“HIGH STRENGTH & CORROSION RESISTANT STEEL FOR CONCRETE REINFORCEMENT”

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MMFX Technologies Corp.
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PRESENTATION OUTLINE

- Introduction of MMFX Steel
- MMFX Steel Superior Physical Properties
- MMFX Steel Corrosion Testing
- Applications and Use of MMFX Steel
- Construction Issues
- Comparative Cost Analysis

MMFX 2 STEEL BARS FOR CONCRETE REINFORCEMENT

THE LOWEST COST CONSTRUCTION SYSTEM

Intended for Concrete Reinforcement

Virginia Concrete Conference
Bridge Breakout Session

THE LOWEST COST CONSTRUCTION SYSTEM

Why Is MMFX Superior To Conventional Steel?

- Microcomposite Steels, Packet Lath Martensite
- High Strength
- Corrosion Resistant
- Excellent Ductility
- Fracture Toughness
- Cost Effective

MMFX Patented Microstructure

- CARBIDE FREE MICROSTRUCTURE to Eliminate Formation of Microstructural Galvanic Cells

Corrosion of Conventional Pearlitic Steels

Microgalvanic Cell Formation Between Iron-Carbide and Ferrite Phases

Corrosion Can Be Minimized By Avoiding Microgalvanic Cell Formation

History of MMFX

- MMFX initial core technology was the result of 25 years of research at UC Berkeley and Lawrence Berkeley National Laboratory.
- MMFX’s initial proprietary technology was developed at the University of California Berkeley under the guidance of world-renowned scientist and inventor Professor Gareth Thomas.

Photo Courtesy of the National Center for Electron Microscopy
Corrosion Model

Migration of chlorides, $H_2O$ and $O_2$ into the concrete, no corrosion and no damage to concrete

Initiation

Critical chloride threshold

Degree of Corrosion

Time

Propagation (corrosion)

VIRGINIA TRANSPORTATION RESEARCH COUNCIL - VTRC

Authors:
- Dr. Clemena (Virginia Transportation Research Council)
- Paul Virmani (Turner-Fairbanks Highway Research Center) FHWA

Testing Summary:
- MMFX Reinforcing Steel tested embedded in concrete.
- Critical Chloride Threshold levels found between 4.7 and 5.9 lb/cy.
- MMFX more corrosion resistant than 2101 LDX Stainless Steel

From the report:
- It would be imprudent not to use bars such as the MMFX in major urban areas that will be heavily salted during the winter.

Louisiana DOT Test Data

<table>
<thead>
<tr>
<th>Louisiana DOT laboratories: 1500 Hour Salt Fog Exposure as per ASTM B117</th>
<th>Black Steel (Avg. 4 samples)</th>
<th>MMFX 2 Steel (Avg. 9 samples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter Gain After Salt Fog</td>
<td>6.6%</td>
<td>2.3%</td>
</tr>
<tr>
<td>Diameter Loss After Salt Fog and Wire Brushing</td>
<td>1.8%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Weight Gain After Salt Fog</td>
<td>1.8%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Weight loss After Salt Fog and Wire Brushing</td>
<td>2.6%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Yield Strength Loss after Salt Fog</td>
<td>22.4%</td>
<td>3.2%</td>
</tr>
<tr>
<td>Tensile Strength Loss after Salt Fog</td>
<td><strong>22.8%</strong></td>
<td><strong>1.4%</strong></td>
</tr>
<tr>
<td>Elongation Points Loss after Salt Fog</td>
<td>7</td>
<td>1.6</td>
</tr>
</tbody>
</table>

MMFX 2 Characteristics

- Low Carbon (0.05 to 0.09)
- High Chromium (8 to 10)
- Microstructure designed to avoid formation of grain boundary carbides
- Lath martensite with retained austenite
- Superior Properties:
  - Mechanical $\sigma_{y(0.2\%) > 100 \text{ ksi}}, \sigma_T > 150 \text{ ksi}, \epsilon > 7\%$
  - Corrosion:
    - $C_{th} = (4 \text{ to } 8) \times A615$
    - Corrosion Rate = (1/3 to 2/3) $\times A615$

ADVANCED STEEL-REINFORCED CONCRETE DESIGN

ENGINEERED PROJECT EFFICIENCY

- 20 - 40% LESS STEEL
- QUICKER BUILD TIME
- UP TO 50% LABOR SAVINGS
- SUPERIOR CORROSION RESISTANCE

High-Strength Corrosion Resistance Steel

THE LOWEST COST CONSTRUCTION SYSTEM

- ASTM A1035
- ASTM A615 – Grade 75
- AASHTO M31 – Grade 75
- ACI 318-05
MMFX APPROVALS

MMFX meets ASTM A615 Gr-75 and ASTM A1035 criteria

MMFX can be designed in accordance with ACI 318-05.

MMFX Steel Project Applications

States / Agencies Requesting To or Currently Using MMFX Steel

- South Carolina
- Florida
- Georgia on QPL
- Idaho
- Illinois
- Indiana
- Iowa
- Kansas
- Kentucky
- Louisiana
- Maine
- Maryland
- Massachusetts
- Michigan
- Minnesota
- Missouri
- Montana
- Nebraska
- Nevada
- New Hampshire
- New Jersey
- New Mexico on QPL
- New York
- North Carolina
- Ohio
- Oklahoma
- Oregon
- Pennsylvania
- Puerto Rico
- Rhode Island
- South Dakota
- Tennessee
- Texas
- Utah
- Vermont
- Virginia
- Washington
- West Virginia
- Wisconsin
- Wyoming

Pensacola Beach Balcony Repair
Beachfront Projects Using MMFX Steel

Jensen Beach Causeway

MMFX 2 Rebar - Marine / Ocean Environment Projects
West Coast - Navy Modular Pier Project

East Coast - Aquarium Project
IN-PLACE COST COMPARISON
SOUTH CAROLINA PROJECT

<table>
<thead>
<tr>
<th>Material</th>
<th>Cost per Pound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Rebar</td>
<td>$1.00</td>
</tr>
<tr>
<td>MMFX</td>
<td>$1.25</td>
</tr>
<tr>
<td>SS Clad Shear</td>
<td>$1.75</td>
</tr>
<tr>
<td>SS Clad SMl</td>
<td>$2.00</td>
</tr>
<tr>
<td>Black + Anodes</td>
<td>$2.23</td>
</tr>
<tr>
<td>Solid Stainless</td>
<td>$3.00</td>
</tr>
</tbody>
</table>

MMFX PRODUCTION

Contract Out
- Nucor Steel
- Timken Company
- Cascade Steel
- Latrobe Steel
- Universal Stainless

Current Production of #3 thru #11 Reinforcing Steel
- Dowel Bars
- MMFX employees ensure QA, QC

BENEFITS OF SPECIFYING MMFX
- Longer lasting more durable structures
- Lower long term maintenance costs
- High Strength = Less Steel Required?
- Finally a cost effective Corrosion Resistant Steel
- No risk in implementation
- Reduction in overall installed initial cost

What you see is what you get!

THANK YOU!