

FRP SYSTEM NOTES

City of Portland
Reviewed for
Code Compliance

Date: 10/25/22
Permit #: 21-063627-DFS-01-CO

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☐ Submit Additional/
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WDY, Inc.
Date: May 10, 2022
By: Doug Paola

PART 1	GENERAL
1.01	SCOPE
	1. Simpson Strong-Tie is only responsible for the information contained on these shop drawings related to the Composite Strengthening Systems and has not performed structural analyses beyond the Composite Strengthening Systems as defined by the structural engineer of record. 2. Simpson Strong-Tie has not confirmed and is not responsible for any of the design, engineering, calculations or derivation of structural forces related to the building. Simpson Strong-Tie has only designed the Composite Strengthening Systems to resist forces defined by the structural engineer of record. The identification of locations receiving Composite Strengthening Systems, the level of strength enhancement required, and the overall performance of the structure is the responsibility of the structural engineer of record. 3. These shop drawings are not for construction without review and approval by the responsible structural engineer of record and the governing building jurisdiction. 4. These shop drawings are specific to Simpson Strong-Tie Composite Strengthening Systems and are not applicable to other manufacturer's systems. If an alternate system is used, these shop drawings and accompanying calculations are void, and an alternate submittal is required. 5. Use of a Simpson Strong-Tie product does not imply that Simpson Strong-Tie endorses any project, structure or use.
1.02	DESCRIPTION
A.	This specification section shall define the minimum requirements of the externally bonded composite strengthening system.
1.03	REFERENCES
A.	General
	1. The latest reference edition available on the day of bid invite shall be used for all standards. American Concrete Institute (ACI) 1. ACI 440.2R, Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening of Concrete Structures 2. ACI 562, Code Requirements for Evaluation, Repair and Rehabilitation of Concrete Buildings 3. ACI Repair Application Procedures (RAP) No. 1 through No. 7 American Society for Testing and Materials (ASTM) 1. ASTM D3039, Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials 2. ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method 3. ASTM D4541, Standard Test Method for Pull-Off Strength for Coatings Using Portable Adhesion Testers 4. ASTM D7522, Standard Test Method for Pull-Off Strength for FRP Bonded to Concrete Substrate 5. ASTM D7565, Standard Test Method for Determining Tensile Properties of Fiber Reinforced Polymer Matrix Composites Used for Strengthening of Civil Structures 6. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials International Concrete Repair Institute (ICRI) 1. ICRI Technical Guideline No. 310.1R, Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion 2. ICRI Technical Guideline No. 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays 3. ICRI Technical Guideline No. 320.2R, Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces 4. ICRI Technical Guideline No. 210.3R, Guide for Using In-Situ Tensile Pulloff Tests to Evaluate Bond of Concrete Surface Materials 5. ICRI Technical Guideline No. 210.1R, Guideline for Verifying Field Performance of Epoxy Injection of Concrete Cracks ICC Evaluation Service (ICC-ES) 1. AC125, Acceptance Criteria for Concrete and Reinforced and Unreinforced Masonry Strengthening using Externally Bonded Fiber-Reinforced Polymer (FRP) Composite Systems 2. AC178, Acceptance Criteria for Inspection and Verification of Concrete and Reinforced and Unreinforced Masonry Strengthening using Fiber-Reinforced Polymer (FRP) Composite Systems
1.04	SUBMITTALS
A.	Manufacturers' Product Data
	1. Current ICC Evaluation Service Report for the proposed materials. 2. Technical data sheets for materials to be used. 3. Safety data sheets (SDS) for each material component. 4. Installation instructions, including temperature restrictions, moisture limitations, surface preparation methods, curing times, and finish requirements.
B.	Calculations and Drawings
	1. Design calculations and shop drawings for the composite system shall be compliant with ACI 440.2R and must be stamped and signed by Civil or Structural Engineer registered in the state that the project site resides in. 2. Design calculations must also conform to ACI 562 Equations 5.5.2a, 5.5.2b, and 5.5.3 that stipulate the strength of the unstrengthened structure must be at least equal to the load combinations specified in section 5.5.2. 3. Shop drawings, at a minimum, must detail the necessary surface preparation, composite system to be used, number of layers, locations, end details, primary fiber direction, and finish requirements.
C.	Applicator Qualification
	1. Written documentation from the composite system manufacturer that the contractor has completed the manufacturer's training program and has been trained to install the proposed system.
1.05	PRODUCT DELIVERY, STORAGE, AND HANDLING
A.	All products shall be delivered, stored, and handled according to the manufacturer's recommendations.
B.	Materials shall be clearly labeled and delivered in factory-sealed containers with manufacturing dates and shelf lives easily identifiable.
C.	Materials shall be stored in a protected area free of moisture and UV exposure, with temperatures between 45°F and 95°F.
PART 2	PRODUCTS
2.01	FRP COMPOSITE STRENGTHENING SYSTEM
A.	The FRP composite strengthening system has been preapproved and shall be a Composite Strengthening System™ supplied by Simpson Strong-Tie®, Inc., 5956 W. Las Positas Boulevard, Pleasanton, CA 94588, Phone: 800.999.5099, Fax: 925.847.1597.
	1. Fabrics a. CSS-CUCF22: Code listed, unidirectional carbon fabric. b. CSS-CUGF27: Code listed, unidirectional glass fabric. 2. Epoxy Adhesive

	a. CSS-ES: Epoxy saturant and primer.
3.	Epoxy Paste
	a. CSS-EP: Epoxy paste and filler. b. CSS-ES thickened with fumed silica: Epoxy paste and filler. c. FX-702: Oven-Dried Rounded Silica Filler.
4.	Coating
	a. RPS-207: Slurry Seal.
2.02	CONCRETE REPAIR PRODUCTS
A.	The concrete repair products have been preapproved and shall be supplied by Simpson Strong-Tie®, Inc., 5956 W. Las Positas Boulevard, Pleasanton, CA 94588, Phone: 800.999.5099, Fax: 925.847.1597.
	1. Crack repair products. The crack repair system shall be epoxy based two-component high-solids formulation, meeting the mechanical strength requirements of ASTM C-881 type IV epoxy bonding systems. The crack repair system shall be suitable for the condition at which it will be placed: dry, damp, wet, high or low temperature, horizontal or vertical. The crack repair system shall not be installed in an active leaking crack or an active moving crack. The crack repair system shall be able to be installed by crack injection or gravity fed as needed for the application. Pre-approved systems include: a. For hairline cracks up to 1/4" in width use: Simpson Strong-Tie CI-SLV (Super Low-Viscosity Structural Injection Epoxy); meets the requirements of ASTM C-881 type I and IV, grade 1, class C. b. For fine cracks (greater than 1/64" up to 1/4" in width use: i. Simpson Strong-Tie CI-LV (Low-Viscosity Structural Injection Epoxy); meets the requirements of ASTM C-881 type I and IV, grade 1, class C. Approved under NSF/ANSI standard 61 (719 square inches per 1000 gallons). ii. Simpson Strong-Tie CI-LV FS (Fast-Setting Low-Viscosity Structural Injection Epoxy); meets the requirements of ASTM C-881, type I and IV, grade 1, class C. iii. Simpson Strong-Tie CI-LPL (Long Pot Life Structural Injection Epoxy); meets the requirements of ASTM C-881 type I and IV, grade 1, class C. c. For medium size cracks (greater than 3/32" up to 1/4" in width use: Simpson Strong-Tie CI-GV (Structural Injection Epoxy Gel); meets the requirements of ASTM C-881 type I, and IV, grade 3, class C. 2. Reinforcement steel primer. Primer shall be used to protect steel reinforcing from corrosion and promote positive bond from existing steel reinforcing to new repair material. Pre-approved systems include: Simpson Strong-Tie FX-406 Zinc-Rich Primer 3. Bonding agent for bonding new repair material to existing concrete. Pre-approved systems include: a. For applications 40°F (4.4°C) and above. Bonding agent shall meet the requirements of ASTM C881, type II, grade 2, class B: i. Simpson Strong-Tie FX-752 Epoxy Bonding Agent ii. Simpson Strong-Tie CI-LV iii. Simpson Strong-Tie CI-LV FS b. For applications 60°F (15.5°C) and above or when extended working time is required, bonding agent shall meet the requirements of ASTM C881, type II, grade 2, class C: i. Simpson Strong-Tie FX-792 LPL Long Pot Life Epoxy Bonding Agent ii. Simpson Strong-Tie CI-LPL 4. High performance repair mortars. Repair material shall be used to repair areas of damaged concrete. Note: any repairs made using cementitious repair mortars must be fully cured prior to applying FRP. Allow 3-7 days for full cure or verify moisture content is less than 5% prior to applying FRP. Pre-approved systems include: a. Simpson Strong-Tie FX-263 Rapid-Hardening Vertical/Overhead Repair Mortar b. Simpson Strong-Tie FX-225 Non-Shrink Underwater Grout c. Simpson Strong-Tie FX Rapid-Setting Mortar Rapid-Hardening Cement-Based Mortar d. Simpson Strong-Tie CSS-CM Cementitious Matrix 5. Protective coatings for the FRP System. Pre-approved systems include: a. Simpson Strong-Tie FX-505 Water-Based Acrylic Coating b. Simpson Strong-Tie FX-207 Slurry Seal (Achieved four-hour fire rating per ASTM E119/UL 263) c. Simpson Strong-Tie FX-70-9 Epoxy Coating

PART 3	EXECUTION OF WORK
3.01	CONCRETE REPAIR PRIOR TO FRP INSTALLATION
A.	All problems associated with the condition of the original concrete substrate should be addressed before surface preparation begins. This section details approved concrete repair products and procedures.
B.	Before repairing the concrete, contractor shall remove all loose or deteriorated concrete by high pressure water jetting or other mechanical means to reach sound concrete. If reinforcing steel is exposed, contractor shall remove all concrete behind the reinforcing steel following ICRI Technical Guideline 310.1R.
C.	Cracks in the areas where loose or deteriorated concrete have been removed or in areas where the FRP will be installed shall be repaired using a crack repair system for non-moving and load bearing cracks. Cracked substrates with cracks wider than 0.01 inch must be pressure injected with epoxy prior to FRP installation. For concrete substrates, refer to ACI 224.1R. Smaller cracks exposed to aggressive environments may require resin injection or sealing to prevent corrosion of existing steel reinforcement. Crack-width criteria for various exposure conditions are given in ACI 224R.
D.	Areas where loose or deteriorated concrete have been removed shall be filled with a repair system as necessary to restore the original shape of the element and prepare the surface profile for the composite strengthening system.
	1. The repair system shall either consist of a: a. Single component high performance mortar repair product, or b. A combination of: steel reinforcing primer, bonding agent (if required by the engineer of record), and high performance mortar repair product as noted in the construction drawings depending on the size and condition of the void to be filled. 2. The contractor shall follow the manufacturer's printed surface preparation and installation instructions of each component of the repair system to be used.
3.02	SURFACE PREPARATION
A.	Surfaces to receive FRP shall be clean and sound at time of application. All dust, laitance, grease, curing compounds, and other foreign materials that may hinder the bond must be removed before installation.
B.	All concrete surfaces shall be dry and free of surface moisture. If surface moisture is of concern, the surfaces shall be tested by the contractor to evaluate moisture transmission in accordance with ASTM D4263.
C.	Existing concave and convex surfaces must be filled/transitioned with epoxy paste. To repair voids, CSS-EP or CSS-ES thickened with fumed silica may be extended with FX-702 at no more than a 1:1 ratio by volume.

D.	The concrete shall be abrasively prepared to achieve an ICRI CSP 3 profile by means of grinding, sand blasting, shot blasting, or pressure washing.
E.	Any corners to be wrapped around shall be rounded to a 3/4-inch minimum radius using a grinder or epoxy paste.
3.03	SURFACE MOUNTED APPLICATION
A.	Verify ambient and concrete surface temperatures are between 45°F and 95°F.
B.	Apply one coat of epoxy primer using a nap roller when using fabrics.
C.	Apply epoxy paste where minor surface defects are present.
D.	Allow the primer and/or paste to become tacky to the touch before applying the saturated fabric.
E.	When manually saturating fabric, precut sheets to required length using heavy duty shears before saturating with hand rollers. If mechanically saturating fabric, use of rollers is required. In both cases, ensure full fabric saturation is achieved.
F.	Apply the saturated fabric to the installation surface and remove entrapped air using hand pressure, rollers, or trowels.
G.	Apply additional layers as necessary to meet the project requirements, ensuring each layer is firmly adhered to the previous layer.
H.	Feather all fabric seams/edges with epoxy paste.
I.	Confirm that intimate contact between composite system and substrate will be maintained throughout the curing process.
J.	Apply finish coating after full epoxy cure, lightly sanding epoxy surfaces before installation.
K.	When metal penetrations are made through carbon FRP or metal is to be placed against carbon FRP, a barrier of glass FRP, epoxy paste, or air shall be provided between the carbon FRP and metal to ensure no electrical connection between the two materials.
3.04	QUALITY CONTROL
A.	Field Monitoring
	1. The work performed in the preceding sections of Part 3 of this specification will be field monitored by the Owner's Special Inspection Agency and will be paid for by the owner. The surface preparation shall be checked immediately before application of the composite system materials. Periodic inspection shall be provided during the application process. 2. The special inspector shall create daily reports that document the following: a. Date and time of installation. b. Ambient temperature, relative humidity, and weather conditions. c. Substrate surface temperature and dryness. d. Surface preparation method and ICRI concrete surface profile. e. Surface cleanliness description. f. Fabric batch numbers. g. Epoxy batch numbers, mix ratios, and mixing times. h. Application locations. i. Conformance with installation procedures. j. Location and size of any delaminations/voids identified or repaired. 3. For fabric systems, the contractor shall create a minimum of two material sample sets daily. Each set will consist of two 12 in. by 12 in. panels made of two layers of saturated fabric and the sets shall be taken at different times during the working shift so that it is representative of maximum variances in material/site conditions. Prepare samples on a flat, level surface covered with heavy-duty vinyl (or similar). Prime vinyl with epoxy saturant, place saturated layers, and apply a top coat of epoxy saturant. Samples shall be cured at the site under the same environmental conditions as the production work they represent and must be marked with sample date, time, epoxy/fabric batch numbers, and installation locations.
B.	Field Testing
	1. Adhesion Tests a. Pull-off tests shall be conducted in accordance with ASTM D7522 and/or ASTM D4541 and performed on flat surfaces. 3 tests shall be executed on each type of substrate or surface preparation method used, with a minimum of 3 tests per 1000 square feet of surface area covered. Testing shall be done on an area adjacent to strengthening locations with substrate, surface preparation, and orientation (i.e. overhead, vertical, etc.) that are representative of that being strengthened. Before pull-off tests are performed, the composite system shall be allowed to reach full cure. b. Adhesion strengths shall be in excess of 200 psi. 2. Concrete Repair a. The cured repair material shall be sounded for delaminations. b. An in-situ direct tensile pull-off bond test of the cured repair material shall be performed per ICRI Technical Guideline No. 210.3R to evaluate the bond of the repair material to the substrate (if required by the engineer of record). 3. Lab Testing 1. Tension Tests a. General i. Lab tension tests are only required when structural performance criteria is specified. ii. Tension tests shall be performed to verify the tensile strength, strain, and modulus of the composite strengthening system based on the nominal layer thickness reported on the manufacturer's data sheet and used in the design calculations. iii. The composite tensile properties used in the design calculations must be lower than the average of the test results unless calculations are performed with the reported average tensile properties show that the strengthening requirements are satisfied. b. Fabric Systems i. One panel from a minimum of 15% of all sample sets shall be selected for tension testing performed in accordance with ASTM D7565 and/or ASTM D3039. 2. Defects 1. Small delaminations less than 2 square inches are acceptable so long as the delaminated area is less than 5% of the total laminate area and there are no more than 10 such delaminations per 10 square feet. 2. Large delaminations greater than 25 square inches shall be locally cut away and a new material shall be applied with an equivalent number of layers and sufficient development length overlaps. 3. Delaminations between 2 square inches and 25 square inches shall be injected with epoxy or replaced, depending on the size, number of delaminations, and locations.
E.	Remedial Measures
	1. If the composite tensile properties used in the design calculations are higher than the average of the laboratory test results, design calculations shall be resubmitted, showing that the target design performance has been achieved. If this is not the case, additional layers shall be applied until the target design performance is reached.

REVISIONS					
NO.	DATE				



SIMPSON

Strong-Tie

THERE IS NO EQUAL

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• Web site: www.strongtie.com

DESIGN DOCUMENTS BY:
WDY STRUCTURAL
& CIVIL ENGINEERS

DATE OF DOCUMENTS (D.O.D.):
04/01/2022

**RIVER FORUM FRP
- PORTLAND, OR
4380 & 4386 S MACADAM AVENUE
PORTLAND, OR 97239**

NAME: G.S.

DATE: 04-06-2022

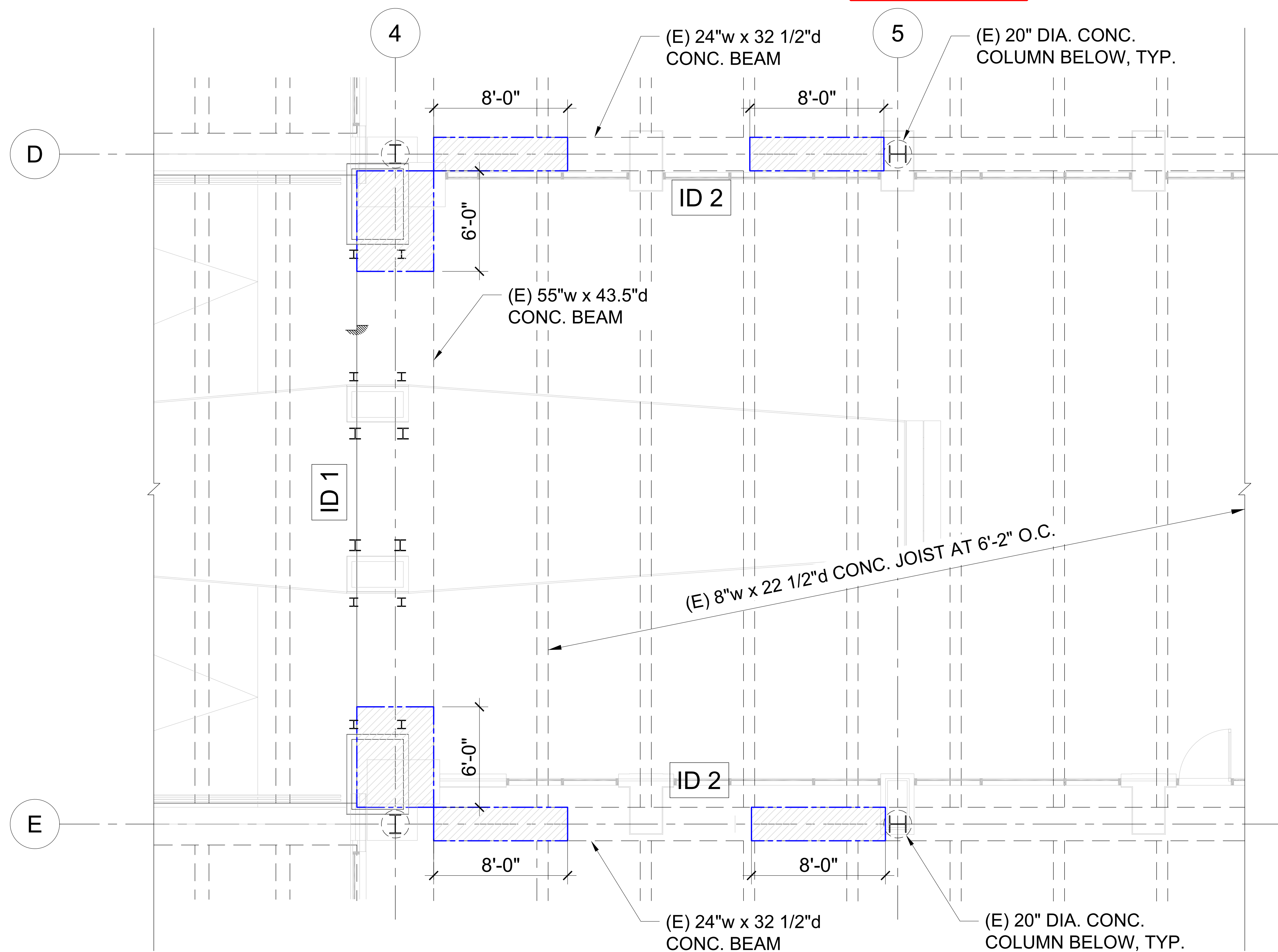
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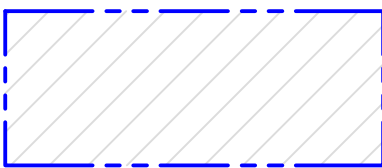
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ENLARGED ENTRY COURTYARD PARTIAL PLAN

LEGEND:



BEAM SHEAR STRENGTHENING
(SEE SHEET 4 FOR MORE DETAILS)

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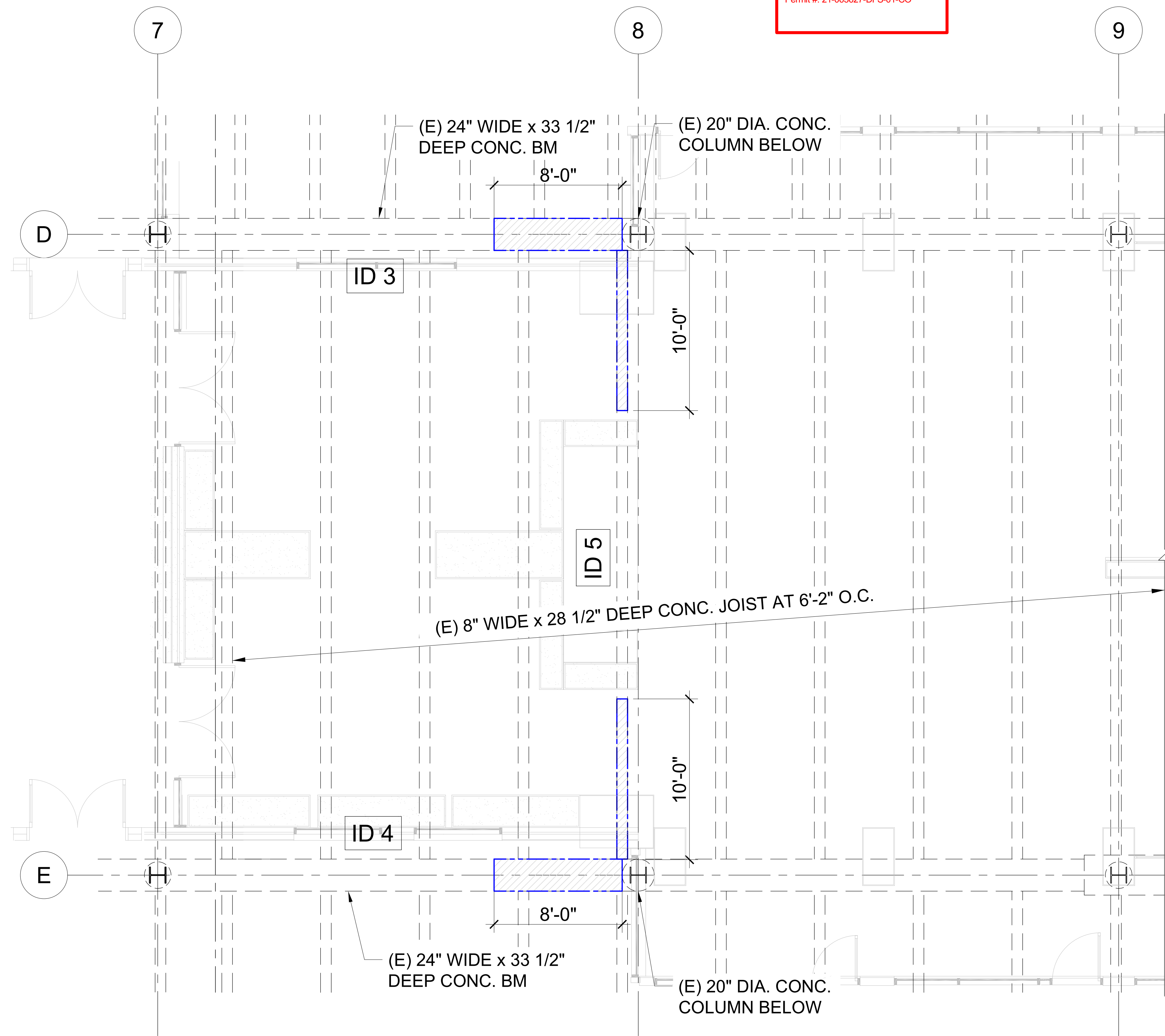
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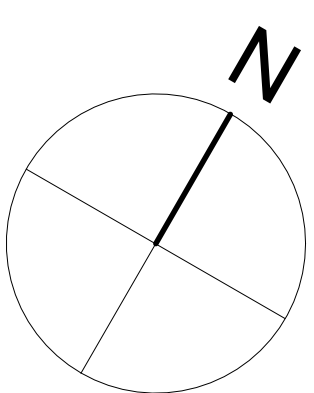
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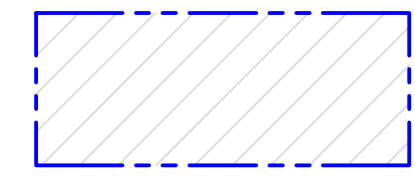


REAR COURTYARD PARTIAL PLAN



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BEAM/JOIST SHEAR STRENGTHENING
(SEE SHEET 4 FOR MORE DETAILS)

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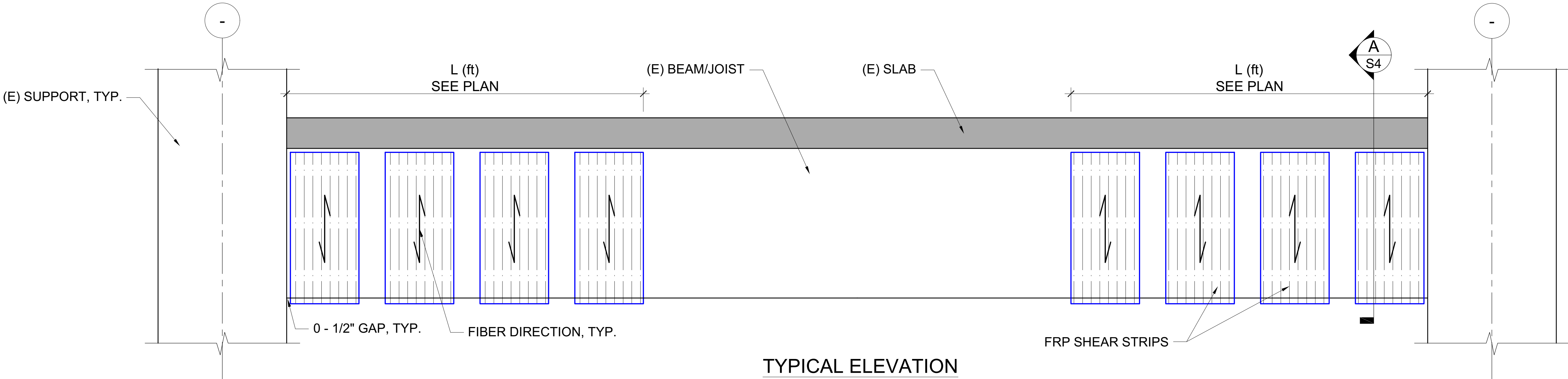
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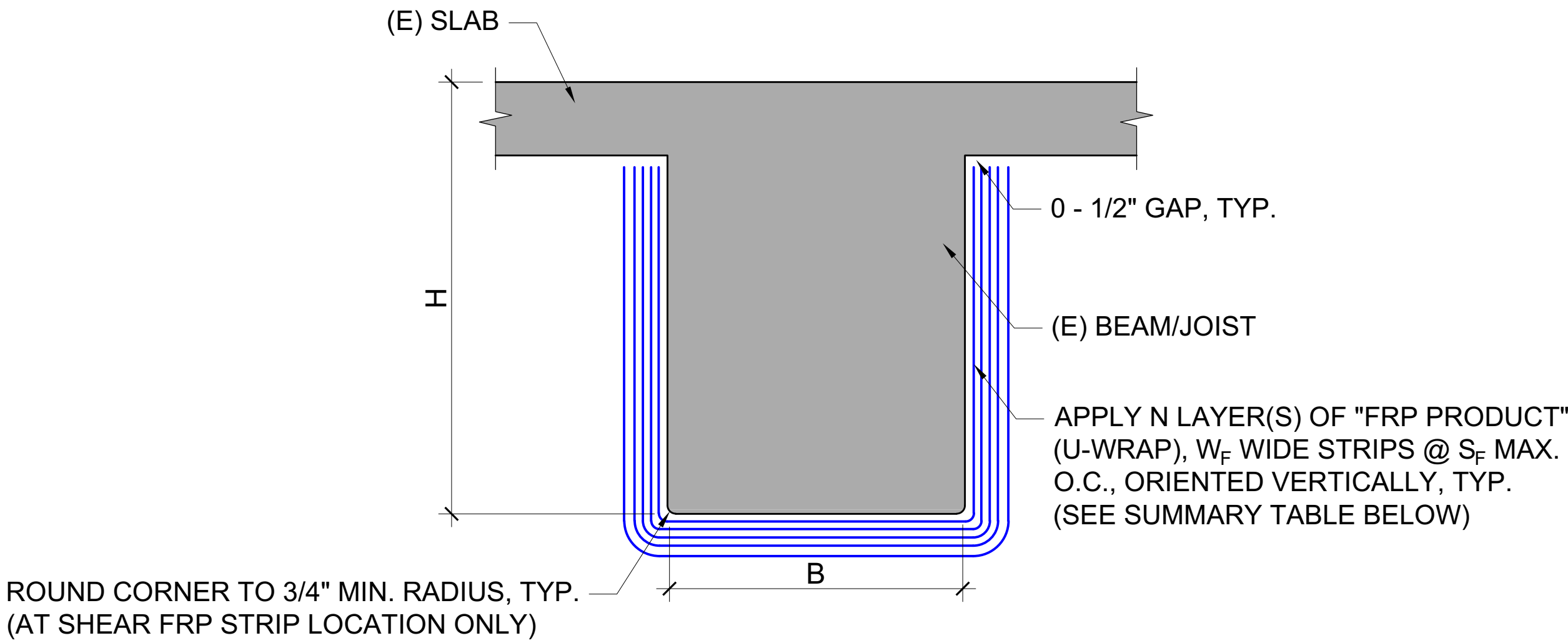
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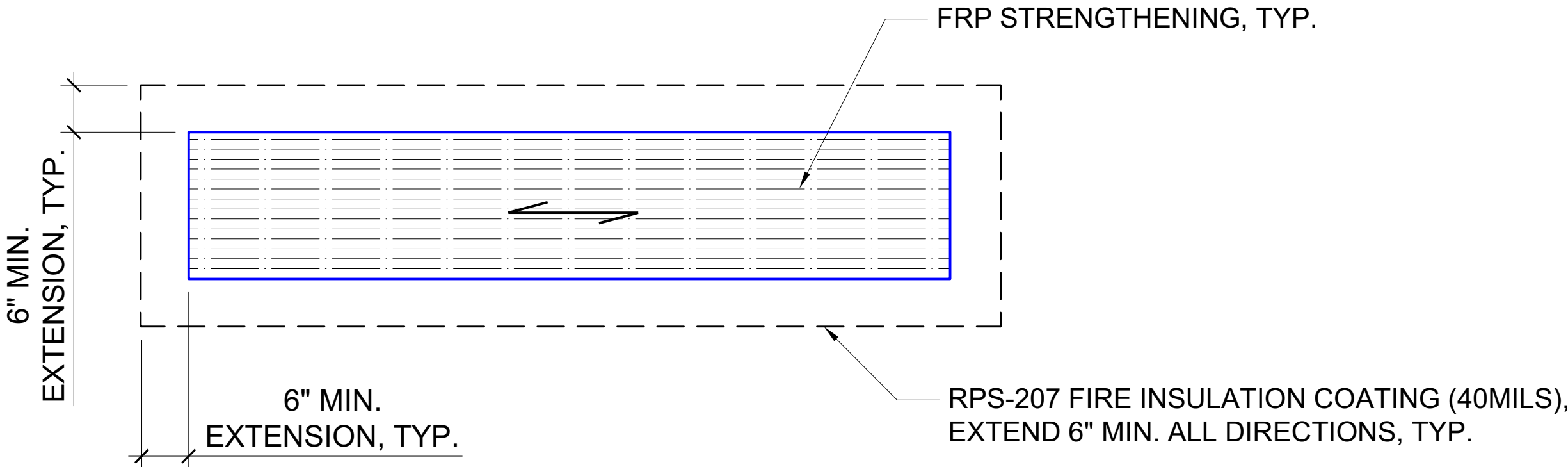


TYPICAL ELEVATION



SECTION A

COVERAGE WITH RPS-207



TYPICAL DETAIL

- NOTES:
- 1. NUMBER OF FRP STRIPS SHOWN ON ELEVATION IS FOR VISUAL REPRESENTATION ONLY.
 - 2. NUMBER OF FRP LAYERS SHOWN ON ELEVATION IS FOR VISUAL REPRESENTATION ONLY.
 - 3. PROVIDE RPS-207 FIRE INSULATION COATING OVER ALL FRP. SEE COVERAGE WITH RPS-207 FOR MORE DETAIL.

SUMMARY TABLE
BEAM/JOIST SHEAR STRENGTHENING

MEMBER ID	MEMBER DESCRIPTION	B (in)	H (in)	PRODUCT	W _F (in)	S _F (in)	N
1	BEAM	55.0	43.5	CSS-CUCF22	12.0	28.0	1
2	BEAM	24.0	32.5	CSS-CUCF22	12.0	20.0	5
3	BEAM	24.0	33.5	CSS-CUGF27	12.5	28.0	2
4	BEAM	24.0	33.5	CSS-CUCF22	12.0	25.0	2
5	JOIST	8.0	28.5	CSS-CUGF27	12.5	18.0	1

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