

**Pei Evaluation Service®** is an accredited ISO Standard 17065 Product Certifier, accredited by the IAS. This **Assembly Evaluation Report** represents a system that **Pei ES** has Evaluated. This **Assembly Evaluation Report** in no way implies warranty for these products or relieves **United States Gypsum Company** or **FrameCAD America, Inc.** of their liabilities for their products and this assembly. This **AER** is an official document if it is within one year of the Initial or Re-Approval date.

**Initial Approval**  
October, 2018

**Re-Approved**

See all **Pei ES** Listings at: [www.p-e-i.com](http://www.p-e-i.com)

**Report Owner**

**United States Gypsum Company**

550 West Adams Street  
Chicago, IL 60661

**Approved Report Listee**

**FRAMECAD America, Inc.**

3603 McLean Ave.  
Fairfax, VA 22030

Contact: 1-888-8209-3182

**Approved Assembly**

**Floor Diaphragm Assembly**

**Assembly Evaluated For**

1. Horizontal Floor Diaphragm Resistance 2. Fire Resistance 3. Acoustical Performance

**Code Compliance**

<p><b>2015 International Residential Code® (IRC)</b> Section R104.11 Section R301.1.3 Section R302 Appendix K</p>	<p><b>2015 International Building Code® (IBC)</b> Section 703 Section 1207 Section 1607.3 &amp; 1607.4</p>
<p><b>2018 International Residential Code® (IRC)</b> Section R104.11 Section R301.1.3 Section R302</p>	<p><b>2018 International Building Code® (IBC)</b> Section 1206 Section 703 Section 1607.3 &amp; 1607.4</p>

**Report Parameters**

The purpose of this Assembly Evaluation report is to provide Horizontal Floor Diaphragm Resistance, Fire Resistance and Acoustical Performance for the described Floor Diaphragm Assembly using USG Structural Panels Concrete Subfloor and FRAMECAD Steel floor trusses that each carry an Evaluation Product Report for their approved uses.

**Floor Diaphragm Components**

**Floor Sheathing**

USG Structural Panel Concrete Subfloor is a non-combustible concrete sheathing panel used in conjunction with cold-formed steel truss framing to form a load bearing structural floor. USG Structural Panel Concrete Subfloor is a nominal 3/4" [19mm] thick x 4' [1220mm] wide x 8' [2440mm] long. The panels have a Tongue and Groove edge along the 8' [2440mm] sides. See PEI-ES report PER-13067 for all physical and mechanical properties.

**Steel Floor Trusses**

The steel floor trusses are designed from the FRAMECAD Licensing components system. The truss component shapes are formed from 18ga. x 50ksi steel. The minimum truss width is 3-5/8" and the depth is 12" and spaced a maximum of 24" o.c. This report does not address the truss construction or span design. See ICC-ES report ESR-2361 for more details.

**Sheathing Fasteners**

Grabber Construction Products, Inc. #8 x 1-5/8" lg. winged self-drilling screw, part number CGH8158LG. A minimum measured head diameter of .36" with a tested pull-through capacity of 581 lbs. in the USG Structural Panel Concrete Subfloor. The screw has an exterior grade coating.

**Resilient Channel**

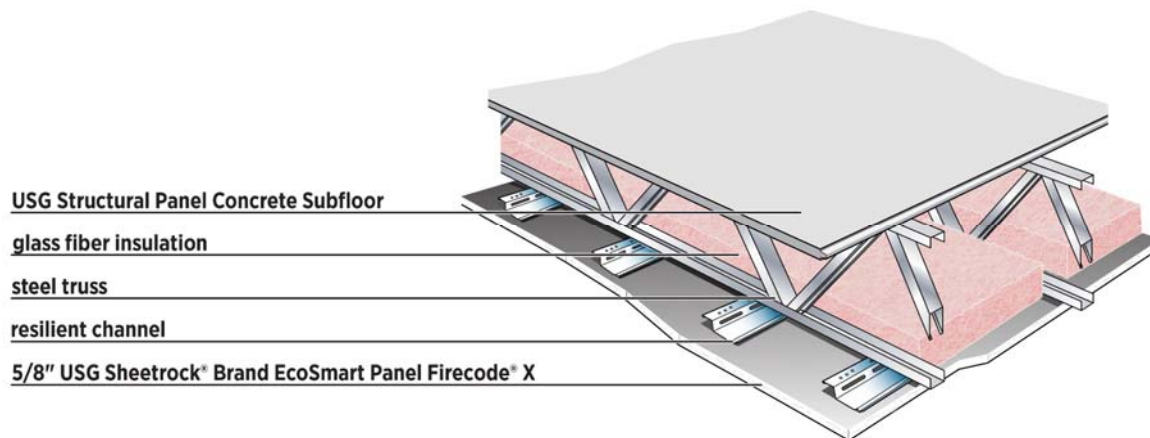
25 ga. "Z" shaped steel spaced 12" o.c. fastened to steel trusses with (1) #8 screw per truss. The channel is overlapped 4" at splices. See Figure 3.

**Batten Insulation**

Unfaced Owens Corning ProPink R-11 fiberglass insulation laid between the trusses on the resilient channel. Batten size 3-1/2" tall x 21-1/2" wide with a density of .57 ls/ft<sup>3</sup>.

**Ceiling Board**

5/8" USG Sheetrock Brand Ecosmart Panels FIRECODE® X Gypsum. The joints and nails are to be finished as described in the USG installation instructions. The gypsum is attached to the channel with #8 x 1" Type S Bugle head screws at 8"o.c.



**Figure 1 - Bare Acoustic Illustration only**

*The color PINK for insulation is a registered trademark of Owens Corning. Used by permission.*

### **Standards Tested To**

- Meets or exceeds the requirements of ICC-ES AC 319 Horizontal Diaphragms Consisting of Structural Cementitious Floor Sheathing Panels Attached to Cold-formed Steel Framing—Approved June 2005, Editorially Revised January 2012.
- Meets the requirements of Table R301.7 Allowable Deflection of Structural Members for Joist Spacing of 24" [610mm] o.c. per the 2012 & 2015 IRC.
- Meets the requirements of Section R301.1.3 Engineered Design for otherwise conventional construction for buildings per the 2012 & 2015 IRC.
- Meets or exceeds the requirements of the 2012 & 2015 IBC Table 1607.1 Minimum Uniformly Distributed Live Loads and Minimum Concentrated Live Loads, when installed per manufacturer's instructions.
- Meets and exceeds the requirements of the 2015 IBC, Section 1607.4, Concentrated Live Load of 2,000 Lbs.
- Meets and exceeds the minimum STC/IIC value of 50 when tested to ASTM E90 and ASTM E492.
- Meets and exceeds the requirements of the 2017 CBC Chapter 13-120, Section 120(a)(3) Conditions of acceptance, Residual Deflection.

### **General Product Installation**

1. USG Structural Panel Concrete Subfloor is to be installed and maintained during construction following this report and the USG installation instructions. Installation instructions must be made easily available to the product installer.
2. When cutting USG Structural Panel Concrete Subfloor, safety glasses and a NIOSH approved N-95 dust mask should be worn at all times due to dust produced by the cutting of this product.
3. Fasteners shall be installed flush or slightly below the surface and care must be taken to not strip out in the framing. No fastener shall be installed within 1-1/4" [31.7mm] of the corner of a panel and shall not be closer than the minimum distance from panel edges indicated in this **AER**.
4. The tongue and groove joints shall be oriented perpendicular to the framing.
5. Install panels in a running bond pattern bridging a minimum of 2 framing spans. The minimum panel width, measured parallel to the framing, shall be no less than 24" [610mm].
6. Fasteners are applied as shown on the following Screw pattern A, B & C diagrams.
7. Up to a 6" [152mm] x 6" [152mm] cutout through the panels is allowed without blocking. Up to a 44" [1118mm] x 44" [1118mm] cutout is allowed with sufficient blocking around the perimeter of the opening. Larger openings shall be designed by the Engineer of record and are beyond the scope of this report.
8. USG Structural Panel Concrete Subfloor must be protected from construction abrasive wear and impact after panel installation until the floor has its final finish applied. Refer to the USG Installation Instructions.

### **Product Storage**

USG Structural Panel Concrete Subfloor shall be stored in a dry location. Placement of the palletized product must be on level firm ground or a floor capable of carrying the approximate 3,400 lb. [1545kg] pallet weight. Pallets shall not be stacked more than three high and must be stacked with direct alignment on the pallet below it. If a dry location is unavailable, cover pallets with a waterproof tarp or covering. Sub-freezing temperature may cause the panels to freeze together. Should this happen, move the panels to a warmer location to thaw out. Do not use tools or chemicals to loosen the panels as this will cause damage to the panels and will void the performance ratings described in this AER.

**Product Documentation**

1. An Assembly Evaluation Service Agreement between *Pei Evaluation Service*® and *United States Gypsum Company*
2. An Evaluation Report Listee agreement between United States Gypsum Company and FRAMECAD America Inc.
3. **USG** Structural Panel Concrete Subfloor Installation Guidelines. Guidelines must be easily available to installers.
4. Various Test Reports Used as Verification of Horizontal Floor Diaphragm Resistance, Fire Resistance and Acoustical
5. PEI ES Evaluation Report No. PER-13067
6. ICC-ES Evaluation Report No. ESR-2361

**Product Labeling**

The **USG** Structural Panel Concrete Subfloor, FRAMECAD trusses, 1/4" Fiberock Underlayment and the 5/8" **USG** Sheetrock Brand EcoSmart Panel Firecode X components must be labeled as described in their individual Product Evaluation Reports. This assembly report is only valid if these components have a current Evaluation report for this use from an accredited agency.

**Table 1: Simple Beam Diaphragm Testing**

Fastener Spacing		Fastening Details	Joint Strap Backing	S <sub>n</sub> - Nominal Shear Strength (plf)	Joint Layout	Aspect Ratio	X =
Perimeter	Field						
4" [102mm]	12" [305mm]	B, C	None	1,774 [25.8 kNm]	Staggered	2:1	<b>.272</b>
6" [152mm]		A, B		1,351 [19.7 kNm]	Staggered		
4" [102mm]		E		1,601 [23.3 kNm]	<b>Stacked</b>	2:1	<b>.280</b>
4" [102mm]		D	4" [102mm] wide x 18ga. [1.438mm] Strap Backing	2,170 [31.6 kNm]	Staggered	2:1	<b>.126</b>

**Notes:**

1. Refer to Table 1 of this **AER** for applicable diaphragm safety factors (Ω) and load resistance (φ) factors corresponding to ASD, LRFD, and/or LSD design methods.
2. Panel fasteners must be inset 1-1/4" [31.7mm] from the corners. Fastener edge distance at all panel edges must comply with distances in Table 4, as well as exception to the tongue and groove joints where the framing joists are perpendicular to the joint. The fasteners should be kept flush or slightly below the surface of the panel. At the T&G panel joints where the framing joists are perpendicular to the joint, one (1) panel fastener is required at 1" [25mm] from the panel edge.
3. Panels shall be fastened as described in note 2 with the addition of fasteners at 4" [102mm] o.c. along the metal Strap Backing on both sides of T&G joint .
4. The values shown apply to 18 ga. FrameCAD trusses using a minimum of 1-1/4" [25mm] edge distance as shown in Table 4.

**Deflection Equation for Simple Beam Diaphragm**

$$\Delta = \frac{5Vl^3}{8EAb} + \frac{Vl}{4Gt} + Xle_n$$

Where: V = Unit shear in the direction under consideration, plf

ℓ = Diaphragm length, ft.

b = Diaphragm width, ft.

E = Elastic modulus of steel rim chords, 29,500,000psi

A = Net area of steel rim chord cross section, in<sup>2</sup>

G = Shear modulus of **USG** Structural Panel Concrete Subfloor for shear, 285,714 psi

t = Effective thickness of **USG** Structural Panel Concrete Subfloor for shear, 0.73 in.

e<sub>n</sub> = Screw joint slippage at load per screw on perimeter of interior panel

$$e_n @ 0.20S_n = 0.006$$

$$e_n @ 0.40S_n = 0.016$$

$$e_n @ 0.60S_n = 0.038$$

$$e_n @ S_n = 0.151$$

X = Slip Co-efficient. See Table 2 above.

**Table 2: Cantilever Floor Diaphragm Testing**

Fastener Spacing		Fastening Details	Joint Strap Backing	S <sub>n</sub> - Nominal Shear Strength (plf)*	Joint Layout	X =
Perimeter	Field					
4" [152mm]	12"	A, B	None	996 [14.5 kN/m]	Staggered	<b>.346</b>
6" [102mm]		B, C		891 [13.0 kN/m]	Staggered	<b>.407</b>
4" [152mm]		E		1,002 [14.6 kN/m]	<b>Stacked</b>	<b>.356</b>
4" [152mm]		D	3-1/2" [102mm] wide x 18ga. [1.438mm] Strap	1,893 [27.6 kN/m]	Staggered	<b>.384</b>

**Notes:**

1. Refer to Table 1 of this **AER** for applicable diaphragm safety (Ω) and load resistance (φ) factors corresponding to ASD, LRFD, and/or LSD design methods.
2. 2 to 1 maximum Aspect Ratio
3. Panel fasteners must be inset 1-1/4" [31.7mm] from the corners. Fastener edge distance at all panel edges must comply with Table 2 distances with exception to the tongue and groove joints where the framing joists are perpendicular to the joint. The fasteners should be kept flush or slightly below the surface of the panel. At the T&G panel joints where the framing joists are perpendicular to the joint, two (2) panel fasteners are required for Pattern A and one (1) fastener for Pattern B. One fastener should be 1" [25mm] and the other 2" [51mm] from the panel edge.
4. Panels shall be fastened as described in note 3 with the addition of fasteners at 6" [152mm] o.c. along the metal Strap Backing on both sides of seam .

**Deflection Equation for Cantilever Diaphragm**

$$\Delta = \frac{5V(2l)^3}{8EAb} + \frac{V(2l)}{4Gt} + X(2l)e_n$$

Where: V = Unit shear in the direction under consideration, plf

l = Diaphragm length, ft.

b = Diaphragm width, ft.

E = Elastic modulus of steel rim chords, 29,500,000psi

A = Net area of steel rim chord cross section, in<sup>2</sup>

G = Shear modulus of **USG** Structural Panel Concrete Subfloor for shear, 285,714 psi

t = Effective thickness of **USG** Structural Panel Concrete Subfloor for shear, 0.73 in.

e<sub>n</sub> = Screw joint slippage at load per screw on perimeter of interior panel

$$e_n @ 0.20S_n = 0.006$$

$$e_n @ 0.40S_n = 0.016$$

$$e_n @ 0.60S_n = 0.038$$

$$e_n @ S_n = 0.151$$

X = Slip Co-efficient. See Table 3 above.

**Table 3: Safety Factors and Resistance Factors for Diaphragms**

Framing Type	Fastener Type	Earthquake			Wind		
		Ω (ASD)	φ (LRFD)	φ (LSD) <sup>3</sup>	Ω (ASD)	φ (LRFD)	φ (LSD) <sup>3</sup>
Steel <sup>1</sup>	Screws	2.50	0.65	0.60	2.35	0.70	0.65

**Notes:**

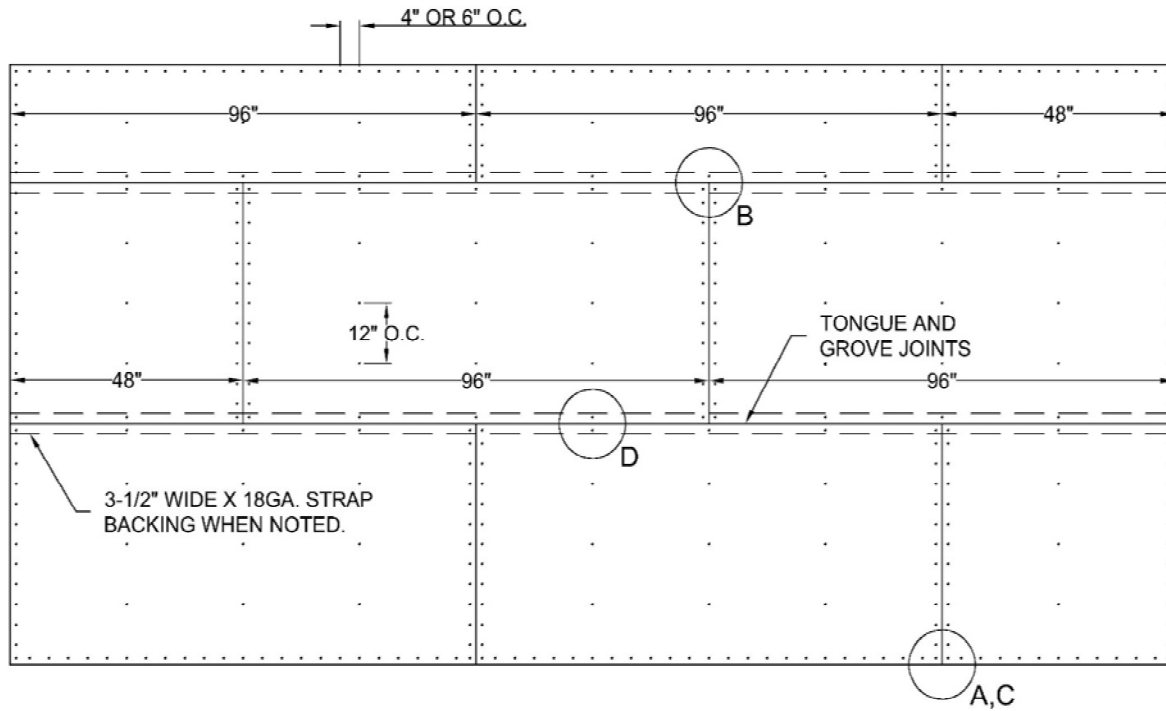
1. Tabulated values have been evaluated for horizontal diaphragm use only.
2. Safety factors and resistance factors for USG Structural Panel Concrete Subfloor diaphragms installed over cold-formed and hot-rolled steel framing are based upon Table D5 of AISI S100-2007.
3. Earthquake factors for installations over wood construction are based upon the wind factors modified by a factor of 1.4 to match the general seismic strength reduction observed in Tables 4.2A, 4.2B, 4.2C, and 4.2D of AWC SDPWS-2008.
4. Limit States Design (LSD) shall be used in combination with the load combinations found in the National Building Code of Canada (NBCC).

**Table 4: Uniform Live Load Performance Rating<sup>2</sup>**  
**USG** Structural Panel Concrete Subfloor

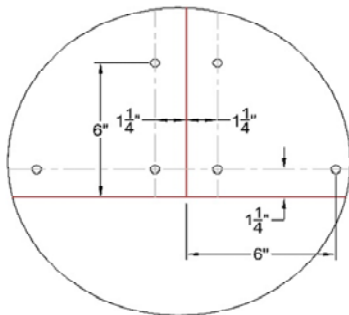
Span Rating	Conditions	Live Load Rating <sup>1</sup> (PSF)
<b>12"</b> [305mm]	Dry or Wet	512 [24.5 kPa]
<b>16"</b> [406mm]	Dry or Wet	283 [13.5 kPa]
<b>24"</b> [610mm]	Dry or Wet	120 [5.7 kPa]

**Notes:**

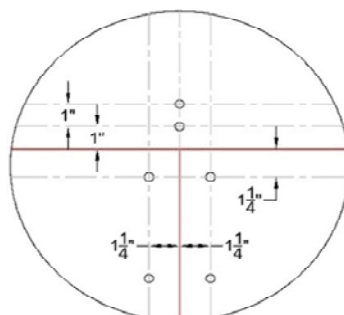
1. Live load ratings have been determined from testing based upon a minimum 120 psf [5.7 Kpa] service live load for the 24" [610mm] span rating and a maximum panel live load deflection = L/360. **A safety factor of 3.0 has been applied.**
2. A minimum of two framing spans required per panel piece.
3. Tabulated live load ratings are valid for a service level dead load of 10 psf [0.5 Kpa] or less.
4. Live load rating values for 12" and 16" span ratings are by engineering analysis based upon 24" span rating results and L/360 deflection criteria.



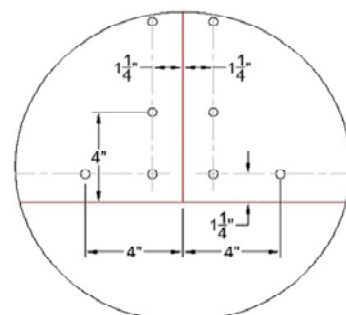
**Figure 2 - Diaphragm Layout**



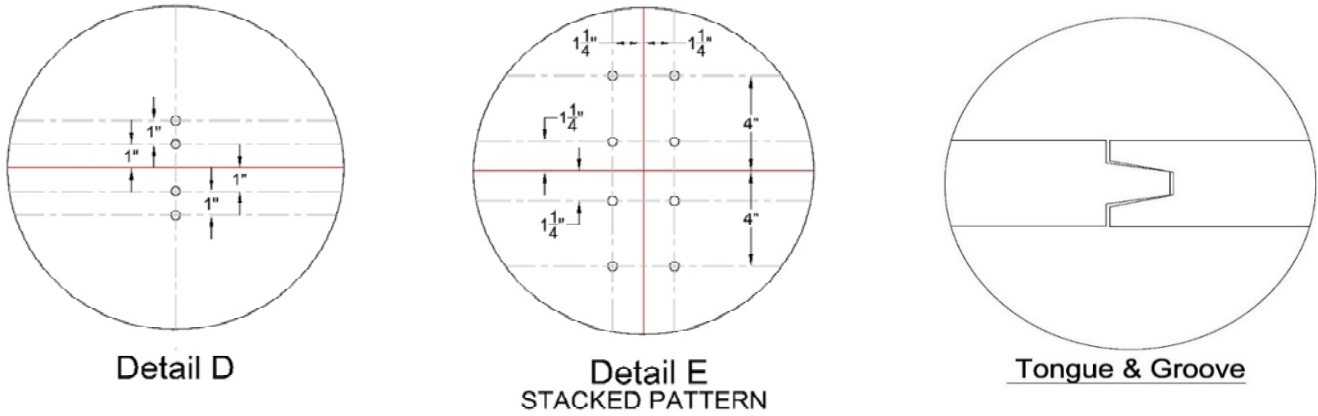
**Detail A**



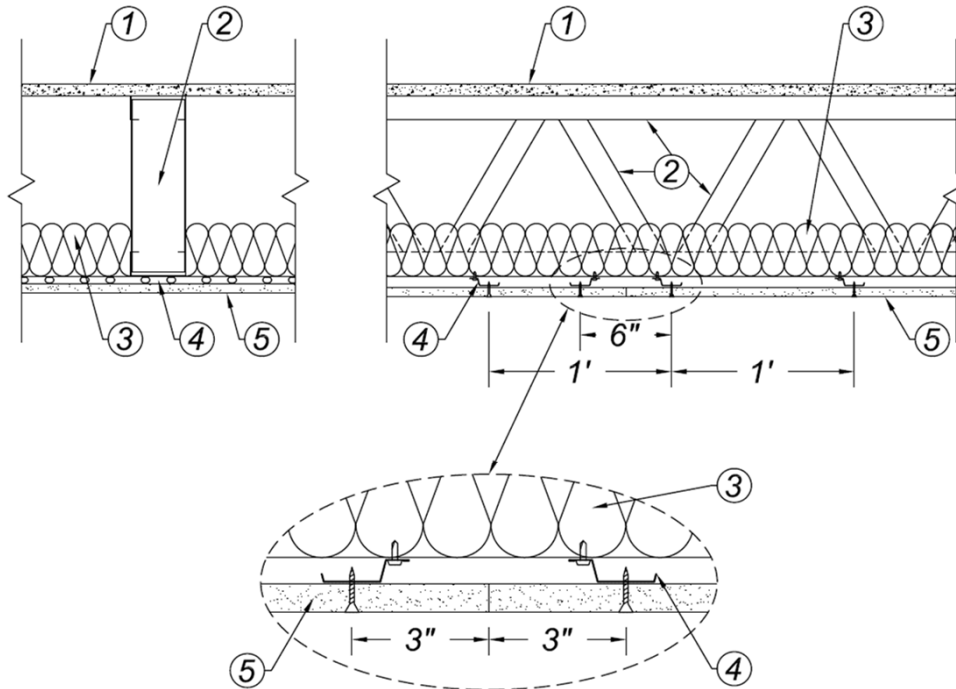
**Detail B**



**Detail C**



**Figure 3: UL Fire Design**  
H515: 1-1/2 and 2 hour rating



- 1a USG Structural Panel Concrete Subfloor (UL type USGSP)
- 1b For 2 hour design, USG Structural Panel Concrete Subfloor (UL type USGSP) plus 1/4" Fiberock Underlayment (UL type FRX-G)
- 2 FRAMECAD 12" deep 43 mil truss (UL type FRAMECAD) at 24" center
- 3 3-1/2" thick glass fiber batt insulation (UL category BKNV)
- 4 22 mil 1/2" deep Resilient Channel at 12" centers perpendicular to trusses
- 5 5/8" USG Sheetrock® Brand Ecosmart Panels Firecode® X (UL type ULIX)

See UL directory for detail description and installation ([www.ULH515.com](http://www.ULH515.com))

**Table 5: Acceptable Diaphragm Fasteners<sup>1</sup>**  
**USG Structural Panel Concrete Subfloor**

Framing Type	Minimum Edge Distance	Manufacturer	Part No.	Type
18ga [1.0236mm] Cold-Formed Steel	1-1/4" [31.7mm]	Grabber Construction Products, Inc.	CGH8158LG	#8 x 1-5/8" winged self-drilling screw



**Figure 4 - Subfloor Fastener**

**Table 6: Acoustical Performance of Bare Assembly and Ceramic Tile**

	STC/IIC	Floor System		Ceiling System		
		Acoustical Mat	Underlayment	Framing	Wall Board	Layers
Bare	54/34	-	-	RC-1 <sup>3</sup>	ULIX	1
	56/38	-	-	RC-1 <sup>3</sup>	ULIX	2
	60/45	-	-	DWSS <sup>2</sup>	ULIX	2
Ceramic Tile (12"X12")	56/51	-	1/4" Fiberock + 1/2" plywood	RC-1 <sup>3</sup>	ULIX	1
	57/52	-	1/4" Fiberock + 1/2" plywood	RC-1 <sup>3</sup>	ULIX	2
	57/53	RST 02	1/4" Fiberock + 1/2" plywood	RC-1 <sup>3</sup>	ULIX	1
	57/55	RST 10	1/4" Fiberock + 1/2" plywood	RC-1 <sup>3</sup>	ULIX	1
	58/54	RST 02	1/4" Fiberock + 1/2" plywood	RC-1 <sup>3</sup>	ULIX	2
	59/57	RST 05	1/4" Fiberock + 1/2" plywood	RC-1 <sup>3</sup>	ULIX	2
	61/56	-	2 - 1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2
	61/59	RST 02	2 - 1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2
	61/61	RST 02	1/4" Fiberock + 1/2" plywood	DWSS <sup>2</sup>	ULIX	2
	62/61	Kinetic F1	1/4" Fiberock + 1/2" plywood	DWSS <sup>2</sup>	ULIX	2
62/62	Kinetic F1	2 - 1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2	

**Table 7: Acoustical Performance of Carpet**

	STC/IIC	Floor System		Ceiling System		
		Acoustical Mat	Underlayment	Framing	Wall Board	Layers
Carpet and Pad	55/58	-	-	RC-1 <sup>3</sup>	ULIX	1
	56/64	-	-	RC-1 <sup>3</sup>	ULIX	2
	61/71	-	-	DWSS <sup>2</sup>	ULIX	2
Carpet Only	55/53	-	-	RC-1 <sup>3</sup>	ULIX	2
	60/54	-	-	DWSS <sup>2</sup>	ULIX	2

**Table 8: Acoustical Performance of Vinyl Systems**

	STC/IIC	Floor System		Ceiling System		
		Acoustical Mat	Underlayment	Framing	Wall Board	Layers
Sheet Vinyl	56/52	-	2 - 1/4" Fiberock	RC-1 <sup>3</sup>	ULIX	2
	57/51	RST 05	2 - 1/4" Fiberock	RC-1 <sup>3</sup>	ULIX	1
	61/55	-	2 - 1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2
	61/56	RST 05	2 - 1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2
	61/57	Kinetic F1	2 - 1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2
	61/57	RST 02	2 - 1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2
Sheet Vinyl with Backer	56/51	RST 05	2 - 1/4" Fiberock	RC-1 <sup>3</sup>	ULIX	1
	57/56	-	2 - 1/4" Fiberock	RC-1 <sup>3</sup>	ULIX	2
	61/57	Kinetic F1	2 - 1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2
	61/57	RST 02	2 - 1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2
VCT	61/59	RST 02	2 - 1/4" Fiberock	RC-1 <sup>3</sup>	ULIX	1
	62/60	Kinetic F1	2 - 1/4" Fiberock	RC-1 <sup>3</sup>	ULIX	2
LVT	56/51	-	1/4" Fiberock	RC-1 <sup>3</sup>	ULIX	2
	56/52	RST 05	2 - 1/4" Fiberock <sup>1</sup>	RC-1 <sup>3</sup>	ULIX	1
	58/56	RST 02	2 - 1/4" Fiberock <sup>1</sup>	RC-1 <sup>3</sup>	ULIX	2
	61/57	-	1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2
	61/58	RST 02	2 - 1/4" Fiberock <sup>1</sup>	DWSS <sup>2</sup>	ULIX	2
	62/58	Kinetic F1	2 - 1/4" Fiberock <sup>1</sup>	DWSS <sup>2</sup>	ULIX	2
	62/58	RST 05	2 - 1/4" Fiberock <sup>1</sup>	DWSS <sup>2</sup>	ULIX	2

**Table 9: Acoustical Performance of Laminate Systems**

	STC/IIC	Floor System		Ceiling System		
		Acoustical Mat	Underlayment	Framing	Wall Board	Layers
Laminate	55/51	-	-	RC-1 <sup>3</sup>	ULIX	2
	56/51	RST02	2 - 1/4" Fiberock <sup>1</sup>	RC-1 <sup>3</sup>	ULIX	1
Laminate (1/2" in or greater thickness)	56/52	RST02	1/4" Fiberock	RC-1 <sup>3</sup>	ULIX	1
	57/54	-	1/4" Fiberock	RC-1 <sup>3</sup>	ULIX	2
	61/59	Kinetic F1	1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2
	61/59	RST02	1/4" Fiberock	DWSS <sup>2</sup>	ULIX	2

**Legend:** DWSS - USG Drywall Suspension System  
 Fiberock - USG Fiberock® Brand Tile Backerboard and Underlayment Panels 1/4" thickness  
 Kinetic F1 - Kinetics® Soundmatt 5/15" (8 mm) thickness  
 RC-1 - Resilient Channel  
 RST02 - PLITEQ® GenieMat® RST 02  
 RST05 - PLITEQ® GenieMat® RST 05  
 ULIX - USG Sheetrock® Brand EcoSmart Panels Firecode® (UL Type ULIX)

**Notes:** 1 - Single layer system tested but two layers required for finish floor system durability  
 2 - Minimum plenum depth of 6"  
 3 - Installed at 12" on center