

Sound Attenuation

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Sound Attenuation

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Learning Objectives

- Define acoustics as it relates to architecture
- Determine the code requirements for sound transmission criteria
- Predict airborne and structure borne noise paths and select appropriate sound isolation details to disrupt these paths
- Identify sound isolation techniques, materials and products
- Recognize the role of resilient sound isolation clips in sound attenuation and specify appropriate locations for their use

Introduction

- Why is acoustics important in architecture?
- How does acoustics impact architectural design?
- Introduce acoustics, impact on design and sound control solutions.



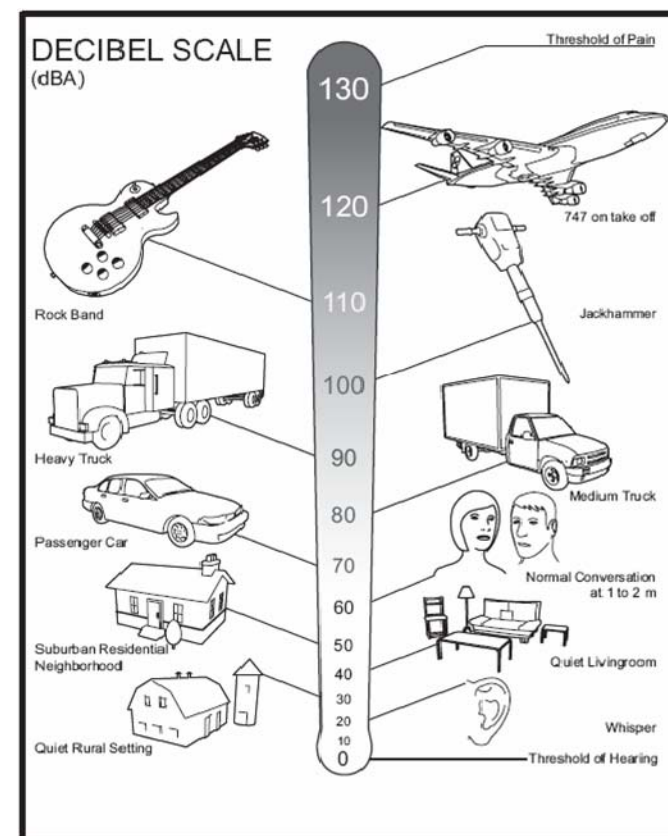
Acoustics and Architecture

- Includes wall and ceiling assembly sound isolation
- Building systems noise and vibration control
- Room shaping and finishes to augment or control sound
- Exterior noise issues and mitigation, sound prediction, modeling and measurements.

Acoustics is the science concerned with the production, control, transmission, reception, and effects of sound

Sound

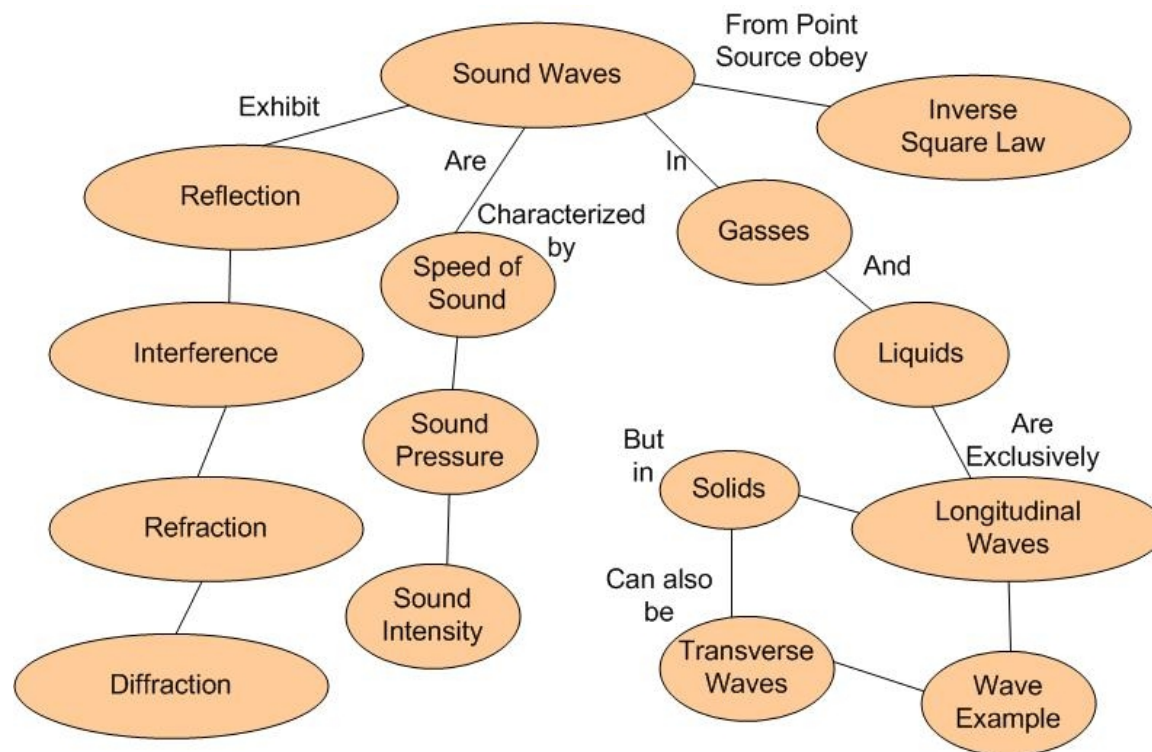
- Stimulation of hearing organs by mechanical vibration
- Travels in air at a speed of 1087 ft/s
- Is measured in decibels



Decibel

- Unit used to express sound level
- Expresses relative difference in power or intensity between two acoustic or electric signals
- A 10 decibel increase in sound is equal to a doubling of sound power level

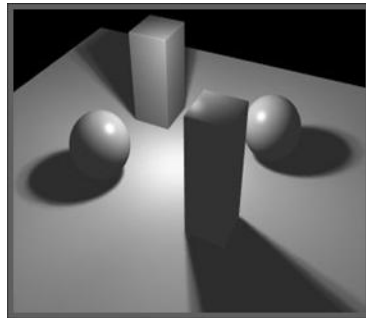
Factors Affecting Sound Propagation



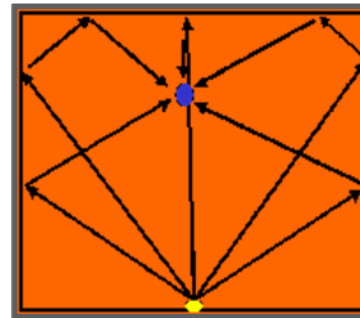
Sound and Light Properties



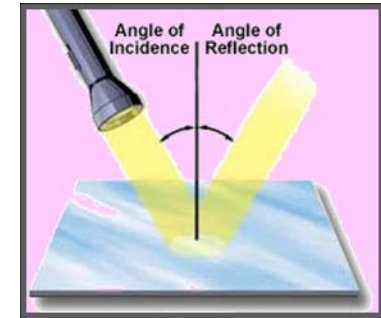
Sound Barrier



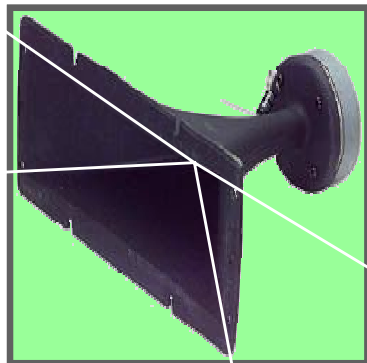
Shadow



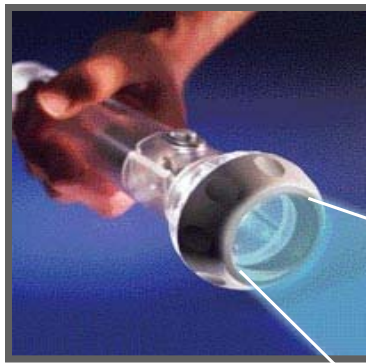
Reflected Sound



Reflected Light



Loud Speaker Horn



Light Beam



Light Bulb



Bell Ringing

Impact of Design on Acoustics

- Landscape design to reduce sound impact on site and building
- Exterior sound affected by ground effect, wind direction, temperature and air density



Sound Diffusion



Sound Berm



Sound Barrier

Impact of Design on Acoustics

- Interior volume, wall and ceiling shaping, and finishes have direct correlation to reverberation time, early decay time, strength, clarity, lateral energy fraction, inter-aural cross correlation, and early support



Sound Focusing



Sound Diffusion



Sound Reflection

Impact of Design on Acoustics

- Sound creepage and sound focusing can occur in interior spaces
- Extreme sound attenuation with sound enclosure



Sound Creeping



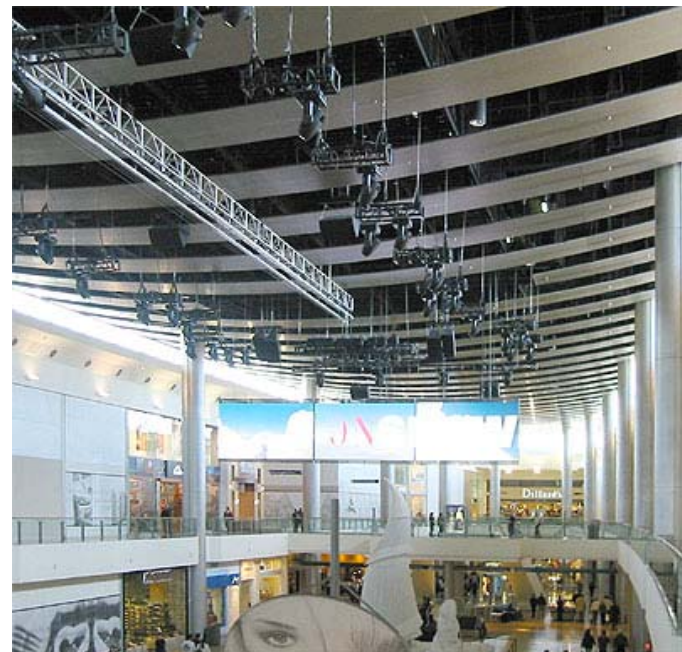
Sound Absorber



Sound Enclosure

Impact of Design on Acoustics

- Building form and space and function
- Large room volume, sound reflecting finishes contribute to excessive reverberant energy build-up



Acoustics Needs

ACOUSTICS NEEDS ASSESSMENT TABLE	Single Family Residence	High Density Dwelling	Arena and Recital Halls	Hotels & Timeshare	Recording Studios	Education	House of Worship	Clubs, Restaurants, Retail	Ballrooms, Meeting and Convention
Environmental Noise Assessment	X	X	X	X	X	X	X		X
Building Shell Evaluation	X	X	X	X	X	X	X		X
Space Adjacency		X	X	X	X	X	X	X	X
Partition Design & Designation		X	X	X	X	X	X	X	X
Floor-Ceiling Assembly		X		X	X			X	X
Acoustical Finishes & Room Shaping			X		X	X	X	X	X
Equipment Noise & Vibration Control		X	X	X	X	X	X	X	X
Plumbing Isolation	X	X	X	X	X		X		X
Field NIC (STC) and IIC Tests	X	X		X					
Sound & Reverberation Time Measurement			X		X	X	X		X
<div> <div>X</div> Normally Required. <div></div> Not Normally Required. </div>									

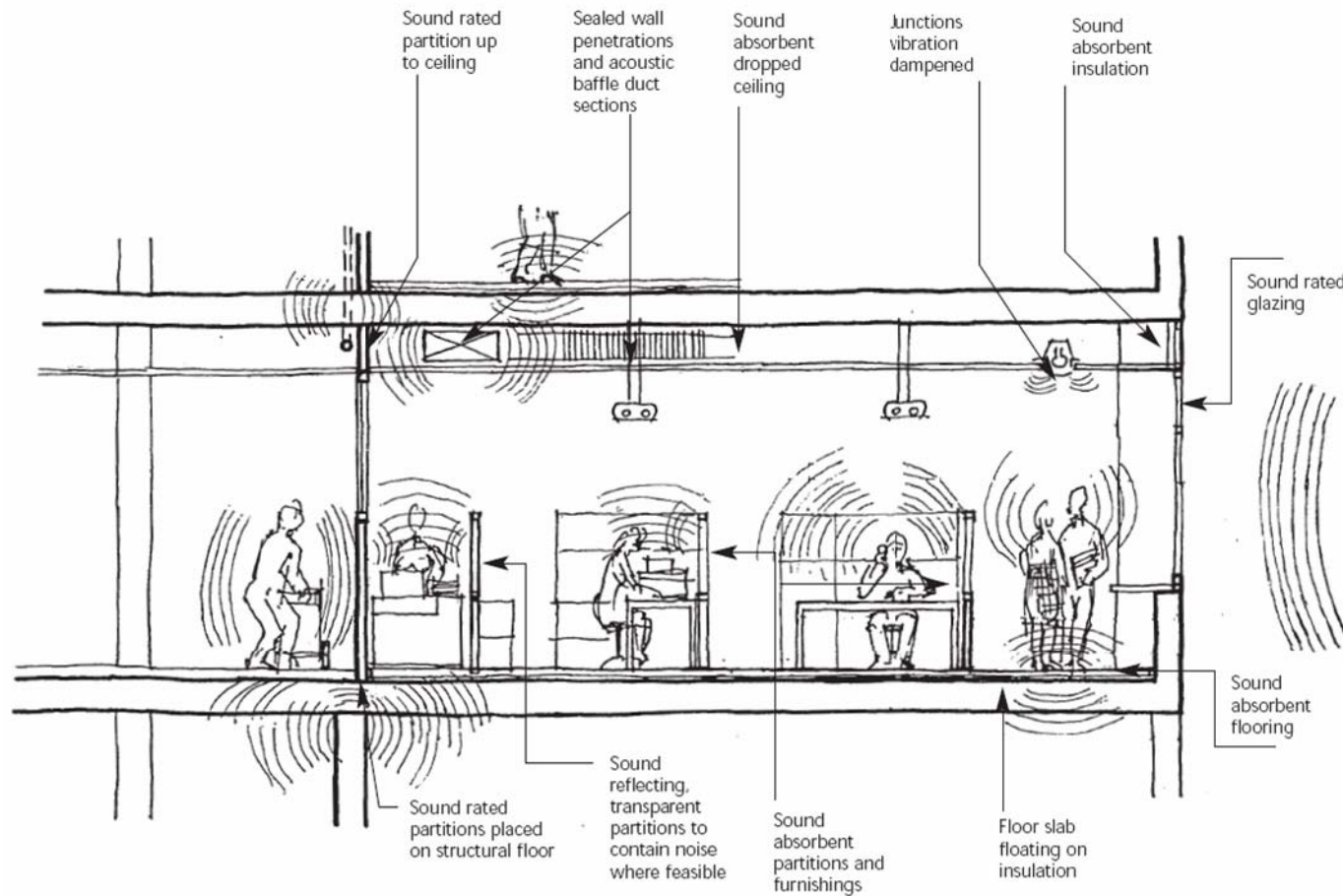
Acoustic Needs

- Environmental Noise Assessment
- Building Shell Evaluation
- Space Adjacency
- Partition Design & Designation

Acoustic Needs

- Floor-Ceiling Assembly
- Equipment Noise and Vibration Control
- Plumbing Isolation
- Field NIC and IIC tests

Noise



Techniques needed to combat noise (unwanted sound)

Urban Noise

- Causes stress, ailments and decrease in productivity

Residential Environment	Representative 4 Hour Average Noise levels (dBA)	Subjective Loudness/Noisiness
Undeveloped Rural	35-40	<u>Baseline</u> - Extremely quiet like typical quiet living room
Rural Residential	40-45	<u>40%</u> louder/noisier (still very quiet)
Quiet Suburban	45-50	<u>Twice</u> as loud or noisy (but still quite quiet)
Urban Residential away from arterial/main streets	50-55	<u>Three</u> times as loud /noisy (still generally no significant noise impacts in residential areas)
Urban residential near arterial road /main street	55-60	<u>Four</u> times as loud/noisy (threshold for onset of noise impacts due to speech and sleep interference)
Urban residential on arterial road or main highway	60-65	<u>Six</u> times as loud/noisy (speech interference outdoors, increasing potential for sleep disturbance)
Urban residential on major arterial or highway	65-75	<u>Eight to eleven</u> times as loud/noisy (outdoor spaces generally not useable, potential indoor speech interference, significant sleep disturbance)

STC and IIC

- Determines acoustical performance of architectural assemblies
- STC - Assembly's ability to resist airborne sound transfer at the frequencies 125-4000 Hz.
- IIC - Indicates the amount of impact noise isolation provided by a floor/ceiling assembly

Minimum STC

- IBC Section 1207 requires STC not less than 50 (45 if field tested) for walls, partitions, and floor/ceiling assemblies separating dwelling units from each other or from public or service areas.
- Local code made supersede this requirement

Minimum STC

- Meeting minimum requirements results in noise complaints

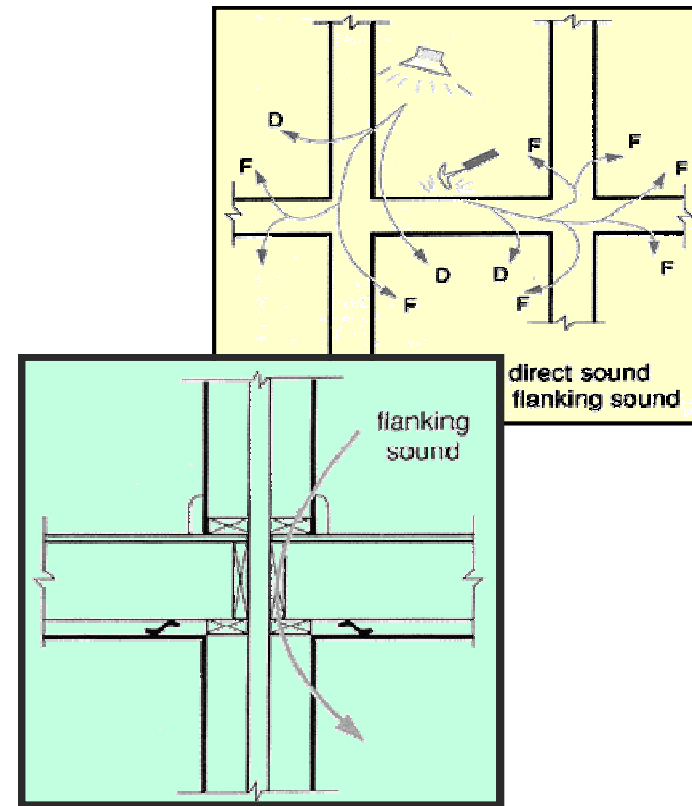
Ideal Sound Transmission Limitations for Floors in Multi-Family Housing		
Location of Floor-Ceiling	STC	IIC
Unit to Unit (1)	STC 60	IIC 60
Unit to Corridor (2,3)	STC 55	IIC 55
<p>Note:</p> <ol style="list-style-type: none"> 1. Inclusive of high noise spaces such as lobbies, boiler rooms, mechanical equipment rooms, elevator shafts, laundries, incinerator shafts and garages. 2. Inclusive of storage rooms, stairways etc. 3. This STC rating is not achievable in walls with entry doors even where gaskets are present. 		

Testing Methods

ASTM E90	Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E336	Standard Test Method for Measurement of Airborne Sound Insulation in Buildings
ASTM E413	Standard Classification for Rating Sound Insulation
ASTM E492	Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine
International Standard ISO 140-4 (11)	Acoustics-Measurement of Sound Insulation in Buildings and of Building Elements

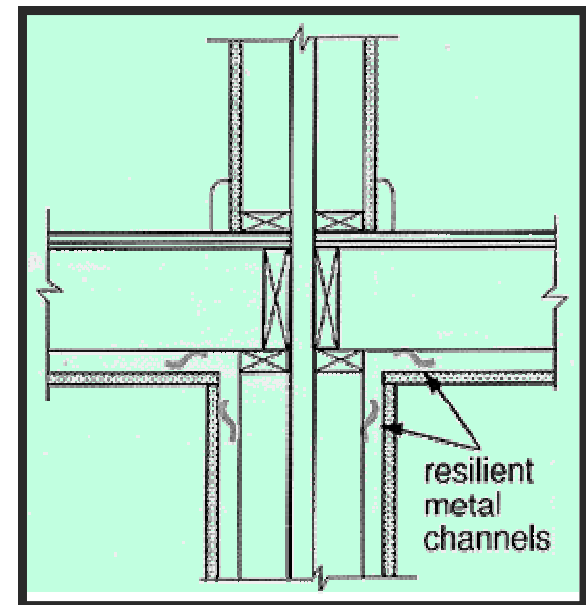
Common Noise Paths

- Direct sound travels directly through a partition
- Flanking sound causes structure borne vibrations that travel through connecting surfaces



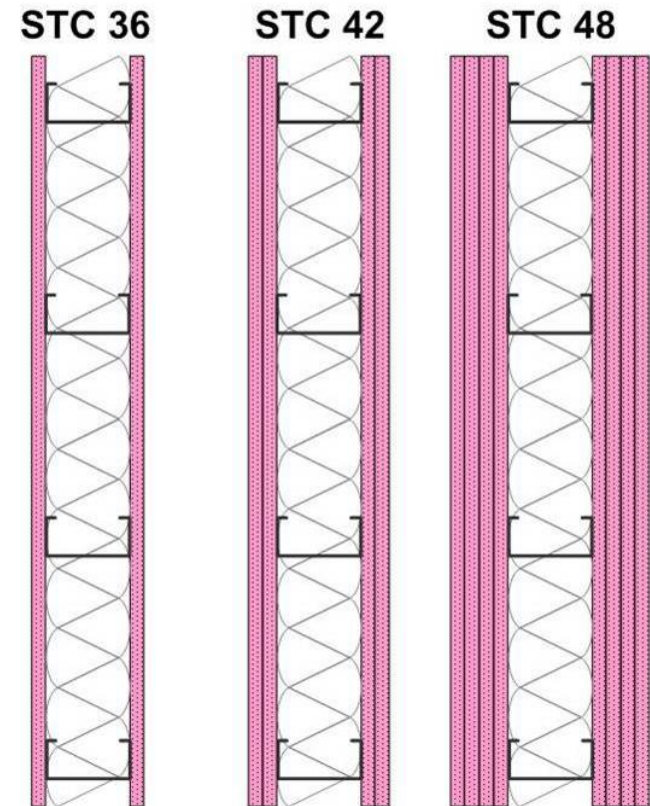
Sound Attenuation Aspects of a Wall

- Mass of the material
- Structural stiffness
- Airspace and sound insulation
- Decoupling of membrane



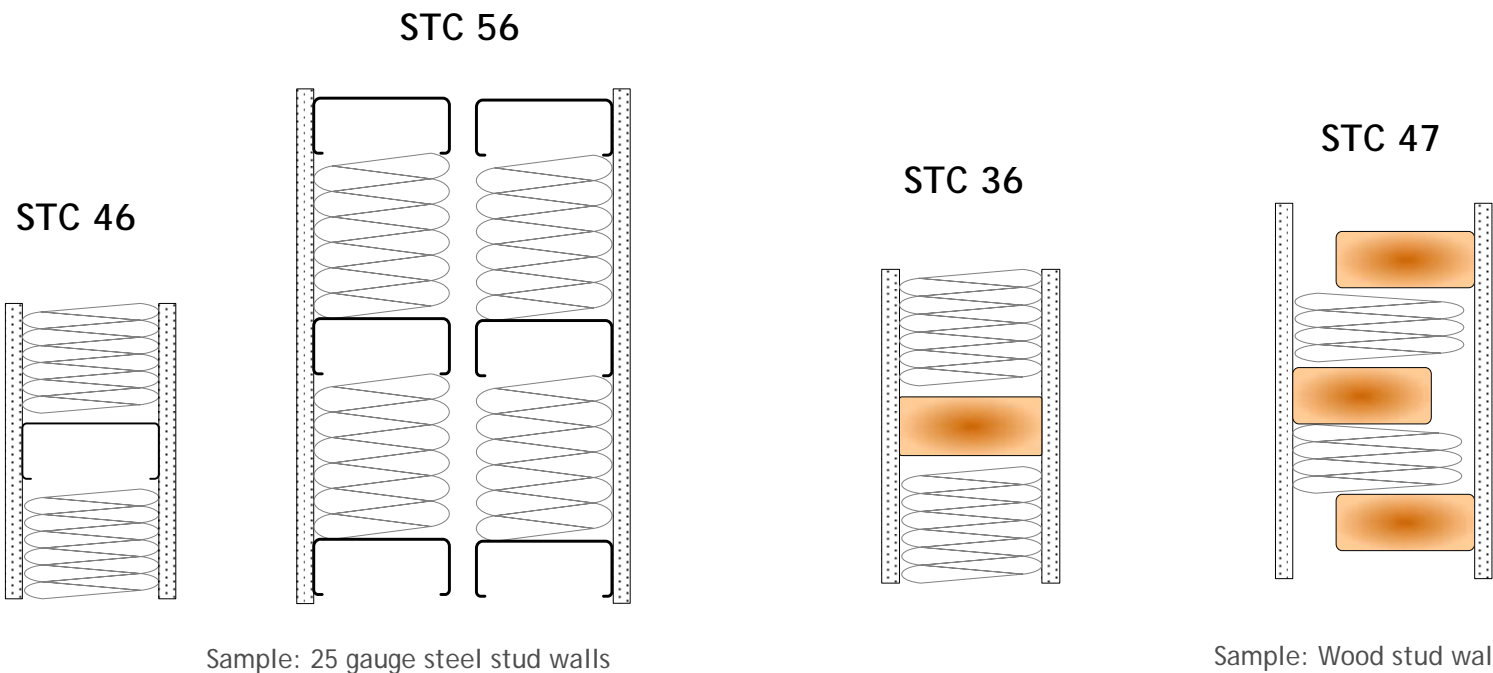
Mass

- Mass Law: The sound transmission of a wall is proportional to its mass per unit area
- Certain constructions can outperform the mass law, in particular cavity constructions



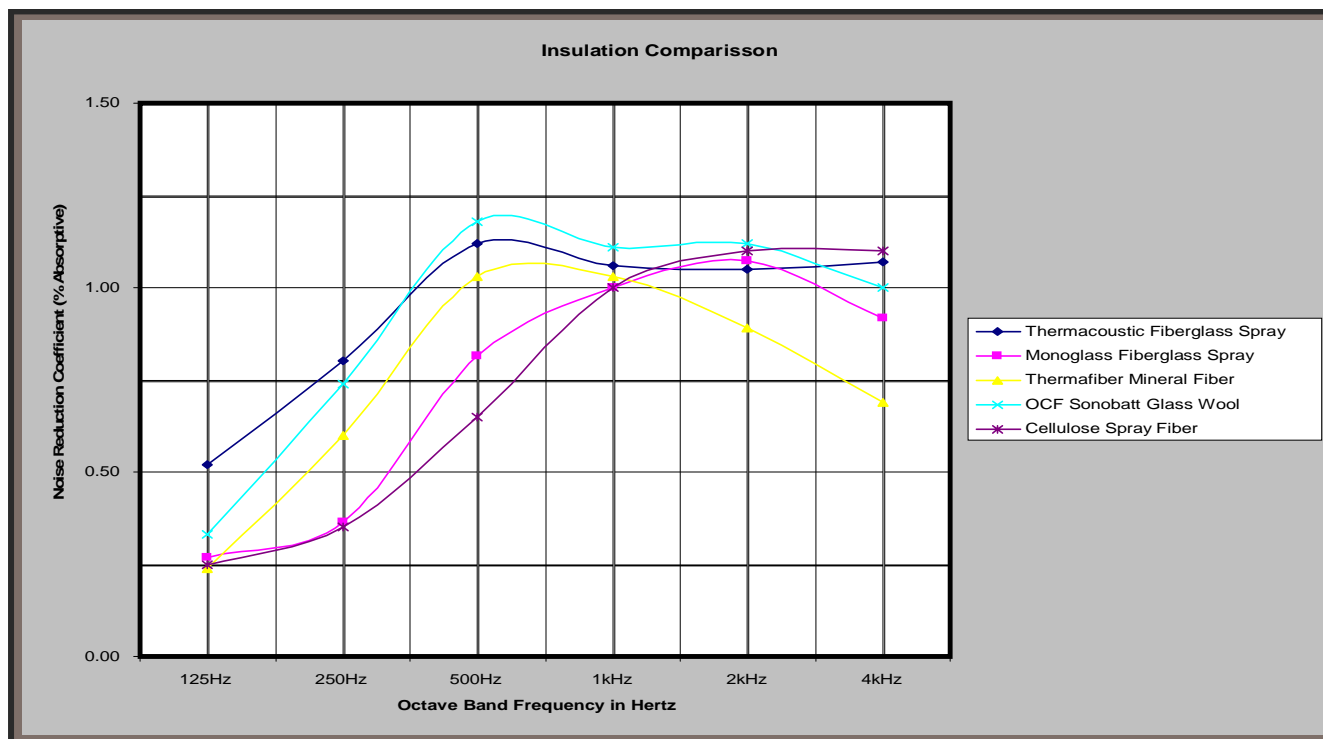
Rigidity

- Less rigid wall interrupts noise/vibration path



Insulation

- STC varies with insulation type and increases with overall thickness



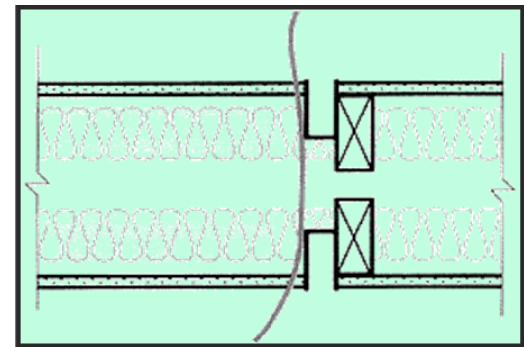
Acoustical Sealant

- Small openings can lower the STC ratings by as much as 10 points
- Sealant critical material in sound attenuation



Wall Openings

- Metal or UL rated plastic electrical boxes placed back to back can lower STC significantly
- Use of firestop, insulation and distance of 24" between boxes produces negligible drop in STC

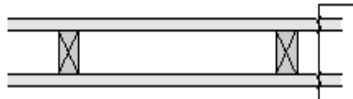
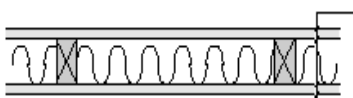
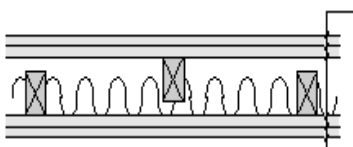
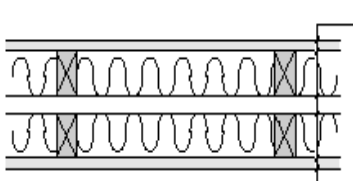


This image above shows the proper way to wrap an electrical box with putty pad.



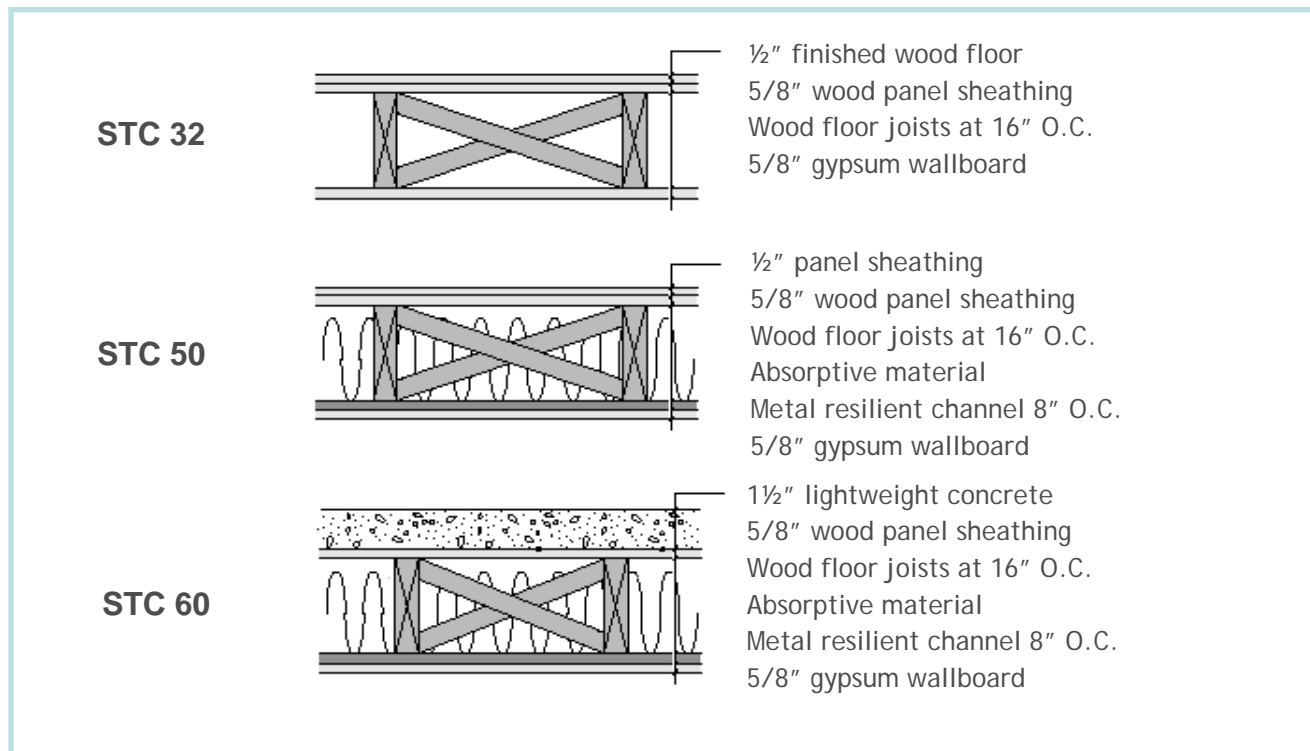
Decoupling of Membrane

- Lowers STC

STC 32		<ul style="list-style-type: none">• 1/2" Type X gypsum wallboard both sides• 2"x4" studs 16" O.C. or 24" O.C.
STC 34		<ul style="list-style-type: none">• 1/2" Type X gypsum wallboard both sides• 2"x4" studs 16" O.C. or 24" O.C.• Absorptive material
STC 55		<ul style="list-style-type: none">• Double 1/2" Type X gypsum wallboard both sides• Two rows 2"x4" studs 16" O.C. or 24" O.C. staggered on common 2"x6" plate• Absorptive material one side
STC 57		<ul style="list-style-type: none">• 1/2" Type X gypsum wallboard both sides• Two rows 2"x4" studs 16" O.C. or 24" O.C. on common 2"x6" plate set 1" apart• Absorptive material both sides

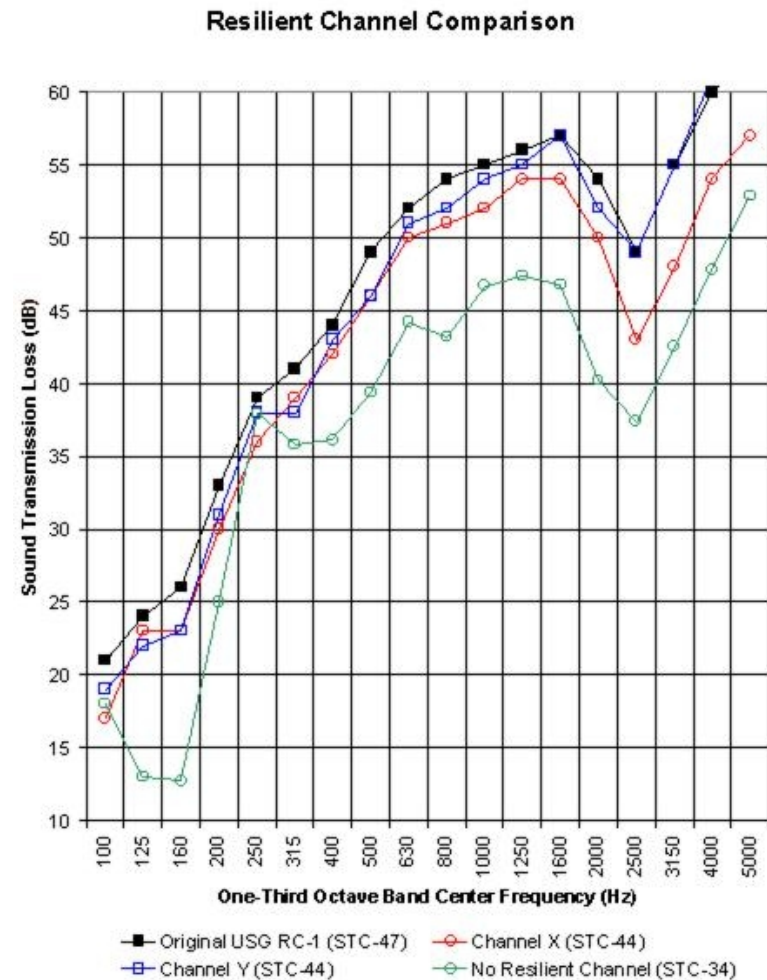
Resilient Channels

- Absorb sound rather than transmit it



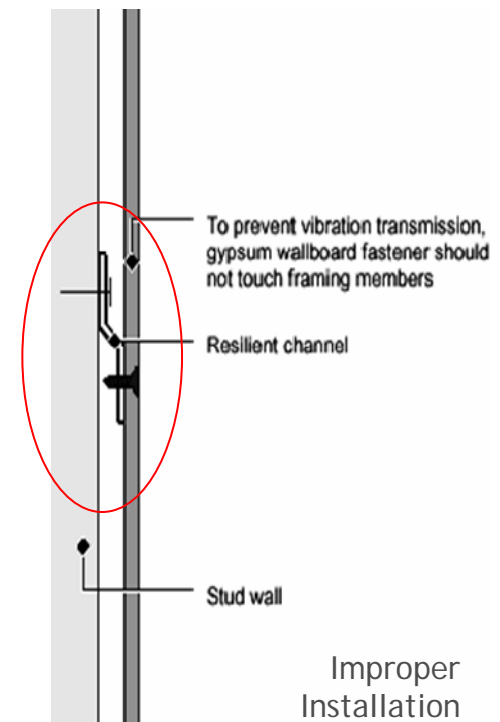
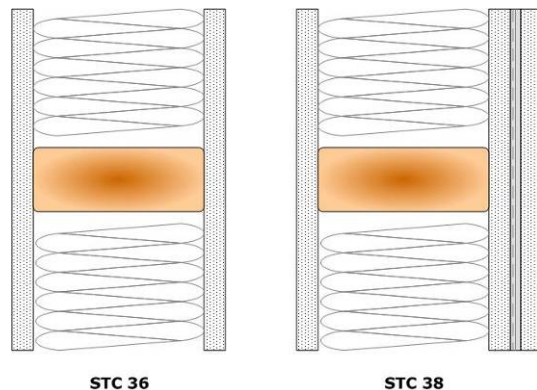
Resilient Channels

- Gauge of steel and slot or hole patterns affect resilient properties
- Must be installed properly



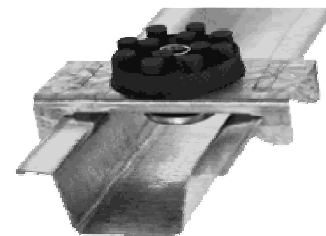
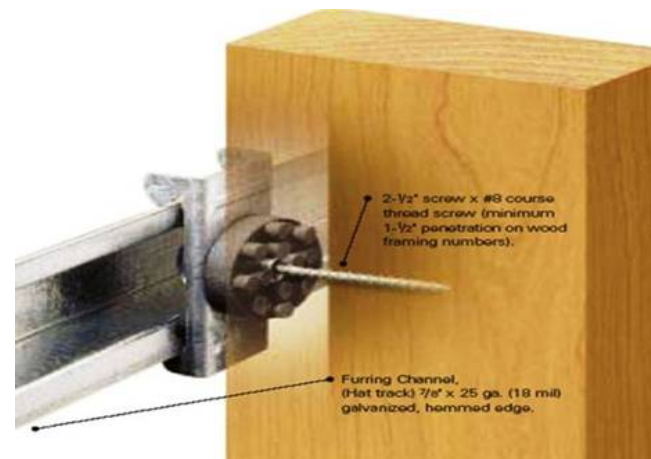
Resilient Channels

- Verify channel is capable of carrying gypsum wallboard load
- Use proper screw length
- Do not install over a solid surface



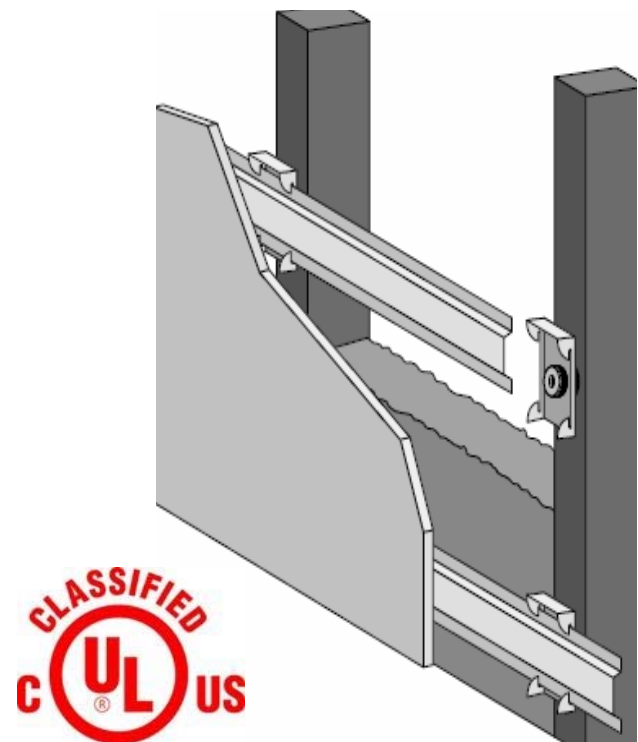
Resilient Sound Isolation Clips

- RSIC rubber and steel assembly designed to hold and isolate 7/8" furring channels from the structure
- Large offset eliminates problem of screwing through channel to framing



Function

- Used in wall or ceiling assemblies
- Replaces resilient channel (RC-1)
- Effectively reduces structure borne sound
- Compatible with standard drywall products



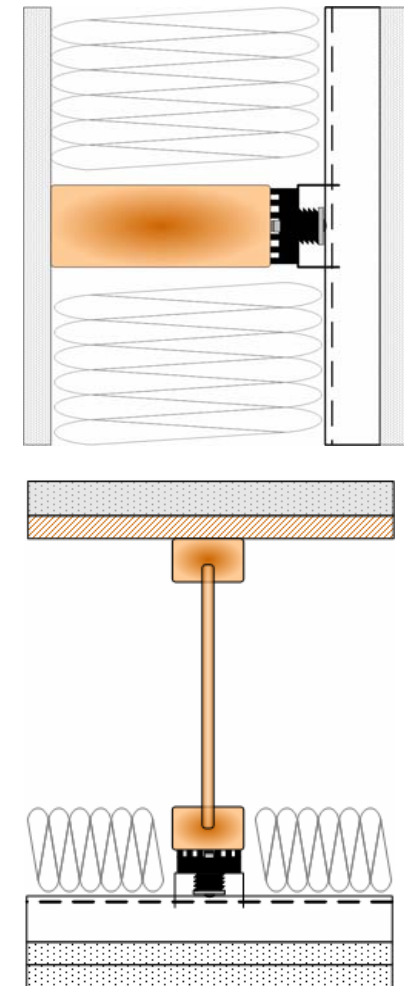
UL Assemblies

- Classified in UL resistive design assemblies
- Verify with manufacturer exact details



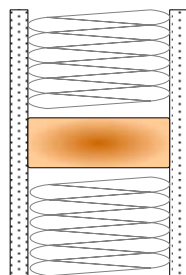
Applicability

- Walls, both new and retro-fit applications, with framing made of wood, steel, concrete, CMU or Aerated Autoclaved Concrete
- Floor-ceiling assemblies built with solid wood joists, I beam wood joists, open web wood trusses, cold rolled steel C section joists, open web steel trusses, and concrete slabs or suspended ceilings

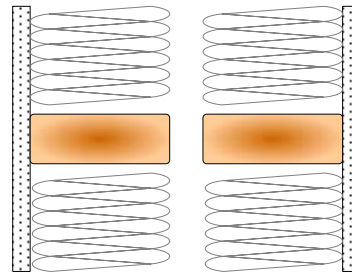


Benefits

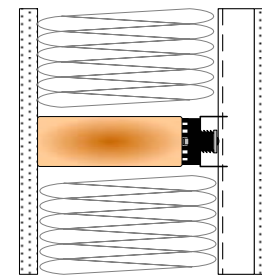
- Reduce width of wall assemblies and increase STC
- Costs to achieve similar STC ratings are lower when RSIC's are employed.



STC 36
No sound
attenuation
\$4.17/sq ft



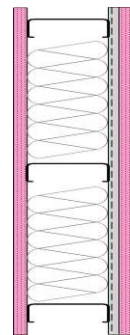
STC 56
No resilient products, width and
separation used to achieve STC rating
\$6.88/sq ft



STC 56
RSIC used to
achieve STC
rating
\$5.65/sq ft

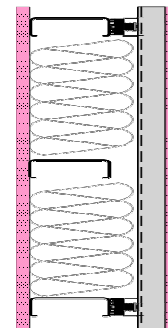
RSIC vs. Resilient Channels

EST. STC-44
WITHOUT RESILIENT
CHANNEL
OR RSIC-1 CLIP



EST. STC-48 to 50
Resilient Channel Assembly
DIRECT FIX TO STEEL STUD

CONSTRUCTION
* 1 layer 5/8" Gypsum Board
* 3-5/8" 20ga. Steel Stud at 24" oc
* R-11 Insulation 3.5"
* Resilient Channels
* 1 layer 5/8" Gypsum Board

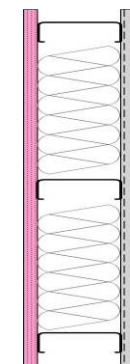


STC-58

RSIC Acoustic Assembly
DIRECT FIX TO STEEL WALL
FRAME

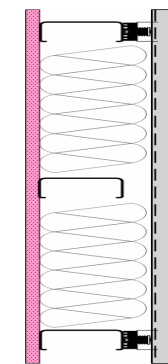
CONSTRUCTION
* 1 layer 5/8" Gypsum Board
* 3-5/8" 20ga. Steel Stud at 24" oc
* R-19 Insulation 5.5"
* RSIC-1™ 48" oc.
* Drywall Furring Channel at 24" oc
* 1 layer 5/8" Gypsum Board
UL U419, U423

EST. STC-48
WITHOUT RESILIENT
CHANNEL
OR RSIC CLIP



EST. STC-53 to 55
Resilient Channel Assembly
DIRECT FIX TO STEEL STUD

CONSTRUCTION
* 1 layer 5/8" Gypsum Board
* 3-5/8" Steel Stud at 24" oc
* R-11 Insulation 3.5"
* Resilient Channel
* 2 layers 5/8" Gypsum Board



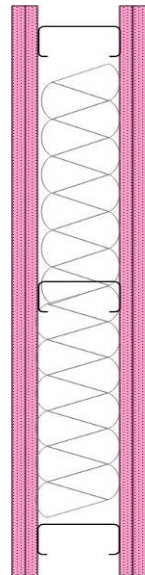
STC-61

RSIC Acoustic Assembly
DIRECT FIX TO STEEL WALL FRAME

CONSTRUCTION
* 1 layer 5/8" Gypsum Board
* 3-5.8" 20ga. Steel Stud at 24" oc
* R-19 Insulation 5.5"
* RSIC-1™ 48" oc.
* Drywall Furring Channel at 24" oc
* 2 layers 5/8" Gypsum Board
* UL U419, U423

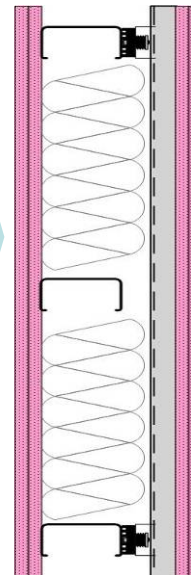
RSIC vs. Resilient Channels

EST. STC-50
WITHOUT RESILIENT
CHANNEL
OR RSIC-1 CLIP



EST. STC-58 to 60
Resilient Channel Assembly
DIRECT FIX TO STEEL STUD

CONSTRUCTION
* 2 layers 5/8" Gypsum Board
* 3-5/8" Steel Stud at 24" oc
* R-11 Insulation 3.5"
* Resilient Channel
* 2 layers 5/8" Gypsum Board



STC-64

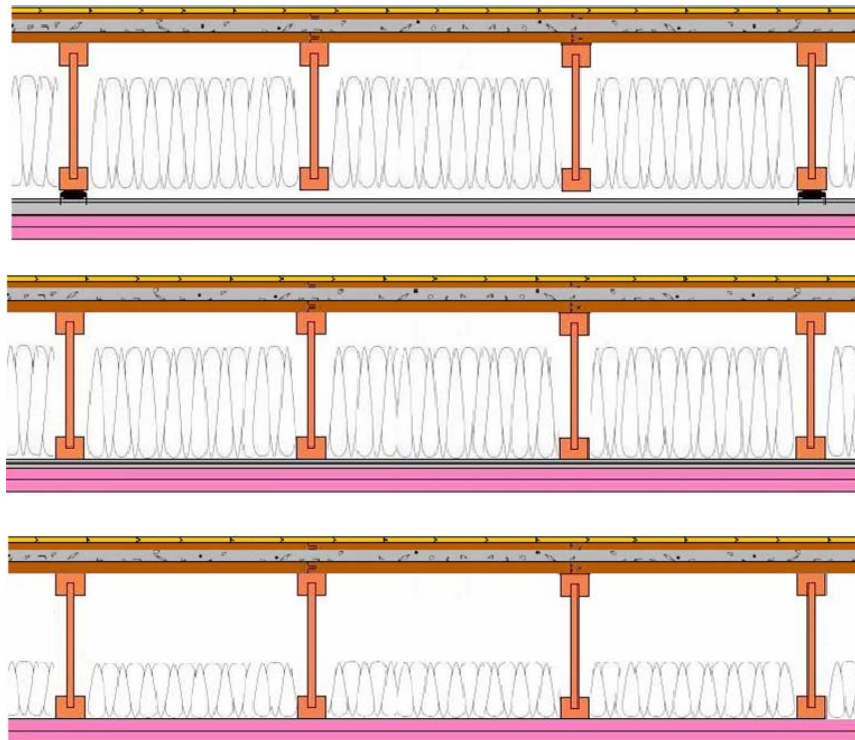
RSIC Acoustic Assembly
DIRECT FIX TO STEEL STUD

CONSTRUCTION

- * 2 layers 5/8" Gypsum Board
- * 3-5/8" 20ga. Steel Stud at 24" oc
- * R-19 Insulation 5.5"
- * RSIC-1™ 48" oc.
- * Drywall Furring Channel at 16" oc
- * 2 layers 5/8" Gypsum Board
- * UL U419, U423

RSIC's and IIC

- Equivalent impact on IIC



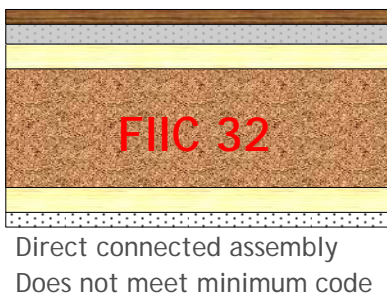
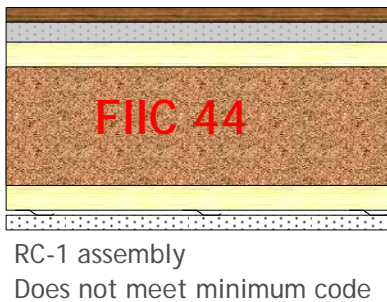
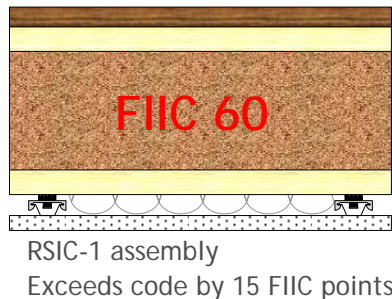
RSIC-1 Assembly
Field
IIC60
FSTC 55

Resilient Channel
Assembly
Field
IIC44
FSTC 53

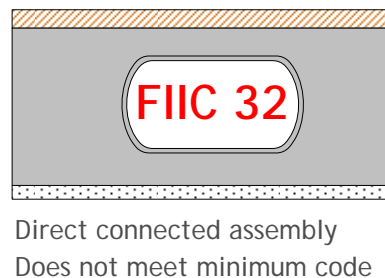
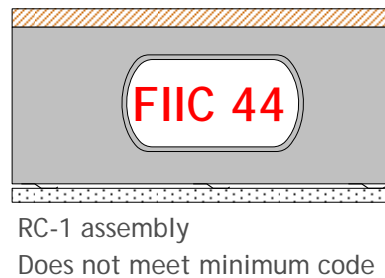
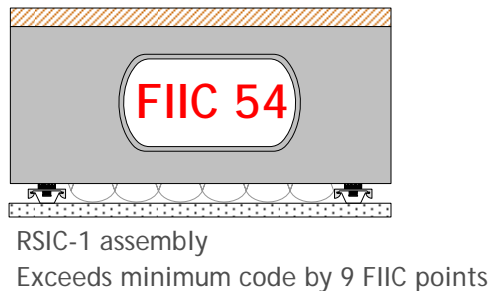
Direct Connected
Assembly
Field
IIC32
FSTC 40

RSIC's and IIC

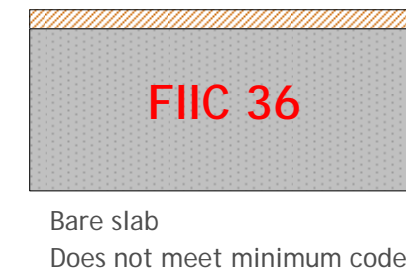
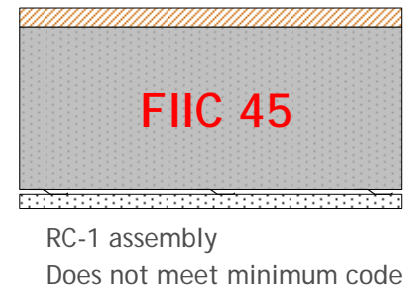
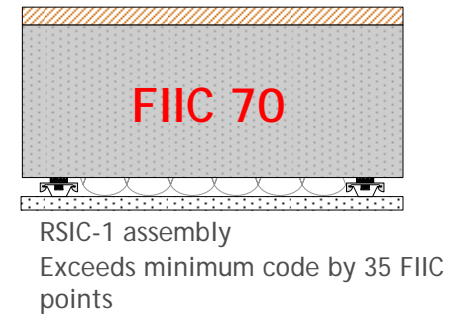
Wood Framed



Structural Steel

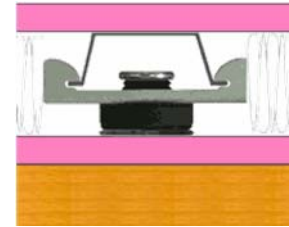


Post-tensioned Concrete

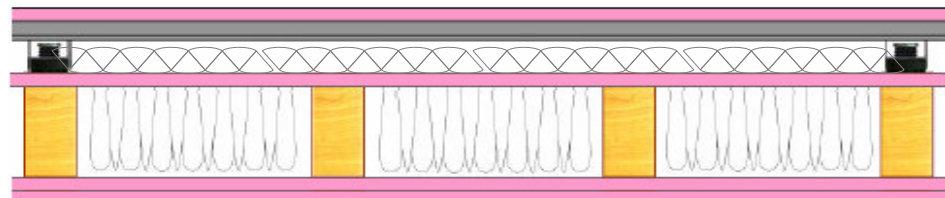


Building Retrofit

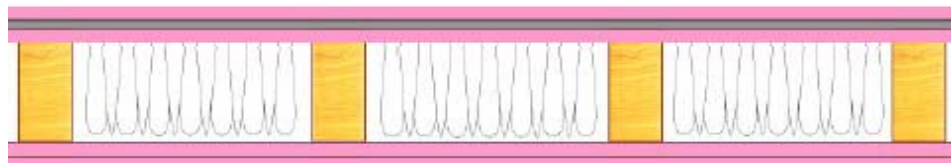
- Reduces labor and expense of removal



RSIC in retrofit

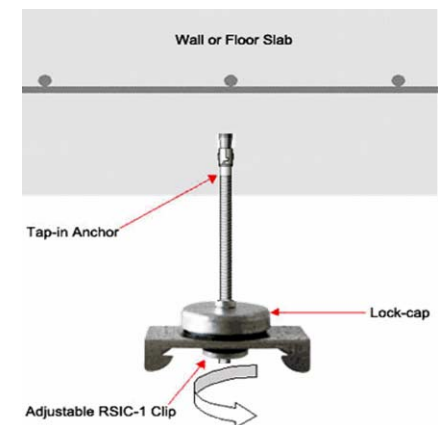
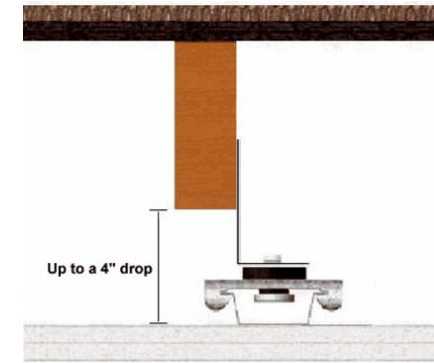


2 Layers 5/8" Gypsum, R-11, 1 Layer 5/8" GWB,
RSIC-1, 7/8" DFC, 1 Layer 5/8" GWB.
FSTC 49



Other Applications

- Accommodate additional ceiling depth
- Under concrete slab uses a 3" or 4" drive pin



Other Applications

- For dropped ceiling RSIC will decouple gypsum board from structure above
- can have thickness of 2" which added to 2"x4" framing creates standard thickness of 2"x6" wall

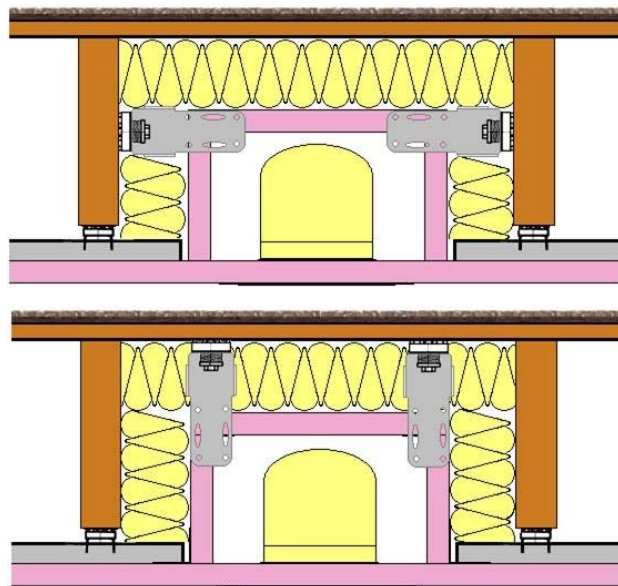


Sound isolation clip for use with dropped ceilings

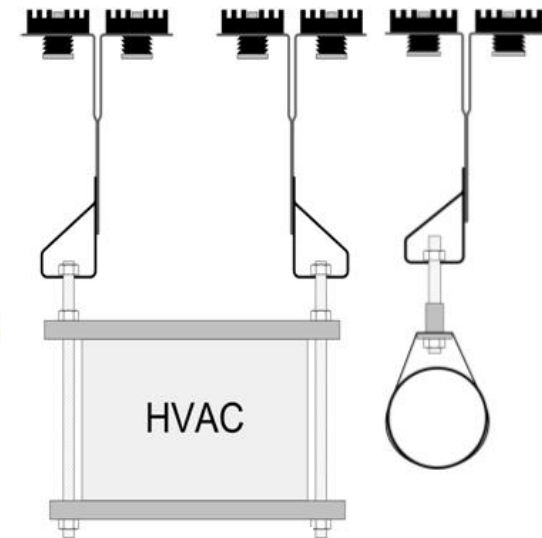
Other Applications



Garage door opener isolation



Lighting isolation

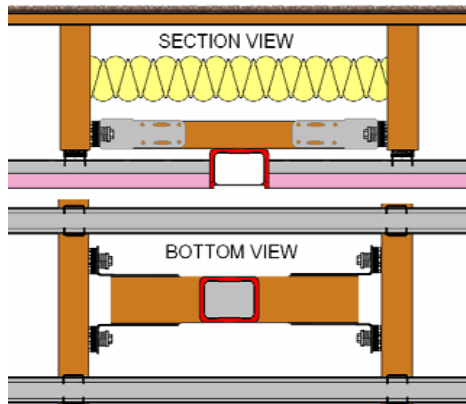


Mechanical isolation

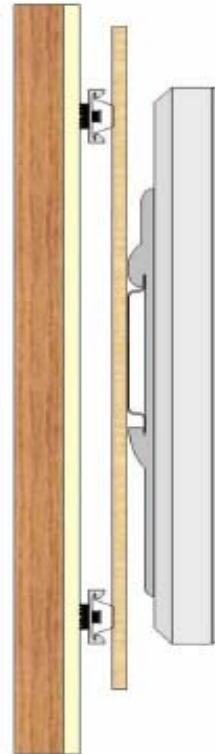
Other Applications



RSIC value clip



Ceiling fan electrical box isolation



Wall mount flat screen TV isolation



RSIC technology combined with spring isolation for superior noise control



Questions

Thank You for Attending!
This concludes the American Institute of Architects
Continuing Education Systems Program

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