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 Microcomposite (MMFX<sub>2</sub>) Steel uncoated, plain and deformed bars for concrete reinforcement.

One of the main reasons for considering MMFX<sub>2</sub> 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. MMFX<sub>2</sub> bars provide significant corrosion resistant properties in reinforced concrete applications.

MMFX<sub>2</sub>'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.

MMFX<sub>2</sub> rebar mechanical properties meet ASTM A1035 Grade 100, ASTM A615 Grade 75 and 80 and AASHTO MP 18M/MP 18-09 requirements and provide enhanced corrosion resistance. Design Code recommendations based on ACI 318-11 requirements complemented with ACI ITG 6R-10 are published by ICC’s AC 429 and ESR 2107 documents in accordance to the International Building Code 2012. In addition, AASTHO LFRD Bridge Design Specifications 6<sup>th</sup> edition (2013 interim) can be used in designing concrete structures reinforced with MMFX<sub>2</sub> rebar.

MMFX Technologies Corporation offers its assistance in editing this specification section for specific project applications of MMFX<sub>2</sub> reinforcing bars.

Specifier Notes: Designers and engineers are referred to the documents noted below, regarding the application of MMFX<sub>2</sub> bars for concrete reinforcement.

1. ACI 318-11, “Building Code Requirements for Concrete” (2011), 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 (ASTM 1035-07) for Structural Concrete.”
4. AASTHO LFRD Bridge Design Specifications 6<sup>th</sup> Edition (2013 Interim)
5. CRSI – Specialty and Corrosion-Resistant Steel Reinforcement – Product Guide - July 2013
6. ICC-ES AC429 - Acceptance Criteria for High-Strength Steel Reinforcing Bars, June 2012

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PART 1 GENERAL

1.1 SPECIFICATION SCOPE
A. This specification covers MMFX Microcomposite (MMFX₂) steel uncoated plain and deformed bars for concrete reinforcement in cast-in-place or pre-cast reinforced concrete.

1.2 RELATED WORK

Specifier Notes: Edit the following list as required for the project. List other sections with work directly related to the MMFX 2 bars.

A. Section 03 30 00 – Cast-in-Place Concrete.
B. Section 03 40 00 – Pre-cast Concrete

1.3 REFERENCES

Specifier Notes: List standards referenced in this section, complete with designations, dates and titles. This article does not require compliance with standards, but is mere a listing of those used in the preparation of this specification section.

A. Codes and Standards

1. American Concrete Institute (ACI)
   b. Details and Detailing of Concrete Reinforcement (ACI 315-99).
   d. Standard Tolerances for Concrete Construction and Materials (ACI 117-06)

   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 A370-12a – 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/A615M–12 Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
   f. ASTM A1035/A1035M–13a 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 MP 18 M/MP 18-09 – Specification for Uncoated Corrosion-Resistant, Deformed and Plain Alloy, Billet-Steel Bars for Concrete Reinforcement and Dowels

4. Concrete Reinforcing Steel Institute (CRSI)

5. Dubai Central Laboratory
   a. **Marking and Tag Requirements for the Control of Reinforcing Steel Bars**

6. International Code Council (ICC)

**Specifier Notes:** MMFX 2 rebar conforms to the provisions of ASTM A1035, ASTM A615 Grade 75 and AASHTO MP 18 Grade 100 allowing for its design in accordance with ACI 318-08. MMFX 2 rebars can be used for spiral confinement up to 100,000 psi yield strength in accordance to ACI 318-11. 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 (ASTM A1035-07) for Structural Concrete”, AASTHO “LFRD Bridge Design Specifications” and **ICC ES Evaluation Report ESR 2107**

### 1.4 DESIGN REQUIREMENTS

A. Design of concrete structures reinforced with MMFX₂ bars shall be based in accordance with the provisions of ACI 318-11 as modified by the ACI ITG 6R, AASTHO LFRD Bridge Design Specifications 6th edition (2003 interim); and the guidelines included as part of the ICC ES Evaluation Report ESR 2107.

### 1.5 SUBMITTALS


**Specifier Notes:** MMFX Technologies Corporation does not currently recommend using the product outside of concrete.

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 MMFX₂ bar placing drawings in accordance with ACI SP-66.

E. Field Welding Procedures: MMFX₂ steel bars shall not be welded.

**Specifier Notes:** MMFX₂ steel bars should not be welded as currently no specific provisions have been included to enhance its weldability.

F. Mechanical Couplers: Submit manufacturer’s product data for use with MMFX₂ steel bars.

### 1.6 DELIVERIES, STORAGE, AND HANDLING

A. General: Deliver, store, and handle MMFX₂ bars in accordance with manufacturer’s instructions.

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

B. Delivery and Storage:

1. Do not store MMFX₂ bars directly on ground to keep them free from dirt and mud and to provide easy handling. It is recommended that MMFX₂ bars shall be covered when exposed to the elements for longer than 60 days, either during transport or storage and as indicated in **CRSI – Specialty and Corrosion - Re-**
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

Handling of MMFX₂ 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

A. MMFX Steel Corporation of America, 2415 Campus Drive, Suite 100 – Irvine, CA 92612
   Phone (949) 476-7600, Fax (949) 474-1130
   E-mail info@mmfx.com Web Site [http://www.mmfx.com](http://www.mmfx.com)

B. MMFX Steel DMCC (Subsidiary of MMFX Technologies Corporation) - P.O. Box 390292 – Dubai, UAE
   Phone (+971) 5 7777394 Fax (+971) 4 395 1537

#### 2.2 MATERIAL

A. MMFX Microcomposite (MMFX₂) Steel Deformed and Plain Bars

1. General:

   MMFX₂ bars shall have a minimum chromium composition by weight of 8% 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:

   MMFX₂ 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] and #18 [57] 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:

   MMFX₂ bars shall meet the requirements of Table 1.

<table>
<thead>
<tr>
<th>Element</th>
<th>Carbon</th>
<th>Chromium</th>
<th>Manganese</th>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Sulfur</th>
<th>Silicon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Amount⁴</td>
<td>0.15%</td>
<td>8 to 10.9%</td>
<td>1.5 %</td>
<td>0.05%</td>
<td>0.035%</td>
<td>0.045%</td>
<td>0.50%</td>
</tr>
<tr>
<td>Typical MMFX₂</td>
<td>0.07%</td>
<td>9.3%</td>
<td>0.6%</td>
<td>0.02%</td>
<td>0.01%</td>
<td>0.014%</td>
<td>0.14%</td>
</tr>
</tbody>
</table>

Note A – Maximum unless range indicated,
Note B – AASHTO MP 18 M/MP 18-09 Minimum 9.2% minimum Cr content -

4. Bar Weight, Dimensions, and Deformation Spacing and Height:

   Deformed MMFX₂ bars shall conform to the weight, dimensions and deformation spacing, height, and gap requirements prescribed in ASTM A1035 Table 1 and/or AASHTO MP18 Tables 2 and 3.
5. Bar Deformations:

MMFX$_2$ bars shall conform to the requirements for bar deformations in ASTM A1035 Section 7 and/or AASHTO MP 18 Section 7 “Requirements for Deformation”.

6. Permissible Variation in Weight [Mass]:

MMFX$_2$ bars shall conform to the requirements for bar deformations in ASTM A1035 Section 11 and/or AASHTO MP 18 Section 12 “Permissible Variation in Weight [Mass]”.

7. Tensile Properties:

a. MMFX$_2$ 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. The strength corresponding to an extension under load of 0.0035 in./in. (0.0035 mm/mm) shall be minimum of 80,000 psi [550MPa] for Grade 100 [690]; and shall be a minimum of 90,000 psi [620MPa] for Grade 120 [830].

<table>
<thead>
<tr>
<th>Tensile strength, min, psi [MPa]</th>
<th>Grade 100 [690]</th>
<th>Grade 120 [830]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield strength (0.2% offset), min, psi [MPa]</td>
<td>100,000 [690]</td>
<td>120,000 [830]</td>
</tr>
<tr>
<td>Strength corresponding to an extension under load of 0.0035 in/in (0.0035 mm/mm), min, psi [MPa]</td>
<td>80,000** [550]</td>
<td>90,000** [620]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elongation in 8 in. [203.2mm], min. %:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar Designation No.</td>
</tr>
<tr>
<td>3 through 11 [10 through 36]</td>
</tr>
<tr>
<td>14, 18 [43, 57]</td>
</tr>
</tbody>
</table>

7. Bend Test Properties:

MMFX$_2$ 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>
<thead>
<tr>
<th>Bar Designation No.</th>
<th>Pin Diameter$^A$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3, 4, 5, [10,13, 16]</td>
<td>3½d$^B$</td>
</tr>
<tr>
<td>6, 7, 8[19,22, 25]</td>
<td>5d</td>
</tr>
<tr>
<td>9,10,11 [29, 32, 36]</td>
<td>7d</td>
</tr>
<tr>
<td>14, 18 [43, 57] (90°)</td>
<td>9d</td>
</tr>
</tbody>
</table>

Note A --- AASHTO MP 18 M/MP 18-09 does not include Grade 120 [830]

9. Bar Identification:

MMFX\(_2\) bars meet the requirements of ASTM A615 Grade 75, ASTM A1035 and AASHTO MP 18 specifications. MMFX\(_2\) bars, excepting plain round bars, which shall be tagged for grade, 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 Identifier- “MMFX” shall indicate a product produced for MMFX Steel meeting the chemical composition of Table 1.
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 and AASHTO MP 18 specification.
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 Grade 120 [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.

Products produced or sold in the UAE shall comply with Dubai Central Laboratory ‘Marking and Tag Requirements for the Control of Reinforcing Steel Bars for ASTM A1035”

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 MMFX\(_2\) steel bars or other approved carbon steel bar material and shall be approved for use with MMFX\(_2\) rebars.

2.3 MATERIAL QUALITY CONTROL

A. Quality Control Testing:

MMFX\(_2\) 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 MMFX\(_2\) bars. Notify the Engineer if areas are not acceptable. Do not begin placing MMFX\(_2\) bars until unacceptable conditions have been corrected.

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 MMFX\textsubscript{2} bars accurately in accordance with approved placing drawings, schedules, typical details, and notes.

\textbf{Specifier Notes:} Placing and fabrication of MMFX\textsubscript{2} bars is performed similarly to that for 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-66 and/or CRSI Manual of Standard Practice – Chapter 6, unless otherwise shown, with fabricated bends conforming to Table 5 per ACI 315 – Table 7.2.

2. Table 4 - Minimum Fabricated Bend Diameters

<table>
<thead>
<tr>
<th>Bar Size</th>
<th>Minimum Bend Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>3, 4, 5, 6, 7, 8</td>
<td>6d</td>
</tr>
<tr>
<td>[10,13, 16, 19, 22, 25]</td>
<td></td>
</tr>
<tr>
<td>9,10,11 [29, 32, 36]</td>
<td>8d</td>
</tr>
<tr>
<td>14, 18 [43, 57]</td>
<td>10d</td>
</tr>
</tbody>
</table>

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.

3. 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 PRB – 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 Welding as an aid to fabrication and/or installation shall not be permitted.

\textbf{Specifier Notes:} MMFX\textsubscript{2} steel bars should not be welded as currently no specific provisions have been included to enhance its weldability.

3.4 INSTALLATION

A. Placement:

Place MMFX\textsubscript{2} 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 ap-
B. Field Cutting and Bending:

When required, field cutting and bending of MMFX₂ 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 rebent in the field.

C. Securing:

Secure MMFX₂ bars in formwork to prevent displacement by concrete placement or workers.

D. Supports and Spacers:

Place and support MMFX₂ 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.

E. 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 318-11. Mechanical connections shall be made only at locations shown in the Contract Documents or as permitted by the Engineer.

1. When required or permitted, 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.

F. Fastening:

Fasten MMFX₂ bars with approved tie wire, or snap ties, in accordance with ACI 315.

G. Cleaning:

Remove form oil or other deleterious materials from MMFX₂ 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.

END OF SECTION