



Acoustical Engineering Solutions.

# Meeting IBC Acoustical Requirements for Multifamily Construction

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Phoenix Noise & Vibration  
Frederick, Maryland



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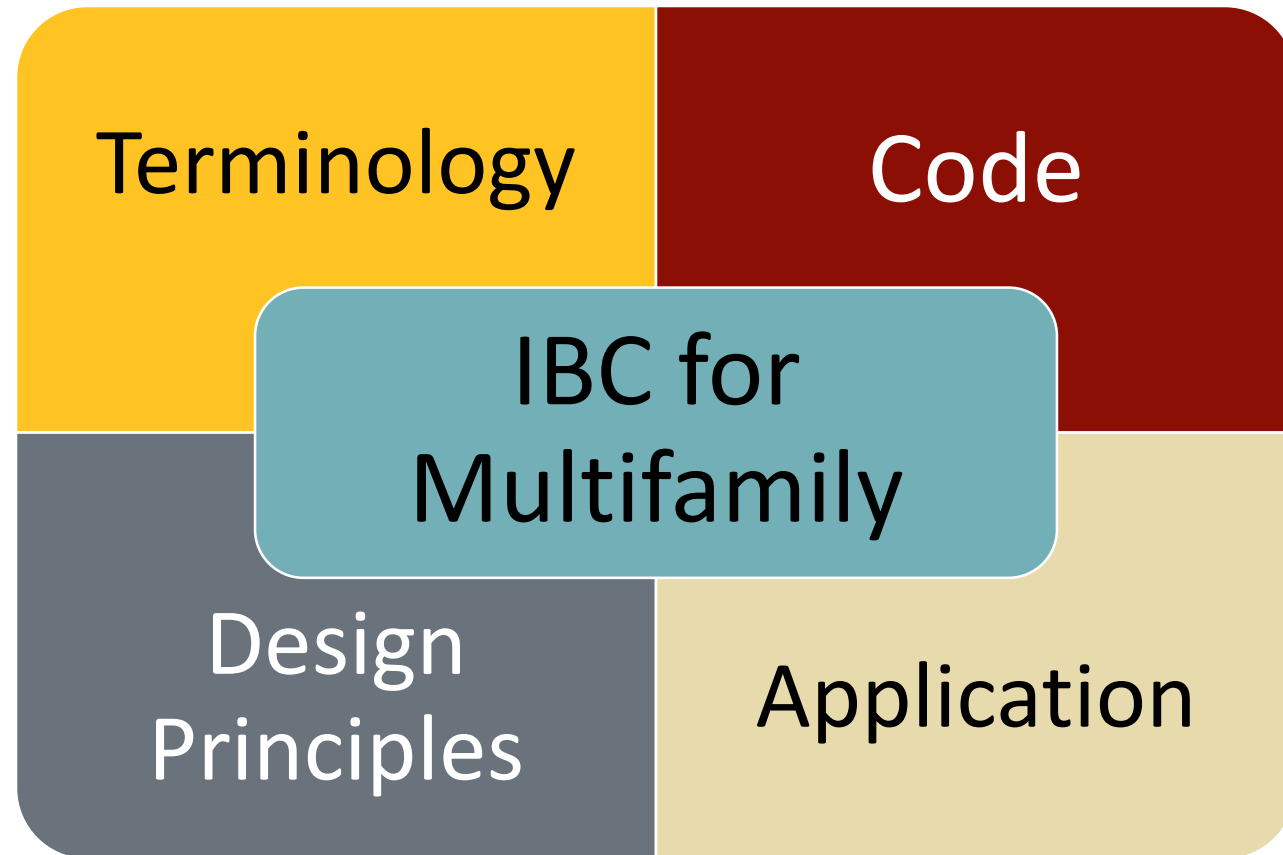


# Learning Objectives

After attending this course, participants will be able to:

- Understand basic acoustical principals and terminology as they relate to the IBC criteria.
- Define both **STC and IIC** and understand their application to multifamily construction.
- Understand what **components** of a partition affect the STC and IIC ratings.
- **Design** multifamily buildings which incorporate proper STC and IIC rated walls and floor/ceiling systems for both wood and concrete based construction.

# Overview



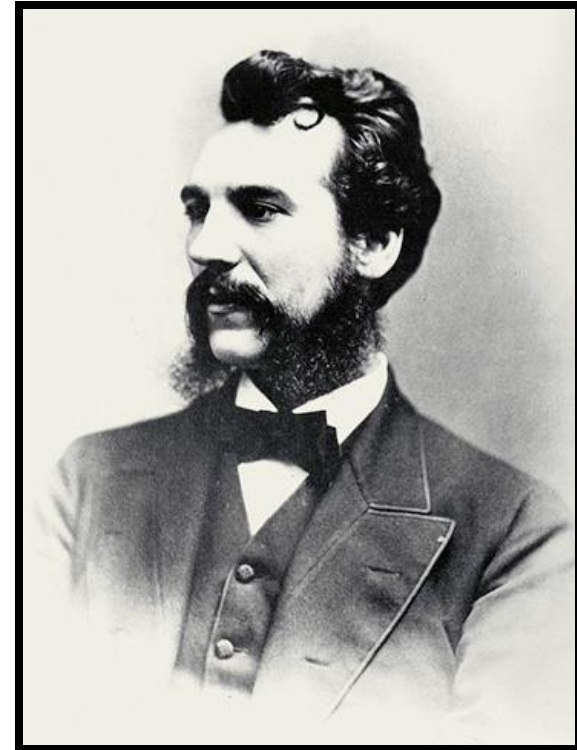
# Terminology



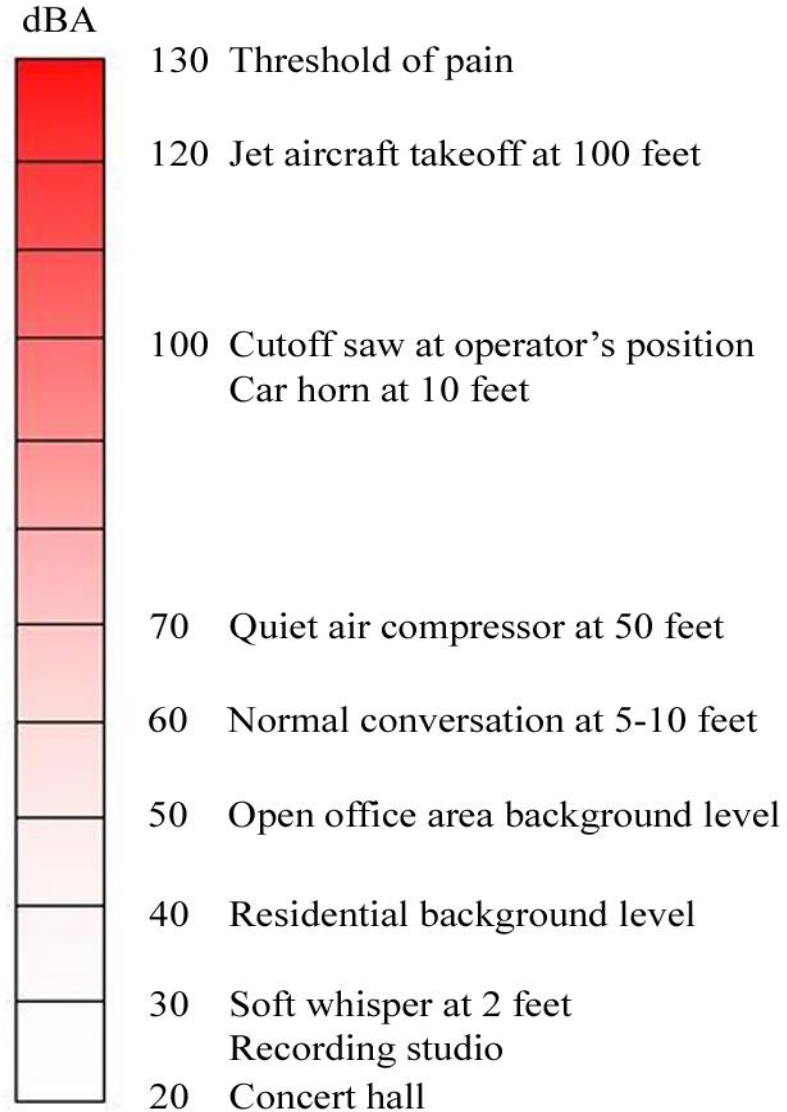
# Terminology

- Loudness measured in decibels (dB)
  - $\text{dB} = 10 \times \log(\text{Pressure}^2 / \text{refPressure}^2)$
- Human Range: 0 to 130 dB
- “A-weight” to simulate human hearing...dBA

Named for Alexander Graham [Bell](#)



## Examples of Common Noise Levels



Source: "Environmental Noise: The Invisible Pollutant", William Cavanaugh and Gregory Tocci



# Terminology

- Why dB???
- Example of the logarithmic nature:

| Change in dB | Subjective Response |
|--------------|---------------------|
| 3 dB         | Barely Perceptible  |
| 5 dB         | Clearly Perceptible |
| 10 dB        | Twice as Loud       |

- Eases Comparisons:
  - 30 to 33 = “Barely Perceptible”
  - 90 to 93 = “Barely Perceptible”

# Terminology

- Everything is based upon the decibel scale
- It's the fundamental unit of acoustic measure

# Terminology

- There are noise barriers and there are noise absorbers.
  - Barriers are not absorbers.
  - Absorbers are not barriers.
  - Many times the absorber is somewhat acoustically transparent.
- Barriers are generally composed of dense, heavy material layers.
- Absorbers are light, fuzzy, soft materials.
- (Quiz Later)

# Quiz

Barrier or Absorber?



- Barrier

# Quiz

- Barrier or Absorber?



- Absorber

# Quiz

- Barrier or Absorber?

- Barrier



# Quiz

Barrier or Absorber?

- Absorber



# Quiz

- Barrier or Absorber?
- This is of absolutely no use to the acoustician except to keep beer cold!





# Air Borne and Structure Borne Noise

- Air borne noise and structure borne noise are really descriptors of the pathways by which sound arrives at the listener from the noise source.

# Air Borne Noise Path

- The sound heard in the room which contains the source is transmitted through partitions and becomes air borne noise in other rooms.
- Generally air borne is sound or noise
- Example:



# To Control Air Borne Noise...

- Remember: Use noise barriers to control or block air borne noise from other locations.



# Structure Borne Noise Path

- **Vibration** from the source is transmitted directly to the building structure, propagates through that structure and becomes audible sound in another part of the building.
- Generally, structure borne is vibration
- For IBC, it's **FOOTFALL NOISE**.



A little quiz...

- Is it
  - Airborne Noise?
  - Or Structure Borne?



# Terminology

## Sound Transmission Class (STC)

- Airborne Noise Control

## Impact Insulation Class (IIC)

- Structure Borne Noise Control

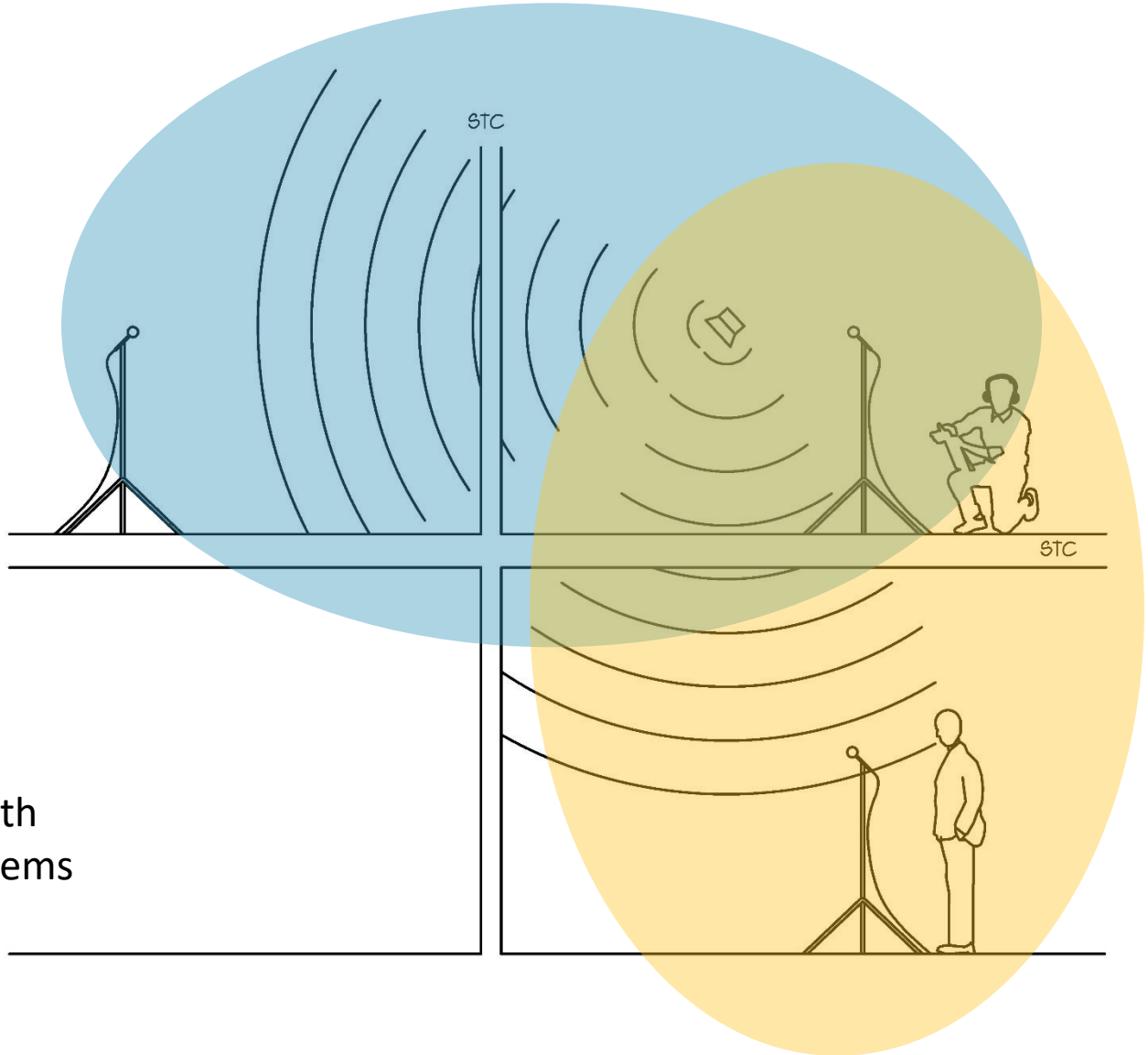
# Terminology

- Sound Transmission Class (STC) – a single number rating of the partition's ability to block speech frequencies from one side to another.



# Terminology

STC Applies to Both  
Floor/Ceiling Systems  
And Walls

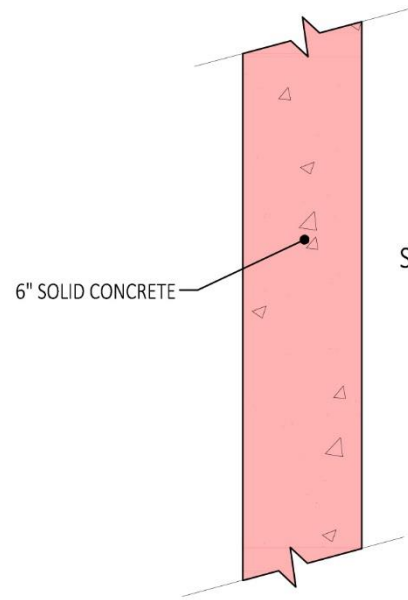


# Terminology

| <b>STC</b> | <b>ASTC</b> | <b>Subjective Description</b>             |
|------------|-------------|---|
| 30         | 22-25       | Most sentences clearly understood         |
| 40         | 32-35       | Speech can be heard with some effort      |
| 50         | 42-45       | Loud speech can be heard with some effort |
| 60         | 52-55       | Loud speech essentially inaudible         |
| 70         | 62-65       | Loud music heard faintly                  |
| 75+        |             | Most noises effectively blocked           |

*Credit: Architectural Acoustics: Principles and Design 1999*

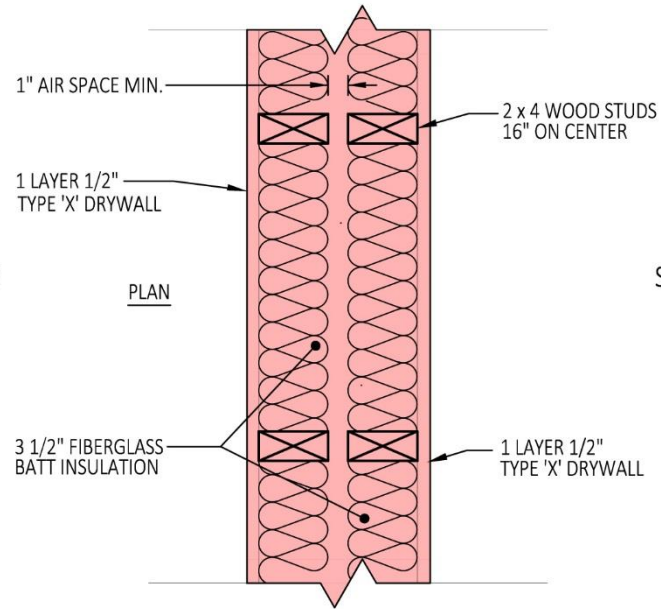
# STC Quiz...



56 STC

STC RATING

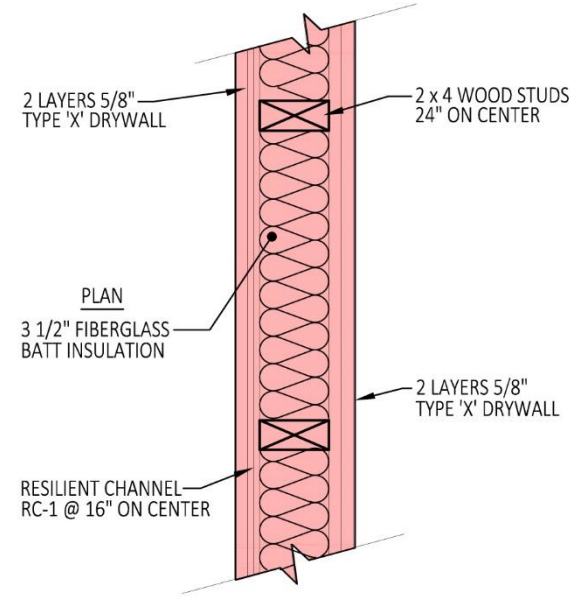
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56 STC

STC RATING

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56 STC

# Terminology

- STC developed for **speech**, applied to many other noise sources such as:
  - Mechanical
  - Transportation
  - Music
- Warning: Not always accurate for these other sources

Close but not really.....



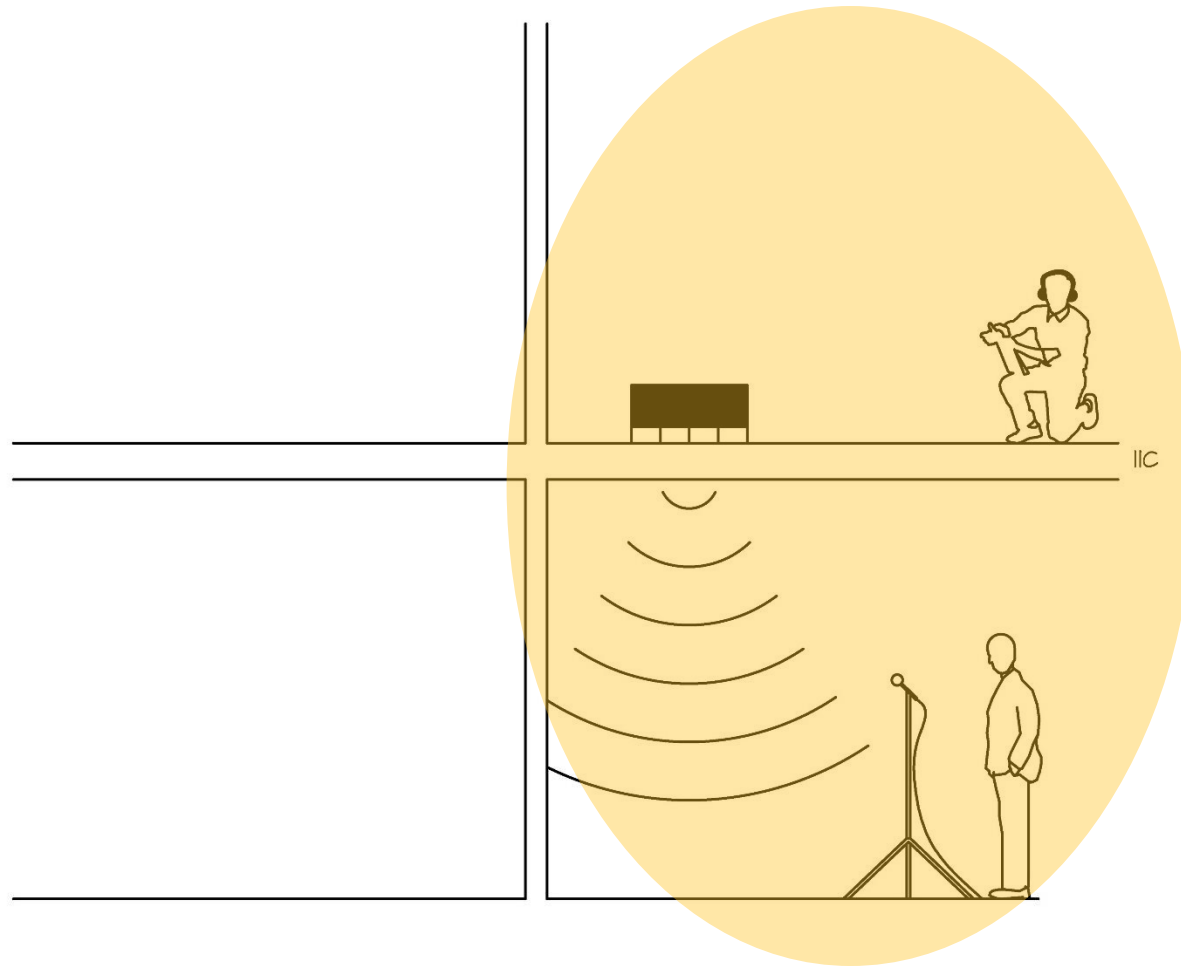
# Terminology

- Impact Insulation Class (IIC) - A single number rating used to compare the effectiveness of floor/ceiling assemblies in providing reduction of impact-generated sound such as footsteps.



# Terminology

IIC Only Applies to  
Floor/Ceiling Systems





Que Tapping Machine Demo



Terminology

Code

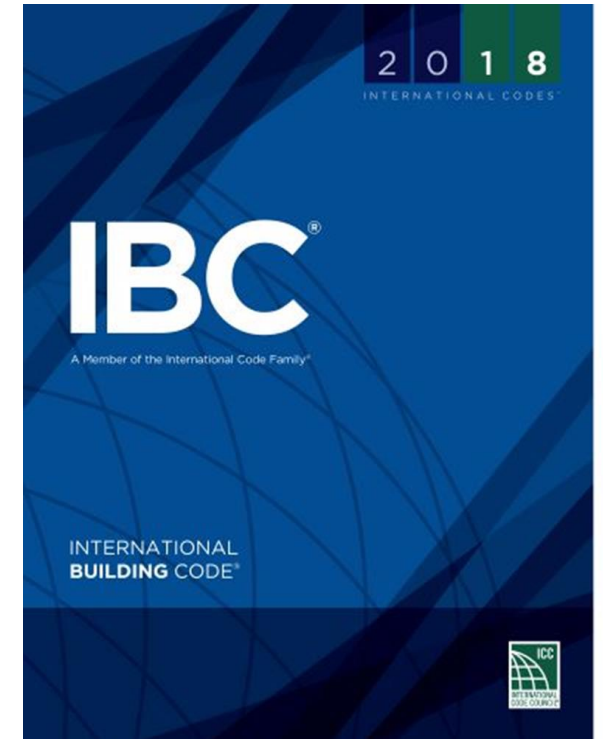
IBC for  
Multifamily

Design  
Principles

Application

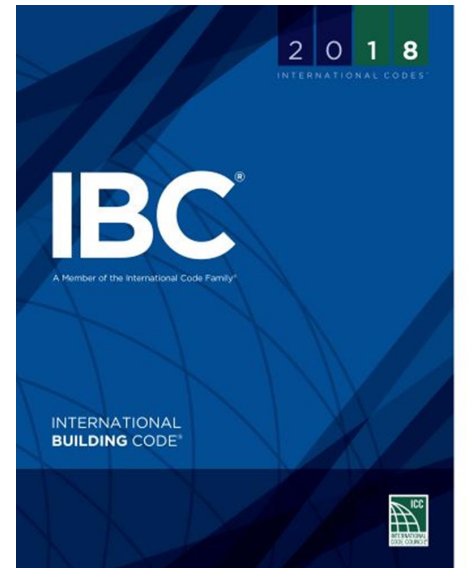
# Chapter 12 – Interior Environment

- Section 1206 – Sound Transmission
  - 1206.1 Scope.
  - 1206.2 Airborne sound.
    - 1206.2.1 Masonry.
  - 1206.3 Structure-borne sound.



# 1206.1 Scope

- This section shall apply to common interior walls, partitions and floor/ceiling assemblies between adjacent *dwelling units* and *sleeping units* or between *dwelling units* and *sleeping units* and adjacent public areas such as halls, corridor, stairways or service areas.



IBC®

A Member of the International Code Family™

INTERNATIONAL  
BUILDING CODE™

# 1206.2 Airborne Sound

- Walls, partitions and floor-ceiling assemblies separating *dwelling units* and *sleeping units* from each other or from public or service areas shall have a sound transmission class of not less than 50, or not less than 45 if field tested, for airborne noise where tested in accordance with ASTM E90. Alternatively, the sound transmission class of walls, partitions and floor-ceiling assemblies shall be established by engineering analysis based on a comparison of walls, partitions and floor-ceiling assemblies have sound transmission class ratings as determined by the test procedures set forth in ASTM E90. Penetrations or openings in construction assemblies for piping; electrical devices; recessed cabinets; bathtubs; soffits; or heating, ventilating or exhaust ducts shall be sealed, lined, insulated or otherwise treated to maintain the required ratings. This requirement shall not applied to entrance doors; however, such doors shall be tight fitting to the frame and sill.

**IBC**<sup>®</sup>

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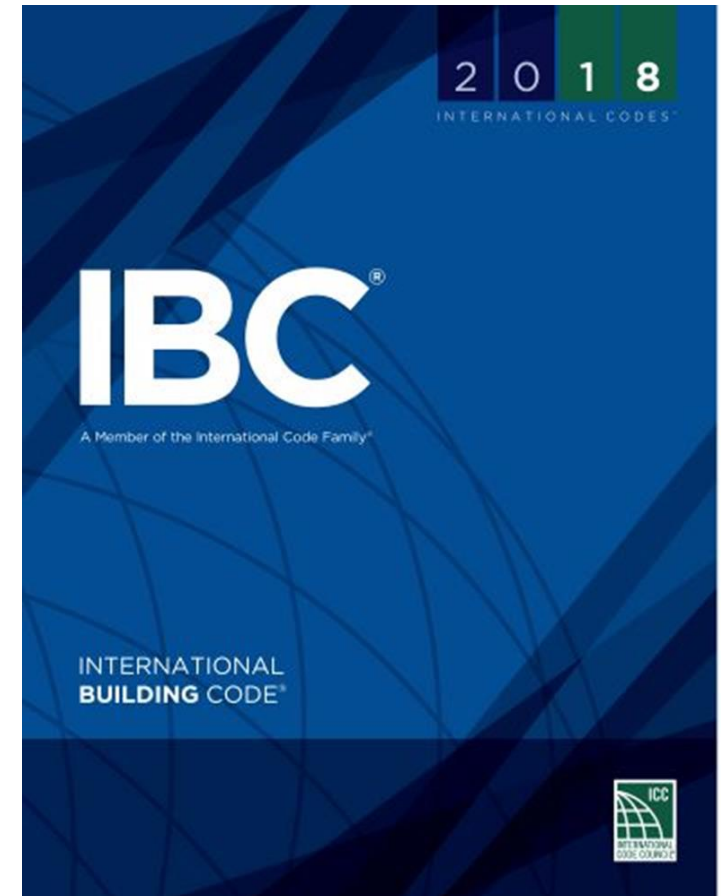
INTERNATIONAL  
**BUILDING CODE**<sup>®</sup>

## 1206.2.1 Masonry

- The sound transmission class of concrete masonry and clay masonry assemblies shall be calculated in accordance with TMS 0302 or determined through testing in accordance with ASTM E90.

# 1206.3 Structure-borne sound.

- Floor-ceiling assemblies between *dwelling units* and *sleeping units* or between a *dwelling unit* or *sleeping unit* and a public or service area within the structure shall have an impact insulation class rating of not less than 50, or not less than 45 if field tested, where tested in accordance with ASTM E492. Alternatively, the impact insulation class of floor-ceiling assemblies shall be established by engineering analysis based on a comparison of floor-ceiling assemblies having impact insulation class ratings as determined by the test procedures in ASTM E492.



| Agency | Unit Types  | STC<br>(lab) | ASTC<br>(field) | IIC<br>(lab) | AIIC<br>(field) |
|--------|---|--------------|-----------------|--------------|-----------------|
| IBC    | Between Dwelling or Sleeping Units, Corridors, or Common Spaces | 50           | 45              | 50           | 45              |

Terminology

Code

IBC for  
Multifamily

Design  
Principles

Application



# To increase STC.....

- Add mass
- Add air space
- Add resiliency

**Resiliency?!?!?!?**

# Design Principles

- One cost effective way to add STC and IIC points to a wall or floor/ceiling system is through the use of

## Resilient Channel

- Cost effective, but...
- **NOT SO SIMPLE...**
- (This really needs much more time...)

# Resilient Channel

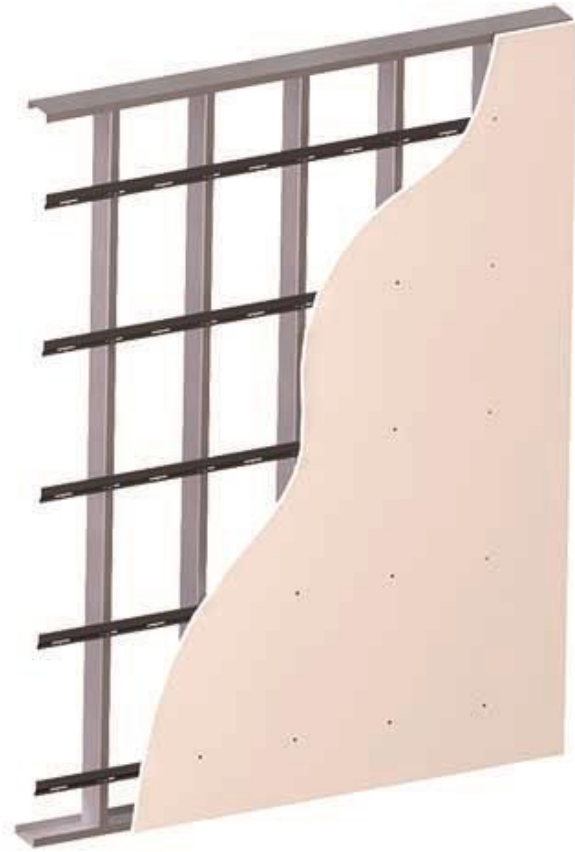
**Single Legged, RC-1  
(Dietrich RC Deluxe)**



**Double Legged, RC-2**

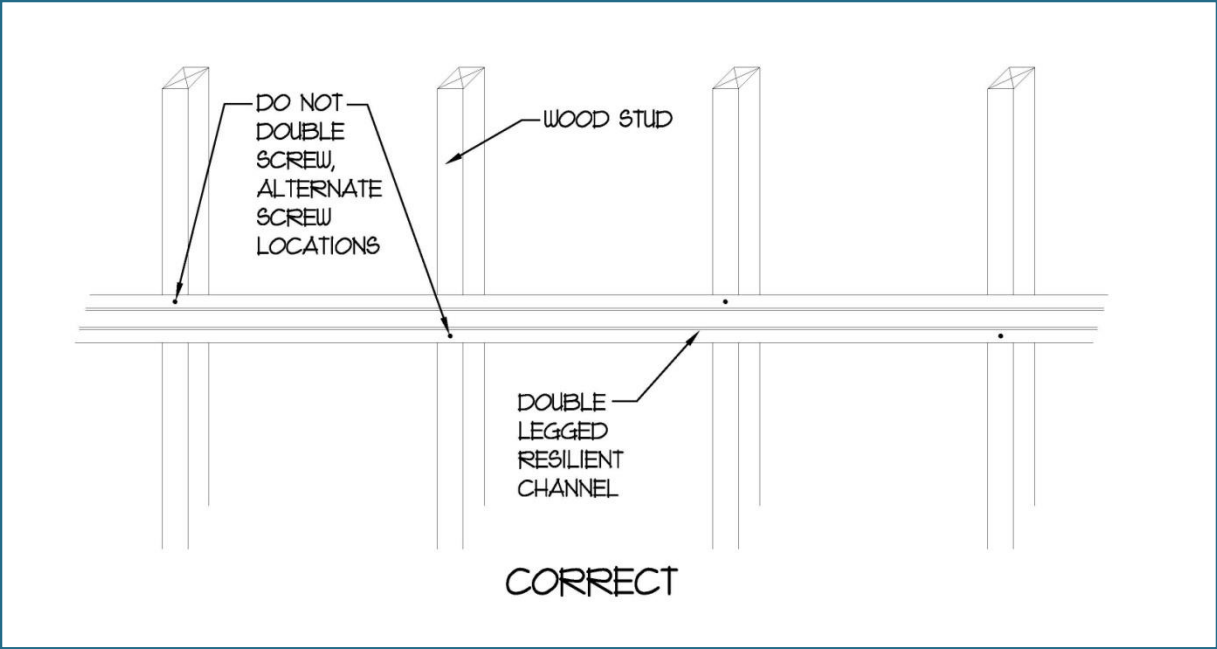
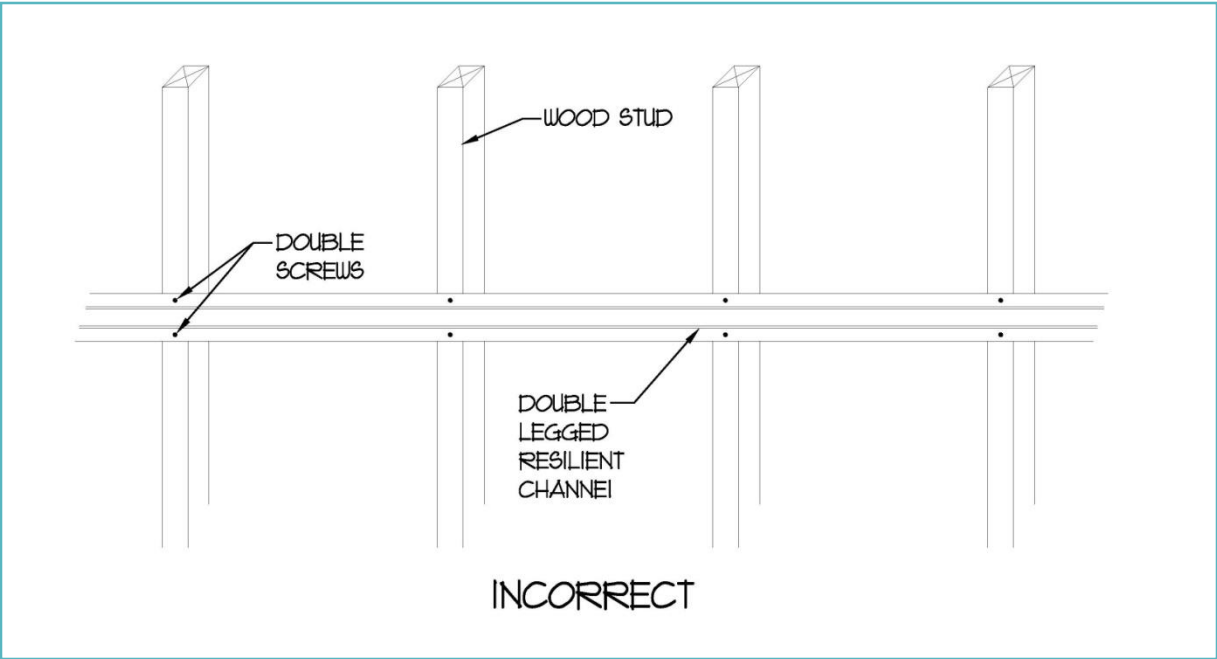


# Resilient Channel



Works in floor/ceilings too...

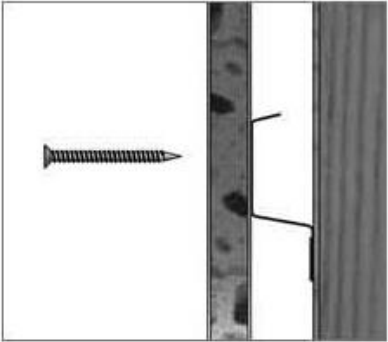
With  
The  
Double  
Legged...



# Resilient Channel – Yes!

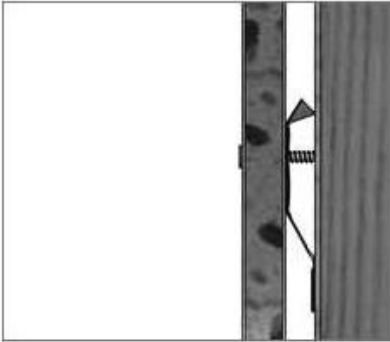


# The #1 Problem with RC



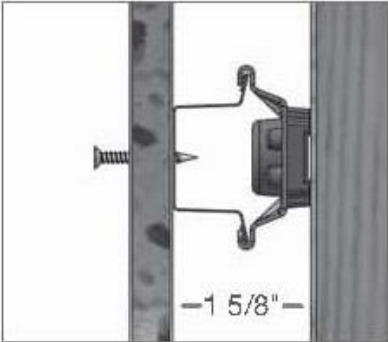
**Resilient Channel**

- Resilient channel is commonly short circuited



**Resilient Channel Crushed**

VS.



**GENIECLIP™**

- GENIECLIP™ is impossible to short circuit

Courtesy of Pliteq Inc.

# Resilient Channel – NO's!



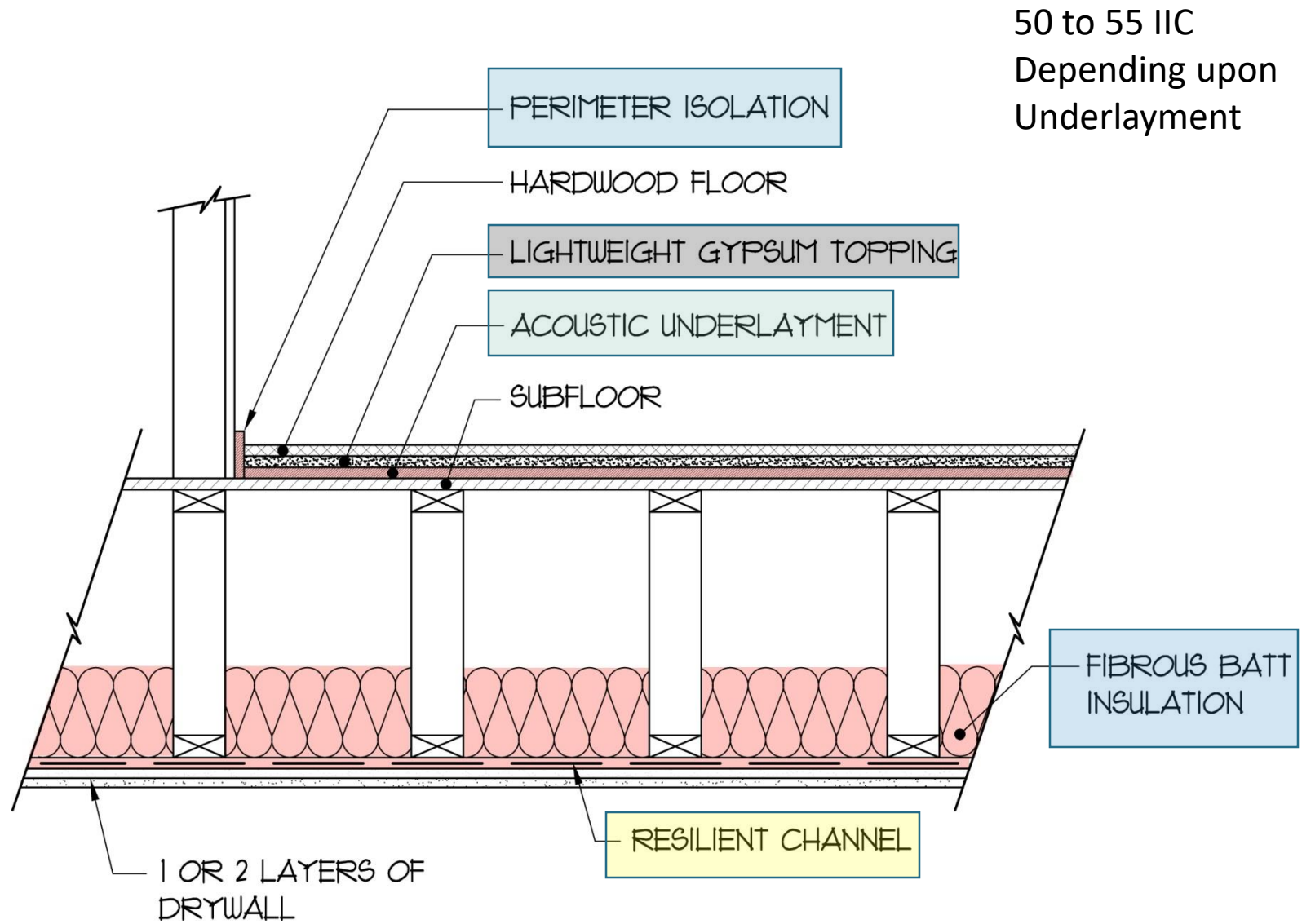


# Design Principles

- The popularity of hard surfaced floors in multifamily buildings has brought a lot of attention to IIC ratings.
  - Most Any Carpet and pad > 60 IIC
  - Hard floors < 40 IIC
- But Remember...
  - IBC standard is 50 IIC

“The best method of noise control is at the source.”

- No where does this rule apply more than for footfall (i.e. structure borne) noise.



# Underlayments: Choose Wisely!

- There are numerous underlayments on the market
- Many are copies of originals
- Make sure there is a test from a third party laboratory
- Make sure the test is of your system

# So you go on line to buy some underlayment...

**FloorMuffler Flooring Underlayment Acoustical and Moisture Barrier for Wood and Laminate with Self Sealing Overlap System 100sf**  
by FloorMuffler  
★★★★☆ 23 customer reviews | 16 answered questions

Note: This item is only available from third-party sellers (see all offers).

- The highest rated and most effective acoustic barrier on the market.
- Most Effective underlayment for reducing foot fall noise. IIC74/STC73
- Ideal choice for most laminate, engineered and solid hardwood flooring applications.

- Light, strong and flexible, making it easy to handle and install in nearly all conditions.
- Mold and mildew resistant.

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[Report incorrect product information.](#)

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Plasticover Floor Protection Film, Temporary Adhesive Plastic, Blue,...

★★★★☆ 21  
\$61.69

Ad feedback

No, No, No...

**Get documentation!**

Order

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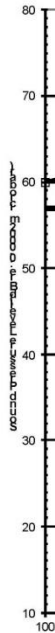
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**REMARKS**

1. Ambient Temperature: 69° F
2. Relative Humidity: 30%

**CONCLUSION**

The test method employed for this test has no pass-fail criteria; therefore, the evaluation of the test results is left to the discretion of the client.

Date of Test: February 27, 2015

Report Approved By:

*Brian Cyr*

Brian Cyr  
Engineer  
Acoustical Testing

Report Reviewed By:

*James R. Kline*

James R. Kline  
Engineer/Quality Supervisor  
Acoustical Testing

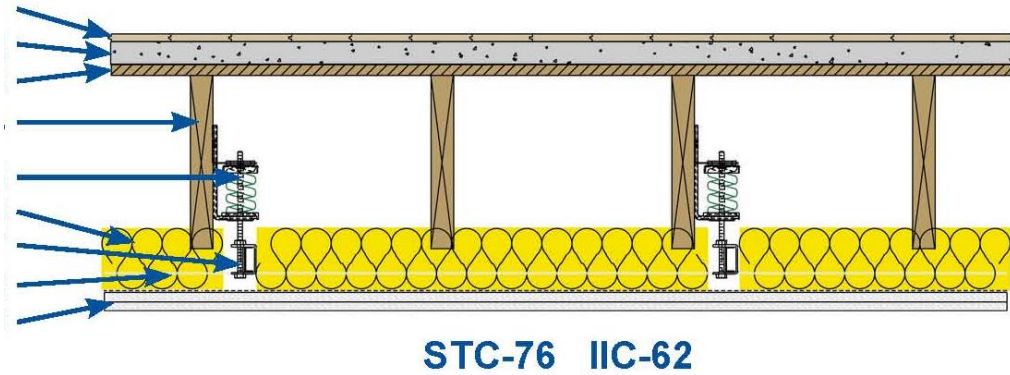
Attachments: None

# Underlayments: Choose Wisely!

- Make sure the test is of **your system!**



For Very High STC & IIC in Floor Ceiling...



This is what's required for retrofits when the IIC fails!!!!



Terminology

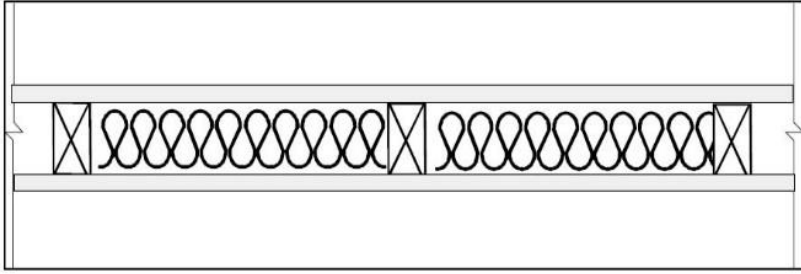
Code

IBC for  
Multifamily

Design  
Principles

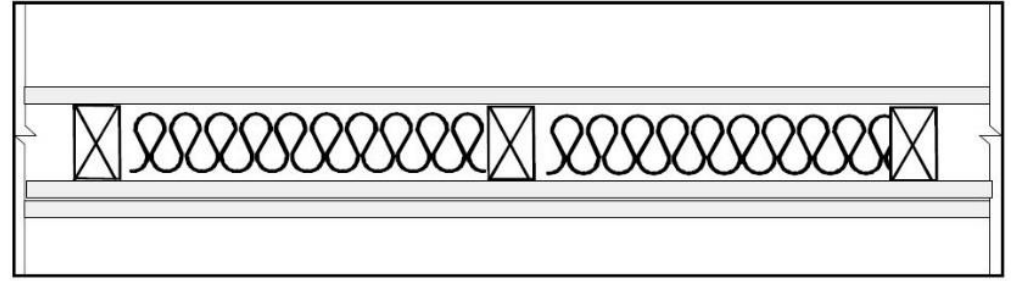
Application

G16\_WS90(406)\_MFB90\_G16



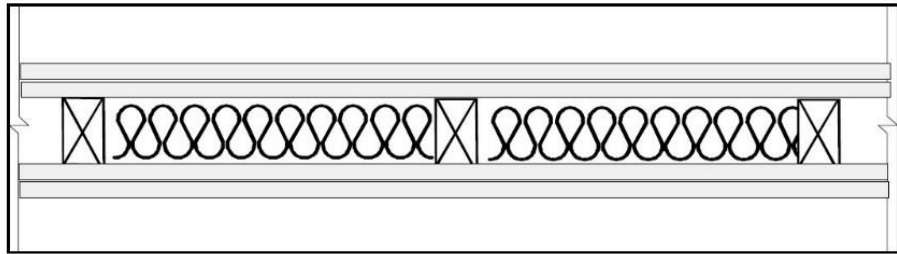
34 STC

G16\_WS90(406)\_MFB90\_2G16



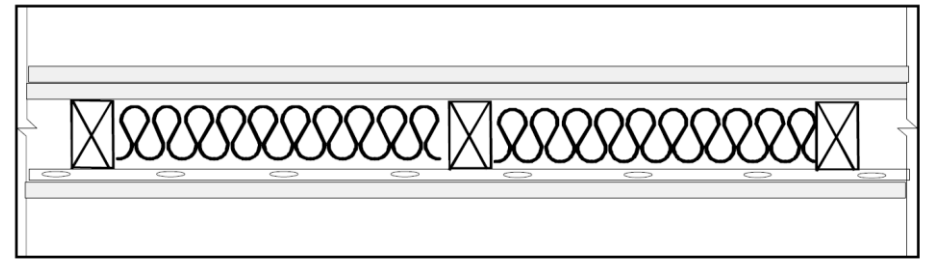
36 STC

2G13\_WS90(406)\_CFL90\_2G13



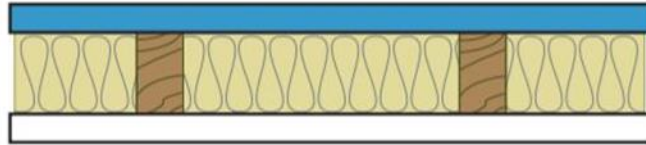
38 STC

2G16\_WS90(406)\_GFB90\_RC13(610)\_G16



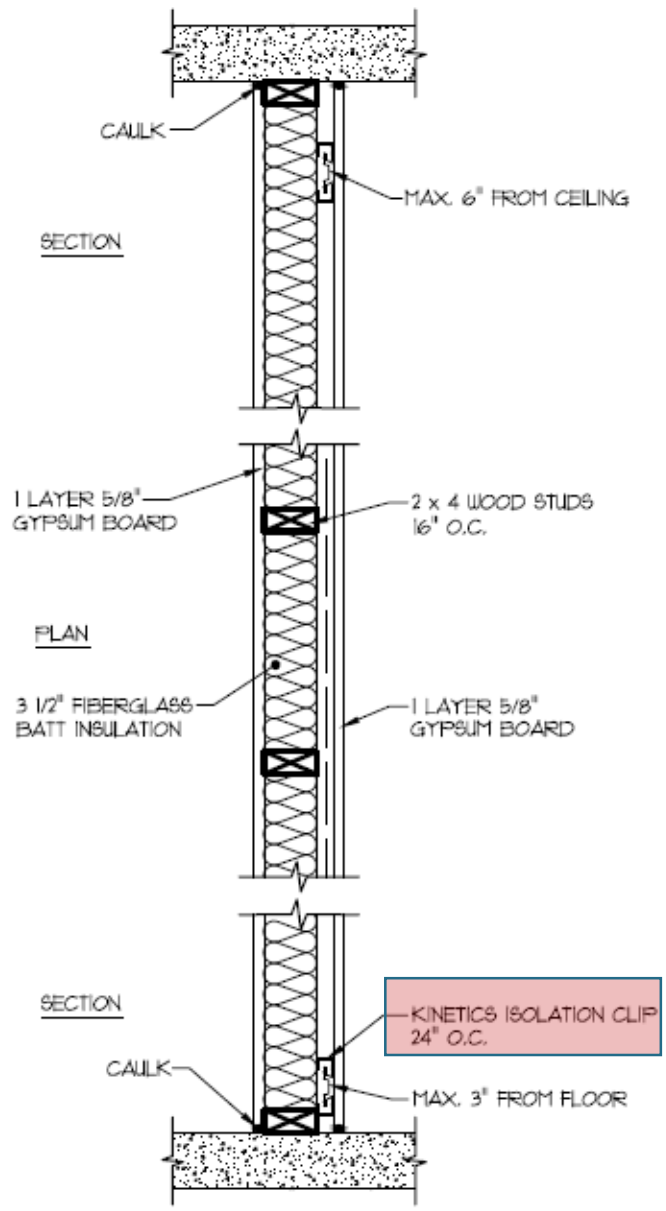
53 STC

Single 2x4 wood studs, 24" OC - **STC 51**

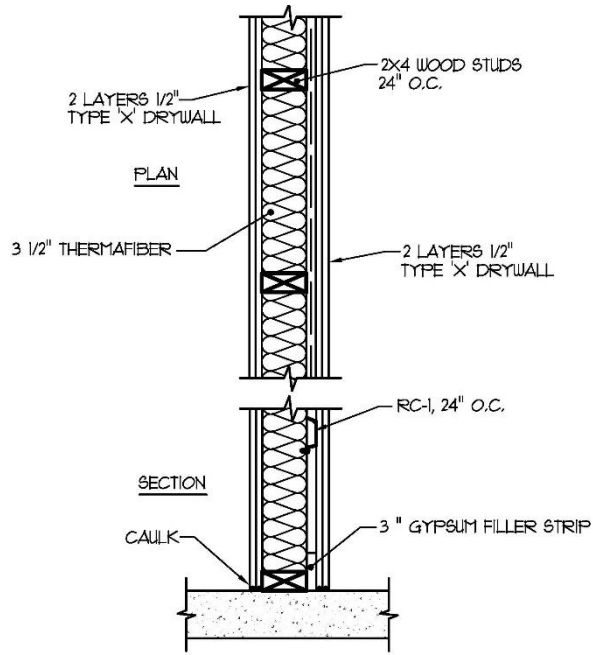


QuietRock® on one side,  
Type X on the other

---

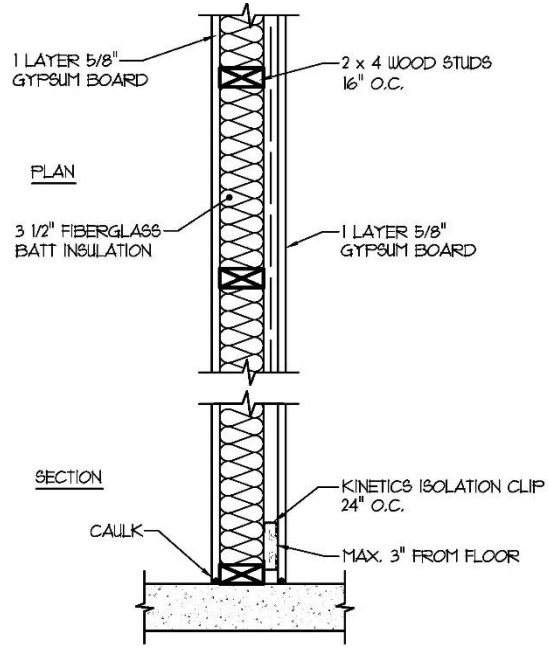



**PARTITION DETAIL (STC 57)**  
 SCALE: 1/2" = 1'-0"



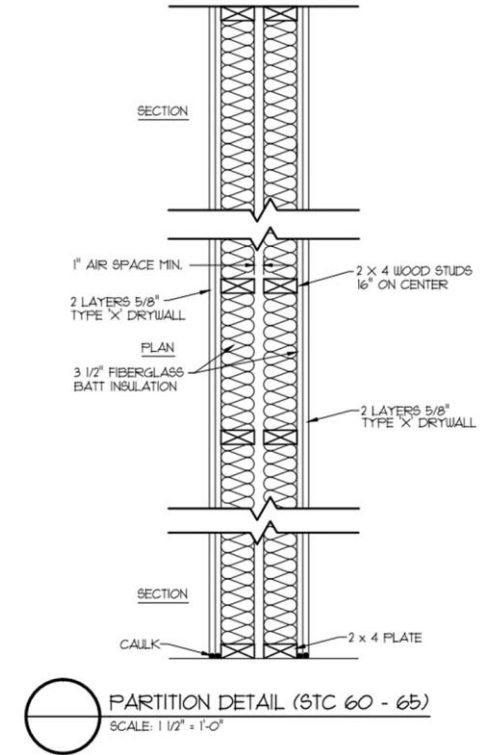
PARTITION DETAIL (STC 56)  
SCALE: 1 1/2" = 1'-0"

Resilient Channel  
STC 56



PARTITION DETAIL (STC 57)  
SCALE: 1 1/2" = 1'-0"

Rubber Clips  
STC 57

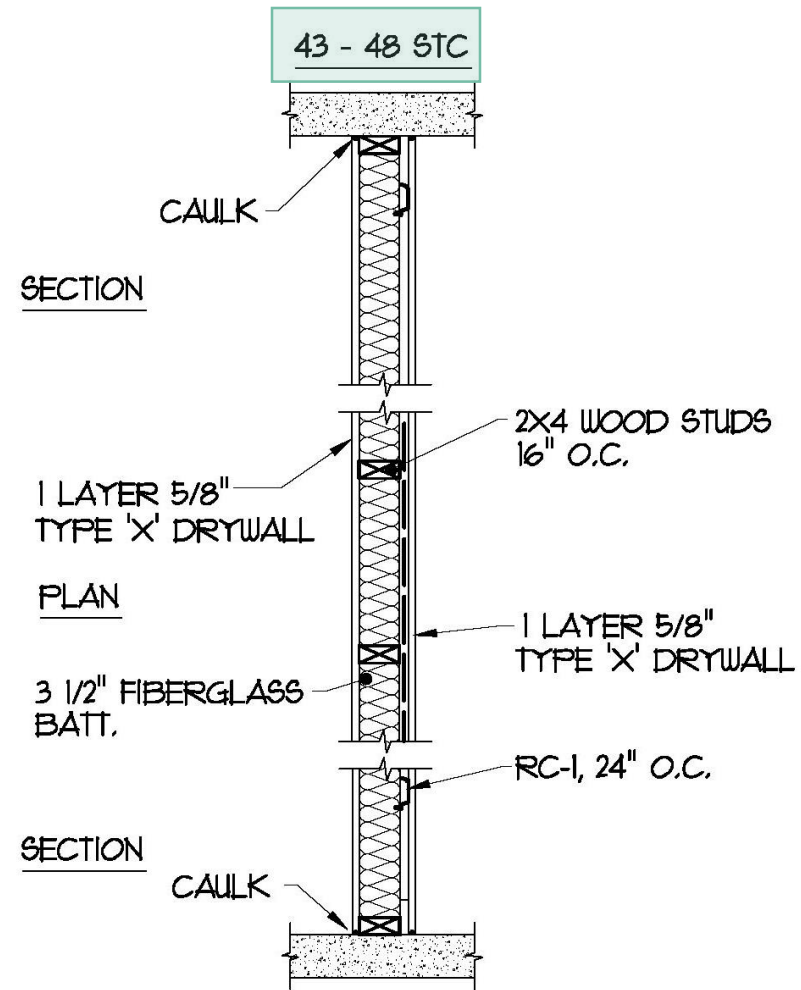
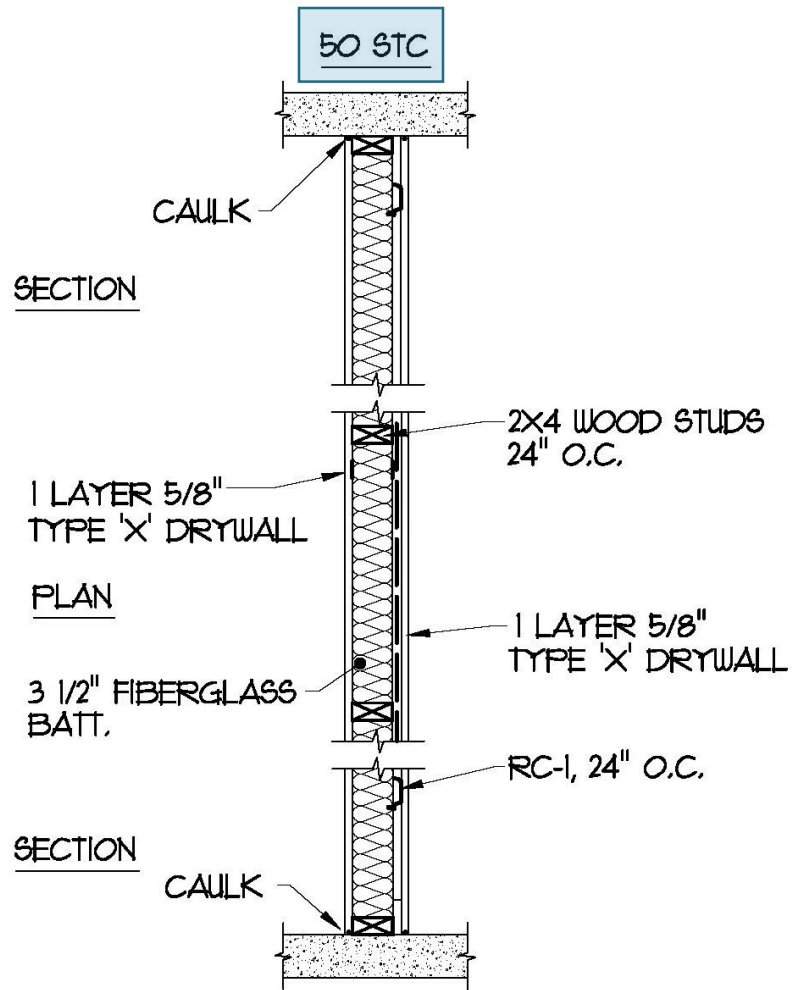


PARTITION DETAIL (STC 60 - 65)  
SCALE: 1 1/2" = 1'-0"

Double studs with air gap  
STC 60-65

# Quiz: What's the Difference?

- Insert

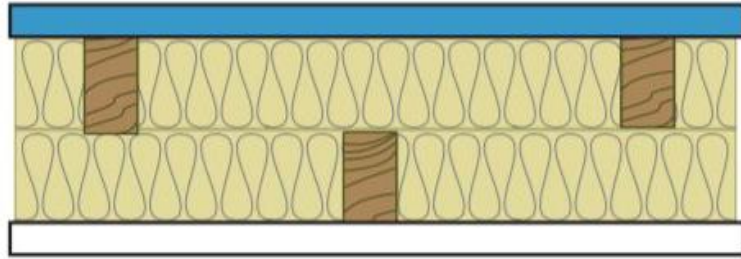


# Stud Spacing

- Stud spacing clearly affects the STC and IIC of the overall partition.
- Generally, the larger the stud spacing, the better the ratings.
- This applies to resilient channel as well.
- In order to achieve the stated rating, the stud or resilient channel spacing must be true to the tested specimen!

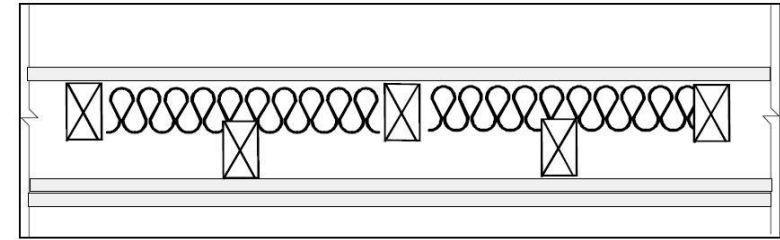


Staggered 2x4 wood studs, 8" OC - **STC 55**



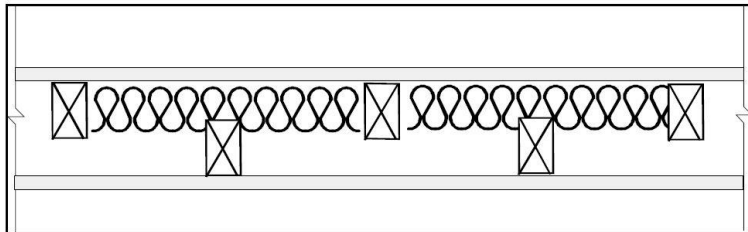
QuietRock® on one side  
Type X on the other

G13\_SWS140(406)\_GFB65\_GFB65\_2G13



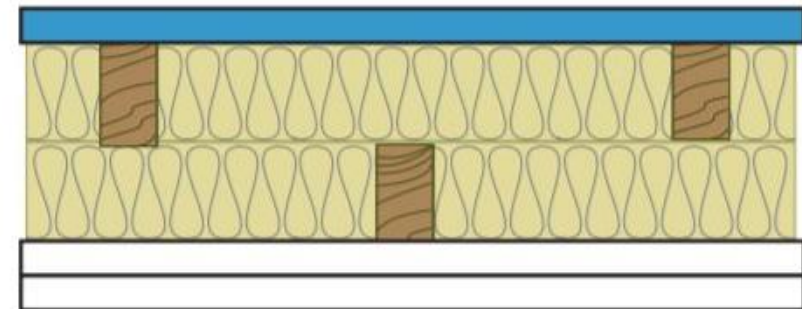
54 STC

G13\_SWS140(406)\_GFB65\_GFB65\_G13



50 STC

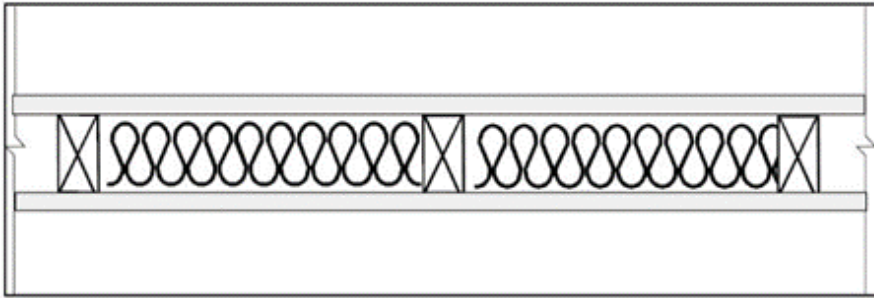
Staggered 2x4 wood studs, 8" OC - **STC 60**



QuietRock® on one side  
2 layers 5/8" Type X on the other

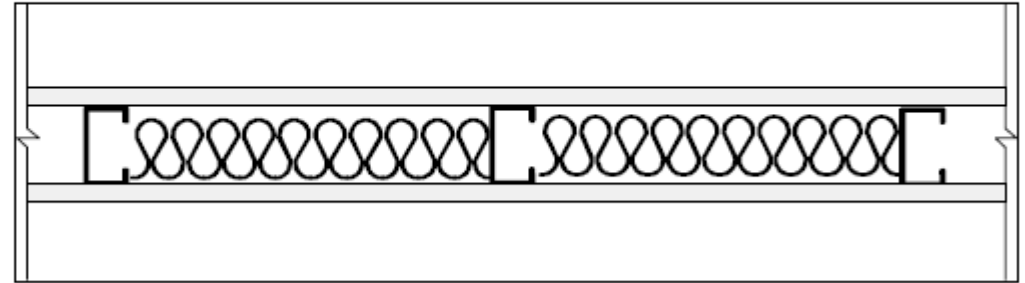
# Beware of Wood vs. Steel!

G16\_WS90(406)\_MFB90\_G16



34 STC

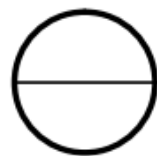
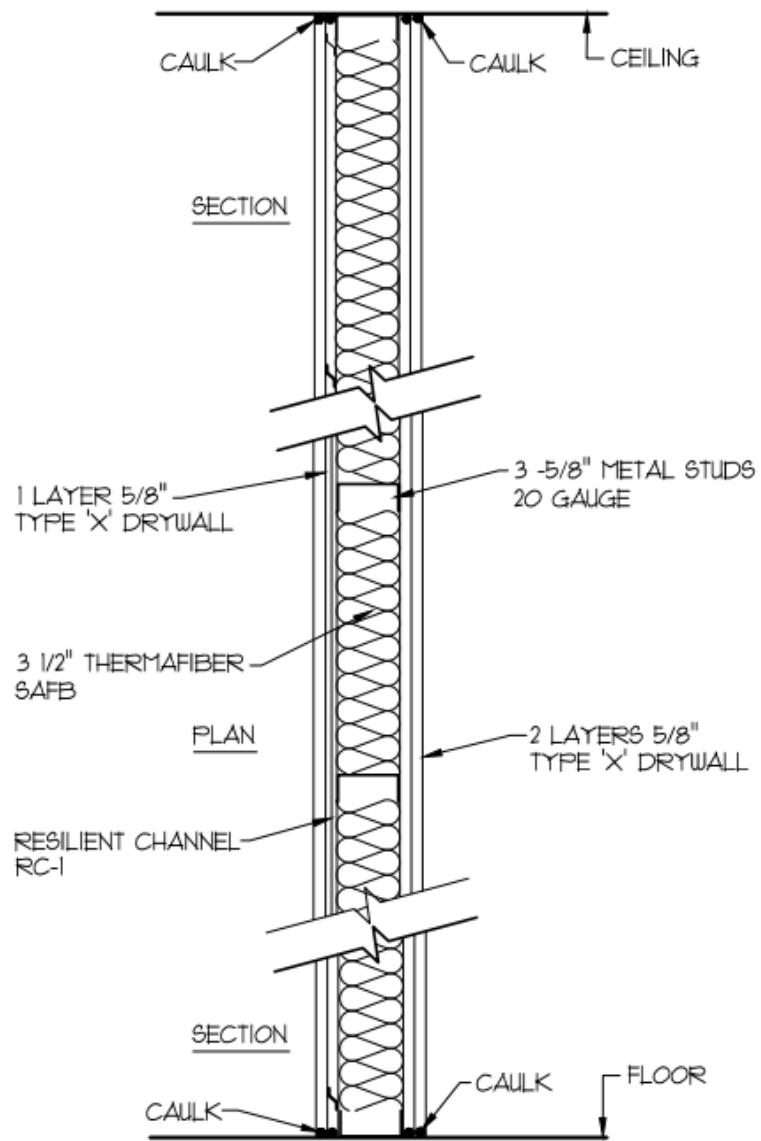
13\_SS90(406)\_GFB90\_G13



42 STC

# Steel Studs

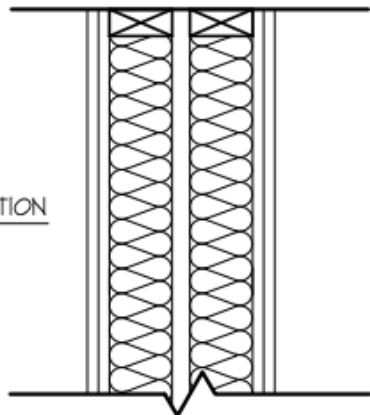
- The flexibility of the steel studs (light, 25 gauge only) provides resiliency similar to that of resilient channel.
- Don't bother with resilient channel on light gauge studs. **No benefit.**
- Do use resilient channel on heavy gauge studs, when necessary.



PARTITION DETAIL (STC 55)

SCALE: 1 1/2" = 1'-0"

SECTION



1" AIR SPACE MIN.

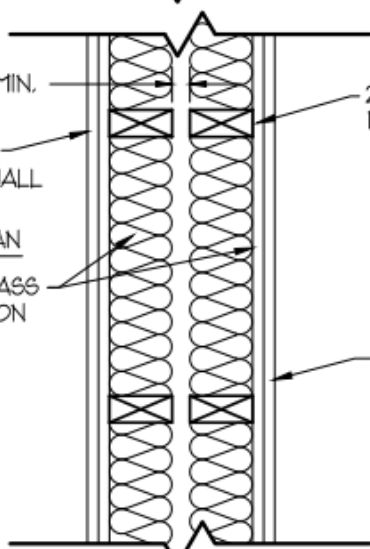
2 LAYERS 5/8" TYPE 'X' DRYWALL

3 1/2" FIBERGLASS BATT INSULATION

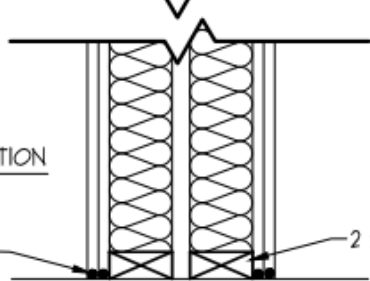
2 X 4 WOOD STUDS 16" ON CENTER

2 LAYERS 5/8" TYPE 'X' DRYWALL

PLAN



SECTION

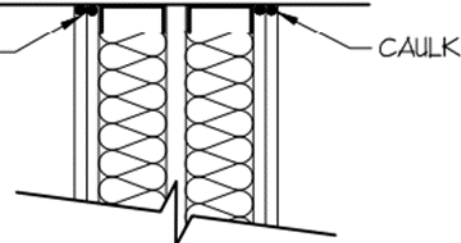


CAULK

2 x 4 PLATE



SECTION



1" AIR SPACE MIN.

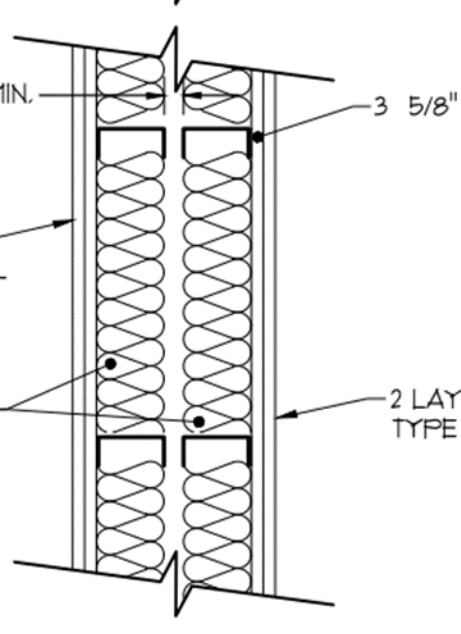
2 LAYERS 5/8" TYPE 'X' DRYWALL

3 1/2" FIBERGLASS BATT INSULATION

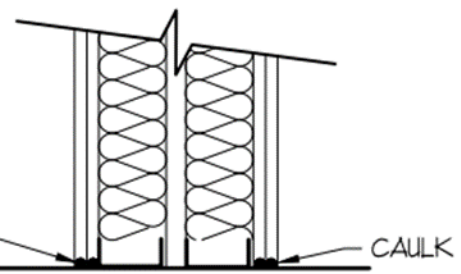
3 5/8" METAL STUDS

2 LAYERS 5/8" TYPE 'X' DRYWALL

PLAN



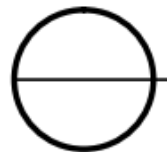
SECTION



CAULK

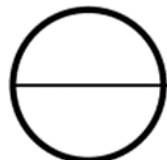
CAULK

60-65 STC



PARTITION DETAIL (STC 60 - 65)

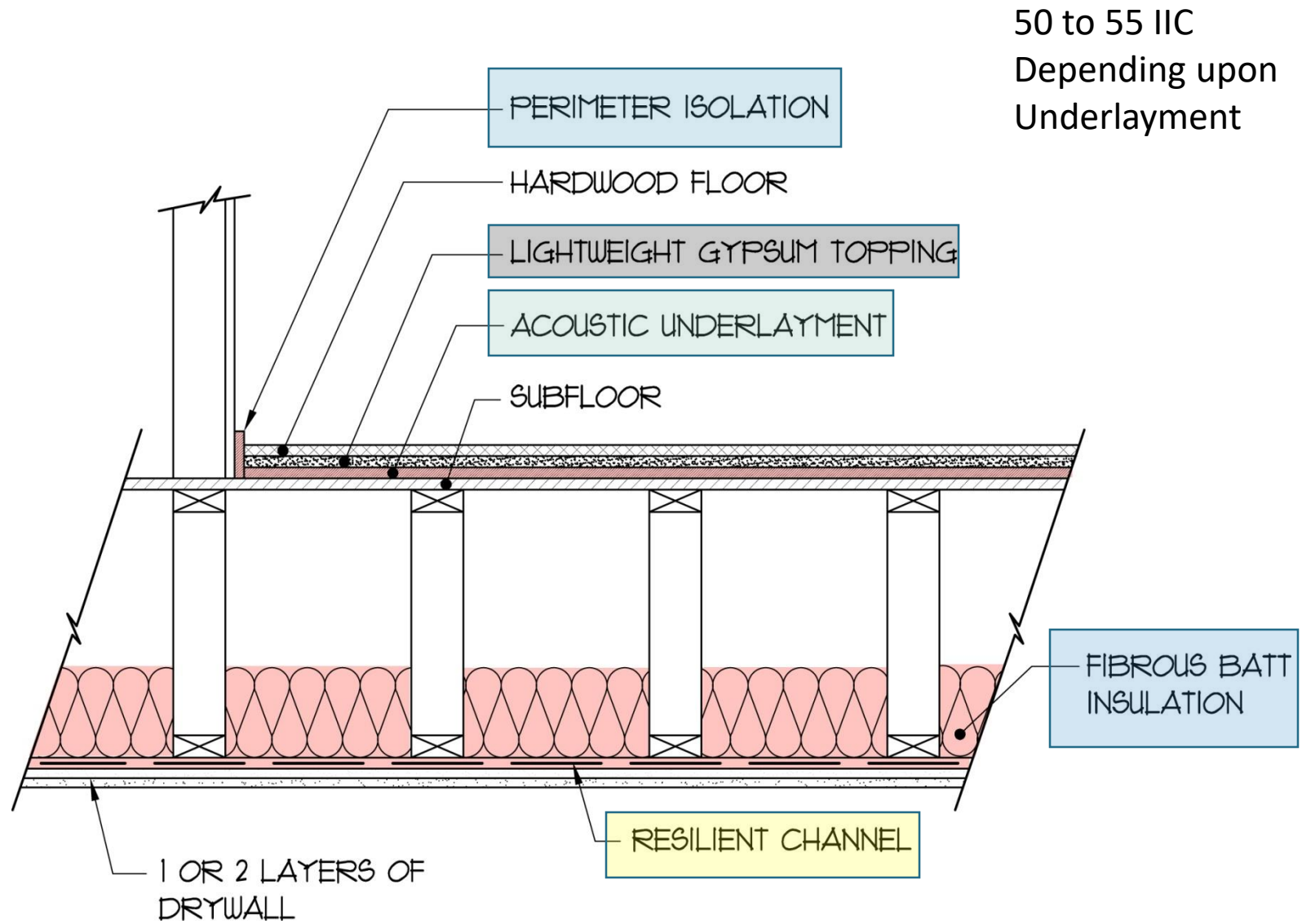
SCALE: 1/2" = 1'-0"


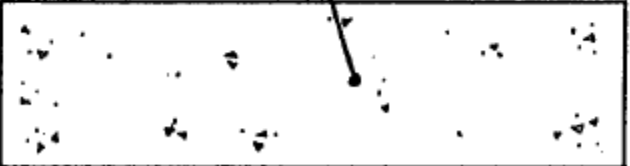


PARTITION DETAIL (STC 60 - 65)

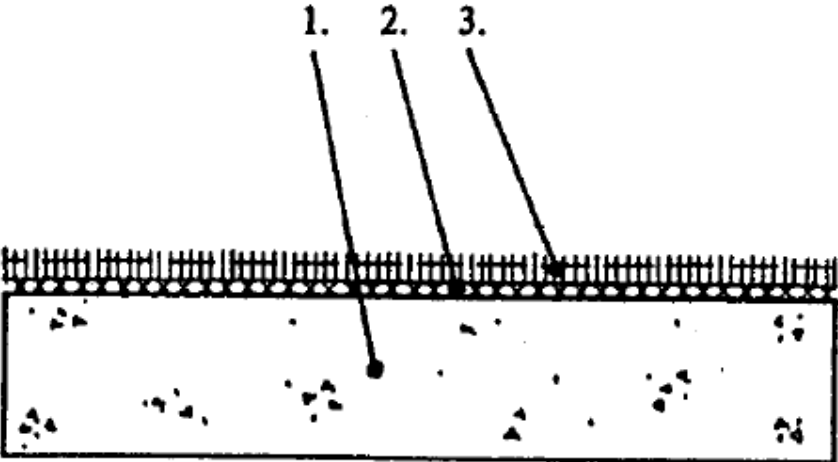
SCALE: 1/2" = 1'-0"

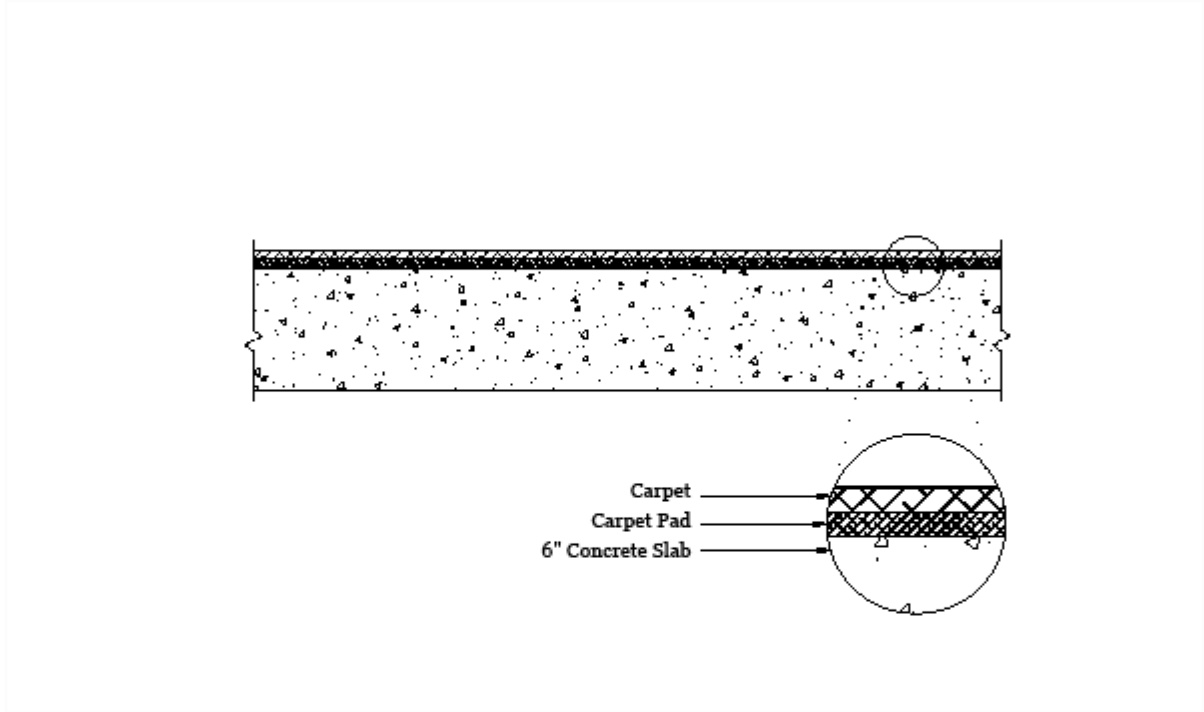
OK, but what about IIC?



| Sketch   | Brief Description                         | ...        | Laboratory Test Number<br>Year<br>Frequencies Tested<br>Source of Data                         | STC                 | Section Number     |
|--|---|------------|--|---------------------|--------------------|
| <p>1.</p>    | <p>1. 6" thick concrete slab, 75 psf.</p> | <p>...</p> | <p>Riverbank Acoustical Labs.<br/>NA<br/>NA<br/>16f<br/>Prestressed Concrete Inst.</p>         | <p>55</p> <p>34</p> | <p>2.3.2.1.1.1</p> |
| <p>1.</p>  | <p>1. 8" thick concrete slab, 95 psf.</p> | <p>...</p> | <p>Riverbank Acoustical Labs.<br/>TL 76-77<br/>1977<br/>16f<br/>Prestressed Concrete Inst.</p> | <p>58</p> <p>NA</p> | <p>2.3.2.1.1.2</p> |



| Sketch  | Brief Description   | ... | Laboratory<br>Test Number<br>Year<br>Frequencies Tested<br>Source of Data | STC | Section<br>Number |
|---|---|-----|---|-----|-------------------|
|  | <ol style="list-style-type: none"> <li>1. 6" thick concrete slab.</li> <li>2. 1/2" wood-fiber board glued to concrete.</li> <li>3. 44 oz. carpet on 40 oz. hair pad.</li> </ol> | ... | Kodaras Acoustical<br>Labs.<br>1351-9-72<br>1972<br>16f<br>Homasote Co.   | NA  | 2.3.2.1.2.1       |
|   |   |     |   | 81  |                   |

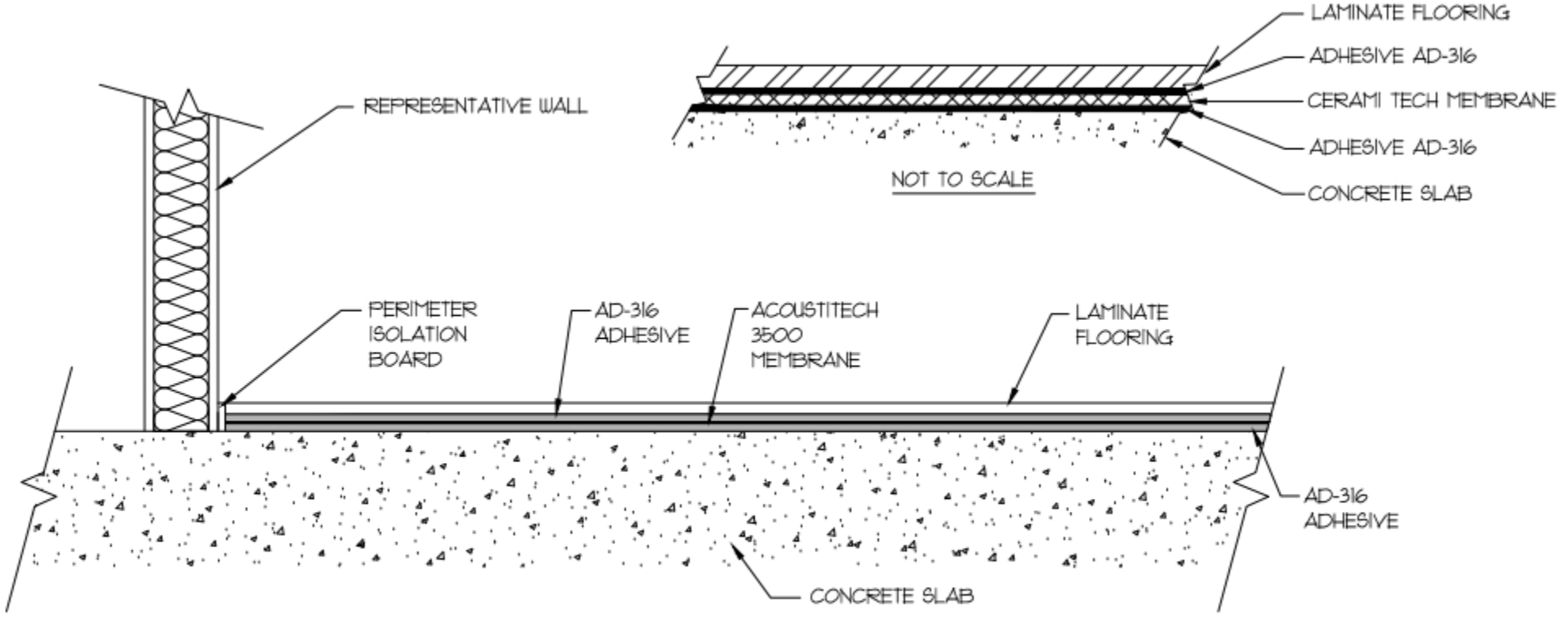


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**GENERAL NOTES:**  
 The information provided in this drawing is accurate to the best of our knowledge at the time of printing. However, we reserve the right to make changes when necessary without notification.  
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| Test Results |           |
|--------------|-----------|
| 52<br>STC    | 84<br>IIC |

|                                     |           |
|-------------------------------------|-----------|
| PROJECT: GenieMat® Concrete Slab 6" |           |
| TEST NO: g2953.14-113-11-10         |           |
| DRAWN BY: NW                        |           |
| DATE: 2017-06-05                    | DWG. NO.: |
| SCALE: N/A                          | CSS-01    |




**LAMINATE FLOOR UNDERLAYMENT (50 IIC)**  
 SCALE: 1-1/2" = 1'-0"

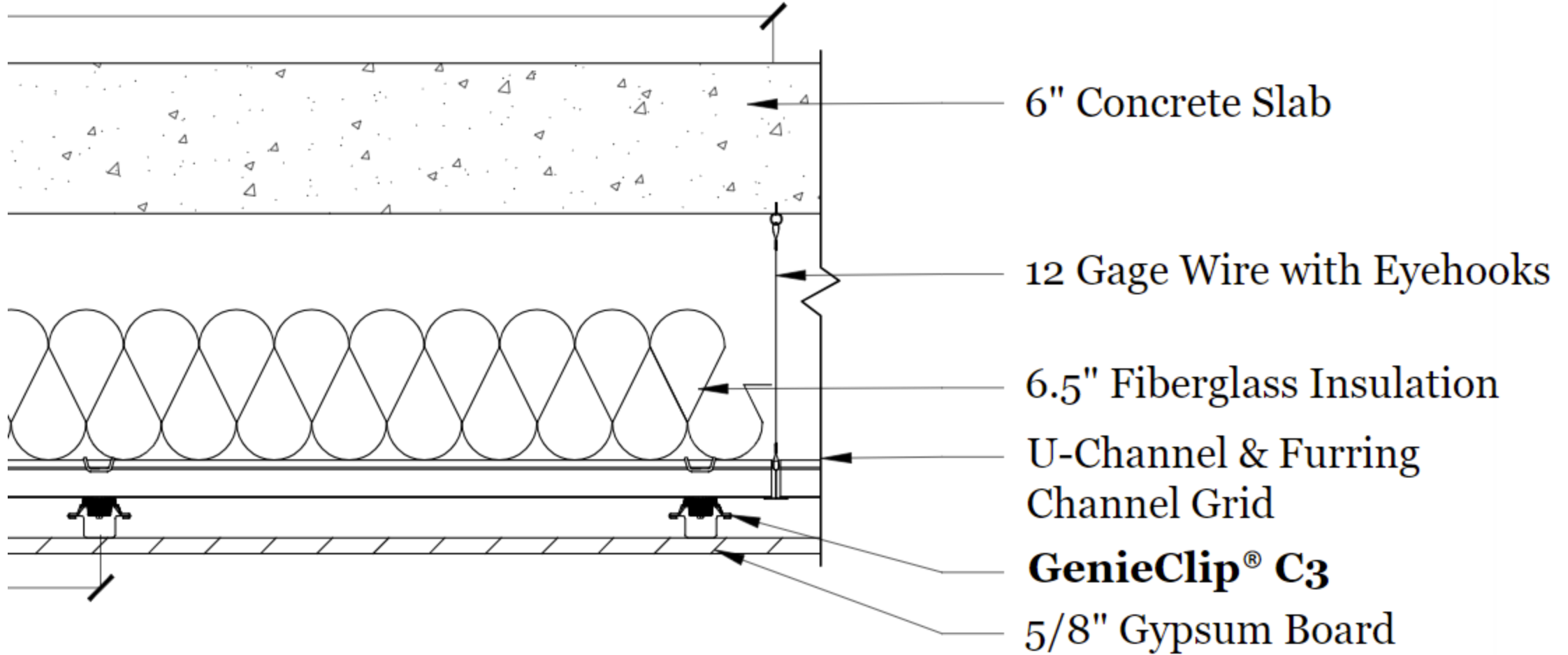
Can I treat concrete from below?

# Yes, but you have to give up head room...



| <u>STC</u> | <u>IIC</u> | <u>Sections</u>  |
|------------|------------|--|
| 53         | 27         | A cross-section diagram of a concrete slab, showing a uniform grey material with small black specks.                                     |
| 66         | 44         | A cross-section diagram of a concrete slab with a yellow layer at the bottom. The yellow layer contains small blue rectangular elements. |
| 63         | 50         | A cross-section diagram of a concrete slab with a yellow layer at the bottom. The yellow layer contains green circular elements.         |

48" Max OC



# Underlayment Market

- Very dynamic at this point
- New products coming out almost daily
- Items like Enhanced Vinyl Plank achieve IIC on concrete slabs in excess of 50 without need for underlayment.
- **Buyer beware...**



Needs summary of top 10 things or something....



Terminology

Code

IBC for  
Multifamily

Design  
Principles

Application

# Questions?

This concludes The American  
Institute of Architects Continuing  
Education Systems Course



**Scott Harvey, PE, INCE Bd. Cert.**

Phoenix Noise & Vibration

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