

**SECTION 933**  
**ACCESSORY MATERIALS FOR PRESTRESSED CONCRETE**

**933-1 Cables for Pretensioning.**

The cables for prestressing concrete members shall be high-tensile-strength, 7-wire strand conforming to the requirements of ASTM A 416 with the addition of 9/16 inch [14.29 mm] strand meeting the following requirements:

TABLE 1 BREAKING STRENGTH REQUIREMENTS			
Nominal Diameter of Strand, inch [mm]	Breaking Strength of Strand, lbf [kN]	Nominal Steel Area of Strand, in <sup>2</sup> [mm <sup>2</sup> ]	Nominal Weight of Strands, lb/1,000 ft [kg/1,000 m]
Grade 270 [Grade 1860]			
9/16 [14.29]	51,700 [230]	0.191 [123.23]	650 [967]

TABLE 2 YIELD STRENGTH REQUIREMENTS		
Nominal Diameter of Strand, inch [mm]	Initial Load, lbf [kN]	Minimum Load at 1% Extension, lbf [kN]
Grade 270 [Grade 1860]		
9/16 [14.29]	5,170 [23.0]	43,940 [195.5]

TABLE 3 DIAMETER RELATION BETWEEN CENTER AND OUTER WIRES	
Nominal Diameter of Strand, inch [mm]	Minimum Difference Between Center Wire Diameter and Diameter of any Outer Wire, inch [mm]
Grade 270 [Grade 1860]	
9/16 [14.29]	0.003 [0.0762]

As an exception to the above, at the Contractor's option, stabilized strands may be used in lieu of stress relieved strands. Calculations shall be submitted, showing the substitution meets the following requirements:

1. The strands meet all the requirements of ASTM A 416, Grade 270 [ASTM A 416M, Grade 1860].
2. The net compressive stress in the concrete after all losses is at least as large as that provided by the stress relieved strands.
3. The ultimate strength of the structure with the new strands meets the requirements of the applicable AASHTO Specifications.

**933-2 Bars for Posttensioning.**

The bars shall be of high-tensile-strength steel, and shall be equipped with wedge-tool end anchorages which will develop the minimum specified ultimate bar stress on the nominal bar area. The physical properties of the bar steel and the stress-strain curve, determined by static tensile tests, shall conform to the following:

Ultimate stress, minimum .....	145,000 psi [1,000 MPa]
Stress at 0.7% elongation, minimum .....	130,000 psi [896 MPa]
Stress at 0.3% elongation, minimum .....	75,000 psi [517 MPa]
Elongation in 20 diameters, minimum.....	4%
Modulus of elasticity, minimum.....	25,000,000 [172 GPa]
Diameter tolerance.....	+0.02375 or -0.010 inch [+0.603 or -0.254 mm]

**933-3 Parallel Wire Assemblies for Posttensioning.**

The wire assemblies shall consist of parallel wires of the number and size shown in the plans. Wires shall conform to the requirements of ASTM A 421 [ASTM A 421M], with Type BA (Button Anchorage) used for cold end deformations and Type WA used for the wedge-type anchorage without cold end deformations. At the option of the Contractor, stabilized strands may be used in lieu of stress relieved strands provided calculations are submitted, showing the substitution meets the requirements specified in 933-1 for stabilized strands.

**933-4 Anchorages for Posttensioned Tendons.**

**933-4.1 For Bars:** Wedge-type anchorages shall be used for bars. The wedge device shall develop the minimum ultimate stress specified for the nominal bar area. Wedge anchorages shall bear against anchorage plates fabricated of hot-rolled steel having physical characteristics not less than as specified for No. 1040 of the American Iron and Steel Institute (AISI) Specifications.

**933-4.2 For Parallel Wire Assemblies:** Anchorage for parallel wire assemblies may be provided by cold-end deformation of the wires (Button Anchorage) bearing against suitable anchorage plates, or by wedge-type anchorages of the sandwich-plate or conical type. The anchorage device shall be capable of developing at least 90% of the specified ultimate strength of the total number of wires anchored.

Conical type anchorages shall be embedded within the ends of the concrete members unless otherwise specified. Anchorages shall generally bear against embedded grids of reinforcing steel of approved type.

**933-4.3 Alternates for Both Types:** Alternate type anchorages will be considered if proposed by the Contractor. Any alternate anchorage will be required to develop the full specified ultimate strength for bars or at least 90% of the specified ultimate strength for parallel wire assemblies.

As a specific exception, threaded anchorages not on upset or over-size reinforcing ends will not be considered.

**933-5 Required Tests for Reinforcing.**

**933-5.1 General:** Tests shall be made to determine the physical characteristics of prestressing reinforcement. For tests specified to be made by the manufacturer, certified copies of all test results shall be submitted to the Department and the Department shall be privileged to have all tests witnessed by its Inspectors.

**933-5.2 Cables, Wires and Wire Anchorages:** Acceptance of cables, wires and wire anchorages shall be based on manufacturer's certified mill analysis of test results meeting the Specification limits of ASTM or AASHTO as specifically designated.

Certifications of cable for prestressing shall contain for each heat number or production LOT, all test results required by ASTM A 416 and the modulus of elasticity expressed in psi [MPa] or the stress-strain curve with units identified.

Random samples may be selected and tested by the Department for verification purposes.

**933-5.3 Bars:**

**933-5.3.1 Proof Test:** During manufacture each bar shall be proof-tested to a minimum stress of 130,000 psi [896 MPa].

**933-5.3.2 Static Test:** From each mill heat received, one static test shall be made by the manufacturer on an assembled bar and anchorage, to determine the physical properties of the steel and the assembly. Such physical properties shall conform to the minimum physical properties specified in 933-2.