# Urban Acoustics

THORBURN ASSOCIATES
ACOUSTICAL, TECHNOLOGY, AND LIGHTING DESIGN

*Steve(n) Thorburn, PE, LEED AP, CTS-I, CTS-D* SJT@TA-Inc.com

# Urban Acoustics – Course Description

As with any issue of building performance, the acoustics of a mixed-use wood-frame structure can be designed to meet or far exceed minimal requirements. It is the responsibility of the design team to determine acoustical expectations for the project and meet them within the available budget.

Through the use of case studies, this fast-paced, interactive session will explore how multi-story wood systems can be used to meet acoustical privacy goals. Discussion will focus on the detailing and construction of units, and how consideration of the construction process can help keep acoustical costs down.

With the objective of providing implementable solutions, the session will include construction details and photos showing what has and hasn't worked in actual buildings.

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At the end of this program, participants will be able to:

- Evaluate the acoustical impact of the Building Code vs. Residential Expectations
- Develop cost effective / acoustically centric space planning ideas for wood frame design
- Produce practical and constructible acoustical isolation detailing for wood frame design
- Identify common acoustical compromises during construction

# Copyright Materials

# Urban Acoustics

THORBURN ASSOCIATES
ACOUSTICAL, TECHNOLOGY, AND LIGHTING DESIGN

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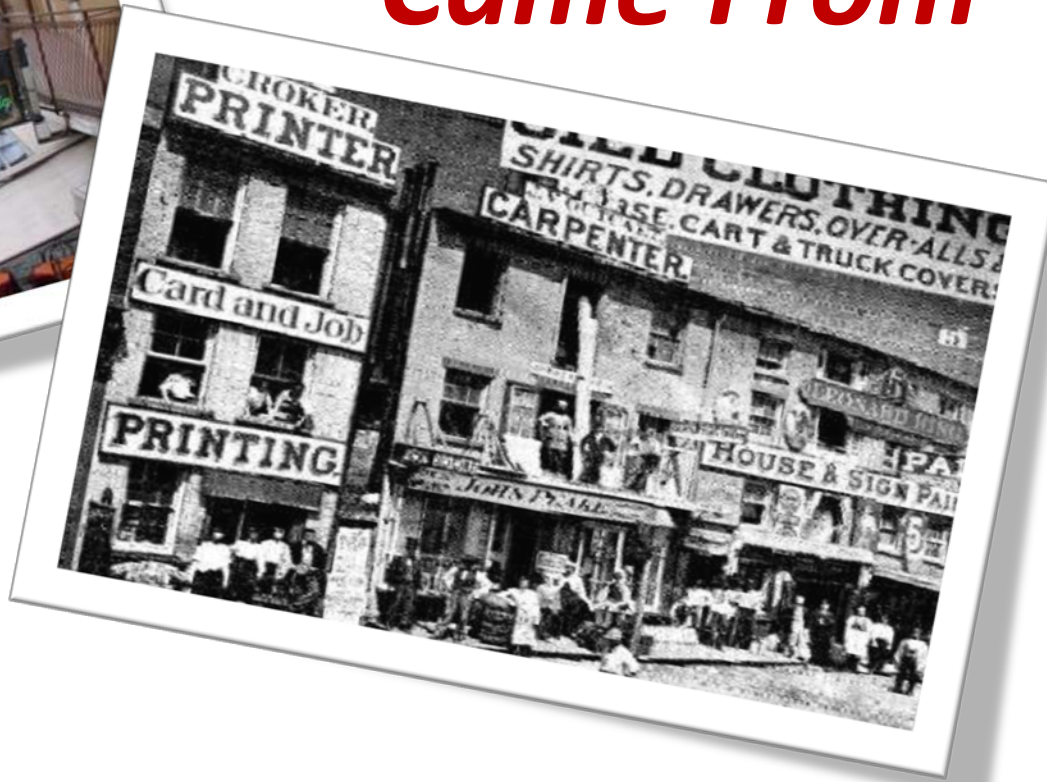
# Where We Came From



# Where We Are Now


ac
TRANSIT
CA 52033

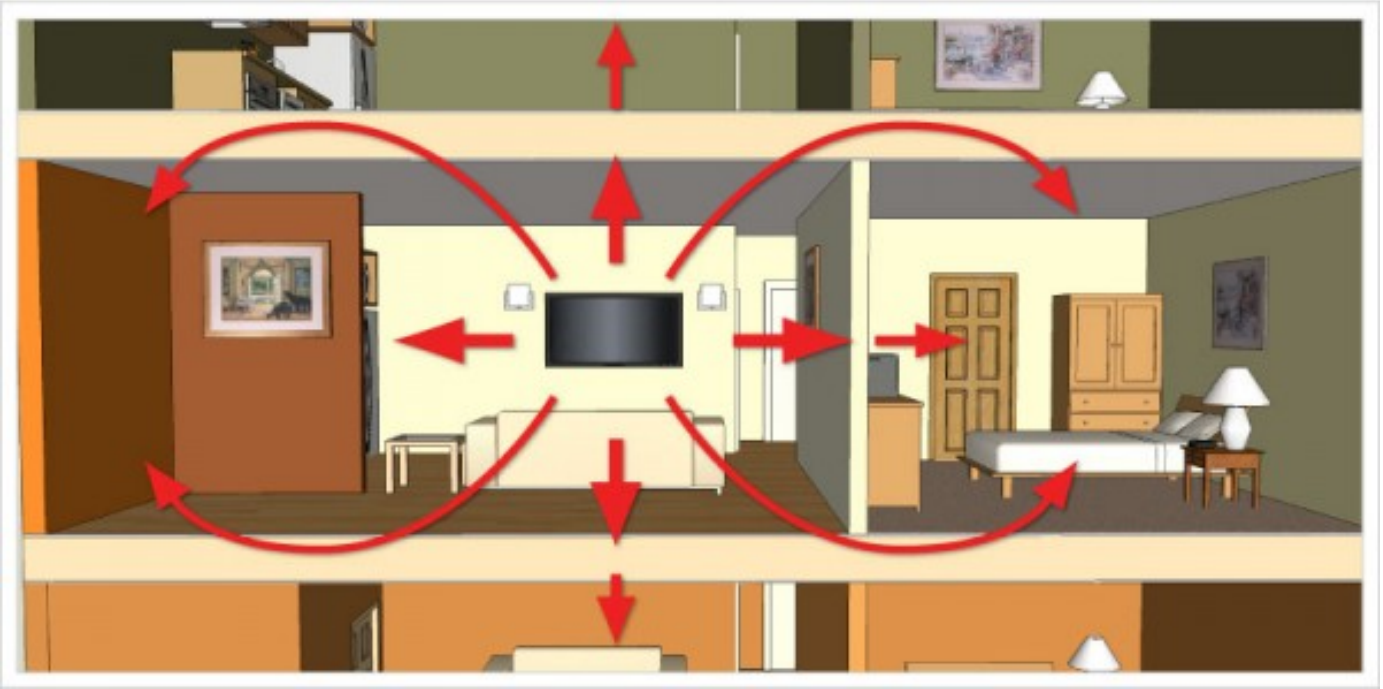

Mixed Use
LADDERS

# Multi-family Housing

# Urban Acoustics

## The Building Code

# Our Goal
# Control the Transfer of Noise!



# Acoustical Expectations

Luxury?

Market Rate?

Entry Level?

# FHA Rules of Thumb from 1962

***NOTE THIS IS NOT A CODE, IT HAS BECOME the DE FACTO STANDARD BUT NOT CODE***

Entry Level Housing

STC 50 / IIC 50 (STC /IIC 48)*

Market Rate Housing

STC 55 / IIC 55 (STC/IIC 52)*

Luxury Rate Housing

STC 60+ / IIC 60+ (STC/IIC 55)*

*IIC 60+ very hard to achieve with wood or tile surfaces*

** Actual 1962 values – adjust when IBC set "50" as minimum*

# ICC G2 2010 Guideline for Acoustics

***STILL NOT A CODE, IT IS FROM THE ICC –***
***FROM WHAT APPEARS TO BE A RESEARCH PAPER FROM THE INTERNET!***

Acceptable Performance
"Grade B Performance"
55 / 52
(Laboratory / Field)
Airborne - STC / NNIC
Impact - IIC / NISR

Preferred Performance
"Grade A Performance"
60 / 57
(Laboratory / Field)
Airborne - STC / NNIC
Impact - IIC / NISR

# National Building Code (2015)

- Section 5.8 Sound Transmission

  5.8.1.1. Dwelling unit separated from every other space that noise might be generated

  a) ASTC 47

  b) STC 50

"Summary refer to the section for the full text of the code"

# National Building Code (2015)

- Section 9.11. Sound Transmission

  9.11.1.1.

  1) Same as 5.8
  2) Secondary Suite in STC 43
  3) Elevator Shaft or Refuse Chute STC 55

"Summary refer to the section for the full text of the code"

# National Building Code (2015)

- Impact Isolation (aka foot fall noise)
  - Not addressed by Code
  - Suggested to be IIC 55 or better

“Summary refer to the section for the full text of the code”

# Exterior to Interior

# Mixed Use – Bar to Housing

# Commercial to Residential


Not Addressed by Building Code

- Implied at 45 dBA /Ldn
  (Interior Noise Criterion)
- Enforced as Nuisance Complaints
- Enforced by “Local Codes”

# Urban Acoustics

## Vocabulary

# Next Week!

## Acoustics Week in Canada 2017

### Delta Guelph Hotel and Conference Centre

### October 11, 2017 – October 13, 2017

**https://awc.caa-aca.ca/index.php/AWC/awc17**

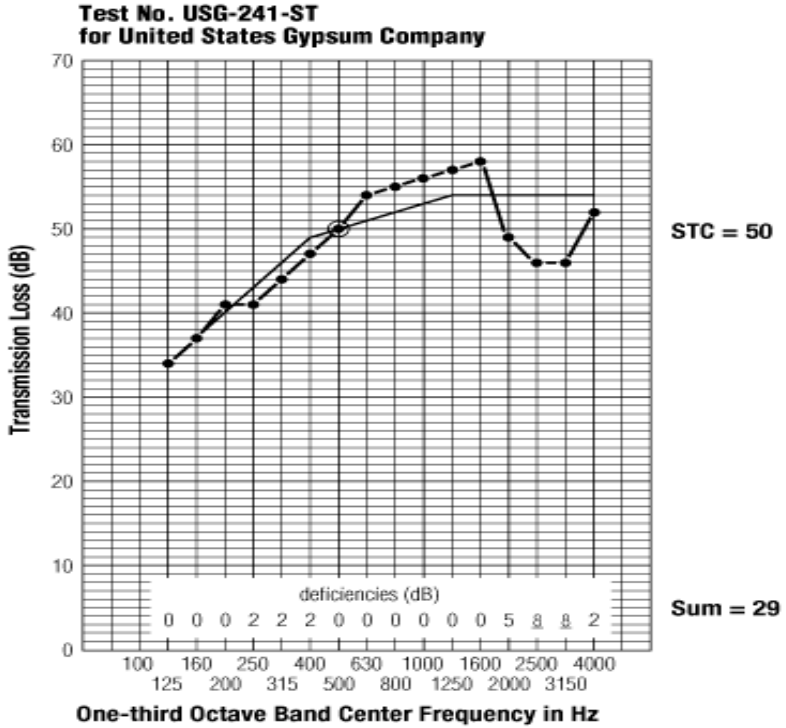
You are invited to be part of Acoustics Week in Canada 2017 to be held October 11-13, 2017 in Guelph (Ontario). Three days of keynote talks and technical sessions will be framed by events such as the welcome reception, conference banquet and an exhibition of products and services relating to the field of acoustics and vibration. Extend your stay before or after the conference for the Octoberfest celebrations in nearby Kitchener-Waterloo.

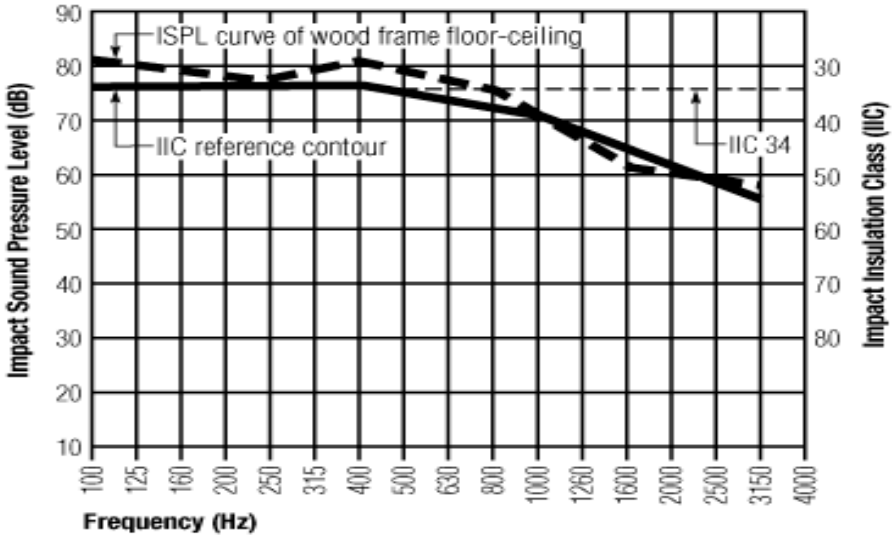
Be sure to review the announcements below and the sidebar to the left for additional details.

# Terms (They Are Changing!)

| General | Sound | Impact |
| --- | --- | --- |
| NR | STC | IIC |
| dBA | FSTC | FIIC |
| Ldn | NIC | ***AIIC*** |
| CNEL | ***ASTC*** | ***NISR*** |
| OITC | ***NNIC*** | |
| NC | | NRC |

# Urban Acoustics - Vocabulary

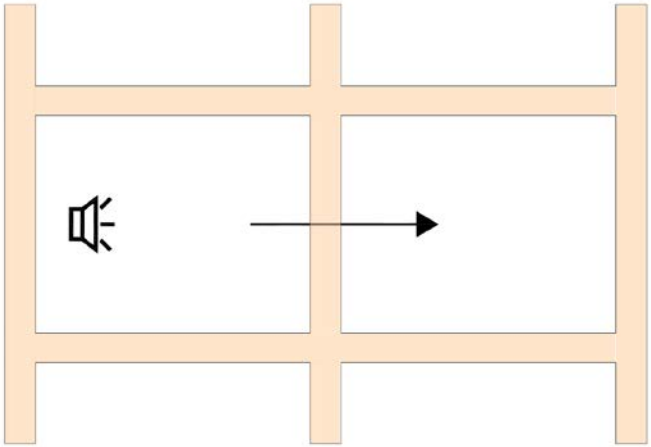


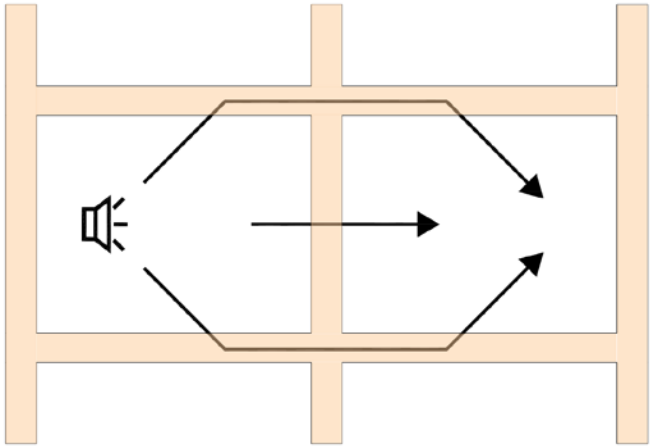
# Acoustical Test Laboratory

# Acoustical Test Chamber

# STC vs ASTC (NIC, FSTC)

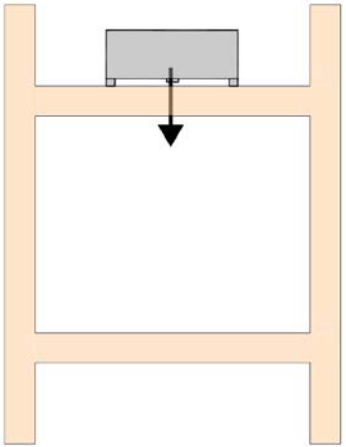


STC Testing

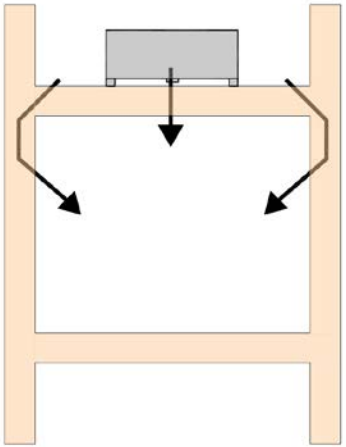


ASTC Testing

# IIC vs AIIC (FIIC)

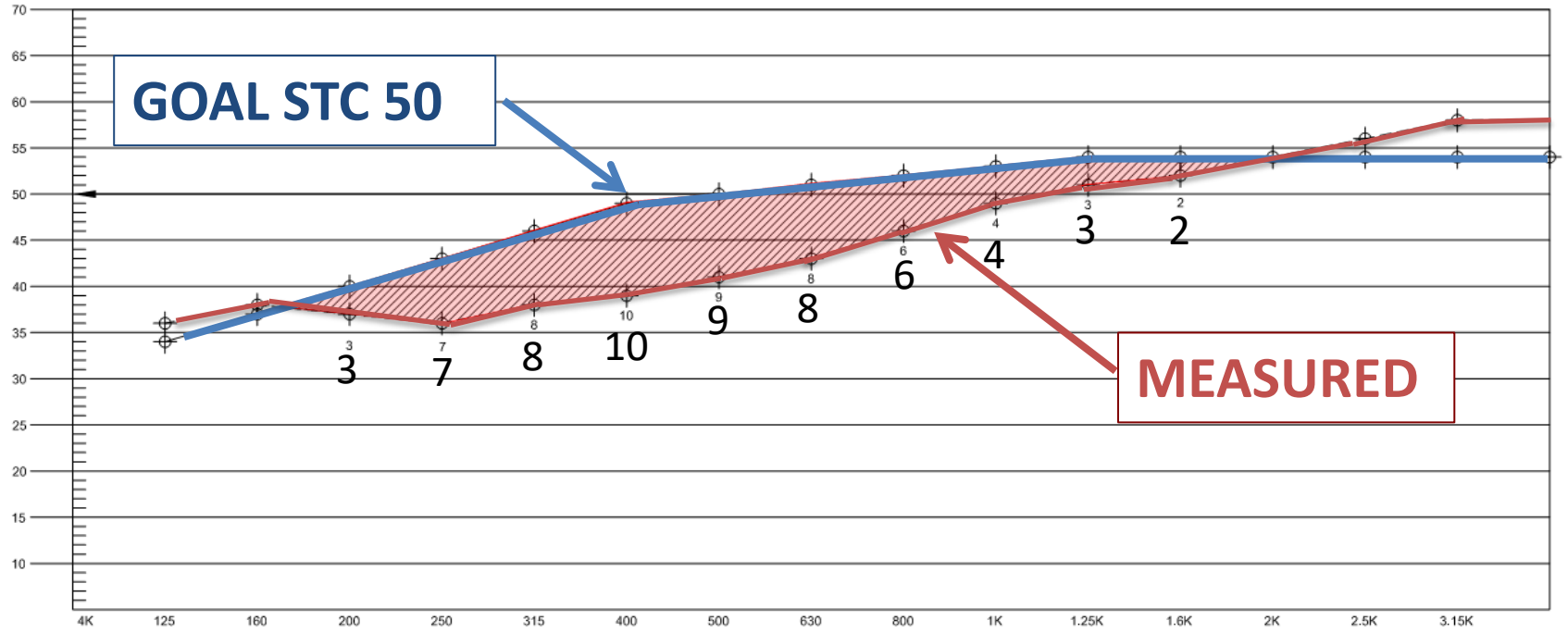


IIC Testing



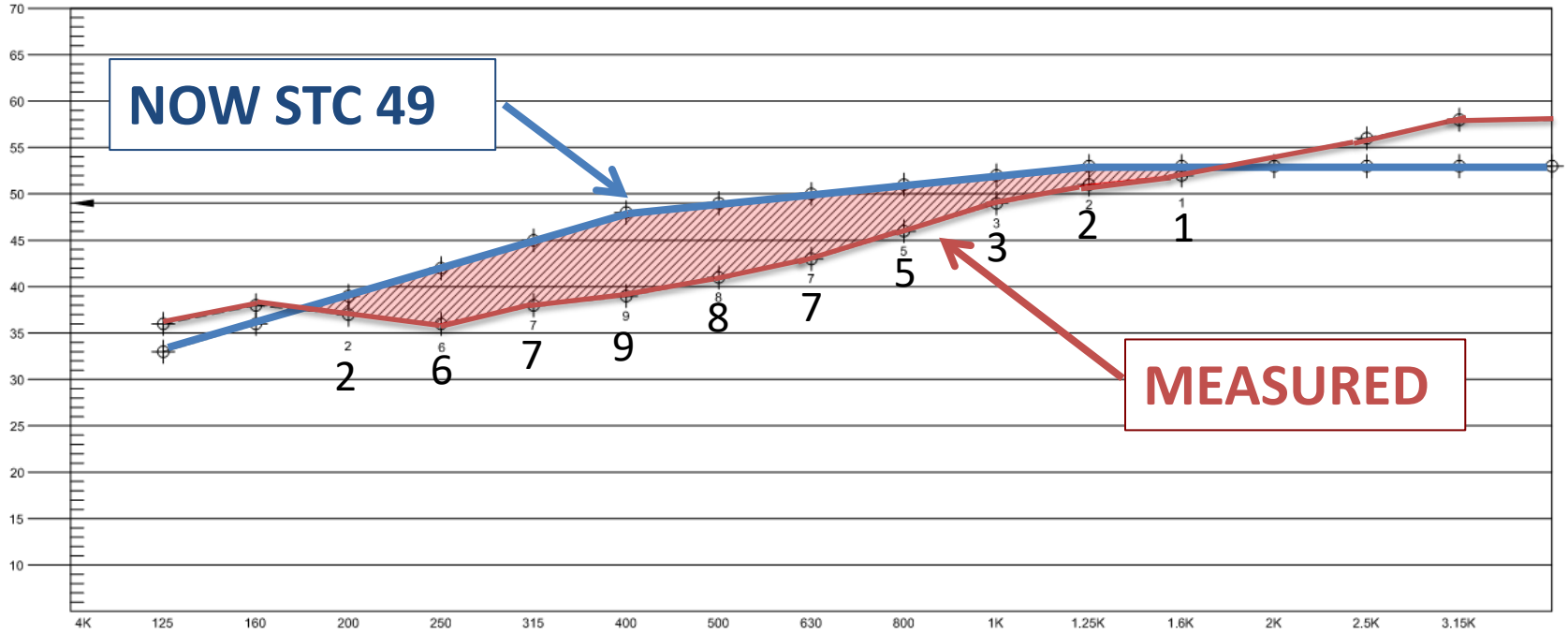
AIIC Testing

# How STC or IIC Rating Is Found



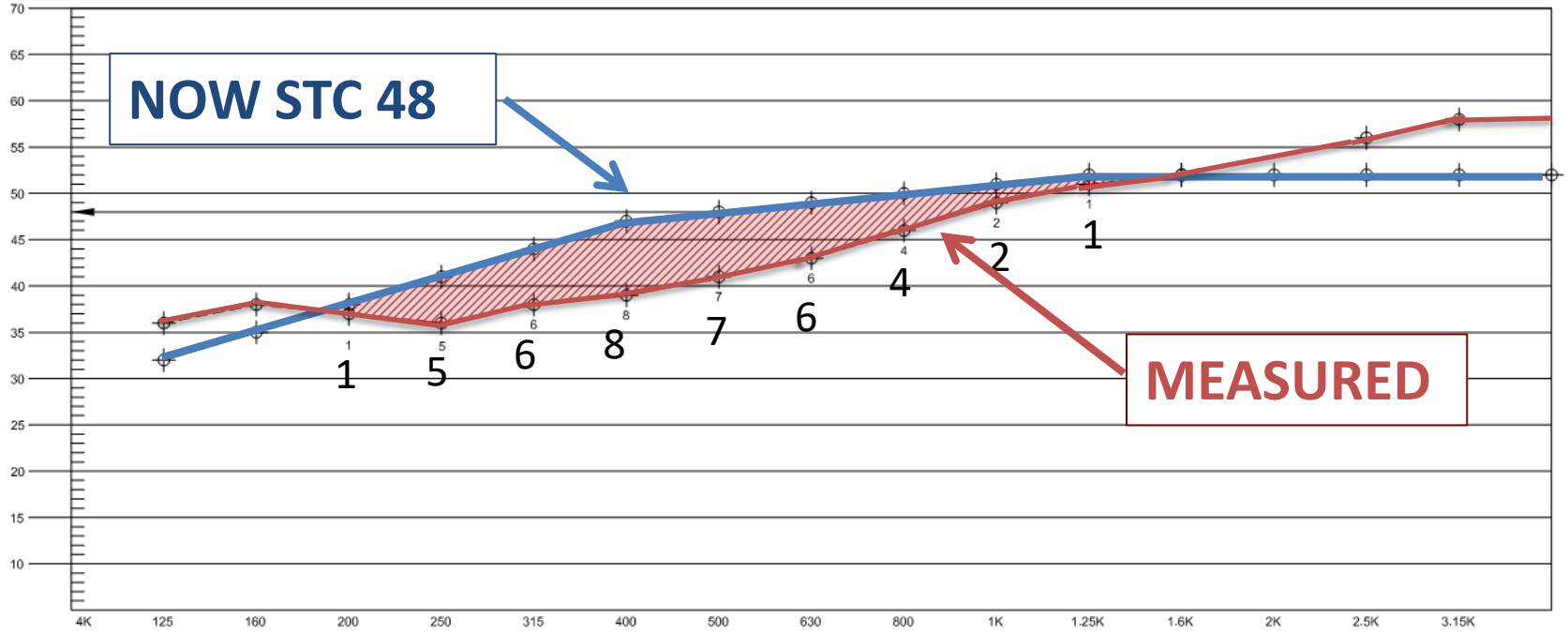

STC 50 - OVERALL DEVIATION 60

# How STC or IIC Rating Is Found



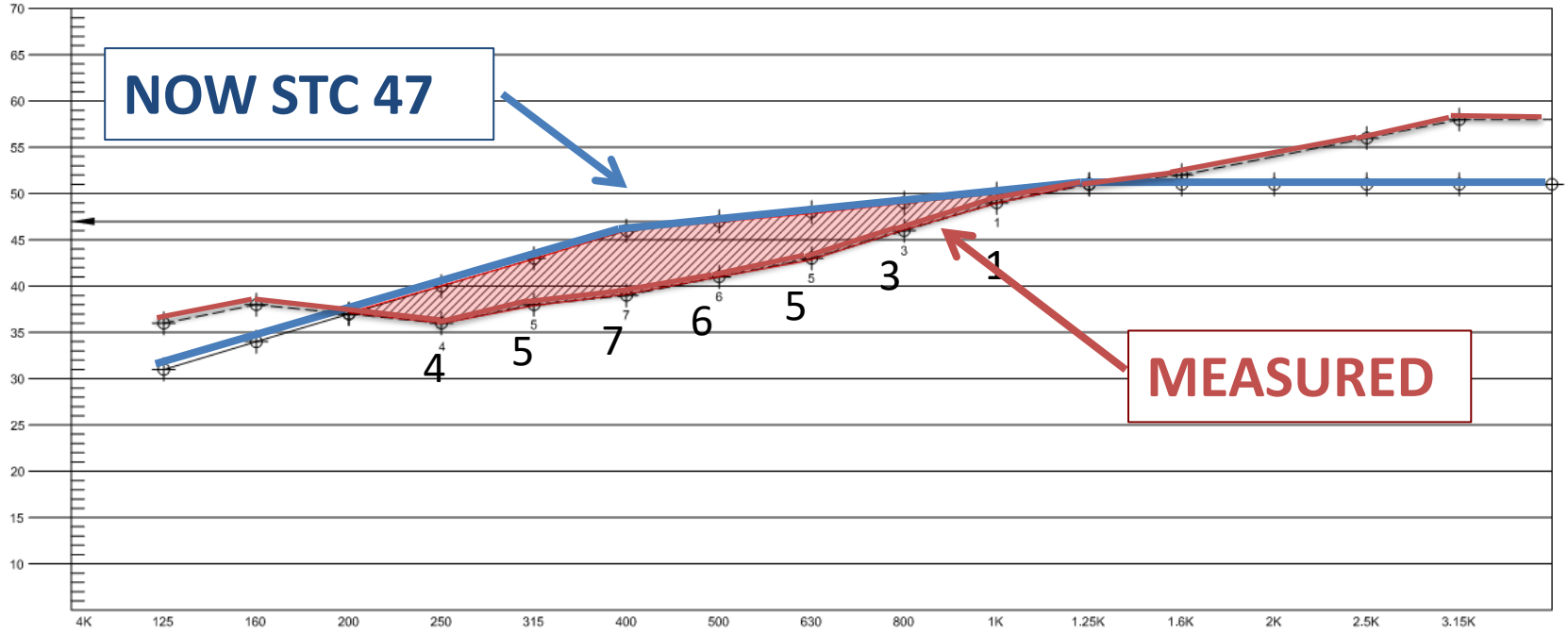

STC 49 - OVERALL DEVIATION 49

# How STC or IIC Rating Is Found



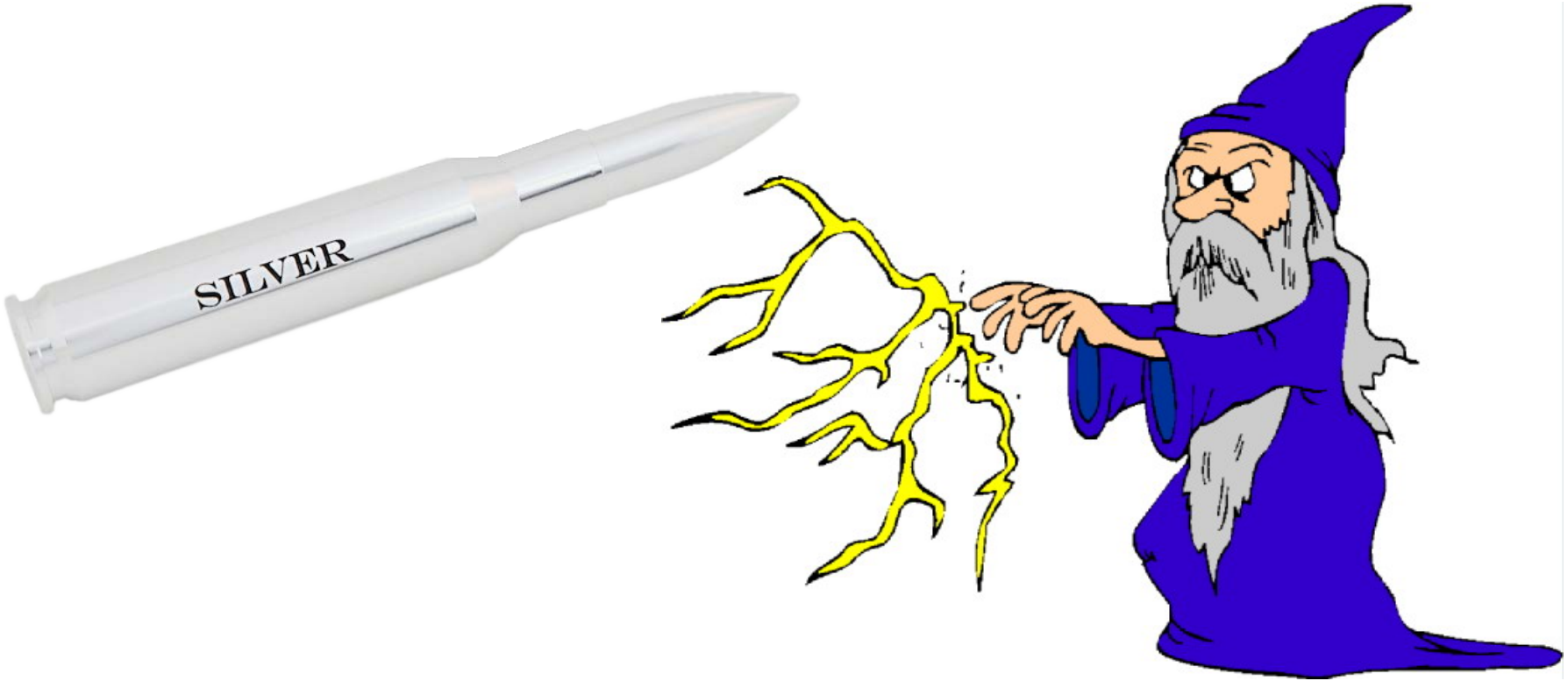

STC 48 - OVERALL DEVIATION 40

# How STC or IIC Rating Is Found




STC 47 - OVERALL DEVIATION 31

# Acoustical Detailing is Systems

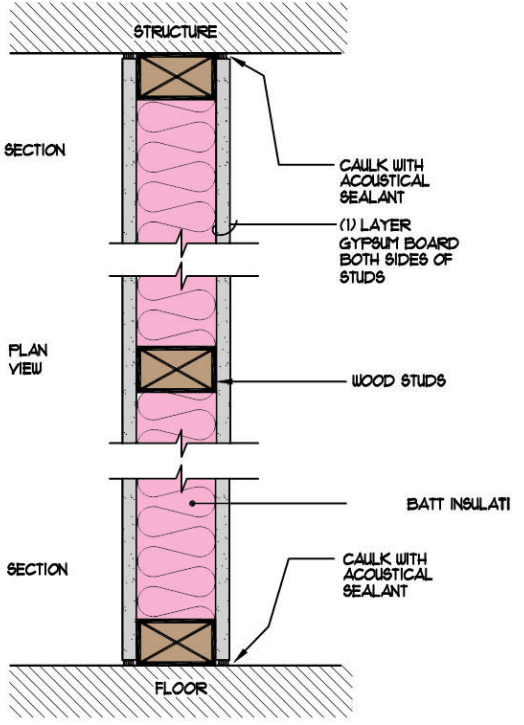


# Urban Acoustics

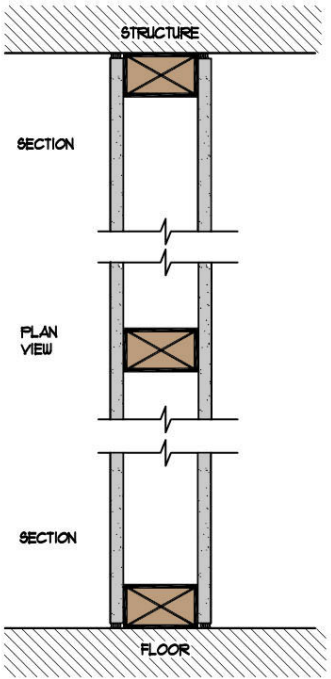
## Acoustical Wall Systems

# Acoustical Detailing – The Givens

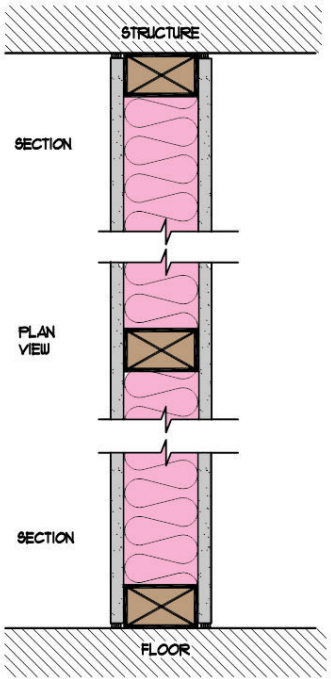
- Walls are Full Height
  (Deck to Deck)
- Insulated (Unfaced Batt)
  In all Stud or Joist Cavities
- Sealed Air Tight
- Floor Sheeting
  Is Glued and Screwed



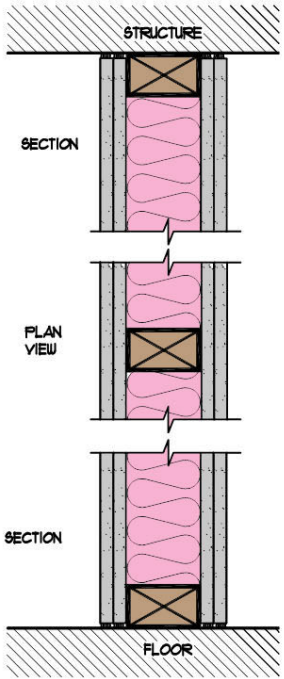
# Wall Progression – Sound Isolation




STC 34

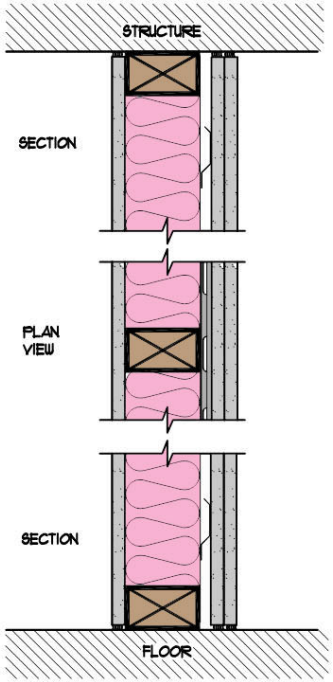



STC 38

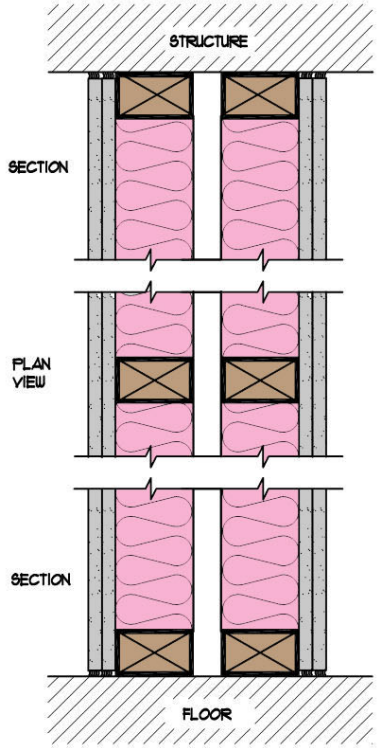



STC 45

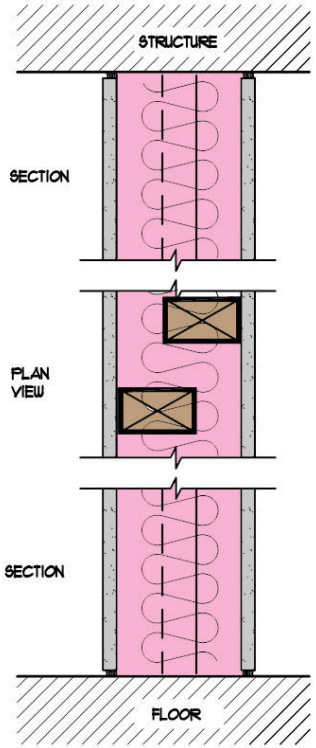
# Wall Progression – Sound Isolation




STC 50



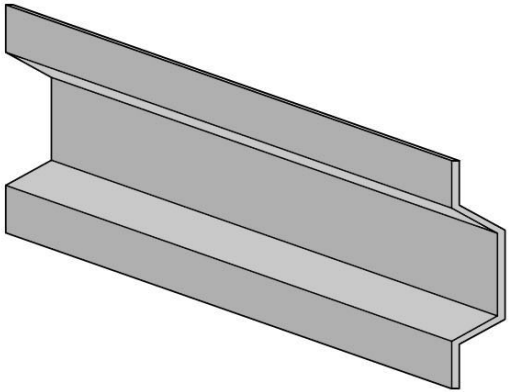

STC 63

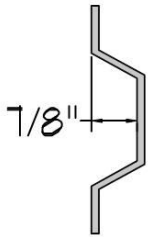



STC 49

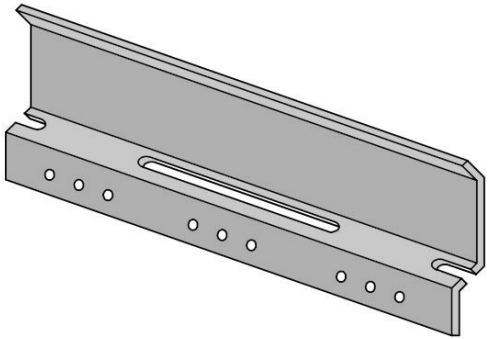
# Metal Channels

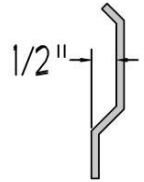
Hat Channels
Are **Not**
Acoustical Channels

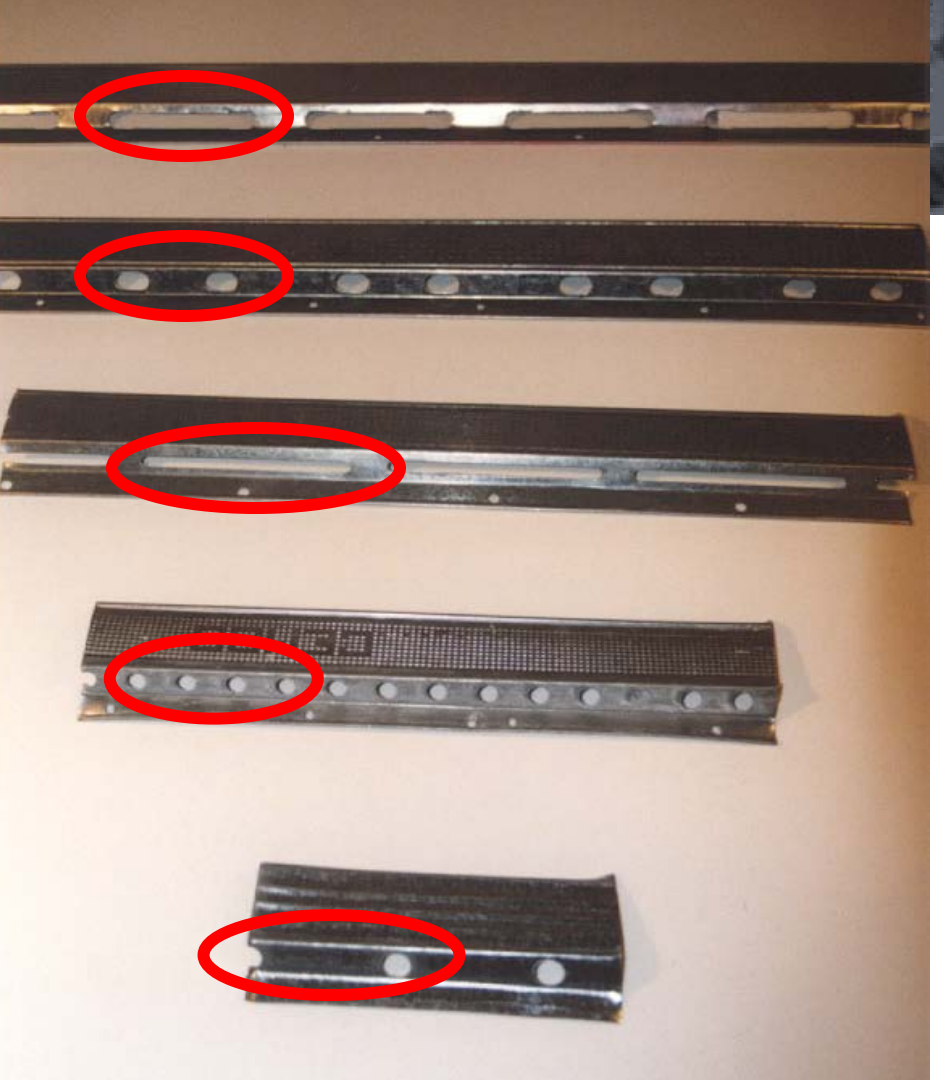


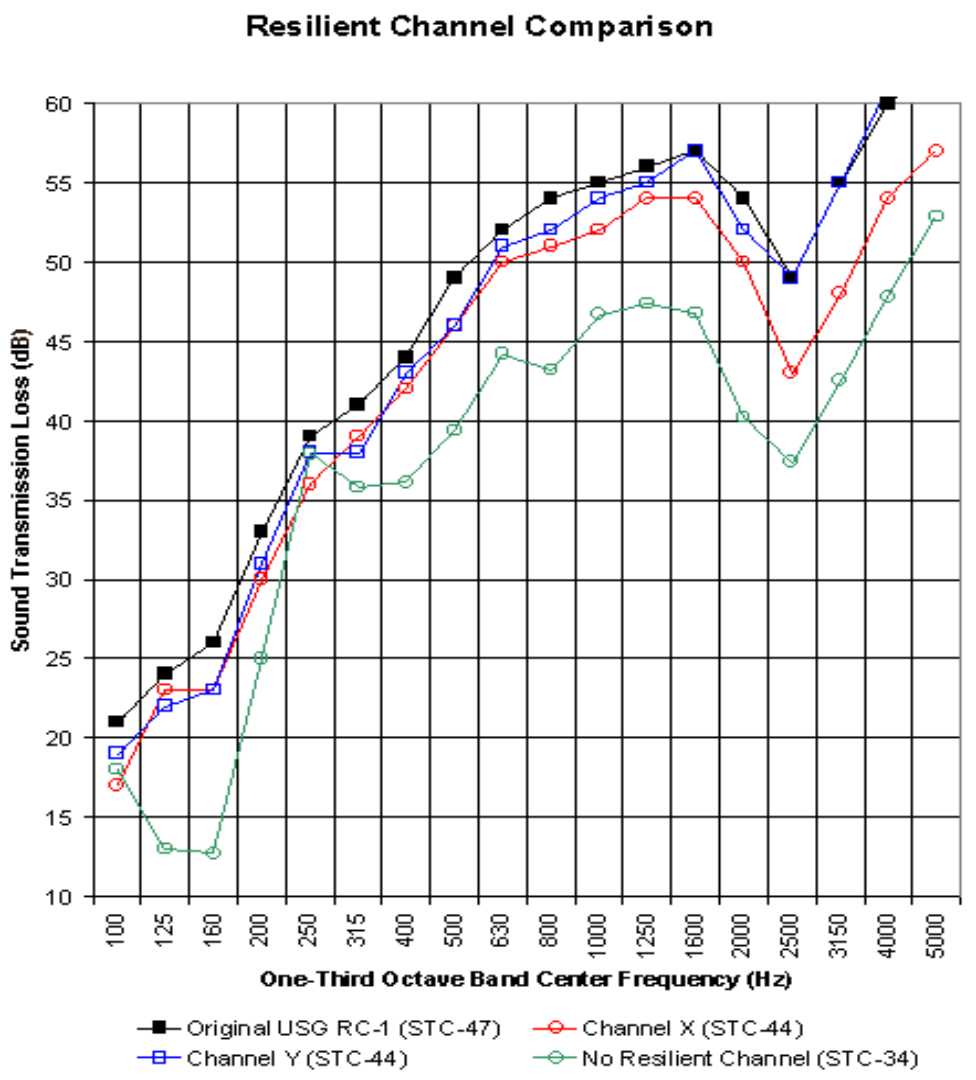



Resilient Channels
Are
Acoustical Channels

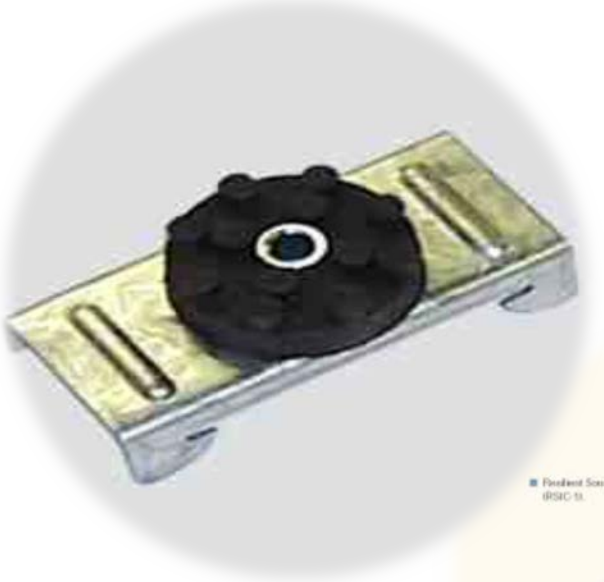


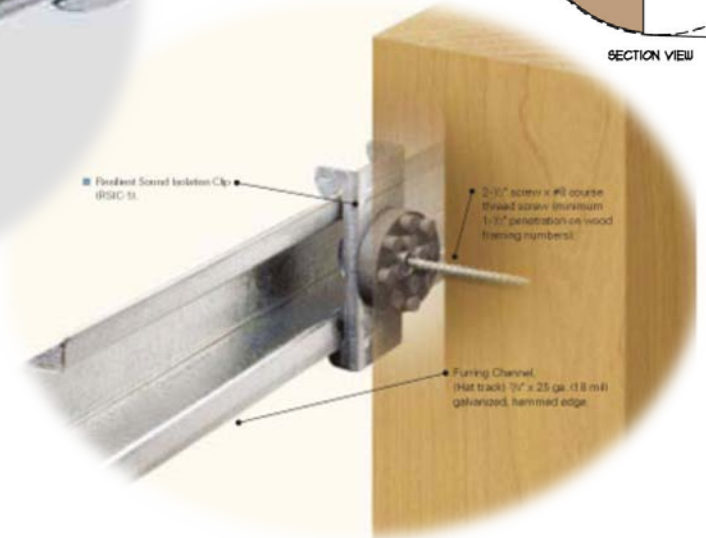


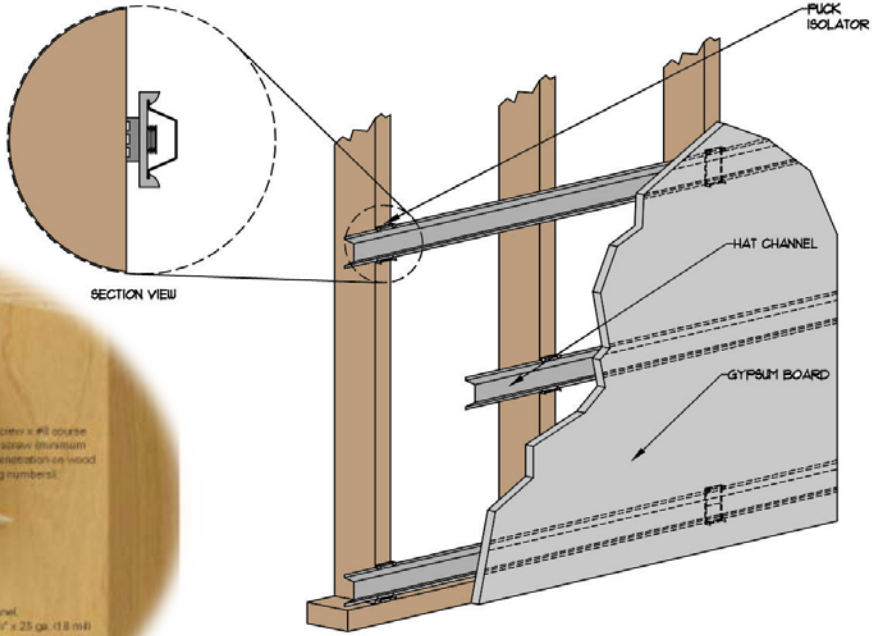



Resilient Channel Comparison
Sound Transmission Loss (dB)
60
55
50
45
40
35
30
25
20
15
10
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
One-Third Octave Band Center Frequency (Hz)
Original USG RC-1 (STC-47)
Channel X (STC-44)
Channel Y (STC-44)
No Resilient Channel (STC-34)

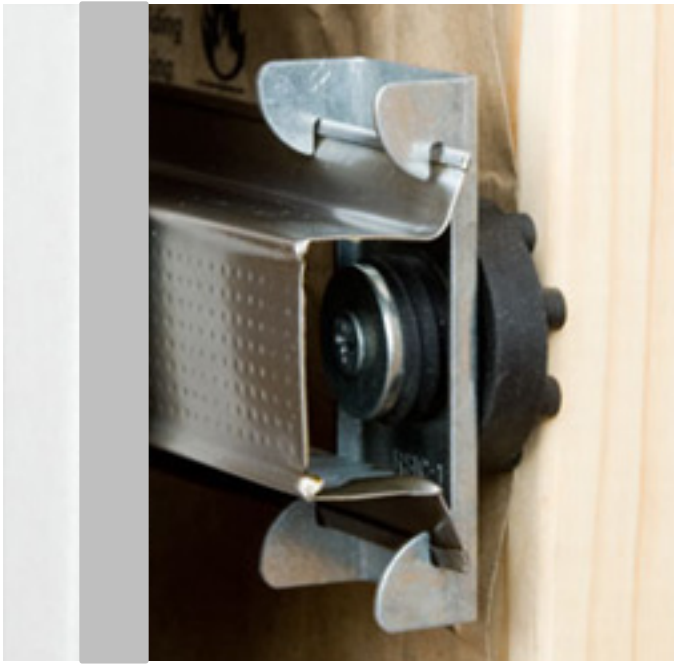
# Hat Channel Resilient Isolators



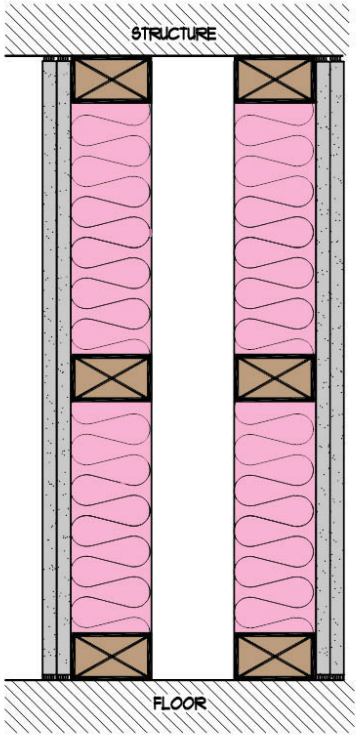


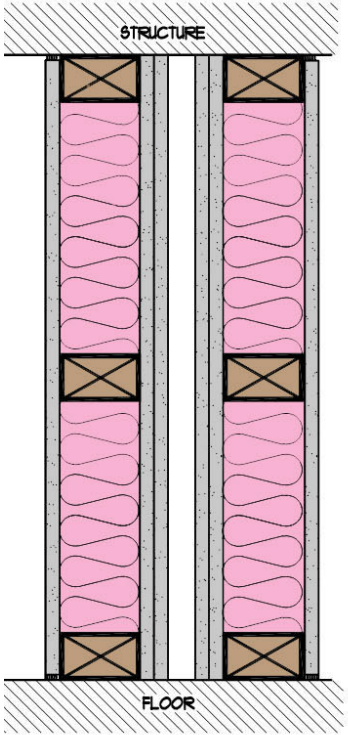
# Hat Channel Resilient Isolators



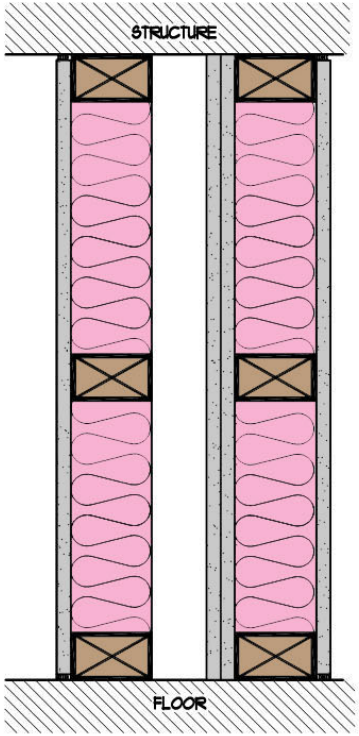
# Lot Line Wall – Sound Isolation



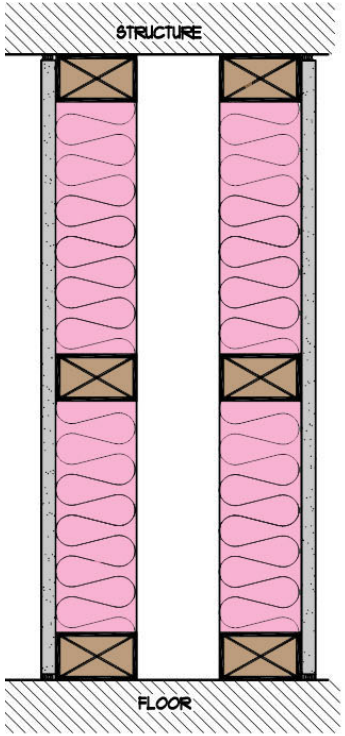

STC-63




STC-48




STC-53

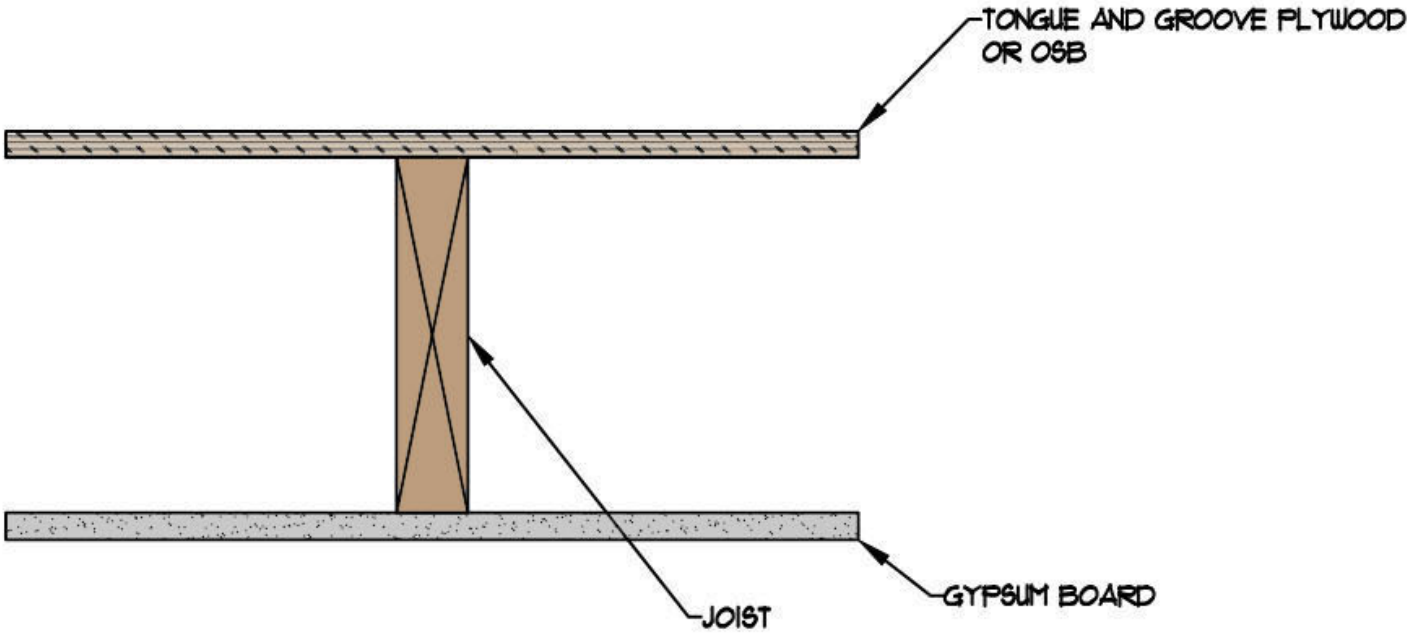



STC-58

# Urban Acoustics

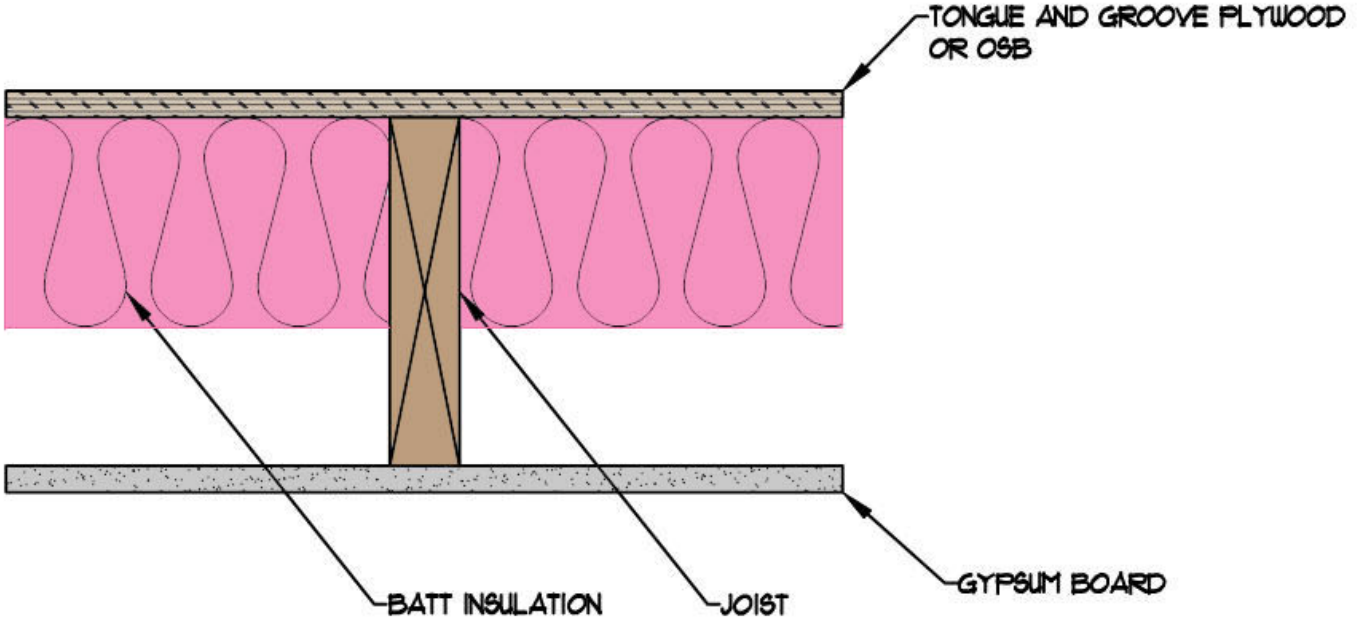
## Acoustical
## Floor / Ceiling Systems
## Sound and Impact

# Floor Systems



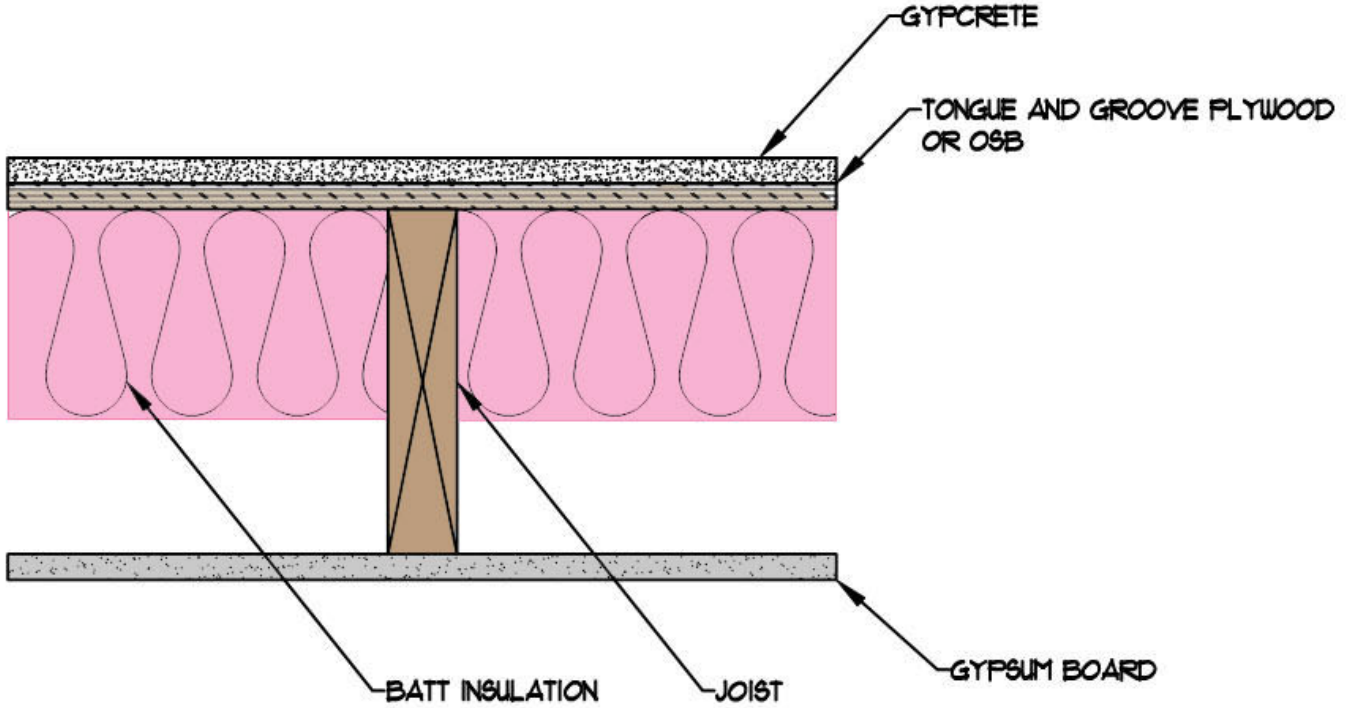

**STC 37**

# Floor Systems




**STC 43**

# Floor Systems




**STC 49**

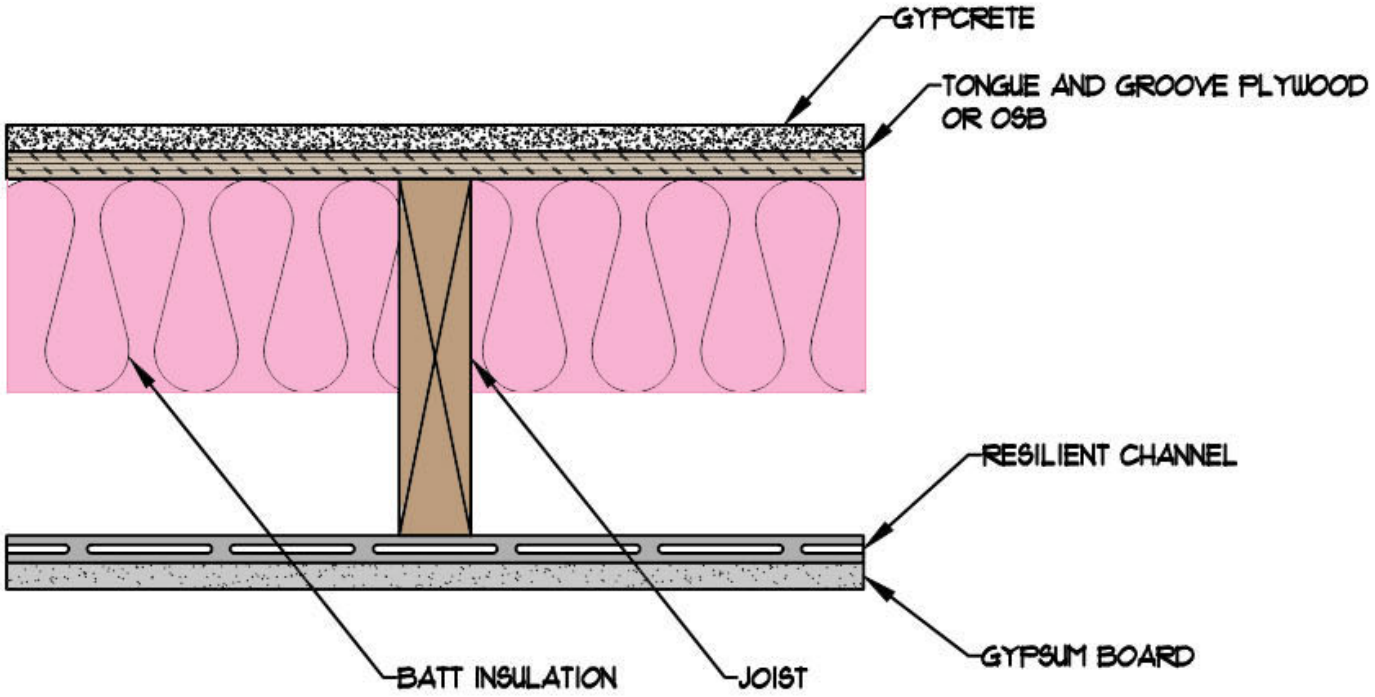
# Floor Systems – Topping Slab

**Gypcrete**

**or**

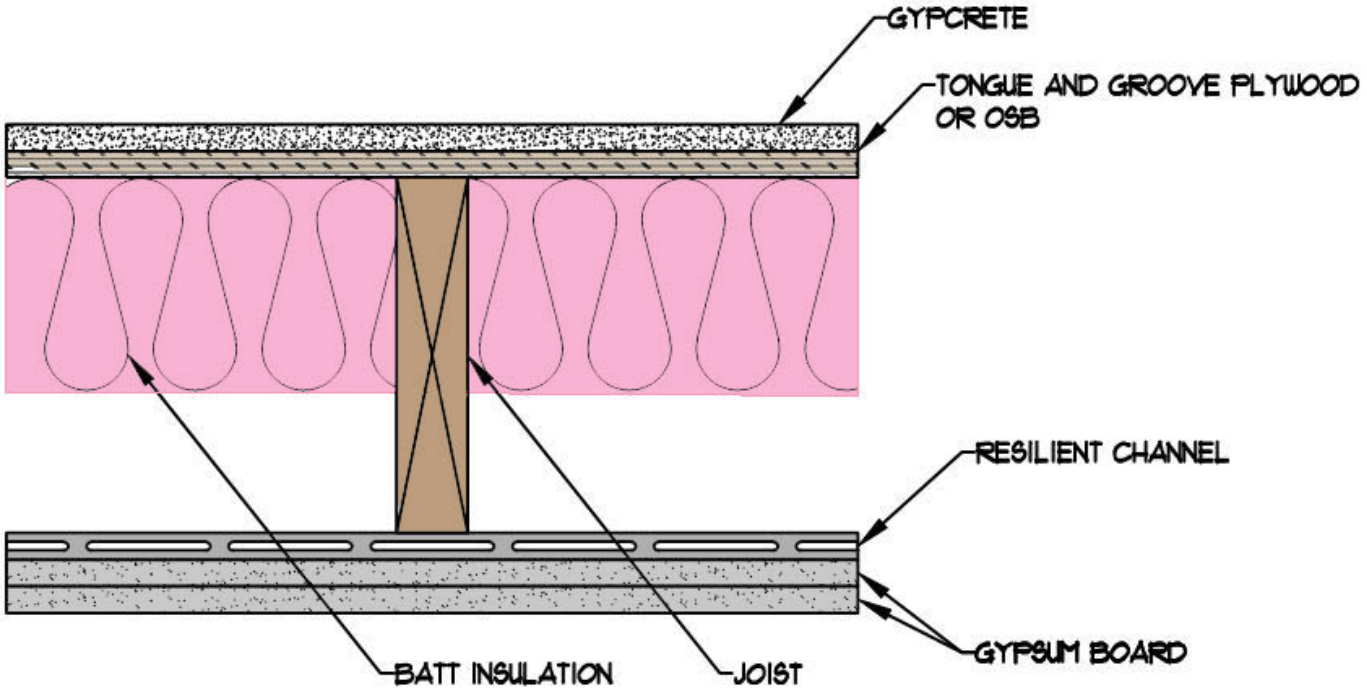
**Light Weight Concrete**

# Floor Systems



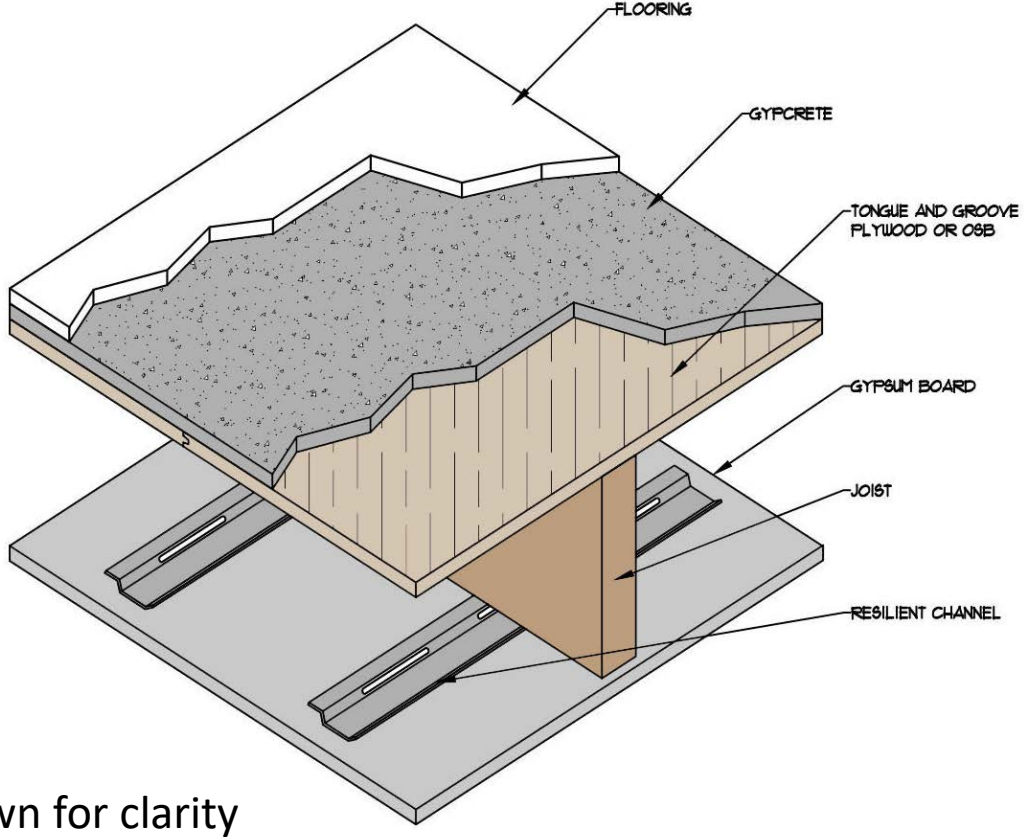

**STC 56**

# Floor Systems



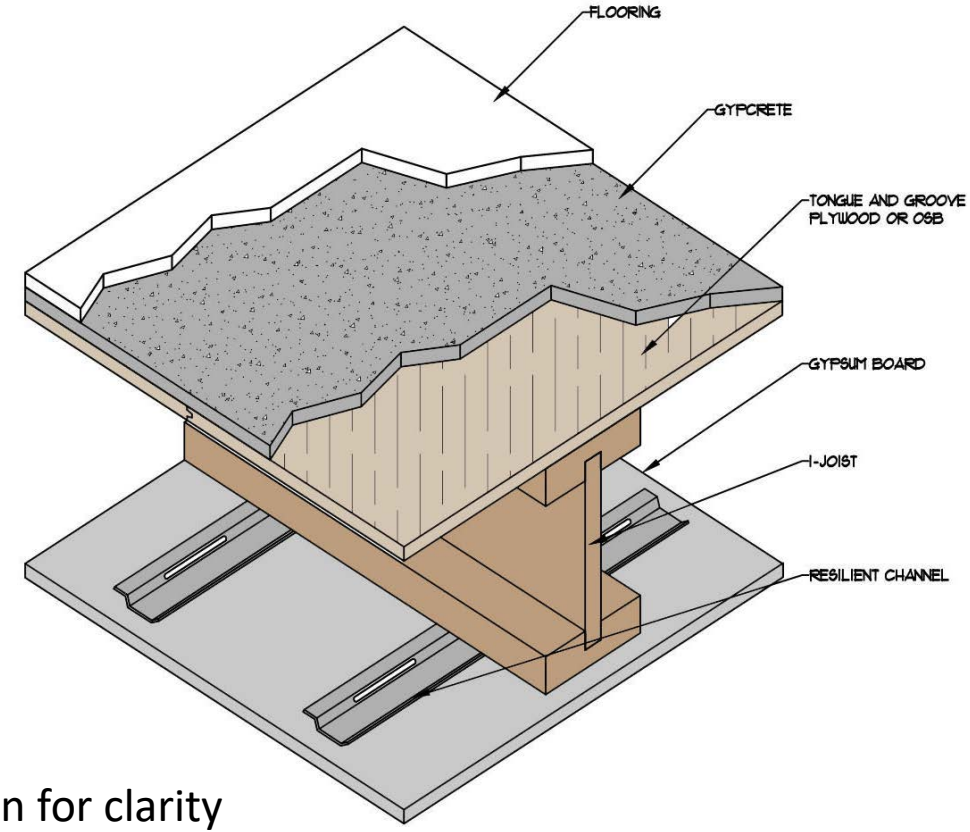

**STC 62**

# Floor Systems



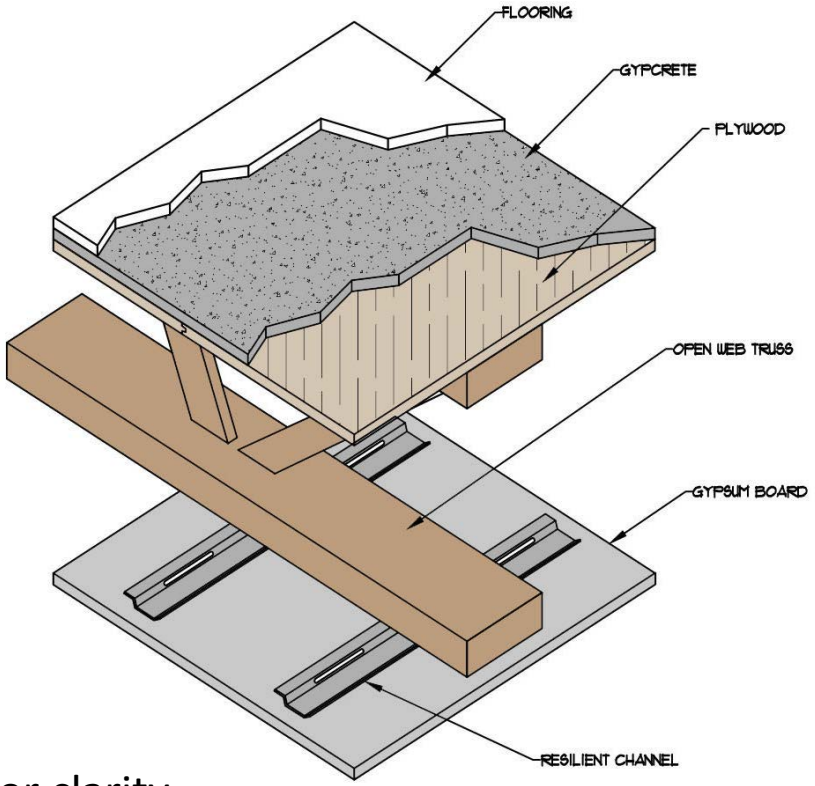

Batt insulation not shown for clarity

# Floor Systems



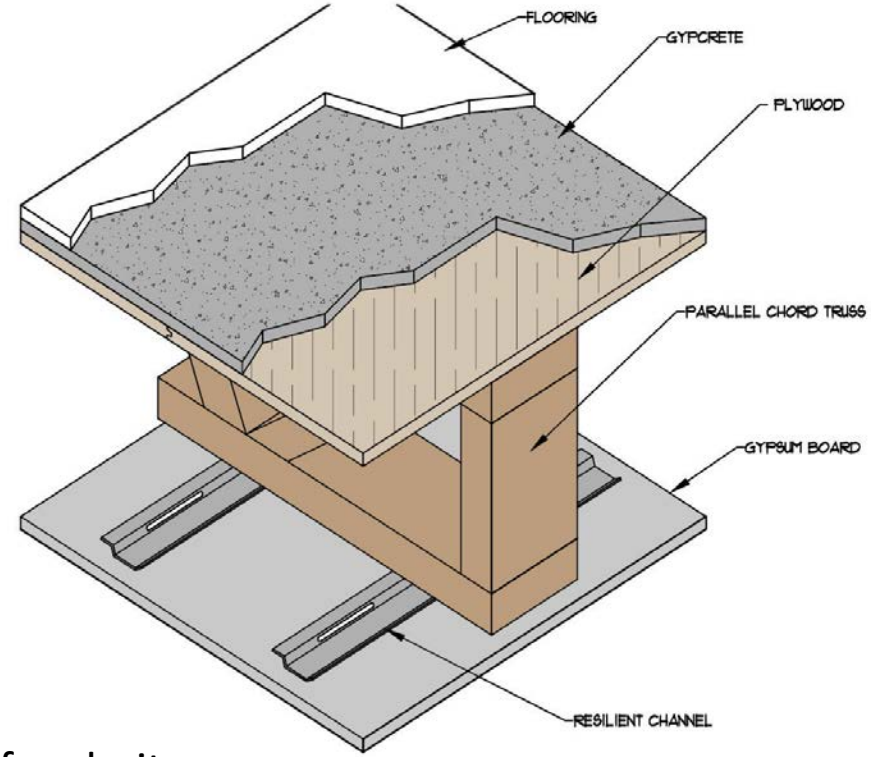

Batt insulation not shown for clarity

# Floor Systems




Batt insulation not shown for clarity

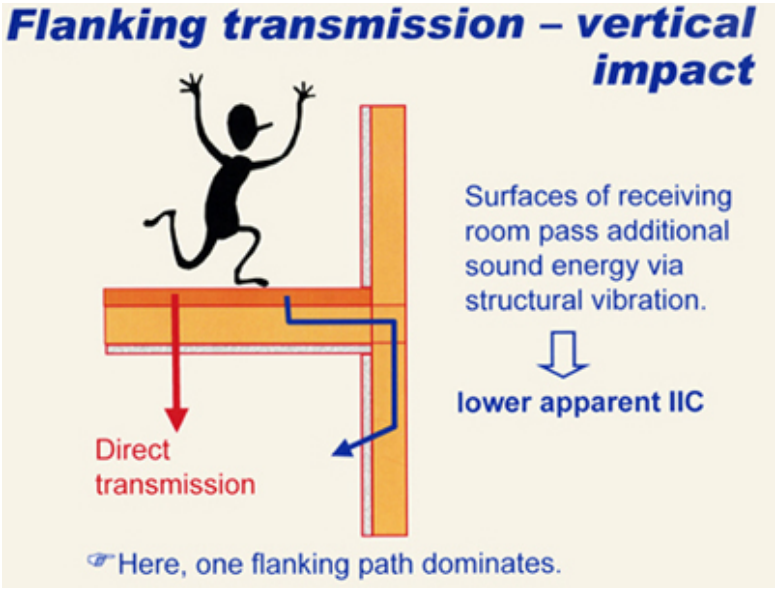
# Floor Systems




Batt insulation not shown for clarity

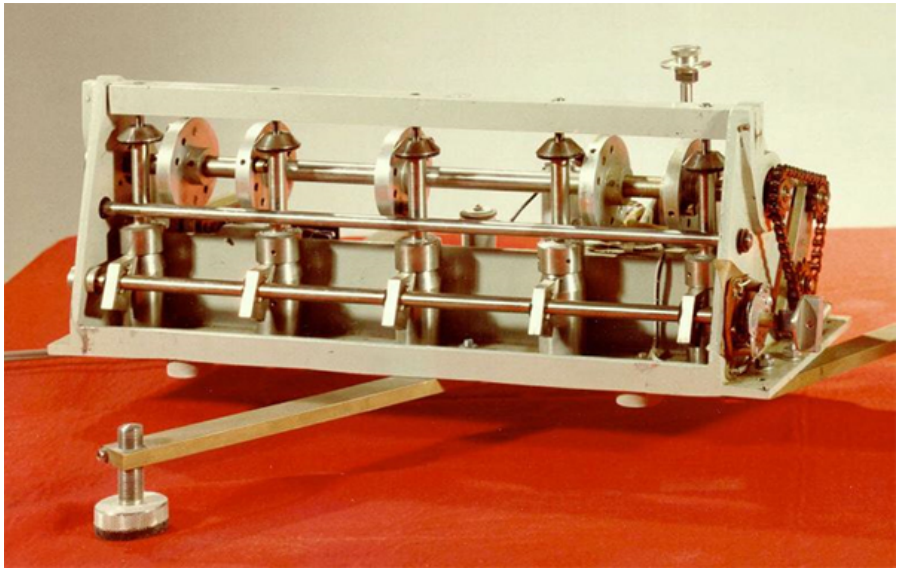
# Independently Framed Ceiling System

# Impact Noise In Buildings



# Impact Noise

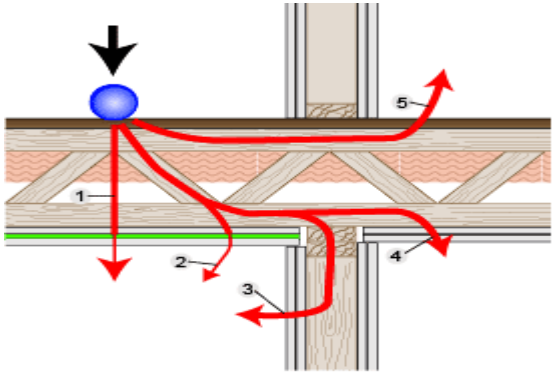
# The Tapper

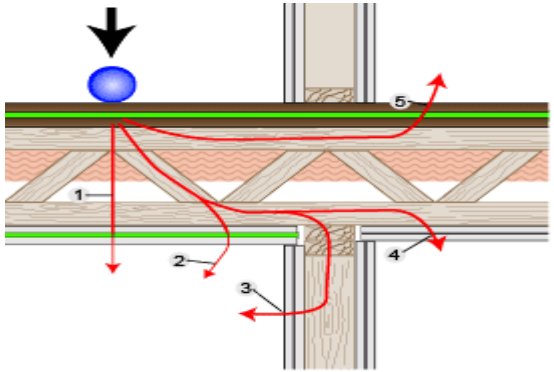


# The Tapper

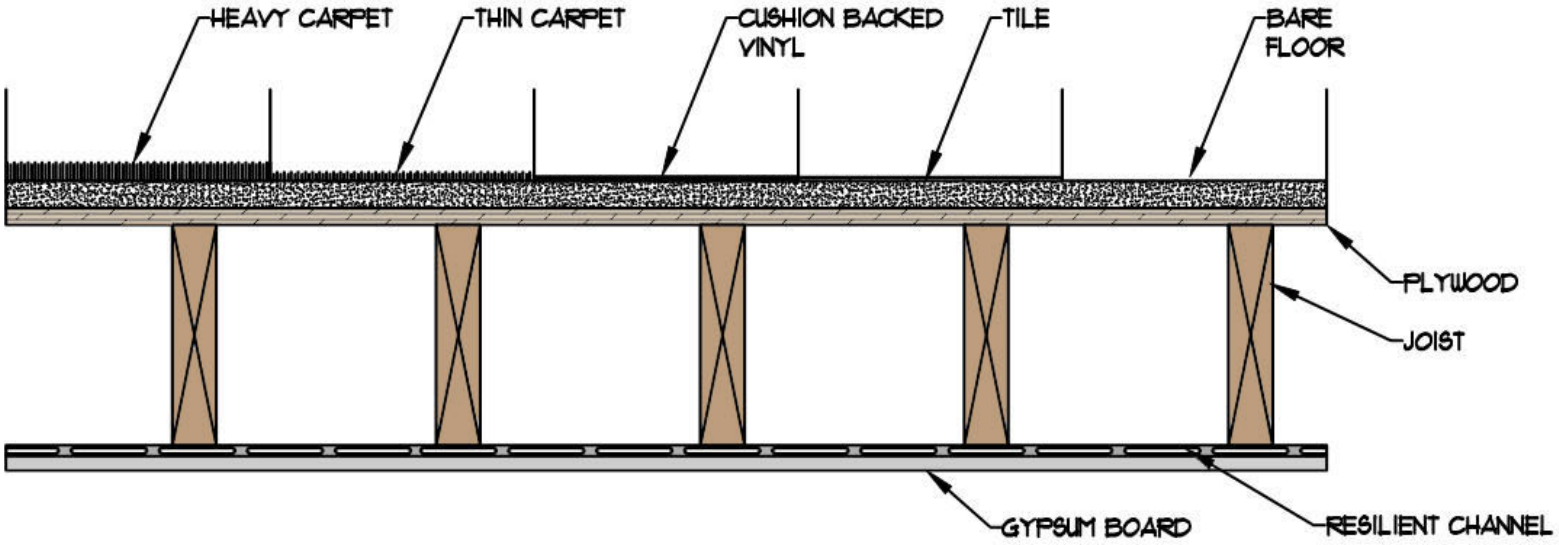
# Impact Isolation

- Impact noise changes as it travels in the building.
- Impact noise is best controlled at the source.



# Effects of Floor Covering on Impact Isolation




IIC 73 IIC 64 IIC 56 IIC 43 IIC 32

STC 56

Batt insulation not shown for clarity

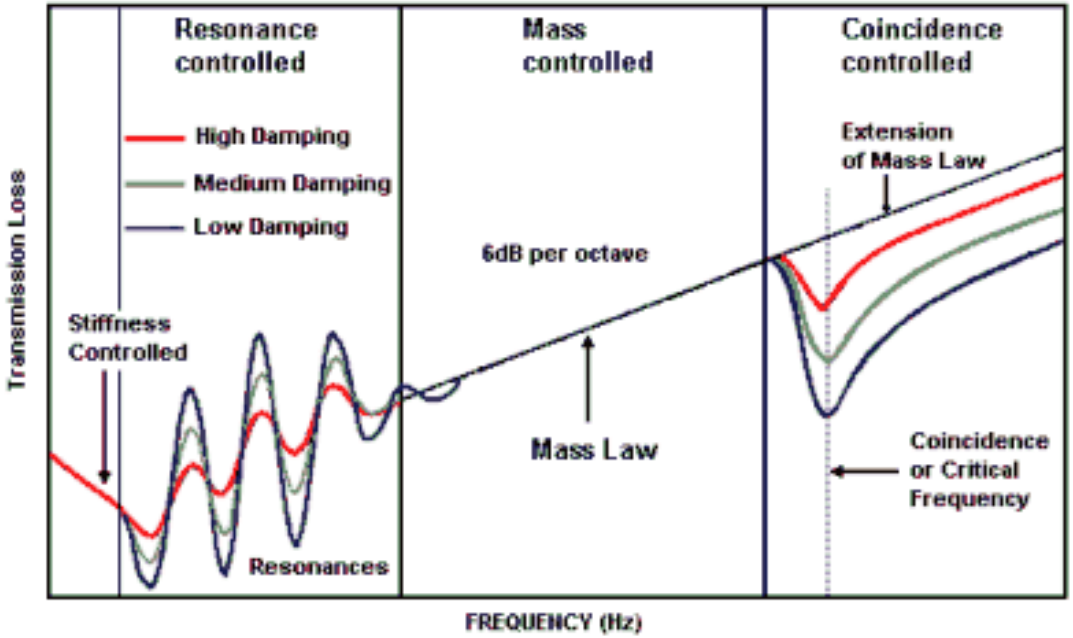
# Cross-Laminated Timber

## About CrossLam

Cross Laminated Timber have many of the benefits that other building materials just don't have.

- Up to 6 times lighter than concrete

# Cross-Laminated Timber




6 inch thick 20 lb./ft$^3$. CLT
Same Mass as
1.6 inch thick Concrete

Based on Acoustics
Mass Law STC Rating
about 38 STC

# Cross-Laminated Timber

*Table 3*
Area mass of some CLT elements for wall and floor applications

| Number of Layers | Thickness in. (mm) | Area Mass lb./ft.$^2$ (kg/m$^2$) |
|---|---|---|
| 3 | 2.36 (60) | 6.14 (30) |
| 3 | 4.72 (120) | 12.29 (60) |
| 5 | 4.61 (117) | 11.98 (58.5) |
| 5 | 7.87 (200) | 20.48 (100) |
| 7 | 7.95 (202) | 20.69 (101) |
| 7 | 11.02 (280) | 28.67 (140) |
| 8 | 9.76 (248) | 25.40 (124) |
| 8 | 12.60 (320) | 32.77 (160) |

"Volume generally assumed for the density of hardened concrete is 150 lb./ft$^3$. (2400 kg/m$^3$)"

*McGraw-Hill Encyclopedia of Science and Technology*.

# Cross-Laminated Timber

ACOUSTICALLY STILL REALLY NEW

We Need More Test Data

In absence of test data we compare to known acoustical systems

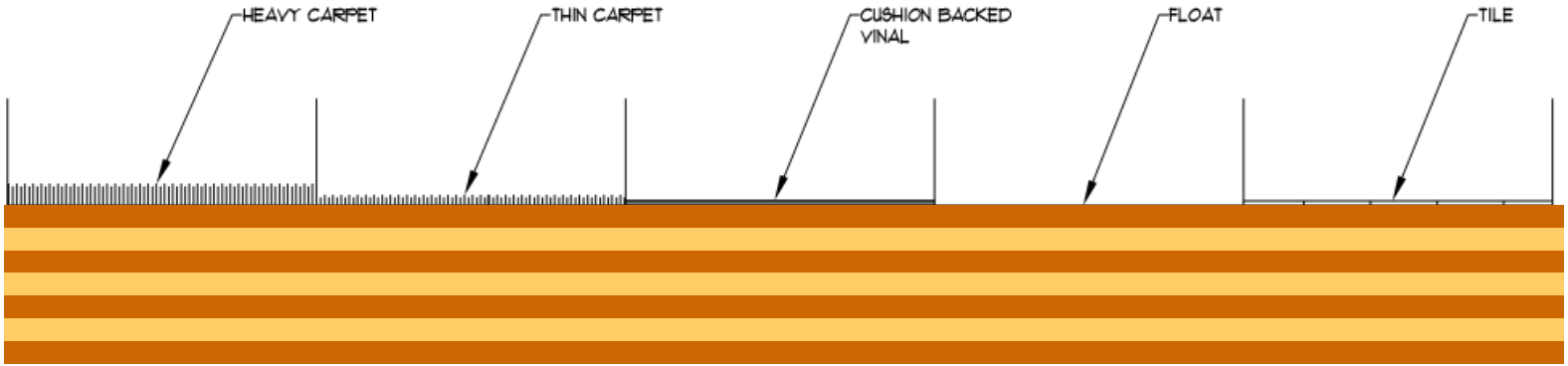
# Cross-Laminated Timber

*Table 4*

Sound insulation performance of bare CLT floors and walls

| Number of Layers | Thickness in. (mm) | Assembly Type | STC | IIC |
|---|---|---|---|---|
| 3 | 3.74 - 4.53 (95-115) | Wall | 32-34 | N/A |
| 5 | 5.31 (135) | Floor | 39 | 23 |
| 5 | 5.75 (146) | Floor | 39 | 24 |
| Measured on field bare CLT wall and floor (Hu, 2013a) | | | | |
| **Number of Layers** | **Thickness in. (mm)** | **Assembly Type** | **FSTC** | **FIIC** |
| 3 | 4.13 (105) | Wall | 28 | N/A |
| 7 | 8.19 (208) | Floor | N/A | 25 |

# Cross-Laminated Timber



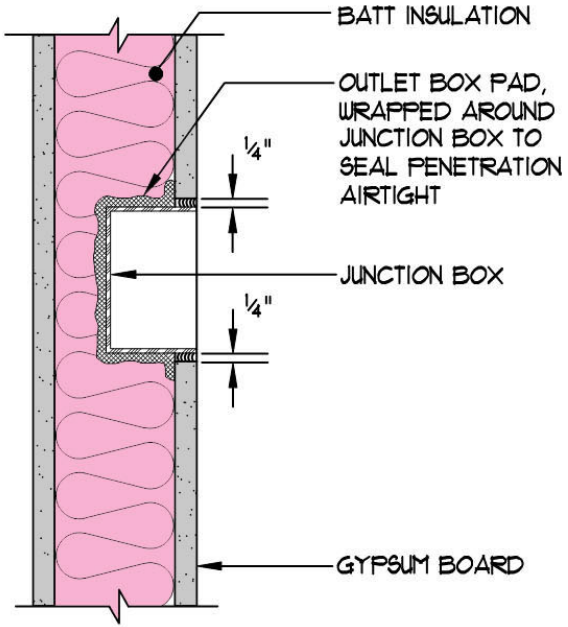

70+ IIC 35

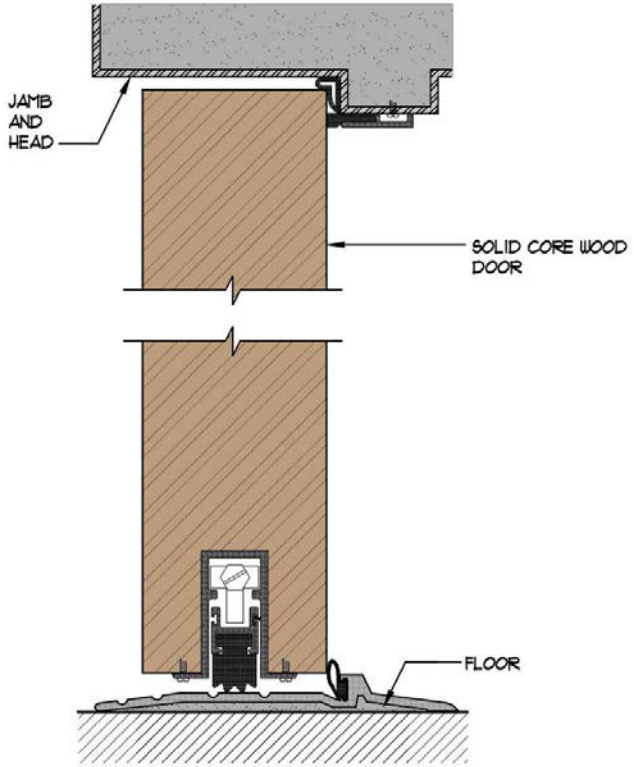
# Urban Acoustics

## Leaks - Doors and Windows


Leaks: Where air can flow…
…so will sound.

# Air Tight Seal



# Batt Insulation

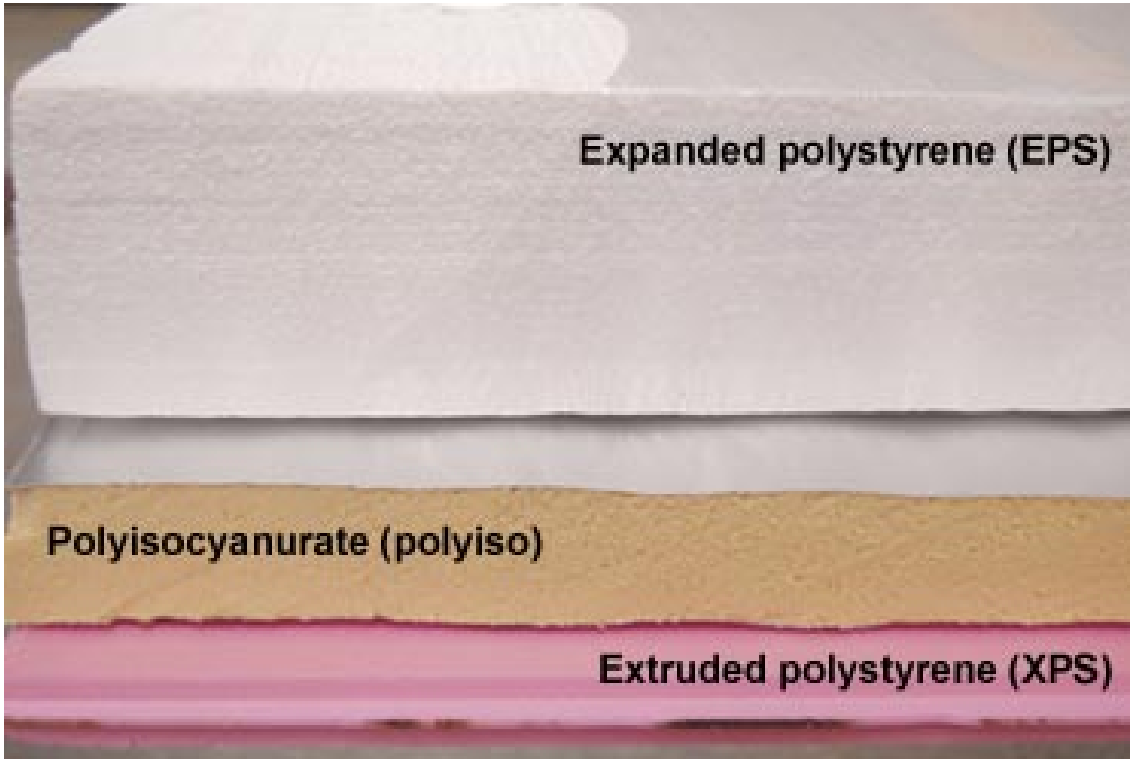
# Blow In Insulation

**CELLULOUS / FIBER**

**OPEN CELL FOAM**

~~**CLOSED CELL FOAM**~~

# Rigid “Foam” Insulation

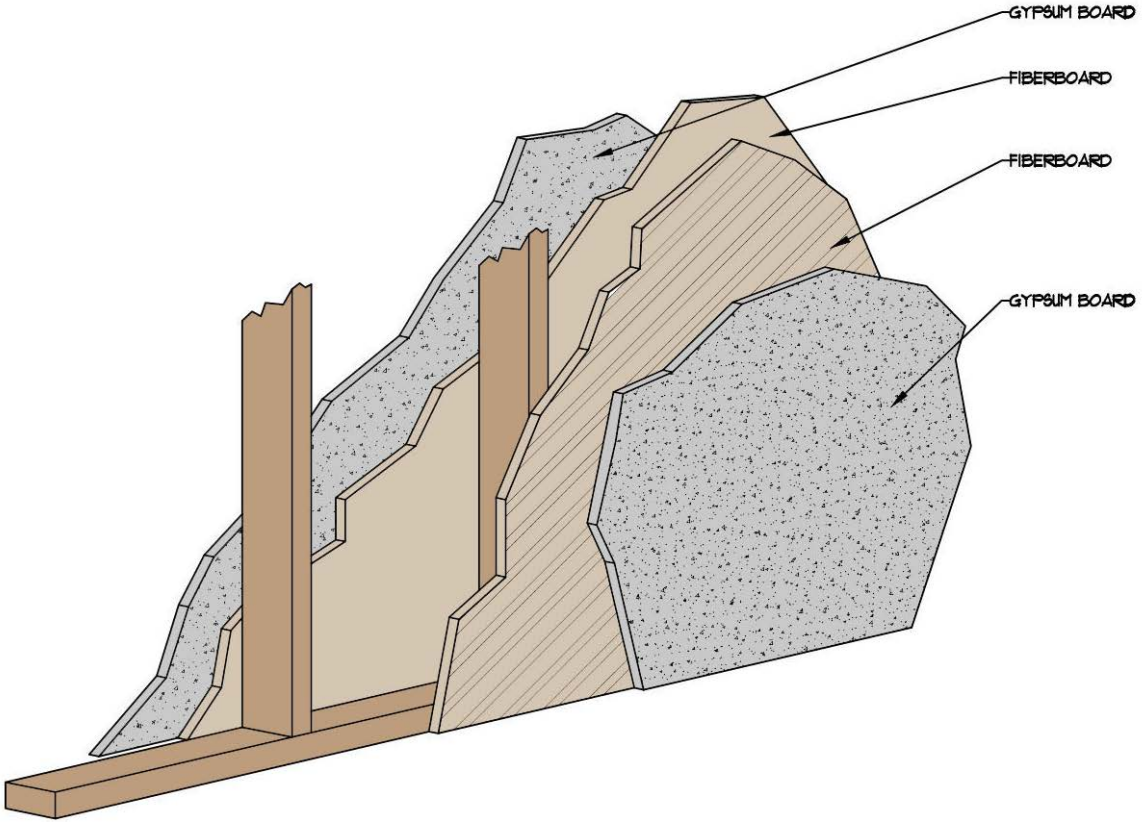


# Urban Acoustics

## Other Issues to Consider

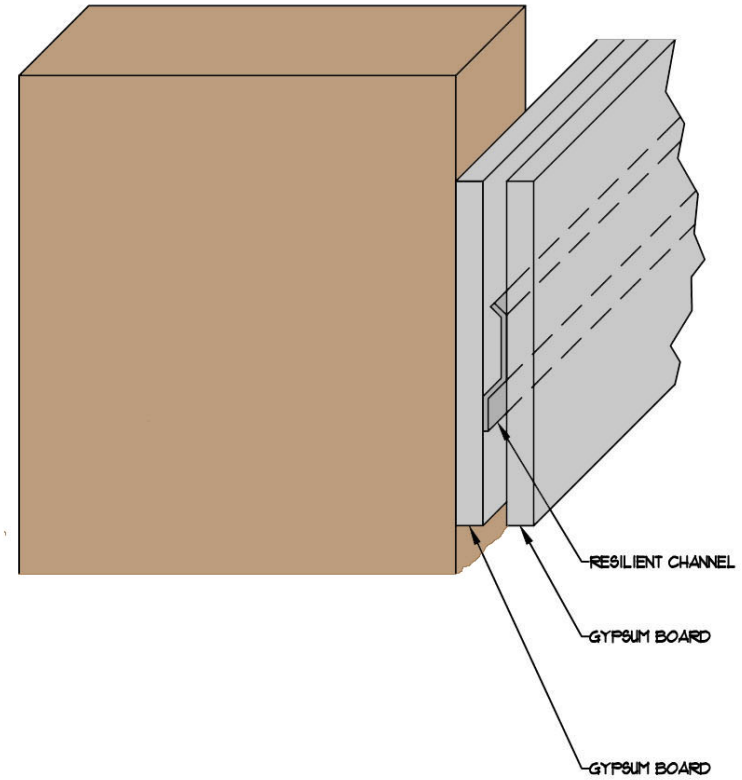
# Acoustical Fiction!

- Fiber Board

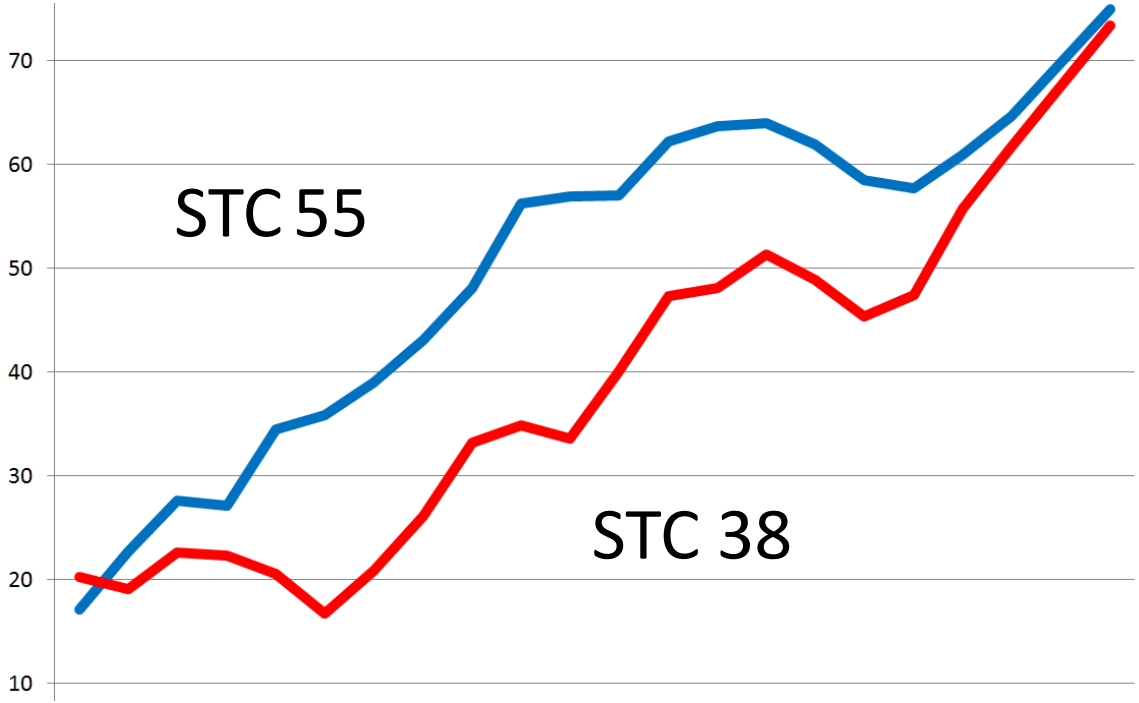


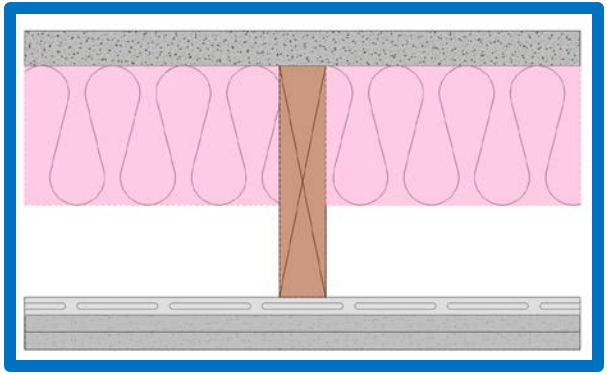
# Acoustical Fiction!

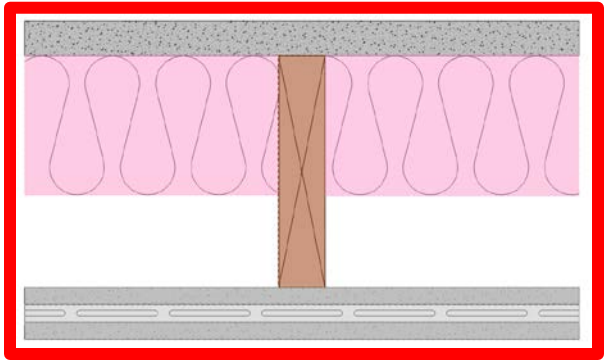
- Trapped Channel



# Trapped Air Space and Screws

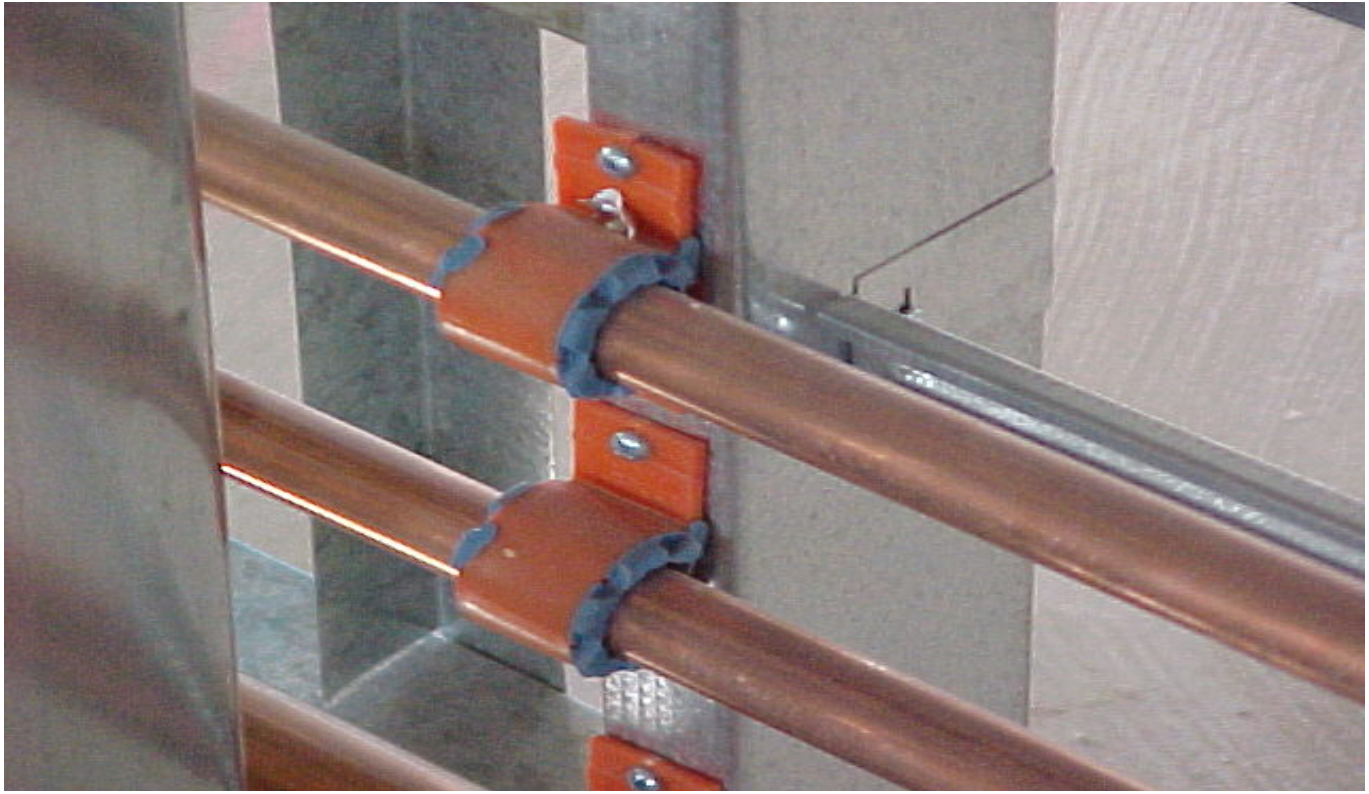




# Installation Issues - RC

# Plumbing Isolation



# Other Noise Issues

# Condominium Noise

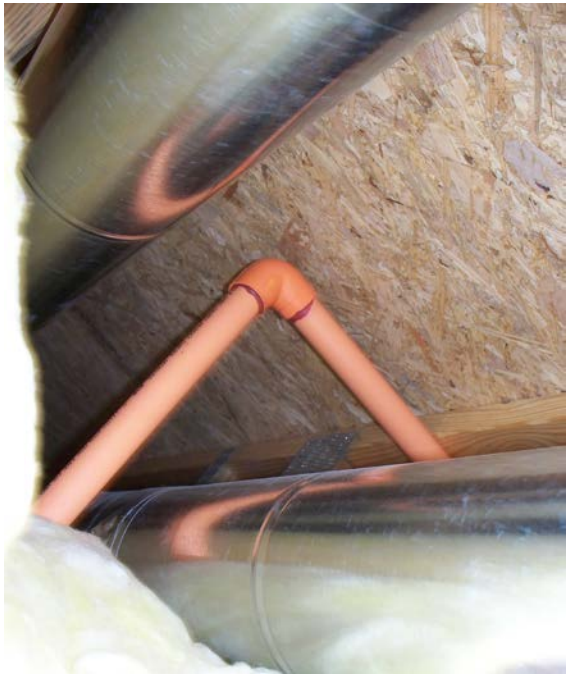
# Now We See the Problem

# Installation Issues - RC

# Installation Issues - RC

*This photograph shows where the builder has used excessively long screws to fasten the gypsum ceiling. This results in the resilient channel being anchored to the wood joist eliminating the vibration and sound isolation provided by resilient channels.*

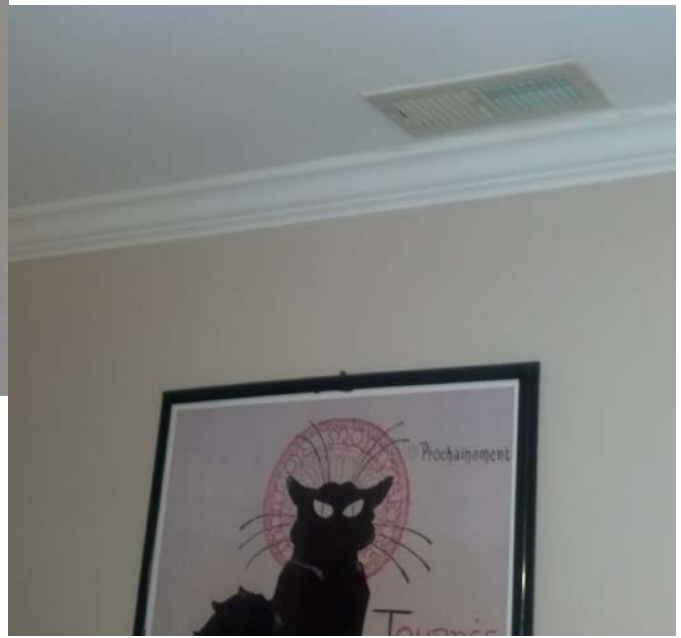
# Sprinkler Lines / Heads



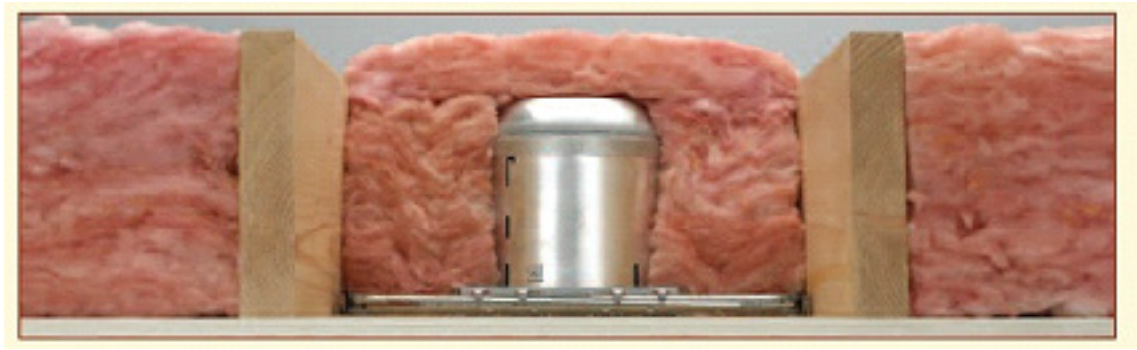
# RESILIENT CEILING SYSTEMS


# Duct Work

# HOLES IN SYSTEMS



# Recessed Light Fixtures



Roll over image to zoom in

Halo H750ICAT, 6" LED Housing, IC Air-Tite, for listed Halo LED Modules

by Cooper Lighting

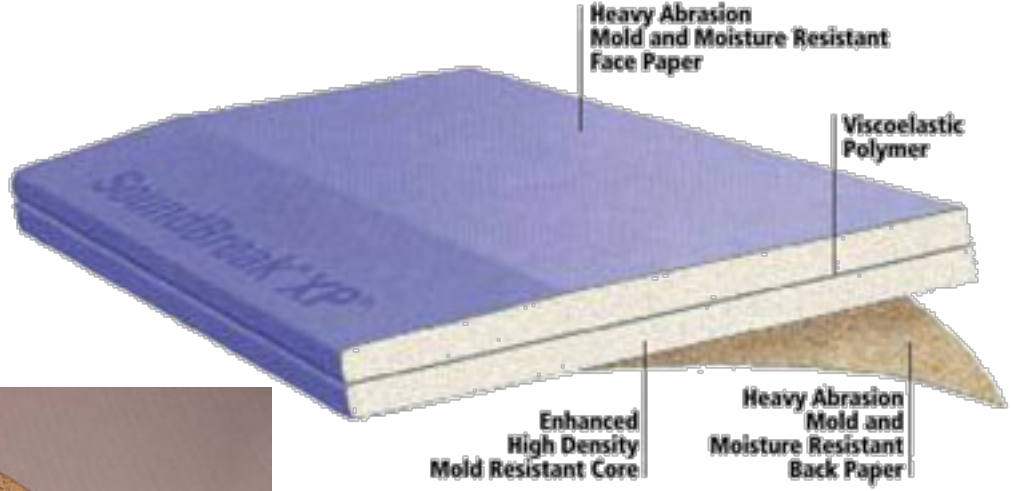
Learn more

# RESILIENT CHANNELS INSTALLATION

# Framing Issues

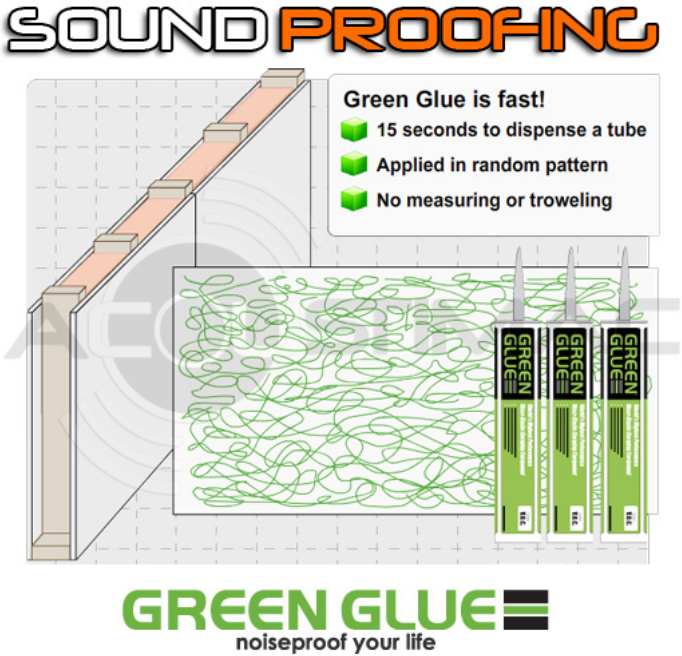
# Framing Issues … (ok Plumbing)

# ACOUSTICAL GYPSUM BOARD


**ES**

# DAMPING


SOUND PROOFING
Green Glue is fast!
15 seconds to dispense a tube
Applied in random pattern
No measuring or troweling
GREEN GLUE
noiseproof your life

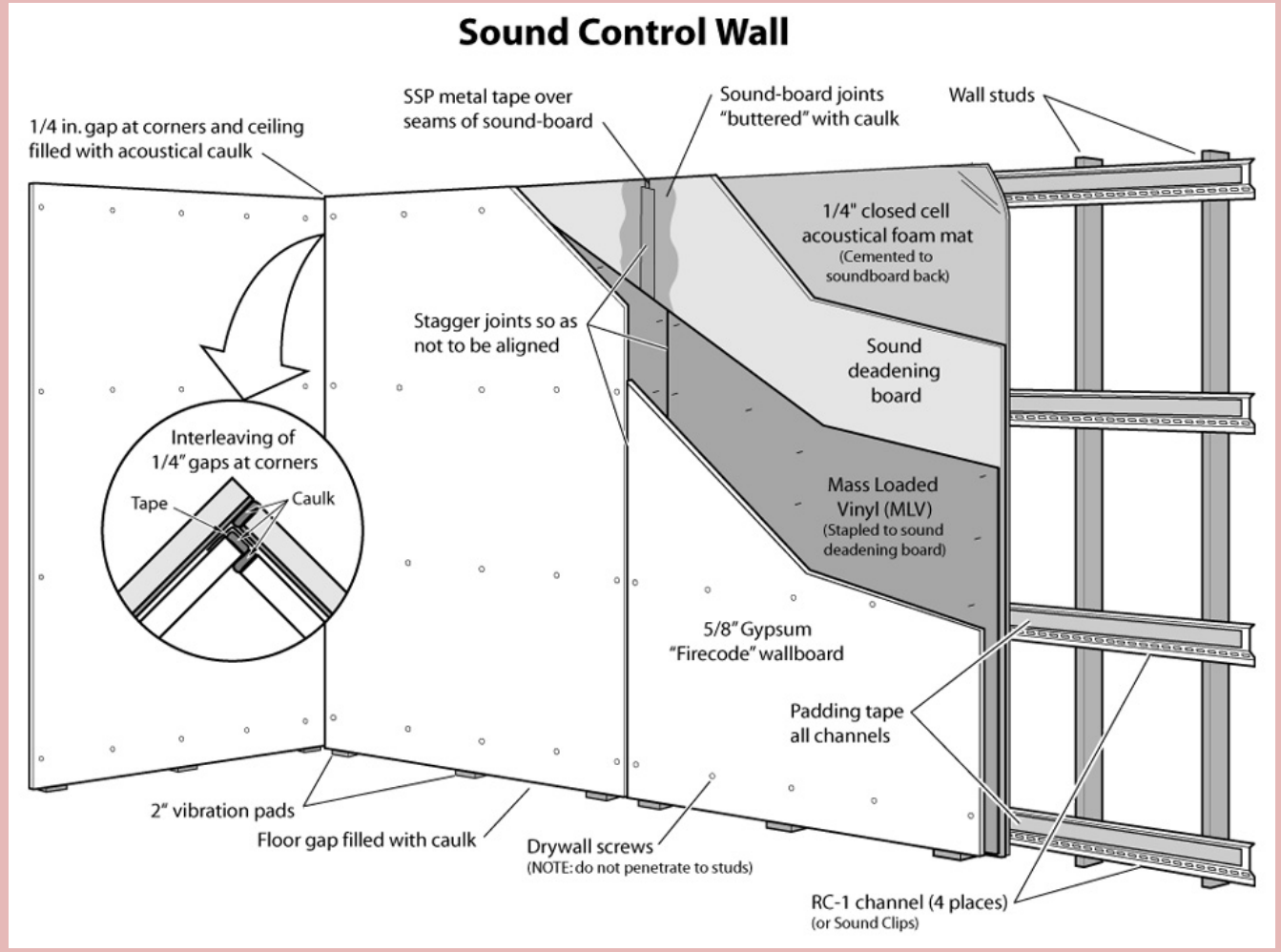

GREEN GLUE


QuietGlue Pro
QuietCoat
QuietGlue Pro
QuietCoat
QuietGlue Pro


FIRECODE
Smoke-Sound Sealant
USG
29 FL. OZ. (1 PT. 13 FL. OZ.) (858 mL)

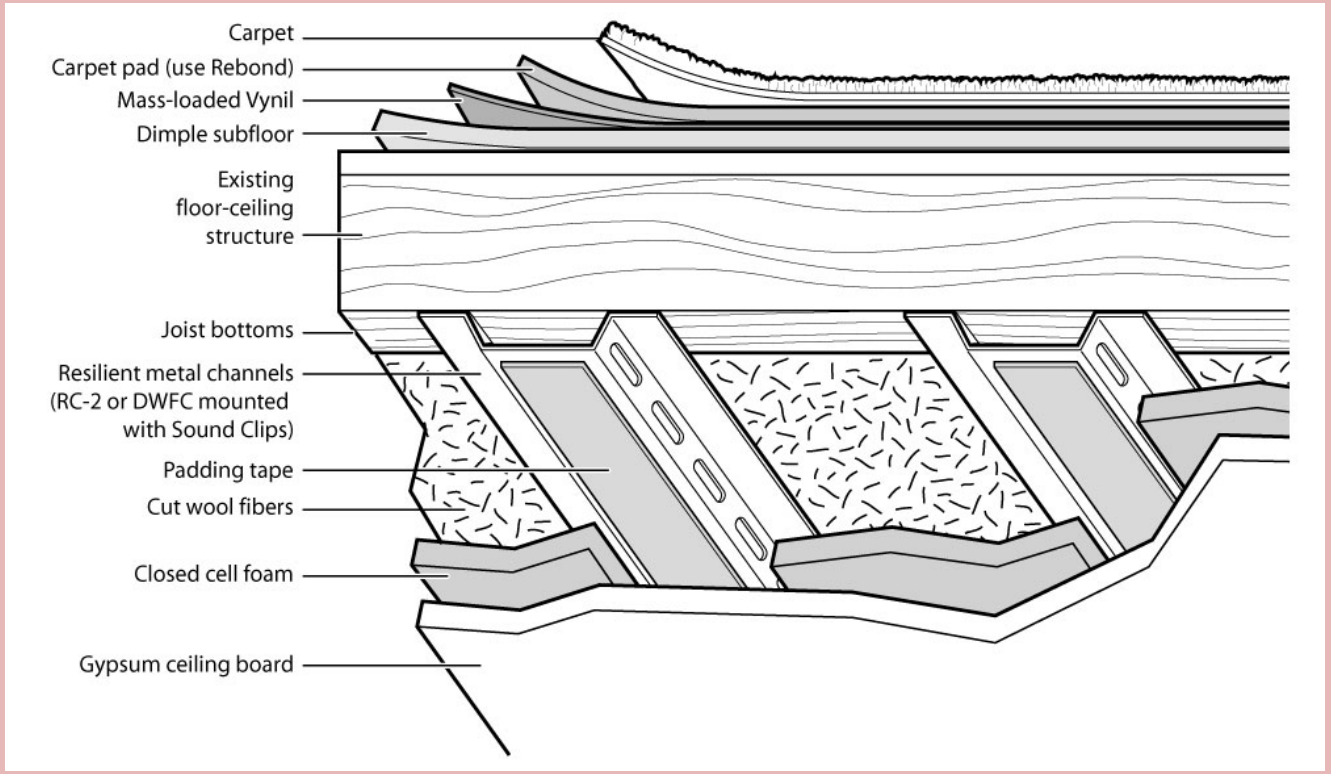
# OMG!

**THIS IS VERY BAD! DO NOT BELIEVE THE INTERNET!**



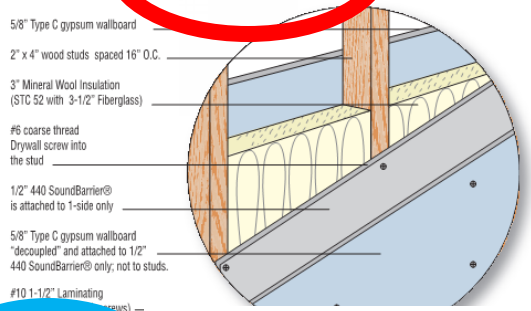
# OMG!

**THIS IS VERY BAD! DO NOT BELIEVE THE INTERNET!**



# OMG!

## STC 53




**U305**

**Design No. U305**

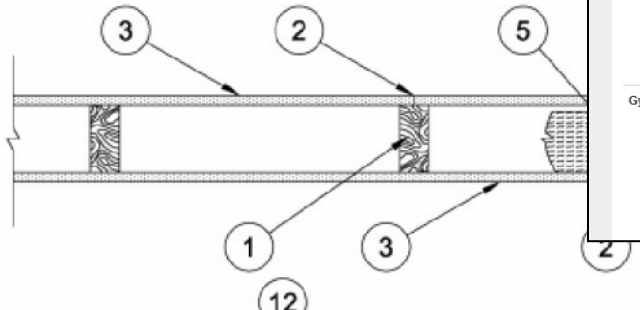
June 26, 2013

**Bearing Wall Rating — 1 Hr**

**Finish Rating** — See Items 3, 3A, 3B, 3F, 3G, 3H,

**STC Rating - 56 (See Item 9)**

**Load Restricted for** — Applications — See Gui




8. **Caulking and Sealants** — (not shown, optional) A bead of acoustical sealant applied around the partition perimeter for sound control.

9. **STC Rating** — The STC Rating of the wall assembly is 56 when it is constructed as described by Items 1 through 6, except:

A. Item 2, above - Nailheads Shall be covered with joint compound.

B. Item 2, above - Joints As described, shall be covered with fiber tape and joint compound.

C. Item 5, above - Batts and Blankets* The cavities formed by the studs shall be friction fit with R-19 unfaced fiberglass insulation batts measuring 6-1/4 in. thick and 15-1/4 in. wide.

D. Item 6, above - Steel Framing Members* Type RSIC-1 clips shall be used to attach gypsum board to studs on either side of the wall assembly.

E. Item 8, above - Caulking and Sealants (not shown) A bead of acoustical sealant shall be applied around the partition perimeter for sound control.

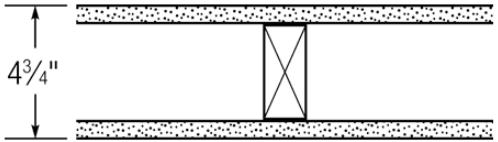
F. Steel Corner Fasteners (Item 4), Fiber, Sprayed (Items 5A and 5B ) and Steel Framing Members (Item 6A), not evaluated as alternatives for obtaining STC rating.

10. **Wall and Partition Facings and Accessories*** — (Optional, Not shown) — Nominal 1/2 in. thick, 4 ft wide

### Fire Assembly Detail - UL Design U305

View More Info on UL.com

| Fire Rating | STC / Sound Test | System Thickness | Limiting Height |
|---|---|---|---|
| 1 hr | N/A | 4-13/16" | |




Download CAD Download REVIT

| | |
|---|---|
| Gypsum Board | Face Layer, 5/8 in. thick gypsum board applied vertically or horizontally.<br>USG Products<br>SHEETROCK® UltraLight Firecode X Gypsum Panels (type ULX)<br>SHEETROCK® Mold Tough™ FIRECODE® Core (Type X) (type SCX)<br>SHEETROCK® FIRECODE® Core (Type X) (type SCX)<br>SHEETROCK® Mold Tough VHI Firecode Core Gypsum Panels (type AR)<br>SHEETROCK® Mold Tough™ AR FIRECODE® Core (Type X) (type AR)<br>SHEETROCK® Abuse-Resistant FIRECODE® Core Gypsum Panels (type AR) |

### Related Fire Assemblies - Wall Selectors

| Detail | Design No. | Rating | STC | Thickness |
|---|---|---|---|---|
| CAD REVIT See Assembly Detail › | UL U305 USG-860807 Interior Partiti | | 37 STC | 4-3/4" thickness |
| CAD REVIT See Assembly Detail › | UL U305 USG-30-FT-G H Interior Partitio | 1 Hr | 34 STC | 4-3/4 thickne |
| CAD REVIT See Assembly Detail › | UL U305 BBN-700725 Interior Partitio | 1 Hr | 46 STC | 4-3/4 thickne |
| CAD REVIT See Assembly Detail › | UL U305 Exterior Wa | | N/A STC | 4-3 thickness |

When it comes to Acoustics

***Only Believe Real Laboratory Test Data or Someone you Pay and can Sue!***

# THORBURN ASSOCIATES

ACOUSTICAL, TECHNOLOGY, AND LIGHTING DESIGN

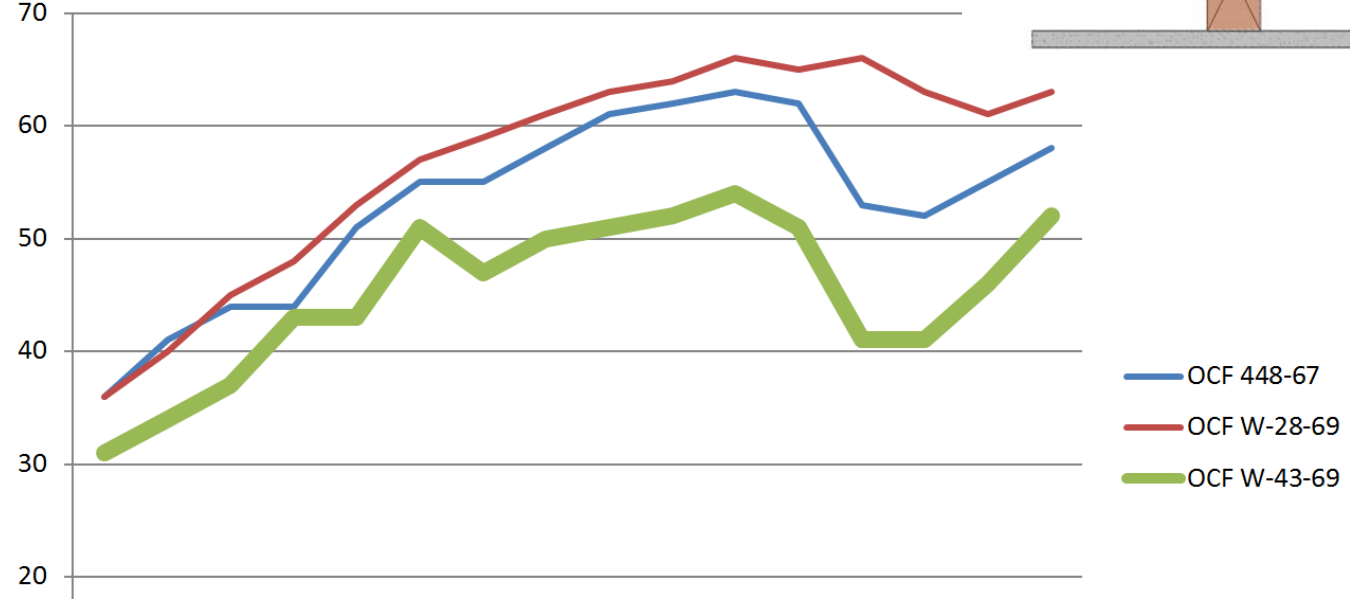
# Urban Acoustics

# THANK YOU!

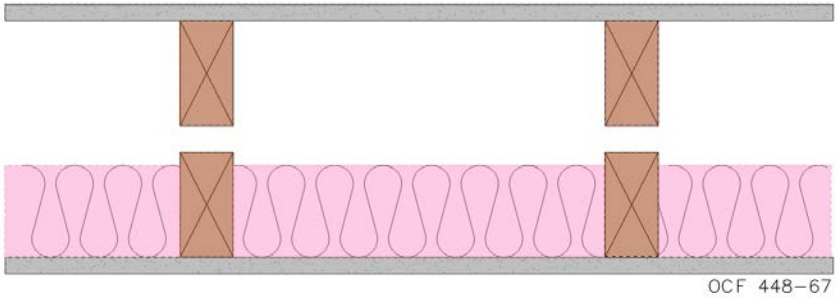
THORBURN ASSOCIATES
ACOUSTICAL, TECHNOLOGY, AND LIGHTING DESIGN

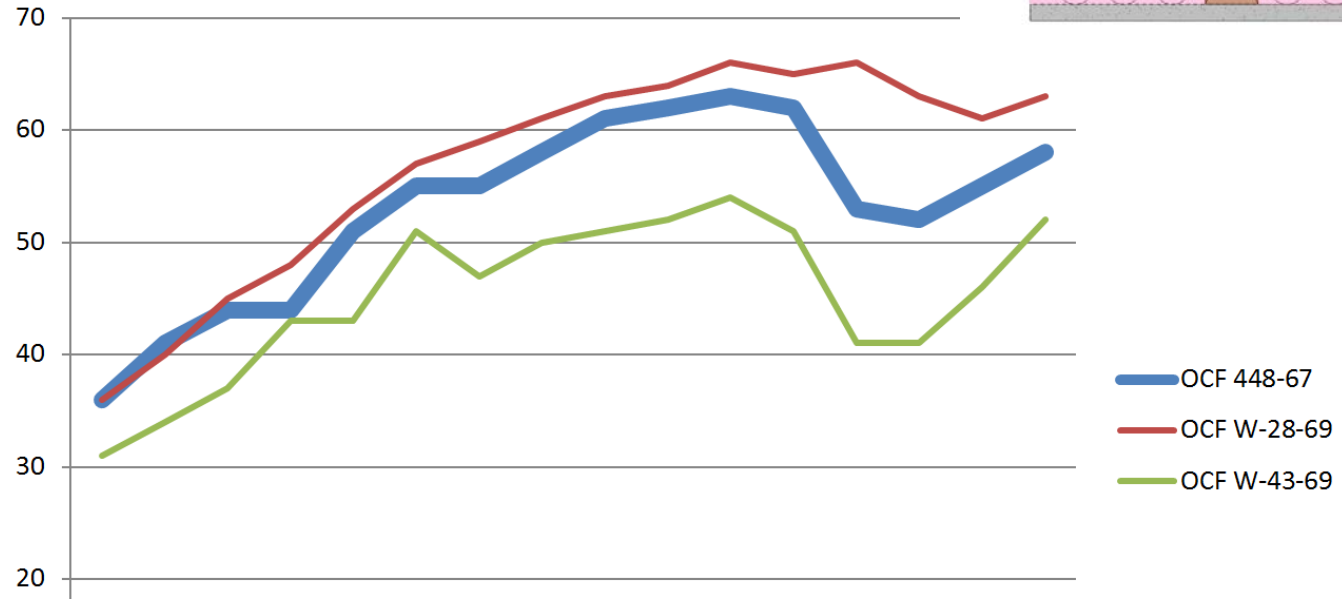
*Steve(n) Thorburn, PE, LEED AP, CTS-I, CTS-D* SJT@TA-Inc.com

# Effects of Insulation Thickness

# Effects of Insulation Thickness



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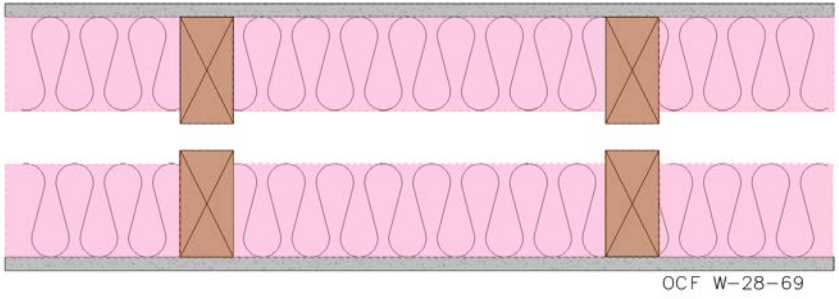
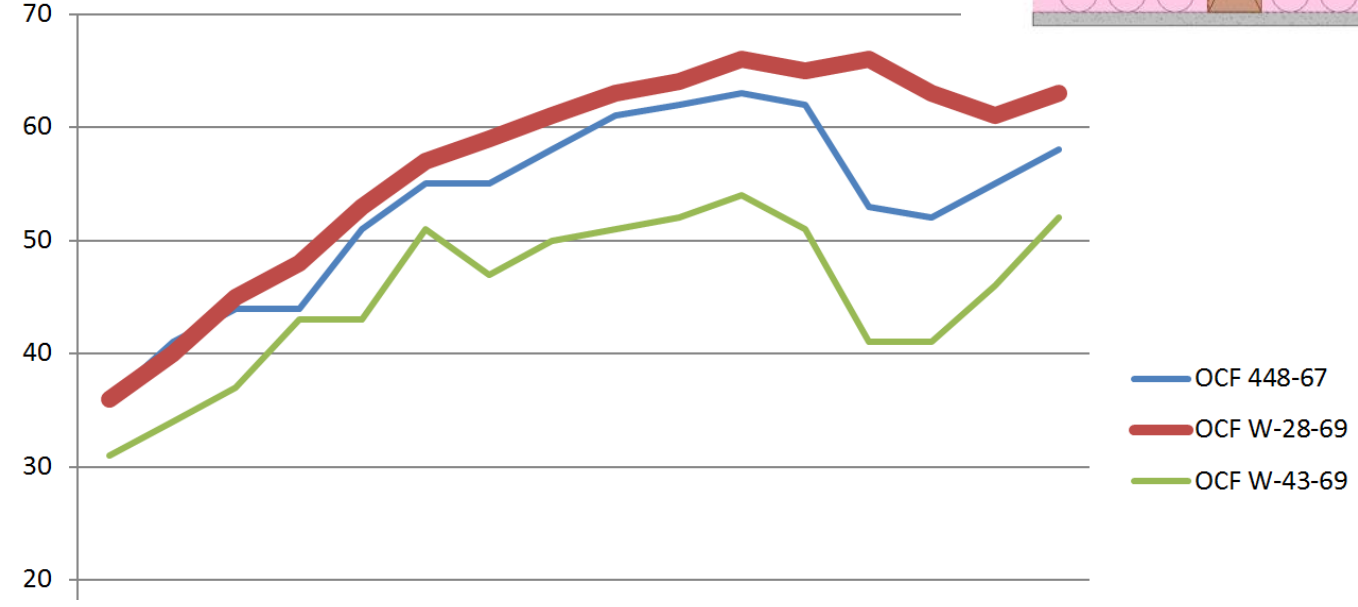
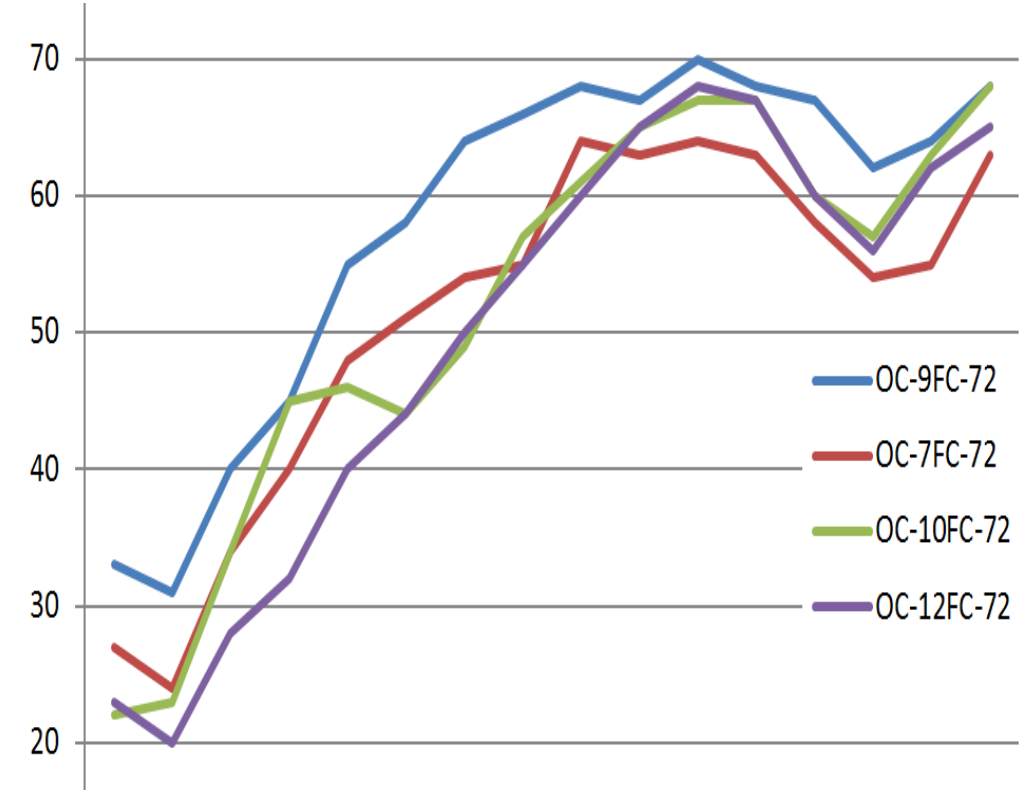
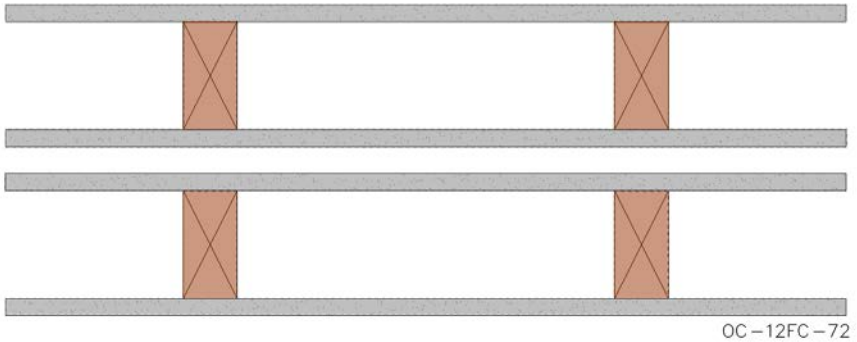


# Effects of Gypsum Board Placement



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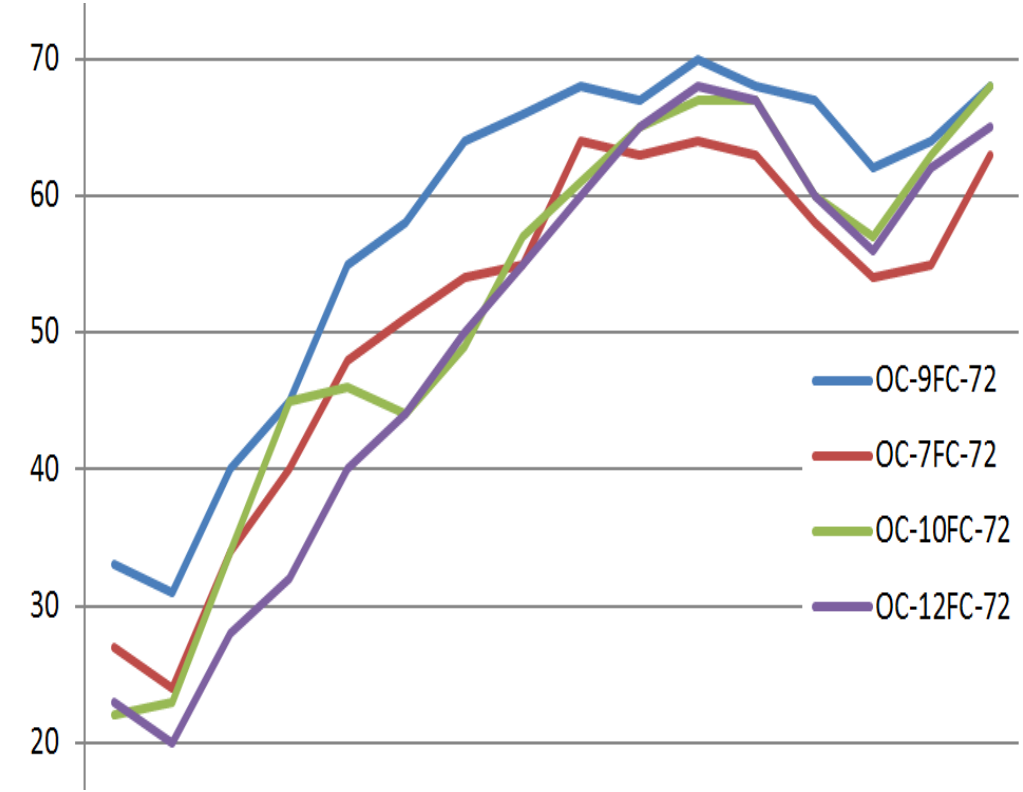
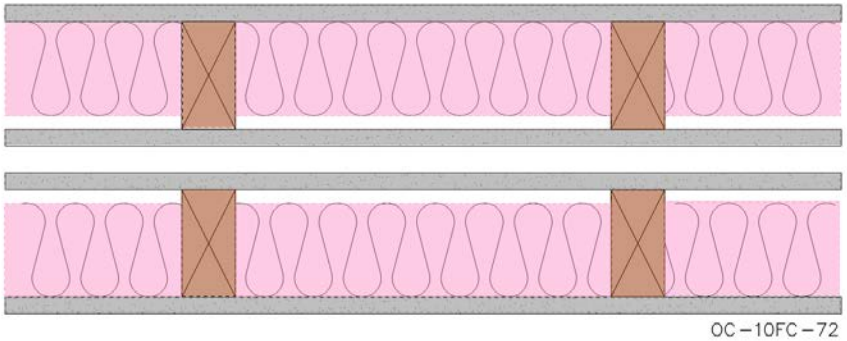
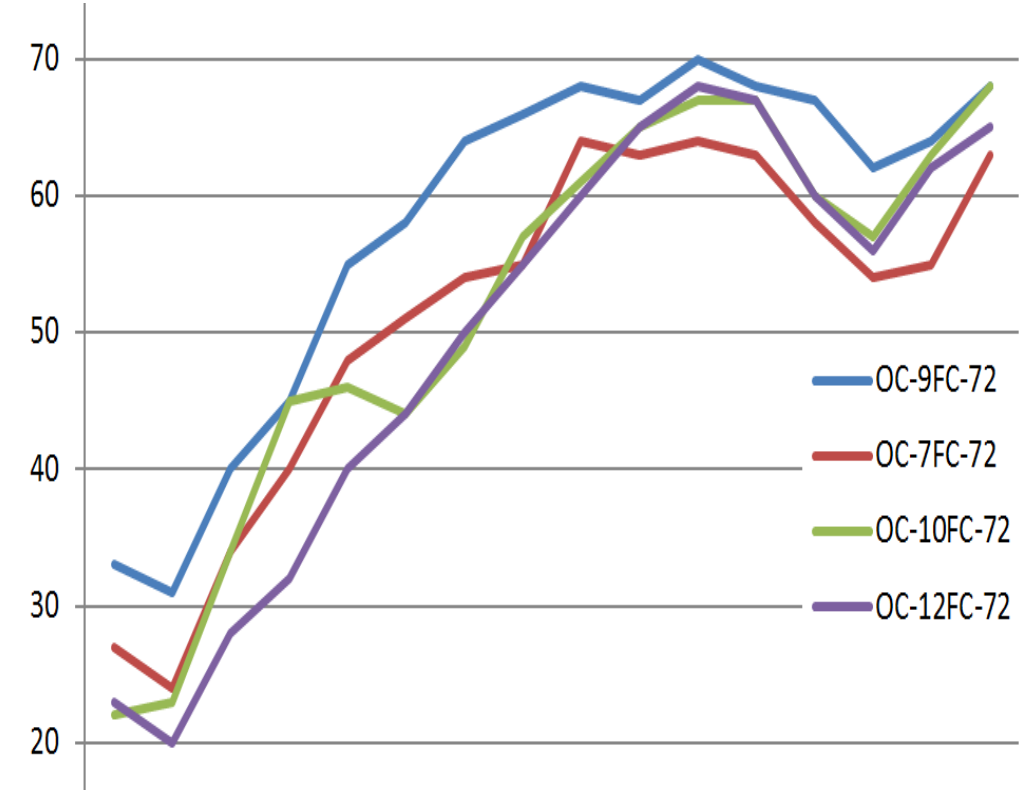
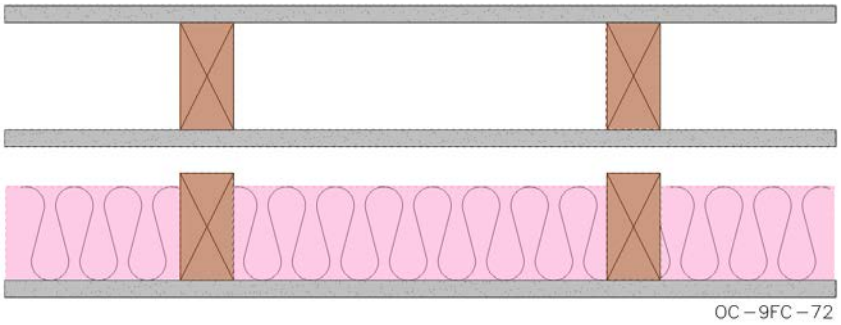


# Effects of Gypsum Board Placement



# Effects of Gypsum Board Placement