ECOSPAN®

COMPOSITE FLOOR SYSTEM

INFORMATION & DESIGN MANUAL

ECONOMY THROUGH ECOLOGY®

NUCOR®
VULCRAFT/VERCO GROUP

INFORMATION & DESIGN MANUAL

ECONOMY THROUGH ECOLOGY®

NUCOR VULCRAFT GROUP

Nucor-Vulcraft/Verco Group
Ecospan® Composite Floor System

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Nucor's Vulcraft/Verco Group has provided this manual for use by Design Professionals in designing and using the Ecospan® Composite Floor System. It includes all products available at the time of printing. Vulcraft/Verco Group reserves the right to revise or withdraw any products without notice.

The information presented in this catalog has been prepared in accordance with recognized engineering principles and is for general information only. While believed to be accurate, this information should not be used or relied upon for any specific application without competent professional examination and verification of its accuracy, suitability and applicability by an engineer, architect or other licensed professional.

The Vulcraft/Verco Group (Vulcraft) employs engineers for the design, manufacture and marketing of its products. The Ecospan® Engineer does not accept the responsibility of the Design Professional of record for any structure. Vulcraft accepts the delegation of the engineering responsibility only for the products it manufactures, provided the application and applicable loading for these products are specified by the Design Professional of record. Vulcraft provides engineering for the design of its products which does not displace the need on any project for a Design Professional of record.

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1.0 The Ecospan® Composite Floor System

The Ecospan® Composite Floor System by Nucor Vulcraft/Verco Group is an innovative, effective, and economical method of providing all steel structural components for elevated floor construction while incorporating the benefits of lighter weight composite design.

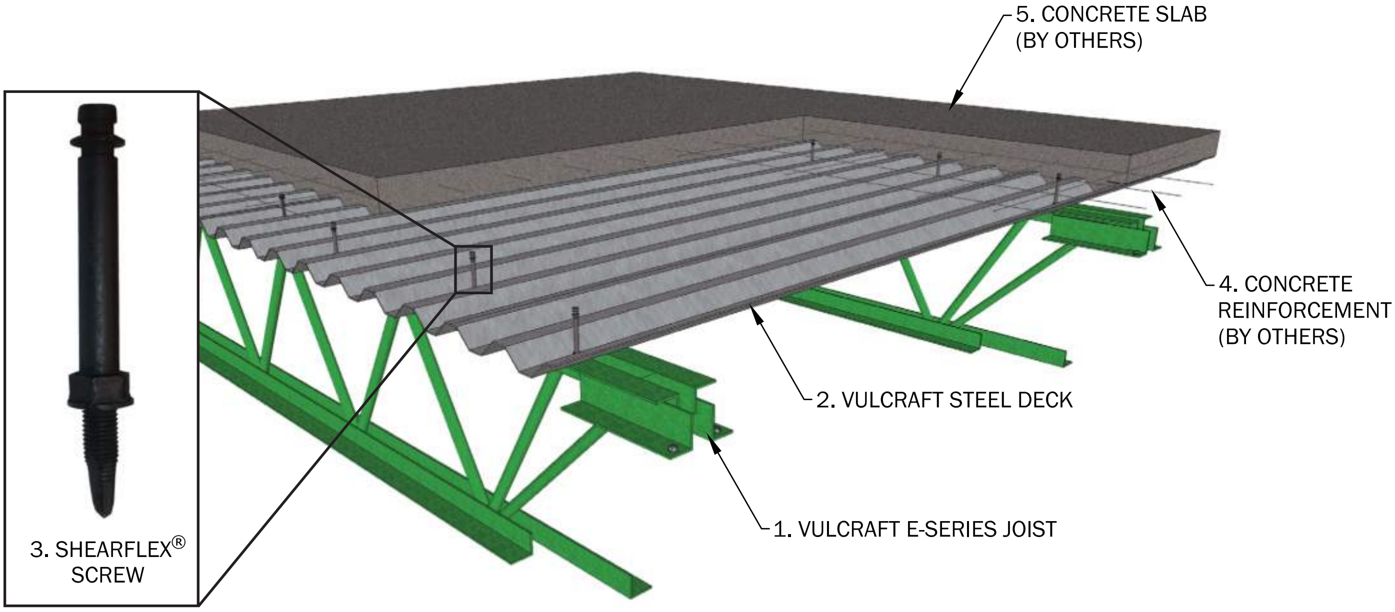

Figure 1-1: The Ecospan® Composite Floor System

1.1 Product Description

1. Joists: The Ecospan® Composite Floor System uses E-Series Vulcraft joists ranging from 10” to 24” deep and a maximum length of approximately 50’-0”. Joists are typically spaced at 4’-0” o.c.

2. Decking: Ecospan® utilizes multi-span sheets of light gauge decking which is typically 1.0C conform.

3. Shearflex® Screws: This screw is self-drilling and self-tapping, ranging from 2 ½” to 3” in length (not including the threaded section). Screws are installed using the Vulcraft provided Shearset® Tool which uses standard 120V electricity.

4. Concrete Slab Reinforcement (by Others): Slab reinforcement (specified by the Design Professional) typically consists of a 6x6 welded wire reinforcement (WWR) with a minimum yield strength of 60,000 psi. If 24 gauge or heavier decking is specified, fiber mesh materials may be considered as an alternate for the Design Professional to consider.

5. Concrete slab (by Others): Concrete slab (by Others): Concrete slab thickness (specified by the Design Professional) is typically 2½” (3½” total depth using 1.0C Deck) normal weight concrete having a minimum 28 day ultimate compressive strength (f’c) of 3,000 psi. Thicker slabs may be designed for heavier duty uses.

1.2 Consider the Advantages

- The Ecospan® Composite Floor System is an effective and economical solution for constructing residential and commercial floor systems.

- Erection is safe, easy and inexpensive. There are no short deck sheets, plywood forms or shoring; and sub-trades can normally continue construction the day after the concrete is placed.

- Floor to floor heights can often be decreased due to the inherent ability to pass mechanical ducts, piping, conduit, etc. through the open web design.

- Ideally suited for use in construction where column free areas are desired.

- High strength to weight ratio of composite steel joists allows for greater spans and spacing with lighter members.

- Weight savings due to efficient joist design reduces building weight and allows foundation and wall costs to be reduced.

- Constructed with non-combustible materials, achieving multiple UL listings with gypsum board, acoustical ceilings, or spray applied fire resistant materials.

- The Ecospan® Composite Floor System has a Sound Transmission Classification (STC) of 57, and meets or exceeds Impact Insulation Classification (IIC) requirements of the IBC for residential and commercial construction with commonly used sound attenuation materials.

- Design professionals are no longer limited to relatively short spans due to the economical restrictions of wood I-joist, open-web wood and cold-formed steel joists, or cold-formed steel C-joists; and can reduce foundation loads commonly associated with cast-in-place, pre-cast or shored heavy deck concrete systems.

1.3 Steel Recycling and LEED® Program Information

Nucor Corporation is the nation's largest recycler, using over 17 million tons of scrap steel in 2011 to create new products. Nucor uses Electric Arc Furnace (EAF) technology at all of its steel recycling facilities. EAFs use post-consumer scrap steel material for the major feedstock, unlike blast furnace operations which use mined iron ore as the major feedstock.

1.3.1 Recycled Content – LEED® Version 3.0 Credit 4

Nucor has prepared the following information to help calculate the recycled content for products being used in "Green Building" applications or for projects in the LEED® program. Percentages are approximate and based on the total weight of the products. Calculations are based on 2011 scrap steel delivered and finished materials produced and are defined in accordance with ISO 14021:1999. Values do not consider home scrap or scrap generated onsite. Specific product information is available from facility representatives.

2011 Recycled Steel Content of Nucor Products (% by Total Weight)	
Product Group	Average Recycled Content
Nucor Bar Products (Vulcraft Structural Products)	>97.7%
Nucor Sheet Products (Vulcraft Decking)	72.0%
Total Nucor Steel Combined	89.5%

Table 1-1

1.3.2 Regional Materials – LEED® Version 3.0 Credit 5

Nucor tracks the origin of all scrap shipments to our mills. Nucor can approximate the amount of scrap extracted from any project site region. Nucor owns steel and steel product manufacturing facilities throughout the United States that are within 500 miles of almost any project site. Please contact your local sales representative if you have questions regarding regional materials.

1.3.3 Nucor Bar Mill Group

The Nucor Bar Mill Group produces rebar, angles, flats, rounds and other miscellaneous shapes. The Bar Mill Group uses recycled scrap steel for over 97.7% of the feedstock.

2011 Approximate Recycled Steel Content of all Nucor Bar Mill Group Products*				
Facility	Total Scrap Steel Use	Total Alloys and Other Iron Units	Total Post-consumer Recycled Content	Total Pre-consumer Recycled Content
All	>97.7%	2.3%	81.1%	16.6%

Table 1-2

Nucor Bar Mill Group facilities are located in: Darlington, SC; Norfolk, NE; Jewett, TX; Plymouth, UT; Auburn, NY; Birmingham, AL; Kankakee, IL; Jackson, MS; Seattle, WA and Marion, OH.

1.3.4 Nucor Sheet Mill Group

The Nucor Sheet Mill Group produces hot band, cold rolled, pickled and galvanized products. Nucor Sheet Mills use varying amounts of recycled materials depending on metallurgical product demands and market conditions. The combined sheet mill total recycled content is approximately 72.0%.

2011 Approximate Recycled Steel Content of all Nucor Sheet Mill Group Products*				
Facility	Total Scrap Steel Use	Total Alloys and Other Iron Units	Total Post-consumer Recycled Content	Total Pre-consumer Recycled Content
Crawfordsville, IN	83.9%	16.1%	69.6%	14.3%
Nucor Castrip® Crawfordsville, IN	94.0%	6.0%	78.4%	16.0%
Hickman, AR	73.7%	26.3%	61.1%	12.5%
Berkeley, SC	62.2%	37.8%	51.6%	10.6%
Decatur, AL	68.3%	31.7%	56.7%	11.6%

Nucor Bar Sheet Group locations: Crawfordsville, IN; Hickman, AR; Berkeley, SC and Decatur, AL.

Table 1-3

1.3.5 Nucor Vulcraft Group

<u>Joists</u> – The bar steel for most Vulcraft joists is obtained from one of the eleven Nucor bar mills that use 97.7% scrap steel as their feedstock. A breakdown of the recycled content of Nucor bar mill products is detailed in table 1-2. Vulcraft facilities may receive steel from sources outside of Nucor that may contain lower amounts of recycled steel. Specific product information is available from facility representatives.

<u>Deck</u> – Steel for decking produced by Vulcraft facilities is typically obtained from one of the four Nucor sheet mills. A breakdown of the recycled content of Nucor Sheet mill products is detailed in Table 1-3. Vulcraft deck products contain approximately 72.0% recycled steel.

Nucor Vulcraft Group facilities are located in Florence, SC; Norfolk, NE; Brigham City, UT; Grapeland, TX; St. Joe, IN; Fort Payne, AL and Chemung, NY.

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Addition information is available online through the Steel Recycling Institute at www.recyclesteel.org.

*Studies show that the recycled steel used for Nucor products consist of approximately 83% post-consumer scrap. The remaining 17% typically consists of pre-consumer scrap generated by manufacturing processes for products made with steel.

All figures shown above are based on 2011 figures and may vary from year to year. Please contact your local sales representative for the current average recycled content for Vulcraft products.

2.0 Specifying the Ecospan® Composite Floor System

2.1 Purpose & Scope

The information herein is intended to educate and assist Design Professionals who wish to integrate the Ecospan® Composite Floor System into their project. Section 2.6 provides the Design Professional an opportunity to view general joist depth-to-span values for residential and commercial loads of the Ecospan® Composite Floor System. While Table 2-3 depicts some of the more common loadings and spans typically encountered in residential and commercial floor construction, more specific design requirements may be specified by the Design Professional.

If more specific design requirements are necessary, the Design Professional should provide Vulcraft's Ecospan® National Sales Office with information outlined in Section 2.4, "Design Parameters Checklist for E-Series Joists" in this catalog, prior to proceeding with preliminary drawings. This provides Ecospan® engineers the ability to assist the Design Professional in the development of the final drawings to meet the unique aspects of each project.

2.2 Design Philosophy

The following information is intended to provide the Design Professional with technical documentation concerning the design of the Ecospan® Composite Floor System. The Ecospan® Composite Floor System is light, stiff, and efficient because the steel and concrete act as a unit, utilizing the compressive strength of the concrete and the tensile strength of the steel.

2.2.1 Non-Composite Joist

Non-composite joists supporting concrete are designed as simply supported members with pinned ends. Figure 2-1 shows a typical joist, deck, and concrete slab configuration.

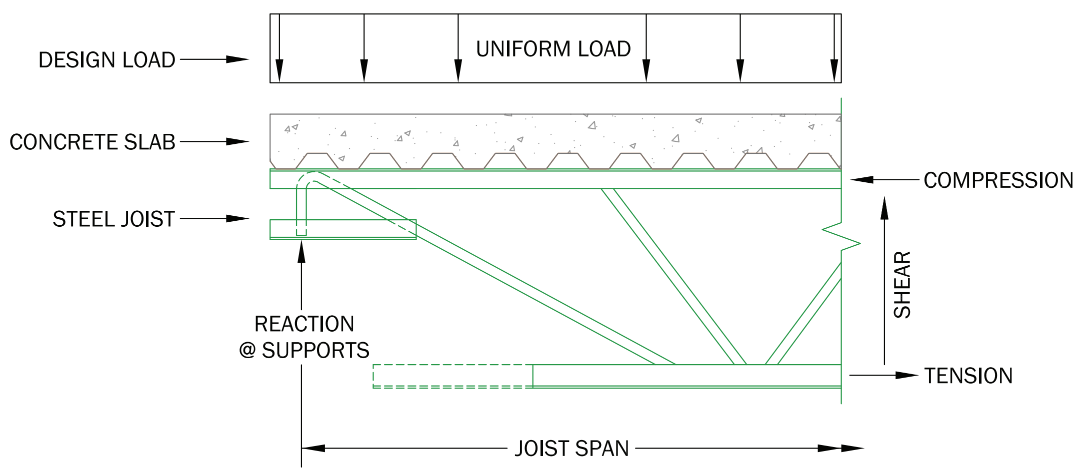

Figure 2-1: Partial Joist Cross-section

The design loads are resisted by the concrete and joist acting independently. The joist strength is based on the cross-sectional area and orientation of the top chord, bottom chord, and web configuration. The bottom chord resists the tension and the top chord resists the compression. The effective depth of this section is equal to the distance between the centroids of the top and bottom chord angles. Figure 2-2 illustrates the effective depth of the non-composite joist.

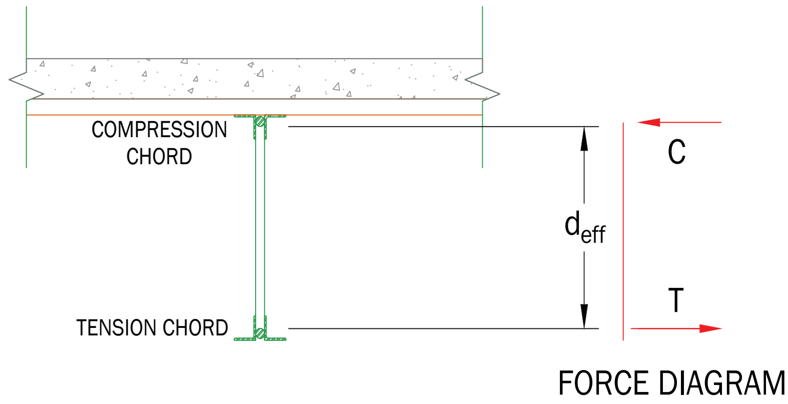

Figure 2-2: Non-Composite Joist Effective Depth (d_{eff})

2.2.2 Composite Joist

Steel Joists and concrete used in composite construction act as a unit creating an assembly that is stronger than each of the materials acting independently. As seen in Figure 2-3, the effective depth (d_{eff}) of the composite section is larger than the non-composite section because the compression is resisted by the concrete, not the top chord of the joist. Strength of the assembly is increased proportionally with the increase in d_{eff}. This increase allows longer spans for the same total framing depth.

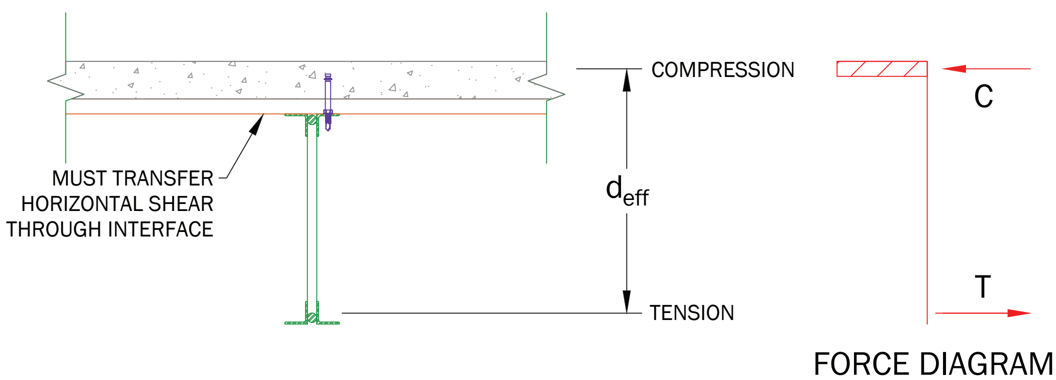

Figure 2-3: Composite Joist Effective Depth (d_{eff})

2.2.3 Development of Composite Action

The equal and opposite forces acting in the concrete and bottom chord of the joist create a couple to resist the bending moment in the section. However, there must be a mechanism to transfer this horizontal shear force between the concrete and steel sections.

The Ecospan® Composite Joist System utilizes the Shearflex® stand-off screw to transfer the horizontal shear forces from the joist top chord into the concrete. The Shearflex® screws are installed into the top chord of the joist through the steel deck and cast into the concrete slab. Shearflex® screws are spaced along the joist as required (See Section 3.5.2).

2.2.4 Development of Section Capacity

The capacity of the composite section developed by the Ecospan® Composite Joist System is governed by three criteria:

1. Capacity of bottom chord in tension
2. Capacity of concrete slab section in compression
3. Horizontal shear transfer capacity of Shearflex® screw

If a balanced design could be achieved, the capacity of all three criteria would be equal at maximum capacity. However, for economical and practical designs the limiting component of the design is normally the horizontal shear transfer or the bottom chord tension capacity.

2.3 Incorporating Ecospan® into a Project

The Ecospan® Composite Floor System can be utilized for most commercial or residential projects. Ecospan® joists (E-series) are individually designed for the span, spacing, and loading specified on the Contract Documents.

In order for designers and engineers to quickly and efficiently detail and engineer each project with minimal shop drawing review time, some basic design criteria will be needed from the Design Professional. To simplify the process, the following items are provided on the Design Parameters Check List, in Section 2.4.

1. Joist Depth
Indicate the steel joist depth in inches, not including the deck and concrete slab. See Figure 2-5.

2. Joist Span
Indicate the joist span in feet. The span is defined as the distance from the centerline of the supporting member to the centerline of the opposite supporting member. See Figure 2-4.

3. Adjacent Joist Spacing
Indicate, in feet, the distance to the adjacent joist or, if joist is at the exterior of a building, to the edge of slab.
See Figure 2-5.

4. Steel Floor Deck
Various depths of deck may be specified. Generally, conform deck with a depth of 1” will be utilized with the Ecospan® Composite Floor System. 1.3” or 1.5” deep deck may also be used.

5. Concrete Unit Weight
Indicate the concrete unit weight. Typical values are 145 pcf for normal weight and 110 pcf for lightweight concrete.

6. Concrete Compressive Strength
Indicate a normal or lightweight concrete having a minimum 28 day ultimate compressive strength (f’c) of 3,000 psi.

7. Slab Thickness
Indicate the slab thickness above the top of the steel deck in inches. The slab thickness is defined as the vertical depth of the concrete above the top flute of the deck. See Figure 2-5.

8. Design Loads
Unfactored loads that should be specified are as follows:

- **a. Non-composite dead load**: Includes concrete, joists, deck, and bridging
- **b. Construction live load**: Indicates the required loading due to work crews and construction equipment before and during the placement of concrete
- **c. Composite dead load**: Includes partitions, mechanical, electrical, fireproofing, floor covering, and ceiling
- **d. Composite live load**: The design live load

9. Camber
E-series joists are designed to be cambered for 100% of the non-composite dead load. The Design Professional may indicate any additional camber requirements. Please note: Due to fabrication tolerances, camber may vary ±¼”.

10. Serviceability

The Design Professional shall indicate the maximum allowable live load deflection for each Ecospan® composite joist.

Calculations for the predicted floor vibration of the Ecospan® Composite Floor System shall be completed by the EOR.

11. Additional Considerations

When specifying the Ecospan® Composite Floor System, the Design Professional should consider the following items:

a. Parallel top and bottom chords of joists
b. Maximum steel floor deck depth is 1.5 inches
c. Slab thickness above the top flute of the deck must be at least 2 inches for non-fire-rated floor systems and a minimum of 2½" for up to 2 hr fire rated assemblies
d. Shearflex® screw must have at least ½" of vertical concrete cover
e. Maintain a constant concrete thickness along the entire joist span

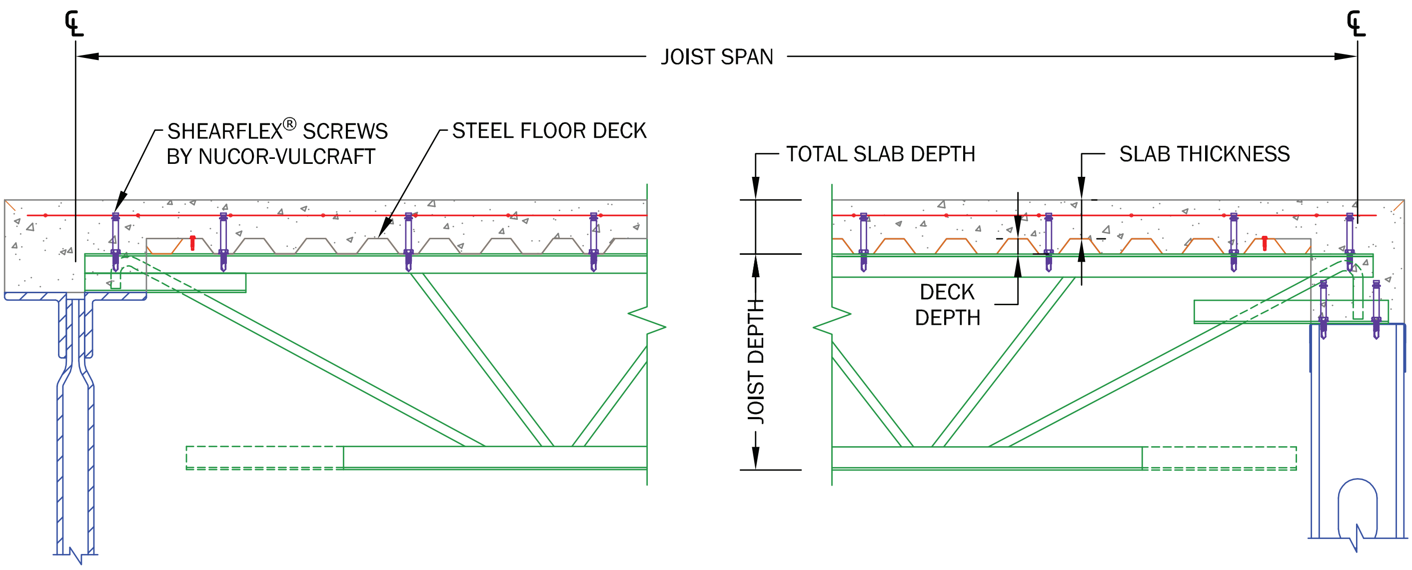

Figure 2-4: Joist Span Detail

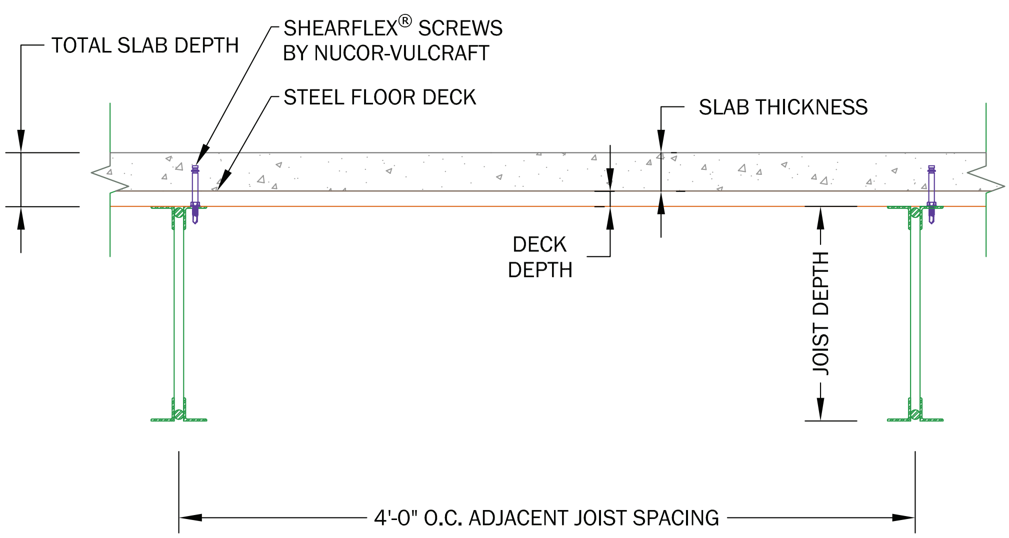

Figure 2-5: Joist Spacing, Joist Depth and Slab Thickness Detail

ECOSPAN® COMPOSITE FLOOR SYSTEM

2.4 Design Parameters Checklist for E-series Joists

Project: ____________________ Area Type: ____________ Date: ____________

Joist Geometry

1. Depth of steel joist ________ inches
2. Span ________ feet
3. Adjacent joist spacing (left) ________ feet
4. Adjacent joist spacing (right) ________ feet

Deck and Concrete

1. Vulcraft floor deck type ________
2. Concrete unit weight ________ pcf
3. Concrete compressive strength ________ psi
4. Slab thickness (above deck) ________ inches

Shearflex® screws

Shearflex® fastener pattern to be determined by Vulcraft National Accounts

Un-factored Design Loads

1. Non-composite dead load
   a. Concrete ________ psf
   b. Joists ________ psf
   c. Decking ________ psf
   d. Bridging ________ psf

   Total ________ psf ________ plf

2. Construction live load ________ psf

3. Composite dead load
   a. Fixed partitions ________ psf
   b. MEP ________ psf
   c. Fire suppression ________ psf
   d. Floor covering ________ psf
   e. Ceiling ________ psf

   Total ________ psf ________ plf

4. Composite live load
   a. Design live load ________ psf
   b. Live load reduction factor ________ %
   c. Reduced design live load ________ psf
   d. Movable partitions ________ psf

   Total ________ psf ________ plf

5. Total non-composite and composite loads ________ psf ________ plf

Camber and Deflection

1. Max. allowable live load deflection = Span / ________
2. Ecospan® Joists are cambered for 100% of non-composite dead load (Typical)
3. Additional Camber for _____ % Composite Dead Load and _____ % Composite Live Load

E-series Joist Designation

________ E ________ / ________ / ________

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2.5 E-series Joist Designation

Figure 2-6 illustrates the format used to designate an E-series joist. Loading numbers are shown in pounds per lineal foot (PLF). Total load is the summation of the un-factored live load, non-composite dead load and composite dead load. (The example shown in Figure 2-6 is based on design loads and joist spacing indicated in Design Example #1 in Section 8.0.)

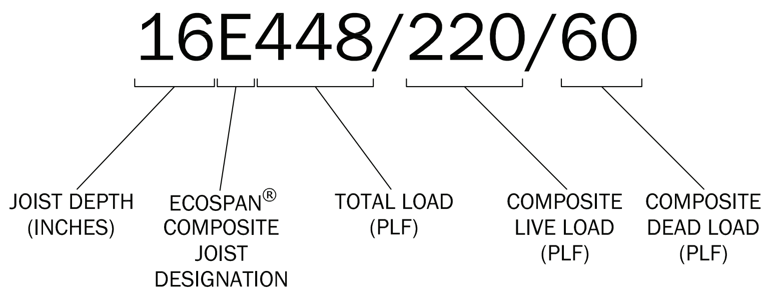

Figure 2-6: E-series Joist Designation Example

2.6 Joist Span Capacity

Ecospan® composite floor joists are designed to meet the requirements specified in the Contract Documents. Information supplied by the Design Professional via the Design Parameters Checklist for E-series Joists (see Section 2.4) will be used by Vulcraft Engineers to design E-series joists and develop shop drawings.

E-series joists are capable of reaching a span-to-depth ratio of L/30 and still meet the serviceability requirements of most floors.

$$\textit{span to depth } (d) \leq \frac{L}{30} = \frac{\textit{span (inches)}}{30}$$

Joist Span Capabilities		
Typical Loading	**Residential** Total load = 112 psf (448 plf) Live Load = 40 psf + 15 psf (220 plf) NC Dead Load = 42 psf (168 plf) Comp Dead Load = 15 psf (60 plf)	**Commercial** Total load = 157 psf (628 plf) Live Load = 100 psf (400 plf) NC Dead Load = 42 psf (168 plf) Comp Dead Load = 15 psf (60 plf)
Depth	Length	Length
10”	25'	25'
12”	30'	30'
14”	35'	34'
16”	40'	36'
18”	45'	39'
20”	49'	41'
22"	52'	43'
24"	54'	45'

Notes: **Table 2-3**

1. Joists are considered to be 4’-0” on center.
2. Table assumes 2½” concrete above deck and 3000 psi concrete strength.

2.7 Ductability

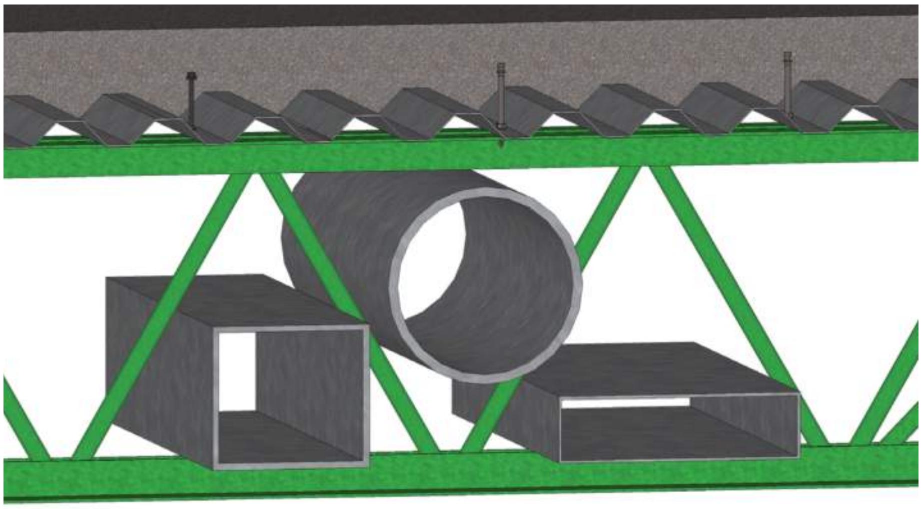

Figure 2-7: Joist Ductability

Ecospan® composite joists are open web steel joists with double angle top and bottom chords and webs consisting of rods or angles. Web configurations are typically uniform for a specific depth of joist. The following table illustrates the approximate duct penetrations for standard E-series joists. When requested, our engineers may modify typical web configurations to align webs or allow additional space for duct penetrations. Vierendeel openings are also available.

Ductability				
Joist		Duct Shapes & Allowable Sizes		
Joist Depth	Panel Distance	Round (diameter)	Square	Rectangular
10”	19”	6”	5”	6”x3”
12”	19”	7”	6”	7”x4”
14”	19”	8”	6”	9”x5”
16”	24”	9”	7”	13”x5”
18”	24”	10”	8”	13”x6”
20”	24”	11”	9”	13”x6”
22”	24”	12”	9.5” x 9.5”	8” x12”
24”	24”	13”	10” x 10”	8” x13”

Table 2-4

2.8 Special Inspections

Provisions for inspection of projects involving Ecospan® shall be included by the Design Professional. Inspection shall include provisions to ensure installation has taken place according to that shown on the Ecospan® Final Plans for Field Use. This inspection shall include checking the concrete strength, and thickness as well as the placement of the Shearflex® screws. This inspection is not provided by Vulcraft.

2.9 Specifications

The following specifications are provided to the Design Professional for the purpose of integrating the Ecospan® system into the Contract Documents for a specific project. The structural system, determined by the Design Professional, shall meet the strength, serviceability, and construction quality requirements of the governing building code for the jurisdiction in which the project is located. The specifications can be downloaded in Word format at www.ecospan-usa.com. Click on '*Design Information*' and the '*Specifications: Section 05 1700 Composite Floor System*' link to download the Ecospan® Specifications.

SECTION 5
COMPOSITE FLOOR SYSTEM

1.1 SUMMARY

A. Section Includes:
   1. Steel floor joists.
   2. Steel decking.
   3. Concrete fill.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Section [03 3200 - Concrete Reinforcement.] [__ ____ - _______.]
   3. Section [03 3000 - Cast-In-Place Concrete.] [__ ____ - _______.]

1.2 REFERENCES

A. American Concrete Institute (ACI) 318 - Building Code Requirements for Structural Concrete.

B. American Welding Society (AWS):
   1. D1.1: Structural Welding Code - Steel.
   2. D1.3: Structural Welding Code - Sheet Steel.

C. ASTM International (ASTM):
   1. A307 - Standard Specification for Carbon Steel Externally Threaded Standard Fasteners.
   2. A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   3. A529 - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
   4. A563 - Standard Specifications for Carbon and Alloy Steel Nuts.
   5. A572/A572M - Standard Specification for High Strength Low Alloy Columbium-Vanadium Steels of Structural Quality.
   6. A653/A653M - Standard Specification for Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   7. A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   8. C1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.
   9. F436 - Standard Specification for Hardened Steel Washers.

D. Society for Protective Coatings (SSPC) - Painting Manual.

E. Steel Deck Institute (SDI) - Manual of Construction with Steel Deck.

F. Steel Joist Institute (SJI) - Standard Specifications and Load Tables for Steel Joists and Joist Girders.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:
1. Design composite floor system including layouts, spans, fasteners, and joints under supervision of a Professional Engineer registered in the State in which the project is located.
2. Design joists to manufacturer's requirements. Camber joists based on [100 percent of non-composite dead load.] [____.]
3. Design welded connections in accordance with AWS D1.1 and D1.3.
4. Where steel deck is not designed to support load, design slab in accordance with recognized construction principles or manufacturer's recommendations.

B. Design system to withstand following un-factored loads:
1. Non-composite dead load:
   a. Concrete: [__] PSF.
   b. Joists: [__] PSF.
   c. Decking: [__] PSF.
   d. Bridging: [__] PSF.
   e. Total: [__] PSF.
2. Construction live load: [__] PSF.
3. Composite dead load:
   a. Fixed partitions: [__] PSF.
   b. Mechanical/Electrical/Plumbing: [__] PSF.
   c. Fire suppression: [__] PSF.
   d. Fireproofing: [__] PSF.
   e. Floor coverings and ceilings: [__] PSF.
   f. Total: [__] PSF.
4. Composite live load:
   a. Design live load: [__] PSF.
   b. Reduction factor: [__] PSF.
   c. Reduced design live load: [__] PSF.
   d. Movable partitions: [__] PSF.
   e. Total: [__] PSF.
5. Total non-composite and composite loads: [__] PSF.
6. Maximum allowable live load deflection: Span/[__].

1.4 SUBMITTALS

A. Submittals for Review:
1. Shop Drawings:
a. Include joist identification numbers, types, locations spacings, bridging, and attachments.
b. Indicate decking plan, support locations, projections through decking, openings, relevant details, and accessories.
2. Product Data: Provide joist and decking profiles, characteristics, dimensions, structural properties, materials, and finishes.

B. Sustainable Design Submittals:
1. Recycled Content: Certify percentages of post-consumer and pre-consumer recycled content, show cost of products containing recycled content, and certify recycled content information source.
2. Regional Materials: Certify that materials have been harvested, extracted, recovered, or manufactured within 500 mile radius of Project site.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Minimum [__] years [documented] experience in work of this Section.

B. Welder Qualifications: AWS D1.1 and D1.3.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store joists off ground. Prevent corrosion and damage.

B. Store decking in accordance with SDI recommendations, off ground at site, with one end elevated to provide drainage; protect with waterproof covering, properly vented.

C. Place decking bundles on structural steel members per SDI MOC2.

D. Tie down loose decking bundles to prevent wind damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Contract Documents are based on Ecospan™ by Vulcraft/Verco Group.

B. Substitutions: [Under provisions of Division 01.] [Not permitted.]

2.2 MATERIALS

A. Steel Shapes:
  1. ASTM A572/A572M, Grade 50, or ASTM A 529, Grade 50.
  2. Recycled content: Minimum [__] percent recycled steel, with minimum [__] percent classified as post consumer.

B. Galvanized Steel Sheet:
  1. ASTM A653/A653M.
  2. Recycled content: Minimum [__] percent, with minimum [__] percent classified as post consumer.

**** OR ****

C. Steel Sheet:
  1. ASTM A1008/A1008M.
  2. Recycled content: Minimum [__] percent recycled steel, with minimum [__] percent classified as post consumer.

D. Slab Reinforcement: Specified in Section [03 2000;] [__ ____;] minimum 6 x 6 inch, W1.4 x W1.4 welded wire mesh, minimum yield strength of 60,000 PSI unless otherwise required by system design.

E. Concrete: Specified in Section [03 3000;] [__ ____;] minimum 3000 PSI compressive strength at 28 days unless noted otherwise.

2.3 ACCESSORIES

A. Bolts, Nuts, and Washers: ASTM A307, ASTM A325, ASTM A563, ASTM F436.

B. Screws: ASTM C1513.

C. Touch-Up Paint for Galvanized Surfaces: SSPC Paint 20, Type I or II.

D. Shear Connectors: Shearflex® screws manufactured by Elco Fastening Systems LLC; size required by system design.

E. Welding Materials: AWS D1.1 and D1.3; type required for materials being welded.

2.4 FABRICATION OF JOISTS

A. Fabricate joists in accordance with manufacturer's Information and Design Manual and approved Shop Drawings.

B. Final approval from the specifying design professional required prior to fabrication.

C. Top and Bottom Chord Members: Two equal sized angles with minimum yield strength of 50,000 PSI.

D. Web Members: Round rod, crimped or un-crimped angles, minimum yield strength of 50,000 PSI.

E. Provide joists with either flush or standard joist bearing seats.

F. Welding materials and methods to conform to SJI requirements.

G. Apply manufacturer's standard gray primer except where noted on contract documents.

2.5 FABRICATION OF DECKING

A. Manufacture decking and accessories to SDI Design Manual and approved Shop Drawings.

B. Manufacture decking from 16 to 26 gage galvanized steel sheets to [1] [1-5/16] [1-1/2] [2] [3] inch depth.

C. Detail deck units to span three or more supports when possible, with lapped ends and nesting side laps.

D. Accessories: Fabricate in accordance with manufacturer's instructions.

E. Finish: [Uncoated.] [Manufacturer's standard gray primer.] [Galvanized, G60 coating class.]

PART 3 - EXECUTION

3.1 ERECTION OF JOISTS

A. Erect joists and accessories in accordance with manufacturer's instructions, SJI Specifications, and approved Shop Drawings.

B. Lift and support joists in the upright position during unloading and erection.

C. Place joists plumb, at elevations, lines, and spacings indicated on approved Shop Drawings.

D. Complete joist attachment to supporting members before placing decking. Complete joist and decking attachments in each bay prior to applying construction loads.

E. Provide minimum bearing length of 2-1/2 inches on steel, 4 inches on masonry or concrete, or per approved Shop Drawings.

F. Install horizontal bridging as indicated on approved Shop Drawings prior to installing decking. Terminate horizontal bridging rows with X-bridging or positive anchorage to wall prior to placing decking.

G. Provide for distribution of concentrated loads incurred during erection.

H. Welding to conform to manufacturer's requirements.

I. Provide supplemental framing at openings where indicated on approved Shop Drawings.

J. Do not make corrections or alterations to joists without manufacturer's approval.

3.2 INSTALLATION OF DECKING

A. Install decking and accessories in accordance with manufacturer's instructions and approved Shop Drawings.

B. Lap ends minimum of 3 inches for form deck. Center laps over supports. Nest side laps.

C. Place decking flat and square, without warp or deflection.

D. Provide minimum 1-1/2 inches of bearing on steel.

E. Mechanically fasten or weld decking to supporting members as indicated on approved Shop Drawings. Deck may be tack welded to secure in position before shear connectors are installed. Welding to conform to AWS D1.3.

F. Install shear connectors at spacings indicated on approved Shop Drawings. Drive shear connectors using equipment provided by manufacturer, through decking and into joist top cord, until bottom collar is tight against decking.

G. Cut and fit deck units and accessories at perimeter and around projections and openings. Make cuts neat and trim.

H. Install pour stops at edges and around projections and openings, upturned to top of slab.
   1. Provide pour stops of sufficient strength to remain stationary under weight of wet concrete without distortion.
   2. Screw or weld pour stops in place.

3.3 PLACEMENT OF CONCRETE

A. Place concrete reinforcement as specified in Section [03 3200.] [__ ____.] Make laps in accordance with ACI 318 and SDI MOP2.

B. Place concrete as specified in Section [03 3000] [__ ____] and SDI MOC2.

C. Maintain minimum concrete thicknesses indicated.

D. Locate slab openings not shown on approved Shop Drawings minimum 6 inches from edge of top chord of joists.

E. Terminate concrete placement perpendicular to top chord wherever possible. Placement may be terminated parallel to joists only at mid-span between joists.

F. Locate construction joints parallel to joist midway between joists. Locate construction joints perpendicular to joist over supporting member.

3.4 FIELD QUALITY CONTROL

A. Testing Laboratory Services:
   1. Inspect joists for conformance to specified requirements:
      a. Verify placement including location, alignment, and bearing.
      b. Inspect joist-to-seat and seat-to-support welds.
   2. Inspect decking for conformance to specified requirements:
      a. Verify decking type and gage.
      b. Verify decking placement and alignment.
      c. Inspect welds and weld pattern.
      d. Inspect fastener types, locations, quantities, and placement.

3.5 ADJUSTING

A. Clean welds and abrasions after erection.

B. Touch up painted surfaces with same primer as originally applied.

C. Touch up galvanized coatings with galvanizing repair paint; apply as recommended by manufacturer.

END OF SECTION

3.0 Technical Resources for the Design Professional

3.1 Joist Configuration

E-series joist are detailed and produced using the same practices and base materials that K-series or CJ-series joists utilize. Top chords and bottom chords are double angles and the webs are typically solid rods, but can be crimped angles or rectangular stock depending on span or joist depth. Figure 3-1 below illustrates the typical configuration of E-series joist utilizing a flush seat on the left end and an extended bearing seat on the right. Design Professionals should be familiar with the standard nomenclature used to specify and detail open-web joists, but the E-series permits a larger range of seat configurations and bearing conditions.

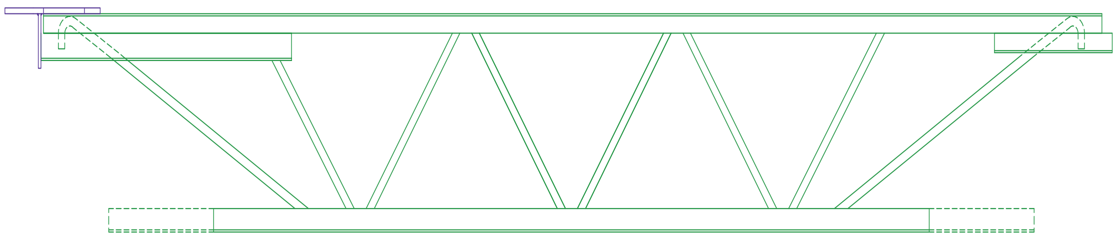

Figure 3-1

3.2 Joist Bearing Conditions

E-series joists may bear on numerous structural systems. The Ecospan® Composite Floor System has been erected on hot-rolled structural steel, CFS load bearing walls, masonry, CIP concrete walls, ICF concrete walls, and even proprietary wall systems. In each case, the Ecospan® Detailer and Engineer worked with the Design Professional to provide a bearing seat configuration that is easily erected and economical to produce.

Figure 3-2: Standard Bearing Seat

Figure 3-3: Extended Bearing Seat

Figure 3-4: Gapped Bearing Seat

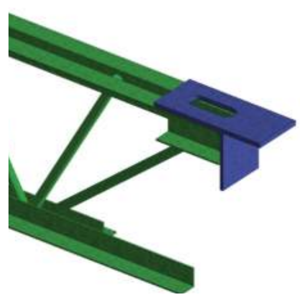

Figure 3-5: Flush Bearing Seat

3.2.1 Joist Seat Reactions

Table 3-1 illustrates the linear relationship between the seat depth and reaction location. For example, a 2 ½" deep joist seat will typically put the joist reaction at 2" from the face of the support. As shown in Figure 3-8, using a 6" CFS wall would result in a 1" eccentricity.

To match masonry coursing depth and to account for seat rotation tendencies, 4½" deep joist seats are commonly used in Ecospan™ projects (see Figure 3-9).

4½" seat + 1" deck + 2½" concrete = 8" nominal = standard 8" block

Joist Seat Reactions	
Joist Seat Depth (in)	**Reaction Location (in)**
2.50	2.00
3.00	2.40
3.50	2.80
4.00	3.20
4.50	3.60
5.00	4.00

Table 3-1

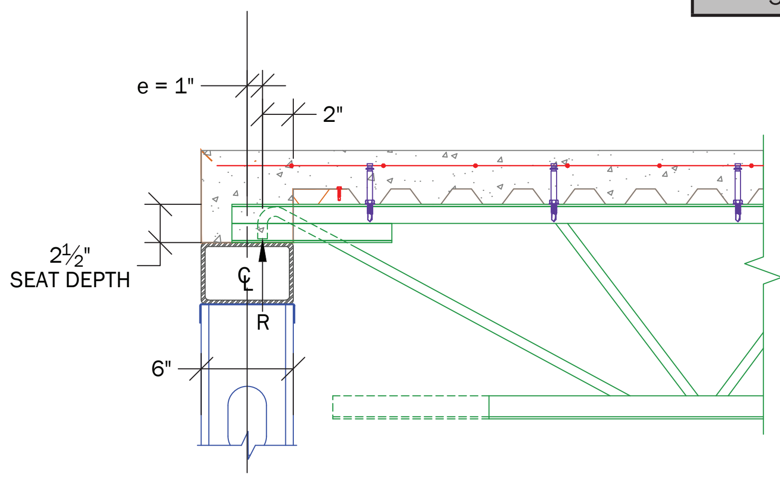

Figure 3-8: Seat Reaction Location with 2½"depth on CFS

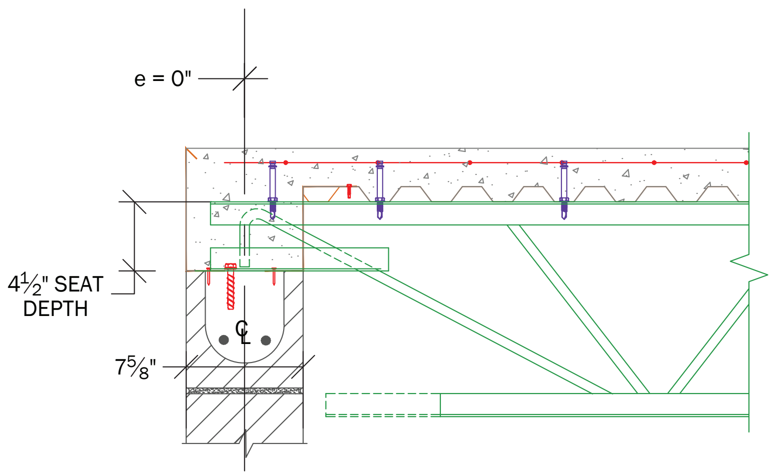

Figure 3-9: Seat Reaction Location with 4½" depth on CMU

3.2.2 Flush Seat

The Design Professional may choose to utilize a flush joist seat to meet floor to ceiling requirements. The flush seat may minimize overall floor thicknesses, but is limited to moderate joist reactions to 10 kips.

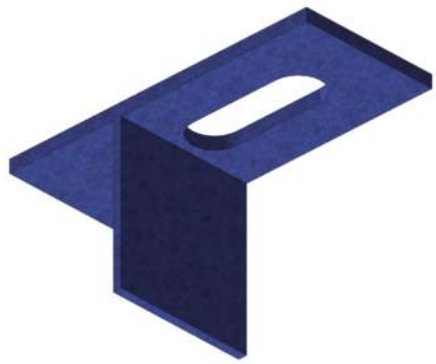

Figure 3-10: Flush Seat – Isometric View

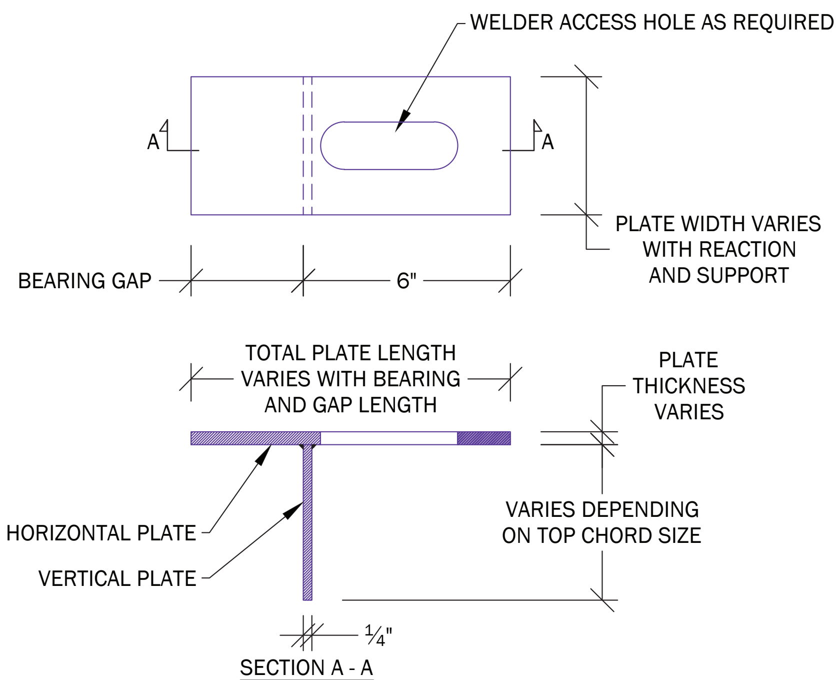

Figure 3-11: Flush Seat Details

3.3 Joist Attachment to Supporting Members

The Ecospan® Composite Floor System utilizes numerous attachment methods depending on the support system used. The required attachment method may also be determined by the joist seat type being used. The following details indicate the minimum joist attachment requirements for various walls systems. Joists should be attached in accordance with the Final Plans for Field Use.

3.3.1 Cold-Formed Steel Studs (CFS)

E-series joists bearing on Cold-Formed Steel Studs are normally attached using two self tapping screws. However, attaching with a 1/8" fillet weld two inches long on each side of the joist seat is also an acceptable method. E-series joists should bear on supporting CFS at least 2½", but Design Professionals must consider eccentric bearing where the joist reaction is not centered on the supporting wall. Generally, flush seats will not be utilized on a CFS wall system.

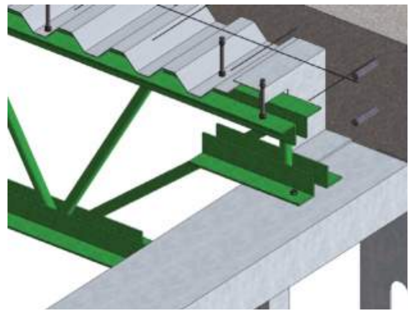

Figure 3-12: CFS Bearing

3.3.2 Hot-Rolled Steel

E-series joists bearing on structural steel are normally attached to the support with the SJI standard weld (two 1/8" fillet welds two inches long). Where flush seats are used (see section 3.2.2) the weld to support must be at least two 1/8" fillet welds 1½" long, to provide adequate restraint for the horizontal plate. E-series joists should bear on supporting steel at least 2½".

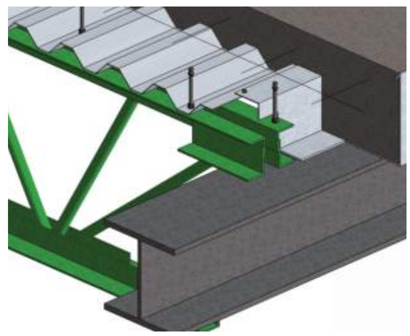

Figure 3-13: Steel Bearing

3.3.3 Grouted CMU

E-series joists bearing on CMU/Masonry are normally attached to the support with two masonry screws. Slots or holes are shop installed to accommodate anchor bolts. E-series joists should bear on supporting CMU at least 4". The Ecospan® Composite Floor System does not require bearing plates when utilizing a CMU/Masonry wall system. E-series joist seats are designed to resist allowable bearing pressures exerted by supporting CMU.

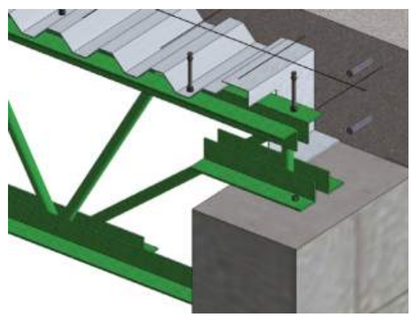

Figure 3-14: CMU/Masonry Bearing

3.3.4 Concrete

E-series joists bearing on concrete are normally attached to the support with two masonry screws. Slots or holes are shop installed to accommodate anchor bolts. E-series joists should bear on supporting concrete at least 4". The Ecospan® Composite Floor System does not require bearing plates when utilizing a concrete wall system. E-series joist seats are designed to resist allowable bearing pressures exerted by supporting concrete.

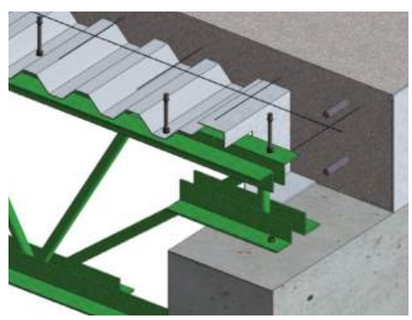

Figure 3-15: Concrete Bearing

3.3.5 Insulated Concrete Forms (ICF)

E-series joists bearing on Insulated Concrete Forms are normally attached using masonry screws. This attachment method applies also to flush seats. E-series joists should bear on supporting ICF at least 4”. When concrete for the wall and slab is placed monolithically, joists will need to be shored directly beneath the joist seat at the inside face of the wall. This bracing system should remain until the concrete cures sufficiently.

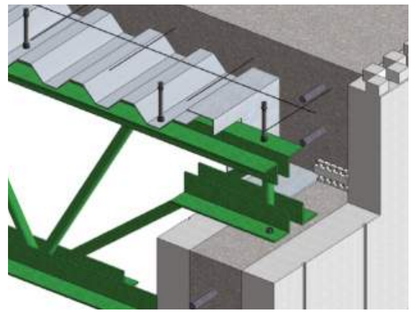

Figure 3-16: ICF Bearing

3.4 Vibration and Serviceability Considerations

As in all structural systems, serviceability considerations related to vibration perception should be understood for each project where the Ecospan® Composite Floor System is used. Evaluating the vibration response of an Ecospan® Composite Floor System can be completed with reasonable ease by utilizing the AISC Design Guide 11: "Floor Vibrations Due to Human Activity". Joist and slab properties for typical spans for the Ecospan® Composite Floor System are shown in Table 3-2 and can be used to complete the vibration evaluation expressed in the AISC Design Guide 11.

3.4.1 Evaluating Vibration in Composite Joist Floors

Evaluating the vibration response of an Ecospan® Composite Floor System requires the evaluation of the supporting structural system. Design Professionals must review the supporting structure and ancillary framing to determine the dynamic response and dampening properties. Vibration response of a structural steel support structure will differ from a load bearing wall system. Open office spaces will have lower damping coefficients than residential units where full height partition walls provide extensive damping.

Nucor-Vulcraft has sponsored extensive vibration testing of numerous open web floor systems for the development of more accurate evaluation of open-web joist floor responses.

3.4.2 Vibration Characteristics of Ecospan® Composite Joists

The information shown in Table 3-2 displays the design properties for an Ecospan® joist designed with residential design loads. E-series design parameters are 468/160/140, spaced at 4’-0” o.c. with a 2½” thick, 3,000 psi normal weight concrete slab, and variable span to depth ratios. Design properties shown in the table should only be used by Design Professionals knowledgeable in vibration evaluation.

3.4.3 Deflection

E-Series joists are typically cambered for the non-composite dead load of the concrete, joists, decking, and bridging. This provides a flat floor following the placement of the concrete. The EOR also has the option of cambering for the actual predicted dead and live loads applied after the concrete slab has hardened. However, since actual live loading commonly falls between 10 – 25% of the design live load, it is not recommended to consider the live loads when calculating camber.

ECOSPAN® COMPOSITE FLOOR SYSTEM

Vibration Characteristics of Ecospan® Composite Joists
(Joist Bearing on Load Bearing Walls, i.e. CFS, CIP Concrete or CMU)

Joist Type	Span / Depth	Length (ft)	Joist I_{xx} (in^4)	Composite Joist I_{eff} (in^4)	Peak Acceleration (a_p /g)		
					β- 0.03	β- 0.05	β- 0.08
10E448/220/60	L/12	10'-0"	22	40	0.06%	0.04%	0.02%
	L/14	11'-8"	22	42	0.20%	0.12%	0.08%
	L/16	13'-4"	22	43	0.42%	0.25%	0.16%
	L/18	15'-0"	22	45	0.67%	0.40%	0.25%
	L/20	16'-8"	25	55	0.77%	0.46%	0.29%
	L/22	18'-4"	25	58	0.96%	0.58%	0.36%
	L/24	20'-0"	27	69	1.00%	0.60%	0.38%
	L/26	21'-8"	33	85	1.01%	0.60%	0.38%
	L/28	23'-4"	35	92	1.07%	0.64%	0.40%
	L/30	25'-0"	43	108	1.07%	0.64%	0.40%
12E448/220/60	L/12	12'-0"	32	55	0.14%	0.08%	0.05%
	L/14	14'-0"	32	57	0.36%	0.21%	0.13%
	L/16	16'-0"	32	59	0.62%	0.37%	0.23%
	L/18	18'-0"	37	72	0.74%	0.45%	0.28%
	L/20	20'-0"	41	87	0.84%	0.50%	0.31%
	L/22	22'-0"	41	92	0.98%	0.59%	0.37%
	L/24	24'-0"	47	112	0.99%	0.59%	0.37%
	L/26	26'-0"	57	137	0.98%	0.59%	0.37%
	L/28	28'-0"	66	157	0.99%	0.60%	0.37%
	L/30	30'-0"	72	170	1.02%	0.61%	0.38%
14E448/220/60	L/12	14'-0"	45	71	0.24%	0.14%	0.09%
	L/14	16'-4"	45	74	0.51%	0.31%	0.19%
	L/16	18'-8"	45	77	0.78%	0.47%	0.29%
	L/18	21'-0"	51	95	0.87%	0.52%	0.33%
	L/20	23'-4"	57	116	0.92%	0.55%	0.35%
	L/22	25'-8"	69	144	0.94%	0.56%	0.35%
	L/24	28'-0"	75	174	0.94%	0.56%	0.35%
	L/26	30'-4"	85	202	0.95%	0.57%	0.36%
	L/28	32'-8"	103	238	0.94%	0.56%	0.35%
	L/30	35'-0"	116	269	0.93%	0.56%	0.35%
16E448/220/60	L/12	16'-0"	59	90	0.35%	0.21%	0.13%
	L/14	18'-8"	59	94	0.64%	0.38%	0.24%
	L/16	21'-4"	67	116	0.76%	0.46%	0.29%
	L/18	24'-0"	77	141	0.85%	0.51%	0.32%
	L/20	26'-8"	86	173	0.88%	0.53%	0.33%
	L/22	29'-4"	102	215	0.89%	0.53%	0.33%
	L/24	32'-0"	123	260	0.88%	0.53%	0.33%
	L/26	34'-8"	138	304	0.88%	0.53%	0.33%
	L/28	37'-4"	160	347	0.87%	0.52%	0.33%
	L/30	40'-0"	174	400	0.85%	0.51%	0.32%
18E448/220/60	L/12	18'-0"	76	112	0.45%	0.27%	0.17%
	L/16	24'-0"	95	166	0.75%	0.45%	0.28%
	L/20	30'-0"	123	238	0.86%	0.52%	0.32%
	L/24	36'-0"	170	369	0.83%	0.50%	0.31%
	L/28	42'-0"	217	473	0.82%	0.49%	0.31%
20E448/220/60	L/12	20'-0"	107	163	0.43%	0.26%	0.16%
	L/16	26'-8"	123	205	0.79%	0.47%	0.30%
	L/20	33'-4"	164	330	0.81%	0.49%	0.31%
	L/24	40'-0"	235	508	0.78%	0.47%	0.29%
	L/28	46'-8"	296	645	0.76%	0.46%	0.28%

Notes: **Table 3-2**

1. Design Criteria is based on the dynamic response of the support structure and the Ecospan® Composite Floor System. The peak acceleration (a_p) as a fraction of the acceleration of gravity (g) shall not exceed the acceleration limit a_o/g.

2. The composite joist (I_{eff}) shown in the table above has been modified for the effects of joist seats, shear deformation and eccentricity of joints per the AISC Design Guide 11.

3. Composite Section Properties are determined using the Dynamic Modulus Ratio (E/1.35*Ec) per AISC Design Guide 11.

NUCOR VULCRAFT/VERCO GROUP

3.5 Shearflex® Screw Fastener

Shearflex® shear connectors undergo a dual process heat treatment during production which enables rapid installation and proper ductility during loading.

3.5.1 Installation Requirements

A Shearset® Tool (supplied by Vulcraft) is used to install the Shearflex® screws. Installation by other means may damage the screw and its ability to function properly. Shearflex® connectors must be screwed through the deck and top chord of the Ecospan® joist until the bottom collar of the screw makes contact with the deck and tightly clamps the deck to the joist top chord (see Figure 3-17).

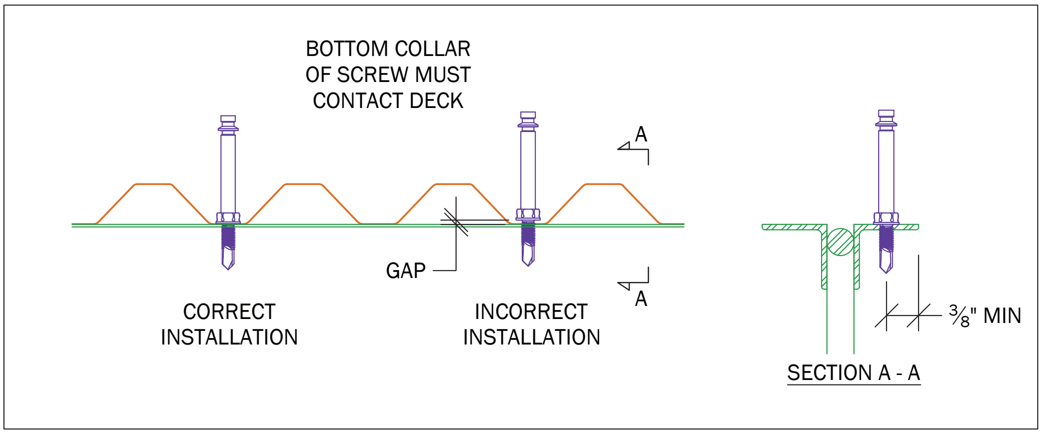

Figure 3-17: Correct Shearflex® Screw Installation

Figure 3-18: Shearset® Tool

3.5.2 Fastener Pattern

Shearflex® connectors shall be located and installed in accordance with the Final Plans for Field Use. Screws will typically be installed based on one of the following Screw Attachment Patterns in Figure 3-19. Screws must be installed alternating between joist top chords (see Figure 3-20).

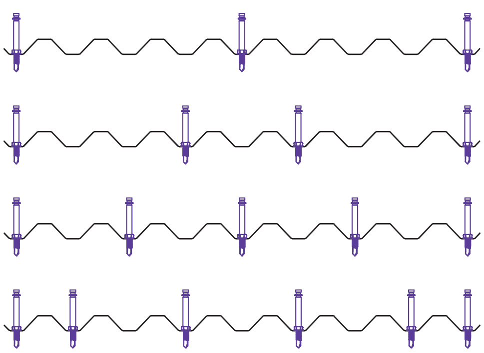

Figure 3-19: Shearflex® Screw Attachment Patterns

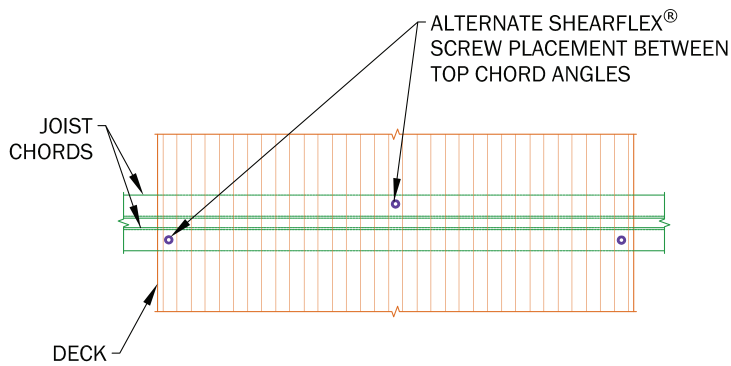

Figure 3-20: Alternate Joist Top Chords

3.5.3 Shearflex® Screw Fastener Capacity

Extensive testing of the behavior of the Shearflex® stand-off screws used in the Ecospan® Composite Floor System has been completed. Design values used for Shearflex® screws in the design of composite E-series joists were developed based on analytical modeling, small scale push-off testing, and also ten full scale joist tests. The Shearflex® screw capacities are based on tested values and shown in Table 3-3. Design values for top chord material thicknesses not shown may be interpolated between the thicknesses that are shown. Provide one screw per flute maximum on each joist.

Shearflex® Capacities			
Deck Type	**Screw Diameter**	**Material Thickness (in)**	**Q_n (kips)**
1.0C	5/16”	0.109	4.0
		0.138	4.0
		0.155	4.3
		0.187	5.3
		0.250	3.8

1. Q_n = Nominal shear strength of one Shearflex® fastener.

Table 3-3

3.6 Steel Deck Design Information

Steel deck supplied as part of the Ecospan® Composite Floor System acts as a form for the concrete and may be utilized as part of the gravity load supporting system. Deck properties and allowable design loads shown in Tables 3-4 through 3-17 were developed according to the North American Specification for the Design of Cold-formed Steel Structural Members and ANSI/SDI-NC1.0 Standard for Non-Composite-Steel Floor Deck.

Many Design Professionals rely on concrete and welded wire reinforcement to support the gravity loads by using concrete beam theory. As an alternate the steel deck can be specified to support live and dead loads in the Ecospan® Composite Floor System.

3.6.1 Concrete Reinforcement

It is the Design Professional’s responsibility to determine welded wire reinforcement, blended fiber-mesh or reinforcing bar quantities for temperature and shrinkage control in the concrete slab. Wire Reinforcing Institute documents WRI TF207-R and TF209-R provide design information regarding welded wire reinforcement and deformed bar reinforcement. Information concerning blended fiber reinforcing for slabs meeting ASTM C1116 may be supplied by Grace Concrete Products (www.na.graceconstruction.com/strux) for Strux 90/40 or Propex Concrete Systems (www.fibermesh.com) for Novomesh 850.

3.6.2 Concrete Reinforcement Recommendations

The Design Professional should specify reinforcing if the specified steel deck has not been designed to support full gravity loads. Tables 3-4 and 3-5 provide guidelines for typical (3) span conditions of 1.0C and 1.3C deck. Superimposed load values shown in bold type require that mesh be draped.

1.0C Welded Wire Fabric Recommendations							
Total Slab Depth (in)	Welded Wire Reinforcement	Superimposed Uniform Load (psf) 3 span Condition					
		Clear Span (ft- in)					
		3'- 6	4'- 0	4'- 6	5'- 0	5'- 6	6'- 0
3.50	6x6-W2.1xW2.1	176	134	106	86	71	
4.00	6x6-W2.1xW2.1	212	162	128	**153**	**126**	**106**
4.50	6x6-W2.1xW2.1	248	190	150	**180**	**148**	**125**
5.00	6x6-W2.9xW2.9	390	298	236	**278**	**230**	**193**
6.00	6x6-W2.9xW2.9	400	375	296	**352**	**291**	**244**

Table 3-4

1.3C Welded Wire Fabric Recommendations							
Total Slab Depth (in)	Welded Wire Reinforcement	Superimposed Uniform Load (psf) 3 span Condition					
		Clear Span (ft- in)					
		4'- 0	4'- 6	5'- 0	5'- 6	6'- 0	6'- 6
4.00	6x6-W2.1xW2.1	144	114	92	76	64	
4.50	6x6-W2.1xW2.1	172	136	**170**	**140**	**118**	**100**
5.00	6x6-W2.1xW2.1	199	158	**205**	**170**	**143**	**121**
5.50	6x6-W2.9xW2.9	311	246	**314**	**260**	**218**	**186**
6.00	6x6-W2.9xW2.9	350	276	**351**	**290**	**244**	**208**

Table 3-5

3.6.3 Concrete Placement

With the camber present in an E-Series joist, it is suggested that the concrete be placed across the full length of the composite joist at a constant thickness. Benefits for doing this include the following:

- Resulting deflections of the E-Series joist can be more accurately predicted if the concrete is placed at a constant thickness.
- The potential for concrete over runs is greatly reduced.
- Sufficient concrete cover over the tops of the Shearflex® fasteners can more easily be obtained.
- UL fire ratings require a minimum slab depth.
- Having a uniform concrete depth is beneficial for carrying composite forces transferred into the concrete slab by the shear connectors.

Concrete construction joints should be placed between the longitudinal axis of E-Series joists. Should a concrete construction joint fall within 12 inches of the longitudinal axis of the E-Series joist, it is the responsibility of the Design Professional to determine if extra transverse reinforcing steel is required.

3.6.4 Concrete Curing

The concrete slab shall be cured following recommended ACI 308 "Standard Practice for Curing Concrete", ACI Manual of Concrete Practice, Part 2, American Concrete Institute.

3.6.5 1.0C and 1.3C Section Properties

1.0C steel deck is the typical deck supplied with the Ecospan® Composite Floor System. Where 1.0C deck is not available, the Design Professional can utilize the 1.3C deck profile. Tables 3-6 and 3-7 indicate section properties for 1.0C and 1.3C conform deck.

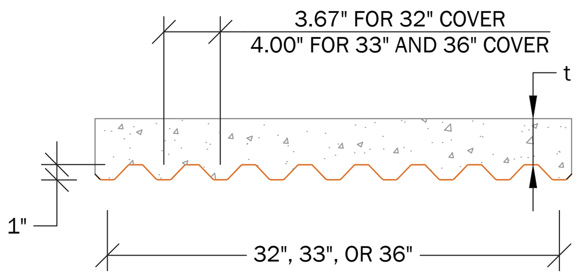

Figure 3-21: 1.0C Conform Deck Profile

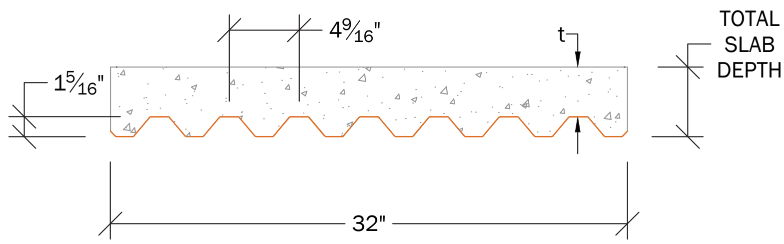

Figure 3-22: 1.3C Conform Deck Profile

1.0C Section Properties								
Deck Type	Design Thickness	Weight (PSF)	I_p in^4/ft	I_n in^4/ft	S_p in^3/ft	S_n in^3/ft	V_a lbs/ft	F_y ksi
1.0C26	0.0179	0.96	0.040	0.042	0.067	0.071	2216	60
1.0C24	0.0239	1.28	0.057	0.059	0.098	0.103	3867	60
1.0C22	0.0298	1.57	0.073	0.073	0.130	0.134	4803	60
1.0C20	0.0358	1.91	0.088	0.088	0.167	0.165	5744	60

Table 3-6

1.3C Section Properties								
Deck Type	Design Thickness	Weight (PSF)	I_p in^4/ft	I_n in^4/ft	S_p in^3/ft	S_n in^3/ft	V_a lbs/ft	F_y ksi
1.3C26	0.0179	0.99	0.070	0.069	0.097	0.098	1940	60
1.3C24	0.0239	1.33	0.093	0.093	0.132	0.132	3458	60
1.3C22	0.0298	1.62	0.115	0.115	0.163	0.162	4789	60
1.3C20	0.0358	1.97	0.140	0.140	0.197	0.197	5727	60

Table 3-7

3.6.6 1.0C and 1.3C Deck Span Tables

The following tables represent the standard deck gauges and spans utilized with E-series joists in residential construction. Design Professionals should refer to the Vulcraft Steel Roof and Floor Deck and Verco catalogs for additional spans not shown below in Table 3-8 and 3-9.

1.0C Maximum Construction Clear Spans (S.D.I. Criteria)				
Total Slab Depth (in)	SDI Max. Unshored Normal Weight Concrete 145 PCF			
	Deck Type	Clear Span (ft- in)		
		1 span	2 span	3 span
3.50 (t=2.50) 38 PSF	1.0C26	3'- 4	4'- 4	4'- 5
	1.0C24	4'- 4	5'- 9	5'- 10
	1.0C22	5'- 3	6'- 10	6'- 10
	1.0C20	5'- 11	7'- 3	7'- 3
4.00 (t=3.00) 44 PSF	1.0C26	3'- 2	4'- 2	4'- 3
	1.0C24	4'- 2	5'- 6	5'- 7
	1.0C22	5'- 0	6'- 6	6'- 6
	1.0C20	5'- 7	6'- 11	6'- 11
4.50 (t=3.50) 50 PSF	1.0C26	3'- 1	4'- 1	4'- 1
	1.0C24	4'- 0	5'- 4	5'- 4
	1.0C22	4'- 9	6'- 3	6'- 3
	1.0C20	5'- 4	6'- 8	6'- 8
5.00 (t=4.00) 56 PSF	1.0C26	2'- 11	3'- 11	4'- 0
	1.0C24	3'- 10	5'- 1	5'- 2
	1.0C22	4'- 7	6'- 0	6'- 0
	1.0C20	5'- 2	6'- 5	6'- 5
6.00 (t=5.00) 68PSF	1.0C26	2'- 10	3'- 8	3'- 9
	1.0C24	3'- 7	4'- 9	4'- 10
	1.0C22	4'- 4	5'- 7	5'- 7
	1.0C20	4'- 10	6'- 0	6'- 0

Table 3-8

1.3C Maximum Construction Clear Spans (S.D.I. Criteria)				
Total Slab Depth	SDI Max. Unshored Normal Weight Concrete 145 PCF			
	Deck Type	Clear Span (ft- in)		
		1 span	2 span	3 span
4.00 (t=2.70) 42 PSF	1.3C26	4'- 2	5'- 6	5'- 7
	1.3C24	5'- 1	6'- 10	6'- 11
	1.3C22	5'- 10	7'- 8	7'- 8
	1.3C20	6'- 7	8'- 2	8'- 2
4.50 (t=3.20) 48 PSF	1.3C26	4'- 0	5'- 4	5'- 4
	1.3C24	4'- 11	6'- 6	6'- 7
	1.3C22	5'- 7	7'- 4	7'- 4
	1.3C20	6'- 3	7'- 10	7'- 10
5.00 (t=3.70) 54 PSF	1.3C26	3'- 10	5'- 1	5'- 2
	1.3C24	4'- 8	6'- 3	6'- 4
	1.3C22	5'- 4	7'- 0	7'- 0
	1.3C20	6'- 0	7'- 6	7'- 6
5.50 (t=4.20) 60 PSF	1.3C26	3'- 8	4'- 11	5'- 0
	1.3C24	4'- 6	6'- 1	6'- 1
	1.3C22	5'- 2	6'- 10	6'- 10
	1.3C20	5'- 9	7'- 3	7'- 3
6.00 (t=4.70) 66 PSF	1.3C26	3'- 7	4'- 7	4'- 10
	1.3C24	4'- 5	5'- 10	5'- 11
	1.3C22	5'- 0	6'- 7	6'- 7
	1.3C20	5'- 7	7'- 0	7'- 0

Table 3-9

3.6.7 1.0C and 1.3C Allowable Uniform Load

The following tables represents load capacities for standard deck gauges and spans utilized with E-series joists in residential construction. Design Professionals should refer to the Vulcraft Steel Roof and Floor Deck and Verco catalogs for additional loads and spans not shown below in Tables 3-10 and 3-11.

1.0C Allowable Uniform Load (psf)								
Deck Type	No. of Spans	Design Criteria	Load (psf)					
			Clear Span (ft.-in.)					
			3'- 6	4'- 0	4'- 6	5'- 0	5'- 6	6'- 0
1.0C26	1	F_b = 36,000	131	100	79	64	53	45
		Defl. = ℓ/240	61	41	29	21	16	12
	2	F_b = 36,000	138	106	84	68	56	47
		Defl. = ℓ/240	151	101	71	52	39	30
	3	F_b = 36,000	171	132	104	84	70	59
		Defl. = ℓ/240	118	79	56	41	30	23
1.0C24	1	F_b = 36,000	192	147	116	94	78	65
		Defl. = ℓ/240	87	58	41	30	22	17
	2	F_b = 36,000	200	153	121	98	81	68
		Defl. = ℓ/240	214	143	101	73	55	42
	3	F_b = 36,000	249	191	151	123	102	85
		Defl. = ℓ/240	167	112	79	57	43	33
1.0C22	1	F_b = 36,000	254	195	154	125	103	86
		Defl. = ℓ/240	112	75	53	38	29	22
	2	F_b = 36,000	260	200	158	128	106	89
		Defl. = ℓ/240	269	180	127	92	69	53
	3	F_b = 36,000	324	249	197	160	132	111
		Defl. = ℓ/240	211	141	99	72	54	42
1.0C20	1	F_b = 36,000	327	250	198	160	132	111
		Defl. = ℓ/240	135	90	63	46	35	27
	2	F_b = 36,000	320	246	194	158	130	109
		Defl. = ℓ/240	324	217	153	111	84	64
	3	F_b = 36,000	399	306	242	197	163	137
		Defl. = ℓ/240	254	170	119	87	65	50

Table 3-10

1.3C Allowable Uniform Load (psf)								
Deck Type	No. of Spans	Design Criteria	Load (psf)					
			Clear Span (ft.-in.)					
			4'- 0	4'- 6	5'- 0	5'- 6	6'- 0	6'- 6
1.3C26	1	F_b = 36,000	145	115	93	77	65	55
		Defl. = $\ell/240$	72	50	37	28	21	17
	2	F_b = 36,000	144	114	93	77	65	55
		Defl. = $\ell/240$	172	121	88	66	51	40
	3	F_b = 36,000	179	142	115	96	81	69
		Defl. = $\ell/240$	134	94	69	52	40	31
1.3C24	1	F_b = 36,000	198	156	126	105	88	75
		Defl. = $\ell/240$	95	67	49	37	28	22
	2	F_b = 36,000	196	155	126	104	87	75
		Defl. = $\ell/240$	230	161	118	88	68	54
	3	F_b = 36,000	243	193	157	130	109	93
		Defl. = $\ell/240$	180	126	92	69	53	42
1.3C22	1	F_b = 36,000	244	193	156	129	108	92
		Defl. = $\ell/240$	118	83	60	45	35	27
	2	F_b = 36,000	241	190	154	128	107	92
		Defl. = $\ell/240$	284	199	145	109	84	66
	3	F_b = 36,000	300	237	193	159	134	114
		Defl. = $\ell/240$	222	156	114	86	66	52
1.3C20	1	F_b = 36,000	295	233	189	156	131	112
		Defl. = $\ell/240$	144	101	74	55	43	33
	2	F_b = 36,000	292	232	188	155	131	111
		Defl. = $\ell/240$	346	243	177	133	102	81
	3	F_b = 36,000	364	289	234	194	163	139
		Defl. = $\ell/240$	271	190	139	104	80	63

Table 3-11

3.6.8 Corridor Deck Span Tables and Section Properties

The following tables may be utilized to specify the proper composite steel deck for corridors and other single span conditions with varying concrete thicknesses. Design Professionals should refer to the Vulcraft Steel Roof and Floor Deck catalog for additional spans not shown in Tables 3-12 through 3-19.

When utilizing 1.5VL, 1.5VLR, 2VLI, or 3VLI steel deck in the corridor with construction details as described in UL D902, D916, and other appropriate listings; fire ratings can be obtained for 1, 1-1/2, and 2 hours without the utilization of a rated ceiling assembly.

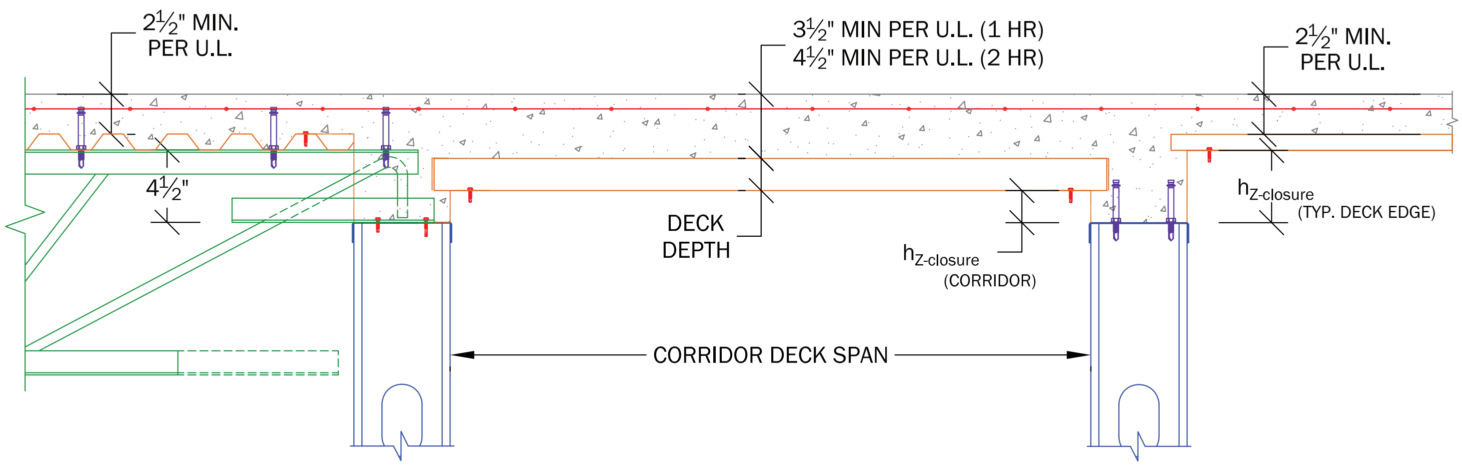

Figure 3-23: Corridor Deck Span

3.6.9 1.5VL Deck Profile, Section Properties and Span Capacities for Corridors

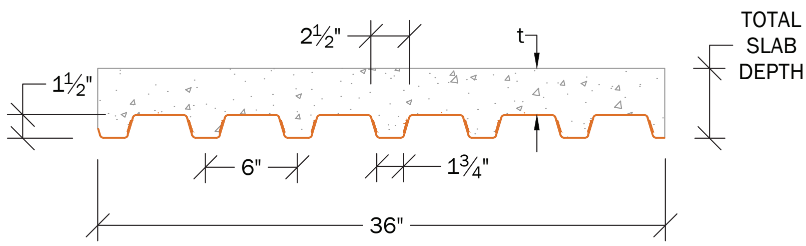

Figure 3-24: 1.5VL Composite Deck Profiles

1.5VL Section Properties								
Deck Type	Design Thickness	Weight (PSF)	I_p in^4/ft	I_n in^4/ft	S_p in^3/ft	S_n in^3/ft	V_a lbs/ft	F_y ksi
1.5VL22	0.0295	1.78	0.143	0.177	0.169	0.179	2754	50
1.5VL20	0.0358	2.14	0.186	0.222	0.224	0.231	3322	50
1.5VL18	0.0474	2.82	0.272	0.295	0.311	0.324	4350	50
1.5VL16	0.0598	3.54	0.373	0.373	0.404	0.411	4336	40

Table 3-12

1.5VL Maximum Construction Clear Spans (S.D.I. Criteria)														
Total Slab Depth (in)	SDI Max. Unshored Normal Weight Concrete N = 9.35 145 PCF				Superimposed Live Load (psf) Clear Span (ft.-in.)									
	Deck Type	Clear Span 1 span	2 span	3 span	5'- 6	6'- 0	6'- 6	7'- 0	7'- 6	8'- 0	8'- 6	9'- 0	9'- 6	10'- 0
5.00 (t=3.50) 51 PSF	1.5VL22	5'-0	6'-9	6'-9	391	347	311	280	254	232	213	195	180	167
	1.5VL20	6'-0	8'-1	8'-2	400	400	343	310	281	257	236	217	200	186
	1.5VL18	7'-3	9'-6	9'-8	400	400	400	389	324	297	272	251	233	216
	1.5VL16	7'-5	9'-6	9'-10	400	400	400	388	323	295	271	250	232	215
5.50 (t=4.00) 57 PSF	1.5VL22	4'-10	6'-6	6'-6	400	388	348	314	285	260	238	219	202	186
	1.5VL20	5'-9	7'-9	7'-10	400	400	383	346	314	287	263	243	224	208
	1.5VL18	7'-0	9'-1	9'-4	400	400	400	400	363	331	305	281	260	241
	1.5VL16	7'-1	9'-2	9'-5	400	400	400	400	361	330	303	279	259	240
6.00 (t=4.50) 63 PSF	1.5VL22	4'-8	6'-4	6'-4	400	400	385	347	315	288	263	242	223	206
	1.5VL20	5'-6	7'-5	7'-6	400	400	400	383	348	318	292	269	248	230
	1.5VL18	6'-8	8'-9	9'-0	400	400	400	400	400	367	337	311	288	267
	1.5VL16	6'-10	8'-10	9'-1	400	400	400	400	399	365	335	309	286	266

Table 3-13

Notes:
1. Typical temperature and shrinkage reinforcement: 6x6-W2.1xW2.1

3.6.10 1.5VLR Deck Profile, Section Properties and Span Capacities for Corridors

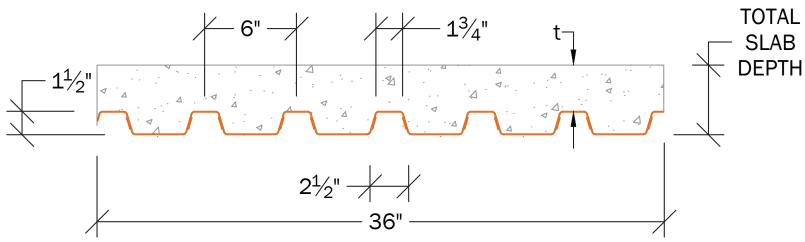

Figure 3-25: 1.5VLR Composite Deck Profiles

1.5VLR Section Properties								
Deck Type	**Design Thickness**	**Weight (PSF)**	**I_p in^4/ft**	**I_n in^4/ft**	**S_p in^3/ft**	**S_n in^3/ft**	**V_a lbs/ft**	**F_y ksi**
1.5VLR22	0.0295	1.78	0.177	0.143	0.179	0.169	2754	50
1.5VLR20	0.0358	2.14	0.222	0.186	0.231	0.224	3322	50
1.5VLR18	0.0474	2.82	0.295	0.272	0.324	0.311	4350	50
1.5VLR16	0.0598	3.54	0.373	0.373	0.411	0.404	4336	40

Table 3-14

1.5VLR Maximum Construction Clear Spans (S.D.I. Criteria)														
Total Slab Depth (in)	**SDI Max. Unshored Normal Weight Concrete N = 9.35 145 PCF**				**Superimposed Live Load (psf) Clear Span (ft.-in.)**									
	Deck Type	**Clear Span**												
		1 span	**2 span**	**3 span**	**5'- 6**	**6'- 0**	**6'- 6**	**7'- 0**	**7'- 6**	**8'- 0**	**8'- 6**	**9'- 0**	**9'- 6**	**10'- 0**
5.00 (t=3.50) 56 PSF	1.5VLR22	5'-0	6'-8	6'-10	387	344	308	277	251	229	209	192	177	164
	1.5VLR20	5'-10	7'-8	7'-11	400	379	339	306	278	254	232	214	197	182
	1.5VLR18	7'-2	9'-0	9'-3	400	400	400	389	321	293	269	248	229	213
	1.5VLR16	7'-3	9'-1	9'-5	400	400	400	388	320	292	268	247	228	212
5.50 (t=4.00) 62 PSF	1.5VLR22	4'-10	6'-5	6'-7	400	385	344	310	281	256	235	216	199	183
	1.5VLR20	5'-8	7'-4	7'-7	400	400	380	343	311	284	260	239	221	204
	1.5VLR18	6'-11	8'-8	8'-11	400	400	400	395	359	328	301	278	257	238
	1.5VLR16	6'-11	8'-9	9'-1	400	400	400	393	357	327	300	276	255	237
6.00 (t=4.50) 68 PSF	1.5VLR22	4'-8	6'-2	6'-4	400	400	382	344	312	284	260	239	220	204
	1.5VLR20	5'-6	7'-1	7'-4	400	400	400	380	345	315	289	265	245	227
	1.5VLR18	6'-9	8'-4	8'-7	400	400	400	400	398	364	334	308	285	264
	1.5VLR16	6'-9	8'-6	8'-9	400	400	400	400	396	362	332	306	283	262

Notes:

1. Typical temperature and shrinkage reinforcement: 6x6-W2.1xW2.1

Table 3-15

3.6.11 2VLI Deck Profile, Section Properties and Span Capacities for Corridors

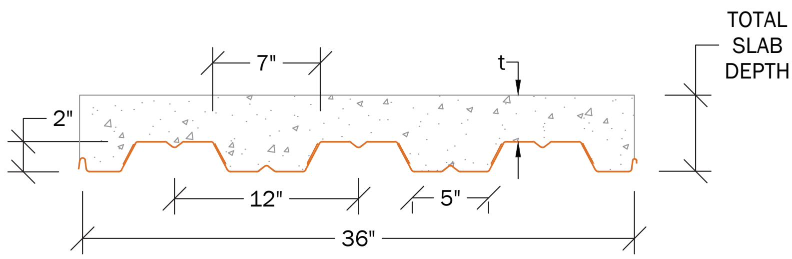

Figure 3-26: 2VLI Composite Deck Profile

2VLI Section Properties								
Deck Type	Design Thickness	Weight (PSF)	I_p in^4/ft	I_n in^4/ft	S_p in^3/ft	S_n in^3/ft	V_a lbs/ft	F_y ksi
2VLI22	0.0295	1.62	0.324	0.321	0.263	0.266	1832	50
2VLI20	0.0358	1.97	0.409	0.406	0.341	0.346	2698	50
2VLI18	0.0474	2.61	0.559	0.558	0.495	0.504	3608	50
2VLI16	0.0598	3.29	0.704	0.704	0.653	0.653	3618	40

Table 3-16

2VLI Maximum Construction Clear Spans (S.D.I. Criteria)														
Total Slab Depth (in)	SDI Max. Unshored Normal Weight Concrete N = 9.35 145 PCF				Superimposed Live Load (psf) Clear Span (ft.-in.)									
	Deck Type	Clear Span 1 span	2 span	3 span	6'- 6	7'- 0	7'- 6	8'- 0	8'- 6	9'- 0	9'- 6	10'-0	10'-6	11'-0
5.50 (t=3.50) 57 PSF	2VLI22	6'-4	8'-0	8'-6	278	244	216	192	172	155	140	127	116	106
	2VLI20	7'-5	9'-5	9'-9	351	312	244	217	194	175	158	143	131	119
	2VLI18	9'-2	11'-4	11'-7	400	377	338	306	279	256	199	182	167	153
	2VLI16	9'-5	11'-6	11'-10	400	400	388	350	318	290	230	210	192	176
6.00 (t=4.00) 63 PSF	2VLI22	6'-1	7'-5	8'-2	308	270	239	213	191	172	156	141	129	118
	2VLI20	7'-1	9'-1	9'-4	390	346	271	241	215	194	175	159	145	132
	2VLI18	8'-10	10'-11	11'-3	400	400	375	339	309	243	221	202	185	170
	2VLI16	9'-1	11'-1	11'-5	400	400	400	388	352	322	255	233	213	195
6.50 (t=4.50) 69 PSF	2VLI22	5'-11	6'-11	7'-11	339	297	263	234	210	189	171	155	141	129
	2VLI20	6'-11	8'-9	9'-0	400	337	297	264	237	213	193	175	159	145
	2VLI18	8'-7	10'-6	10'-11	400	400	400	373	340	268	243	222	203	187
	2VLI16	8'-10	10'-8	11'-0	400	400	400	400	387	309	280	256	234	215

Notes:

Table 3-17

1. Typical temperature and shrinkage reinforcement: 6x6-W2.1xW2.1

3.6.12 3VLI Deck Profile, Section Properties and Span Capacities for Corridors

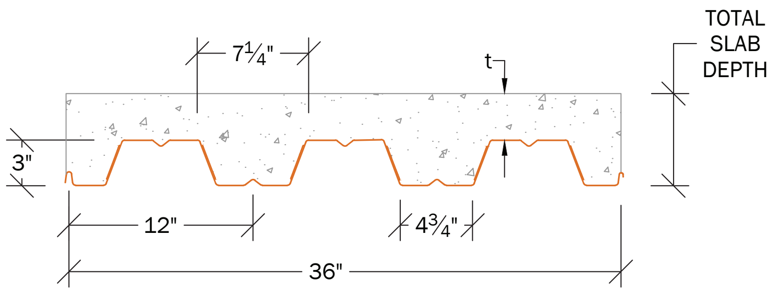

Figure 3-27: 3VLI Composite Deck Profile

3VLI Section Properties								
Deck Type	Design Thickness	Weight (PSF)	I_p in^4/ft	I_n in^4/ft	S_p in^3/ft	S_n in^3/ft	V_a lbs/ft	F_y ksi
3VLI22	0.0295	1.77	0.730	0.729	0.414	0.426	1528	50
3VLI20	0.0358	2.14	0.920	0.919	0.534	0.551	2698	50
3VLI18	0.0474	2.84	1.254	1.252	0.770	0.797	4729	50
3VLI16	0.0598	3.58	1.580	1.580	1.013	1.013	5309	40

Table 3-18

3VLI Maximum Construction Clear Spans (S.D.I. Criteria)														
Total Slab Depth (in)	SDI Max. Unshored Normal Weight Concrete N = 9.35 145 PCF				Superimposed Live Load (psf) Clear Span (ft.-in.)									
	Deck Type	Clear Span 1 span	2 span	3 span	8'- 0	8'- 6	9'- 0	9'- 6	10'-0	10'-6	11'-0	11'-6	12'-0	12'-6
6.50 (t=3.50) 63 PSF	3VLI22	8'-0	8'-3	9'-4	251	190	171	155	141	129	118	108	99	91
	3VLI20	9'-3	11'-5	11'-9	278	253	232	174	158	144	132	121	111	103
	3VLI18	11'-4	13'-9	13'-10	338	309	285	264	246	229	215	162	151	140
	3VLI16	11'-7	13'-10	14'-3	378	345	317	293	272	253	237	222	169	157
7.00 (t=4.00) 69 PSF	3VLI22	7'-9	7'-8	8'-8	233	209	188	171	155	142	130	119	109	101
	3VLI20	9'-0	10'-11	11'-4	305	278	255	192	174	159	145	133	122	113
	3VLI18	11'-0	13'-3	13'-6	371	340	313	290	270	252	236	178	166	154
	3VLI16	11'-4	13'-4	13'-9	400	379	348	322	298	278	260	200	185	172
7.50 (t=4.50) 75 PSF	3VLI22	7'-7	7'-2	8'-2	254	228	205	186	169	154	141	130	119	110
	3VLI20	8'-9	10'-2	11'-0	333	303	231	209	190	173	158	145	134	123
	3VLI18	10'-9	12'-10	13'-3	400	370	341	316	294	275	210	195	181	168
	3VLI16	11'-0	12'-11	13'-4	400	400	380	351	325	303	283	218	202	188

Notes:

1. Typical temperature and shrinkage reinforcement: 6x6-W2.1xW2.1

Table 3-19

3.6.13 Concrete Volumes and Equivalent Thickness on Deck

Concrete volumes shown in Table 3-20 can be used to determine the dead load of the concrete as well as for estimating concrete volume per floor system.

Concrete Volumes and Equivalent Thickness on Deck				
Deck Profile	Total Slab Depth (in)	Theo. Concrete Volume		Equivalent Thickness (in)
		Yd^3 / 100 ft^2	ft^3 / ft^2	
1.0C	3.50	0.93	0.250	3.00
	4.00	1.08	0.292	3.50
	4.50	1.23	0.333	4.00
	5.00	1.39	0.375	4.50
	6.00	1.70	0.458	5.50
1.3C	4.00	1.03	0.279	3.35
	4.50	1.19	0.321	3.85
	5.00	1.34	0.363	4.35
	5.50	1.50	0.404	4.85
	6.00	1.65	0.446	5.35
1.5VL	5.00	1.24	0.336	4.00
	5.50	1.40	0.378	4.50
	6.00	1.55	0.419	5.00
1.5VLR	5.00	1.38	0.372	5.00
	5.50	1.53	0.414	5.50
	6.00	1.69	0.456	6.00
2.0VLI	5.50	1.39	0.375	4.50
	6.00	1.54	0.417	5.00
	6.50	1.70	0.458	5.50
3.0VLI	6.50	1.54	0.417	5.00
	7.00	1.70	0.458	5.50
	7.50	1.85	0.500	6.00

Table 3-20

3.7 Specifying Criteria for Accessories

The information provided in this section has been limited to the typical conditions for the Ecospan® Composite Floor System. More extensive tables may be found in the Vulcraft Steel Roof and Floor Deck Catalog.

3.7.1 Pour Stop Table

Table 3-21 has been developed in accordance with the SDI criteria for concrete pressure and construction loads (*ANSI/SDI-C-1.0 Attachement C2*).

Pour Stop Gauge Requirements					
Slab Depth (in)	Overhang (inches)				
	0	1	2	3	4
3.50	20	20	20	20	20
3.75	20	20	20	20	20
4.00	20	20	20	20	18
4.25	20	20	20	18	18
4.50	20	20	20	18	18
4.75	20	20	18	18	16
5.00	20	20	18	18	16
5.25	20	18	18	16	16
5.50	20	18	18	16	16
5.75	20	18	16	16	14
6.00	18	18	16	16	14
6.25	18	18	16	14	14
6.50	18	16	16	14	14
6.75	18	16	14	14	14
7.00	18	16	14	14	12
7.25	16	16	14	14	12
7.50	16	14	14	12	12
7.75	16	14	14	12	12
8.00	14	14	12	12	12
8.25	14	14	12	12	12
8.50	14	12	12	12	12
8.75	14	12	12	12	12
9.00	14	12	12	12	10

Table 3-21

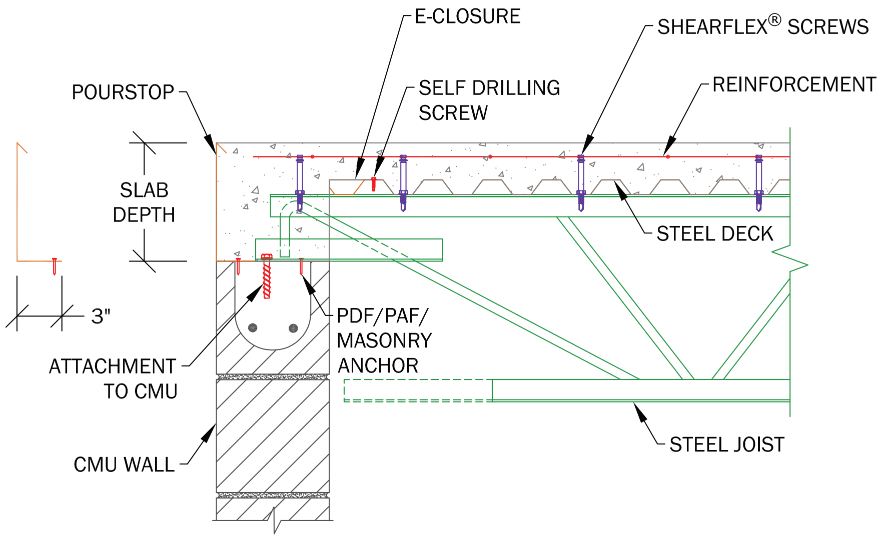

Figure 3-28: Pour Stop Bearing on CMU

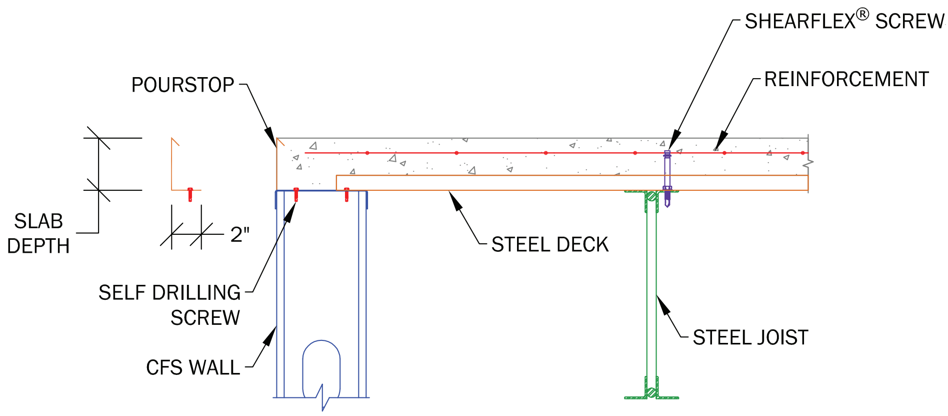

Figure 3-29: Pour Stop Bearing on CFS

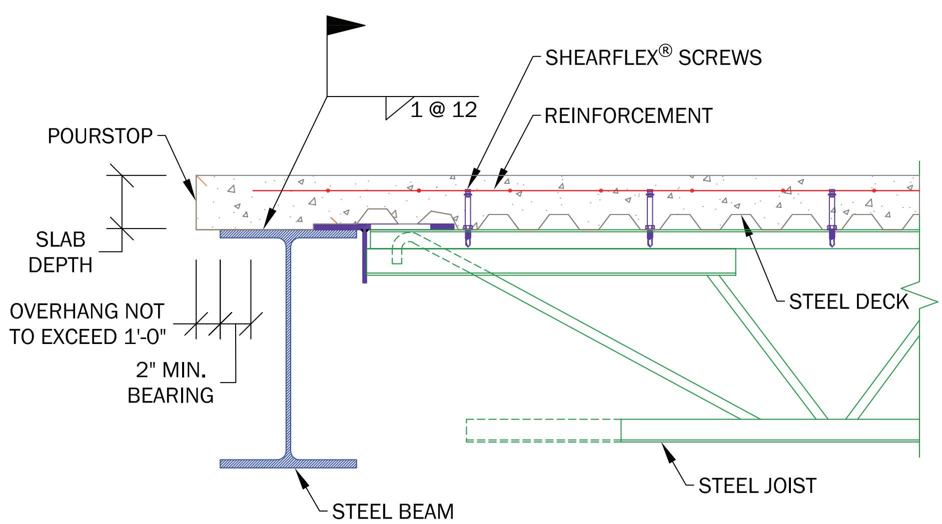

Figure 3-30: Pour Stop Bearing on Steel

3.7.2 E-Closure

E-closure is supplied for the purpose of creating a concrete seal between joists with standard seats. Projects utilizing flush joist seats will not require E-closures.

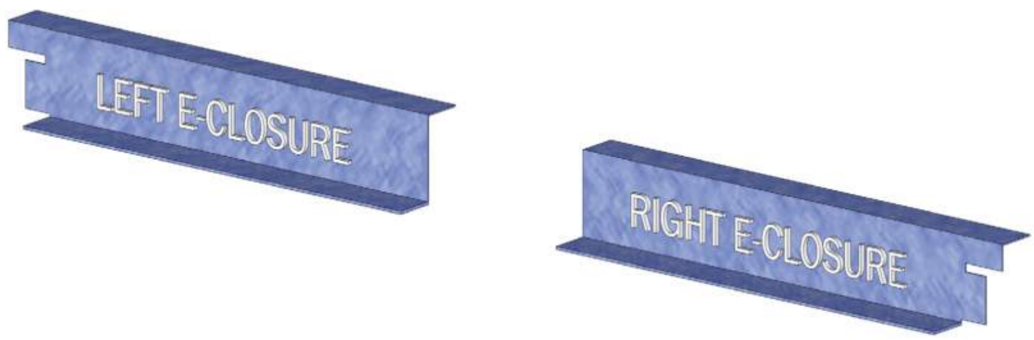

Figure 3-31: E-Closure Examples

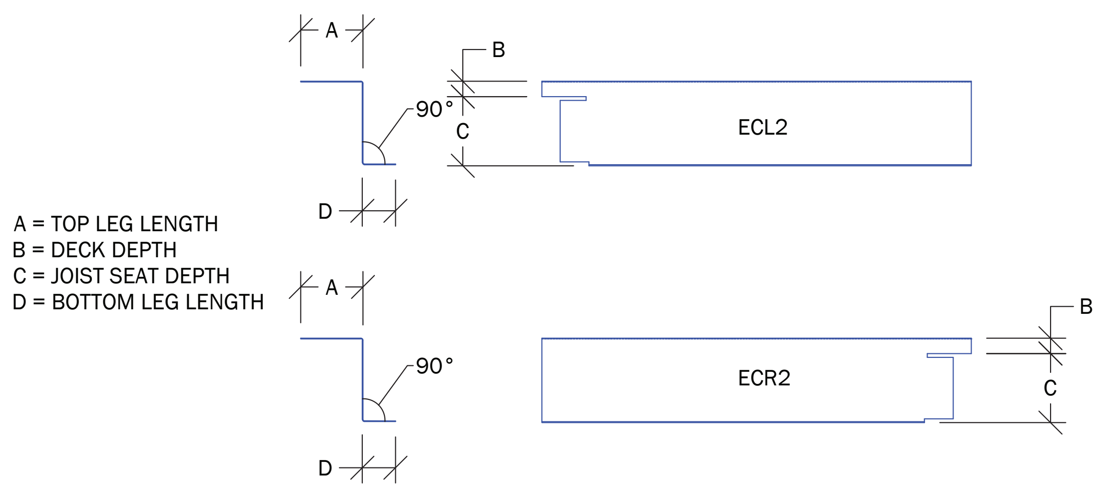

Figure 3-32: E-Closure Details

Typically, E-Closures are provided as a pre-cut and notched light gauge angle that are placed on the bearing wall or beam surface and attached to the deck. A Left and a Right piece will be supplied for each joist space. These two pieces will be lapped, adjusted, and connected with self-drilling and tapping screws to accommodate the required joist spacing. See Figure 3-33.

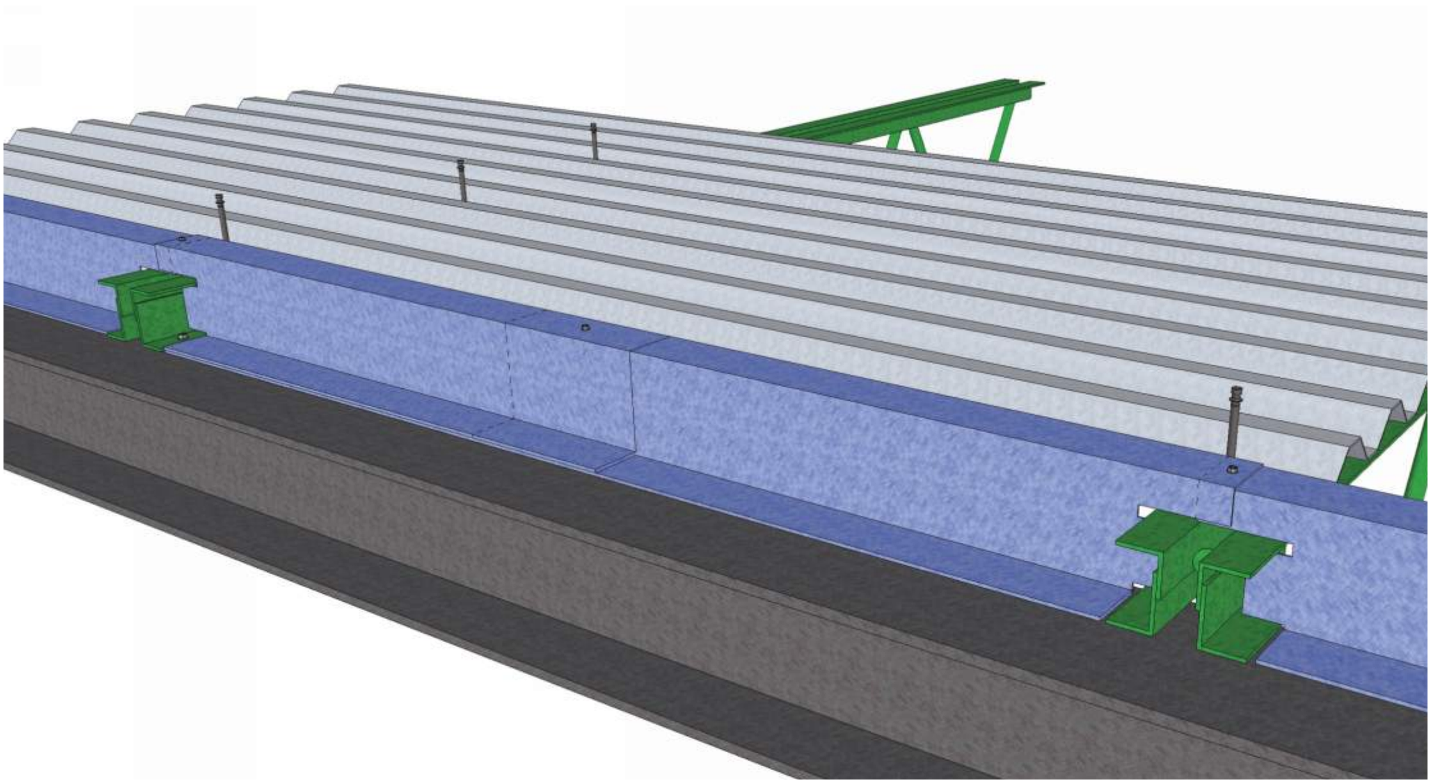

Figure 3-33: E-Closure Installation Example

ECOSPAN®
COMPOSITE FLOOR SYSTEM

3.7.3 Deck Support Closures

Deck supports/bearing parallel to E-series joist spans may not allow direct bearing of deck. Deck support closures, also referred to as Z-closures, enable the Design Professional to maintain support height at all edges. Properly specified deck support closures may reduce CFS panel variations and minimize CMU and ICF block cutting in the field.

Required Deck Closure Gauge						
Closure Depth (in)	Vertical Load					
	250 plf	300plf	350plf	400plf	450plf	500plf
2.5	22	22	20	20	20	20
3	20	20	20	20	18	18
3.5	20	20	18	18	18	18
4	18	18	18	18	18	18
4.5	18	18	18	18	16	16
5	18	18	18	16	16	16
5.5	18	16	16	16	16	16
6	18	16	16	16	16	16
6.5	16	16	16	16	14	14
7	16	16	16	14	14	14
7.5	16	16	14	14	14	14
8	16	14	14	14	14	14
8.5	16	14	14	14	14	12
9	14	14	14	14	12	12
9.5	14	14	14	12	12	12
10	14	14	14	12	12	12
10.5	14	14	12	12	12	12
11	14	12	12	12	12	12
11.5	14	12	12	12	12	12
12	12	12	12	12	12	12

Notes: **Table 3-22**

1. Normal weight concrete with reinforcing weighs 12.5 psf/inch of thickness. (Example: 3" concrete solid concrete slab = 37.5 psf)
2. Z-closure to be attached to support and deck at 18" o.c. maximum.
3. Typical Z-closure horiz. legs 1 1/2" min. Legs resting on concrete or masonry 2 1/2" min.
4. Factor of Safety against buckling F.S. = 3.
5. Deck gauges from SDI.
6. F_y = 33 ksi

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3.7.4 Deck Support Closure Example

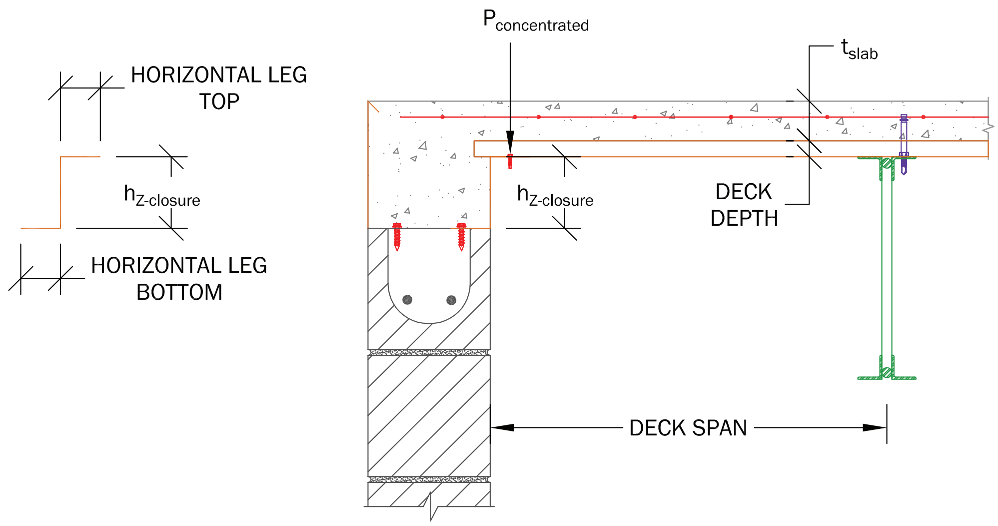


Figure 3-34: Deck Closure Support Example

Given:

- $h_{Z\text{-closure}}$ = 4 in.
- DECK SPAN = 4 ft.
- DECK DEPTH = 1.0 in. (1.0C Deck)
- t_{slab} = 2.5 in.
- TOTAL SLAB DEPTH = 3.5 in.
- $t_{equivalent}$ = 3 in. (From Table 3-18)
- $\gamma_{concrete}$ = 150 pcf
- $P_{concentrated}$ = 250 lb. (Construction Worker)

$$\text{Vertical Load} = 250\text{ lbs} + (t_{equivalent})(\gamma_{conrete})\left(\frac{\text{DECK SPAN}}{2}\right) = 250\text{ lbs} + (3\text{ in.})\left(\frac{150\text{ pcf}}{12\text{ in/ft}}\right)\left(\frac{4\text{ ft.}}{2}\right) = 325\text{ plf}$$

From Table 3-22:

An 18 gauge closure with depth of 4 in. will support 500 plf.

Allowable load = 500 plf > 325 plf required - O.K.

Detailed Closure:

- 2.5 inch Horizontal Leg - Top
- 4.0 inch $h_{Z\text{-closure}}$
- 2.5 inch Horizontal Leg - Bottom
- 18 Gauge

3.7.5 Diaphragm Capacity

The Ecospan® Composite Floor System may be used as an effective diaphragm for transferring lateral forces within a building system. Design Professionals should review the information provided by the Steel Deck Institute for the design and detailing of composite and non-composite steel deck diaphragms. E-series joist seats are not designed to resist lateral loads and should not be used as transfer mechanisms.

3.7.6 Joist Bridging

Joist Erection Loading

Deck bundles placed on Ecospan® joists are limited to a maximum bundle weight of 2,000 lbs and must be placed within 1 foot of the bearing surface of the joist end. Each joist is checked to see if it can safely support a 300 lb concentrated load (250 lb construction worker x 1.2 safety factor) at the midspan of the joist during joist erection. Bolted diagonal erection bridging, where required, must be installed prior to releasing the joist hoisting cables. No more than one employee shall be allowed on the joist span until all diagonal erection bridging has been installed.

Horizontal Bridging

Horizontal bridging consists of continuous horizontal steel members. The ratio of unbraced length to least radius of gyration, ℓ/r, of the bridging member is designed to not exceed 300, where ℓ is the distance in inches between attachments, and r is the least radius of gyration of the bridging member.

Diagonal Bridging

Diagonal bridging is designed utilizing cross-bracing with a ℓ/r ratio of no more than 200, where ℓ is the distance in inches between connections and r is the least radius of gyration of the bracing member. Where cross-bridging members are connected at their point of intersection, the ℓ distance is taken as the distance in inches between connections at the point of intersection of the bracing members and the connections to the chord of the joists.

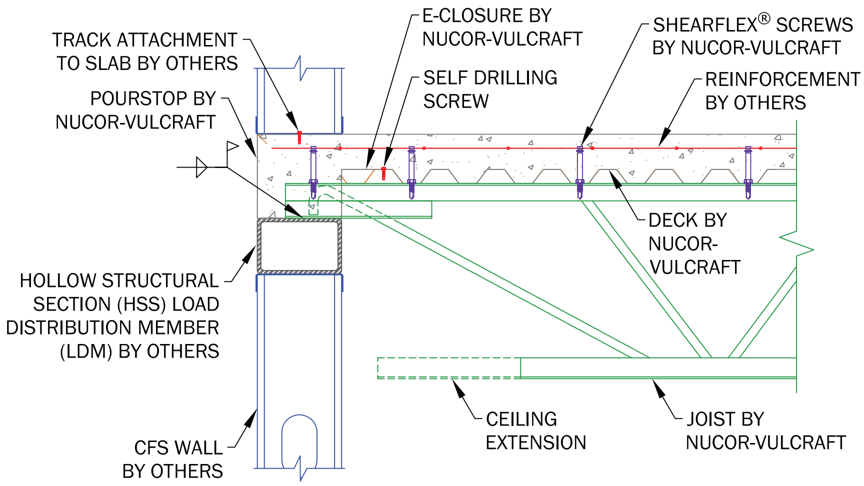
Quantity and Spacing of Bridging

Bridging must be properly spaced and anchored to support the decking and the steel erector employees prior to the attachment of the deck to the top chord. The radius of gyration of the top chord about its vertical axis is designed to not be less than $L_{br}/170$ where L_{br} is the spacing in inches between lines of bridging. The top chord is considered to be stayed laterally by the floor deck when the Shearflex® connectors have been fully installed across the full length of the joist.

4.0 Ecospan® Composite Floor System Details

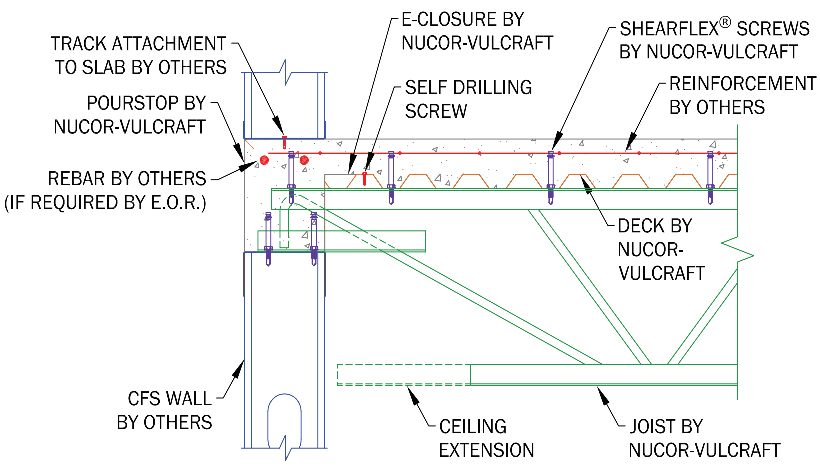
The Ecospan® Composite Floor System is compatible with any wall framing system. As a result there are numerous detail section possibilities. The following are typical details and are for reference only.

4.1 Ecospan® System on Cold Formed Steel (CFS) Details



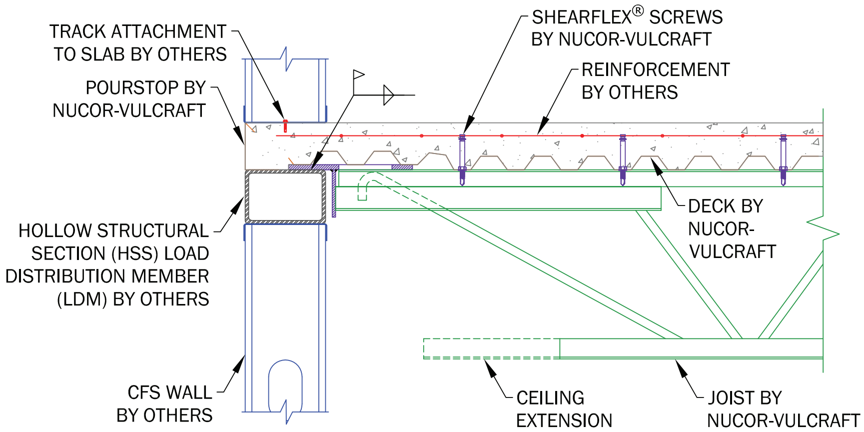
1.1 2.5" SEAT ON CFS

Not To Scale



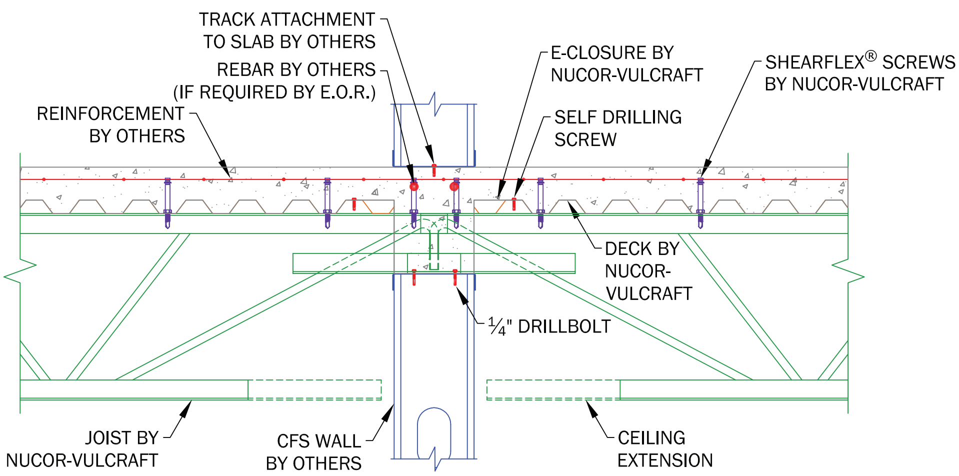
1.2 4.5" SEAT ON CFS

Not To Scale



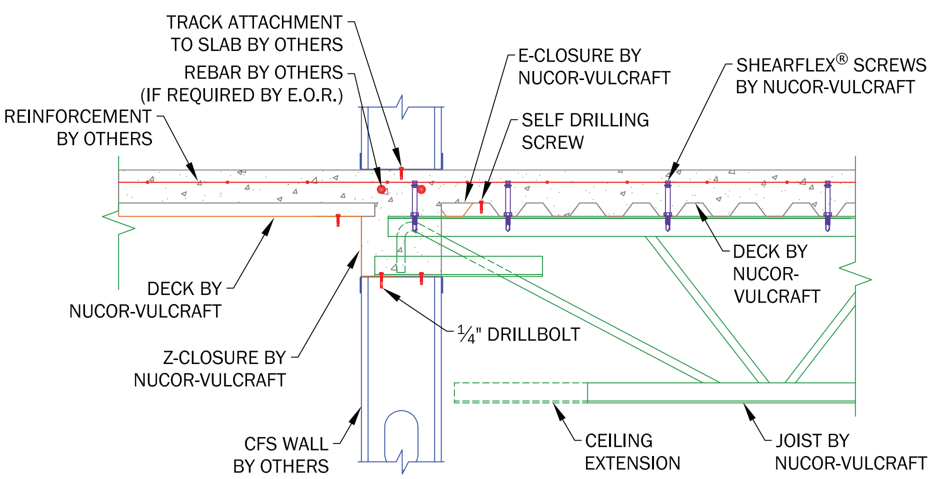
1.3 FLUSH SEAT ON CFS

Not To Scale



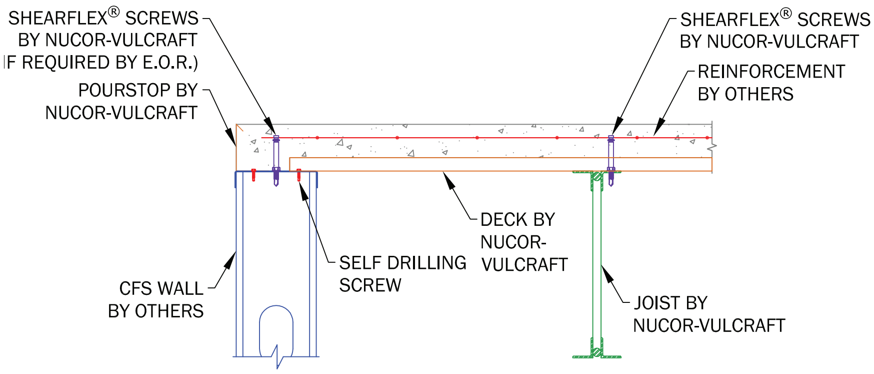
1.4 4.5" SEATS ON CFS

Not To Scale



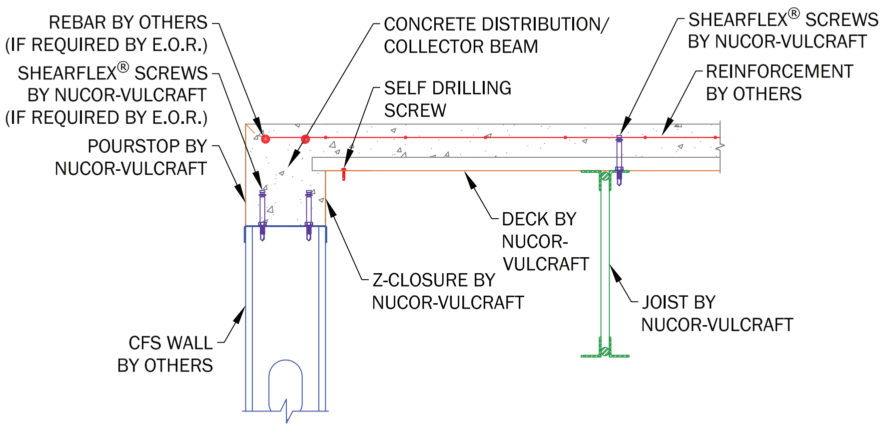
1.5 DECK DIRECTION CHANGE AT 4.5" SEAT IN CFS

Not To Scale



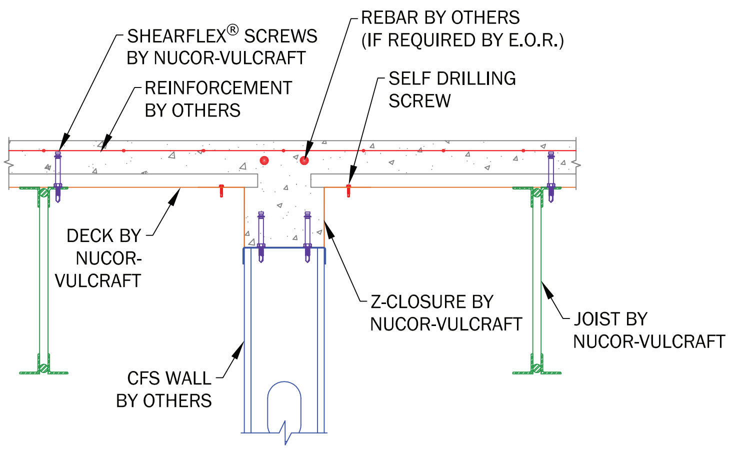
1.6 DECK EDGE ON CFS

Not To Scale



1.7 DECK LAP ON CFS

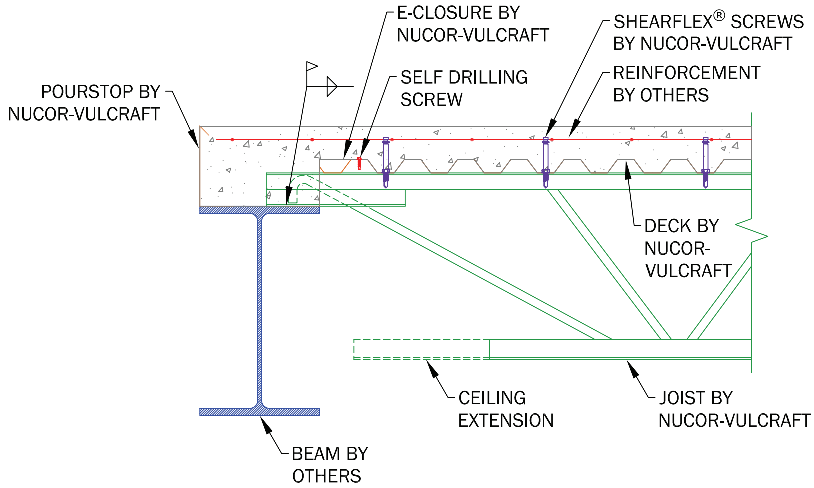
Not To Scale



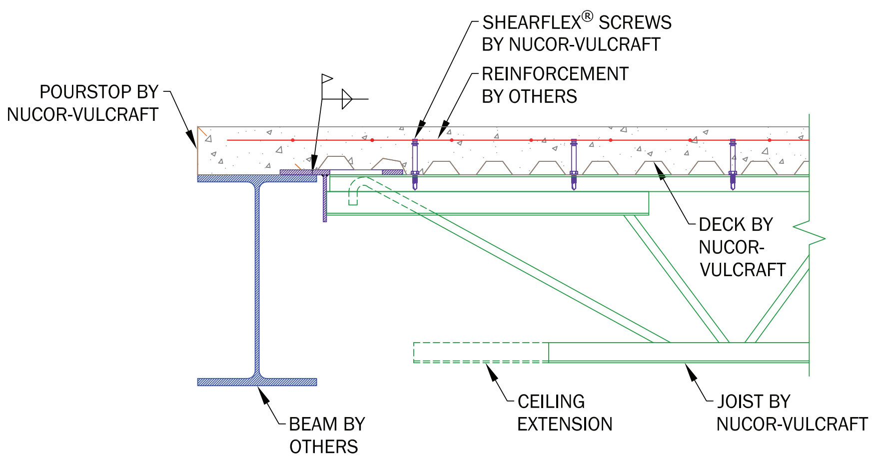
1.8 DECK SUPPORT OVER CFS

Not To Scale

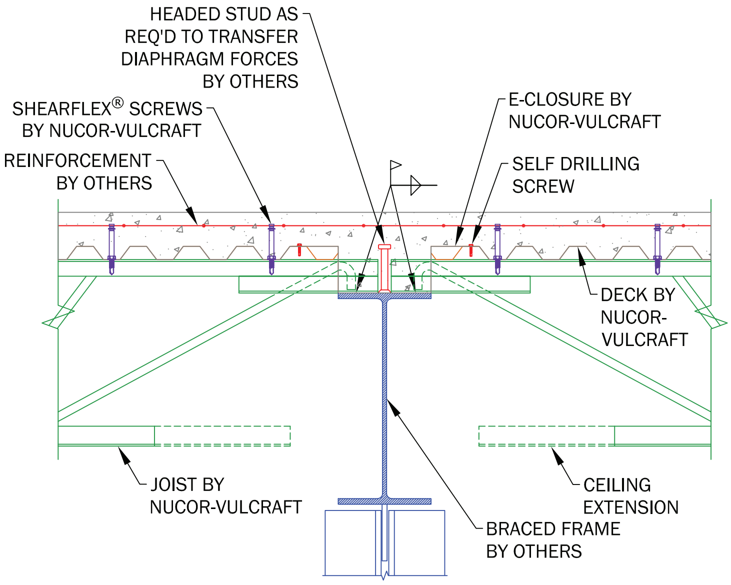
4.2 Ecospan® System on WF Beam Details



2.1 2.5" JOIST SEAT ON BEAM — Not To Scale

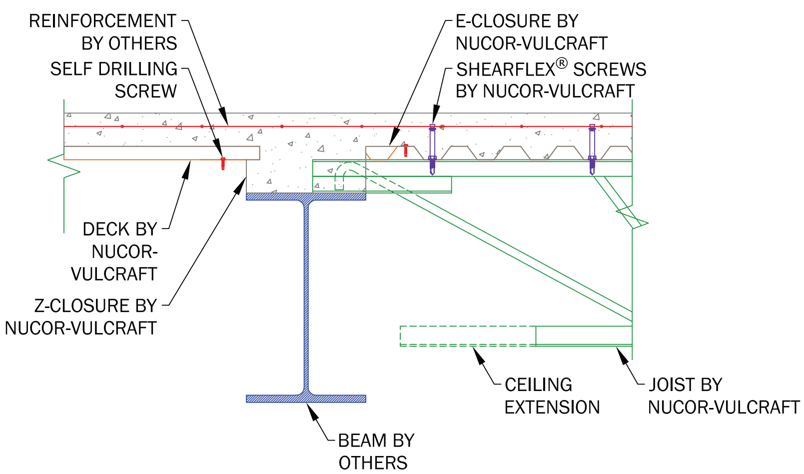


2.2 FLUSH SEAT ON BEAM — Not To Scale



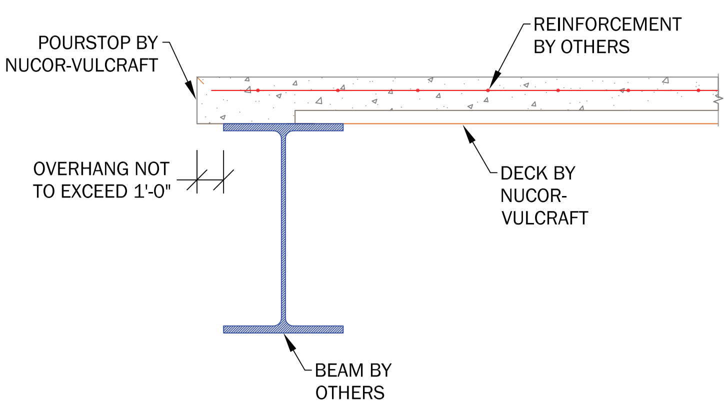
2.3 2.5" SEATS ON BRACED FRAME

Not To Scale



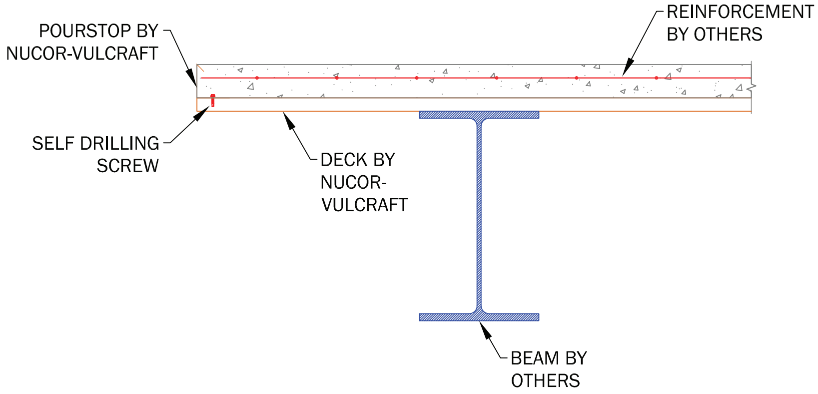
2.4 DECK DIRECTION CHANGE AT 2.5" SEAT

Not To Scale



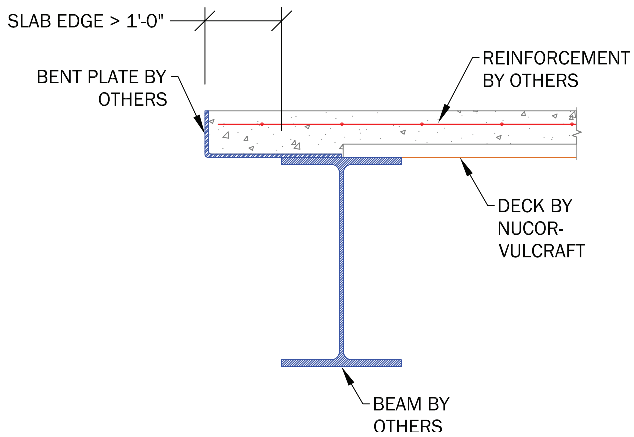
2.5 DECK EDGE AT BEAM

Not To Scale



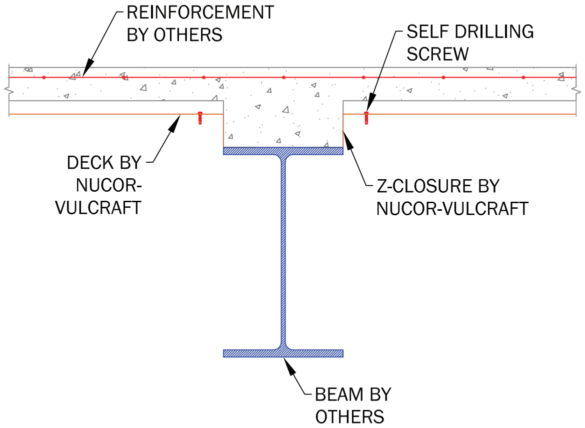
2.6 CANTILEVERED DECK EDGE

Not To Scale



2.7 DECK EDGE WITH BENT PLATE

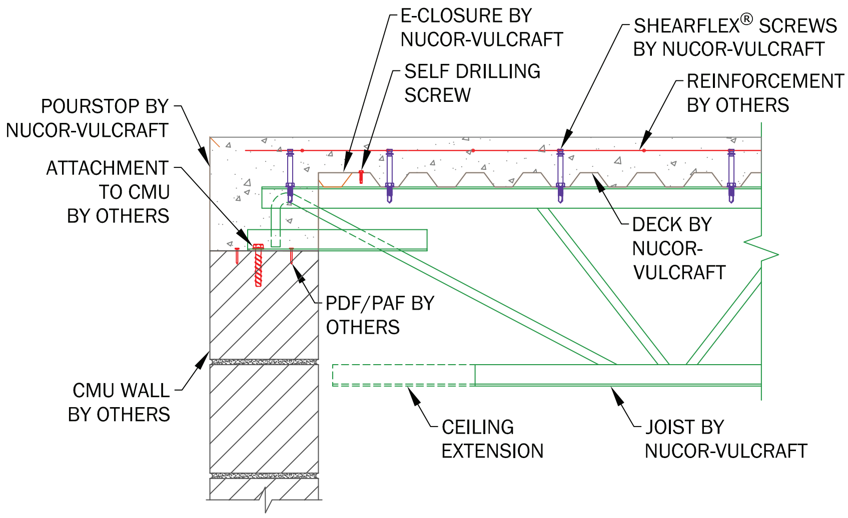
Not To Scale



2.8 DECK SUPPORT OVER BEAM

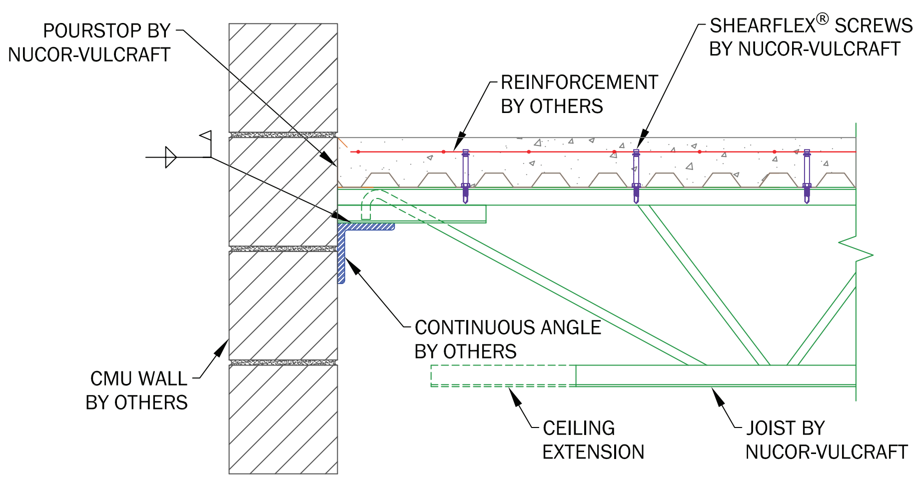
Not To Scale

4.3 Ecospan® System on Masonry/Concrete Details



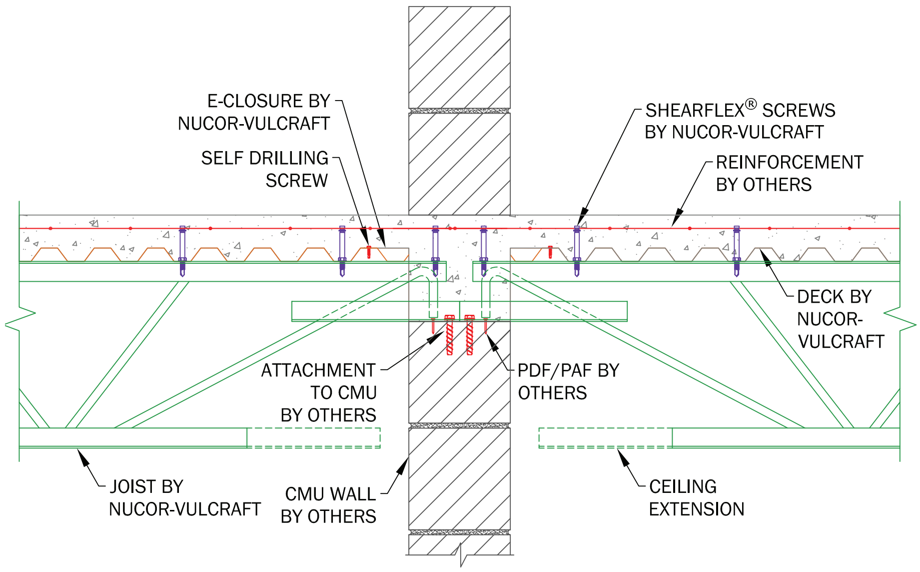
3.1 4.5" JOIST SEAT ON CMU

Not To Scale



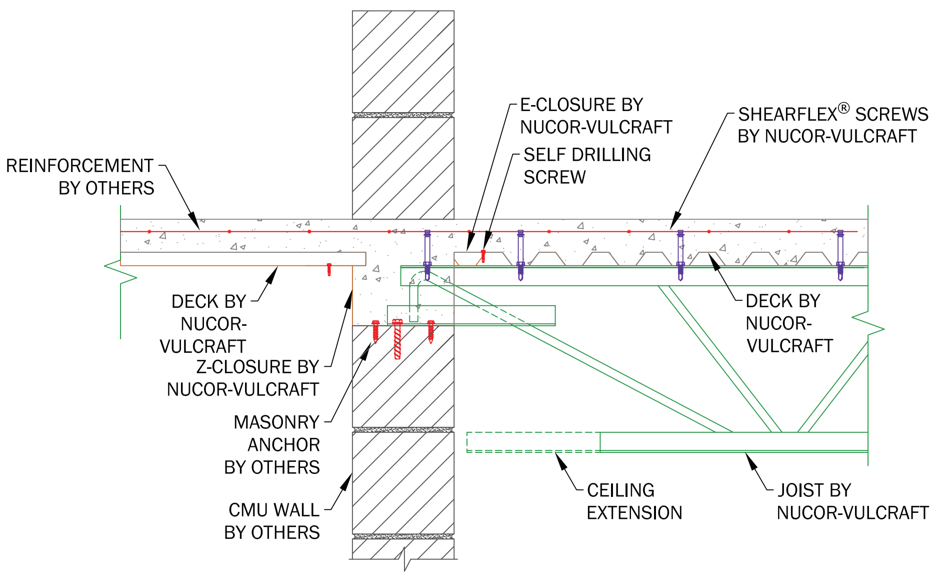
3.2 2.5" SEAT AT FACE OF CMU

Not To Scale



3.3 4.5" SEATS ON CMU

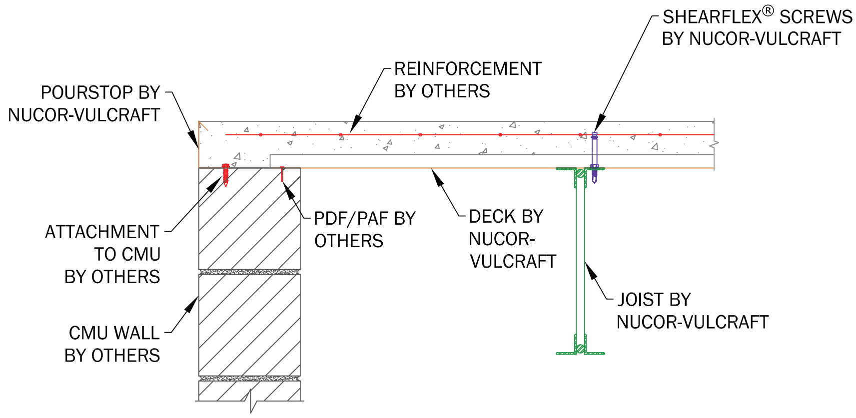
Not To Scale



3.4 DECK DIRECTION CHANGE AT CMU

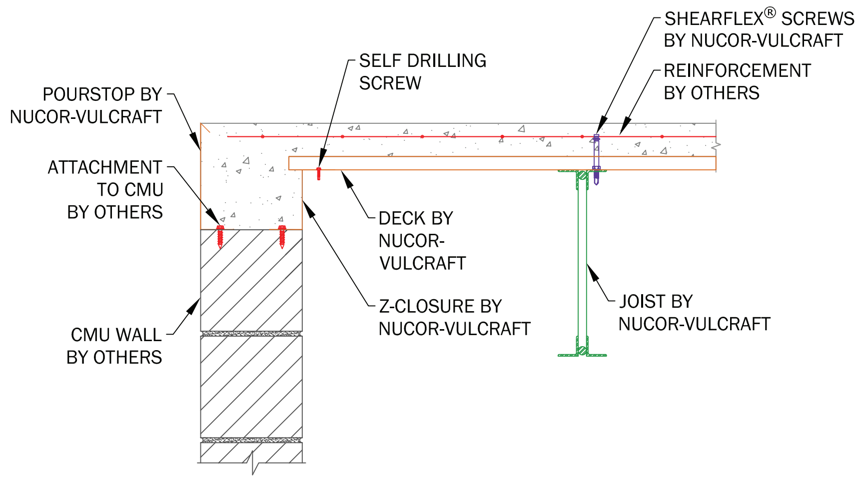
Not To Scale

ECOSPAN® COMPOSITE FLOOR SYSTEM



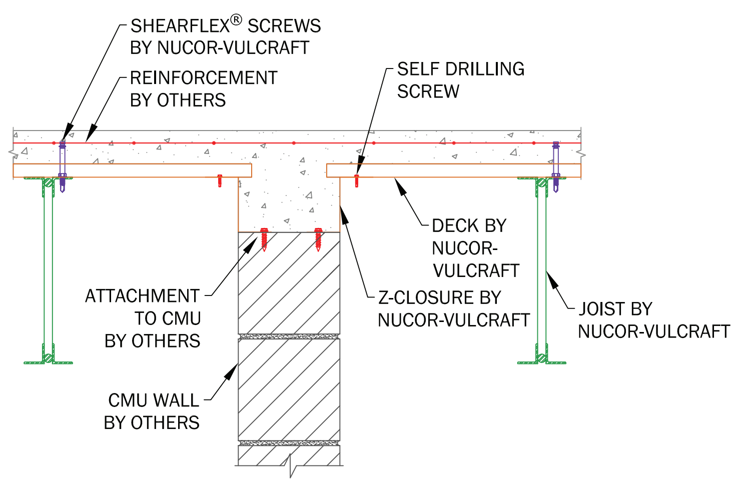
3.5 DECK EDGE AT CMU

Not To Scale



3.6 DECK LAP ON CMU

Not To Scale



3.7 DECK SUPPORT OVER CMU

Not To Scale

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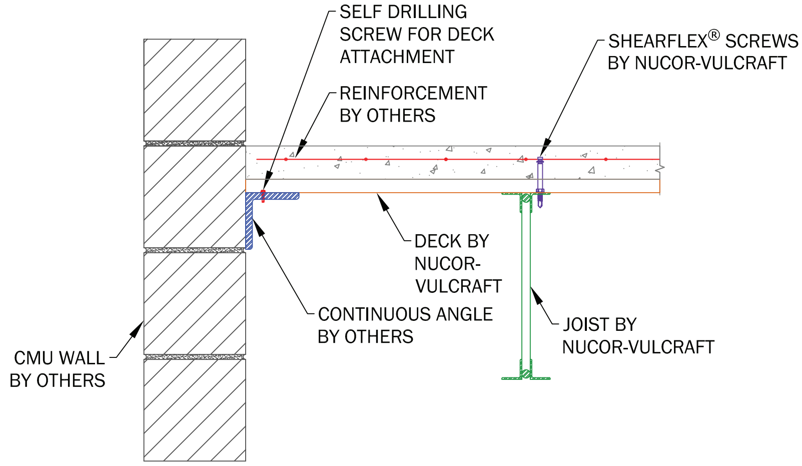
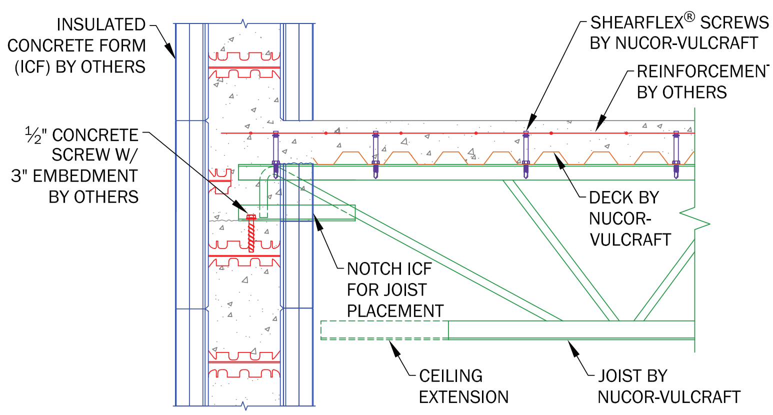
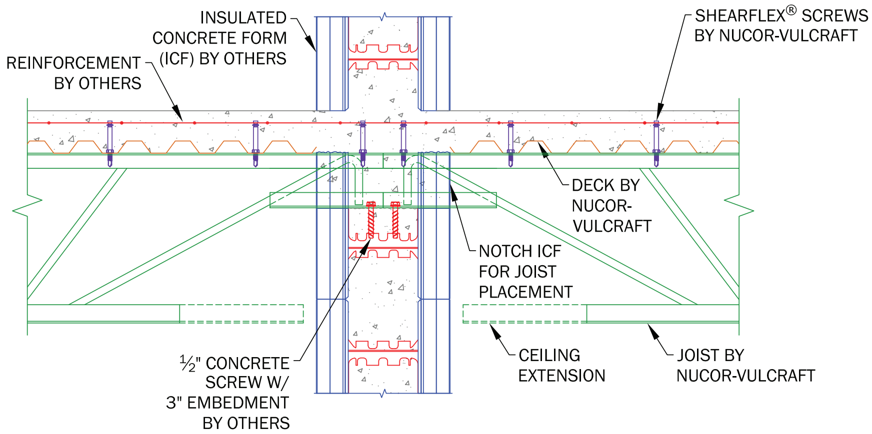


3.8 DECK AT CMU WALL CONT. ANGLE
Not To Scale

4.4 Ecospan® System on Insulated Concrete Form (ICF) Details

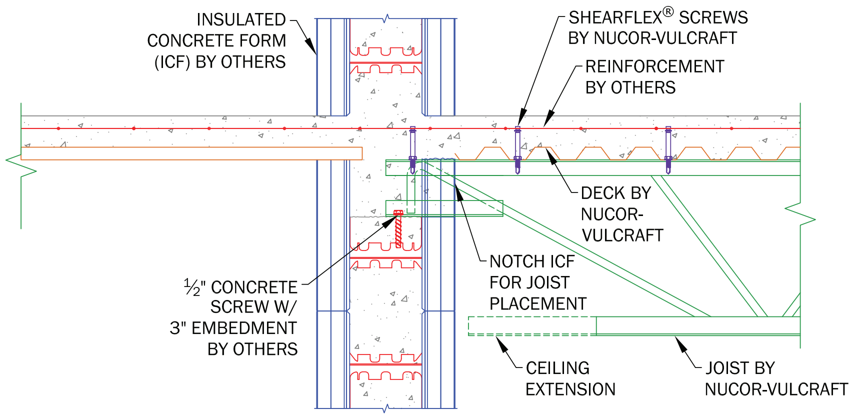


4.1 4.5" SEAT ON ICF
Not To Scale



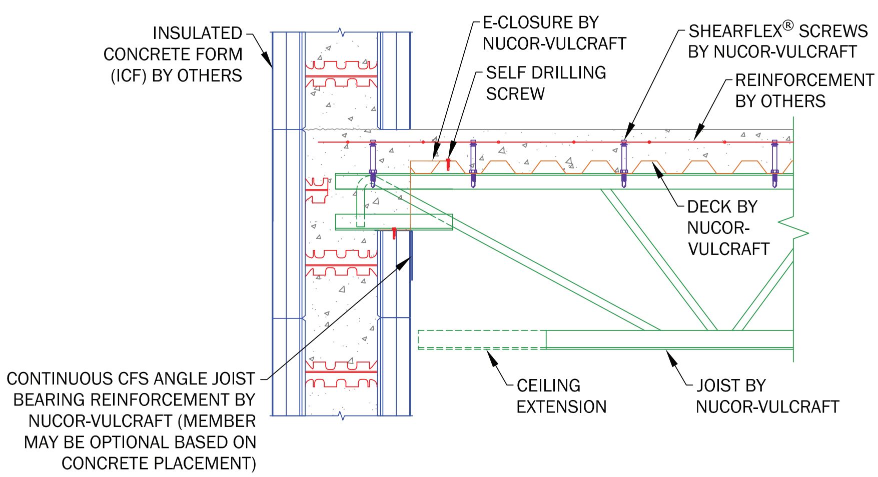
4.2 4.5" SEATS ON ICF

Not To Scale



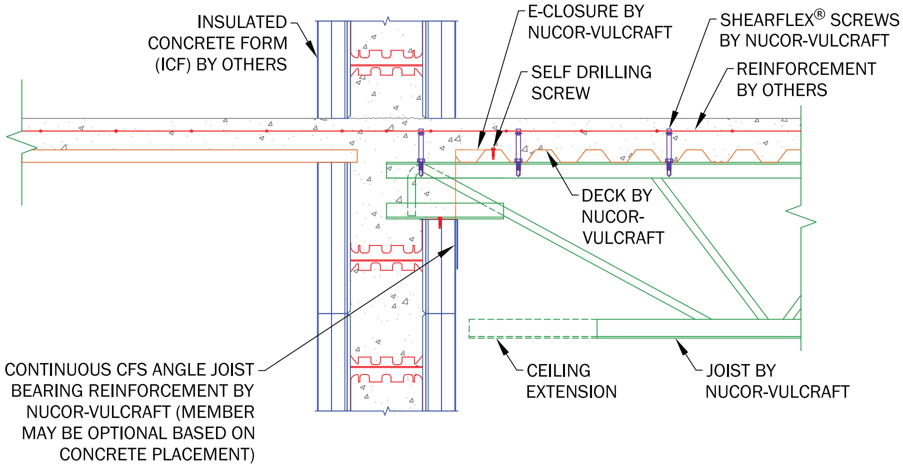
4.3 DECK DIRECTION CHANGE ON ICF 4.5" SEAT

Not To Scale



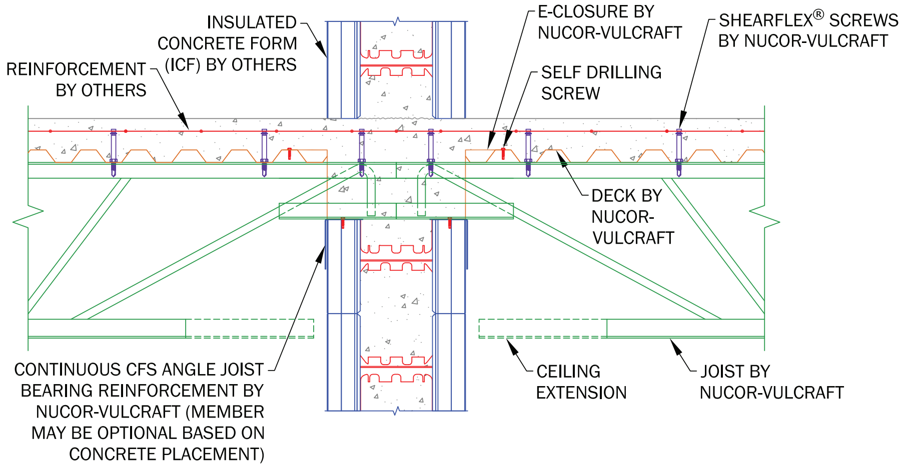
4.4 4.5" SEAT ON ICF - MONOLITHIC POUR

Not To Scale



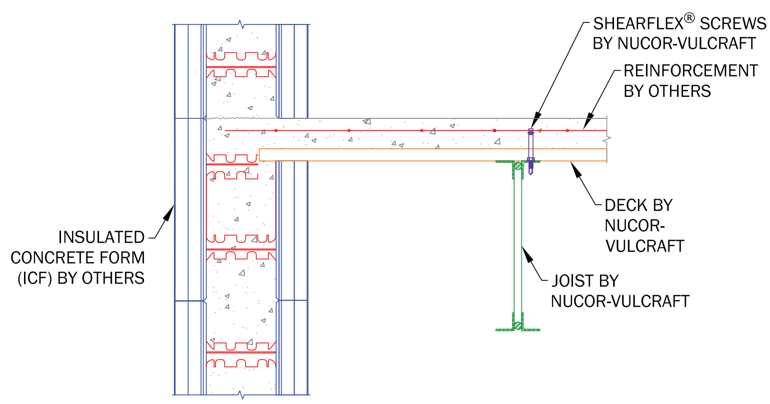
4.5 DECK DIRECTION CHANGE ON ICF - MONOLITHIC POUR

Not To Scale



4.6 4.5" SEATS ON ICF - MONOLITHIC POUR

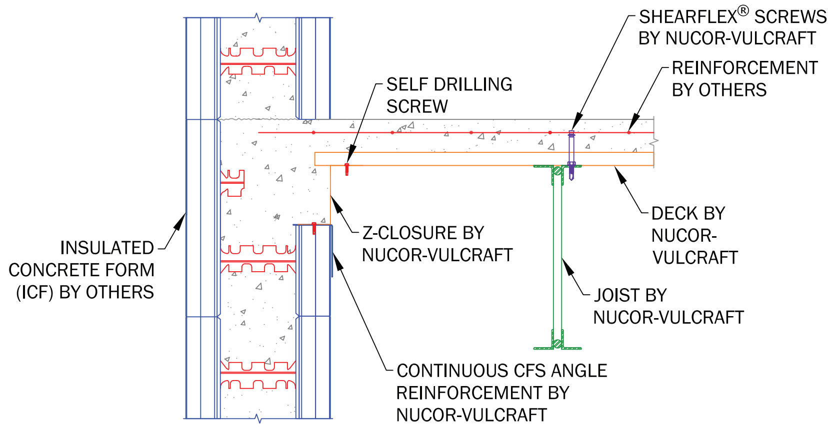
Not To Scale



4.7 DECK EDGE AT ICF

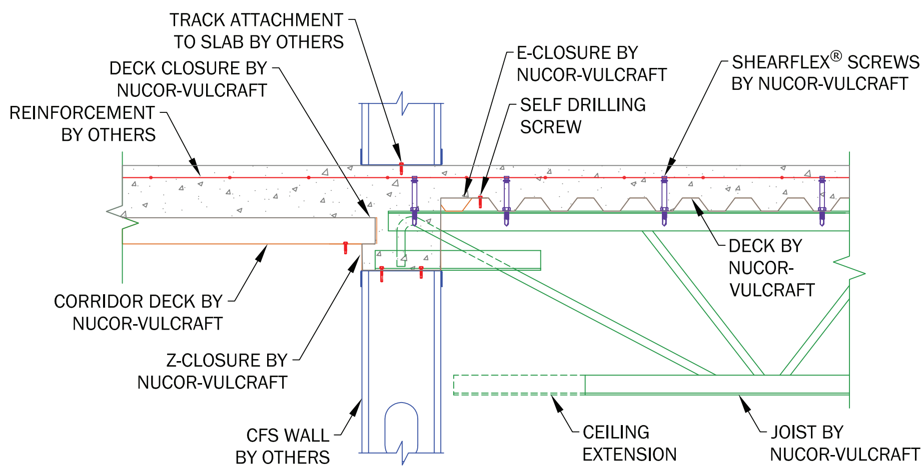
Not To Scale

ECOSPAN®
COMPOSITE FLOOR SYSTEM



4.8 DECK LAP ON ICF
Not To Scale

4.5 Ecospan® System at Corridor Details



5.1 4.5" SEAT AT CFS AT CORRIDOR LAPPED
Not To Scale

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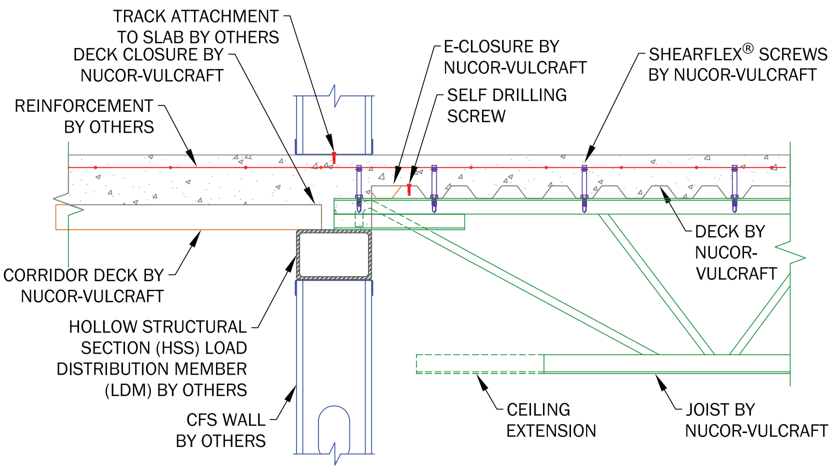
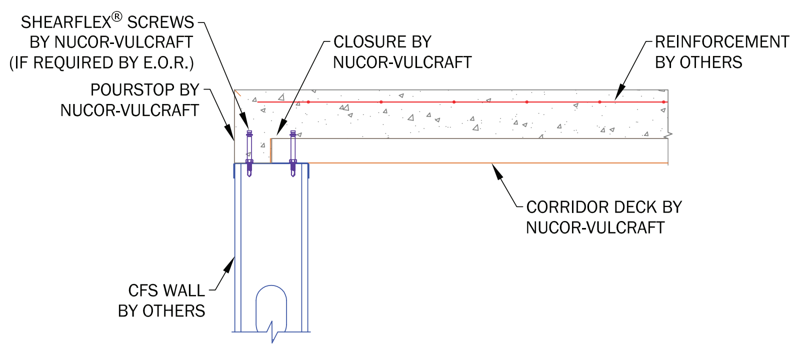


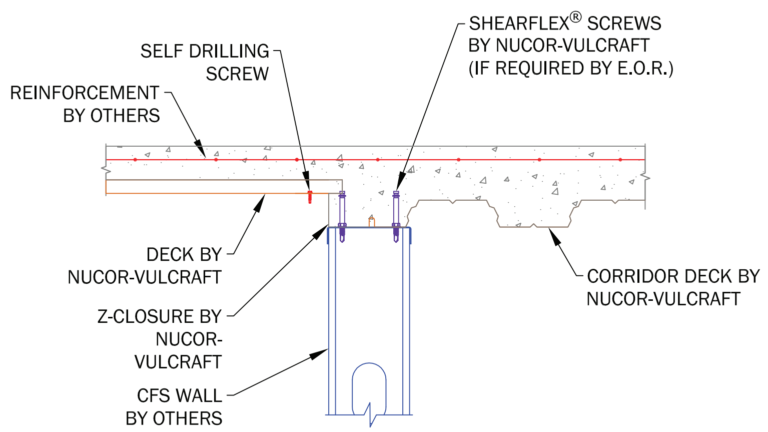
5.2 2.5" SEAT ON HSS AT CORRIDOR

Not To Scale



5.3 DECK EDGE AT CFS

Not To Scale

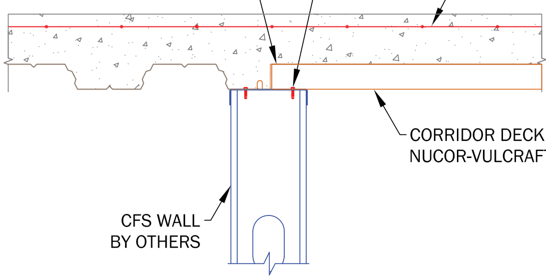


5.4 CORRIDOR TRANSITION AT CFS

Not To Scale

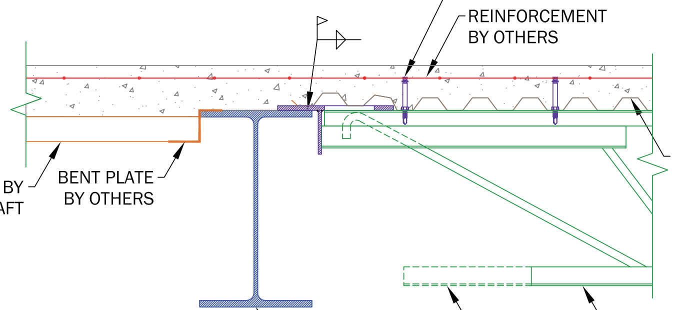
![ECOSPAN Composite Floor System]

COMPOSITE FLOOR SYSTEM



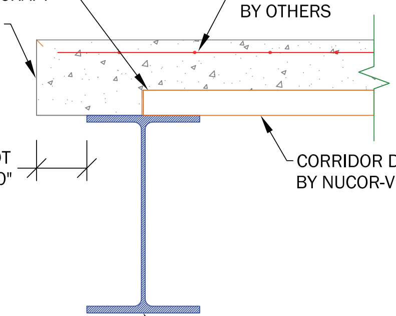
5.5 CORRIDOR DECK DIRECTION CHANGE AT CFS

Not To Scale



5.6 FLUSH SEAT ON BEAM AT CORRIDOR

Not To Scale

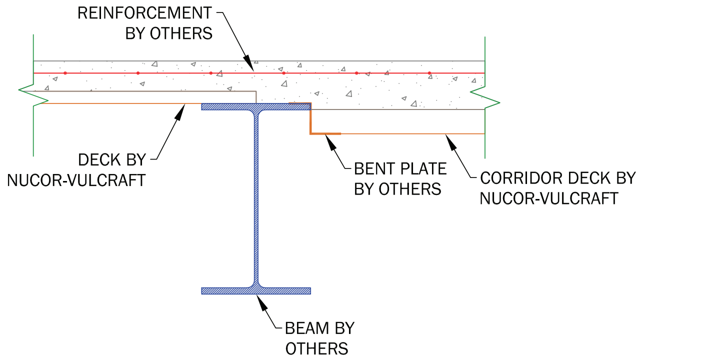


5.7 CORRIDOR AT BEAM

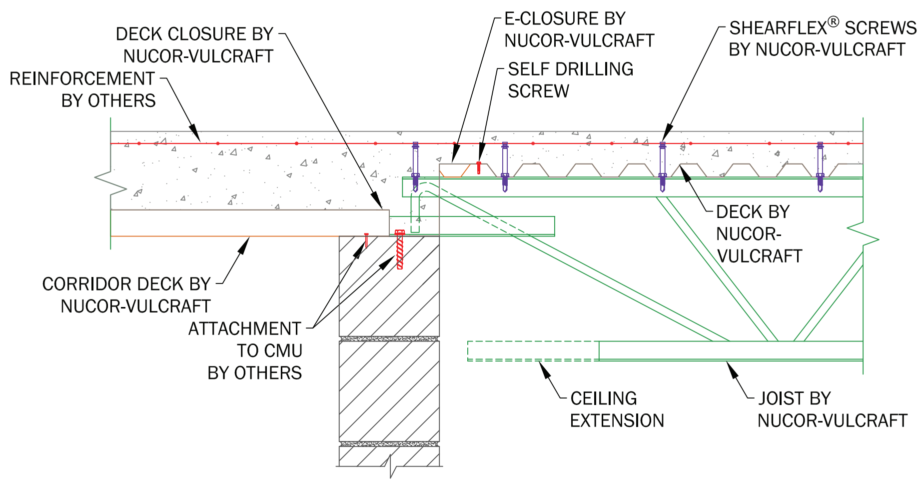
Not To Scale

NUCOR VULCRAFT/VERCO GROUP

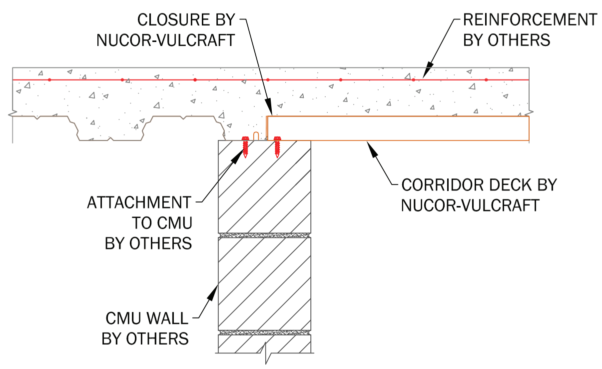
COMPOSITE FLOOR SYSTEM



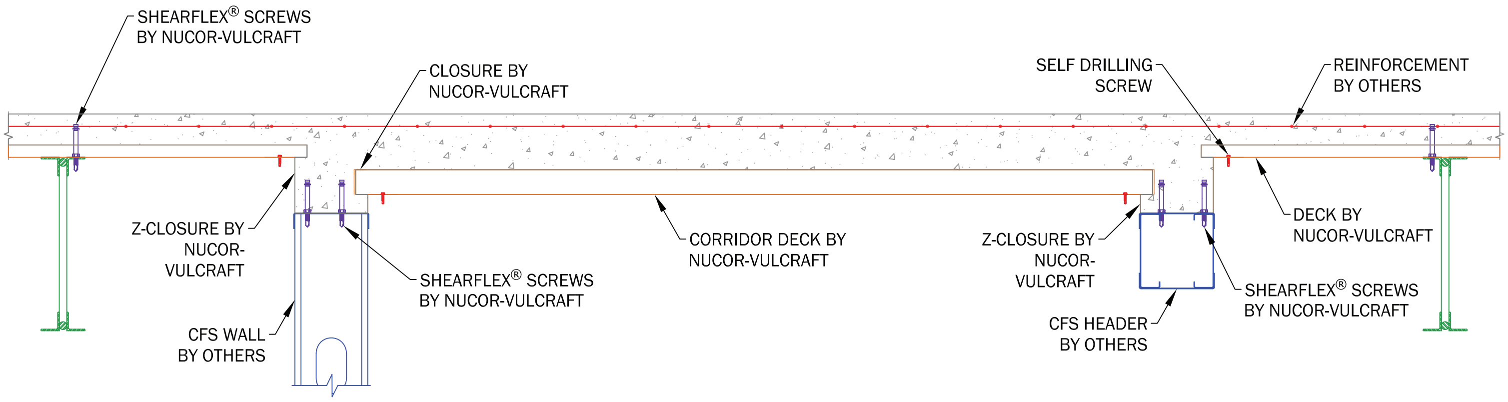
5.8 DROPPED CORRIDOR TRANSITION AT BEAM
Not To Scale



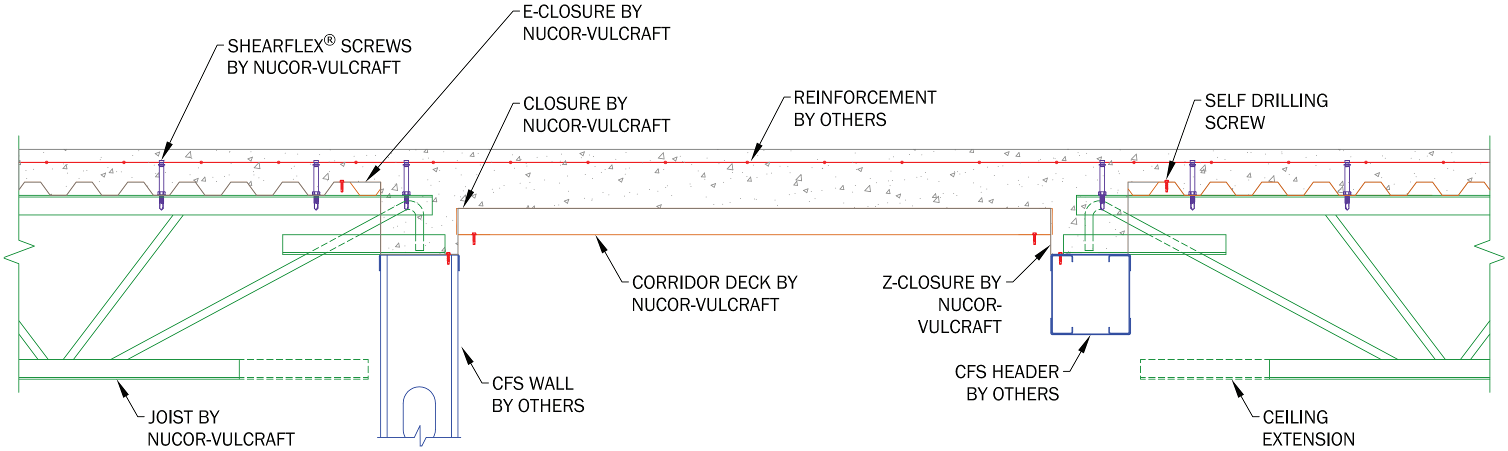
5.9 4.5" SEAT ON CMU AT CORRIDOR
Not To Scale



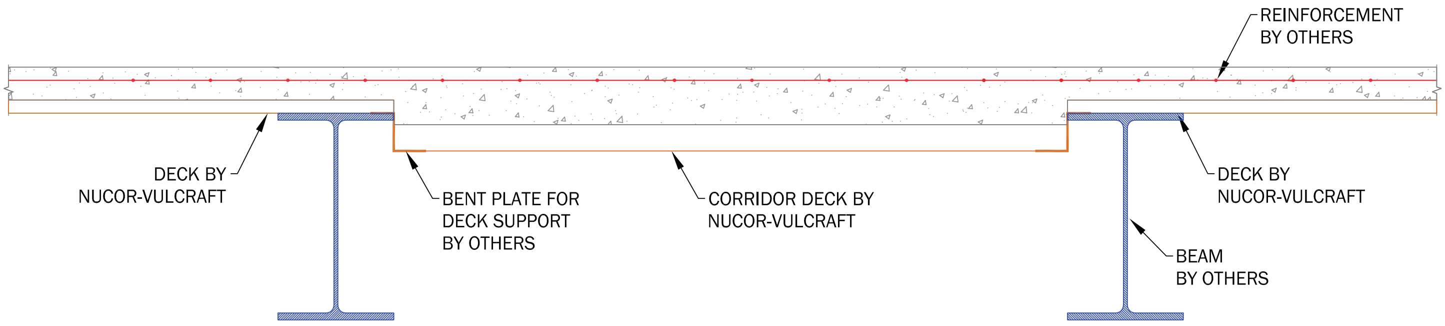
5.10 CORRIDOR DIRECTION CHANGE AT CMU
Not To Scale



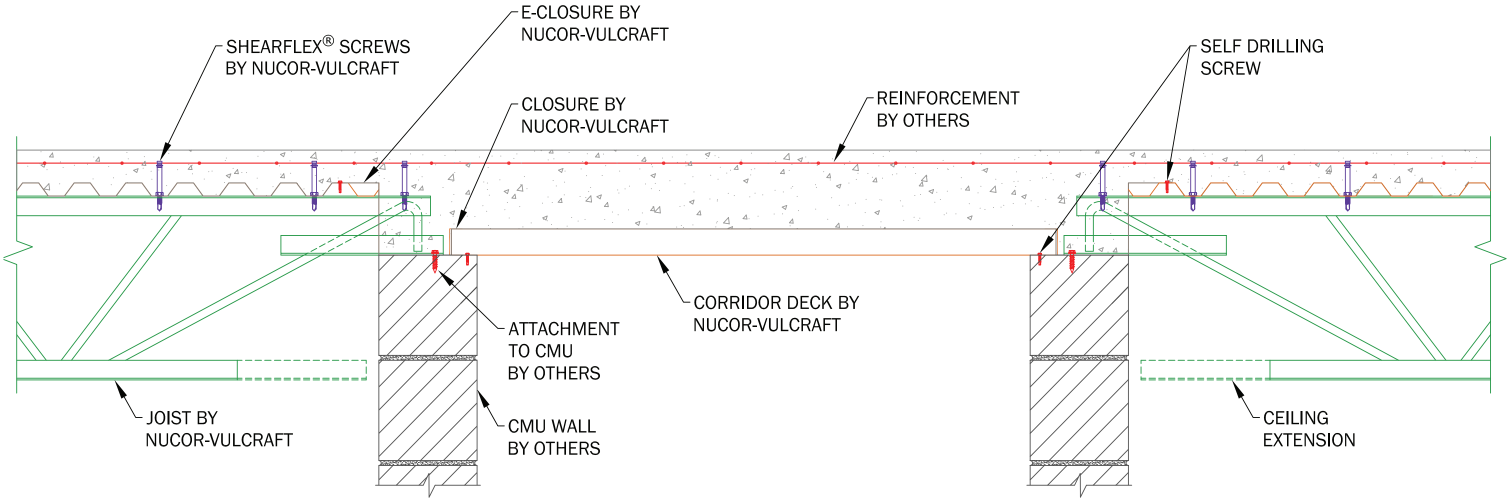
5.11 CORRIDOR SECTION AT CFS - DECK BEARING
Not To Scale



5.12 CORRIDOR SECTION AT CFS - 4.5" JOIST SEAT
Not To Scale

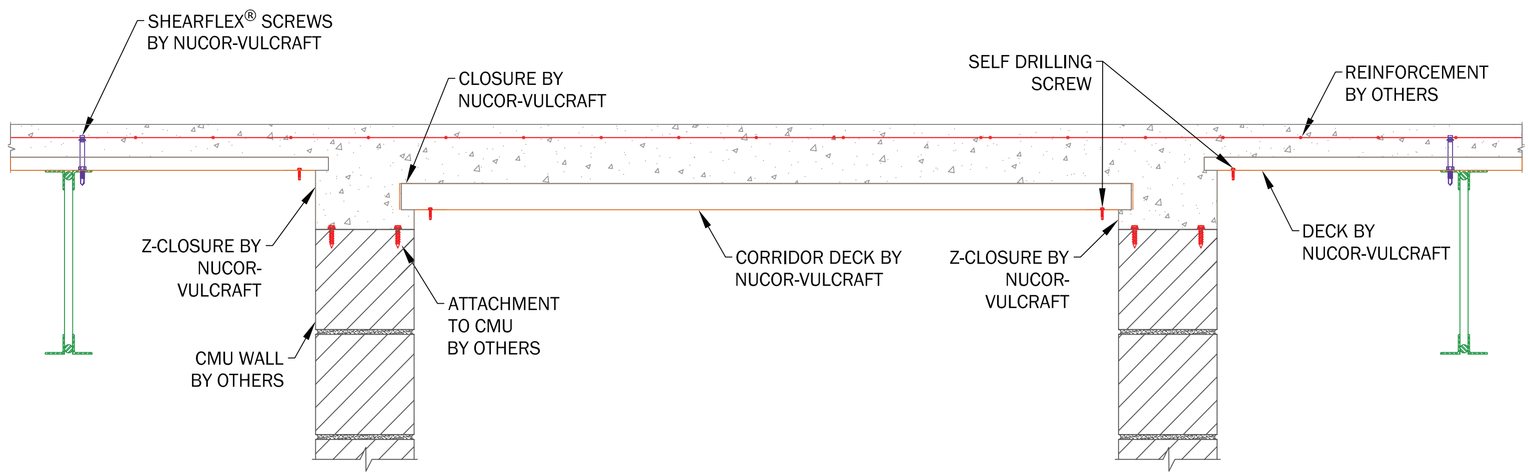


5.13 CORRIDOR SECTION AT WF BEAM - BENT
Not To Scale



5.14 CORRIDOR SECTION AT CMU - 4.5" JOIST

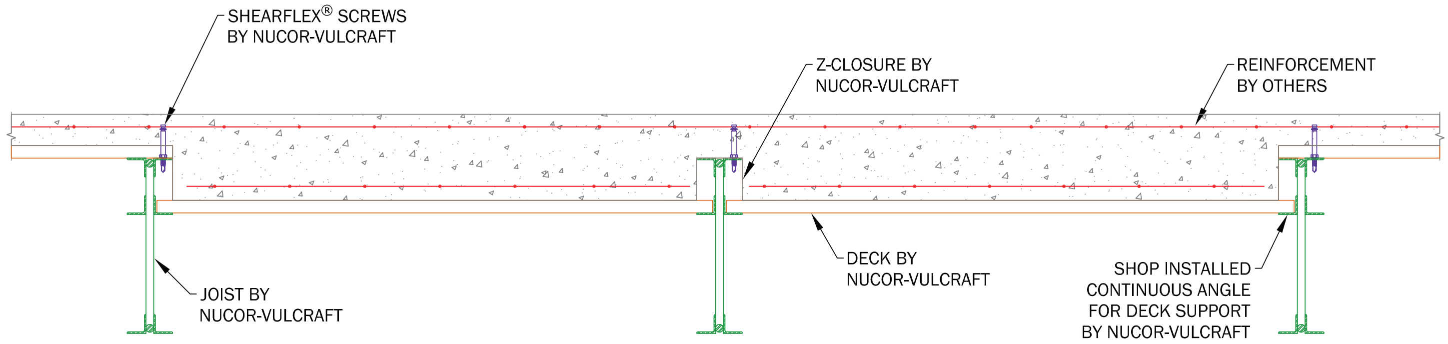
Not To Scale



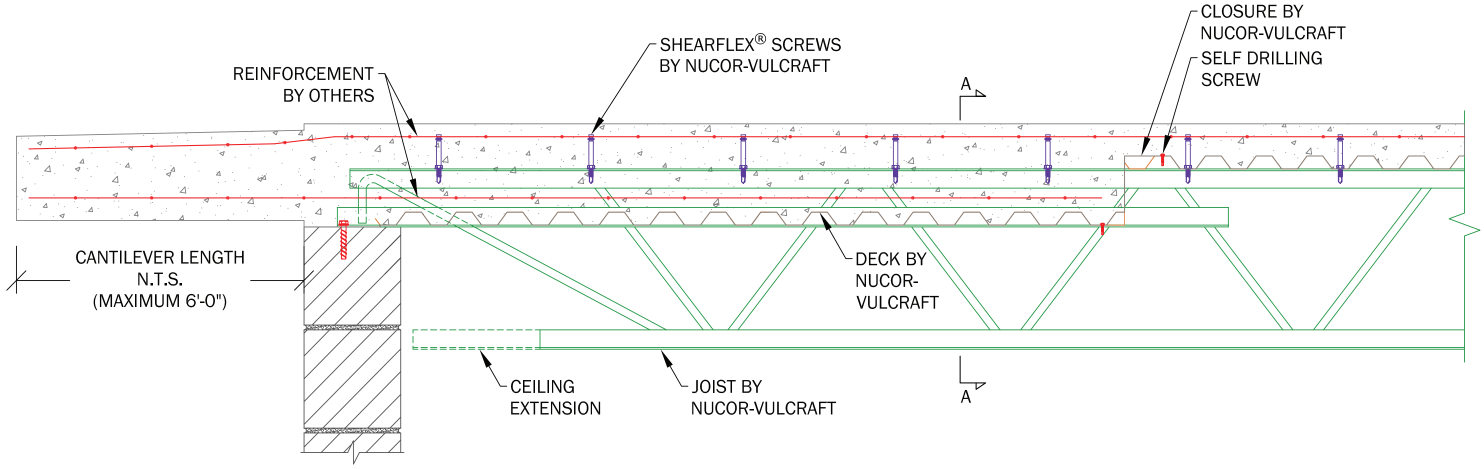
5.15 CORRIDOR SECTION AT CMU - DECK BEARING

Not To Scale

4.6 Ecospan® System Balcony and Mechanical Header Details

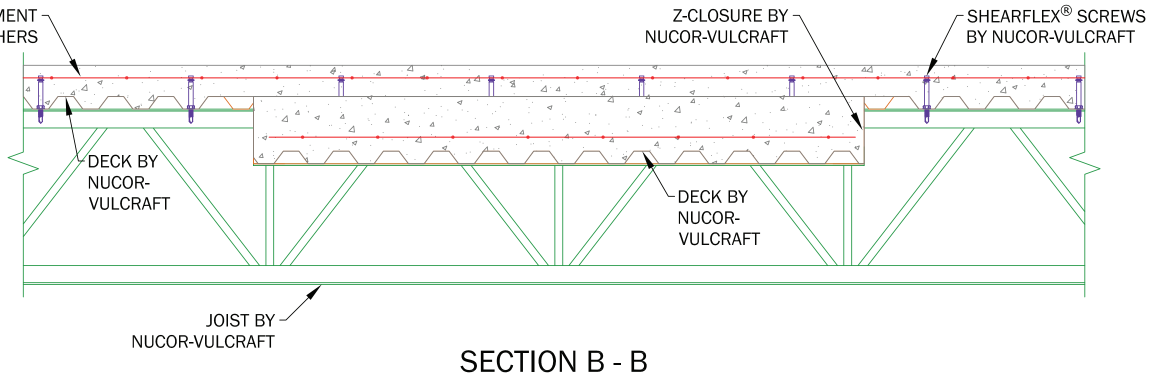


SECTION A - A

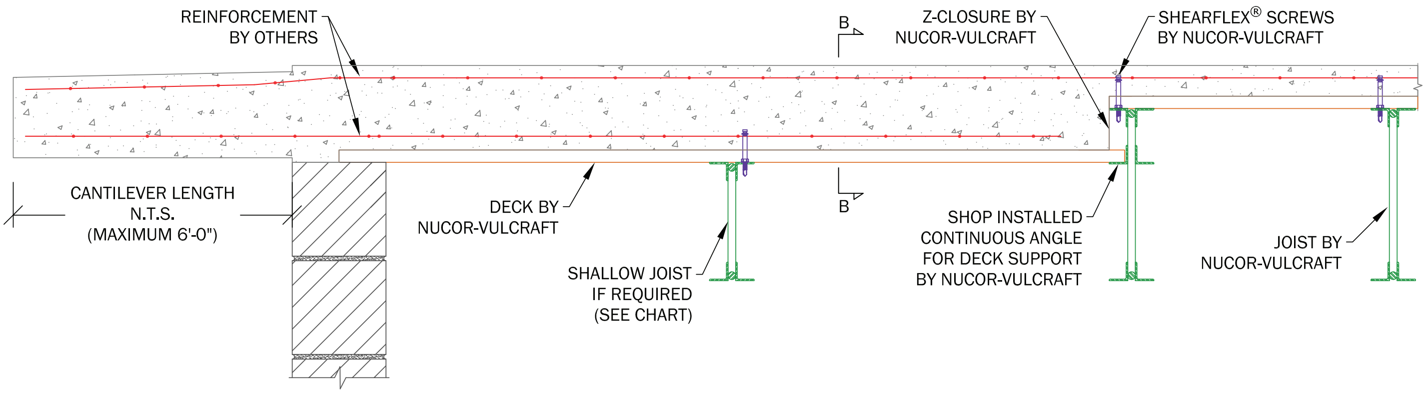


6.1 BALCONY PARALLEL TO JOIST

Not To Scale

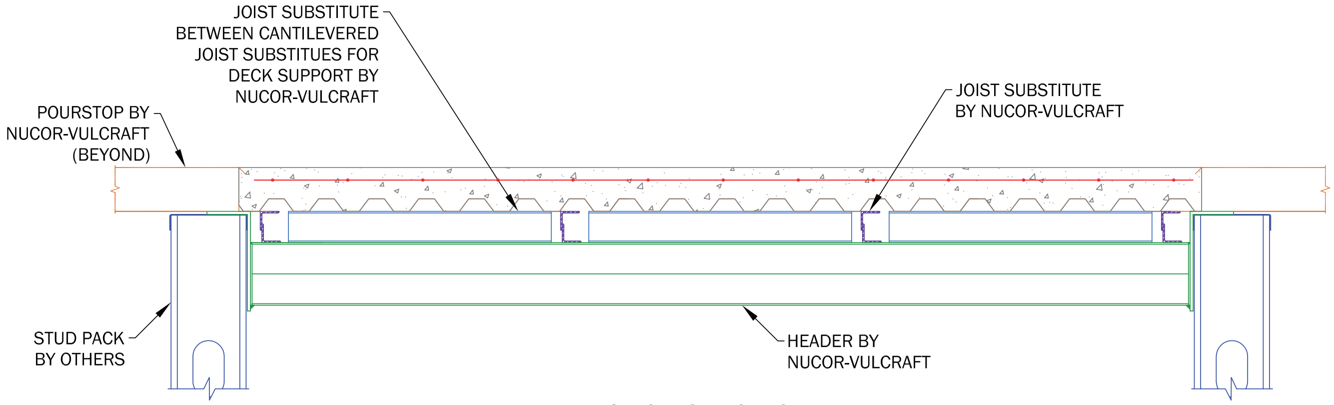


SECTION B - B

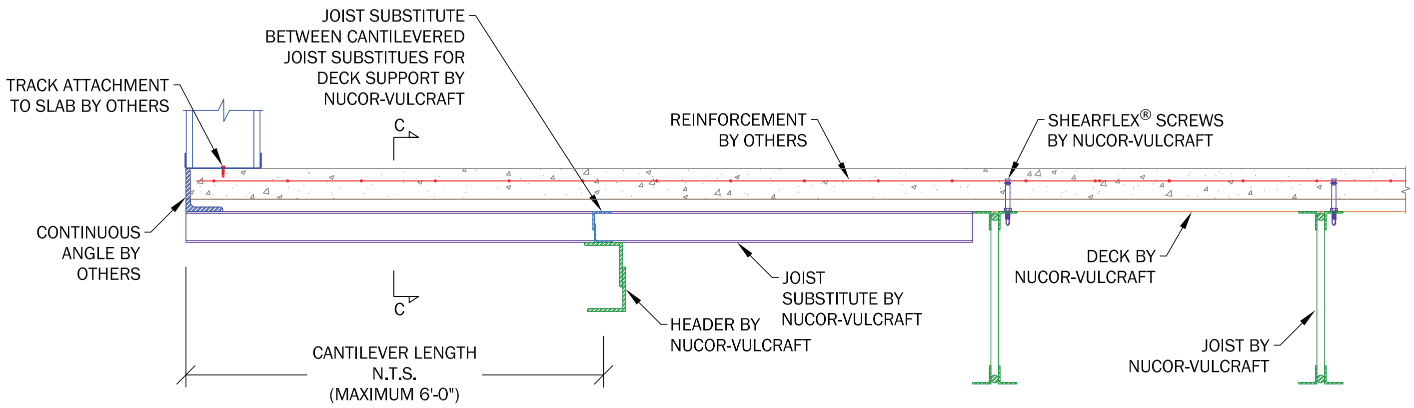


6.2 BALCONY PERPENDICULAR TO JOIST

Not To Scale

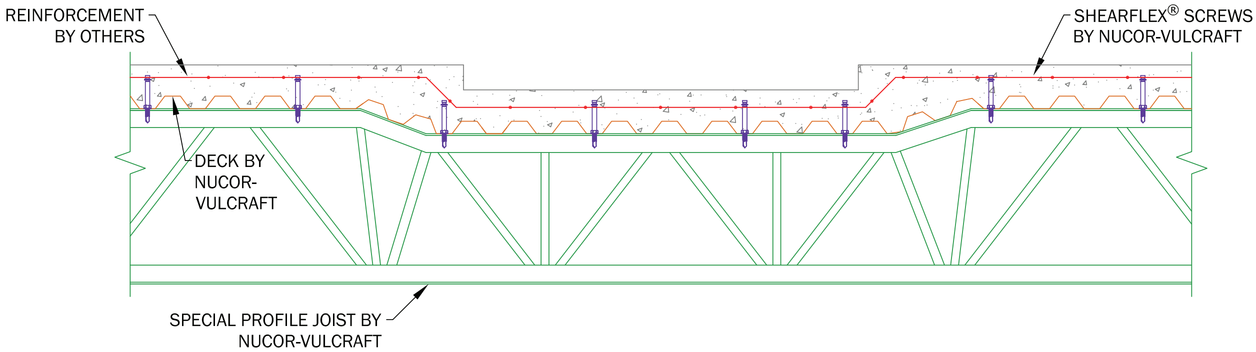


SECTION C - C

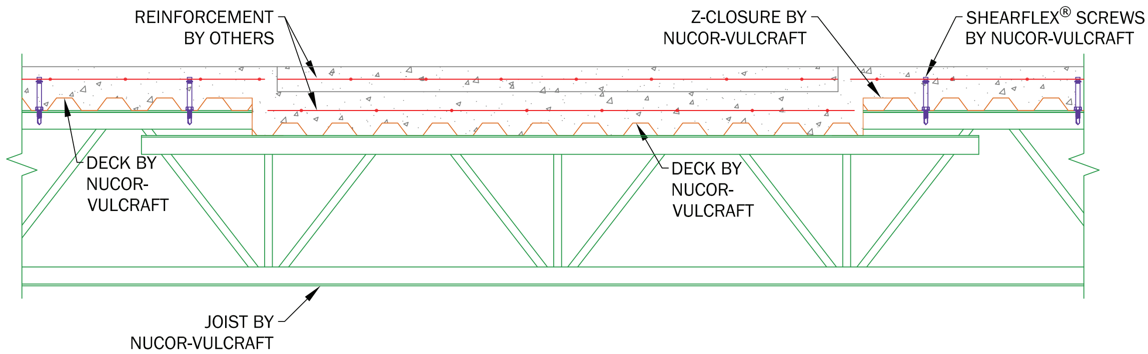


6.3 SELF SUPPORTING CANTILEVER PERPENDICULAR TO JOISTS

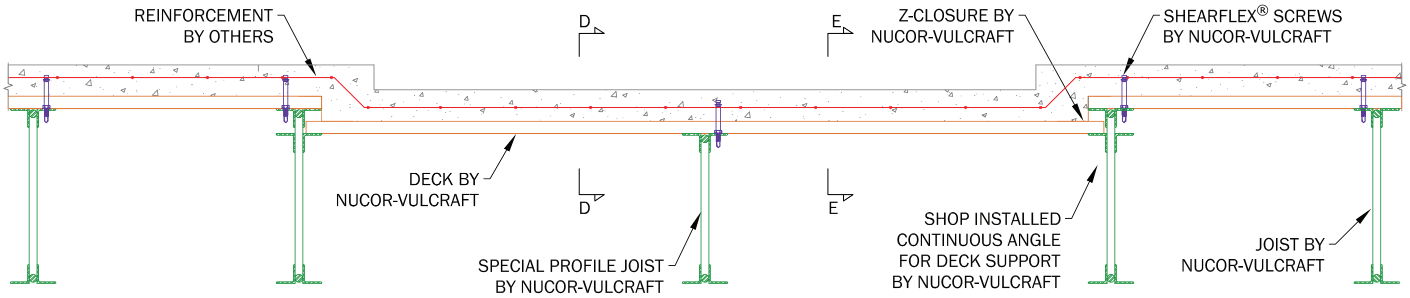
Not To Scale



SECTION D - D

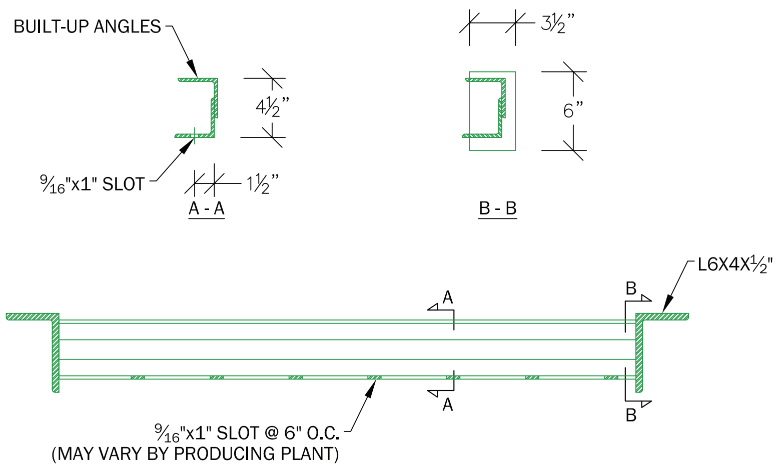


SECTION E - E



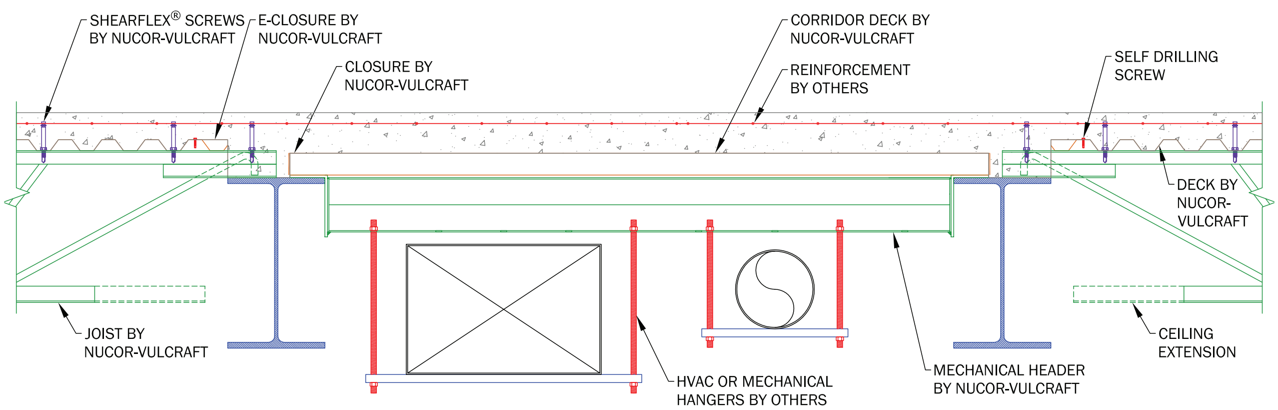
6.4 SLAB DEPRESSION AT INTERIOR JOIST

Not To Scale



6.5 MECHANICAL HEADER

Not To Scale



6.6 MECHANICAL HEADER LAYOUT

Not To Scale

COMPOSITE FLOOR SYSTEM

5.0 UL Fire Ratings

The Ecospan® Composite Floor System is listed by Underwriters Laboratories Inc. with multiple Fire Ratings for Acoustical and Gypsum ceiling applications. The most common UL codes encountered in construction utilizing the Ecospan® Composite Floor System are listed with bold type in Table 5-1. Figures 5-1 through 5-3 illustrate examples of fire rated assemblies.

UL Fire Ratings	
UL Code	**Application**
***Design No. G561**	**Direct Applied and/or Suspended Gypsum Board Ceiling**
Design No. G213	Suspended Acoustical Ceiling
Design No. G227	Suspended Acoustical Ceiling
***Design No. G229**	**Suspended Acoustical Ceiling**
Design No. G236	Suspended Acoustical Ceiling
Design No. G243	Suspended Acoustical Ceiling
Design No. G222	Suspended Gypsum Board Ceiling
Design No. G547	Suspended Gypsum Board Ceiling
***Design No. G710**	**Spray-on Fire Proofing**
Design No. N789	Spray-on Fire Proofing
Design No. D916	Unprotected Comp. Deck in Corridor Areas
***Design No. D902**	**Unprotected Comp. Deck in Corridor Areas**
Design No. D918	Unprotected Comp. Deck in Corridor Areas
Design No. D919	Unprotected Comp. Deck in Corridor Areas

*Most commonly utilized UL Ratings

Table 5-1

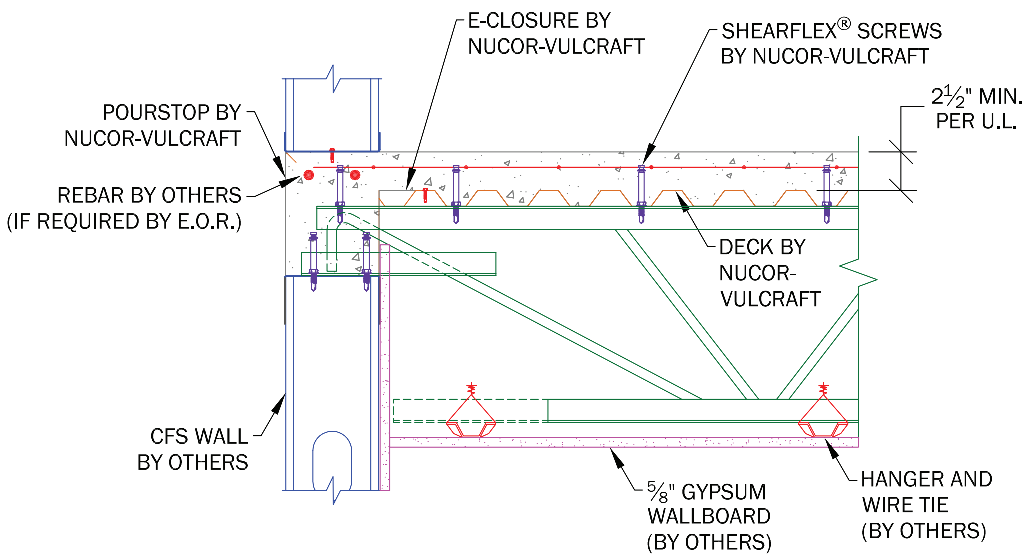


Figure 5-1
Fire Rated AssemblyJoist Bearing on CFS

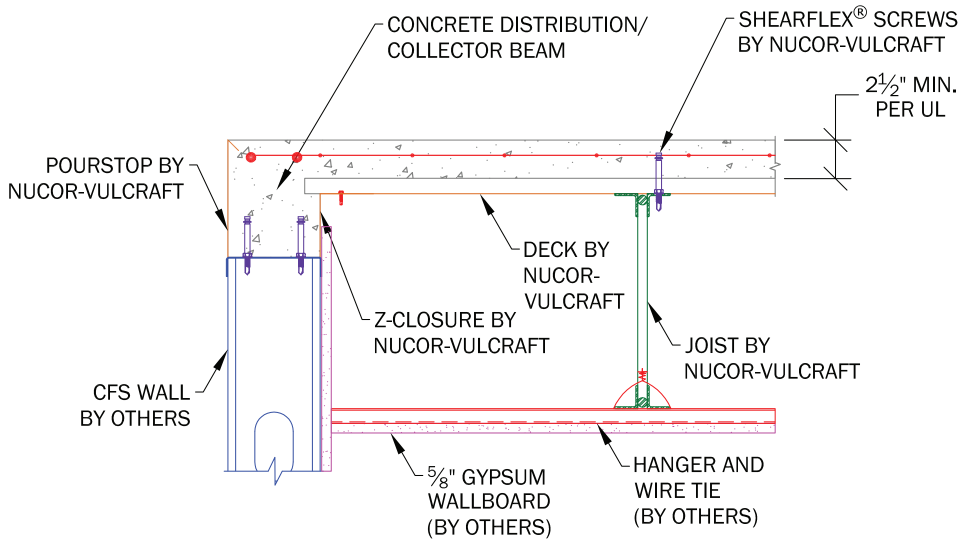


Figure 5-2
Fire Rated Assembly Deck Bearing on CFS

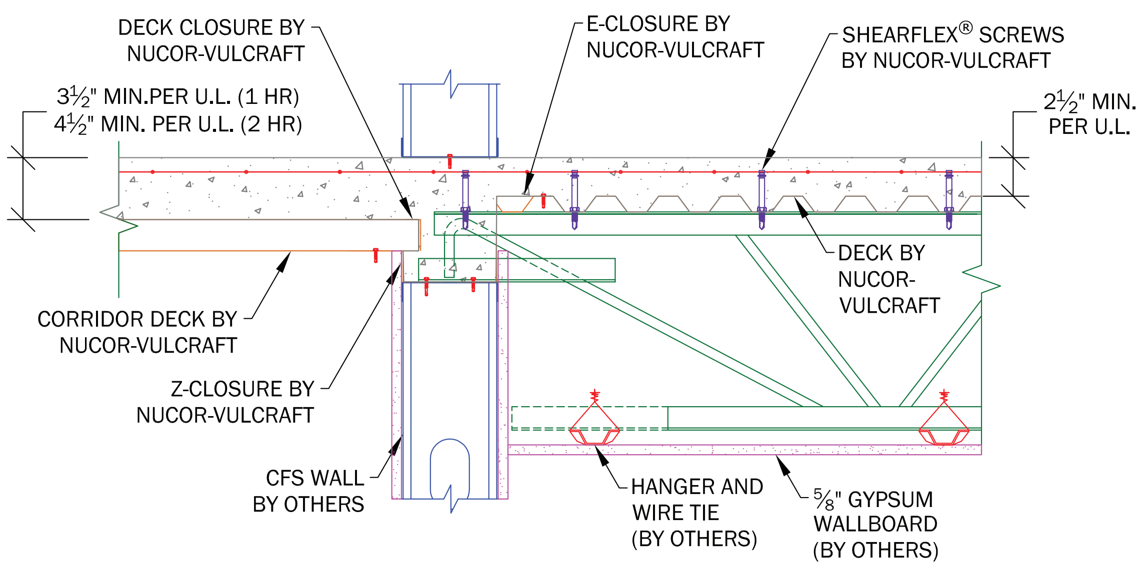


Figure 5-3
Fire Rated Assembly on CFS at Corridor

6.0 Sound Ratings

All tests were performed in explicit conformity with ASTM designations E429, E989 and other pertinent standards. Impact Insulation Classifications (IIC) were computed in accordance with the ASTM designations E989 and E492. Sound Transmission Classifications (STC) were computed in accordance with ASTM designations E90 and E413. All tests were performed at Riverbank Acoustical Laboratories in Geneva, IL. Full reports of each test are available upon request. For testing information, visit www.ecospan-usa.com.

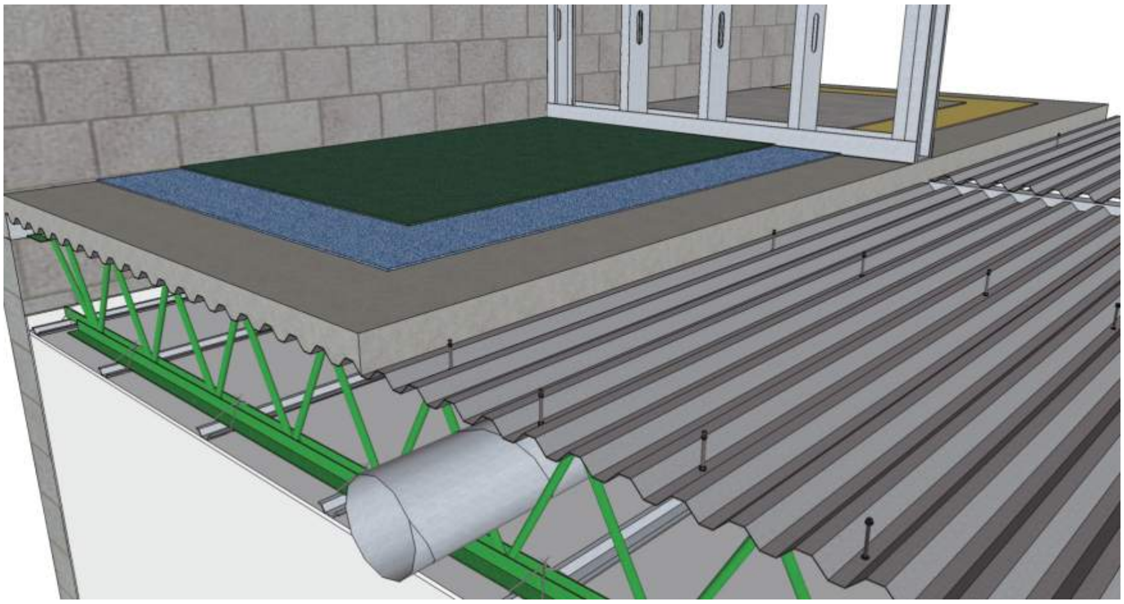


Figure 6-1

6.1 Full Scale Tests:

Full Scale Tests		
Flooring Materials/Thickness	**IIC**	**STC**
Bare Concrete	26, 30*	57
Carpet 1. 6PCF Pad (0.4”) 2. 100% Pet Polyester Carpet (0.438”)	77	57
Ceramic Tile 1. Loose-laid Cork (0.235”) 2. Thinset Mortar 3. Glazed Ceramic Tile (0.3”)	51, 54*	N/A
Wood Laminate 1. Underlayment (0.07”) 2. Wood Laminate Floor (0.38”)	54	N/A

*Resilient sound isolation clips (RISC-1) used in place of wire tires.

Table 6-1

6.2 Small Scale Tests:

Small Scale Tests			
	Flooring Materials/Thickness	Total Depth	IIC
CERAMIC TILE	Ceramic Tile (0.30") Nobleseal CIS (0.03") Levelrock 2500 (1.00") SRM-25 (0.25")	1.62"	54
	Ceramic Tile (0.30") Nobleseal CIS (0.03") Levelrock 2500 (1.50") USG SRB (0.375") SRM-25 (0.25")	2.46"	58
	Ceramic Tile (0.30") Nobleseal CIS (0.03") USG Underlayment (0.25") Levelrock 2500 (1.50") USG SRB (0.375") SRM-25 (0.25")	2.71"	62
	Ceramic Tile (0.30") USG Wonderboard (0.25") Enkasonic Underlayment (0.40")	1.01"	59
	Ceramic Tile (0.30") USG Wonderboard (0.25") Enkasonic Underlayment (0.40")	1.26"	58
	Ceramic Tile (0.30") Cork (0.25")	0.63"	51
HARDWOOD	Hardwood Flooring (0.5625") Sound Underlayment (0.0625") Levelrock 2500 (1.00") SRM-25 (0.25")	1.88"	53
	Hardwood Flooring (0.5625") Sound Underlayment (0.0625")	0.63"	53
PERGO	Pergo Flooring (0.375") Sound Underlayment (0.0625") Levelrock 2500 (1.00") SRM-25 (0.25")	1.69"	54*
	Pergo Flooring (0.375") Sound Underlayment (0.0625")	0.44"	53

*Resilient sound isolation clips (RISC-1) used in place of wire tires.

Table 6-2

7.0 Installation Guide

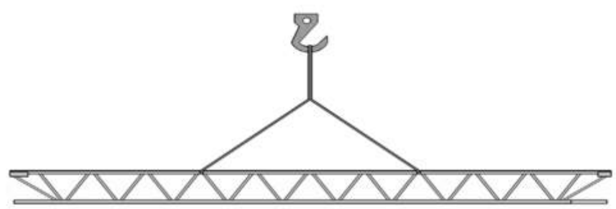
Delivery

Check quantities and mark numbers and condition of joists, deck, Shearflex® screws, Shearset® tools, E-Closure and other accessories upon arrival.

Make a note on the delivery ticket if there are any shortages or discrepancies.

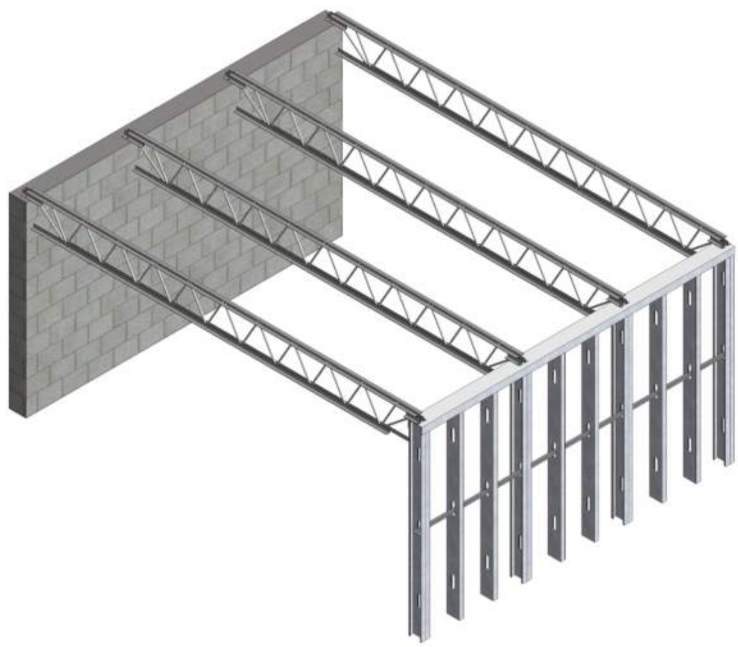
If joists arrive damaged or damage to joists occurs during erection, contact Vulcraft immediately.

Unloading



When unloading joists by crane, always hook chains or sling to top or bottom chords at panel points (preferably at 1/3 points). Never hook to web members.

Installation - Joists



Place joists according to Final Plans for Field Use. Take note of the "tag end" to assure correct installation. Both sides of the seat on one end of the joist must be attached to the support prior to releasing hoisting cables. Use one the following methods (as a minimum) to secure the joist seat to bearing condition.

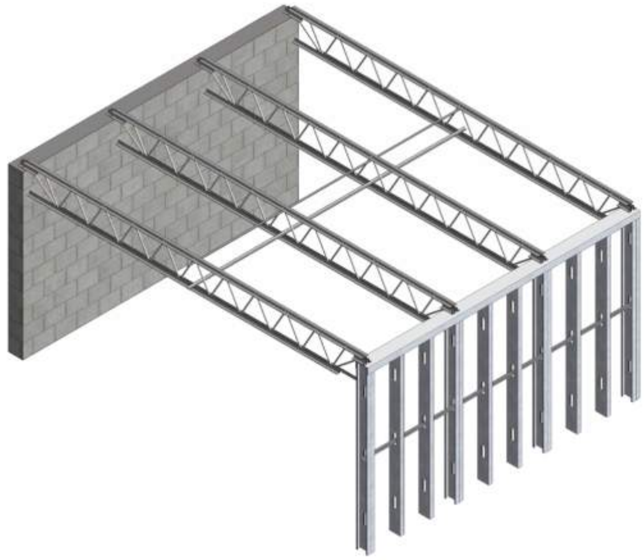
Structural Steel:
- Standard Seat: Two 1/8 inch fillet welds 2 inches long or equivalent.
- Flush Seat: Two 1/8 inch welds 1 1/2 inches long on each side of bearing seat.

Cold Formed Steel:
- Standard Seat: Two self-tapping screws.

Concrete, Masonry:
- Standard and Flush Seat: Two masonry screws.

Note: When bolted connections are used with seat slots, the final connection must also be welded unless a slip connection is required.

Installation - Bridging



Bolted/Screwed Horizontal & Diagonal Bridging:
Snug tighten bolted/Screwed horizontal and diagonal bridging.

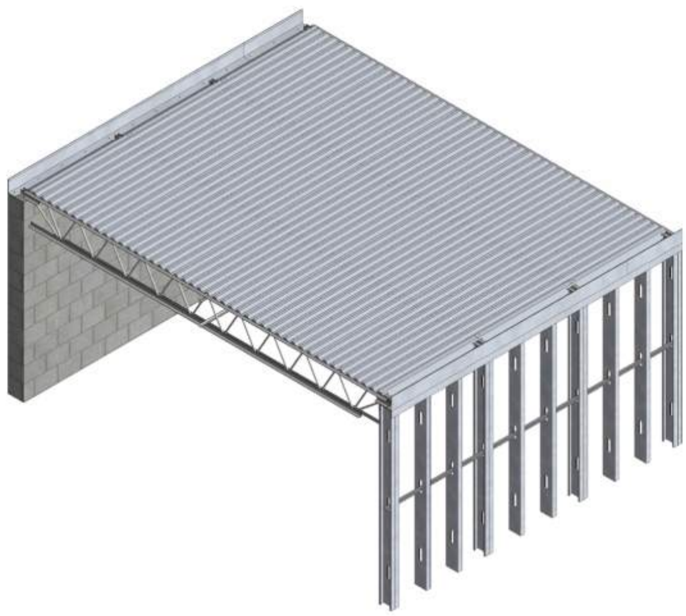
Welded Horizontal Bridging: Lap bridging a minimum of 3 inches. Connect bridging to joist with a minimum of 1/8 inch fillet weld 1/2 inch long. Use drops where possible.

Welded Diagonal Bridging: Weld at intersection with a minimum 1/8 inch fillet weld 1 inch long or equivalent.

Typically (1) or (2) rows of bridging will be required per bay. Locate bridging as shown on the Field Use Erection Drawings. If more than one row is required, locate bridging equally spaced along the joist.

In cases where bridging is not required, care must be taken to align joists in accordance with the Final Plans for Field Use.

Installation - Accessories



Attach the deck accessories by screwing, welding, or button punching using the following minimum attachment requirements:

Accessory Attachment Requirements	
Type	**Spacing**
Pour Stop	12” O.C.
Girder Filler	12” O.C.
Split Deck Sheets	18” O.C.
End Closure	36” O.C.
Flat Plate	16-18” O.C.
Z-Closure	16-18” O.C.

Installation - Decking

- Attach deck to joists using erector preferred method before using deck as a working platform.
- Fasten deck in accordance with deck attachment requirements on the Final Plans for Field Use.
- Shearflex® Screws or self-drilling screws can be used in lieu of puddle welds. (**See Installation – Shearflex® Screws**)
- Deck requires a minimum bearing of 1½ inches.
- Ensure sheet end laps are a minimum of 2 inches and occur over a joist top chord angle or other support, unless noted otherwise.
- If Welding: Use weld washers for deck thicknesses less than 22 gage.

Installation - E-Closure

E-closure is supplied for the purpose of creating a concrete seal between joists. **Note:** E-closure is not required for projects utilizing flush joist seats.

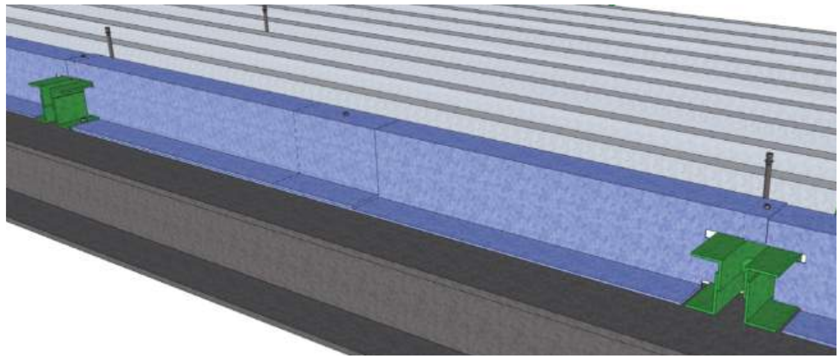


Figure 7-1

A combination of two pieces of E-Closure will be supplied with opposing profiles at one end (one Left Side and one Right Side). These two pieces are designed to be lapped, adjusted and attached to accommodate the required joist spacing. See Figure 7-1 for example of E-closure installation. E-closure should be screwed at each end (one screw where pieces lap).

Installation - Shearflex® Screws

Locate and install Shearflex® connectors per the Final Plans for Field Use using the Shearset® Tool (supplied by Vulcraft) to install. Installation by other means may damage the fastener and its ability to function properly. Reference Figure 7-2 for general Shearflex Screw installation requirements. Note, for ease of installation, joist top chord size will be no less than 1 ½" horizontal angle legs.

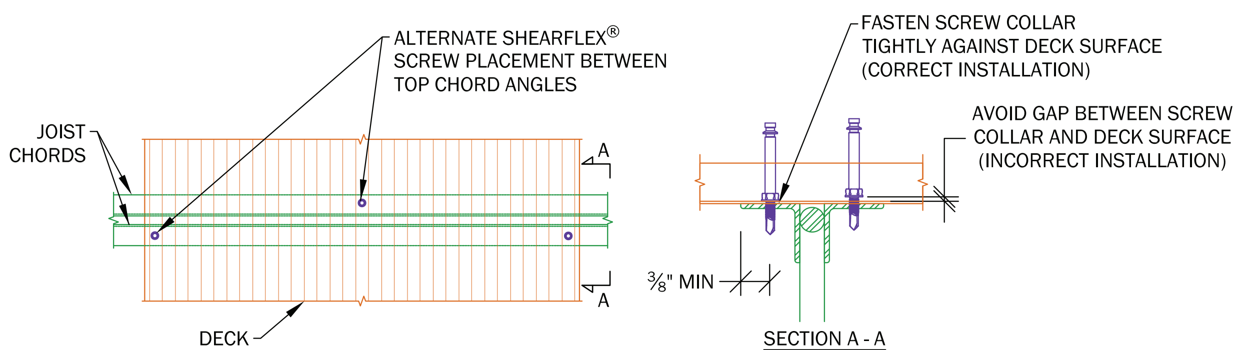


Figure 7-2

Installation - Concrete Reinforcing and Concrete

The Design Professional shall specify required concrete reinforcing. Install concrete reinforcing in accordance with American Concrete Institute (ACI) & Concrete Reinforcing Steel Institute (CRSI) installation guidelines.

The Design Professional shall specify concrete material properties and strength requirements. Install concrete in accordance with ACI installation guidelines. Concrete shall be installed to a uniform depth.

• • • • •

ECOSPAN®
COMPOSITE FLOOR SYSTEM

8.0 Ecospan® Design Example

Step 1:

Fill out the Joist Parameter checklist for E-Series joists shown in Section 2.4.

Project: Design Example - Residential   Date: ____________

Joist Geometry

1.	Depth of steel joist	16	inches
2.	Span	30	feet
3.	Adjacent joist spacing (left)	4	feet
4.	Adjacent joist spacing (right)	4	feet

Deck and Concrete

1.	Vulcraft floor deck type	1.0C	24 Gage with 36” Cover
2.	Concrete unit weight	145	pcf
3.	Concrete compressive strength	3000	psi
4.	Slab thickness (above deck)	2.5	inches = 3.5” Total Slab Depth

Shearflex® screws

Shearflex® fastener pattern to be determined by Vulcraft National Accounts

Un-factored Design Loads

1.	Non-composite dead load				
a.	Concrete	36.3	psf		
b.	Joists	4	psf		
c.	Decking	1.3	psf		
d.	Bridging	0.1	psf		
	Total	42	psf	168	plf
2.	Construction live load	25	psf		
3.	Composite dead load				
a.	Fixed partitions	0	psf		
b.	MEP	8	psf		
c.	Fire suppression	0	psf		
d.	Floor covering	4	psf		
e.	Ceiling	3	psf		
	Total	15	psf	60	plf
4.	Composite live load				
a.	Design live load	40	psf		
b.	Live load reduction factor	100	%		
c.	Reduced design live load	40	psf		
d.	Movable partitions	15	psf		
	Total	55	psf	220	plf
5.	Total non-composite and composite loads	112	psf	448	plf

Camber and Deflection

1. Max. allowable live load deflection = Span / 360
2. Ecospan® Joists are cambered for 100% of non-composite dead load (Typical)
3. Additional Camber for 0% Composite Dead Load and 0% Composite Live Load

E-series Joist Designation
16E448/220/60

NUCOR® VULCRAFT/VERCO GROUP

Step 2:
Determine loading criteria for non-composite and composite design checks.

LRFD will be utilized for this design example. The following loading checks will be performed:

Load Case 1: Non-composite load case where the joist must support all non-composite loads prior to development of concrete and composite strength.

$$\text{Factored } TL_{non\text{-}composite} = 1.2\ DL_{non\text{-}composite} + 1.4LL_{non\text{-}composite}$$
$$= 1.2\ (42\ psf) + 1.4\ (25\ psf)$$
$$= 86\ psf$$
$$= (4'\text{-}0'')\ (86\ psf) = 344\ plf$$

Load Case 2: Composite load case where composite section must support loads required by current building code for designated occupancy.

$$\text{Factored } TL_{composite} = 1.2\ DL_{non\text{-}composite} + 1.2DL_{composite} + 1.6LL_{composite}$$
$$= 1.2\ (42\ psf) + 1.2\ (15\ psf) + 1.6\ (55\ psf)$$
$$= 156\ psf$$
$$= (4'\text{-}0'')\ (156\ psf) = 624\ plf$$

Step 3:
Calculate the required design moment for the non-composite and composite load cases.

The joists are supported on 6 inch cold formed wall studs. Utilize a joist bearing seat depth of 4.5 inches so that the center of the joist reaction coincides with the centerline of the wall studs. Therefore the Ecospan® design length, L = Joist span = 30.0 ft. Ecospan® joists are designed as simply supported members.

$$M_{u\ (non\text{-}composite)} = \frac{\text{Factored } TL_{non\text{-}composite} * L^2}{8}$$
$$= \frac{344\ plf\ *\ (30.0\ ft)^2}{8}$$
$$= 38{,}700\ ft \bullet lbs$$

$$M_{u\ (composite)} = \frac{\text{Factored } TL_{composite} * L^2}{8}$$
$$= \frac{624\ plf\ *\ (30.0\ ft)^2}{8}$$
$$= 70{,}200\ ft \bullet lbs$$

Step 4:
Determine minimum top and bottom chord areas for non-composite loads.

Assume the following nominal stresses and resistance factors in these calculations:

$F_{n\ (compression)} = 43{,}000\ psi$

$F_{n\ (tension)} = 50{,}000\ psi$

Resistance factor for member in compression, $Ø_c = 0.9$
Resistance factor for member in tension, $Ø_t = 0.9$

Estimate effective depth for steel joist.

$d_{eff} = 0.92\ (D)$
$= 0.92\ (16")$
$= 14.72"$

These assumptions are reasonable for most Ecospan® joist depths and web configurations. Now an estimate of the required area of the chords can be calculated. The effective depth assumption will be verified once the final angle sizes have been determined.

$$TC_{area} = \frac{M_{u\ (non\text{-}composite)}}{d_{eff} * F_{n(compression)} * Ø_c} = \frac{38{,}700\ ft \bullet lbs)(^{12in}/_{1ft})}{(14.72")(43{,}000\ psi)(0.9)}$$

$= 0.815\ in^2$

$$BC_{area} = \frac{M_{u\ (non\text{-}composite)}}{d_{eff} * F_{n(tension)} * Ø_t} = \frac{38{,}700\ ft \bullet lbs)(^{12in}/_{1ft})}{(14.72")(50{,}000\ psi)(0.9)}$$

$= 0.701\ in^2$

Step 5:
Choose TC and BC angles based on required areas.

Chord	Angle Size	Area	$y_{centroid}$
TC	2-L1.5x1.5 x 0.155	0.882	0.432
BC	2-L1.5x1.5X0.123	0.708	0.420

Table 8-1

Step 6:
Estimate the required bottom chord area to support the composite design moment.

Assume depth of compressive area for the concrete (a=0.75").

$$d_{eff\ composite} = D - y_{BC} + t_{slab} - \frac{a}{2}$$
$$= 16" - 0.420" + 3.5" - \frac{0.75"}{2}$$
$$= 18.71"$$

$$BC_{area} = \frac{M_{u\ (non\text{-}composite)}}{d_{eff} * F_{n(tension)} * Ø_t} = \frac{(70{,}200\ ft \bullet lbs)(^{12in}/_{1ft})}{(18.71")(50{,}000\ psi)(0.9)}$$

$= 1.000\ in^2$

The below bottom chord is selected to support the total composite load.

Chord	Angle	Thickness	Area	$y_{centroid}$
BC	2-L2.0 x2.0	0.137	1.058	0.551

Table 8-2

Step 7:

7a: Check composite design assumptions:

- $d_{eff\ noncomposite}$ = 0.92 (D)
- a = 0.75"

Verify $d_{eff\ (noncomposite)}$:

$$d_{eff\ noncomposite} = D - y_{TC} - y_{BC}$$
$$= 16" - 0.432" - 0.551"$$
$$= 15.02"$$

Assumed $d_{eff\ noncomposite}$ = 14.72" < Actual $d_{eff\ noncomposite}$ = 15.02" ∴ OK

7b: Determine effective width of the concrete compression block (b_{eff}):

The effective width, b_{eff}, is the lesser of:

- *Sum of ½ the distance left and right to the adjacent joist = 48"*
- *L/4 = 30.0 ft (12 in/ft) /4 = 90"*

Use 48" as b_{eff}:

$$a = \frac{Area_{BC}\,(F_y)}{0.85f'_c\,b_{eff}} = \frac{1.058\ in^2\,(50ksi)}{0.85(3ksi)(48")}$$
$$= 0.432\ inches$$

$$d_{eff\ composite} = D - y_{BC} + t_{slab} - \frac{a}{2}$$

$$d_{eff\ composite} = 16\ in - 0.551\ in + 3.5\ in - \frac{0.432\ in}{2} = 18.73\ in$$

$$øM_n = øA_{bc}F_y d_{eff\ composite}$$

$$øM_n = 0.9\,(1.058\ in^2)(50{,}000\ lb/in^2)(18.73\ in)(1\ ft/12\ in) = 74{,}311\ ft\text{ - }lbs$$

$$M_{u\ composite} \le øM_n = 70{,}200\ ft\text{ - }lbs \le 74{,}311\ ft\text{ - }lbs\ \therefore\ OK$$

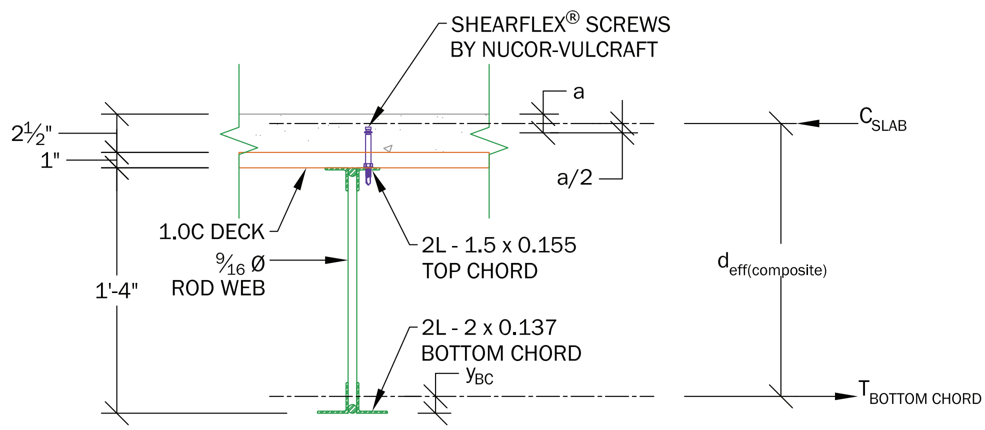


Figure 8-1: Composite Joist Diagram

Step 8:
Determine camber requirements for the E-series joist.

From the design parameter check list, the joist is to be cambered for 100% of the noncomposite dead load. The weight of the concrete, joists, decking, and bridging, $w_{noncomposite} = 168\ lb\,/\,ft$

The method outlined in AISC Design Guide 11, "Floor Vibrations Due to Human Activity", provides an accurate way estimating the joist moment of inertia and resulting deflection.

The 16 inch deep Ecospan® joist has continuous round rod web members.

D = *Depth of the joist = 16 in*

L = *Joist length = 360 inches*

$$C_r = 0.721 + 0.00725\left(\frac{L}{D}\right)$$ *(Eqn 3.17, AISC Steel Design Guide 11)*

$$C_r = 0.721 + 0.00725\left(\frac{360in}{16in}\right) = 0.884$$

$I_{chords} = 109\ in^4$ *(see Calcs. pg. 91)*

$$I_{mods} = C_r I_{chords}$$ *(Eqn 3.15, AISC Steel Design Guide 11)*

$$I_{mods} = C_r I_{chords} = 0.884\,(109in^4) = 96in^4$$

$$\Delta_{non\text{-}composite} = \frac{5w_{non\text{-}composite}L^4}{384E_sI_{mod}} = \frac{5(168\frac{lb}{ft^2})(\frac{1ft}{12in})(30ft)^4(\frac{12in}{ft})^4}{384(29{,}000{,}000\frac{lb}{in^2})(96in^4)} = 1.09''$$

Cambering the E-series joists 1-1/8 inches will result in a flat floor after the placement of the bridging, deck, and concrete.

Step 9:
Determine the composite live load deflection

$w_{composite} = 220\ lb / ft$

$I_{composite} = 316 in^4$

Assume a shear connector slip coefficient, $C_{connector} = 0.05$

Based on full scale composite joist tests, the reduced composite moment of inertia, $I_{reduced}$, can be determined:

$$I_{reduced} = \frac{I_{composite}(1 - C_{connector})}{0.92 + \frac{79}{(\frac{L}{D})^2}} = \frac{316\,(1 - 0.05)}{0.92 + \frac{79}{(\frac{30ft \times 12in/ft}{16in})^2}} = 279in^4$$

$$\Delta_{non\text{-}composite} = \frac{5w_{compositeLL}L^4}{384E_sI_{reduced}} = \frac{5(220\frac{lb}{ft^2})(\frac{1ft}{12in})(30ft)^4(\frac{12in}{ft})^4}{384(29{,}000{,}000\frac{lb}{in^2})(279in^4)} = 0.49'' < \frac{(30ft)(\frac{12in}{ft})}{360} = 1in$$

$\Delta_{Composite\ LL} = 0.49$ inches < 1 in max, ∴ OK

Step 10:
Determine Shearflex® screw pattern required to transfer the required horizontal shear force.

Assume a 36/4 Shearflex® screw pattern as shown in Section 3.5.2.

Screw spacing ($S_{Shearflex®}$) = 36"/3 spaces = 12" o.c. average

From Table 3-3, the nominal Shearflex® screw capacity in 0.155 inch thick TC material is $Q_{n\ Shearflex®} = 4.3$ kips/screw. Calculate number of screws to develop the horizontal shear force in the bottom chord. This can conservatively be taken as the force in the bottom chord force occurring at the maximum moment location:

$$T_{bc} = \frac{M_{u\ composite}}{d_{eff\ composite}} = \frac{70{,}200\ ft.lbs\,(\frac{12in}{ft})}{18.73in} = 44.98\ kips$$

$$\text{Min. Req'd screws per half span} = \frac{T_{bc}}{\text{Ø}_s Q_{n\ Shearflex®}} = \frac{44.98\ kips}{(0.9)(4.3\frac{kips}{screw})}$$

= 11.6 screws ∴ 12 screws/ half span or 24 screws / span

Determine number of screw locations available along span with 36/4 pattern:

$$Spaces = \frac{L}{S_{Shearflex^{®}}} = \frac{(30\ ft)(12\ in/ft)}{12"\ o.c.} = 30$$

Number Screw Locations available = Spaces + 1 = 31 Shearflex® / span

There are sufficient number of deck ribs for installing the required 24 Shearflex® screws / joist.

∴ *Provide a 36/ 4 Shearflex® pattern for the Ecospan® joist.*

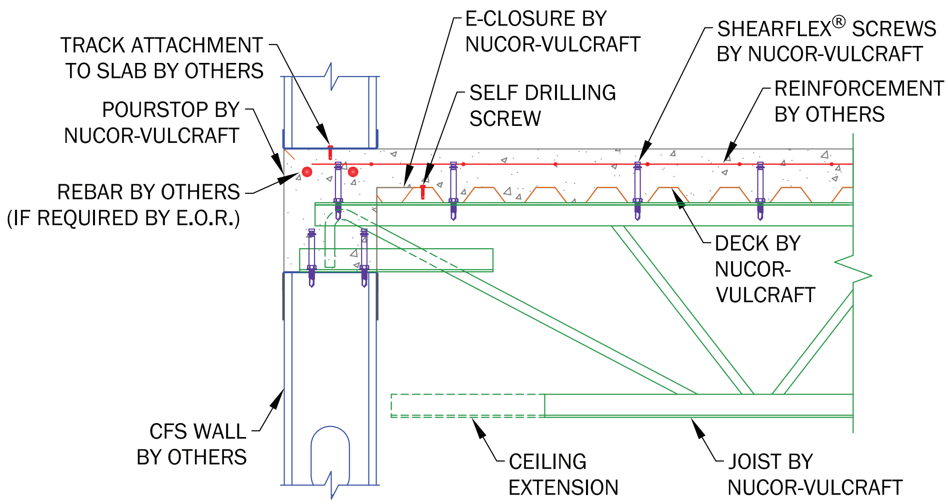


Figure 8-2: Composite Joist Detail

Step 11:
Determine Joist Bridging Required

11a: Joist Erection Bridging

A check of the [(1)]Minkoff Equation indicates that the joist can safely support a 250 lb worker at the midspan of the joist. Therefore, no diagonal erection bridging is required.

11b: Construction Bridging

Bridging will be provided such that the maximum spacing between top chord bridging anchorage points, $L_{yy\text{-}tc}$, will not exceed $170r_{yy}$. Interior webs on this E-Series joist are 9/16 inch round bars. Therefore, the minimum spacing between top chord angles is 9/16 inch as shown in Figure 8-3 below.

[(1)]Minkoff, Robert and Galambos, T. – "Stability of Steel Joists During Erection", Research Report No. 39, Structural Division, CE Dept, Washington University, St. Louis, MO, August, 1975.

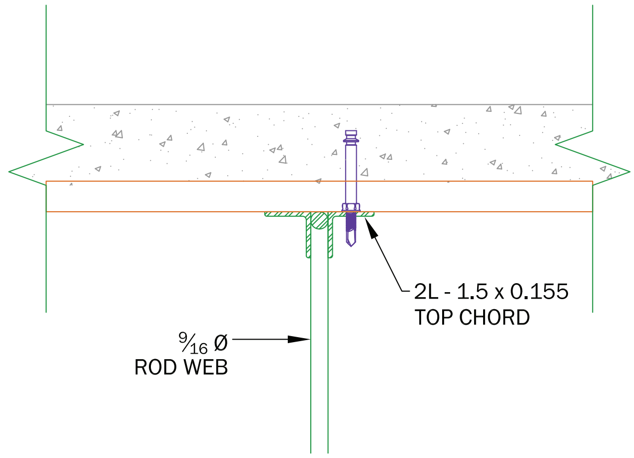


Figure 8-3: Top Chord Spacing

r_{yy} = *0.849* in. for the *2L- 1.5 x 1.5 x 0.155* top chord angle with *9/16* inch gap between top chord angles.

The E-Series joist design length, L = *30.0 feet = 360 inches.*

With zero rows of bridging, $L_{yy\ tc}$ = *360 in.*

$L_{max}=170\ r_{yy}=170(0.849)=144$ *in.*

$L_{yy\ tc} = 360$ *in.* $> L_{max} = 144$ *in,* $\therefore$ Zero rows of bridging is N.G.

Check two rows of horizontal bridging at the 1/3 points

$L_{yy\ tc}$ = *360 inches \ 3 = 120 in.*

$L_{yy\ tc} = 120$ *in.* $< L_{max} = 144$ *in.,* $\therefore$ Two rows of horizontal bridging is OK

Determine required size of bridging.

For horizontal bridging, the ratio of unbraced length to least radius of gyration, *l/r,* shall not exceed *300.*

Check a *L-1.0 x 1.0 x 0.109* bridging angle:

$r_z = 0.196$ *in*

Conservatively assume that the unbraced length of the horizontal bridging = Joist Spacing = *48 in.*

$$\frac{L}{r_z} = \frac{48\ in}{0.196\ in} = 245 < 300, \therefore OK$$

Use two rows of horizontal *L-1.0 x 1.0 x 0.109* bridging at the joist 1/3 points

Step 12:
Check the Floor for Vibration

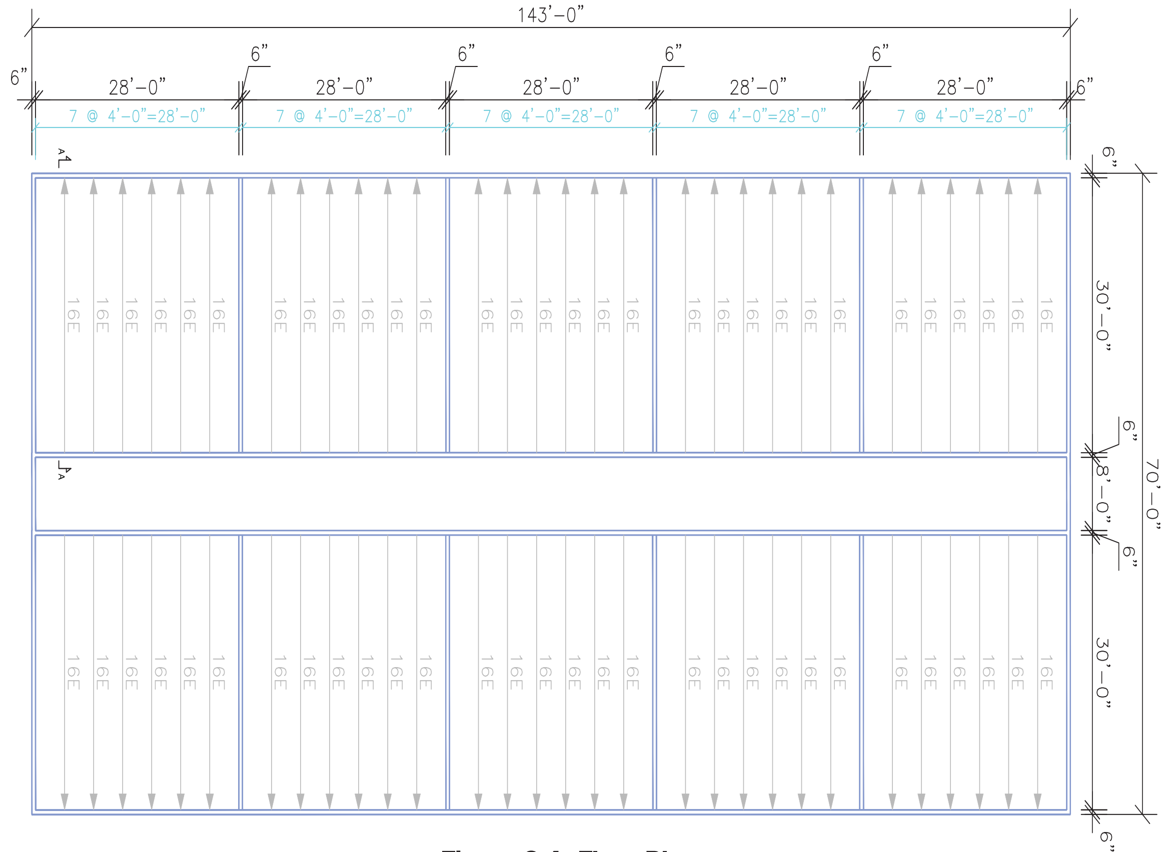


Figure 8-4: Floor Plan

Input vibration values:

β = 0.08 *(assuming full height partitions)*

P_0 = 65 *lb.*

Overall floor width perpendicular to the joists, F_{lw} = 143 *ft*

Overall floor length parallel to the joists, F_{ll} = 70 *ft*

Top Chord, *2L- 1.5 x 1.5 x 0.155*

$A_{tc} = 0.882\ in^2 \qquad y_{tc} = 0.432\ in \qquad I_{x\,tc} = 0.187\ in^4$

Bottom Chord*, 2L- 2.0 x 2.0 x 0.137*

$A_{bc} = 1.058\ in^2 \qquad y_{bc} = 0.551\ in \qquad I_{x\,bc} = 0.413\ in^4$

Joist effective depth = $D_e = D - y_{tc} - y_{bc} = 16\ in - 0.432\ in - 0.551\ in = 15.017\ in$

$A_{chords} = A_{tc} + A_{bc} = 0.882\ in^2 + 1.058\ in^2 = 1.94\ in^2$

$$I_{chords} = \frac{A_{tc}\ A_{bc}\ D_e^2}{A_{chd}} + I_{x\,tc} + I_{x\,bc} = \frac{0.882\ in^2\ (1.058\ in^2)\ (15.017in)^2}{1.94\ in^2} + 0.177\ in^4 + 0.413\ in^4 = 109.09in^4$$

Centroid of joist top and bottom chords,

$$y_{joist} = \frac{A_{bc}}{A_{chd}} D_e + y_{tc} = \frac{1.058\ in}{1.94\ in}(15.017\ in) + 0.432\ in = 8.624\ in.\ \text{below the top of the top chord}$$

y_{joist} = Slab topping over the deck = 2.5in

Concrete unit weight, $\gamma_c = 145\ lb/ft^3$

$$E_c = 1.35\ \gamma_c^{1.5}\sqrt{f'_c} = 1.35\ (145\ \frac{lb^3}{ft})^{1.5}\sqrt{3\ ksi} = 4{,}083\ kips/in^2$$

$$n = \frac{E_s}{E_c} = \frac{29{,}000\ kips/in^2}{4{,}083\ kips/in^2} = 7.103$$

$$\text{Effective width - left, } b_{e\text{-}left} = Min(\frac{S_{left}}{2}, 0.2L) = Min(\frac{48}{2} in, 0.2(30.0\ ft \times 12\ \frac{in}{ft})) = 24\ in$$

$$\text{Effective width - right, } b_{e\text{-}right} = Min(\frac{S_{left}}{2}, 0.2L) = Min(\frac{48}{2} in, 0.2(30.0\ ft \times 12\ \frac{in}{ft})) = 24\ in$$

Total Effective width, $b_e = b_{e\text{-}left} + b_{e\text{-}right} = 24in + 24in = 48\ in$

$$b = \frac{b_e}{n} = \frac{48\ in}{7.103} = 6.758\ in$$

$$I_{comp} = \frac{A_{chd} b d_{slab}}{A_{chd} + b d_{slab}}(d_{deck} + \frac{t_{slab}}{2} + y_{joist})^2 + I_{chd} + \frac{b(t_{slab})^3}{12}$$

$$I_{comp} = \frac{1.94\ in^2(6.758\ in)3.5\ in}{1.94\ in^2(6.758\ in)3.5\ in}(1\ in + \frac{2.5\ in}{2} + 8.624\ in)^2 + 109.09\ in^4 + \frac{6.758\ in(2.5\ in)^3}{12}$$

$I_{comp} = 324\ in^4$

$I_{mod} = C_r I_{chords}$ (Eqn 3.15, AISC Steel Design Guide 11)

$C_r = 0.90(1 - e^{-0.28(\frac{L}{D})})^{2.8}$ (Eqn 3.16, AISC Steel Design Guide 11)

D = Nominal Depth of the joist = 16 in

L = Joist theoretical length = 360 in

The 16 inch deep Ecospan® joist has continuous round rod web members.

$C_r = 0.721 + 0.00725(\frac{L}{D})$ (*Eqn 3.17, AISC Steel Design Guide 11*)

$C_r = 0.721 + 0.00725(\frac{360\ in}{16\ in}) = 0.884$ (*Eqn 3.17, AISC Steel Design Guide 11*)

$\gamma = \frac{1}{C_r} - 1$ (*Eqn. 3.19, AISC Steel Design Guide11*)

$\gamma = \frac{1}{0.884} - 1 = 0.131$

Transformed effective moment of inertia for the composite joist and slab = I_{eff}

$$I_{eff} = \frac{1}{\frac{\gamma}{I_{chords}} + \frac{1}{I_{comp}}} = \frac{1}{\frac{0.131}{109.1\ in^4} + \frac{1}{324\ in^4}} = 233\ in^4$$

Non-composite dead load of slab, deck, & bridging, $w_{sdb} = 36.3 + 1.3 + 0.1 = 37.7\ lb/ft^2$

Actual composite dead load acting on the floor, $w_{DL} = 4\ lb/ft^2$

Actual composite live load acting on the floor, $w_{LL} = 11\ lb/ft^2$

Actual wt. of joist, $w_{josit} = 3\ lb/ft^2$

Joist spacing, $S_j = 4\ ft$

$$w_j = (w_{sbd} + w_{DL} + w_{LL} + w_{joist})\ S_j = (37.7\frac{lb}{ft^2} + 4\frac{lb}{ft^2} + 11\frac{lb}{ft^2} + 3\frac{lb}{ft^2})\ 4\ ft = 223\ lb/ft$$

$$\Delta_{joist} = \frac{5w_j Lw_j^4}{384E_s I_{eff}} = \frac{5(223\frac{lb}{ft})^5(\frac{1ft}{12in})(30ft)^4(\frac{12in}{ft})^4}{384(29{,}000{,}000\frac{lb}{in^2})(233in^4)} = 0.601\ in$$

$f_{joist} = 0.18\sqrt{\frac{g}{\Delta_{joist}}}$ (*Eqn 3.3 AISC Steel Design Guide 11*)

$$f_{joist} = 0.18\sqrt{\frac{386\ in/sec^2}{0.601in}} = 4.56\ Hz$$

Effective depth of concrete slab, d_e = *Concrete slab thickness above deck + 0.5 deck ht.*

$d_e = 2.5\ in + 0.5\ (1.0\ in) = 3\ in$

Using an average concrete thickness, $d_e = 3.0\ in$, the transformed moment of inertia of the concrete slab per unit width, (*12 in*), in the slab direction is

$$D_{slab} = \frac{bd_e^3}{(12n)} = \frac{12d_e^3}{(12n)}$$

$$D_{slab} = \frac{12in\ (3in)^3}{12(7.103)} = 3.80\ in^4/ft$$

Determine the transformed moment of inertia per unit width in the joist direction, D_{joist}

$$D_{slab} = \frac{I_{eff}}{S} = \frac{233\ in^3}{4\ ft\ joist\ spacing} = 58.3\ in4/ft$$

The effective width of the joist panel mode, $B_{joist} = min\ (C_{joist}\ (\frac{D_{slab}}{D_{joist}})^{0.25} (L_{joist})\ ,\ \frac{2}{3}F_{tw})$ (*Eqn 4.3a*)

For joists or beams that are not parallel to an interior edge, $C_{joist} = 2.0$

$$B_{joist} = min\ (2.0\ (\frac{3.80}{58.3})^{0.25}\ L_{joist}\ ,\ \frac{2}{3}F_{tw})$$

$$B_{joist} = min\ (2.0\ (\frac{3.80}{58.3})^{0.25}\ (30\ ft)(\frac{12in}{ft})\ ,\ \frac{2}{3}(143ft)(\frac{12in}{ft}))$$

$$B_{joist} = min\ (364\ in\ ,\ 1144\ in) = 364\ in = 30.33ft$$

W_j = *Effective joist panel weight*

$$W_j = \frac{w_j}{S_{joist}} B_{joist} L_{joist} = \frac{223(\frac{lb}{ft^3})}{4\ ft}(30.33ft)30ft = 50.7\ kip$$

AISC Design Guide 11 indicates that the floor system is satisfactory if the peak acceleration, a_p , due to walking excitation does not exceed 0.5% of the acceleration due to gravity (See Table 4.1 of Design Guide 11).

$$\frac{a_p}{g} = \frac{P_o e^{-0.35fn}}{\beta W_{joist}}$$ (*Eqn 4.1, Design Guide 11*)

$$\frac{a_p}{g} = \frac{P_o e^{-0.35fn}}{\beta W_{joist}} = \frac{(65\ lb)\ e^{-0.35(4.56\ hz)}}{0.08(50{,}700\ lb)} = 0.325\% < 0.5\% \therefore OK$$

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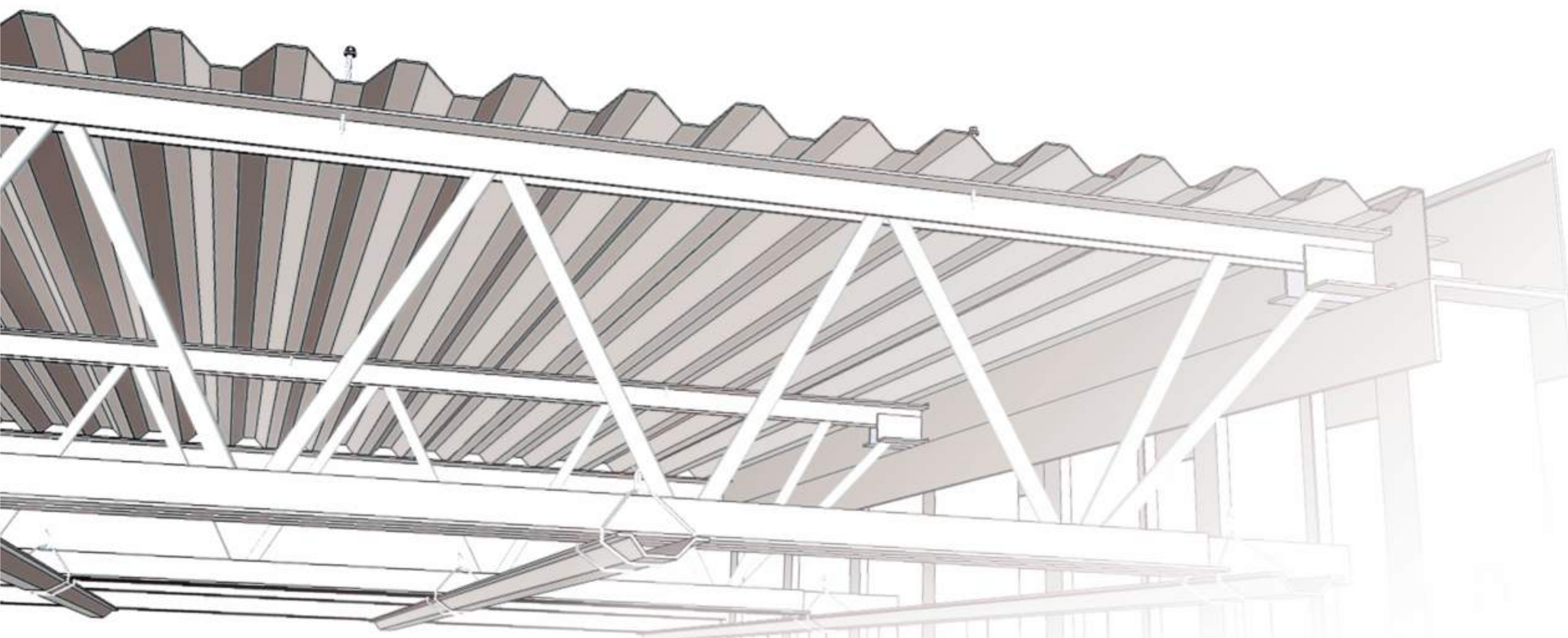

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