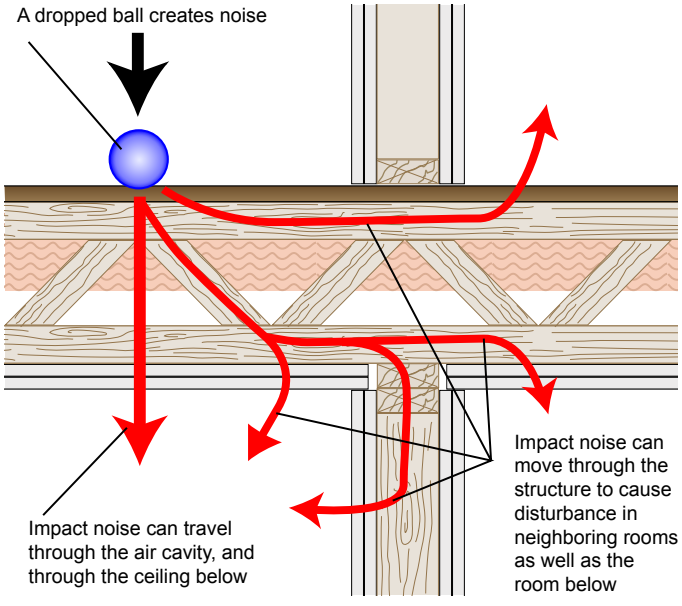
By Andrew Steel

Dealing With Impact Noise

One of the most common noise complaints is that of footsteps or sliding chairs from rooms above. In a world where hard surfaced floors are increasingly popular, this problem is becoming more prevalent, and needs to be dealt with.

What is impact noise?

It is just what its name implies - noise generated from something or other impacting something else. Usually when we consider impact noise, we are talking about floors. Footsteps, sliding chairs and so on generate noise, particularly when the surface of the floor is hard. Wood and tile - aesthetically pleasing and popular in today's culture -create situations where more efforts to control noise are needed.



The diagram to the above shows that when we talk about impact noise, we have to talk about structural noise as well as noise passing through the air cavity and ceiling below. Indeed, structure-borne noise is extremely important when discussing impact noise because, by definition, impact noise begins in the structure.

Even a quick glance at the diagram implies that since the noise can travel freely throughout the structure once it is generated, it is by far most wise to treat the noise at the floor, at the source, lest it get away from you and find some structural path to your ears despite your high quality ceiling.

Carpet & pad is king.

Of all the products available for controlling footstep noise and other forms of impact noise, none is more effective than carpet with a thick pad. The soft carpet and thick pad cushion the impacts so that much less energy is delivered to the floor and therefore to the structure.

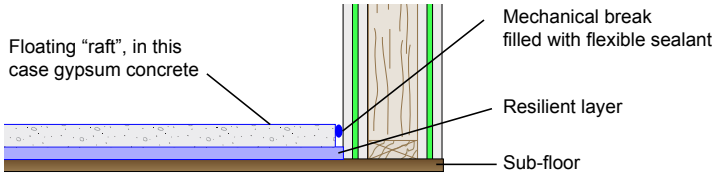
Effect of carpet & pad. Carpet & pad will give an enormous reduction in impact noise at mid and high frequencies, where noise is most annoying. Its effectiveness falls as frequency gets lower, and by some frequency it will be essentially non-effective. Because the action of carpet and pad is to reduce how much noise gets made in the first place, it is effective in all areas - including rooms to the side, below, and reducing noise inside the room where someone is walking.

Carpet & pad can be so effective that no additional consideration is necessary. The only limitation of carpet & pad as an impact noise control product is that its effect is frequency dependent, with decreasing effect at decreasing frequency. For common lightweight wood sub-floor constructions it may be beneficial to take additional measures to reduce impact noise at low frequencies. Again, however, it is more than possible that carpet and pad alone will do the trick.

Carpet and pad have only a very minimal effect on airborne sound isolation - they are not effective at keeping sound from downstairs from coming up, or sound from upstairs from making its way down.

Resilient underlayments - "floating" floors.

The use of resilient underlayments consists of putting some type of surface material over a resilient layer, like this:



Typical "rafts" include all kinds of finished floors, including tile, hardwood,etc.

Resilient layers come in many forms, including

- Recycled rubber mat
- Rigid fiberglass

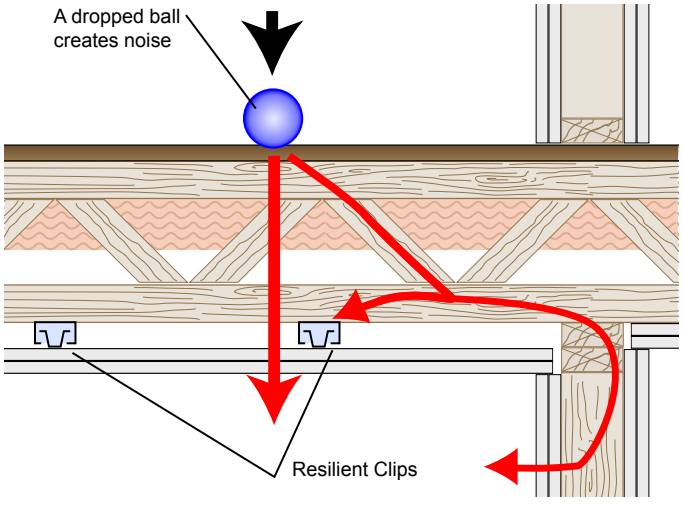
- Foams of various sorts
- Rigid fiberglass
- Cork
- Many others

Underlayments such as these are extremely commonplace in conjunction with gypsum concrete, and over precast concrete flooring, but are used in conjunction with common wood subfloor/joist floors as well. For heavy flooring systems, such as precast concrete, resilent layers contribute only resilience. For lightweight HMR/joist floors, however, they can also contribute mass.

Effect of resilient underlayment. Resilient underlayment acts to keep energy from reaching the sub-floor below it. Resilient underlayment systems have, like carpet, an immense effect at high frequencies, and having less effect as frequency declines. They are, however, not effective at low frequencies and may cause negative effect at some point. In this manner they are not unlike resilient mounts used to stop airborne sound on walls. Because resilient underlayments work to keep energy away from the structure, they are effective in all directions.

Resilient mounts for the ceiling below & room within a room designs.

Products such as resilient channel, modern sound clips, and spring ceiling hangers can have a significant positive effect on impact noise by breaking the structural path from floor to ceiling below.



In lab tests, resilient ceiling mounts can deliver big benefits. In the real world, however, if flanking paths are not dealt with, some of this benefit will be lost.

To get effect from resilient mounts that approaches that shown in the lab, you may have to use them on all sides of the room below.

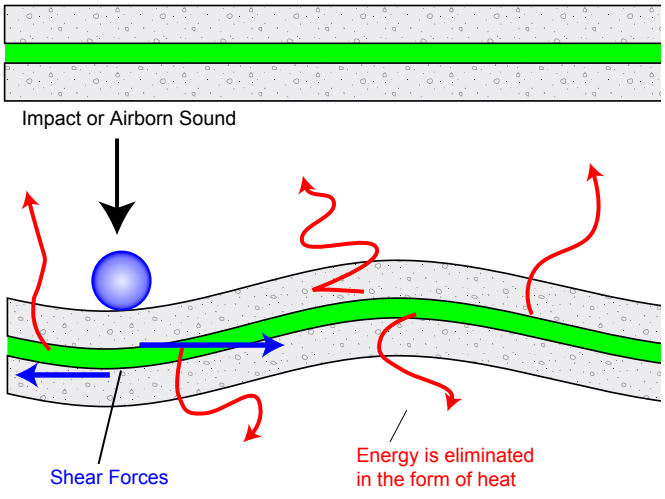
Even better than resilient mounts is a "room within a room" where two stud rows are used in walls, and separate joists are used for the ceiling.

The value of resilient mounts is, like the techniques above, greatest at higher frequencies, and at some low frequency, their benefit will cease to exist. Because they are mounted on the ceiling below the floor, they have no effect on noise going in any direction except directly through the ceiling below, and do not reduce generated noise in the room where someone is walking. Still, they are a very potent tool for reducing impact noise. Resilient mounts will have their well known positive effect on airborne sound isolation.

Viscoelastic Damping

Viscoelastic damping has been used to reduce impact noise for many, many decades, but as a technology applied to construction, it is relatively new. Viscoelastic damping reduces impact noise by lowering the amount of noise generated by an impact, and by dissipating vibration quickly as it moves through a structure.

Constained Layered Damping



Effect of viscoelastic damping. Viscoelastic damping is unique in that it is effective at reducing noise levels across the entire frequency range with no failure at low frequencies. Damping stands alongside carpet & pad as the only techniques that have no negative impact at any frequency. Its capacity to dissipate energy mitigates flanking noise, helping keep rooms to the side quiet and minimizing structural noise going down.

Viscoelastic damping will reduce the amount of noise generated in the room above, which can give a luxurious feeling to your floor.

Viscoelastic damping has a substantial positive effect on airborne sound isolation.

Like resilient mounts, VE materials in your ceiling can only help your situation. However, like resilient ceiling mounts, damping materials can't help with flanking noise or reducing the amount of noise generated when they aren't in the floor. This is one point we hope to stress in this document - treating noise at the source is important.

Mass. Last, and in the case of impact sound, least, is mass. Simply adding more mass in the form of additional subfloor layers can have some effect on impact noise. Historical lab tests imply that this effect alone isn't overwhelming. Mass is more valuable in stopping airborne sound than it is in stopping impact noise, and you could expect increased mass to have some positive effect on airborne sound isolation.

Insulation / sound absorbing material.

For all construction situations involving sound, you should utilize insulation in the ceiling cavities. Which type of insulation is not important, and there is never good cause to spend lots of money on esoteric absorbing materials, but it is important that you use at least some absorbing material in the cavity. Studies have shown that insulation thicker than R19 has a diminishing return-on-investment, a fact that might save you some money.

Section 2
- Planning your designs to control impact noise

Now for the fun part of this document, and perhaps the part that will be most useful. We will walk through some hypothetical scenarios in which we plan various impact noise controlling schemes, and take a look at performance and cost.

Scenario 1
- Kitchen with a tile floor above a future home theater

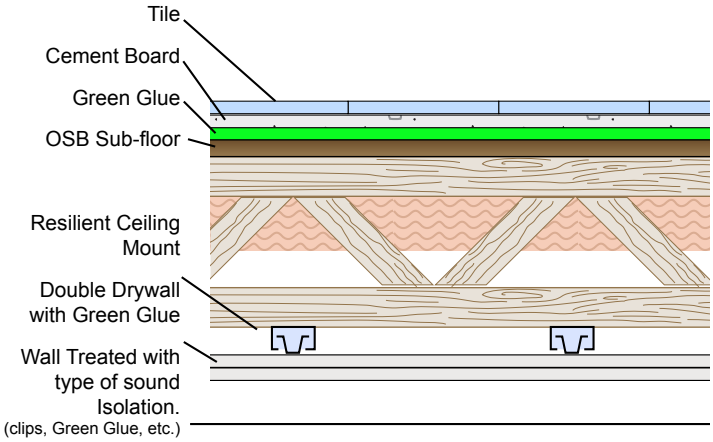
So you have a theater, which you want to be quiet for your movie-viewing pleasure, but you are faced with the challenge of a tile floor directly above it. The tile is mounted on cement board set over an HMR subfloor. What can we do? Knowing that the great cure-all of impact noise problems - carpet & pad - is not an option, we have to come up with a prudent plan.

Treat the noise at the source.

We mentioned above and will be stressed repeatedly through the rest of this document, it is important to treat the noise at the source. Once the noise is in the structure, half the battle is already lost.

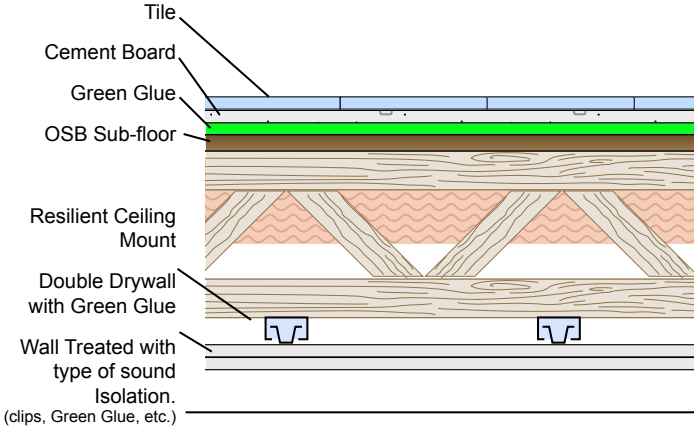
To treat the noise at the source, we opt for a combination of underlayment and damping. Green Glue has proven in lab tests to outperform all others for stopping airborne sound. This higher damping should perform similarly for impact noise, so we select that. For the underlayment we select a shredded rubber mat as this type of material is heavy and the weight will be a positive contribution. Green Glue must be used in between two rigid materials to function, but the inclusion of the rubber mat between something stiff (cement board in this case) and something stiff (the HMR in this case) will not impair Green Glue's performance. Nor will Green Glue impair the performance of the underlayment.

Finally, Green Glue is a fraction of the cost of typical resilient underlayments, so its contribution comes at an incremental cost increase.



And there we have a scheme that should prove highly satisfying. It has many components, it is practical only for new construction, and it is not the least expensive solution possible. Therefore we will look at some other alternatives on the next page.

Here we lower our costs by removing the most costly element - the rubber mat. Now we have Green Glue sandwiched in between the cement board and the HMR sub-floor, which is a great place for it.



We have lowered costs in the ceiling by removing Green Glue. Even though GG is less costly than clips for a ceiling application, we feel that clips with conventional drywall will outperform GG drywall screwed to the joists for impact noise from tile.

We keep Green Glue on the walls of the room below, as this is the lowest cost method of attaining good performance walls. Resilient channel might be considered as well, but this material is very prone to installation problems and field failure. This table will step you through some of the changes that could be made, and attempt to loosely rank them in order of performance. Please understand that these are estimations and not concrete data taken in the same location so as to be presentable with complete certainty.

Floor options, best to worst:

- Rubber mat + Green Glue or damped plywood (damped plywood is another form of damping for floors, available from various makers. It is said to perform well, but is far more expensive than Green Glue).

- Underlayment OR Green Glue/damped plywood. If you can't have both, then it's one or the other. Green Glue is the lowest cost of those and without testing every product on the planet we can't say concretely which is best.

- No sound treatment to the floor. Definitely not the best option. Noise is not treated at the source, and problems are far more likely to occur. Ceiling options, best to worst:

- Room within a room with double drywall and Green Glue or factory damped drywall (available from various makers). This involves double stud walls in the room below and separate joists for the ceiling below. If you opt for factory-damped drywall, you should target product that is as heavy as the Green Glue assembly would be.

- Green Glue between double drywall on ceiling spring hangers. Next best are modern engineered sound clips from makers like PAC International and Kinetics Noise, with resilient channel bringing up the rear.

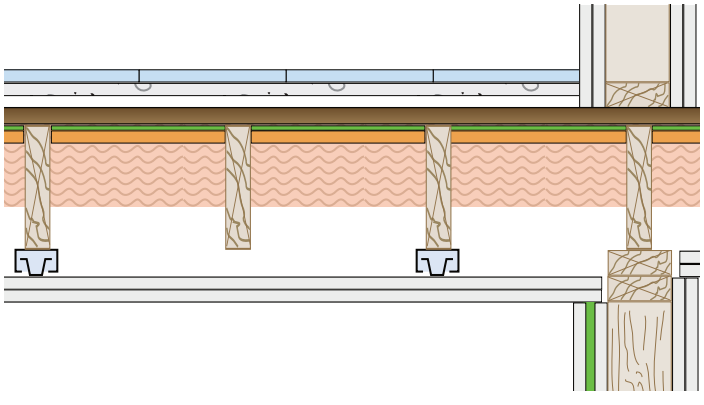
- Clips or ceiling hangers with double drywall, no damping material.

- GG double drywall on wooden furring strips. Resilient channel with conventional drywall should be considered a risky alternative.

- Conventional ceiling (poor performance), or tile ceiling.

NOTE: Do not use clips over existing drywall. Doing so creates a small air cavity that can have detrimental effects. If you opt to use resilient channel, hangers, or sound clips on your ceiling you must plan on removing the existing drywall.

Scenario 2
- As above, but the tile is already installed in the kitchen.



Green Glue sandwiched between the subfloor and strips of HMR or drywall in between the joists.

This type of post-treatment is labor intensive, but many persons opt to do it nonetheless. It is not as effective as Green Glue between two layers of subfloor above, but it can help a lot. Still gives us some change to treat the noise at the source.

Same ceiling and wall choices and options as before, with the same order of performance. Depending on the level of sound isolation required, you can use multiple layers of Green + board in between.

We aren't aware of any other post-treatment to the floor, of any other way to treat the noise at its source after the floor is installed, and so we offer this idea.

Scenario 3 -Reducing impact noise with a gypsum concrete subfloor. We offer the same comments as above; just replace the cement board with gypsum concrete.

That said, the mass of the rubber mat is far less important as the gypsum concrete floor will already be very heavy, so many other underlayment possibilities could be utilized, not all of which may be compatible with Green Glue. Damping is a good thing for impact noise control, but it's not necessary. Gypsum concrete manufacturers and installers typically offer high performance underlayments as an option, and those are certainly a good place to start.

Scenario 4 -Precast concrete slabs. Without a doubt two things will make the biggest difference in impact noise with precast concrete slabs.

The first is, of course, carpet. But carpet isn't always an option when taste calls for wood or tile floors. If you cannot utilize carpet, you should seek out a resilient underlayment to go under the tile or wood flooring.

The second is a ceiling below the concrete. The ceiling should be decoupled, meaning some type of resilient mount or separate ceiling joists, and it should utilize as large of an air cavity as possible. The larger the air cavity, the lower the resonance frequencies of the system, the more insulation can be utilized, and the higher performance will be. We recommend that you avoid utilizing air cavities under perhaps 2 inches, and we recommend that you use double drywall on the ceiling especially if a small air cavity must be utilized. BC