

# Special Specification 4181

## Cable Hangers



### 1. DESCRIPTION

Fabricate, test, transport, erect, and tension cable hanger system, including structural strand, end socket fittings, cable connectors, pins, hardware, and appurtenances, and all field adjustments required to achieve the target bridge profile.

### 2. MATERIALS

Provide new materials which comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items:

- Item 441, "Steel Structures,"
- Item 442, "Metal for Structures," and
- Item 445, "Galvanizing."

Provide the following items with each cable assembly:

- structural strand,
- open strand sockets, and
- cable connectors.

2.1. **Structural Strand.** Provide pre-stretched galvanized spiral strand conforming to ASTM A586, Grade 2, with a Class A coating throughout. Provide structural strand with a nominal diameter of 1 in., with a metallic area of 0.60 in<sup>2</sup>, and a minimum breaking strength (MBS) of 70 tons (140,000 lb.) Attach cable hangers to swaged sockets.

2.2. **Socket Assemblies.**

Provide open strand sockets that meet the details shown on the plans and the requirements listed herein. Provide cast steel sockets conforming to the requirements of ASTM A148 GR 105-85. Radiograph one socket per casting heat in accordance with ASTM E 280.

Provide pins conforming to the requirements of ASTM A668, Class F. Provide pins capable of developing the MBS of the cable hanger. The pin retaining device may be a threaded pin cap or cotter pin. Provide a pin retaining device capable of sustaining a force along the axis of the pin equal to or greater than 5% of the MBS of the attached cable hanger.

Galvanize all components with ASTM A153 Class A coating per the requirements of Item 445 "Galvanizing."

Design all components to develop the MBS of the attached structural strand without experiencing stresses beyond the yield point of the socket steel or excessive creep of the zinc filler under load.

- 2.3. **Cable Connectors.** Provide ultra-high molecular weight polyethylene (UHMW – PE) cable connectors, color gray with UV resistance to match cable hangers with the following material properties.

Density	58 pcf	ASTM D 792
Tensile Strength	3100 psi	ASTM D 638
Elongation at 73°F	350%	ASTM D 638
Coefficient of Friction at 73°F on steel	Static 0.15-0.20 Dynamic 0.08-0.18	
Hardness at 73°F	Shore D 62-66	ASTM D 785
Melting Point	275°F -280°F	
Coefficient of Linear Thermal Expansion	$2.0 \times 10^{-4}$ 1/K	ASTM D 696
Volume Resistivity	$> 10^{16}$ Ohm/in	

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### 3. CONSTRUCTION

#### 3.1. General Requirements.

- 3.1.1. **Fabrication and Testing.** All structural strand, socket components, and socket fabrication is to be performed by a fabricator with a minimum of 10 yr. of experience in the manufacture of the specific components. The Fabricator's quality procedures plan and manual are subject to approval by the Engineer. The cable hanger supplier will supervise cable hanger installation, stressing, and adjustments. The supervisor will be on-site during all these operations. The supervisor must have previous experience with the installation of cable hangers of similar or larger size cables.

Allow the Engineer to have access to all manufacturing fabrication and testing performed at the Fabricator's facilities, independent laboratories, or shipping and storage facilities. The Fabricator will afford the Engineer the necessary facilities to confirm that the material is being furnished in accordance with this specification. Perform all tests and inspections before shipment, unless otherwise specified.

Furnish certified copies of test results conducted by the Fabricator to the Engineer in accordance with Item 6 "Control of Materials."

- 3.1.2. **Notice of Beginning Fabrication.** Give adequate notice before commencing fabrication work as specified in Item 441, "Steel Structures," Table 1.

#### 3.2. Drawings.

- 3.2.1. **Shop Drawings.** Prepare and submit shop drawings in accordance with Item 5, "Control of Work" showing all information necessary for the fabrication and erection sequence including the installation of cable hangers and connection hardware. Include the location, type, and size of all cable hangers, fittings, anchorages, and connection hardware accounting for and clearly detailing for tolerances and field adjustments on the drawings. Submit shop drawings that are signed and sealed by a licensed Professional Engineer registered in the State of Texas. Obtain approval of shop drawings before ordering and fabrication.
- 3.2.2. **Erection Manual.** Prepare and submit an erection manual fully illustrating the method of erection and jacking procedure. Show details of all false work, guys, lifting devices, hydraulic jacks, and attachments to bridge members. Show sequence of erection, location of cranes, crane capacities, location of lifting points, and weights of bridge members. Show complete details, including cable forces, for all anticipated phases and

conditions of erection. Provide calculations to demonstrate that allowable stresses are not exceeded and that member capacities and final geometry are correct. Have a professional engineer, registered in the State of Texas, prepare, sign, and seal the erection manual.

### 3.3. Testing and Fabrication of Wire, Strand, and Sockets.

#### 3.3.1. Fabrication of Structural Strand. Fabricate the strand to meet or exceed the strength requirements specified herein. Submit documentation of compliance with these requirements and make-up of the wires in the strand to the Engineer.

Fabricate the strand in machines of enough size to ensure good workmanship and fabricate to the final length. Once the fabrication of the strand has started, make no changes in wire grade, construction, lay of strand, or other factors that would affect the uniformity of the finished product. Do not straighten bent wires. Any kinked or damaged strands will be rejected.

Strand all wires with uniform tension. Stranding must be close enough to ensure no appreciable reduction in diameter when the strand is subjected to a tension of 10% of the specified MBS.

Pre-stretch all strands by stressing each strand with a load equal to 50% of the MBS in straight tension. Load the strand from the unstressed condition to the maximum pre-stretch force, unload to 10% of the MBS, and then cycle 4 times between these two load values (10% and 50%). Reduce the load to the cable load specified in the Contract Document. Determine and report the modulus of elasticity of each manufactured length of strand in accordance with ASTM A586. Submit this information to the Engineer.

If for any reason the cable is distressed after load cycling but before marking to length, repeat the load cycle process and mark the cables to length.

Ensure that the overall cut lengths, including fittings, comply with the following tolerances at the loadings specified in the Contract Documents: cable lengths less than 30 ft.:  $\pm 0.05\%$  of the specified length, and cable lengths exceeding 30 ft.:  $\pm 3/16$  in. of the specified length.

Following pre-tensioning, subject the cable assembly to the prescribed dead load force and adjust the cable length such that the center to center distance between cable connections is consistent with the final cable length prescribed in the contract documents.

Stripe cables longitudinally while under the specified loadings established for length measurement.

Cut strands using disc cutters or other approved mechanical devices. Thermal cutting is not permitted.

Provide strand identification marks to facilitate erection. Provide each strand with a legible waterproof tag attached to it giving the fabricated length and cable ID number as noted in the contract plans.

Splicing of finished cable hangers between end fittings is not permitted.

Properly coil strands on reels in a manner such that no permanent deformation of wires in the strand will occur. Store strands in a well-protected location. Handle, transport, and store strands in accordance with the AISI Wire Rope Users' Manual. Replace any strands damaged by handling, transporting, or storing at the Contractor's expense.

#### 3.3.2. Socket Finishing.

Neatly finish sockets to the exact dimensions of the required style. The Engineer will visually examine each socket for defects. Repair defects judged to be unacceptable by the Engineer to the satisfaction of the Engineer, or replace the socket with a new casting at no additional expense to the Department. The reparability of a socket is at the discretion of the Engineer. Perform additional testing to determine extent of repair needed. Such tests may be radiograph, ultrasonic, magnetic particle, or liquid penetrant and are at the Contractor's expense. The Engineer may direct or approve such tests.

Magnetic particle, test all castings at critical areas according to ASTM E709 with acceptance levels per ASTM E125 as follows.

Type	Discontinuity	Acceptance Level
1	Linear Discontinuities	*
2	Shrinkage	2
3	Inclusions	2
4	Internal Chills-Chaplets	N/A
5	Porosity	1

\*Remove all linear indications by grinding and blending.

Stamp each socket MT indicating "Magnetic Particle Inspection" adjacent to a non-machined area.

Cast all castings with pattern number or part number, material grade, heat number, and foundry symbol.

Unless otherwise specified, discontinuities may be removed either by grinding or welding. Perform all repairs in accordance with ASTM A148, supplementary requirements S1 and S2 as specified.

Heat treat all castings by either full annealing, normalizing, normalizing and tempering, or quenching and tempering, unless otherwise specified. The castings may be heat treated by any of these heat treatments at the option of the Fabricator.

Complete chemical analysis using Optical Emission Vacuum Spectrometers. Perform tensile testing in accordance with ASTM A370. Conduct magnetic particle inspections by approved ASNY-TC-1A examiners.

Fabricate all strand sockets with line bored pin holes. Pin tolerances are  $+.020-.000$  with a 125 ANSI finish. Open sockets available to B/E, SD 2155 specification.

Provide fittings that comply with the following tolerances: dimensions under 4 in.:  $\pm 1/16$  in., dimensions over 4 in.:  $\pm 1/8$  in., and pin diameter:  $+0$  to  $-1/32$  in.

### 3.3.3.

**Socket Installation.** Attach sockets to the strands in accordance with the procedures approved by the Engineer before socketing. Install swaged sockets in the cable manufacturer's shop under closely supervised and controlled conditions.

Attach sockets to the structural strand at 20% of the MBS of each diameter strand. After being splayed in preparation for socketing, clean the wires of a strand from grease and other impurities by a carefully controlled process that will assure no harm is done to wire zinc coating. After socketing, re-lubricate the strand wires adjacent to the socket.

Sockets must be aligned within  $\pm 1^\circ$  of the strand centerline.

Where a cable hanger socket has a threaded length adjustment device, make the specified length with the device set to the mid-point of the adjustment range.

Ensure that the diameter of the strand, after socketing at a distance of 3 ft. from the point of entry of the strand into the socket, is within a tolerance of  $\pm 2\%$  of the strand diameter.

Furnish zinc that complies with ASTM B6, High Grade, or better to attach the sockets to the strand. Fill the socket with molten zinc in one continuous operation. Place the molten zinc at the lowest practical temperature, usually within the range of  $925^\circ\text{F}$  but never exceeding  $1000^\circ\text{F}$ , so as to minimize the effect of heat on the strands. Record the zinc temperature at the time of pouring and submit to the Engineer.

Ensure socket and strand alignment and that the lengths of the cable assemblies, after socketing, are correct. Submit a tabulation of shop-measured lengths of each assembly to the Engineer for use in erection. Record the ambient temperature in the shop at the time the final strand assembly lengths are determined.

### 3.3.4. **Testing of Structural Strand and Sockets.**

Submit copies of certified mill test reports for each heat of steel used for wire fabrication and for cable connection steel. Mill test reports will include heat and product analysis report. Mill test reports will be traceable to individual strands.

Cut and test 2 pieces at least 100 in. long from a pre-stretched length of strand to demonstrate the strength of the strand and sockets. Use ends of test pieces with installed sockets selected at random from those that are to be used in filling the order. The material and method of socketing is required to be the same for test and production pieces. Stress each piece to destruction in a suitable testing machine. Test to not less than the minimum specified breaking strength. Do not use the sockets used for these tests in the bridge.

3.4. **Delivery to the jobsite.** Inspect the cable assemblies before shipping. Transport the assemblies to the jobsite in a manner such that no permanent deformation of the strand occurs. Replace any cable assembly damaged by handling, transporting, or storing at Contractors expense.

3.5. **Storage of New Cable Assemblies.** Store the new assemblies under a roofed structure and do not drag assemblies at any time. Reject assemblies with damage to zinc coating. Store off the ground to keep strands dry.

### 3.6. **Cable Assembly Installation.**

#### 3.6.1. **Erection of Cable Assemblies.**

Carefully remove cable assemblies from wooden reels by revolving them. Do not permit unreeled cable assemblies to lie on the ground, on a dirty or dusty surface, or on an abrasive surface such as a concrete slab or face of rock. Support cable assemblies on timber blocking for the entire length, spaced closely enough to prevent kinking and contact with the ground. Lift the cable assemblies into position in the structure in a manner which avoids kinking or other distress to the cable assemblies. Use only nylon straps to lift the cable assemblies. Ensure that no twisting of the cable assemblies occurs during installation.

Erect cables in accordance with the Drawings and Specifications and in accordance with the best current practice. Dimensions shown on drawings are based on an assumed design temperature of 70°F. Ensure that fabrication and erection procedures take into account the ambient temperature range at the time of the respective operations.

Perform cable erection such that no cable hanger load exceeds 70% of the MBS of any cable hanger. Limit bend diameters in cable hangers to 30 times the cable diameter. Do not overstress the superstructure structural steel during erection.

The geometry indicated in the Drawings is the final stressed geometry of the structure under the specified loads and at the specified temperature.

Position each cable such that the relative turns from one end socket to the other end socket (external turns) are a maximum of 10°. This will establish the theoretical position of the longitudinal stripe line as the line from striped end socket to striped end socket. At any cross-section between sockets, the maximum turns of a point on the actual stripe line relative to a point on the theoretical position of the stripe line must be  $\pm 90^\circ$  (internal turns).

Before connection of cable hanger end-fittings to the arch rib and tie girder, clean all surfaces that will be in permanent contact after assembly free of laitance.

Immediately after erection, clean damaged areas and repair all surfaces with a zinc dust-zinc oxide paint compatible with the cable wire coating. Limit damage to coating on cables to localized areas of 1/2 in. sq.

3.7. **Corrosion Protection Repair.** Before and after all erection procedures, including deck and appurtenance installation, inspect cable assemblies for damage to zinc coating. Repair damaged areas of 1/2 in. x 1/2 in.

or less per Item 445, "Galvanizing." Submit procedures to repair areas larger than 1/2 in. x 1/2 in. sq. to the Engineer for review and approval.

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**4. MEASUREMENT**

This item will be measured by lump sum.

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**5. PAYMENT**

The work performed and materials furnished, in accordance with this Item and measured as provided under "Measurement," will be paid for at the unit price bid for "Cable Hangers." This price is full compensation for testing, furnishing, fabricating, installing, and adjusting the cable assemblies, and for materials, equipment, labor, tools, and incidentals.