This is your future.

Summary of Independent Testing

MMFX Steel Corporation of America and its products are receiving validation and recognition on many fronts, while gaining standards acceptance both nationally and internationally. Third parties, such as the Federal Highway Administration (FHWA), State Departments of Transportation (DOTs), and universities throughout the United States, have conducted independent testing to evaluate MMFX Microcomposite steel against conventional steel to determine its corrosion resistance and strength, among other properties.

Full reports, as published by individual agencies and universities are available upon request, in addition to this summary of findings.

1. **Virginia Transportation Research Council (VTRC), December 2003**
2. **Iowa State University, October 2003**
3. **Louisiana Department of Transportation Study, Interim Report**
4. **South Dakota Department of Transportation Study, March 2003**
5. **Florida Department of Transportation, June 2002**
6. **New Jersey Department of Transportation Study, Interim Report**
7. **Texas Engineering Experimental Station Study, July 2003**
8. **University of South Carolina Research Study, May 2002**
9. **Concrete Innovations Appraisal Service (CIAS) Appraisal Report, May 2003**

Virginia Transportation Research Council (VTRC), December 2003

"Report on the Investigation of the Resistance of Several New Metallic Reinforcing Bars to Chloride-Induced Corrosion in Concrete," published in December 2003, by Dr. Gerardo G. Clemeña

Virginia Transportation Research Council (VTRC) VTRC 04-R7

– In cooperation with the U.S. Department of Transportation Federal Highway Administration

The corrosion resistance of new alloyed steel, including MMFX 2 steel bars, have been investigated by the VTRC in heavily salted concrete blocks when compared with carbon steel bars. The investigation is intended to provide some information that would be very beneficial to the various transportation agencies on the selection of economical metallic reinforcing bars that can withstand high concentration of chloride ions in concrete bridge decks exposed to deicing chemicals.

Based on the results presented at the American Association of State Highway and Transportation Officials (AASHTO) Bridge Corrosion Committee (T-9) Meeting by Dr. Gerardo G. Clemeña, the following table estimates the chloride threshold values for the MMFX 2 steel with 9% chromium content compared with black carbon steel and the 2101 LDX stainless steel with nominal chromium and nickel content of 21% and 1.5%, respectively.

MMFX 2 Chloride Threshold is 5 to 6 times better than A615 Steel and 1.75 times better than 2101 Stainless Steel

	ASTM A615 Steel	Stainless Steel 2101 LDX	MMFX 2 Steel
Time-To-Corrosion (Macro-Cell Current)	92 Days	146 Days	244 Days
Chloride Threshold	460 – 580 ppm	2.7 – 3.4 times A615	4.7 – 5.9 times A615

For more information on Virginia Transportation Research Council contact:

Dr. Gerardo G. Clemeña - Virginia Transportation Research Council, Charlottesville, VA 22903

Summary of Independent Testing

Iowa State University, October 2003

"Evaluation of Corrosion-Resistant Steel Reinforcement," submitted October 20, 2003

Iowa State University – Milan J. Jolley

After 12 weeks, ASTM G109 ACT test samples produced severe corrosion risk potentials for uncoated mild steel reinforcement. The corrosion potential for drilled and chipped holiday conditions of epoxy-coated reinforcement experienced nearly twice as much as those of the MMFX steel bar specimens.

In the Rapid Macrocell ACT testing, the drilled holiday condition of the epoxy-coated and uncoated specimens had the greatest corrosion risk potential, while the as-delivered condition of the epoxy-coated had less corrosion potential. The MMFX specimens had the least corrosion risk potential.

Louisiana Department of Transportation Study - Interim Report

The Louisiana DOT (LA DOT) has recently completed a comparative corrosion study between MMFX 2 steel bars and A615 steel bars (LA DOT, 2003). A 1,500-hour salt fog test as per ASTM B-117 was run. A measurement of weight, diameter, average deformation height, and average deformation spacing was taken before immersion, after removal, and after wire brushing on all the reinforcing steel samples. In addition, tests for yield-strength, tensile-strength, elongation, and cold bend were run before and after the salt fog. Table 1 shows the average results of nine MMFX samples and the average results of four A615 samples.

MMFX 2 Steel Bars far exceeded the A615 steel bars in all aspects of the corrosion resistant testing done at Louisiana DOT Laboratories.

Table 1 - Summary of average results obtained by Louisiana DOT laboratories

After 1,500-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%	3 times
Diameter Loss After Salt Fog and Wire Brushing	1.8%	0.1%	18 times
Weight Gain after Salt Fog	1.8%	0.3%	6 times
Weight loss after Salt Fog and Wire Brushing	2.5%	0.5%	5 times
Yield Strength Loss after Salt Fog	22.6%	3.2%	7 times
Tensile Strength Loss after Salt Fog	22.8%	1.4%	16 times
Elongation Points Loss after Salt Fog	7	1.6	4 times

** Because of malfunctioning in apparatus, test was stopped for a few months after 800 hours of salt fog exposure; samples were kept untouched in a salt fog cabinet. The test was then resumed for an additional 700 hours of salt fog exposure.

South Dakota Department of Transportation, March 2003

"Report on the Mechanical and Corrosion Properties of a High-Strength, High-Chromium Reinforcing Steel for Concrete," published in March 2002, by David Darwin, JoAnn Browning, Trung Van Nguyen, Carl Locke, Jr. for the South Dakota Department of Transportation - Department of Research Study - SD2001-05

…The **corrosion of MMFX steel is delayed**, requiring a higher chloride content for initiation, and proceeds at **a lower rate than it does for conventional steel**…

…laboratory results, supported by prior research, indicate that conventional reinforcement or exposed epoxy-coated reinforcement will begin corroding at a chloride concentration of approximately 1 lb/yd^3, whereas the MMFX Microcomposite steel will begin corroding at a value of approximately 3.5 lb/yd^3…

…the corrosion threshold chloride content for MMFX Microcomposite steel **is approximately four times higher than the corrosion threshold of conventional reinforcement.** The corrosion rate for MMFX Microcomposite steel is between one-third and two-thirds of conventional reinforcing steel…

Florida Department of Transportation, June 2002

"An Investigation into the Structural Performance of MMFX Reinforcing," published in June 2002, by Marc Ansley, Florida Department of Transportation

A series of four sets of beams were tested to determine the structural performance of MMFX reinforcing steel compared to standard Grade 60 reinforcing (ASTM A615).

In general, the MMFX steel performed well, providing capacity that exceeded the standard reinforcing in all cases.

New Jersey DOT Study - Interim Report

"MMFX Reinforcing Bars Corrosion Susceptibility Comparison - Interim Results at 2000 Hours Exposure." Conducted at the New Jersey Department of Transportation Laboratories

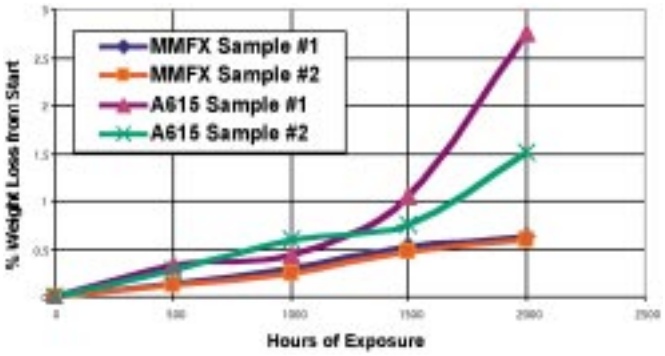
Parameters:

- 5% NaCl Solution
- 1 hr. salt fog at ambient temperature (20 - 30 degree C)
- 1 hr. dry cycle at 35 degree C
- Repeat Cycle

The following figure summarizes the percentage weight loss comparison between MMFX steel and A615 carbon steel subjected to cycles of salt fog and dry cycles for 2000 hours exposure.

(Weight loss in A615 samples is about three to five times than that of MMFX Steel in the 2000-hour exposure.)

Percent Weight Loss vs. Hours of Exposure



A615 samples show heavy rust with deep pitting, severe corrosion of deformations, flaking, and scaling rust. MMFX samples show surface rust with pitting.

Texas Engineering Experiment Station, July 2003

"Evaluation of the Critical Chloride Threshold and Corrosion Rate for Different Steel Reinforcement Types" – July 2002

Texas A & M University
Department of Civil Engineering
D. Trejo, Ph.D., P.E.

Accelerated chloride threshold (ACT) test data shown in Table 1, provides a relative comparative critical chloride threshold value for MMFX 2 when compared to other reinforcing materials. The high corrosion resistance provides increased service life to the steel before its structural carrying capacity has dissipated, leading to reduced serviceability of reinforced concrete structures, damage to structural load carrying capacity, or loss of esthetic appeal. Table 1 demonstrated that MMFX 2 has between eight to nine times the corrosion resistance of conventional carbon steel (A615) as a measure of its critical chloride threshold level (CCTL) when tested using the accelerated chloride threshold (ACT) test procedure.

Table 1 – Comparative Corrosion Resistance

Rebar Material(A)	Critical Chloride Threshold Level (CCTL) Lbs of Chloride Ions per Cubic Yards of Concrete(B)	**% Comparative Corrosion Resistance to A615 Steel**
MMFX 2	7.7	**850%**
A615	0.9	**100%**

(A) MMFX 2 and A615 samples with Mill Scale

(B) Average CCTL as determined using patent pending ACT at Texas Engineering Experiment Station (TEES).

MMFX 2 Steel Rebar – Corrosion resistance has been measured using ACT test data from the TEES at Texas A&M University.

Summary of Independent Testing

University of South Carolina Research Study, May 2002

"A Corrosion Evaluation of MMFX Reinforcing Steel Study," published in May 2002, by B. N. Popov, B. Haran, and H. Colon, University of South Carolina, Department of Chemical Engineering

The corrosion evaluation of MMFX reinforcing steel was completed at the University of South Carolina (Popov et. al. 2002). The focus of the study was to compare the corrosion behavior of MMFX steel and different types of carbon steel in simulation concrete model solution. Table 1 summarizes some of the corrosion rates of the MMFX and A615 samples tested after being immersed for 180 days in different environments.

*In pH 12.5 with chloride, the corrosion rates for the MMFX samples are lower than A615 carbon steel. Corrosion rates indicate that MMFX Steel forms a stable passive film, which keeps the corrosion rate low.

**In both solutions of pH 9.5 and pH 12.5 with chloride and Grace Inhibitor (calcium nitrate), the corrosion rate remains low indicating that the surface passive film on the MMFX Steel is highly stable.

Table 1 – Corrosion rates of the MMFX Steel vs. A615 Carbon Steel in different environments after being immersed for 180 days

Environmental Conditions	Corrosion Rate, mpy MMFX 2	Corrosion Rate, mpy A615	Corrosion Rate A615 vs MMFX 2
pH 12.5 with chloride*	0.48	3.87	8 times
pH 12.5 without chloride	0.077	0.375	5 times
pH 12.5 with chloride and Grace Inhibitor**	0.212	1.49	7 times
pH 9.5 with Chloride	4.68	7.35	2 times
pH 9.5 without Chloride	0.107	0.297	3 times
pH 9.5 with chloride and Grace Inhibitor**	0.263	4.05	15 times
pH 12.5 with chloride, wet and dry cycles	0.296	1.80	6 times
pH 12.5 without chloride, wet and dry cycles	0.07	0.42	6 times

MMFX Steel shows significant improvement in corrosion performance in comparison to A615 carbon steel in solution immersion tests.

Concrete Innovations Appraisal Service (CIAS) Appraisal Report, May 2003

"High Corrosion Resistance MMFX Microcomposite Reinforcing Steels," published in May 2003

Concrete Innovations Appraisal Service for the Strategic Development Council
Report # 03-2 Professor Paul Zia, PE

During 2002, MMFX Technologies submitted a series of corrosion claims to the American Concrete Institute (ACI) ConREF (Concrete Research and Education Foundation) Concrete Innovations Appraisal Service (CIAS) for validation of MMFX 2's corrosion-resistance properties. The CIAS Corrosion Appraisal Report has tested and documented the basis of those claims, including experimental data and analysis.

Claim 1

MMFX Microcomposite (MMFX 2) steel reinforcement exhibits improved corrosion performance when compared with conventional (ASTM A615) steel reinforcement. Structures constructed with MMFX 2 steel reinforcement will exhibit longer times between repairs than structures constructed with conventional steel reinforcement that meets ASTM A615 requirements when exposed to chloride environments.

Claim 2

MMFX Microcomposite steel's chrome and low carbon content provides improved corrosion resistance over conventional carbon steels and approaches that of some stainless steels, when measured under various environmental situations.

Claim 3

MMFX Microcomposite steel reinforcement is an economical corrosion-resistant alternative to conventional ASTM A615 steel reinforcement.

Claim 4

Uncoated MMFX Microcomposite steel reinforcement does not have the variability in corrosion performance when compared with epoxy-coated ASTM A615.

CIAS Conclusion

"There is sufficient data provided in the basis information to support the claims that MMFX steel reinforcement exhibits improved corrosion performance when compared with conventional ASTM A615 steel-reinforcing bars, and that the improved corrosion resistance of MMFX Microcomposite steel is due to its high-chromium and low-carbon content."