ICC-ES Evaluation Report

ESR-5205

Reissued December 2024

Subject to renewal December 2025

This report also contains:

- CA Supplement

- City of NY Supplement

DIVISION: 03 00 00 — CONCRETE Section: 03 31 00 — Structural Concrete	REPORT HOLDER: CORNERSTONE MFG. & DIST., INC DBA BADGER FORMS	EVALUATION SUBJECT: STEELX 5:25	

1.0 EVALUATION SCOPE

Compliance with the following codes:

■ 2021, 2018 and 2015 *International Building Code*® (IBC)

■ 2021, 2018 and 2015 *International Residential Code*® (IRC)

■ 2013 *Abu Dhabi International Building Code* (ADIBC)[†]

[†]The ADIBC is based on the 2009 *International Building Code*. 2018 IBC code sections referenced in this report may be considered as equivalent sections under in the ADIBC.

Properties evaluated:

■ Durability

■ Structural

■ Crack control

2.0 USES

SteelX 5:25 reinforcements are used as alternatives to the shrinkage and temperature reinforcement specified in Section 24.4 of ACI 318 for plain concrete footings and for plain concrete slabs (as defined by ACI 360) supported directly on the ground.

SteelX 5:25 reinforcements are also used to increase the modulus of rupture for the design of structural plain concrete using linear elastic design in applications within the scope of ACI 318 Chapter 14, IBC Section 1906 and ACI 332 Section 8.2.1, IRC Sections R404.1.3 and R608.1, or Tables 8.2.1.3a and 8.2.1.3b of ACI 332.

SteelX 5:25 reinforcements are also used as an alternative to horizontal temperature and shrinkage reinforcement in structural plain concrete walls as described in IBC Section 1906, IRC Sections R404.1.3 and R608.1, and ACI 332 Sections 8.2.1 and 8.2.7.

SteelX 5:25 reinforcements also applies to slabs-on-ground applications that are designed in accordance with Chapter 7 or Chapter 11 of ACI 360.

SteelX 5:25 reinforcements also applies to plain concrete parking lot applications that are designed in accordance with Chapter 3 of ACI 330.

Under the IRC, an engineered design in accordance with IRC Section R301.1.3 must be submitted to the code official for approval, except in the following cases:

1. Below grade walls designed in accordance with the requirements of Table 5 of this report or in accordance with the requirements included in ESR-5205.

2. When SteelX 5:25 is used at a dosage rate of 9 lb/yd³ (5.3 kg/m³) to replace temperature and shrinkage reinforcement in footings in Seismic Design Categories A, B and C meeting the requirements of IRC Design R403.1.1.

3.0 DESCRIPTION

3.1 General: SteelX 5:25 reinforcements are made from minimum 261 ksi (1800 MPa), 0.019 in +/- 0.0012 in (0.50 mm +/- 0.03 mm) cold drawn steel wire. Each SteelX 5:25 has a minimum of one 360-degree twist. SteelX 5:25 reinforcement is used in dosages between 9 lb/yd³ and 36 lbs/yd³ (5.3 kg/m³ and 21.2 kg/m³) for application types as given in Section 4.0 of this report.

3.2 Structural Plain Concrete: Structural normal-weight plain concrete must comply with Section 1906 of the IBC. Concrete design must follow ACI 211.1 and ACI 318 Section 26.12.3.1 with specified design compressive strength, f'c, between 2000 psi and 4000 psi (13.7 MPa and 27.5 MPa) [minimum 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

4.0 DESIGN & INSTALLATION

4.1 Type N (Temperature and Shrinkage): SteelX 5:25 reinforcements are used as an alternative to shrinkage and temperature reinforcement specified in Section 24.4 of ACI 318 for plain concrete footings and for plain concrete slabs (as defined by ACI 360) supported directly on the ground for dosage rates between 9 lb/yd³ and 36 lbs/yd³ (5.3 kg/m³ and 21.2 kg/m³).

4.2 Type S (Linear Elastic Design): Type S applications fall within the scope of ACI 318 Chapter 14, IBC Section 1906 and ACI 332 Section 8.2.1, IRC Sections R404.1.3 and R608.1, or Tables 8.2.1.3a and 8.2.1.3b of ACI 332. Design for flexure in accordance with Section 4 of this report must be limited in capacity by the values presented in Table 1 and Equations 1 or 2, and all designs must be verified to meet the criteria of ACI 318 Section 14.1.3 excluding slabs on grade (e.g. slabs designed per ACI 360 Chapter 7.2.1 PCA method where only flexural capacity is required).

a) For pure flexure

$$M_u \leq \lambda_s \, \varphi \, L_f \, \sqrt{f_c'} S_m \qquad \text{(Equation 1)}$$

b) For combined flexure and axial compression

$$\frac{M_u}{S_m} - \frac{P_u}{A_g} \leq \lambda_s \, \varphi \, L_f \, \sqrt{f_c'} \qquad \text{(Equation 2)}$$

Where

L_f = Maximum limit for flexural capacity.

M_u = Ultimate moment, lb.-in.

P_u = Ultimate axial load, lb.

S_m = Section modulus, in³.

A_g = Gross section area, in².

f_c' = Specified compressive strength as defined in ACI 318-14 26.12.3.1 and ACI 214R.

φ = Strength reduction factor as reported in Table 1 for Type S.

λ_s = Scale-effect adjustment factor per Table 2 of this report or computed using Equation 3 by a registered design professional (RDP).

$$\lambda_s = \frac{2.5\left(\frac{h_b}{h_o}\right)^{0.7}}{1+1.5\left(\frac{h_b}{h_o}\right)^{0.7}} \qquad \text{(Equation 3)}$$

Where:

h_o = depth of member being designed.

h_b = depth of test beam 12.00 in (300 mm).

Axial compression and shear capacity, when required for design, must be based on the requirements of Sections 14.5.3 and 14.5.5 of ACI 318, respectively. Resistance to lateral forces, as part of a lateral force resisting system, must be based on the requirements of ACI 318, Chapter 14. Connections between members

must be based on ACI 318, Chapter 16. Provisions of Section 14.6.1 of ACI 318-14, IRC Section R608.8.1, and Section 8.2.7 (g) of ACI 332 must apply.

See Examples 1, 2 and 3 for sample calculations using the Type S Method.

4.3 Type G (Design Limits for Slabs-on-Ground):

4.3.1 Plain Concrete Method: When the modulus of rupture is required for plain concrete slabs-on-ground design in accordance with ACI 360, Chapter 7, the modulus of rupture (f_r) must be applied using Equation 4 and the values presented in Table 1:

$$f_r = L_f \sqrt{f_c'} \qquad \text{(Equation 4)}$$

4.3.2 Fiber Reinforced Concrete Slabs-on-Ground: When the modulus of rupture is required for plain concrete slabs-on-ground design using the Elastic method or Yield Line Method in accordance with ACI 360, Sections 11.3.3.2 and 11.3.3.3, respectively, the modulus of rupture (f_r) must be taken as Equation 4 using the values presented in Table 1.

4.3.3 Factor of Safety: For all plain concrete slabs-on-ground design, a factor of safety must be applied to the loads in accordance with ACI 360 Section 5.9. The resistance factors specified for Type S structures do not apply.

See Examples 4 and 6 for sample calculations using the Type G Methods.

4.4 Type P (Design Limits for Concrete Parking Lots):

4.4.1 Plain Concrete Method: When the modulus of rupture is required for design of plain concrete parking lots in accordance with Chapter 3 of ACI 330, the modulus of rupture (f_r) must be determined using Equation 5 and the values presented in Table 1. Factor of safety of the pavement design (reliability) must be in accordance with ACI 330 Appendix A provisions.

$$f_r = L_f \sqrt{f_c'} \qquad \text{(Equation 5)}$$

See Tables 3 and 4 for prescriptive commercial and industrial parking pavement designs, respectively. See Example 5 for sample calculation using the Type P Method.

4.5 Installation: SteelX 5:25 reinforcements may be added to the concrete at the concrete batch plant or to the ready-mix truck at the jobsite. The manufacturer's published installation instructions and this report must be strictly adhered to for adequate dispersal of fibers throughout the batch mixture. A copy of the manufacturer's published installation instructions must be available at all times at the location of the SteelX 5:25 installation into the concrete.

4.6 Special Inspection: Periodic special inspection is required in accordance with Sections 1705.1.1 and 1705.3 of the IBC.

5.0 CONDITIONS OF USE

The SteelX 5:25 reinforcements described in this report comply with, or are suitable alternatives to, what is specified in those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 SteelX 5:25 reinforcements must be blended into the concrete mixture in accordance with the installation requirements in the ICC-ES evaluation report and the manufacturers published installation instructions.

5.2 When SteelX 5:25 reinforcements are added at the ready-mix plant, a batch ticket signed by a ready-mix representative shall be available to the code official upon request.

5.3 Type N applications must comply with Section 4.1 of this report. Joints as specified in Chapter 14.3.4 of ACI 318 (IBC and IRC) are required.

5.4 Design for Type S applications must follow Section 4.2 of this report.

5.5 Design for Type G applications must follow Section 4.3 of this report.

5.6 Design for Type P applications must follow Section 4.4 of this report.

5.7 Installation of the plain concrete slabs supported directly on the ground, must be limited to areas not subject to exposure to freezing and thawing conditions or deicing chemicals.

5.8 The fire-resistance rating of constructions with SteelX 5:25 reinforcements have not been evaluated by ICC-ES and is outside the scope of this report. When requested, evidence of the fire-resistance rating of the construction must be submitted to the code official for their approval.

5.9 Special inspection must comply with Section 4.6 of this report.

5.10 SteelX 5:25 reinforcements are produced by Cornerstone Mfg. & Dist., Inc. under an inspection program with inspections by ICC Evaluation Service, LLC.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Use of Twisted Steel Micro-rebar (TSMR) in Concrete (AC470), approved February 2023 (editorially revised June 2023).

7.0 IDENTIFICATION

7.1 The ICC-ES mark of conformity, electronic labeling, or the evaluation report number (ICC-ES ESR-5205) along with the name, registered trademark, or registered logo of the report holder must be included in the product label.

7.2 In addition, each container of SteelX 5:25 reinforcement must bear the manufacturer's name, trademark and address, and the product name.

7.3 The report holder's contact information is the following:

CORNERSTONE MGF. & DIST. INC DBA BADGER FORMS
1460 EAST CEDAR STREET
ONTARIO, CALIFORNIA 91761
(951) 360-0852
www.badgerforms.com

TABLE 1—CALCULATED L_f VALUES[1,2,3,4]

Dosage rate (lbs/yd³)	Compressive strength (psi)				
	2000	2500	3000	3500	4000
	φ Strength Reduction Factor				
	0.60	0.60	0.60	0.60	0.60
9	11.19	10.58	9.96	10.83	11.70
13.5	10.91	10.40	9.89	10.85	11.82
18.0	10.63	10.22	9.81	10.88	11.94
22.5	10.44	10.19	9.94	10.94	11.94
27.0	10.25	10.16	10.07	11.01	11.94
31.5	10.05	10.13	10.20	11.07	11.94
33.8	9.96	10.11	10.27	11.10	11.94
34.5	9.86	10.10	10.33	11.14	11.94
36	9.86	10.10	10.33	11.14	11.94

For **SI**: 1 psi = 0.0069 Mpa. 1 lb/yd³ = 0.59 kg/m³.

[1]Interpolation between dosage rates and compressive strengths is permitted. Minimum of 24 Mpa compressive strength is required under ADIBC Appendix L, Section 5.1.1.

[2]Structures assigned to Seismic Design Category D, E or F must be in compliance with Section 14.1.4 of ACI 318, and combined flexure and axial compression must be considered in accordance with Section 14.5.4 of ACI 318.

[3]RDP must calculate project-specific scale-effect factor (Equation 3) and multiple it with Table 1 values.

[4]To convert L_f from psi to Mpa, reported values must be multiplied by 0.083, which is $\sqrt{0.0069}$.

TABLE 2—SCALE-EFFECT ADJUSTMENT FACTOR*, λ_s

Member Depth, h_o		λ_s
in	mm	
4 through 12	100 through 300	1.00
18	460	0.88
24	600	0.80
36	910	0.68

* See Section 4.2, Equation 3 of this report for other member depths.

TABLE 3—COMMERCIAL PARKING PAVEMENT THICKNESS [1,2,3,4,5,6,7]

Category	Trucks	9 lb/yd³ SteelX 5:25	
		f'c = 4000 psi	
		k =100 pci	k=220 pci
A	1	3.75	3.75
A	10	3.75	3.75
B	10	4.75	3.75
B	25	4.00	4.00
B	50	4.50	4.50
C	5	6.00	5.75
D	1	3.75	3.75
D	10	5.00	4.75
D	25	5.50	5.75
E	1	4.25	4.25

For **SI**: 1 in = 25.4 mm, 1 psi = 0.0069 MPa, 1 pci = 27.6 kN/m³, 1 lb/yd = 0.59 kg/m³
[1.] No dowels at joints
[2.] Design Life: 20 years
[4.] Reliability A/B: 60%, C/D/E: 75% (ACI 330 Appendix A)
[5.] Crack 15% at end of life (ACI 330 Appendix A)
[6.] SteelX Design: Per ICC-ES ESR-5205 Type P (ACI 330).
[7.] Interpolation is permitted.

TABLE 4—INDUSTRIAL PARKING PAVEMENT THICKNESS [1,2,3,4,5,6,7]

No. of trucks per day	9 lb/yd³ SteelX 5:25	
	f'c = 4000 psi	
	k =100 pci	k=220 pci
	d, in	
10	5.00	4.75
50	6.00	6.75
100	6.50	6.25
200	6.75	6.50
500	7.25	7.00
1000	7.50	7.25

For **SI**: 1 in = 25.4 mm, 1 psi = 0.0069 MPa, 1 pci = 27.6 kN/m³, 1 lb/yd = 0.59 kg/m³
[1.] No dowels at joints
[2.] Category D Traffic
[3.] Design Life: 20 years
[4.] Reliability 85%
[5.] Crack 15% at end of life
[6.] SteelX Design: Per ICC-ES ESR-5205 Type P (ACI 330.2R).
[7.] Interpolation is permitted.

TABLE 5—STEELX 5:25 REINFORCEMENT FOR BELOW GRADE WALLS[1,2,3,4,5,6,7]

SteelX 5:25 for Below Grade Walls[1, 2, 3, 4, 5, 9, 10, 11, 15]					
		Minimum SteelX 5:25 Dosage Rate (lb/yd³)[12]			
		Soil classes[7] and design lateral soil load (psf per foot of depth)			
Wall Height (feet)[13]	Backfill Height[6] (feet)	GM, GC, SM, SM-SC, and ML 45 psf/ft		SC, ML-CL, and inorganic CL 60 psf/ft	
		Nominal[8] Wall Thickness (in)		Nominal[8] Wall Thickness (in)	
		8	10	8	10
6	4	9	9	9	9
	5	9	9	9	9
7	4	9	9	9	9
	5	9	9	9	9
	6	9	9	9	9
8	4	9	9	9	9
	5	9	9	9	9
	6	9	9	9	9
	7	9	9	9	9
9	4	9	9	9	9
	5	9	9	9	9
	6	9	9	9	9
	7	9	9	9	9
	8	9	9	9 @f'_c 3500 (see footnote 3)	9

For **SI:** 1 inch = 25.4 mm; 1 foot = 305 mm; 1 psf/ft = 0.1571 kPa/m; 1 psi = 6.895 kPa; 1 lb/yd³ = 0.593 kg/m³

Notes:
1. Applies to both cast-in-place walls with removable forms and flat ICF walls. Design and installation of SteelX 5:25 reinforced concrete must be in accordance with ESR-5205. Designs given in above table are Design "Type S", and walls must conform to all applicable provisions of ESR-5205.
2. Concrete walls constructed in accordance with this table must conform to the applicability limits of IRC Section R404.1.3.
3. Minimum specified compressive strength is 3000 psi unless compressive strength, f'c is denoted on the table (in psi).
4. Deflection criteria: L/240, where L is the height of the basement wall in inches. No soil surcharge allowed. Vertical bearing load is neglected and/or assumed to act at centerline of wall.
5. Interpolation is not permitted.
6. Backfill height is the difference in height between the exterior ground level and the top of the concrete footing that supports the foundation wall. SteelX designs assume a 4" thick slab above the top of footing. Walls must be laterally supported at top and bottom of wall before backfilling.
7. Soil classes are in accordance with the Unified Soil Classification System. Refer to IRC Table R405.1.
8. See IRC Table R608.3 for tolerance from nominal thickness permitted for flat walls.
9. Design under this table is limited to Seismic Design Categories A and B. Design for Seismic Design Categories C through F is outside the scope of this table and if required must be determined by a registered design professional.
10. Reinforcement around wall openings must be provided in accordance with R404.1.3.3.7.3.
11. Dowels connecting footing to wall must be provided in accordance with IRC R404.1.3.3.7.8.
12. The SteelX 5:25 with reported dosage rate can be used in lieu of minimum horizontal reinforcement as permitted by Section 2.0 of this report.
13. The unsupported wall height is the wall height minus the interior floor slab thickness, assumed to be 4 inches thick.
14. The table is limited to a building with maximum aspect ratio (length-to-width) of 3.6.
15. See R608.6 for any above grade concrete walls subject to out-of-plane forces that are supported by a basement wall and require additional shear strength.
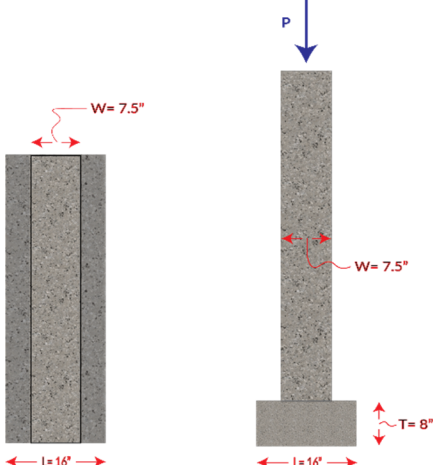
Example 1: Foundation Wall (Type S Design)

	Design Parameters: Height (h_{wall}) = 9 ft Backfill Height (h_{fill}) = 8 ft. Thickness (t) = 7.5 in. Base Width (b) = 12 in. Soil Pressure (W_{soil}) = 60 lb/ft³ Geometric Conversion Factor (z) = 1.05774 f'_c = 3500 psi 9 lb/yd³ SteelX 5:25 Neglect Axial Load Seismic Design Category B
Step 1: Find Governing Load Combinations (ASCE 7-16)	Ultimate Load ($Wsoil$) $= 1.2D + 1.6H = 0 + \ 60 \times 1.6 = 96$ lb/ft³ Assume lateral loads only, neglect self-weight $P_{base} \ = \ h_{fill} W_{soil} \ = 768 \ psf$
Step 2: Compute Moment (Mᵤ)	$h_w \ = \ \dfrac{hfill}{3} \ = \ 2.67 \ ft$ $W \ = \ \frac{1}{2} P_{base} h_{fill}$ = 3,072 lbs R_A = V_U (Reaction at base of wall) $R_A = \dfrac{4 W h_{soil} \ h_{fill} \left(h_{wall} - \dfrac{h_{fill}}{3} \right)}{h_{wall}} = 2{,}162 \ lbs$ $R_H \ = \ \dfrac{4 W_{soil} \ h_{fill}^2}{3 h_{wall}}$ = 910 lbs (Reaction at top of wall) $M_u \ = \ \dfrac{z h_{fill} \ W \left(h_{wall} - \dfrac{2 h_{fill}}{3} \right)}{h_{wall}}$ = 3,530 ft-lbs x 12 = 42,362 in-lbs
Step 3: Compute Shear (Vᵤ)	$V_u = R_A \ = 2162 \ lb$
Step 4: Check Shear (ACI 318 14.5.5.1 Table 1)	Allowable Shear, $V_{c1} \ = \ 0.6 \dfrac{4}{3} \sqrt{f'_c} \, bt = 4260$ lb $2162 \ lb \ < \ 4260$ lb (OK)
Step 5: Scale Effect Adjustment Factor (ESR 5205 Eq 3)	$\lambda_s \ = 1.00$
Step 6: Compute Section Modulus	$S_m = \dfrac{bt^2}{6} = 112.5 \ \dfrac{in^3}{ft}$
Step 7: Compute Flexural Limit (ESR 5205 Table 1)	$f'_c \ = 3500 \ psi \quad \varphi L_f \ = 0.60 \ \times 10.83 = 6.50$
Step 8: Compute Mᵤ & Check Capacity (ESR 5205 Eq 1)	$M_u \leq 1.00 \times 6.50 \sqrt{3500} \times 112.5 = 43{,}248$ in-lb/ft 42,362 in-lb/ft < 43,248 in-lb/ft (OK)

Example 2: Square Footing (Type S Design)

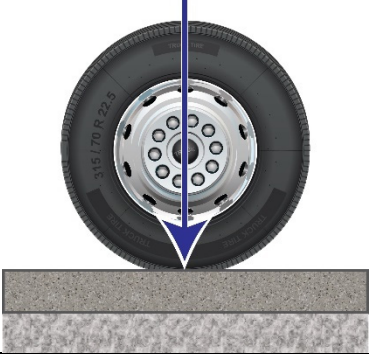|	
	Footing Dimensions (L) = 8 ft. x8 ft. Design Thickness (t) = 20.5 in. (design thickness) + 2 in. (soil formed) = 22.5 in. Allowable soil bearing pressure (q) = 2000 psf Concrete self-weight (ρ_{conc}) = 150 pcf f_c' = 2000 psi with 9 lb/yd³ SteelX 5:25 Base Plate Size: w = 12 in. x 12 in. Column Gravity Loads (50x50 column spacing) Loads: Dead Load (D) =30,000 lb / Live Load (L$_r$)=75,000 lb
Step 1: Find Governing Load Combinations (ASCE 7-16)	$S\,(ASD) = \,D\,+ (L_r \text{ or } S) = 105{,}000$ lb (governs) $U\,(LRFD) = 1.2D + 1.6(Lr \text{ or } S) + \,L = 156{,}000$ lb (governs)
Step 2: Size Footing	Applied Bearing Pressure, $Q_{asd} = \,S/L^2 = 1641$ psf Effective Allowable SBP, $Q_e = \,q - \rho_{conc}\,(t/12) = 1744$ psf $1641 < \,1744$ (8 ft. x 8 ft. OK)
Step 3: Ultimate Moment	Cantilever Length, $c_L = \dfrac{L\times"\frac{12"}{1}}{2} - w/2 = \,42$ in $= 3.5$ ft Ultimate Applied Bearing Pressure, $Q_u = \dfrac{U}{L^2} = 2438$ psf Ultimate Moment, $M_u = 1'/12" \times \left(Q_u \times L \times c_L{}^2/2\right) = 1{,}433{,}324$ lb-in
Step 4: Check Bending (ESR 5205 4.2)	Scale Effect Factor (ESR 5205 Eq 3), $\lambda_s = 0.846$ Section Modulus, $S_m = \dfrac{bt^2}{6} = 6724\,in^3$ ESR 5205 Table 1, $\varphi L_f = 0.60\,\times 11.19 = 6.71$ ESR 5205 Eq1, $M_u \le \lambda_s \times \varphi L_f\sqrt{f_c'} \times S_m = 2{,}018{,}943\,in-lb$ $1{,}433{,}250\,in-lb\,< \,2{,}018{,}943\,in-lb$ (OK)
Step 5: Check Beam Shear (ACI 318 14.5.5.1 Table 1)	Beam Shear, $V_{u1} = \,Q_u L \left(\frac{L}{2} - (\frac{w}{2} + t)/(12"/ft)\right) = 34{,}944$ lb Allowable Shear, $V_{c1} = \,0.6\,\times \left(\frac{4}{3}\sqrt{f_c'}bt\right) = \,70{,}409$ lb $34{,}944\,lb\,< \,70{,}409$ lb (OK)
Step 6: Check 2-Way Shear (ACI 318 14.5.5.1 b & c)	Critical Perimeter, $b_0 = \,4(t + w) = \,130\,in$ Column Ratio, $\beta_c = \,1.0$ Shear, $V_{u2} = Q_u * (L^2 - (w/12 + t/12)^2) = 138{,}128$ lb Shear Strength, $V_{c1} = 0.6\left(1 + \frac{2}{\beta_c}\right)\left(\frac{4}{3}\sqrt{f_c'}b_0 t\right) = 286{,}038$ lb Shear Strength, $V_{c2} = 0.6\,\times 2\left(\frac{4}{3}\sqrt{f_c'}b_0 t\right) = 190{,}692$ lb $138{,}128\,lb\,< 190{,}692$ lb (OK)
Step 7: Adjust for Thickness (ACI 318 14.5.1.7)	Adjusted Thickness (assuming formed against soil), $t_{adj} = \,t + 2\,in\,= \,22.5\,in$ 8 ft. x 8 ft. x 22.5 in. footing with 9 lb/yd³ SteelX 5:25 (OK)

Example 3: Wall/Strip Footing (Type S Design)

<table>
<tr>
<td colspan="2">

Wall Footing, L= 1.33 ft (16")
Thickness, t = 8 in. (design thickness) + 2 in. (soil formed) = 10 in.
Allowable soil bearing pressure, q = 2000 psf
Concrete self-weight, ρ_{conc} = 150 pcf
f_c' = 2500 psi with 9 lb/yd³ SteelX 5:25
Wall thickness, w = 7.5"
Loads: Dead Load (D)= 1500 lb/ft / Live Load (L_r)= 550 lb/ft
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</tr>
<tr>
<td>Step 1: Find Governing Load Combinations (ASCE 7-16)</td>
<td>

$S\ (ASD) = \mathrm{D} + (\mathrm{L}_r \text{ or } S) = 2{,}050 \text{ lb/ft}$ (governs)
$U\ (LRFD) = 1.4\mathrm{D} = 2{,}100 \text{ lb/ft}$ (governs)
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<tr>
<td>Step 2: Size Footing</td>
<td>

Applied Bearing Pressure, $Q_{asd} = S/L = 1{,}541 \text{ psf}$
Effective Allowable SBP, $Q_e = \mathrm{q} - \rho_{conc}\ (t/12\text{ "/ft}) = 1{,}900 \text{ psf}$
$1{,}541 < 1{,}900$ (4 ft. OK)
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<tr>
<td>Step 3: Ultimate Moment</td>
<td>

Cantilever Length,
$$c_L = \mathrm{L} \times 12"\frac{1'}{2} - w/2 = 4.23 \text{ in} = 0.3525 \text{ ft}$$
Ult. Applied Bearing Pressure, $Q_u = \dfrac{\mathrm{U}}{\mathrm{L}} = 1{,}579 \text{ psf}$
Ult. Moment, $M_u = \dfrac{1'}{12}"\left(Q_u \times c_L{}^2/2 \right) = 45{,}874 \text{ lb} - \text{in/ft}$
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<tr>
<td>Step 4: Check Bending (ESR 5205 4.2)</td>
<td>

Scale Effect Factor (ESR 5205 Eq 3), $\lambda_s = 1.00$
Section Modulus, $S_m = \dfrac{bt^2}{6} = 128 \dfrac{in^3}{ft}$
ESR 5205 Table 1, $\varphi L_f = 0.60 \times 10.58 = 6.35$
ESR 5205 Eq1, $M_u \le \lambda_s \times \varphi L_f\sqrt{f_c'} \times S_m = 40{,}627 \text{ in} - \dfrac{\text{lb}}{\text{ft}}$
$1{,}177 \ in - \dfrac{lb}{ft} < 40{,}627 \text{ in} - \dfrac{\text{lb}}{\text{ft}}$ (OK)
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<tr>
<td>Step 5: Check Beam Shear (ACI 318 14.5.5.1 Table 1)</td>
<td>

Beam Shear, $V_{u1} = Q_u\left(L/2 - \dfrac{\frac{w}{2}+t}{\frac{12"}{ft}} \right) = 0\dfrac{\text{lb}}{\text{ft}}$
Allowable Shear, $0.6 \times \left(\dfrac{4}{3}\sqrt{f_c'}bt\right) = 3840\dfrac{\text{lb}}{\text{ft}}$
$0 < 3840 \text{ lb}$ (OK)
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<tr>
<td>Step 6: Adjust for Thickness (ACI 318 14.5.1.7)</td>
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Adjusted Thickness (assuming formed against soil),
$t_{adj} = t + 2 \text{ in} = 10 \text{ in}$
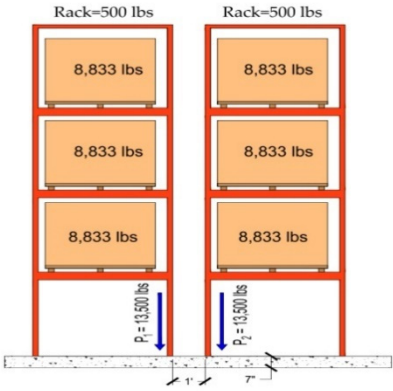1.33 ft. wide x 10 in. thick footing with 9 lb/yd³ SteelX 5:25 (OK)
</td>
</tr>
</table>

Example 4: Slab on Grade Design Elastic Design (Type G Section 4.3.1)

Rack=250 lbs Rack=250 lbs 3,000 lbs 3,000 lbs 3,000 lbs 3,000 lbs P_1 = 3,125 lbs P_2 = 3,125 lbs 1' 8"	Two Post Loads, P_1 & P_2 = 6,250 lb. Base plate size = 4 in. x 6 in. Back-to-back at S = 12 in. spacing, located adjacent to sawcut joint Concrete thickness, h = 8 in. f_c' = 4000 psi, Poisson's Ratio, μ = 0.15 SteelX 5:25 Dosage = 9 lb/yd^3 Modulus of Subgrade Reaction, k = 100 pci Factor of Safety, FS= 1.7 (ACI 360R Table 5.2)
Step 1: Modulus of Elasticity (ACI 318-14, Eq 19.2.2.1.b)	Modulus of Elasticity, $E_c = 57000\sqrt{f_c'} = 3{,}605{,}000$ psi
Step 2: Radius of Relative Stiffness (ACI 360R-10, Equation 7-3)	Radius of relative stiffness, $L = \sqrt[4]{\dfrac{E_c \times h^3}{12 \times (1-\mu^2) \times k}} = 35.4\ in$
Step 3: Radius of Contact Area	Total Contact Area, $A_c = 4" \times 6" = 24\ in^2$ Radius of Contact Area, $a_w = \sqrt{(A_c/\pi)} = 2.8\ in$
Step 4: Combined Load (Principle of Superposition)	$P = P_1 + P_2\left(1 - \left(\dfrac{S}{1.5L}\right)\right) = 11{,}088\ lb$
Step 5: Bending Stress at Edge (ACI 360R-10, Equation 7-5)	Bending Stress, $f_b = 0.572\dfrac{P}{h^2}\left[\log(h^3) - 4\log(\sqrt{1.6a_c^2 + h^2} - 0.675h) - \log(k) + 5.77\right] = 435psi$
Step 6: Bending stress at Sawcut (ACI 360R-10 Example A6.2.2)	$0.8f_b = 348\ psi$ (20% of load transfers across joint)
Step 7: Compute Flexural Strength (ICC-ESR 5205 Equation 4)	Modulus of Rupture Factor (ICC-ESR 5205 Table 1), L_f = 11.70 Modulus of Rupture, $f_r = L_f\sqrt{f'c} = 740\ psi$
Step 8: Compute Allowable Bending Stress (ICC-ESR 5205 Equation 4)	Allowable Bending Stress = f_r/FS = 435 psi Check Stress, $348\ psi < 435\ psi$ (OK)

Example 5: Parking Lot Design (Type P)

	Industrial Trucking Parking/Site Paving (no dowels at joints) Traffic category D (ACI 330.2R Table 4.2.4a), 1000 trucks/day Composite k-value of substructure: 150 pci Design Life: 20 years / Reliability 85% / Crack 15% at end of life f'_c = 3500 psi SteelX 5:25 Dosage = 9 lb/yd^3
Step 1: Modulus of Elasticity (ACI 318-14, Eq 19.2.2.1.b)	Modulus of Elasticity, $E_c = 57,000 \sqrt{f'_c} = 3,372,165$ psi
Step 3: Compute 28-day Flex Strength (ICC-ESR 5205 Equation 5)	Modulus of Rupture Factor (ICC-ESR 5205 Table 1), L$_f$ = 10.83 Modulus of Rupture, f$_r$ = $L_f \sqrt{f'_c} = 641 \; psi$
Step 2: Compute Thickness ACI 330.2R B1 (www.pavementdesigner.org)	Pavement Structure: computed in step 1 and 2, user defined k Recommended Thickness: 7.5 in / 13 ft joints

Example 6: Slab on Grade Design Yield Line Design (Type G - 4.3.2)

Rack=500 lbs Rack=500 lbs 8,833 lbs 8,833 lbs 8,833 lbs 8,833 lbs 8,833 lbs 8,833 lbs $P_1 = 13,500$ lbs $P_2 = 13,500$ lbs	Two Post Loads, P_1 & P_2 =13,500 lbs each Base plate size = 4 in. x 6 in. Back-to-back at S = 12 in. spacing, located adjacent to sawcut joint Concrete thickness, h = 7 in. Section width, b = 12 in. f'_c = 4000 psi. Poisson's Ratio, μ = 0.15 SteelX 5:25 Dosage = 9 lb/yd^3 Modulus of Subgrade Reaction, k = 100 pci Factor of Safety, FS= 1.7 (ACI 360 Table 5.2)
Step 1: Modulus of Elasticity (ACI 318-14, Eq 19.2.2.1.b)	Modulus of Elasticity, $E_c = 57000\sqrt{f'_c} = 3{,}605{,}000$ psi
Step 2: Radius of Relative Stiffness (ACI 360R-10, Equation 7-3)	Radius of relative stiffness, $L = \sqrt[4]{\dfrac{E_c \times h^3}{12 \times (1-\mu^2) \times k}} = 32\ in$
Step 3: Radius of Contact Area	Total Contact Area, $A_c = 4 \times 6 = 24\ in^2$ Radius of Contact Area, $a_w = \sqrt{(A_c/\pi)} = 2.8\ in$
Step 4: Combined Load (Principle of Superposition)	$P = P_1 + P_2\left(1 - \left(\dfrac{S}{1.5L}\right)\right) = 23{,}629\ lb$
Step 5: Bending Moment Demand Edge (ACI 360R-10, 11.3.3.3, Case 2)	Moment Demand, $M = \dfrac{P}{3.5\left[1+\frac{3a_w}{L}\right]} = 5{,}363$ lb-ft/ft $= 63.8$ kip-in/ft
Step 5: Demand at Sawcut	$0.8M = 51.1$ kip-in/ft (20% of load transfers across joint)
Step 6: Compute Flexural Strength (ICC-ESR 5205 Equation 4)	Modulus of Rupture Factor (ICC-ESR 5205 Table 1), L_f = 11.67 Modulus of Rupture, $f_r = L_f\sqrt{f'c} = 740\ psi$
Step 7: Bending Moment Capacity (ACI 360R-10, 11.3.3.3, Case 2)	Moment Capacity, $M_0 = \left[1 + \dfrac{R_{e,3}}{100}\right] \times \dfrac{f_r \times b \times h^2}{6} = 94.27$ kip-in/ft Allowable Bending $= \dfrac{M_0}{FS} = 55.5 > 51.1$ kip-in/ft. (OK)

DIVISION: 03 00 00—CONCRETE
Section: 03 31 00—Structural Concrete

REPORT HOLDER:

CORNERSTONE MFG. & DIST., INC DBA BADGER FORMS

EVALUATION SUBJECT:

STEELX 5:25

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that SteelX 5:25, described in ICC-ES evaluation report ESR-5205, has also been evaluated for compliance with the codes noted below.

Applicable code edition*(s)*:

■ 2022 *California Building Code* (CBC)

For evaluation of applicable Chapters adopted by the California Office of Statewide Health Planning and Development (OSHPD) AKA: California Department of Health Care Access and Information (HCAI) and the Division of State Architect (DSA), see Sections 2.1.1 and 2.1.2 below.

■ 2022 *California Residential Code* (CRC)

2.0 CONCLUSIONS

2.1 CBC:

The SteelX 5:25, described in Sections 2.0 through 7.0 of the evaluation report ESR-5205, complies with CBC Section 1906, provided the design and installation are in accordance with the 2021 *International Building Code*® (IBC) provisions noted in the evaluation report and the additional requirements of CBC Section 1906, as applicable.

2.1.1 OSHPD:

The applicable OSHPD Sections and Chapters of the CBC are beyond the scope of this supplement.

2.1.2 DSA:

The applicable DSA Sections and Chapters of the CBC are beyond the scope of this supplement.

2.2 CRC:

The SteelX 5:25, described in Sections 2.0 through 7.0 of the evaluation report ESR-5205, complies with CRC Sections R404 and R608, provided the design and installation are in accordance with the 2021 *International Residential Code*® (IRC) provisions noted in the evaluation report and the additional requirements of CRC Sections R404 and R608, as applicable.

This supplement expires concurrently with the evaluation report, reissued December 2024.

DIVISION: 03 00 00—CONCRETE
Section: 03 31 00—Structural Concrete

REPORT HOLDER:

CORNERSTONE MFG. & DIST., INC DBA BADGER FORMS

EVALUATION SUBJECT:

STEELX 5:25

1.0   REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that SteelX 5:25 reinforcements, described in ICC-ES evaluation report ESR-5205, have also been evaluated for compliance with the code noted below as adopted by the New York City Department of Buildings.

Applicable code edition:

2022 *City of New York Building Code* (NYCBC)

2.0   CONCLUSIONS

The SteelX 5:25 reinforcements, described in Sections 2.0 through 7.0 of the evaluation report ESR-5205, comply with the NYCBC Sections BC 1908 and BC 1909, and are subject to the conditions of use described in this supplement.

3.0   CONDITIONS OF USE

The SteelX 5:25 reinforcements described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-5205.

- The design, installation, conditions of use and identification of the anchors are in accordance with the 2015 *International Building Code®* (IBC) provisions noted in the evaluation report ESR-5205.

- The design, installation and inspection are in accordance with additional requirements of NYCBC Chapters 16 and 17, and Sections BC 1908 and BC 1909, as applicable.

This supplement expires concurrently with the evaluation report, reissued December 2024.