MMFX$_2$ (ASTM A1035) CONCRETE REINFORCING STEELS

OVER 100-YEAR SERVICE LIFE

MMFX$_2$ uncoated corrosion-resistant, high-strength concrete reinforcing bars extend the operational service life of structures **beyond 100 years**. Extending the operational service life – the time from construction to first repair – significantly lowers life-cycle costs, especially important for bridges, marine piles and severe soil applications.

Independent studies show that only MMFX$_2$ and stainless steel rebar meet the 100-year operational service life standard.

COMPARATIVE TABLE OF SERVICE LIFE IN YEARS FOR VARIOUS REINFORCEMENT & ENVIRONMENTS*

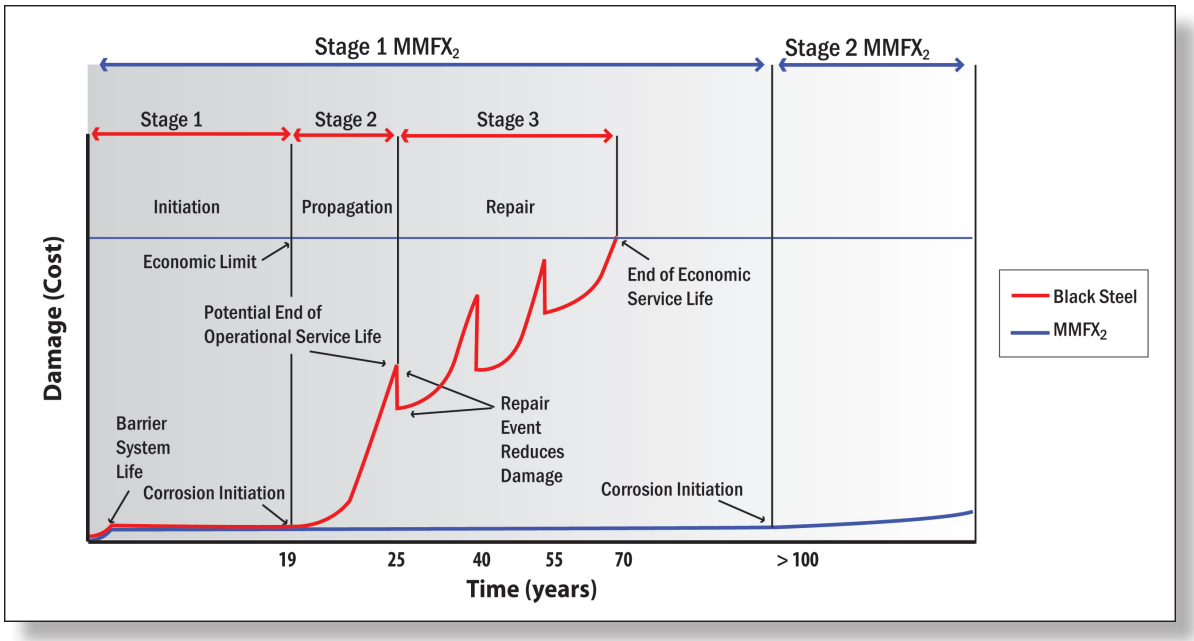
Exposure	Bridge	Marine Piles	Severe Soils
Concrete Type	Bridge LP	Pile Mix LP	Pile Mix LP
Minimum Cover	1.5 in (37.5 mm)	2.0 in (50.0 mm)	1.5 in (37.5 mm)
Reinforcement Type:			
Black Bar (BB)	25	26	18
Epoxy Coated (ECR)	34	35	18
Galvanized (GS)	76	64	57
MMFX$_2$ ASTM A1035	>100	>100	>100
UNS S32304 (Stainless Steel)	>100	>100	>100

** Reinforcing Steel Comparative Durability Assessment and 100 Year Service Life Cost Analysis Report, Tourney Consulting Group, LLC, May 2012.*

The life of a structure goes through three stages:

- Stage 1 (corrosion initiation) – time for chlorides to penetrate into the concrete to the level of the steel and reach the corrosion threshold level of the steel.
- Stage 2 (propagation) – time from initiation of corrosion to initiation of concrete spalls.
- Stage 3 (repair) – period after spalling when repairs temporarily extend life of structure.

MMFX$_2$ rebar extends the operational service life by delaying the concrete spalling and need for first repair beyond 100 years by delaying corrosion initiation with a higher chloride threshold and slowing propagation due to a lower corrosion rate.



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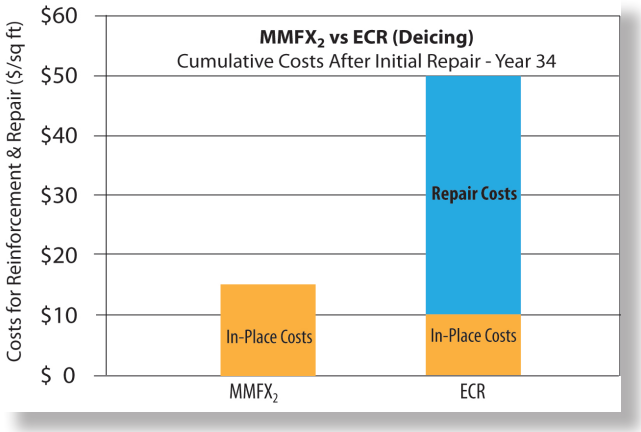
On average rebar accounts for approximately 1% - 4% of the total cost of construction. Therefore, for a structure that can cost millons of dollars, a construction material that represents only 1% - 4% of the costs ultimately determines the operational service life expectancy of the structure. In addition, repair costs easily overshadow minor differences in initial construction costs, so using $MMFX_2$ rebar can greatly reduce the overall costs of a structure.

LIFE-CYCLE COST ANALYSIS (LCCA) BASED ON 100-YEAR SERVICE LIFE (NPV $/FT^2)*

Exposure	Bridge	Marine Piles	Severe Soils
Concrete Type	Bridge LP	Pile Mix LP	Pile Mix LP
Minimum Cover	1.5 in (37.5 mm)	2.0 in (50.0 mm)	1.5 in (37.5 mm)
Reinforcement Type: ***Current estimated costs include direct in-place costs + repair costs, if applicable****			
Black Bar (BB)	$20.14	26 yr. Replacement***	18 yr. Replacement***
Epoxy Coated (ECR)	$17.79	35 yr. Replacement***	18 yr. Replacement***
Galvanized (GS)	$14.86	64 yr. Replacement***	57 yr. Replacement***
$MMFX_2$ – Gr. 60	$14.40	> 100 yr. Replacement***	> 100 yr. Replacement***
$MMFX_2$ – Gr. 75	$11.28		
$MMFX_2$ – Gr. 100	$8.64		
UNS S32304 (Stainless Steel)	$30.36	> 100 yr. Replacement***	> 100 yr. Replacement***

** Reinforcing Steel Comparative Durability Assessment and 100 Year Service Life Cost Analysis Report, Tourney Consulting Group, LLC, May 2012.*
*** Costs exclude indirect and road user costs during construction and repair.*
**** Repairs in these applications are not possible. Total replacement is required at the respective service lives.*

$MMFX_2$ clearly provides the lowest life-cycle costs for a 100-year operational service life, but you do not have to wait 100 years to reap the cost savings. Even at the standard 60 ksi (420 MPa) strength, the cost savings of $MMFX_2$ is realized at first repair. The graph below shows the relative costs of $MMFX_2$ compared to ECR after first repair necessary in year 34 for ECR reinforced structures.



Additional Upfront Savings Using High-Strength

By utilizing $MMFX_2$ rebar's higher strength of 100 ksi (690 MPa), bridges, piles and buildings can be designed with 20% – 50% less steel, reducing up front material, labor and other associated construction costs. See examples of service life costs for $MMFX_2$ Grades 75 (520) and 100 (690) in the LCCA table above.

For details on the analyses summarized above, please refer to Reinforcing Steel Comparative Durability Assessment and 100 Year Service Life Cost Analysis Report, Tourney Consulting Group, LLC, May 2012 – Available upon request.

$MMFX_2$ Steel. Today's Steel Standard.