ChromX 9100, 4100 and 2100 Rebar – Product Guide Specification

Specifier Notes: This product guide specification is written in accordance with the Construction Specifications Institute (CSI) MasterFormat 2012.

The Engineer shall carefully review this specification to meet the requirements of the project and local building code and to coordinate with other specification sections and the drawings.

Delete all "Specifier Notes" after editing this section.

Specifier Notes: This section covers MMFX Technologies (ChromX 9100, 4100 and 2100) Steel uncoated, plain and deformed bars for concrete reinforcement conforming to ASTM A1035/A 1035M.

One of the main reasons for considering ChromX 9100, 4100 and 2100 rebar for concrete reinforcement is that carbon steel reinforcing bars easily corrode in concrete when subjected to harsh environments, resulting in loss of strength and structural integrity or aesthetic appeal of the structure. Reinforced structures are prone to corrosion, when they are exposed to the outdoor environment and to deicing salts in colder climates or coastal ocean environments. ChromX 9100, 4100 and 2100 bars provide varying degrees of corrosion resistant properties in reinforced concrete applications, with: 9100 – high, 4000 – moderate, and 2100 lower but better the black bar.

ChromX 9100, 4100 and 2100's high strength also provides an opportunity to save on the quantity of rebar required for specific structural loading applications, allowing for reduced reinforcement congestion in heavily reinforced concrete structures.

ChromX 9100, 4100 and 2100 rebar mechanical properties meet ASTM A1035 Grade 100 and 120 ASTM A615 Grade 80 and 100; and AASHTO M 334 M/M334 Grade 100 requirements and provide enhanced corrosion resistance. Design Code recommendations based on ACI 318-14 requirements complimented with ACI ITG 6R-10 are published by ICC ES's AC 429 and ESR 2107 documents in accordance to the International Building Code 2014. In addition, AASHTO LRFD Bridge Design Specifications 7th edition 2016 Interims can be used in designing concrete structures reinforced with ChromX 9100, 4100 and 2100 rebar. MMFX Technologies does not currently recommend use of its products outside of concrete.

MMFX Technologies offers its assistance in editing this specification section for specific project applications of ChromX 9100, 4100 and 2100 reinforcing bars.

Specifier Notes: Designers and engineers are referred in to the documents noted below regarding the application of ChromX 9100, 4100 and 2100 bars for concrete reinforcement:

1. ACI 318-14, "Building Code Requirements for Concrete" (2014), American Concrete Institute, Detroit, MI.
2. "Placing Reinforcing Bars" (1997), Concrete Reinforcing Steel Institute, Schaumburg, IL.
3. ACI ITG 6R-10 "Design Guide for the Use of High-Strength Steel Bars for Structural Concrete."
4. AASHTO LRFD Bridge Design Specifications 7th Edition – 2016 Interim Revisions.
5. CRSI – Specialty and Corrosion-Resistant Steel Reinforcement – Product Guide – July 2013.
6. ICC-ES AC429 – Acceptance Criteria for High-Strength Steel Reinforcing Bars .
7. ICC ES Evaluation Report ESR 2107 – January 2018.
8. ASTM A1035/A1035M – Specification for Deformed and Plain Low-Carbon, Chromium Steel Bars for Concrete Reinforcement.
9. AASHTO M 334M/M 334 -17 – Specification for Uncoated Corrosion-Resistant, Deformed and Plain Alloy, Billet-Steel Bars for Concrete Reinforcement and Dowels.

20190301

SECTION 03 21 15
MICROCOMPOSITE (ChromX 9100, 4100 and 2100)
PLAIN AND DEFORMED BARS FOR CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SPECIFICATION SCOPE

Specifier Notes: ChromX 9100 bars are uncoated corrosion resistant reinforcing (CRR) bars with a high degree of corrosion resistance in reinforced concrete applications. ChromX 4100 bars are uncoated corrosion resistant reinforcing (CRR) bars with a moderate degree of corrosion resistance in reinforced concrete applications. ChromX 2100 bars are uncoated concrete reinforcing bars with a lower degree of corrosion resistance.

A. This specification covers MMFX Technologies (ChromX 9100, 4100 and 2100) steel uncoated plain and deformed bars for concrete reinforcement in cast-in-place or pre-cast reinforced concrete.

1.2 RELATED WORK

A. Section 03 30 00 – Cast-in-Place Concrete.
B. Section 03 40 00 – Pre-cast Concrete.
Specifier Notes: Edit the following list as required for the project. List other sections with work directly related to the ChromX 9100, 4100 and 2100 bars.

1.3 REFERENCES

A. Codes and Standards

1. American Concrete Institute (ACI)

   a. Building Code Requirements for Reinforced Concrete (ACI 318-14).
   Specifier Notes: List standards referenced in this section, complete with designations, dates and titles. This article does not require compliance with standards, but is merely a listing of those used in the preparation of this specification section.
   b. Details and Detailing of concrete Reinforcement (ACI 315-99).
   c. ACI Detailing Manual – 1994 (ACI SP-66).
   d. Standard Tolerances for Concrete Construction and Materials (ACI 117-06).

2. American Society for Testing and Materials (ASTM)

   a. ASTM A6/A6M-12a – Specification for General Requirements for Rolled Structural, Steel Bars, Plates, Shapes, and Sheet Piling.
   b. ASTM A82-07 – Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   c. ASTM A370-14 – Test Methods and Definitions for Mechanical Testing of Steel Products.
   d. ASTM A510/A 510M-11 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
   e. ASTM A615 - 16 – Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
   f. ASTM A1035/A1035M - 16b – Specification for Deformed and Plain Low-Carbon, Chromium Steel Bars form Concrete Reinforcement.
   g. ASTM E29-08 – Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications.

3. American Association of State Highway and Transportation Officials (AASHTO)

   a. AASHTO M 334M/M 334 -17 – Specification for Uncoated Corrosion-Resistant, Deformed and Plain Alloy, Billet-Steel Bars for Concrete Reinforcement and Dowels.
   b. AASHTO LRFD Bridge Design Specifications 7th Edition 2016 Interim Revisions.

4. Concrete Reinforcing Steel Institute (CRSI)

   a. CRSI Manual of Standard Practice, 28th Edition, 2009.
   b. Placing Reinforcing Bars (CRSI), 9th Edition, 2011.
   c. CRSI – Specialty and Corrosion-Resistant Steel Reinforcement – Product Guide - July 2013.

5. Dubai Central Laboratory

   a. Marking and Tag Requirements for the Control of Reinforcing Steel Bars

6. International Code Council (ICC)

   a. ICC-ES AC429 – Acceptance Criteria for High-Strength Steel Reinforcing Bars – October 2017.
   b. ICC ES Evaluation Report ESR 2107 - January 2018.
   Specifier Notes: ChromX 9100 rebar conforms to the provisions of ASTM A1035 Grade 100 and AASHTO M 334 Grade 100 allowing for its design in accordance with ACI 318-14. ChromX 9100, 4100 and 2100 rebars can be used for spiral confinement up to 100,000 psi yield strength in accordance to ACI 318-14. In addition, 100,000 psi yield strength can be used for design in tension as per ACI ITG 6R-10 "Design Guide for the Use of High- Strength Steel Bars for Structural Concrete", AASHTO "LRFD Bridge Design Specifications" and ICC ES Evaluation Report ESR 2107.

1.4 DESIGN REQUIREMENTS

A. Design of concrete structures reinforced with ChromX 9100, 4100 and 2100 bars shall be based in accordance with the provisions of ACI 318-14 as modified by the ACI ITG 6R, AASHTO LRFD Bridge Design Specifications 7th Edition 2016 Interim Revisions, and the guidelines included as part of the ICC ES Evaluation Report ESR 2107.
Specifier Notes: MMFX Technologies does not currently recommend using the product outside of concrete.

1.5 SUBMITTALS

A. Comply with Specification – Submittal Procedures.

B. Product Data – Submit manufacturer's product data, including material and mechanical properties.

C. Test Reports – Submit manufacturer's mill certifications for material and mechanical properties for each bar size used by the project.

D. Placing Drawings – Submit ChromX 9100, 4100 and 2100 bar placing drawings in accordance with ACI SP- 66.

E. Field Welding Procedures – ChromX 9100, 4100 and 2100 steel bars shall not be welded except for tack welds as indicated in Section 3.3 Part C.
Specifier Notes: ChromX 9100, 4100 and 2100 steel bars should not be welded for structural applications as currently no specific provisions have been included to enhance its weldability.

F. Mechanical Couplers: Submit manufacturer's product data for use with ChromX 9100, 4100 and 2100 steel bars.

1.6 DELIVERIES, STORAGE, AND HANDLING

A. General: Deliver, store, and handle ChromX 9100, 4100 and 2100 bars in accordance with manufacturer's instructions.

B. Delivery and Storage:
1. Do not store ChromX bars directly on ground to keep them free from dirt and mud and to provide easy handling. It is recommended that ChromX 9100, 4100 and 2100 bars shall be covered when exposed to the elements for longer than 60 days, during transport from manufacturer, storage, fabrication and until placement; and as indicated in CRSI – Specialty and Corrosion - Resistant Steel Reinforcement – Product Guide.

2. Seams, surface irregularities, or mill scale oxidation shall not be cause for rejection, provided the weight, dimensions, and cross sectional area of a hand-wired-brush test specimen are not less than the requirements of this specification.

C. Handling

Handing of ChromX 9100, 4100 and 2100 bars shall be in accordance with conventional steels bar as noted in CRSI Manual of Standard Practice, and CRSI – Specialty and Corrosion-Resistant Steel Reinforcement – Product Guide.

PART 2 PRODUCTS

2.1 SUPPLIER

MMFX Technologies, A Commercial Metal Company, 11444 East Germann Road, Mesa, AZ 85212, Phone 866.466.7878
E-mail info@cmc.com Web Site http://www.mmfx.com

2.2 MATERIAL

A. MMFX Technologies (ChromX 9100, 4100 and 2100) Steel Deformed and Plain Bars

1. General:

ChromX 9100, 4100 and 2100 bars shall have a minimum chromium composition as indicated in Section 3. "Material Composition" Tables 1, 2 and 3; and have either a minimum yield strength of 100,000 psi [690 MPa] for Grade 100 [690] or 120,000 psi [830 MPa] for Grade 120 [830] as measured by using the 0.2% offset test method of ASTM A370.

2. Manufacture Process and Bar Sizes:

ChromX 9100, 4100 and 2100 bars shall be hot rolled from properly identified mold or strand cast steel. Available bars are standard plain and deformed bar sizes #3 [10], thru #11 [36]. Bar sizes #14 [43], #18 [57] and #20 [64] can be special ordered. Alternate sizes as per the Middle East Standard sizes are available in sizes 12mm through 40mm as per ASTM A1035 Annex A1.

3. Material Composition:

Specifier Notes: Contact MMFX Technologies for a list of qualified Mechanical Bar Splice Coupler Manufacturers.

a. ChromX 9100, bars shall meet the requirements of Table 1

Table 1 - Maximum ChromX 9100 Chemical Constituents (Weight %)[A]

Element	Carbon	[C]Chromium	Manganese	Nitrogen	Phosphorus	Sulfur	Silicon
Max Amount[B]	0.15%	8 to 10.9%	1.5%	0.05%	0.035%	0.045%	0.50%

Note A – ChromX 9100 UNS K81550
Note B – Maximum unless range indicated,
Note C – AASHTO M 344 M/M 334 -17Minimum 9.2% minimum Cr content.

b. ChromX 4100 bars shall meet the requirements of Table 2.

Table 2 - Maximum ChromX 4100 Chemical Constituents (Weight %)[A]

Element	Carbon	[C]Chromium	Manganese	Nitrogen	Phosphorus	Sulfur	Silicon
Max Amount[B]	0.20%	4.0 to 7.9%	1.5%	0.05%	0.035%	0.045%	0.50%

Note A – ChromX 4100 UNS K42050
Note B – Maximum unless range indicated,
Note C – AASHTO M 344 M/M 334 -17doesn't include bars, which have Chromium content less than 9.2 %.

c. ChromX 2100 bars shall meet the requirements of Table 3.

Table 3 - Maximum ChromX 2100 Chemical Constituents (Weight %)[A]							
Element	**Carbon**	**[C]Chromium**	**Manganese**	**Nitrogen**	**Phosphorus**	**Sulfur**	**Silicon**
Max Amount[B]	0.30%	2.0 to 3.9%	1.5%	0.05%	0.035%	0.045%	0.50%

Note A – ChromX 2100 UNS K23050
Note B – Maximum unless range indicated,
Note C -- AASHTO M 344 M/M 334 -17doesn't include bars, which have Chromium content less than 9.2 %.

4. Bar Weight, Dimensions, and Deformation Spacing and Height:
Specifier Notes: When specifying ChrmX 9100 bars for state and local government transportation agencies – refer to AASHTO M 334 for bar weight, dimensions, deformation spacing, height properties.

5. Deformed ChromX 9100, 4100 and 2100 bars shall conform to the weight, dimensions and deformation spacing, height, and gap requirements prescribed in ASTM A1035 Table 1.

ChromX 9100, 4100 and 2100 bars shall conform to the requirements for bar deformations in ASTM A1035 Section 7

6. Permissible Variation in Weight [Mass]:

ChromX 9100, 4100 and 2100 bars shall conform to the requirements for bar deformations in ASTM A1035 Section 11.

7. Tensile Properties:

a. ChromX 9100, 4100 and 2100 bars shall conform to the requirements for tensile properties prescribed in Table 2.

b. The yield strength shall be determined by the offset method (0.2% offset), described in Test Methods and Definitions A370.

Table 4 - Tensile Properties Requirements		
	Grade 100 (690)	**[A] Grade 120 (830)**
Tensile strength, min, psi (MPa)	150,000 (1030)	150,000 (1030)
Yeild strength (0.2% offset), min, psi, (MPa)	100,000 (690)	120,000 (830)
Elongation in 8 in. (203.2mm), min. %:		
Bar Designation No.		
3 throught 11 (10 through 36)	7	7
14, 18 (43, 57)	6	6

Note A. AASHTO M 344 M/M 334 -17 does not include Grade 120 [830]

Specifier Notes: For additional design guidance for use of ChromX 9100, 4100 and 2100 rebars see ACI ITG 6R- 10 "Design Guide for the Use of High-Strength Steel Bars for Structural Concrete", ICC ES Evaluation Report ESR 2107 and AASHTO "LRFD Bridge Design Specifications" 7th edition – 2016 Interim Revisions.

8. Bend Test Properties:
ChromX 9100, 4100 and 2100 bend test specimens shall withstand being bent around a pin without cracking on the outside radius of the bent portion. The requirements for degree of bending and sizes of pins are prescribed in Table 3. When material is furnished in coils, the test sample shall be straightened prior to placement in the bend tester.

Table 5 - Bend Test Requirements	
Bar Designation No.	**Pin Diameter [A]**
3,4,5 (10, 13, 16)	3 1/2d [B]
6, 7, 8 (19, 22, 25)	5d
9, 10, 11 (29, 32, 36)	7d
14, 18 (43, 57) (90°)	9d

Note A Test Bends 180° unless otherwise noted in [ ].
Note B d= nominal diameter of specimen.

9. Bar Identification:
ChromX 9100, 4100 and 2100 bars meet the requirements of ASTM A615 Grade 80 and 100, ASTM A1035-16 and AASHTO M 334 Grade 100 specifications. ChromX 9100, 4100 and 2100 bars, excepts plain round bars, which shall be tagged for grade, and shall be identified by a distinguishing set of marks legibly rolled onto the surface of one side of the bar to denote the specification in the following order:

a. Bar Identifiers
"CRX9" shall indicate a product produced for ChromX 9100 Steel meeting the chemical composition of Table 1. "CRX4" shall indicate a product produced for ChromX 4100 Steel meeting the chemical composition of Table 2. "CRX2" shall indicate a product produced for ChromX 2100 Steel meeting the chemical composition of Table 3.

b. Point of Origin - Letter or symbol established as the manufacturer's mill designation.

c. Size Designation - Arabic number corresponding to bar designation number of Table 2.

d. Type of Steel - Letters "CS" indicating that the bar was produced to ASTM A1035 Type CS and AASHTO M 334 specifications. Letters "CM" indicating that the bar was produced to ASTM A1035 Type CM. Letters "CL" indicating that the bar was produced to ASTM A1035 Type CL.

e. Minimum Yield Designation - For Grade 100 [690], either the number 100 [6] or three continuous longitudinal lines through at least five spaces offset each direction from the center of the bar. For Grade120 [830], either the number 120 [8] or four continuous longitudinal lines through at least five spaces offset each direction from the center of the bar. It shall be permissible to substitute a metric size bar for the corresponding inch pound size bar.

B. Bar Supports

1. Bar supports and spacers shall be per recommendations set forth by Chapter 3 of the CRSI Manual of Standard Practice.

2. Ferrous metal bar supports in concrete areas where soffits are exposed to view or are painted shall be Class 1 or Class 2, Types A or B; Class 3 is acceptable in other areas.

C. Tie Wire

1. Metallic ties shall be 16 gauge (1.5 mm diameter) or heavier, black-annealed ferrous metal wire.

2. Non-metallic ties shall be appropriate for the intended application.

C. Mechanical Bar Splice Couplers

1. Couplers shall be made from ChromX 9100, 4100 and 2100 steel bars or other approved carbon steel bar material and shall be approved for use with ChromX 9100, 4100 and 2100 rebars.

2.3 MATERIAL QUALITY CONTROL

A. Quality Control Testing:

ChromX 9100, 4100 and 2100 bars shall be furnished with material certifications in accordance with SECTION 1.5 SUBMITTALS.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive ChromX 9100, 4100 and 2100 bars. Notify the Engineer if areas are not acceptable. Do not begin placing ChromX 9100, 4100 and 2100 bars until unacceptable conditions have been corrected. See also Section 1.6 DELIVERIES, STORAGE, AND HANDLING.

B. Seams, surface irregularities, or mill scale oxidation shall not be cause for rejection, provided the weight, dimensions, and cross-sectional area of a hand-wired-brush test specimen are not less than the requirements of this specification.

3.2 PLACING DRAWINGS

A. Place ChromX 9100 bars accurately in accordance with approved placing drawings, schedules, typical details, and notes.
Specifier Notes: Placing and fabrication of ChromX 9100, 4100 and 2100 bars are performed similarly to that of uncoated steel reinforcing bars, and common practices should apply with some key exceptions, and as specified below. (See also CRSI – Specialty and Corrosion-Resistant Steel Reinforcement – Product Guide).

3.3 FABRICATION

A. Reinforcing steel shall be accurately fabricated to the dimensions shown in the Contract documents.

1. Bends shall conform to the dimensions and details in accordance with ACI 315-99 – Chapter 3, ACI SP-66and/or CRSI Manual of Standard Practice – Chapter 6, unless otherwise shown, with fabricated bends conforming to Table 5 per ACI 315 – Table 7.2.

Table 4 - Minimum Fabricated Bend Diameters

Bar Size	Minimum Bend Diameter
3, 4, 5, 6, 7, 8 (10, 13, 16, 19, 22, 25)	6d
9,10, 11 (29, 32, 36)	8d
14, 18 (43, 57)	10d

2. Bars shall be bent cold and shall not be bent or straightened in a manner that will injure the material. Heating of the bars to facilitate bending shall not be permitted.

3. Bar cutting shall be accomplished by shearing or with a fluid-cooled saw. Torch cutting shall not be permitted.

4. Bars shall be fabricated within the tolerances shown in the ACI 315-99 figures 8 and 9, and/or CRSI Manual of Standard Practice – Chapter 7 and/or CRSI – Chapter 6.

B. Spirals

1. Provide one and one-half finishing turns top and bottom minimum.

2. Splice lap lengths shall be to the length shown on the contract documents.

3. Provide spacers per Chapter 5, Section 10 of the CRSI Manual of Standard Practice.

C. Field Tack Welding as an aid to fabrication and/or installation is permitted but not allowed if weld is required for structural applications.

3.4 INSTALLATION

A. Placement:
Place ChromX 9100, 4100 and 2100 bars in accordance with CRSI PRB – Chapter 10, and to the tolerances given in ACI 117 and/or CRSI PRB, unless otherwise specified or approved by the Engineer. Bars shall be free from loose mill scale oxidation, dirt, oil or other deleterious coatings that could reduce bond with the concrete. When bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits, or embedded items, the resulting arrangement of the bars shall meet the structural requirements of the project as approved by the Engineer.

B. Field Cutting and Bending:
When required, field cutting and bending of ChromX 9100, 4100 and 2100 bars shall be per SECTION 3.3 FABRICATION. Reinforcing bars partially embedded in concrete shall not be field bent. Fabricated bent bars shall not be straightened and re-bent in the field.

C. Securing:
Secure ChromX 9100, 4100 and 2100 bars in formwork to prevent displacement by concrete placement or workers Supports and Spacers:

Place and support ChromX 9100, 4100 and 2100 bars accurately using specified supports before concrete placement is started and placed in accordance with the provisions of ACI 315 – Chapter 5 or CRSI PRB.

D. Splicing:
All splicing of reinforcement shall be as indicated in the Contract Documents, unless otherwise permitted. Concrete cover and bar spacing shall conform to ACI 318-14. Mechanical connections shall be made only at locations shown in the Contract Documents or as permitted by the Engineer.

1. When required, mechanical coupler connections shall develop 125 percent of the specified minimum tensile strength of the bars being spliced; and shall be installed per coupler manufacturer's recommendations.

E. Fastening:
Fasten ChromX 9100, 4100 and 2100 bars with approved tie wire, or snap ties, in accordance with ACI 315.

F. Cleaning:
Remove form oil or other deleterious materials from ChromX 9100, 4100 and 2100 bars before placing concrete.

3.5 TESTING AND INSPECTION

A. Upon request a certified copy of a mill certification report showing physical and chemical analysis for each heat of reinforcing bars delivered shall be provided.

B. Field inspection shall be in accordance with local Building Code or agency requirements.

11444 East Germann Rd., Mesa, AZ 85212
Phone: 480.396.7124 Toll Free: 866.466.7878
www.cmc.com/chromx