

SECTION 00567 - TITANIUM ALLOY REINFORCEMENT SYSTEM

(Follow all instructions and make all edits with “Track Changes” turned on. This Section is not published in the Oregon Standard. If there are no instructions [purple text] above a subsection, paragraph, sentence, or bullet, then include it in the project, unless the item(s) that are included in the subsection, paragraph, sentence, or bullet are not required on the Project and then they should be deleted. In general do not re-number or re-letter subsections when item(s) are deleted. Delete all purple text before preparing the final document. All other modifications to this Section will require ODOT Technical Resource and State Specifications Engineer approval.)

Section 00567 is not a Standard Specification and is included in this Project by Special Provision.

Description

00567.00 Scope - This Work consists of furnishing and installing a complete, near surface mounted, titanium alloy reinforcement system as shown or specified. The system is comprised of titanium alloy reinforcement (“bars”) embedded in sawcut grooves and anchor holes with epoxy.

00567.01 Submittals - Submit the following to the Agency at least 21 Calendar Days before starting Work. Do not begin Work before receiving written approval of submittals from the Engineer.

(a) Materials Certifications - Submit the manufacturer’s Material certifications and mill test certificates for the titanium alloy reinforcement system according to 00150.37. Include the supplier’s name, ranges of the properties listed below, and test methods used for titanium alloy reinforcement and epoxy resin.

Material	Properties to be Furnished
Titanium Alloy	Tensile Strength Elongation Tensile Modulus Cross-Sectional Area Chemical Composition
Epoxy Resin	Tensile Strength Elongation Tensile Modulus Coefficient of Thermal Expansion Mix Ratio Pot Life Shelf Life UV Resistance

(b) Titanium Alloy Reinforcement Installation Plan - Before beginning girder preparation submit the following according to 00150.37:

- The sequence of anchor hole and groove preparation as it relates to the overall construction Plan.
- Methods for locating and protecting existing steel reinforcement. Details regarding the Equipment and structural attachments required for installation of the titanium alloy reinforcement. Include rail mount locations and dimensions required for accurate groove placement in bridge elements.
- Details of the proposed method, if different than specified, for ensuring the titanium alloy reinforcement is installed as shown.
- Details regarding construction tolerances for preparation, including groove depth, width and anchor hole dimensions.

(c) Order Lists and Bending Diagrams - Before ordering Material, submit all order lists according to 00150.37 and unstamped bending diagrams according to 00150.35 for approval. Do not order Material until such lists and bending diagrams are approved.

The review of order lists and bending diagrams by the Engineer will in no way relieve the Contractor of responsibility for the correctness of such lists and diagrams. Revise lists and diagrams as required to make them comply with the Plans at no additional cost to the Agency.

Material

00567.10 Titanium Alloy Reinforcement - Furnish deformed titanium alloy reinforcement conforming to the requirements of ASTM B1009. Unless otherwise shown or specified, furnish all titanium alloy bars that conform to the following mechanical properties:

Yield Strength	Ultimate Strength	Elastic Modulus	Elongation
130,000 psi	140,000 psi	15,000,000 psi	10%

Calculate elastic modulus using slope of the stress-strain curve between a stress range of 20,000 psi and 60,000 psi. Use 0.2 percent offset of the calculated elastic modulus line to obtain a yield strength of titanium alloy bars.

Furnish uniform deformations equally spaced along the titanium alloy bars with a minimum deformation height of 0.01 inch and a maximum spacing of 0.06 inch. Sharp stress risers are not allowed. Furnish the final cross-sectional area of the bars including the deformations that are not less than 96 percent of the nominal area of undeformed bars.

An approved source for titanium alloy reinforcement is Perryman Company, 213 Vandale Drive Houston, PA 15342. Contact the Infrastructure Development Manager, at 724-746-9390.

00567.11 Fabrication - Hot bend reinforcement bars to the shapes shown. Shop bending or field bending is allowed, unless otherwise shown or directed. Heat reinforcement bars to a minimum of 900 °F and a minimum of three inches on each side beyond the bend section. At 900 °F, the bars will turn yellow or straw color. Continue heating until the bars turn into blue color approximately equal to 1200 °F, that is the desired color and temperature for bar bending. Do not heat reinforcement bars more than 1300 °F or until the bars turn red hot. Discard the red hot (overheated) bars. After the bending is complete, grind surface of the inside bend radius to remove the deformations. Make bends, tag, mark and ship reinforcement bars according to the current edition of the CRSI *Manual of Standard Practice*. Re-bending of reinforcement bars is not permitted.

00567.12 Material Sampling - Furnish sufficient material for the Engineer to select ~~four~~ three samples from each lot of titanium alloy reinforcement delivered to the site, for testing by the Agency. Furnish samples that are a minimum of 4 feet in length.

00567.13 Epoxy Resin - Furnish epoxy resin from one of the following list of pre-approved epoxy resins.

Manufacturer	Material
Hilti, Inc. 7250 Dallas Parkway, Suite 1000 Plano, Texas, 75024 Contact: Pete Anderson Phone: (972) 403-5948	HIT-RE 500 V3
Adhesive Technology Corp 450 East Copans Road Pompano Beach, Florida, 33064 Contact: Mike Gaffigan Phone: (954) 541-7091	Ultrabond HS-1CC

(Use the following Epoxy resin only for projects with construction on top surfaces due to high flowability. Contact the Bridge Designer.)

Pilgrim Permocoat, Inc. 402 South 22 nd Street Tampa, Florida, 33605 Contact: Robert Forlong Phone: (813) 248-3328 FAX: (813) 248-1076	Magmaflow Grout-Pak CF
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Construction

00567.40 Protection of Material - Protect reinforcement at all times from damage. Ensure reinforcement is free of dirt, detrimental scale, paint, oil and other foreign substances when placed in the Work.

00567.41 Existing Reinforcement Location and Concrete Cover - Use rebar detectors or other approved devices, capable of locating existing reinforcement within 0.1 inch, to locate existing reinforcement and to determine the thickness of concrete cover. Before constructing

anchor holes and grooves, provide the Engineer with a summary of cover thickness and clear distance measurements between existing reinforcement and the titanium alloy reinforcement system.

00567.42 Drilling Anchor Holes and Sawcutting Grooves - Drill holes for hook embedment depth and size as shown using a rotary hammer drill with a carbide tipped drill bit. If existing reinforcement is encountered, stop drilling and adjust the hole location. Adjust the location of the holes for the end anchorage up to 3 inches longitudinally and laterally to avoid conflicts. Maintain the titanium bar lengths.

Cut grooves as shown to the designed width and depth $\pm 1/8$ inch. Make grooves deep enough to allow the titanium bar to be installed at least $1/8$ inch below the surface in all locations along the length of bars. Do not cut into existing rebar during construction of sawcut grooves. Visually inspect all existing rebar locations after sawcutting grooves. When existing reinforcement is cut, notify the Engineer before installation of titanium alloy reinforcement.

Groove spacing may be adjusted in the field as necessary to avoid existing reinforcement or other unforeseen conflicts; however, the average spacing of all grooves over any 2-foot-long section may not be more than the spacing as shown. Maintain a minimum clear spacing greater than three times the diameter of the bar and a minimum clear edge distance of six times the diameter of the bar.

00567.43 Anchor Hole and Groove Preparation - Prepare sawcut grooves and anchor holes for titanium reinforcement installation as follows:

(a) **Surface Cleaning** - Clean the groove and anchor holes thoroughly with high-pressure water and a nonmetallic brush. Before the groove and anchor holes dry out, blow it free of water and debris with compressed air. Ensure that all dust, sand, laitance, grease, curing compounds, and any other bond-inhibiting matter is removed from the groove and anchor holes. Ensure the concrete surface of groove and anchor holes is clean and structurally sound prior to installing titanium alloy bars.

(b) **Moisture on Groove and Hole Surfaces** - Before installation of titanium alloy bars, dry groove and anchor hole surfaces using a drying method approved by the Engineer and according to the epoxy manufacturer's recommendations. Do not directly apply a flame to the groove and anchor holes surfaces.

00567.44 Compressed Air - When using high-pressure air for cleaning, use adequate separators and traps to ensure that the air is free of water, oil, or any other Material detrimental to the titanium alloy reinforcement system. Compressed air cleanliness may be tested by the Engineer according to ASTM D4285.

00567.45 Titanium Alloy Bar Installation - Begin installation only after groove and anchor hole preparation Work is complete.

Install the titanium alloy bars to the embedment depths and in the anchor holes as shown.

Do not install the titanium alloy bars and epoxy resin when the concrete temperature is below 50 °F, unless otherwise advised by the resin manufacturer's recommendations.

Mask the concrete adjacent to the groove to prevent excess epoxy from adhering to the concrete outside the groove.

Place nylon or polyethylene spacer material between the titanium alloy bars and exposed, existing steel reinforcement.

Fill two-thirds of the anchor hole and one-half of the groove with epoxy resin. Press the titanium alloy bar in the anchor holes and in the center of groove using approved centering devices at one-third points along the titanium alloy bar. Install centering devices with a minimum of 1/8-inch resin cover.

Ensure epoxy resin is well consolidated around the bars without air pockets. Level epoxy resin flush with the surface of the adjacent concrete.

00567.46 Surface Cleanup - Remove excess epoxy resin outside the groove.

Measurement

00567.80 Measurement - No measurement of quantities will be made for Work performed under this Section. The estimated quantity of titanium alloy reinforcement system is shown below.

(Obtain structure number and quantities from the Bridge Designer. Delete the entire row if the diameter specified is not used on the project.)

Structure	Quantity (Feet)
Bridge No. _____ - 0.375 Inch Diameter	
Bridge No. _____ - 0.500 Inch Diameter	
Bridge No. _____ - 0.625 Inch Diameter	
Bridge No. _____ - 0.750 Inch Diameter	

Payment

00567.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following item(s):

(Delete pay item(s) from the list that are not included in the Schedule of Items, but do not change the alpha characters next to the pay items.)

Pay Item	Unit of Measurement
(a) Titanium System, 0.375 Inch Diameter.....	Lump Sum
(b) Titanium System, 0.500 Inch Diameter.....	Lump Sum
(c) Titanium System, 0.625 Inch Diameter.....	Lump Sum
(d) Titanium System, 0.750 Inch Diameter.....	Lump Sum

Payment will be payment in full for furnishing, fabricating and placing all Materials and for providing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

