

Virginia Concrete Conference
Bridge Breakout Session

THE LOWEST COST CONSTRUCTION SYSTEM

**"HIGH STRENGTH
&
CORROSION RESISTANT STEEL
FOR CONCRETE REINFORCEMENT"**

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PRESENTATION OUTLINE

MMFX 2 STEEL BARS FOR CONCRETE REINFORCEMENT
HIGHER STRENGTH + CORROSION RESISTANT

THE LOWEST COST CONSTRUCTION SYSTEM

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

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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.

The first high-voltage transmission Electron Microscope

Photo Courtesy of the National Center for Electron Microscopy

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Corrosion of Conventional Pearlitic Steels

Schematic of Micro Galvanic Cells in the Ferrite-Iron Carbide Microstructure

Transmission Electron Microscope (TEM) Micrograph of the Ferrite-Iron Carbide Microstructure

Microgalvanic Cell Formation Between Iron-Carbide and Ferrite Phases

Corrosion Can Be Minimized By Avoiding Microgalvanic Cell Formation

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Why Is MMFX Superior To Conventional Steel?

Schematic of a single grain

Microcomposite Steels, Packet Lath Martensite

Dislocated laths of martensite enveloped by stable retained austenite films

CARBIDE FREE MICROSTRUCTURE
to Eliminate Formation of Microstructural Galvanic Cells

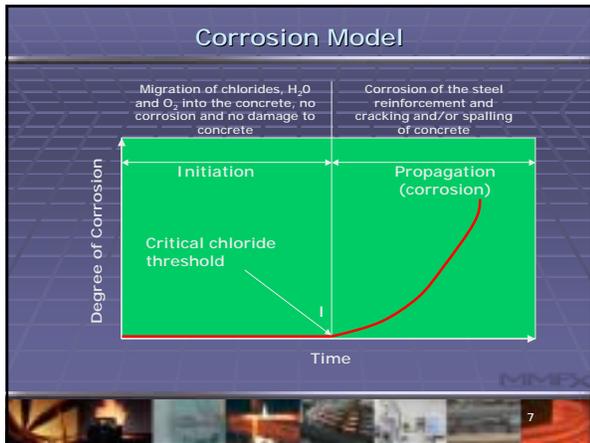
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MMFX Patented Microstructure

Our Patented Microstructure

High Strength
Corrosion Resistant
Excellent Ductility
Fracture Toughness
Cost Effective

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VIRGINIA TRANSPORTATION RESEARCH COUNCIL - VTRC

Authored by:
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 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-2 in major urban areas that will be heavily salted during the winter..."

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Louisiana DOT Test Data

Louisiana DOT laboratories: 1500 Hour Salt Fog Exposure as per ASTM B117	Black Steel A615 (Avg. 4 samples)	MMFX 2 Steel (Avg. 9 samples)
Diameter Gain After Salt Fog	6.6%	2.3%
Diameter Loss After Salt Fog and Wire Brushing	1.8%	0.1%
Weight Gain after Salt Fog	1.8%	0.3%
Weight loss after Salt Fog and Wire Brushing	2.5%	0.5%
Yield Strength Loss after Salt Fog	22.6%	3.2%
Tensile Strength Loss after Salt Fog	22.8%	1.4%
Elongation Points Loss after Salt Fog	7	1.6

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- ### 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 [$\sigma_{y(0.2\%)} > 100$ ksi, $\sigma_t > 150$ ksi, $\epsilon > 7\%$]
 - Corrosion:
 - $Cl_{th} = (4 \text{ to } 8) \times A615$
 - Corrosion Rate = (1/3 to 2/3) $\times A615$
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ADVANCED STEEL-REINFORCED CONCRETE DESIGN

ENGINEERED PROJECT EFFICIENCY

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




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- ## High-Strength Corrosion Resistance Steel
- ### THE LOWEST COST CONSTRUCTION SYSTEM
- ASTM A1035
 - ASTM A615 – Grade 75
 - AASHTO M31 – Grade 75
 - ACI 318-05
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ASTM A1035



1. Scope

1.1 This specification covers low-carbon, chromium steel bars, deformed and plain, for concrete reinforcement in cast lengths and coils. The standard sizes and dimensions of deformed bars and their number designations are given in Table 1. The rest of this specification references notes and footnotes which provide explanatory material. These notes and footnotes (including those to tables and figures) shall not be considered as requirements of the specification.

1.2 Bars are of a single minimum yield strength level as defined in 9.2, namely, 100 000 psi (680 MPa).

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ASTM A1035 Cont.

TABLE 2 Tensile Properties Requirements

Tensile strength, min, psi (MPa)	100 000 (680)
Yield strength (0.2 % offset), min, psi (MPa)	100 000 (680)
Stress corresponding to an extension under load of 0.0035 in/in, (0.0035 elongation), min, psi (MPa)	80 000 (550)
Elongation in 8 in. (203.2 mm), min, %	
Bar Designation No.	
3 through 11 (10 through 30)	7
16, 18 (43, 57)	8

9.2 The chemical composition as checked by time analysis shall be limited by the following:

Carbon	0.25%
Phosphorus	0.035%
Sulfur	0.035%
Manganese	0.30%
Chromium	0.03%
Copper	0.03%
Aluminum	0.01%

^a Maximum values apply to individual elements other than weight percentages.

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ASTM 1035 Cont.

9.2 The yield strength shall be determined by the offset method (0.2 % offset), described in Test Methods and Definitions A 370. In addition, the stress corresponding to a tensile strain of 0.0035 shall be a minimum of 80 000 psi [550 MPa].

TABLE 3 Bend Test Requirements

Bar Designation No.	Do Diameter by Bend Test ^a
3, 4, 5, 16, 18, 30	3 in (Ø)
6, 7, 8, 19, 22, 26	5 in
9, 10, 11, 27, 32, 36	7 in
16, 18 (43, 57) (Ø) ^b	30

^a Bend around 180° unless otherwise noted.

^b d = nominal diameter of specimen.

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MMFX APPROVALS

- MMFX meets ASTM A615 Gr-75 and ASTM A1035 criteria
- MMFX can be designed in accordance with ACI 318-05.

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MMFX Steel Project Applications



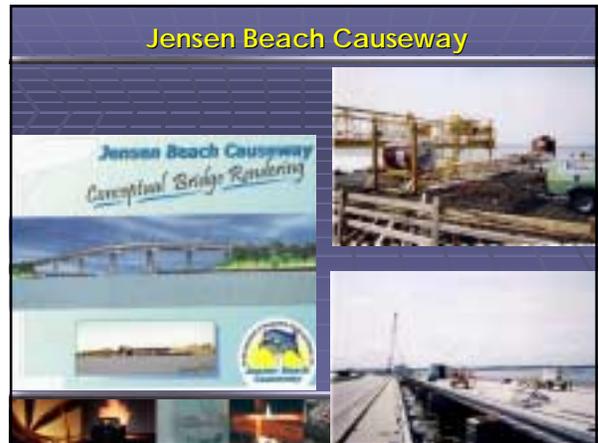
States / Agencies Requesting To or Currently Using MMFX Steel

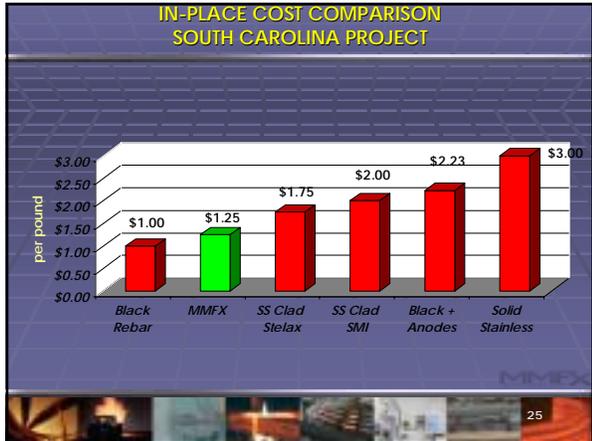
South Carolina	Michigan	California
PA Turnpike	Manitoba	Delaware
Idaho	Texas	Pennsylvania
New Hampshire	Vermont	Iowa
New Jersey	Florida	Kentucky
Connecticut	Oklahoma	Virginia
US Navy	North Carolina	Puerto Rico
USACE	Georgia on QPL	New Mexico on QPL

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Pensacola Beach Balcony Repair







- ### 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 \$\$\$\$
 - With MMFX there is no worry of damaging coatings during handling, fabrication or placement ---
- What you see is what you get !**

THANK YOU

MMFX STEEL
THE LOWEST COST
CONSTRUCTION SYSTEM