ICC-ES Evaluation Report

ESR-2107

Reissued January 2025

This report also contains:

- **City of LA Supplement**

Subject to renewal January 2026

ICC-ES Evaluation Reports are not to be construed as representing aesthetics or any other attributes not specifically addressed, nor are they to be construed as an endorsement of the subject of the report or a recommendation for its use. There is no warranty by ICC Evaluation Service, LLC, express or implied, as to any finding or other matter in this report, or as to any product covered by the report.

DIVISION: 03 00 00—CONCRETE Section: 03 21 00—Reinforcing Steel	REPORT HOLDER: COMMERCIAL METALS COMPANY	EVALUATION SUBJECT: ChromX® 9100, 4100 AND 2100, GRADE 100 STEEL REINFORCING BARS	

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2018, 2015, 2012, and 2009 *International Building Code®* (IBC)
- 2018, 2015, 2012, and 2009 *International Residential Code®* (IRC)
- 2013 *Abu Dhabi International Building Code* (ADIBC)†

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

Property evaluated:

- Structural

2.0 USES

The ChromX® 9100 (CRX9), 4100 (CRX4) and 2100 (CRX2), Grade 100 bars are deformed steel reinforcing bars used as longitudinal and transverse reinforcement in reinforced concrete structural members, such as foundations, columns and walls.

3.0 DESCRIPTION

3.1 ChromX® 9100, 4100 and 2100, Grade 100 Bars:

The ChromX® 9100, 4100 and 2100, Grade 100 bars are deformed steel reinforcing bars available in sizes Nos. 3 through 11, No. 14 and No. 18. Examples of available bars are illustrated in Figure 1. Nominal weights, dimensions, and deformations comply with values given in Table 1 of ASTM A1035-16b.

3.2 Materials:

The bars are rolled from identified heats of cast steel and comply with requirements in ASTM A1035/A1035M-16b for Type CS, CM and CL Grade 100 bars. The specified or minimum yield strength is 100,000 psi (690 MPa) and the specified or minimum tensile strength is 150,000 psi (1030 MPa).

4.0 DESIGN AND INSTALLATION

4.1 Design:

The bars must be designed in accordance with IBC, ACI 318-14 and ACI 439.6R under the 2018 and 2015 IBC (ACI 318-11 and ACI ITG-6R under the 2012 IBC and ACI 318-08 and ACI ITG-6R under the 2009 IBC), as summarized in Annex 1 of this report, entitled, “Design Methodology, ASTM A1035/A1035M-16b Types CS, CM and CL Grade 100 Bars.”

The following limitations also apply:

1. The reinforcing bars must not be used as longitudinal reinforcement in special moment frame members, special structural wall boundary elements, or coupling beams.
2. The ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcing bars must not be welded.
3. The ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcing bars must not be used as headed deformed bars in tension.
4. The specified compressive strength for concrete must range from 4,000 psi to 16,000 psi (27.6 MPa to 110.3 MPa).
5. Use of the ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcing bars is applicable to reinforcement under Sections 8.6.2.3, 20.2.1.2, 20.2.1.3, and 20.2.2.4 of ACI 318-14, and Section 4.1.2 of ACI 318.2-14 under the 2018 and 2015 IBC (Sections 3.5.3.2, 3.5.3.3, 9.4, 11.4.2, 11.5.3.4, 11.6.6, 18.9.3.2, and 19.3.2 of ACI 318-11 or -08 under the 2012 and 2009 IBC). ACI 318 is referenced in Section 1901.2 of the IBC.
6. For structures assigned to Seismic Design Category (SDC) D, E, or F, ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcing bars are limited to placement in slab systems, foundations, and structural components not designated as part of the seismic force–resisting system but explicitly analyzed for induced effects of design displacements in accordance with ACI 318-14 Section 18.14 under the 2018 and 2015 IBC (ACI 318-11 or -08 Section 21.13 under the 2012 and 2009 IBC, as applicable). Additional requirements pertaining to structures assigned to SDC D, E, or F are described in Section A.2.20 of this report.

4.2 Installation:

4.2.1 The ChromX® 9100, 4100 and 2100, Grade 100 bars and splices must be located in the structure as set forth in the approved drawings and specifications. Reinforcement details, including surface conditions, bar placement, clear spacing, offsets, spirals and ties, must comply with the applicable provisions in Chapter 25 of ACI 318-14 under the 2018 and 2015 IBC (Chapter 7 of ACI 318-11 or -08 under the 2012 and 2009 IBC, respectively).

4.2.2 Mechanical splices using the high-strength reinforcing bars in this report must be evaluated by ICC-ES in a separate report with evidence submitted complying with the requirements of AC133 and AC429. The mechanical splices must be Type A for use with the 2018 and 2015 IBC, and Type 1 or 2 for use with the 2012 and 2009 IBC.

4.3 Special Inspection:

Special inspection is required in accordance with 2018, 2015 and 2012 IBC Sections 1705.1.1 and 1705.3 (2009 IBC Sections 1704.4 and 1704.15). The special inspector must verify, but are not limited to, the following:

1. That reinforcing steels are of the type, grade and size specified and are labeled in conformance with this report.
2. That bending of reinforcing steel bars complies with ACI 318-14 Section 26.6.3 under the 2018 and 2015 IBC, ACI 318-11 Section 7.3 under the 2012 IBC, or with 2009 IBC Section 1907.3, and the modifications given in Annex 1 Section A2.3.
3. That reinforcing steel surface conditions comply with ACI 318-14 Section 26.6.6.1.2 under the 2018 and 2015 IBC, ACI 318-11 Section 7.4 under the 2012 IBC, or with 2009 IBC Section 1907.4.
4. That reinforcing steels are placed within tolerances set forth in ACI 318-14 Section 26.6 under the 2018 and 2015 IBC, ACI 318-11 Section 7.5 under the 2012 IBC, or with 2009 IBC Section 1907.5; and are adequately supported and secured to prevent displacement during concrete placement.
5. That minimum concrete protection is provided in accordance with ACI 318-14 Section 20.6 under the 2018 and 2015 IBC, ACI 318-11 Section 7.7 under the 2012 IBC, or with 2009 IBC Section 1907.7.
6. That placement of reinforcing steel complies with required spacing, profile and quantity requirements, as specified in the approved drawings and specifications.
7. That hooks, bends, ties, stirrups and supplemental reinforcement are fabricated and placed as specified in the approved drawings and specifications.
8. That lap lengths, stagger and offsets are provided in accordance with the approved drawings and specifications.

5.0 CONDITIONS OF USE:

The ASTM A1035/A1035M-16b Types CS, CM and CL Grade 100 Bars described in this report comply with applicable provisions of the codes indicated in Section 1.0 of this report, subject to the following conditions:

5.1 The bars must be installed in accordance with the applicable code, the manufacturer's instructions and this report. In case of conflict between the manufacturer's published instructions and this report, the more restrictive governs.

5.2 Splice locations must comply with applicable code requirements and be noted on drawings approved by the building official.

5.3 Prior to installation, calculations and details demonstrating compliance with this report must be submitted to the building official. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.4 Use in structures assigned to Seismic Design Category D, E, or F and regulated by Chapter 18 of ACI 318-14 under the 2018 and 2015 IBC (Chapter 21 of ACI 318-11 or -08 under the 2012 and 2009 IBC, respectively) are beyond the scope of this report, except as noted in Section 4.1, limitation item 6 of this report.

5.5 Special inspection must be provided in accordance with Section 4.3 of this report.

5.6 Limitations listed in Section 4.1 of this report must be observed.

5.7 Under the IRC, an engineered design in accordance with IRC Section R301.1.3, showing compliance with IBC and this evaluation report, must be submitted to the code official for review and approval.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for High-strength Reinforcing Bars (AC429), approved May 2017 (editorially revised April 2020).

7.0 IDENTIFICATION

7.1 Each bar is identified in accordance with the provisions of ASTM A1035/A1035M-16b. Figures 2a and 2b provide an explanation of each bar marking (for English Units and Metric Units, respectively). The bar bundles are identified by tags bearing the manufacturer's name, report holder's name (Commercial Metals Company), product's name, Type, grade of bar, size of bar, length of bar, heat number, roll number, and the evaluation report number (ESR-2107).

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

COMMERCIAL METALS COMPANY
310 NEW STATE ROAD
CAYCE, SOUTH CAROLINA 29033
(803) 936-3700
www.cmc.com/chromx

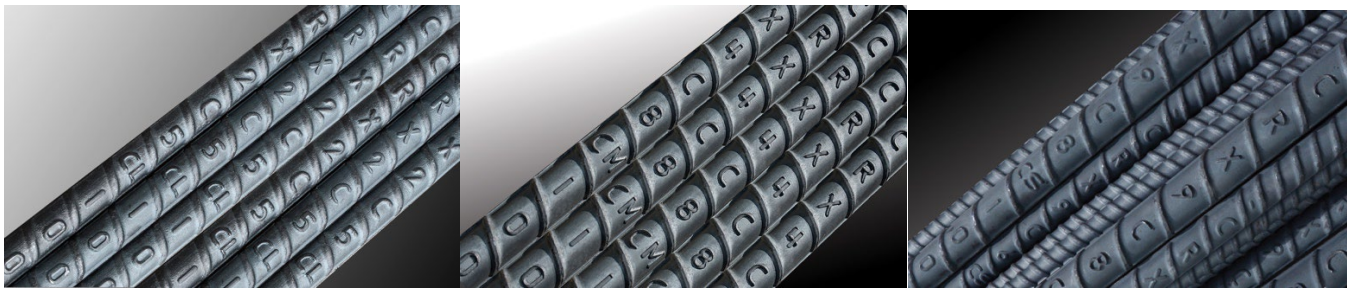
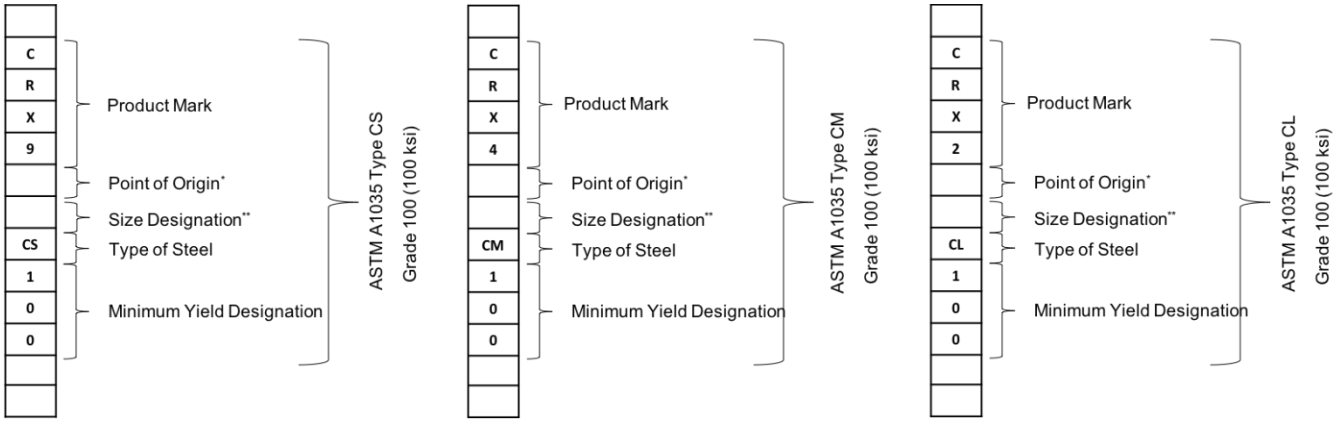


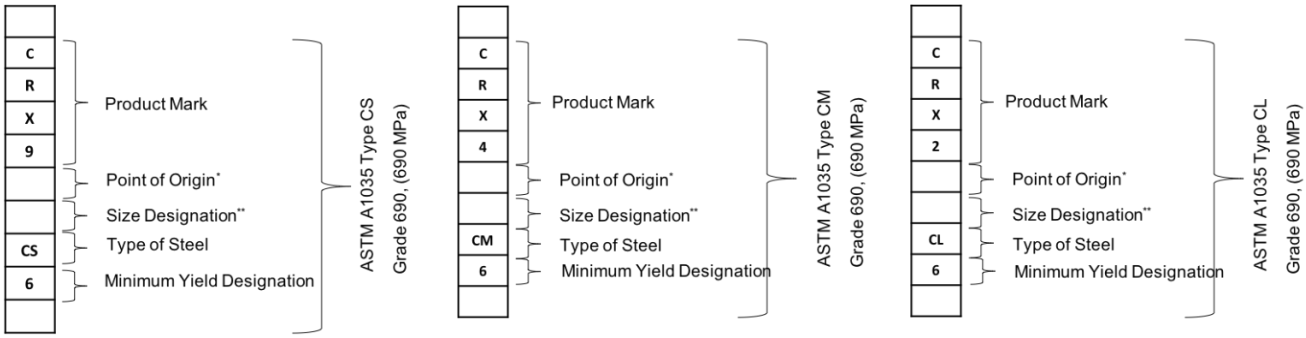
FIGURE 1—EXAMPLES OF AVAILABLE CHROMX® 2100 (CL), CHROMX 4100 (CM) AND CHROMX 9100 (CS) GRADE 100 BARS



*Symbol “C” for Cascade Mills, Symbol “” for CMC Cayce SC.

**Size Designation bar sizes 12, 16, 20, 25, 28, 32, 36, 40, 50

FIGURE 2A—ASTM A1035-16B TYPE CS, CM & CL GRADE 100 BAR MARKINGS (ENGLISH UNITS)



*Symbol “C” for Cascade Mills, Symbol “” for CMC Cayce SC.

**Size Designation bar sizes 12, 16, 20, 25, 28, 32, 36, 40, 50

FIGURE 2B—ASTM A1035-16B TYPE CS, CM & CL GRADE 100 BAR MARKINGS (METRIC UNITS)

ANNEX 1—DESIGN METHODOLOGY, ASTM A1035/A1035M-16b TYPES CS, CM AND CL GRADE 100 BARS

A1.0 Structural design with high-strength reinforcing bars must be in accordance with ACI 318, as modified by ACI ITG-6R. Table A1 provides the highest permissible values of the specified yield strengths for the ASTM A1035/A1035M-16b *Types CS, CM and CL* Grade 100 bars to be used in the design of structural members.

A2.0 ACI ITG-6R provides further guidance for using high-strength steel reinforcing bars beyond current ACI 318 limitations. The design and installation of ASTM A1035/A1035M-16b Types CS, CM and CL Grade 100 bars must observe the following modifications to ACI 318, taken from ACI ITG-6R, identified in Sections A2.1 through A2.20, and additional clarifications noted in Sections A2.21 and A2.22:

A2.1 Deformed Reinforcement: Modify ACI 318-14 Section 20.2.1.3 (ACI 318-11 or -08 Section 3.5.3.3) to read as follows:

Deformed Grade 100 reinforcing bars conforming to ASTM A1035-16b, Types CS, CM and CL, as noted in Section 3.2 of this evaluation report, shall be permitted to be used subject to the specific modifications to ACI 318 given in this report.

A2.2 Exposure Categories and Classes: Modify ACI 318-14 Section 19.3.1 (ACI 318-11 or -08 Section 4.2) by adding new Section 19.3.1.2 in ACI 318-14 (Section 4.2.2 in ACI 318-11 or -08):

ASTM A1035-16b Types CS, CM and CL Grade 100 bars shall be permitted to be in direct contact with other grades of steel except where the structure is in an aqueous environment. Aqueous environments include concrete exposure categories and classes where moisture or water contact is anticipated, as set forth in Section 19.3.1.1 in ACI 318-14 (Section 4.2.1 in ACI 318-11 or -08).

A2.3 Bending: Modify ACI 318-14 Section 26.6.3 (ACI 318-11 or -08 Section 7.3) by adding new Section 26.6.3.1(d) in ACI 318-14 (Section 7.3.3 in ACI 318-11 or -08):

Unbending of ASTM A1035-16b Types CS, CM and CL Grade 100 bars is prohibited.

A2.4 Redistribution of Moments: Modify ACI 318-14 Section 6.6.5 (ACI 318-11 or -08 Section 8.4) by adding the following:

Redistribution of moments shall not apply to members containing ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcing bars.

A2.5 Strength Reduction Factor: Under the 2012 and 2009 IBC: Modify by ACI 318-11 or -08 Section 9.3.2.2 by replacing the second paragraph in ACI 318-11 or -08 with the following:

For sections reinforced with ASTM A1035-16b Types CS, CM and CL Grade 100 bars in which the net tensile strain in the extreme tension steel at nominal strength, ε_t, is between the limits for compression-controlled (See Section A2.9) and tension-controlled (See Section A2.10) sections, φ shall be permitted to be linearly increased from that for compression-controlled sections to 0.90 as ε_t increases from the compression-controlled strain limit to 0.009 in accordance with Eq. A2-1:

$$\varphi = 0.45 + 50\varepsilon_t \leq 0.9 \qquad \text{(Eq. A2-1)}$$

Under the 2018 and 2015 IBC: Modify Section 21.2.2 in ACI 318-14 as follows:

The strength reduction factor, ϕ, shall be determined in accordance with (Eq. A2-1), where ε_t is the net tensile strain in the extreme tension steel at nominal strength as described in the paragraph above in Section A2.5.

A2.6 Design Strength for Reinforcement: Modify ACI 318-14 Section 20.2.2.4 and Table 20.2.2.4a (ACI 318-11 or -08 Section 9.4) to read as follows:

The specified yield strengths of ASTM A1035-16b Types CS, CM and CL Grade 100 bars used in the design of structural members shall be no more than the values shown in Table A1.

TABLE A1—SPECIFIED YIELD STRENGTHS FOR DESIGN OF MEMBERS USING ASTM A1035/A1035M-16b TYPES CS, CM AND CL GRADE 100 REINFORCEMENT[1,4]

TYPE OF MEMBER	LONGITUDINAL REINFORCEMENT		TRANSVERSE REINFORCEMENT		
	Tension, psi (MPa)	Compression, psi (MPa)	Shear, psi (MPa)	Torsion, psi (MPa)	Confinement, psi (MPa)
Beams and one-way slabs	100,000 (690)	See Note 5.	80,000 (550)	60,000 (410)	N/A
Columns	100,000 (690)	See Note 5.	80,000 (550)	60,000 (410)	100,000 (690)[2]
Tension ties	80,000 (550)	N/A	N/A	N/A	N/A
Compression struts	N/A	See Note 5.	N/A	N/A	N/A
Two-way slabs	100,000 (690)	See Note 5.	60,000 (410)	60,000 (410)	N/A
Walls	100,000 (690)	See Note 5.	80,000 (550)	N/A	100,000 (690)[3]
Footings and pile caps	100,000 (690)	See Note 5.	80,000 (550)	60,000 (410)	N/A
Mat foundations	100,000 (690)	See Note 5.	80,000 (550)	N/A	N/A

[1]N/A = Not applicable
[2]Spirals and ties
[3]Ties
[4]Refer to Section A2.20 for additional limitations related to use in earthquake-resistant structures.
[5] The specified yield strength of longitudinal reinforcement in compression for the ASTM A1035 Grade 100 bars to be used in design is the stress corresponding to a strain of 0.35 percent (Extension Under Load Method in ASTM A370). The specified yield strength in compression for No. 4 – 11 bar sizes is 100,000 psi (690 MPa) and the specified yield strength in compression for No. 14 and No. 18 bar sizes is 80,000 psi (550 MPa).

A2.7 Control of Deflections: Modify ACI 318-14 Tables 7.3.1.1 and 9.3.1.1 (ACI 318-11 or -08 Table 9.5(a)) by adding the following note:

ACI 318-14 note [2] (ACI 318-11 or -08 note c) This table does not apply to members reinforced with ASTM A1035-16b Types CS, CM and CL Grade 100 bars. Deflections shall be computed in accordance with Sections 19.2.3.1 (for determination of modulus of rupture, f_r) and 24.2.3 of ACI 318-14 (Section 9.5.2.3 of ACI 318-11 or -08).

Replace ACI 318-14 Eq. (24.2.3.5a) (ACI 318-11 or -08 Eq. (9-8)) with Eq. A2-2.

$$I_e = \frac{I_{cr}}{1-\left(1-\frac{I_{cr}}{I_g}\right)\left(\frac{M_{cr}}{M_a}\right)^2} \leq I_g \qquad \text{(Eq. A2-2)}$$

A2.8 Tensile stress: Modify ACI 318-14 Section 20.2.2.1 (ACI 318-11 or -08 Section 10.2.4) to read as follows:

Tensile stress in ASTM A1035-16b Types CS, CM and CL Grade 100 bars shall be computed in accordance with Eq. A2-3 or A2-4:

$f_s = 29{,}000\varepsilon_s$ (ksi) for $\varepsilon_s \leq 0.00345$ (Eq. A2-3)

$f_s = 100$ ksi for $\varepsilon_s > 0.00345$ (Eq. A2-4)

A.2.9 Rectangular Stress Block: Modify ACI 318-14 Section 2.2 (ACI 318-11 or -08 Section 2.1) to add or revise the following notation:

α_1 = factor relating magnitude of uniform stress in equivalent rectangular compressive stress block to specified compressive strength of concrete as defined in Section 10.2.7.1, Chapter 10.

β_1 = factor relating depth of equivalent rectangular compressive stress block depth to neutral axis depth, Section 10.2.7.4, Chapters 10, 18, Appendix B.

χ_1 = factor relating mean concrete compressive stress at axial load failure of concentrically loaded columns to specified compressive strength of concrete as defined in Section 10.3.6.4, Chapter 10.

Modify ACI 318-11 or -08 Section 10.2.7 as follows:

10.2.7.1 Concrete stress of $\alpha_1 f'_c$ shall be assumed uniformly distributed over an equivalent compression zone bounded by edges of the cross-section and a straight line located parallel to the neutral axis at a distance of a = $\beta_1 c$ from the fiber of maximum compressive strain.

10.2.7.2 For f'_c between 2,500 psi and 8,000 psi, α_1 shall be taken as 0.85. For f'_c above 8,000 psi, α_1 shall be reduced linearly at a rate of 0.015 for each 1,000 psi of strength in excess of 8,000 psi, but α_1 shall not be taken less than 0.70.

10.2.7.3 Distance from the fiber of maximum strain to the neutral axis, c, shall be measured in a direction perpendicular to that axis.

10.2.7.4 For f'_c between 2,500 psi and 4,000 psi, β_1 shall be taken as 0.85. For f'_c above 4,000 psi, β_1 shall be reduced linearly at a rate of 0.05 for each 1,000 psi of strength in excess of 4,000 psi, but β_1 shall not be taken less than 0.65.

Modify ACI 318-11 or -08 Section 10.3.6 as shown below:

10.3.6.1 For nonprestressed members with spiral reinforcement conforming to Section 7.10.4 or composite members conforming to Section 10.16, or confined columns conforming to Sections 21.4.4.1 through 21.4.4.3 for the full height of the column

$$\phi P_{n,max} = 0.85\phi\,[\chi_1\, f'_c\,(A_g - A_{st}) + f_y\, A_{st}] \qquad (10\text{-}1)$$

10.3.6.2 For nonprestressed members with tie reinforcement conforming to Section 7.10.5

$$\phi P_{n,max} = 0.80\phi\,[\chi_1\, f'_c\,(A_g - A_{st}) + f_y\, A_{st}] \qquad (10\text{-}2)$$

10.3.6.3 For prestressed members, design axial load strength ϕP_n shall not be taken greater than 0.85 (for members with spiral reinforcement or 0.80 (for members with tie reinforcement) of the design axial strength at zero eccentricity ϕP_o calculated assuming concrete stress of $\chi_1 f'_c$ uniformly distributed across the entire depth of the section.

10.3.6.4 For f'_c between 2,500 psi and 8,000 psi, χ_1 shall be taken as 0.85. For f'_c above 1,000 psi of strength in excess of 8,000 psi, but χ_1 shall not be taken less than 0.70.

A2.10 Compression-controlled Strain Limit: Modify ACI 318-14 Section 21.2.2.1 and Table 21.2.2 (ACI 318-11 or -08 Section 10.3.3) to read as follows:

Sections are compression-controlled if the net tensile strain in the extreme tension steel, ε_t, is equal to or less than the compression-controlled strain limit when the concrete in compression reaches its assumed strain limit of 0.003. The compression-controlled strain limit is the net tensile strain in the reinforcement at balanced strain conditions. For ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcement, it shall be permitted to set the compression-controlled strain limit equal to 0.004.

A2.11 Tension-controlled Strain Limit: Modify ACI 318-14 Section 21.2.2 and Table 21.2.2 (ACI 318-11 or -08 Section 10.3.4) to read as follows:

Sections reinforced with ASTM A1035-16b Types CS, CM and CL Grade 100 bars are tension-controlled if the net tensile strain in the extreme tension steel, ε_t, is equal to or greater than 0.009 when the concrete in compression reaches its assumed strain limit of 0.003. Sections with ε_t between the compression-controlled strain limit and 0.009 constitute a transition region between compression-controlled and tension-controlled sections.

A2.12 Volumetric Spiral Reinforcement Ratio: Modify ACI 318-14 Section 25.7.3.3 (ACI 318-11 or -08 Section 10.9.3) to read as follows:

Volumetric spiral reinforcement ratio, ρ_s, shall be not less than the value given by Eq. A2-5:

$$\rho_s = 0.45\left(\frac{A_g}{A_{ch}} - 1\right)\frac{f'_c}{f_{yt}} \qquad (Eq.\ A2\text{-}5)$$

where the value of f_{yt} used in Eq. (A2-5) shall not exceed 100,000 psi (690 MPa). For f_{yt} greater than 60,000 psi (410 MPa) and ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcement, lap splices according to ACI 318-14 Section 25.7.3.6 (ACI 318-11 or -08 Section 7.10.4.5(a)) shall not be used.

A2.13 Slenderness Effects: Modify ACI 318-14 Section 6.2.6 (ACI 318-11 or -08 Section 10.10.2) to read as follows:

When slenderness effects are not neglected as permitted by Section 6.2.5 in ACI 318-14 (Section 10.10.1 in ACI 318-11 or -08), the design of compression members, restraining beams, and other supporting members reinforced with ASTM A1035-16b Types CS, CM and CL Grade 100 bars shall be based on the factored forces and moments from a second-order analysis satisfying Section 6.6.4 in ACI 318-14 (Section 10.10.5 in ACI 318-11 or -08). These members shall also satisfy Sections 6.2.6 and 6.6.4.6.4 in ACI 318-14 (Sections 10.10.2.1 and 10.10.2.2 in ACI 318-11 or -08). The dimensions of each member cross section used in the analysis shall be within 10 percent of the dimensions of the members shown on the contract documents or the analysis shall be repeated.

A2.14 Shear Strength Provided by Concrete for Nonprestressed Members: Modify ACI 318-14 Section 22.5.5.1 (ACI 318-11 or -08 Section 11.2.1.1) by adding the following:

For one-way slabs reinforced with ASTM A1035-16b Types CS, CM and CL Grade 100 bars where (1) lightly reinforced members with ρ less than one percent; (2) no significant axial load is present; and (3) no shear reinforcement is provided, V_c shall be computed in accordance with Eq. A2-6 or Eq. A2-6M:

$$V_c = \frac{73}{39+2.1d}\sqrt{f'}\,b_w d \ \text{(lb)} \qquad (Eq.\ A2\text{-}6)$$

$$V_c = \frac{154}{1000+2.1d}\sqrt{f'}\,b_w d \ \text{(N)} \qquad (Eq.\ A2\text{-}6M)$$

A2.15 Shear Reinforcement Design Strength: Modify ACI 318-14 Section 20.2.2.4 and Table 20.2.2.4a (ACI 318-11 or -08 Section 11.4.2) to read as follows:

The values of f_y and f_{yt} used in design of shear reinforcement shall not exceed 60,000 psi (410 MPa), except the value may be increased to 80,000 psi (550 MPa) for beams and walls reinforced with ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcement where appearance and serviceability due to shear cracking are not critical design considerations.

A2.16 Minimum Shear Reinforcement:

Concrete members reinforced with ASTM A1035-16b *Types CS, CM and CL* Grade 100 bars shall comply with the minimum shear reinforcement requirements in ACI 318-14 under the 2018 and 2015 IBC (ACI 318-11 or-08 under the 2012 and 2009 IBC, respectively).

A2.17 Development of Deformed Bars in Tension: Modify ACI 318-14 Section 25.4.2 (ACI 318-11 or -08 Section 12.2) by deleting Sections 25.4.2.2 and 25.4.2.3 in ACI 318-14 (Sections 12.2.2 and 12.2.3 in ACI 318-11 or -08), renumbering Section 25.4.2.4 in ACI 318-14 to become Section 25.4.2.3 (Section 12.2.4 in ACI 318-11 or -08 to become 12.2.3) and replacing Section 25.4.2.2 in ACI 318-14 (Section 12.2.2 in ACI 318-11 or -08) with the following:

For ASTM A1035-16b Types CS, CM and CL Grade 100 deformed bars, l_d shall be in accordance with Eq. A2-7 or Eq. A2-7M:

$$l_d = \frac{\left(\frac{f_y}{f_c'^{1/4}} - \phi 2400\omega\right)\alpha\beta_c\lambda}{\phi 76.3\left(\frac{c\omega + K_{tr}}{d_b}\right)} d_b \text{ (in.)} \quad \text{(Eq. A2-7)}$$

where:

ϕ = 0.8, strength reduction factor
α = Ψ_t defined in ACI 318
= 1.3 for top cast bars
β_c = 1.0 for uncoated bars
λ = 1.0 for normal-weight concrete
c = spacing or cover dimension for reinforcing bar = $c_{min} + {d_b}/{2}$
c_b = bottom concrete cover for reinforcing bar being developed
c_{max} = maximum of (c_b, c_s)
c_{min} = smaller of minimum concrete cover or ½ of the spacing between bars
c_{si} = ½ of the bar spacing
c_{so} = side concrete cover for reinforcing bar
c_s = minimum of [c_{so}, c_{si} + 0.25 in. (6.35 mm)]
d_b = diameter of bar
n = number of bars being developed
R_r = relative rib area of the reinforcement
$= \frac{project\ rib\ area\ normal\ to\ bar\ axis}{nominal\ bar\ diameter \times center\text{-}to\text{-}center\ rib\ spacing}$
s = spacing of transverse refinement
$\omega = 0.1\left(\frac{c_{max}}{c_{min}}\right) + 0.9 \leq 1.25$
K_{tr} = $(0.52 t_r t_d A_{tr}/sn)\sqrt{f'_c}$ (in.) (Eq. A2-8)
t_r = $9.6Rr + 0.28 \leq 1.72$ (Eq. A2-9)
t_d = $0.78 d_b + 0.22$ (in.) (Eq. A2-10)
$\left(\frac{c\,\omega + K_{tr}}{d_b}\right) \leq 4.0$ (Eq. A2-11)

In SI units

$$l_d = \frac{\left(\frac{f_y}{f_c'^{1/4}} - \phi 57.4\omega\right)\alpha\beta_c\lambda}{\phi 1.83\left(\frac{c\omega + K_{tr}}{d_b}\right)} d_b \text{ (mm)} \quad \text{(Eq. A2-7M)}$$

K_{tr} = $(6.26 t_r t_d A_{tr}/sn)\sqrt{f'_c}$ (mm) (Eq. A2-8M)
t_r = $9.6Rr + 0.28 \leq 1.72$ (Eq. A2-9M)
t_d = $0.03db + 0.22$ (mm) (Eq. A2-10M)
$\left(\frac{c\,\omega + K_{tr}}{d_b}\right) \leq 4.0$ (Eq. A2-11M)

A2.18 Development of Deformed Bars in Compression: Modify ACI 318-14 Section 25.4.9 (ACI 318-11 or -08 Section 12.3) by adding the following:

The specified yield strength f_y in compression of ASTM A1035-16b Types CS, CM and CL Grade 100 bars is limited to the values in Table A1 footnote 5.

A2.19 Mechanical and Welded Splices: Modify ACI 318-14 Section 25.5.7.1 (ACI 318-11 or -08 Section 12.14.3.1) to read as follows:

Mechanical splices shall be permitted when specifically recognized for use with ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcing bars in an ICC-ES evaluation report complying with AC133 and AC429. Welding of bars is prohibited.

A2.20 Modification of Moments for Two-way Slab Systems: Modify ACI 318-14 Section 8.10.4.3 (ACI 318-11 or -08 Section 13.6.7) to read as follows:

Modification of negative and positive factored moments using moment redistribution is prohibited in two-way slabs reinforced with ASTM A1035-16b Types CS, CM and CL Grade 100 bars.

A2.21 Use in Earthquake-resistant structures: Modify ACI 318-14 Section 20.2.2.4 (ACI 318-11 or -08 Section 21.1.5) by adding new section as follows:

Use of ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcing bars as longitudinal reinforcement in a structural member that is part of the seismic-force-resisting system of a structure assigned to SDC D, E or F is prohibited. The use of ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcing bars as transverse reinforcement is permitted, provided f_{yt} is limited to 60,000 psi (410 MPa) maximum for computing shear strength.

Modify ACI 318-14 Section 18.4.1.1 by adding a new paragraph at the end of 18.4.1.1 (Modify ACI-11 or -08 Section 21.3.2 to read as follows):

Where Grade 60 (420 MPa) reinforcing bars are used for column longitudinal reinforcement and ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcing bars are used for beam longitudinal reinforcement in intermediate moment frames, the flexural strength requirements (strong-column-weak beam) in Section 18.7.3.2 in ACI 318-14 (ACI 318-11 or -08 Section 21.6.2.2) shall be met using the actual strengths of the beams containing ASTM A1035-16b Types CS, CM and CL Grade 100 reinforcement. A nonlinear analysis shall be conducted to determine M_{nb}. The required shear strength of the beam shall be determined based on M_{nb} from such nonlinear analysis. Permitted methods of nonlinear analysis are given in ACI ITG-6R.

A2.22 Clarification with Respect to the Effect of Reinforcing Bar Tensile Strain: The design methodology for the ASTM A1035-*16b Types CS, CM and CL* Grade 100 reinforcing bars shall consider the effect of reinforcing bar tensile strain on the structural performance of the reinforced concrete structures containing ASTM A1035-*16b Types CS, CM and CL* Grade 100 reinforcement, including provisions noted in Sections 4.2, 4.8, 4.9 and Appendix B of ITG-6R.

A2.23 Clarification with Respect to Minimum Stress Corresponding to 0.0035 Strain: The requirement of a minimum stress of 80 ksi (550 MPa) corresponding to a strain of 0.0035, prescribed in ASTM A1035-09 and previous editions, referenced in Section 3.3 of ITG-6R, is no longer included in ASTM A1035-14 and later editions, including ASTM A1035-16b, and the effect of this difference on the design methodology, if any, should be considered.

ICC-ES Evaluation Report

ESR-2107 City of LA Supplement

Reissued January 2025

This report is subject to renewal January 2026.

www.icc-es.org | (800) 423-6587 | (562) 699-0543 *A Subsidiary of the International Code Council®*

DIVISION: 03 00 00—CONCRETE
Section: 03 21 00—Reinforcing Steel

REPORT HOLDER:

COMMERCIAL METALS COMPANY

EVALUATION SUBJECT:

ChromX® 9100, 4100 AND 2100, GRADE 100 STEEL REINFORCING BARS

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that ChromX® 9100 (CRX9), 4100 (CRX4) and 2100 (CRX2), Grade 100 bars, described in ICC-ES evaluation report ESR-2107, have also been evaluated for compliance with the codes noted below as adopted by the Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:

- 2020 *City of Los Angeles Building Code (LABC)*
- 2020 *City of Los Angeles Residential Code (LARC)*

2.0 CONCLUSIONS

The ChromX® 9100 (CRX9), 4100 (CRX4) and 2100 (CRX2), Grade 100 bars, described in Sections 2.0 through 7.0 of the evaluation report ESR-2107, comply with the LABC Chapter 19 and the LARC, and are subject to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The ChromX® 9100 (CRX9), 4100 (CRX4) and 2100 (CRX2), Grade 100 bars described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-2107.
- The design, installation, conditions of use and identification of the ChromX® 9100 (CRX9), 4100 (CRX4) and 2100 (CRX2), Grade 100 bars are in accordance with the 2018 *International Building Code®* (IBC) provisions noted in the evaluation report ESR-2107.
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.
- Continuous special inspection by Deputy Inspector shall be provided during installation of mechanical splices.
- Under the LARC, an engineered design in accordance with LARC Section R301.1.3 must be submitted.

This supplement expires concurrently with the evaluation report, reissued January 2025.