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ESR-1792

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DIVISION: 06 00 00—WOOD PLASTICS AND COMPOSITES
SECTION: 06 02 13—CEMENTITIOUS REINFORCED PANELS
DIVISION: 07 00 00—THERMAL AND MOISTURE PROTECTION
SECTION: 07 44 53—GLASS-FIBER-ENFORCED CEMENTITIOUS PANELS

REPORT HOLDER:

UNITED STATES GYPSUM COMPANY

550 WEST ADAMS STREET
CHICAGO, ILLINOIS 60661

EVALUATION SUBJECT:

USG STRUCTURAL PANEL CONCRETE SUBFLOOR

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DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES
Section: 06 12 13—Cementitious Reinforced Panels

REPORT HOLDER:

UNITED STATES GYPSUM COMPANY
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CHICAGO, ILLINOIS 60661
(312) 436-6139
www.usg.com

EVALUATION SUBJECT:

USG STRUCTURAL PANEL CONCRETE SUBFLOOR

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2015, 2012, 2009 and 2006 *International Building Code*® (IBC)
- 2015 2012, 2009 and 2006 *International Residential Code*® (IRC)
- 2013 *Abu Dhabi International Building Code* (ADIBC)†

†The ADIBC is based on the 2009 IBC. 2009 IBC code sections referenced in this report are the same sections in the ADIBC.

Properties evaluated:

- Structural
- Combustibility
- Fire propagation

2.0 USES

USG Structural Panel Concrete Subfloor is a noncombustible, cementitious floor sheathing panel used as combination subfloor and underlayment or as subfloor only. Installation must be limited to weather-protected, interior locations.

USG Structural Panel Concrete Subfloor is fastened to cold-formed steel floor framing to form a structural floor system. The floor system is capable of resisting gravity loads and acting as a horizontal shear diaphragm, resisting wind and seismic loads.

When used in structures regulated under the IRC, floor systems using USG Structural Panel Concrete Subfloor must be designed in accordance with IRC Section R301.1.3.

3.0 DESCRIPTION

3.1 USG Structural Panel Concrete Subfloor:

USG Structural Panel Concrete Subfloor is formed from a composite consisting of glass fibers and cementitious materials. USG Structural Panel Concrete Subfloor is nominally $^{3}/_{4}$ inch (19.1 mm) thick, 4 feet (1219 mm) wide, and 8 feet (2428 mm) long with tongue-and-groove edges along the length of the panel. Based on tests in accordance with ASTM E136, the panels are noncombustible. The panels yield a flame-spread index of 0 and a smoke-developed index of 5 or less when tested in accordance with ASTM E84.

3.2 Floor Framing:

Floor framing, web stiffeners, and blocking must be cold-formed from steel complying with AISI S100 (AISI-General for the 2006 IBC), with a minimum base-metal thickness of 54 mils [0.0538 inch (1.37 mm)], a minimum yield strength of 50 ksi (345 MPa), and a minimum G60 galvanized coating. The supporting flange of the framing member must be at least 1.625 inches (41 mm) wide.

3.3 Blocking:

When blocking is required, as shown in Tables 2 and 3, it must consist of minimum Grade 33 cold-formed steel straps which are 4 inches (102 mm) wide with a minimum base steel thickness of 54 mils [0.0538 inch (1.37 mm)], and a minimum G60 galvanized coating.

3.4 Fasteners:

The panels must be fastened to the steel floor framing and blocking with Grabber Construction Products, Inc., #8 x $1^{5}/_{8}$" winged self-drilling screws, Part No. CGH18158LG.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 General: The floor joists and other floor framing components must be designed to comply with the strength and deflection requirements of the IBC and the project specifications. The design of the floor system must address the selection of the framing members, the connections of the framing members to the supporting structure, the layout of the floor sheathing, and the fastening schedule for attaching the floor sheathing to the framing members.

4.1.2 Allowable Uniform Gravity Loads: The allowable uniform gravity loads for the USG Structural Panel Concrete Subfloor are shown in Table 1.

4.1.3 Diaphragm Loads:

4.1.3.1 General:

For horizontal diaphragms constructed with the USG Structural Panel Concrete Subfloor, the length-to-width aspect ratio of the diaphragm must be no greater than 3:1 for unblocked diaphragms and 4:1 for blocked diaphragms. Diaphragm classification as flexible or rigid must be determined in accordance with Section 12.3.1 of ASCE 7.

Diaphragm design must consider diaphragm loading parallel and perpendicular to the floor framing. For select configurations, the results of testing of simple beam assemblies, are shown in Table 2. These values are applicable when the diaphragm load is parallel to the floor framing members. Results of testing of cantilever assemblies are shown in Table 3. These values apply to diaphragm loads which are parallel and perpendicular to the floor framing, except where loading parallel to framing is addressed in Table 2. The values in Tables 2 and 3 are nominal diaphragm shear values, which must be adjusted for use in ASD or LRFD in accordance with the footnotes to the tables.

4.1.3.2 Deflections: Diaphragm deflection must be calculated as follows:

$$\Delta = \frac{5VL^3}{8EAb} + \frac{VL}{4Gt} + XLe_n$$

where:

Δ = Diaphragm deflection, inch

V = Unit shear in the direction under consideration, plf

L = Diaphragm length, feet

E = Elastic modulus of steel rim members designed as diaphragm chords, 29,500,000 psi

A = Net area of steel rim chord cross section, in^2

b = Diaphragm width, feet

G = Shear modulus of sheathing, 285,714 psi

t = Effective thickness of sheathing, 0.73 inch

X = Slip coefficient from Table 2 or 3, as applicable

e_n = Fastener slip, which is based on the ratio of V/S_u as follows:

e_n = 0.011 inch at $0.20S_u$

e_n = 0.019 inch at $0.33S_u$

e_n = 0.032 inch at $0.60S_u$

e_n = 0.084 inch at S_u

where:

S_u = Nominal shear strength given in Table 2 or 3, as applicable

Other values of e_n are permitted to be determined by interpolation.

4.2 Installation:

4.2.1 General: Installation of USG Structural Panel Concrete Subfloor and framing must be in accordance with the IBC, this report, USG's published installation instructions and the approved plans. Copies of this report, USG's published installation instructions and the approved plans must be available at the jobsite at all times during installation of the panels.

4.2.2 Framing: The floor joists must be supported on a foundation that is uniform and level, or directly by bearing studs or headers installed at the top of the bearing wall to distribute the load.

Web stiffeners must be provided at reaction points and/or concentrated loads as specified in the approved plans, based on the joist manufacturer's requirements and the applicable ICC-ES evaluation report on the joists. End blocking must be provided where joists ends are not otherwise restrained from rotation.

Joists must be provided at a maximum spacing of 24 inches (610 mm) on center, as indicated in the tables in this report. Additional joists must be provided under parallel partitions and around all floor openings that interrupt one or more spanning members. Floor joists must be fastened to the supporting walls or structure in accordance with the approved plans.

All blocking or bridging for the steel framing must be installed prior to the installation of the USG Structural Panel Concrete Subfloor.

Framing must comply with the manufacturing tolerances specified in Section A5.4 of AISI S200-12, which is referenced in Section 2211.1 of the 2015 IBC.

When strap blocking is required at the abutting edges of the panels, it must be centered under the tongue-and-groove joints between sheathing panels, and installed prior to installation of the sheathing panels.

4.2.3 USG Structural Panel Concrete Subfloor Application:

4.2.3.1 General: The temperature during panel installation must be a minimum of 0°F (18°C).

4.2.3.2 Panel Layout: USG Structural Panel Concrete Subfloor must be installed with the long edges perpendicular to the framing. Panels may be installed with either surface against the framing. However, because the panel markings that facilitate fastening are on one side only, the panels should preferably be applied with the markings toward the installer.

Panel installation must commence by marking a line across the joists parallel to the rim joist at a distance equal to the width of the first panel being placed. The floor layout must be planned so the first and last panel row width is a minimum of 24 inches (610 mm).

The cut edge or tongue must be placed along the rim joist. Each panel must be supported across three or more framing members. Panels must be trimmed to ensure that the butted ends of each panel are centered on the framing member flanges.

Adjacent panels must be butted together so that the tongue of one panel being installed fits into the groove of the installed panel. No gaps are required between panels. Panel rows must be placed in a running bond pattern so that end joints fall over the center of the framing members and are staggered by at least two framing members from where the end joints fall in the adjacent rows, except when panels less than 8 feet (2440 mm) long are used, an offset of one framing member is allowed.

4.2.3.3 Panel Fastening: Each panel must be fastened to the framing members in accordance with the requirements for the applicable screw pattern shown in Tables 2 and 3, and in accordance with the fastening schedule specified in the approved plans. Fastening must commence at one end and fan out across the panel, and corners must not be fastened initially. Fasteners must be placed sequentially one row at a time. Screws must be installed using tools recommended by the screw manufacturer. Screw fasteners must be installed so the heads are flush with the panel

surface. Panels must be fastened in accordance with one of the following patterns, as required by Tables 2 and 3:

- **Screw Pattern A:** Floor sheathing must be fastened at 4, 6 or 8 inches (102, 152 or 203 mm) on center at the perimeter of the diaphragm and at the panel-to-panel butt joints, as required by Tables 2 and 3. At the panel corners, fasteners must be inset 2 inches (51 mm). In the field of the panel, fasteners must be spaced a maximum of 12 inches (305 mm) on center. Fastener edge distance at all panel edges must be a minimum of $^1/_2$ inch (12.7 mm), except at T-joints (intersection of butt joint with tongue-and-groove joint) where two fasteners are required, one placed 1 inch (25.4 mm) and another at 2 inches (51 mm) from the panel edge. Figure 1 illustrates the Screw Pattern A fastener layout.
- **Screw Pattern B:** Floor sheathing must be fastened at 4, 6 or 8 inches (102, 152 or 203 mm) on center at the perimeter of the diaphragm and at the panel-to-panel butt joints, as required by Tables 2 and 3. At the panel corners, fasteners must be inset 2 inches (51 mm). In the field of the panel, fasteners must be spaced a maximum of 12 inches (305 mm) on center. Fastener edge distance at all panel edges must be a minimum of $^1/_2$ inch (12.7 mm), except at T-joints where one fastener must be placed 1 inch (25.4 mm) from the panel edge. Figure 2 illustrates the Screw Pattern B fastener layout.
- **Screw Pattern C:** Floor sheathing must be fastened at 6 inches (152 mm) on center at the perimeter of the diaphragm, at the panel-to-panel butt joints, and at blocking at the tongue-and-groove joints. At the panel corners, fasteners must be inset 2 inches (51 mm), with an additional fastener installed at the T-joint. In the field of the panel, fasteners must be spaced a maximum of 12 inches (305 mm) on center. Fastener edge distance at panel edges parallel to framing and at cut edges must be a minimum of $^1/_2$ inch (12.7 mm). Fastener edge distance at tongue and groove panel joint over blocking must be a minimum of 1 inch (25.4 mm). Figure 3 illustrates the Screw Pattern C fastener layout.

4.2.3.4 Field Modifications: As needed, the panels must be cut to proper length and width in accordance with USG's installation instructions.

Cut-outs in the panels must be created before installation of the panels. All cut-out ends and edges exceeding 6 inches (152 mm) in any dimension must be supported by framing.

4.2.4 Floor Finish: Before application of floor finish materials, all structural panels must be completely fastened. All voids and depressions in the panel surface must be filled with cement-based patching or leveling compounds. Panel surfaces must be clean and free of moisture.

Before application of floor finish materials, USG Structural Panel Concrete Subfloor must conditioned in the same environment as required for the finish floors, if applicable, for at least 48 hours.

Underlayments must be secured to USG Structural Panel Concrete Subfloor with fastenings specified for the flooring material. Mechanical fasteners must be long enough to penetrate the USG Structural Panel Concrete Subfloor $^1/_4$ to $^1/_2$ inch (6.4 to 12.7 mm).

For wood flooring, No. 15 felt or equivalent must first be laid over the USG Structural Panel Concrete Subfloor. For engineered wood flooring, the specified moisture barrier must be used in lieu of the felt. The USG Structural Panel Concrete Subfloor must be kept dry and maintained in a conditioned space for a minimum of 30 days prior to the installation of wood flooring. The wood flooring must then be installed in accordance with the wood flooring manufacturer's installation instructions for application over wood floor sheathing.

Tackless strips, designed for concrete application, must be used for the installation of stretched carpet.

5.0 CONDITIONS OF USE

The USG Structural Panel Concrete Subfloor described in this report complies with, or is a suitable alternative to what is specified in, the code indicated in Section 1.0 of this report, subject to the following conditions:

5.1 The product must be installed in accordance with this report, the manufacturer's published instructions, the approved plans and the applicable code. In the event of a conflict amongst these documents, the most restrictive requirements govern.

5.2 Calculations and details showing that the applied gravity loads do not exceed the uniform load capacity and that the applied diaphragm loads do not exceed the diaphragm strengths specified in this report must be submitted to the code official for approval. The calculations must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.3 Design of the building foundation system, walls or roof is outside the scope of this report.

5.4 The USG Structural Panel Concrete Subfloor is manufactured under a quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Structural Cementitious Floor Sheathing Panels (AC318), dated October 2015.

6.2 Data in accordance with the ICC-ES Acceptance Criteria for Horizontal Diaphragms Consisting of Structural Cementitious Floor Sheathing Panels Attached to Cold-formed Steel Framing (AC319), dated June 2005 (editorially revised October 2015).

7.0 IDENTIFICATION

Each panel is labeled with the USG Structural Panel Concrete Subfloor brand name; the United States Gypsum Company name and address; the panel thickness; the maximum joist spacing for the panel (referred to as maximum span); the maximum allowable load (live and dead gravity load); the ICC-ES report number (ESR-1792); and the date of manufacture.

TABLE 1—ALLOWABLE UNIFORM GRAVITY LOADS FOR USG STRUCTURAL PANEL CONCRETE SUBFLOOR

JOIST SPAN (inches)	ALLOWABLE UNIFORM LOAD[1] (psf)
12	440
16	248
19.2	172
24	110

For **SI:** 1 inch = 25.4 mm, 1 psf =47.88 Pa.

[1]These loads represent the load-carrying capacity of the panels spanning between the floor joists. A minimum of two spans is required. This table does not consider the influence of joist deflection.

TABLE 2—NOMINAL SHEAR STRENGTH FOR SIMPLE BEAM DIAPHRAGMS CONSTRUCTED WITH USG STRUCTURAL PANEL CONCRETE SUBFLOOR[1,2,3,4]

JOIST SPACING (inches)	BLOCKING REQUIRED[5]	MAXIMUM FASTENER SPACING (inches)		SCREW PATTERN	SHEAR STRENGTH, S_u (plf)	SLIP COEFFICIENT, X
		Perimeter	Field			
24	Yes	6	12	C	1,526	0.346
24	No	4	12	A or B	1,357	0.476
24	No	6	12	A or B	1,073	0.397
16	No	4	12	B	1,462	0.443
16	No	6	12	B	1,429	0.421

For **SI:** 1 inch = 25.4 mm, 1 plf = 14.6 N/m.

[1]See Section 3.2 for cold-formed steel floor framing requirements.
[2]See Section 3.4 for fastener requirements.
[3]See Section 4.2.3.3 for a description of the screw patterns.
[4]The maximum ASD diaphragm shear strength must be determined by applying a minimum factor of safety, Ω, of 2.5 to the tabulated nominal strength for seismic forces, and a minimum factor of safety, Ω, of 2.35 for wind forces. The maximum LRFD diaphragm shear strength must be determined using a maximum resistance factor, ϕ, of 0.65 applied to the tabulated nominal strength for seismic forces and a maximum resistance factor, ϕ, of 0.70 for wind forces.
[5]See Section 3.3 for blocking requirements.

TABLE 3—NOMINAL SHEAR STRENGTH FOR CANTILEVER DIAPHRAGMS CONSTRUCTED WITH USG STRUCTURAL PANEL CONCRETE SUBFLOOR

JOIST SPACING (inches)	BLOCKING REQUIRED[5]		MAXIMUM FASTENER SPACING (inches)		SCREW PATTERN	SHEAR STRENGTH, S_u (plf)	SLIP COEFFICIENT, X
			Perimeter	Field			
24	Yes		6	12	C	1,148	0.354
24	No		4	12	A	738	0.732
24	No		6	12	A	566	0.518
24	No		8	12	A	488	0.511
24	No		6	12	B	522	0.625
24	No		8	12	B	487	0.754
16	No		4	12	A	1,029	0.833
16	No		6	12	A	956	0.765
16	No		8	12	A	860	0.702
12	No		4	12	A	1,146	0.759
12	No		6	12	A	956	0.541
12	No		8	12	A	779	0.484

For **SI:** 1 inch = 25.4 mm, 1 plf = 14.6 N/m.

[1]See Section 3.2 for cold-formed steel floor framing requirements.
[2]See Section 3.4 for fastener requirements.
[3]See Section 4.2.3.3 for a description of the screw patterns.
[4]The maximum ASD diaphragm shear strength must be determined by applying a minimum factor of safety, Ω, of 2.5 to the tabulated nominal strength for seismic forces, and a minimum factor of safety, Ω, of 2.35 for wind forces. The maximum LRFD diaphragm shear strength must be determined using a maximum resistance factor, ϕ, of 0.65 applied to the tabulated nominal strength for seismic forces and a maximum resistance factor, ϕ, of 0.70 for wind forces.
[5]See Section 3.3 for blocking requirements.

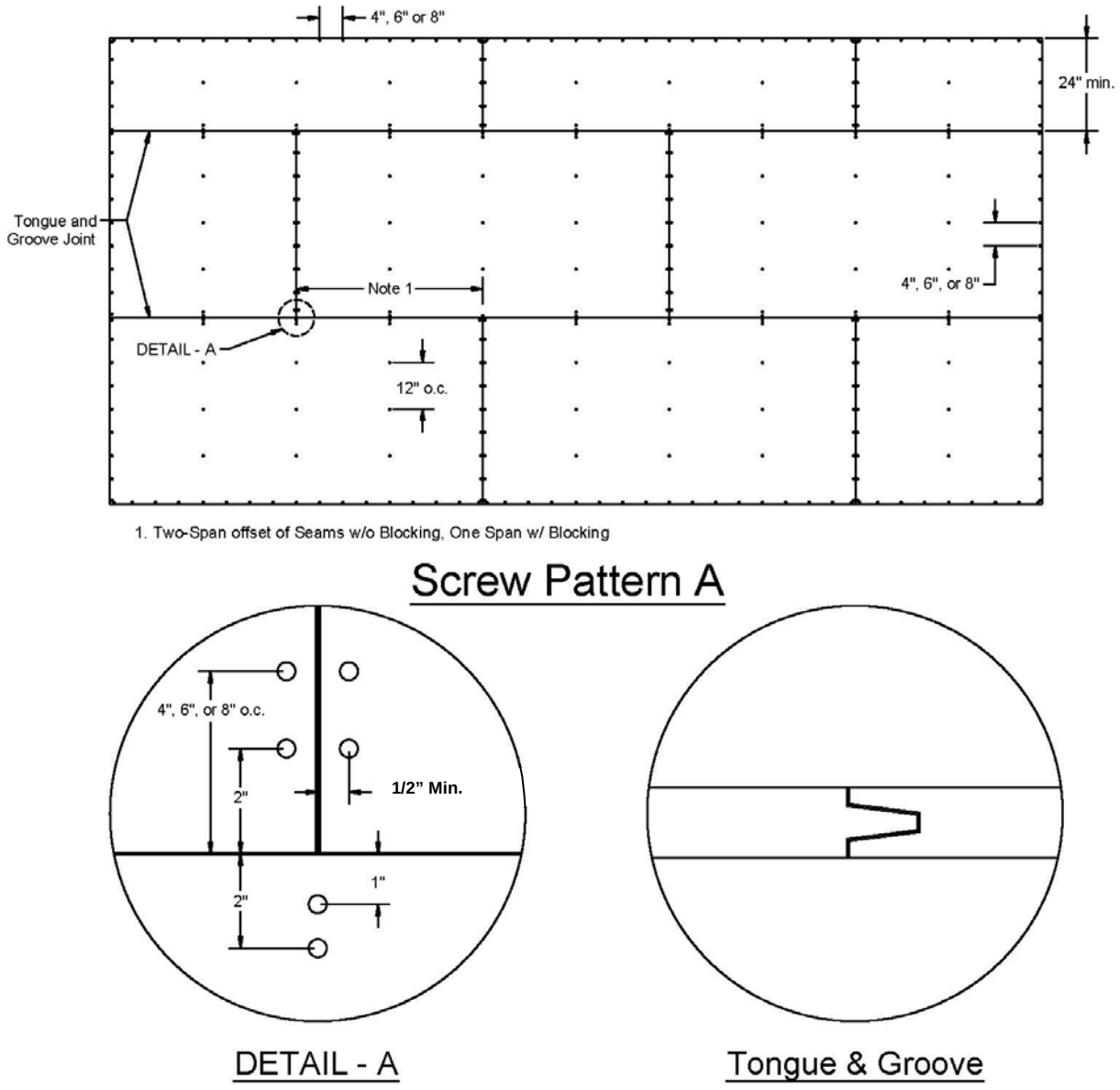
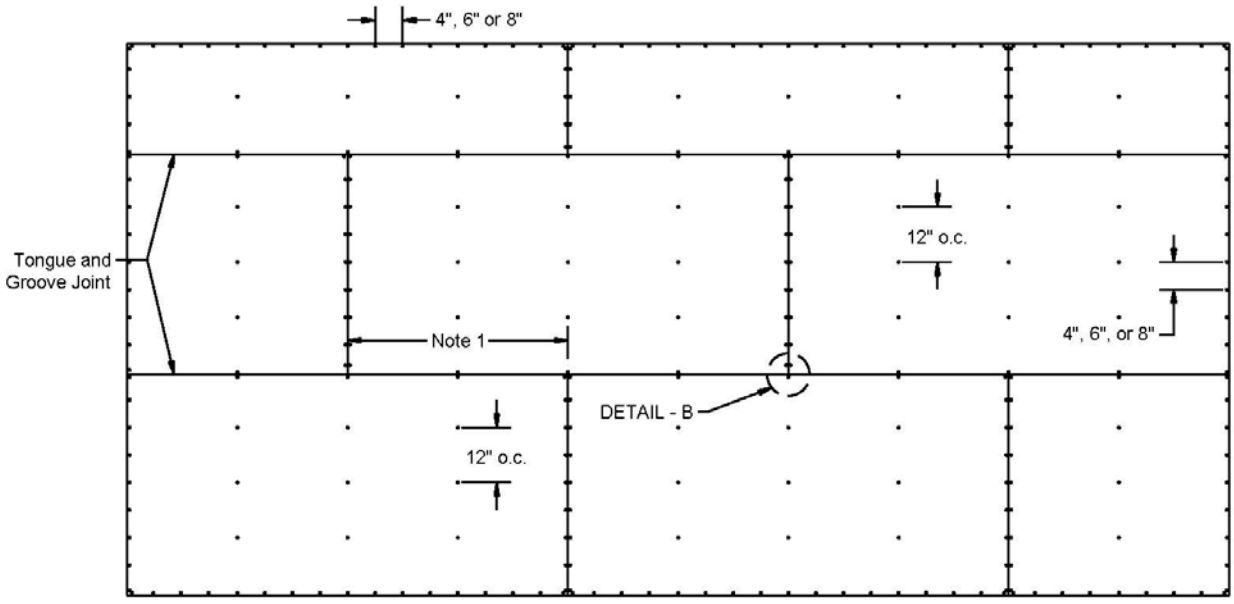


FIGURE 1—SCREW PATTERN A LAYOUT



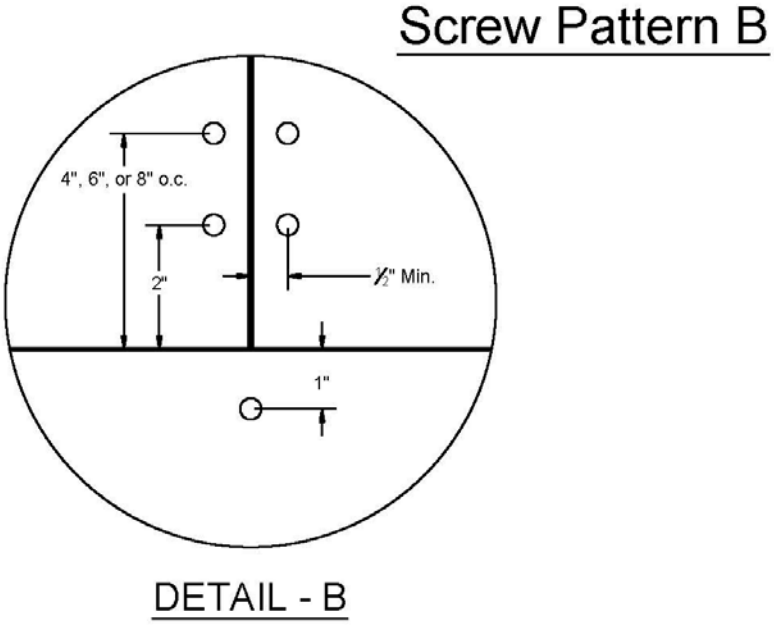
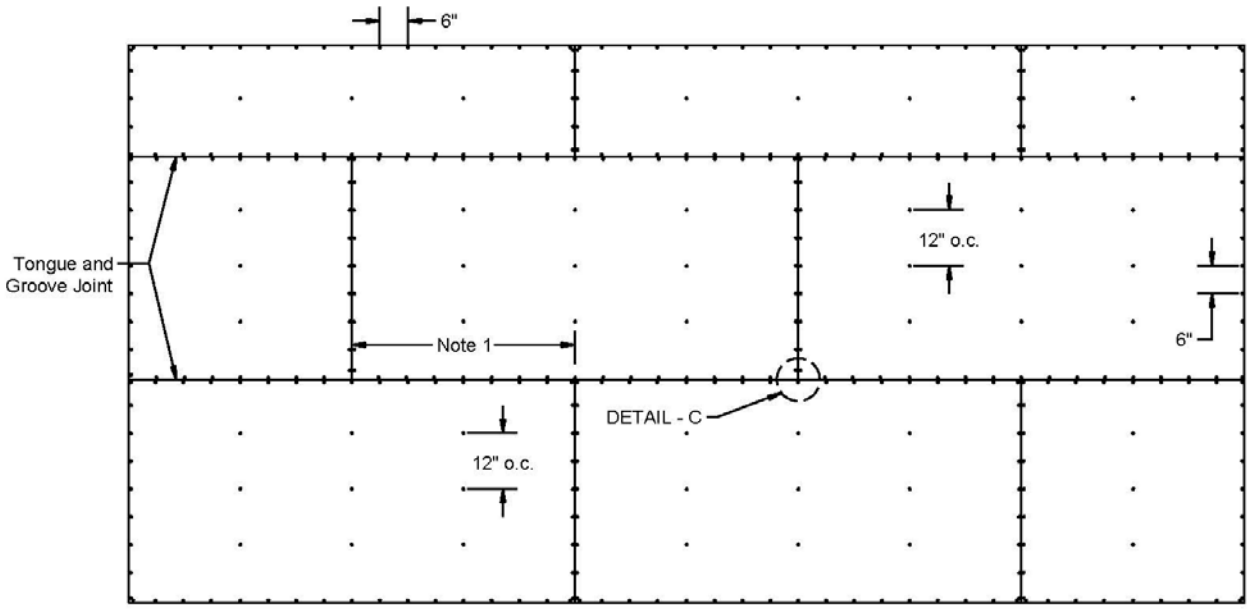


FIGURE 2—SCREW PATTERN B LAYOUT



1. One Span offset w/ Blocking

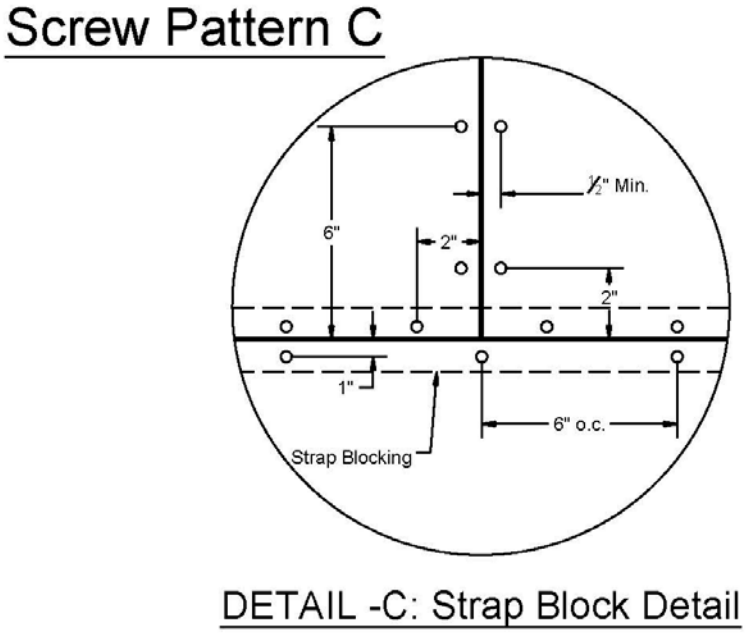


FIGURE 3—SCREW PATTERN C LAYOUT