redundancy ensures that sealant performance will be good, and we strongly recommend it.

Caulk with resilient mounts

Resilient mounts such as resilient channel or more modern, high performance engineered sound clips call for special sealant practices. To get performance as good as the lab tests, particularly low frequency performance, it is generally recommended to leave 1/8" to 1/4" between the drywall and any other surface, and then fill that gap with very flexible acoustic sealant. This creates a "floating" wall in the truest sense. However, as with any such installation, if these walls are active, meaning being touched in a regular manner, separation is a real possibility. For this reason we recommend you contact the resilient system manufacturer for their recommendations.

Flanking Noise Summary

We have taken a look at flanking noise and how to cope with it in this document. The topics contained herein are as much a component in the success of your project as is the selection of wall or ceiling type. Ultimately the success of any isolation project relies on competent planners, designers, and installers.

So when you reach your goals of peace and quiet, remember to pat yourself on the back because a lot of your success couldn't have been done without your prudent efforts.