SPECIAL SPECIFICATION

4130

Stay cable Testing

1. **Description.** Stay cable testing shall be required for the following items prior to fabrication of cable anchorages, or installation of stay cables. This work shall consist of the furnishing of all materials, anchors, stay cable specimens, strand specimens and all labor and equipment for fatigue, ultimate fatigue strength, ductility and static load testing as follows:

   A. Fatigue and ultimate strength of fully assembled cables for acceptance of the anchorage system.

   B. Ductility and fatigue strength of individual strand for acceptance of strand to be incorporated into the final structure.

The specimen assemblies shall be tested by a recognized independent testing laboratory approved by the Engineer. The Contractor shall supply all materials for testing to the laboratory a minimum of one month prior to the actual tests. The Engineer shall be notified a minimum of 30 days in advance of any fabrication or testing so that a representative of the Engineer may be present when the respective work is being performed.

All testing data and testing results shall be submitted to the Engineer.

Fabrication of anchors or stay cable strands for permanent installation on the structure shall not begin until the tests are successfully completed and written approval is given by the Engineer.

The testing laboratory shall provide certification that the stay cable testing was performed in accordance with the specifications and that the cables meet the requirements of the specifications.

2. **Materials.**

   A. **Stay Cable Acceptance Test.** Two completed fully assembled stay cable specimens shall be fabricated for testing, one specimen shall be made representing the smallest stay cable, and the other the largest stay cable in the bridge. Each specimen shall be fully representative of all details and procedures proposed for the production stay cables.

   The Contractor shall fully detail the stay cable specimens including end anchorages and submit to the Engineer, complete detailed drawings and calculations (including reinforcements, jack specifications, concrete strength, etc.) for review. Samples need not be wrapped with tape.
The Contractor shall assemble the test cables at the laboratory. Assembly of the cable shall represent the sequence of operations that will be used in the actual construction.

The specimens representing the stay cables shall be fabricated straight and consist of two anchorages (including all appurtenances) with a clear space of 32 feet between bearing faces and a clear length of 4 feet of typical stay pipe between anchorage assemblies.

B. Fatigue Acceptance Test. Each specimen of the stay cable assemblies shall be tested for two million cycles of fatigue loading with an upper stress of 45% of the guaranteed ultimate tensile strength (GUTS) of the material and a stress range of 23 ksi.

During fatigue testing, not more than two percent of the number of individual wires (rounded to the nearest whole number) may fail. Multiple fractures of the same wire shall be counted as one failure. Failures shall be distributed on a random basis throughout the stay cable. No failure shall occur within the anchorage zones, or in any components of the anchorage. The frequency of the test load for all fatigue tests shall be a constant value between 2 Hz and 4 Hz.

After fatigue testing, each test specimen shall be reloaded and tested; it shall develop a minimum tensile force equal to 95 percent of GUTS of the stay cable. Failure of the specimen to achieve 95 percent of GUTS will require retesting of the cable assembly.

Actual ultimate tensile strength of cable is defined as the average ultimate tensile strength of 9 test specimens of single strands, according to ASTM Designation: A 416 and A 370, from the same reel of strand used for the above tests.

C. Quality Control Testing of Stay Cable Materials. In order to ensure strand fatigue resistance is incorporated into the stays, the following conditions shall be met:

1. One 16-foot sample strand shall be taken for every 10 tons of strands produced from each heat of steel. This sample shall be used for both fatigue and ductility testing.

2. All strands and test samples shall be marked in such a manner to ensure traceability during production, transit, storage and testing.

3. The test strands shall be protected from failure in the gripping zone. Should any test strand fail in the gripping zone, the test will be discarded and another test specimen made from the sample.

4. One test for each manufactured length of strand shall be made for the following:

   Minimum guaranteed ultimate tensile strength \( f_s = 270 \text{ ksi} \)
   Minimum yield strength \( f_y = 0.9 f_s \)
   Young’s Modulus \( E = 28, 600 \text{ ksi} \pm 5\% \)

D. Fatigue and Static Testings. One tensile fatigue test shall be conducted on an approximately 6-foot long test specimen from each sample. Minimum length shall be 3 feet face-to-face of grips. The strands shall be anchored in such a way as to avoid
failures in the gripping zone. Should any specimen fail within the gripping zone, the test shall be discarded and another specimen used from the same sample.

The strand specimens shall be tested at an upper stress of 0.45 f's and a stress range of 64 ksi for 100,000 cycles.

One static test to failure shall be conducted after completion of each strand fatigue test. Specimens shall provide not less than 95 percent of the Guaranteed Ultimate Tensile Strength (GUTS) in the static test without failure.

If the actual tensile strength of material used in acceptance tests of stay cables exceeds f's by more than 5%, material used in production stay cables shall be tested to demonstrate comparable tensile strength (f's x A_s). The actual guaranteed ultimate tensile strength of the test cable shall be determined from the results of tensile test for individual strands. The actual fatigue strength of the stay cable test material shall be determined from the results of the fatigue tests from companion strands.

1. **Rejection Criteria.** If the first valid test strand from each sample fails, two additional tests shall be made from the same samples. If failure occurs in either of these tests, the strand represented by that sample shall be rejected. Retesting shall not be permitted.


1. **Acceptance Criteria.** For acceptance, the tensile force in the sample during the one-pin test shall equal at least 80% of the ultimate strength of the sample.

   The sample taken for the One-Pin Test shall be long enough for two ultimate strength tests and three One-Pin Tests. If the first specimen fails the one-pin test, two additional samples shall be tested. If both samples pass, the material is acceptable. If either sample fails, the material from which the sample was taken shall be rejected.

3. **Measurement.** Stay Cable Testing will be measured by the lump sum.

4. **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 “Stay Cable Testing”. This price is full compensation for furnishing of all materials, anchors, stay cable specimens, strand specimens; for all labor and equipment for fatigue, ultimate fatigue strength, ductility and static load testing; and for all equipment, labor, tools and incidentals.