



Tyfo[®] Ti Near Surface Mounted (NSM) Titanium Bars

FyfeCo.com | FyfeInfo@cs-nri.com | +1.855.708.3617

Structural reinforcement for long-lasting structures

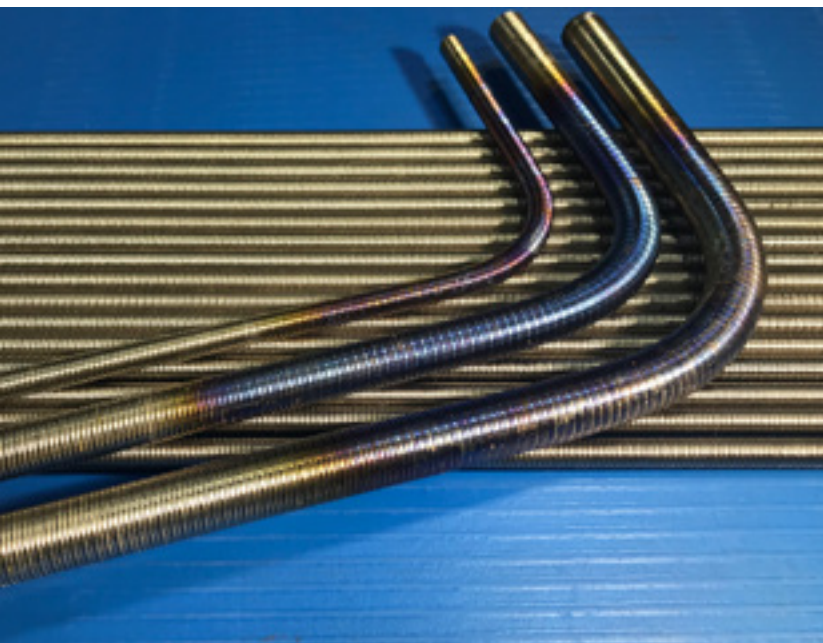
The Tyfo Ti NSM bars are an aerospace grade alloy consisting of Titanium, 6% Aluminum and 4% Vanadium (commonly referred to as Ti-6Al-4V) used to strengthen reinforced concrete structures (e.g. slabs, beams, walls, columns and diaphragms). These bars provide ductility, are high strength, light-weight tension members that do not corrode and do not fatigue. The Tyfo Ti NSM bars are typically bonded in grooves cut into the concrete cover of an existing structural element using a technique called Near Surface Mounting or NSM strengthening. The bars can be bent at the ends to provide anchorage and are designed to increase the structural performance as required by the engineer of record.

Tyfo Ti NSM Bars:

- Provides a ductile strengthening alternative where externally bonded FRP is not suitable
- Improve flexural and shear capacity of existing concrete beam, columns, slab and wall elements
- Does not corrode and extends the life of the structure
- Can be bent at the ends to provide anchorage.

Uses and Benefits

- Repairs structurally deficient members.
- High yield strength with 10% ultimate elongation.
- Corrosion resistant.
- High strength-to-weight ratio (approximately 43% lighter than steel).



Applications

- Increase/maintain ductility of strengthened structural members
- Provide additional tensile reinforcement to existing concrete or masonry elements
- Increase flexural capacity of existing concrete beams, columns, slabs and walls
- Develop insufficient steel reinforcing bar splices
- Replace corroded steel reinforcement
- Increase shear strength of existing concrete beams and slabs

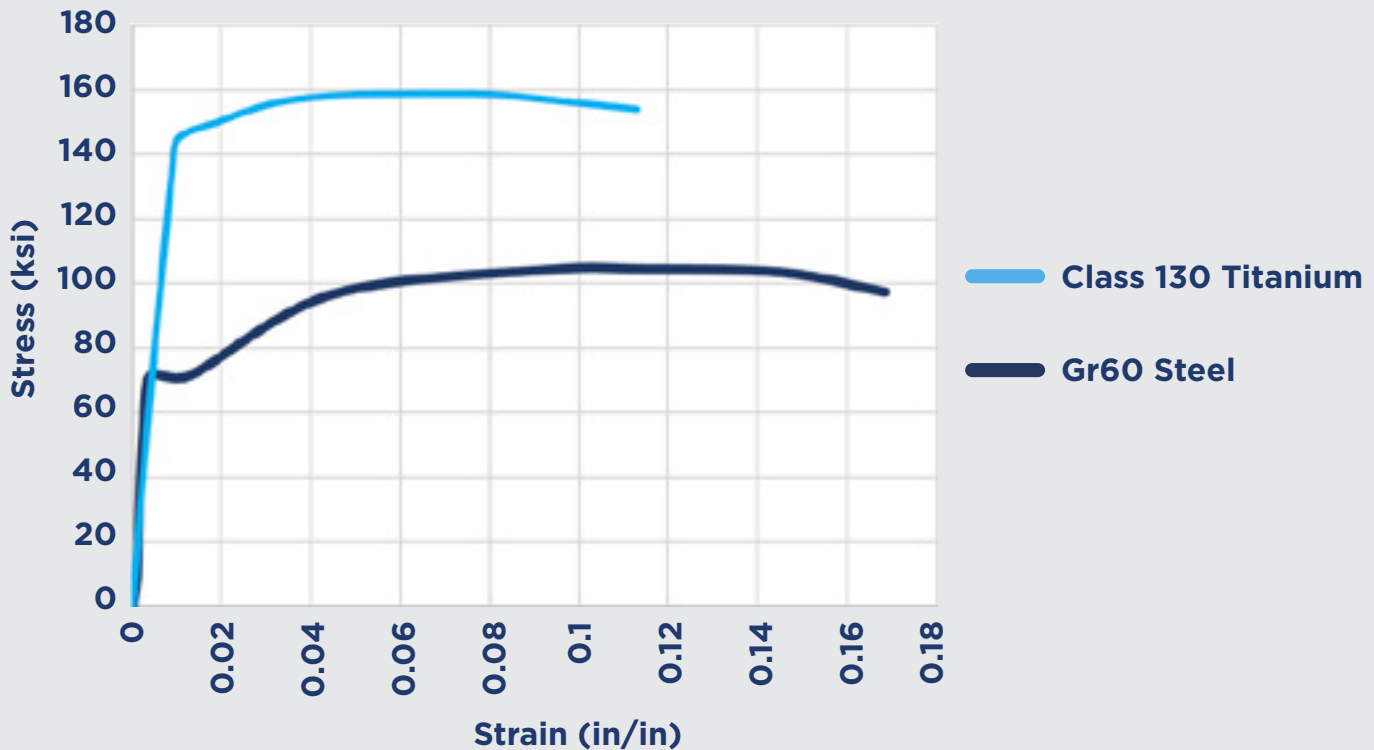
Mechanical and Physical properties:

Material Properties		
Property	ASTM Method	Minimum Test Value*
Ultimate Tensile Strength	E8/E8M	140 ksi (965 MPa)
Tensile Modulus	E8/E8M	15.2 x 10 ³ ksi (105 GPa)
Elongation ¹	E8/E8M	10%
Density		0.160 lbs./in ³ . (4.43 g/cm ³)
Yield Strength	E8/E8M	130 ksi (895 MPa)

¹The minimum mechanical properties are reported based on Class 130 Titanium alloy as specified in ATM B1009-20.



Steel vs Titanium - Stress vs Strain

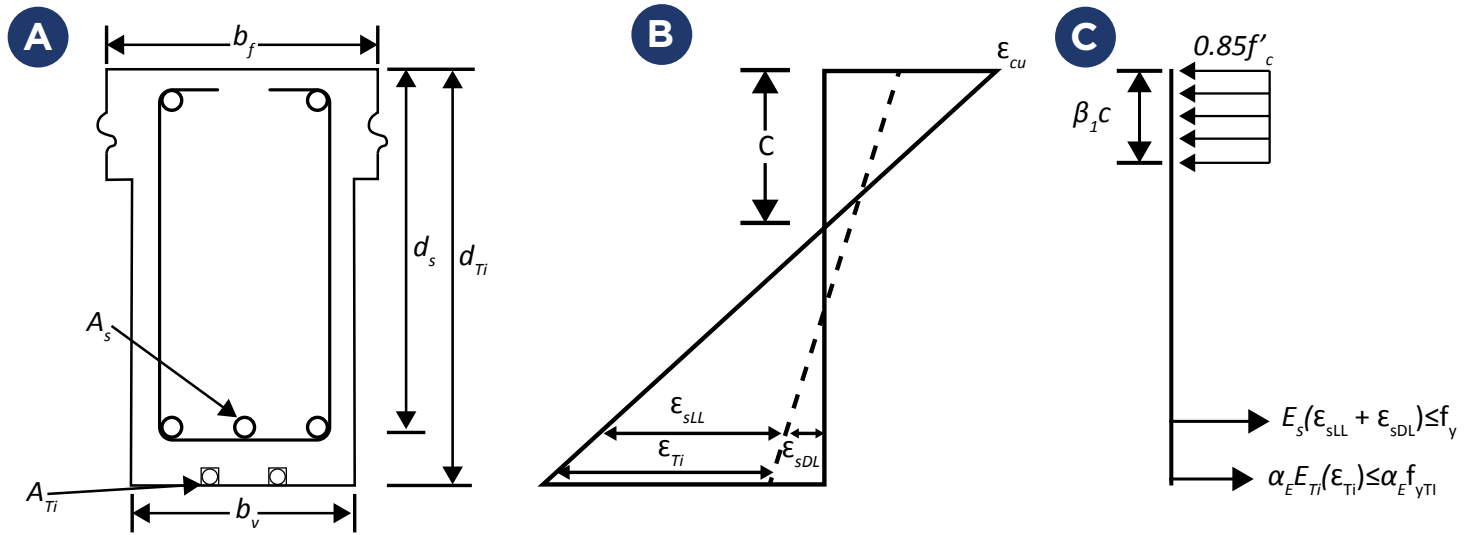


Design Considerations

The design should follow the recommendations from the appropriate guideline along with relevant structural testing results. The titanium alloy shall comply with the ASTM B1009 standard specification. The latest design guide and standard specification are listed below. To aid the designer who might not be familiar with these guidelines and standards, we maintain a staff of registered professional engineers to assist the engineer of record in safely implementing our products.

- **AASHTO “Guide for Design and Construction of Near-Surface Mounted Titanium Alloy Bars”** Provides authoritative, consensus guidelines that include provisions for flexural and shear strengthening using Titanium Near Surface Mount Strengthening.
- **ASTM B1009 “Standard Specification for Titanium Alloy Bars for Near Surface Mounts in Civil Structures”** Provides authoritative specifications that all manufacturer’s products must adhere to when supplying/implementing titanium for near surface mount applications in civil structures.

The flexural contribution from adding Ti NSM bars to a concrete section shall follow the same section analysis as executed for mild reinforcing steel.



- A. Simplified section with Tyfo Ti NSM bars
- B. Strain Distribution
- C. Simplified Stress Distribution

Table: Standard Tyfo Ti bar sizes and corresponding diameters, areas and required groove dimensions.

Tyfo Ti NSM Bar Detailing							
Nominal Diameter ¹			Nominal Area ²		Groove Height/ Width		Nominal Weight
Size	in	mm	in ²	(mm ²)	in	(mm)	lb/ft (kg/m)
2	1/4	6	0.048	30.97	0.375	(9.53)	0.094 (0.140)
3	3/8	10	0.1028	66.32	0.5625	(14.3)	0.212 (0.315)
4	1/2	13	0.1899	122.5	0.750	(19.1)	0.377 (0.561)
5	5/8	16	0.288	185.8	0.9375	(23.8)	0.589 (0.877)
6	3/4	19	0.423	272.9	1.125	(28.6)	0.848 (1.262)

¹Nominal diameter of a deformed bar is equivalent to a plain round bar having the same weight (mass) per foot (meter) as the deformed bar.

²The minimum area of the deformed bars as per material testing is computed by taking the average cross-sectional area of five NSM bars and subtracting three standard deviations ($A_{Ti} = \bar{A}_{Ti} - 3\sigma$) for a production run. Divide each bar's total weight by Titanium's unit weight (276 lb/ft³ [4421 kg/m³]) and the total bar length (3 ft min.) to calculate each bar's nominal area.

Installation Procedure



Step 1 Cut bar groove to a depth and width as specified in the bar detailing table for the project specific bar size.



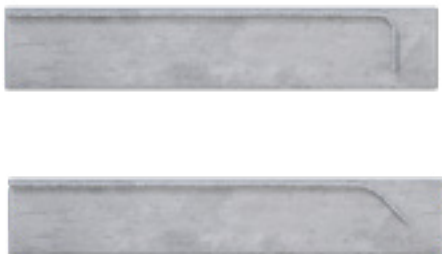
Step 2 Use a chisel to remove cut concrete and remove any remaining sharp points or rough edges.



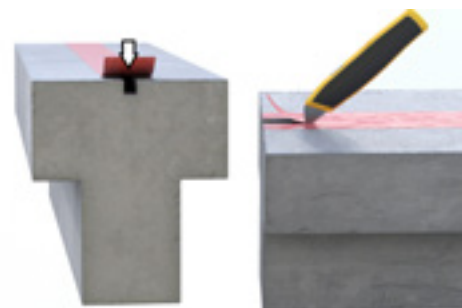
Step 3 Drill anchor hook holes at each end of the groove at their appropriate locations (when required).



Step 4 Clean the groove and drilled holes to eliminate any residual dust with compressed air or vacuum. Note: It is not necessary to roughen the concrete surface with additional abrasion or brushing.



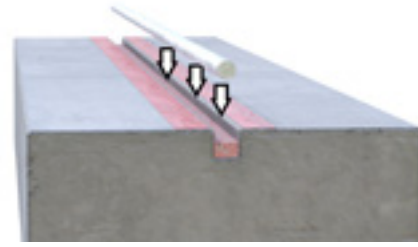
Step 5 Bend bar (when required) to appropriate angle as per the Tyfo Ti NSM Bar Bending Work Instructions.



Step 6 Mask the groove perimeter to ensure the surface remains clean when applying adhesive.



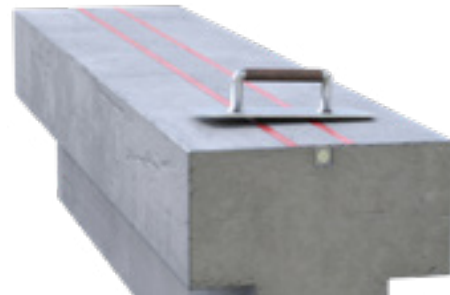
Step 7 Fill the groove approximately half-to-three-quarters full with Tyfo NSM Gel or Tyfo EZ Paste. Note that the Tyfo NSM Gel is for top surface or vertical applications, while the Tyfo EZ Paste is for overhead applications.



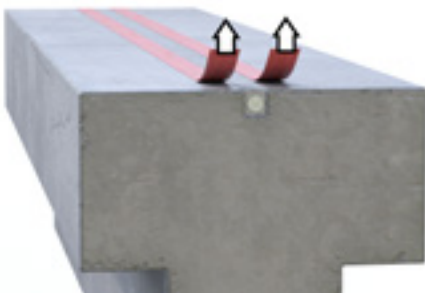
Step 8 Press the Tyfo Ti NSM Bar into the groove. The objective is to ensure adhesive is well consolidated around the bar without air pockets. This can be achieved by moving the bar back and forth in a “saw-cutting” motion.



Step 9 Completely fill the groove with adhesive ensuring the bar is fully covered.



Step 10 Level off the excess adhesive with a trowel or putty knife.



Step 11 Remove masking.



Completed installation



FyfeCo.com



V: 09.12.24