Radial Crush Test for E3X 1431 kcmil ACSS Overhead Conductor

NEETRAC Project: 24-151

Final Report

May 2026

NEETRAC
National Electric Energy Testing, Research, and Applications Center

Requested by: Idaho National Labs

Principal Investigator/Reviewed by: Joe Goldenburg, P.E.

Report written by: Ian Brown, E.I.T.

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1.0 EXECUTIVE SUMMARY

Idaho National Labs requested that NEETRAC perform crush testing on Prysmian E3X 1431 kcmil ACSS conductor in compliance with Cigre Technical Bulleting 426 and ASTM B803. The purpose of this testing was to evaluate the conductor's integrity and susceptibility to "hidden" damage caused by relatively light crushing loads (in the hundreds of pounds, such as being run over by a utility truck), which the conductor may experience in the field.

2.0 TEST SAMPLES

In preparation for this test, 15 three-foot conductor sections were acquired, as shown in Figure 1. Various mechanical loads were applied to each. After load application each section was disassembled, and a single strand was harvested from each core layer. The harvested strands were subjected to tensile testing, also shown in Figure 1.

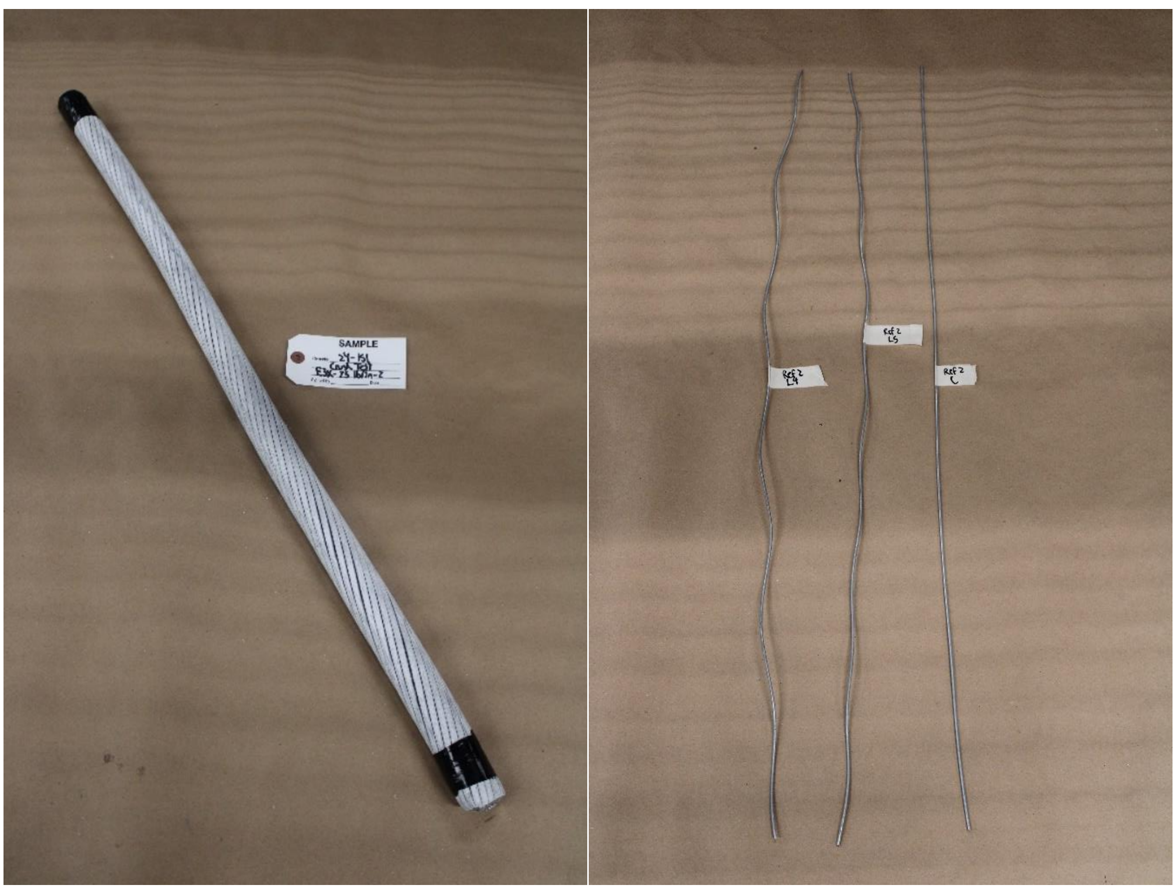

Figure 1: Conductor Section (L) and Strand Samples (R)

3.0 PROCEDURE

3.1 Crush

Each of the 15 conductor sections were separated into five groups, which allowed for three replicates of each group's mechanical load application. These groups were labeled as and subjected to particular crushing loads as follows:

1. 75 lb/in
2. 100 lb/in
3. 125 lb/in
4. 150 lb/in
5. Reference samples (no crush load was applied)

Crush loads were applied to the conductor sections by NEETRAC's universal testing machine (UTM) between a compression platen on the machine's crosshead and a 4" long rectangular crush platen on the bottom, as shown in Figure 2. The 4" length of the bottom platen determined the crushing load that each of the triplet groups were subjected to based upon the loads labeled above. For example, the 75 lb/in group was subjected to a crush load of 300 lbs (75 lb/in x 4 in = 300 lbs).

Each conductor section was crushed once by itself in its approximate center, as shown in Figure 2. For each section, the crush load was applied and held for 10 minutes before being released. However, three reference samples were not subjected to crushing at all, as they were control samples.

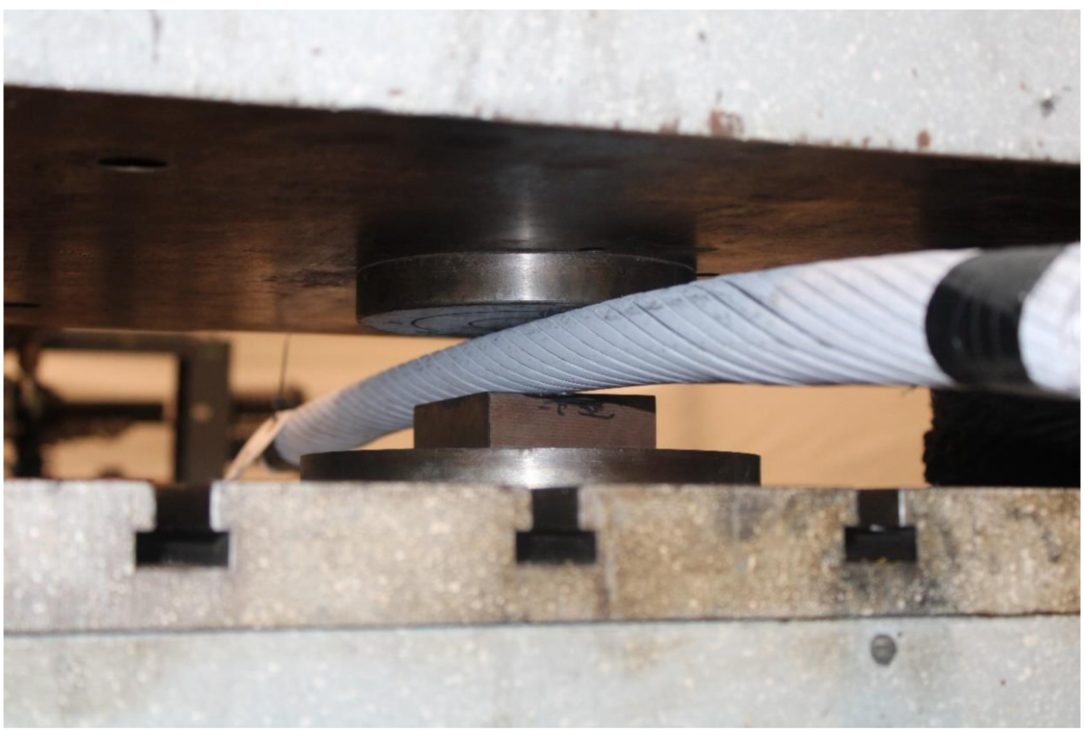

Figure 2: Crushing setup shown while crushing is in progress

3.2 Evaluation and Tensile Test

After application of mechanical crush loads, each of the sections were broken down as described in section 2.0. They were straightened as much as possible before an ultimate tensile strength test was performed on each of the samples, as shown in Figure 3. Compliance for tensile testing of these strands is dictated by ASTM B803.

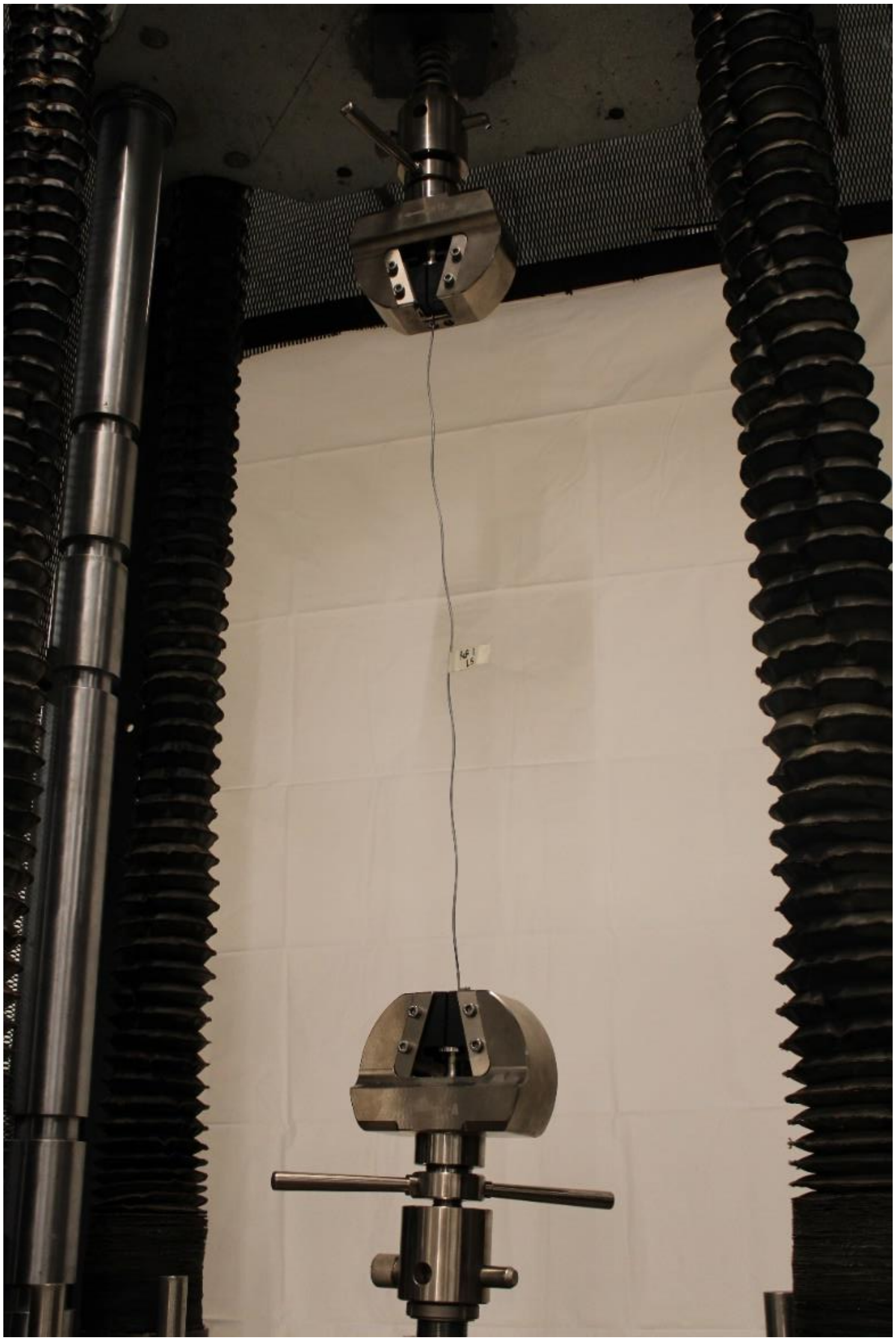

Figure 3: Sample installed in UTM before testing

4.0 RESULTS

After crushing, minimal flattening was noticed on some of the outer aluminum strands of some conductor sections, as shown in Figure 4. However, no significant damage was noted beyond this. The inner aluminum strand layers did show signs of rubbing from the aluminum layers on top of them, as seen in Figure 5. Based on similar observations of the reference samples, these marks were not due to crushing.

Figure 4: Very light flattening shown on a 150 lb/in sample with marks indicating the span where the bottom platen made contact

Figure 5: Example of marks on inner aluminum strands from upper layer

For a radial crush test such as this, Cigre TB 426 only requires testing for residual core strand strength along with noting damage to strands. Therefore, tensile testing only evaluated the strands' ultimate tensile strength and not its elongation. Per ASTM B803, the minimum ultimate tensile stress of the strands is 230 ksi. In testing, all samples passed this requirement. The box and whisker plot below in Figure 6 shows the tensile testing results. Figure 7 shows a sample's typical stress-deflection curve.

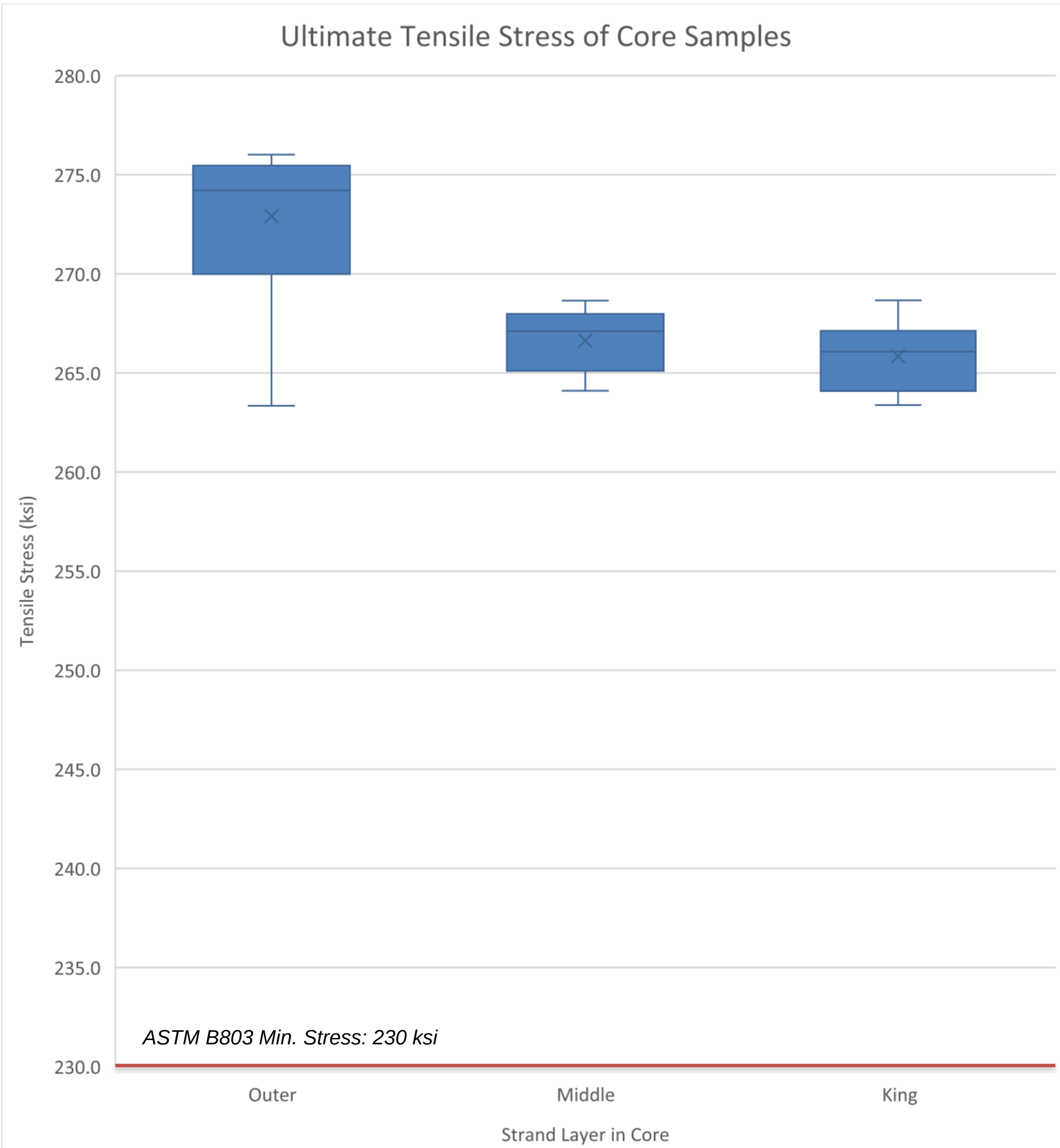

Figure 6: Tensile Test Results

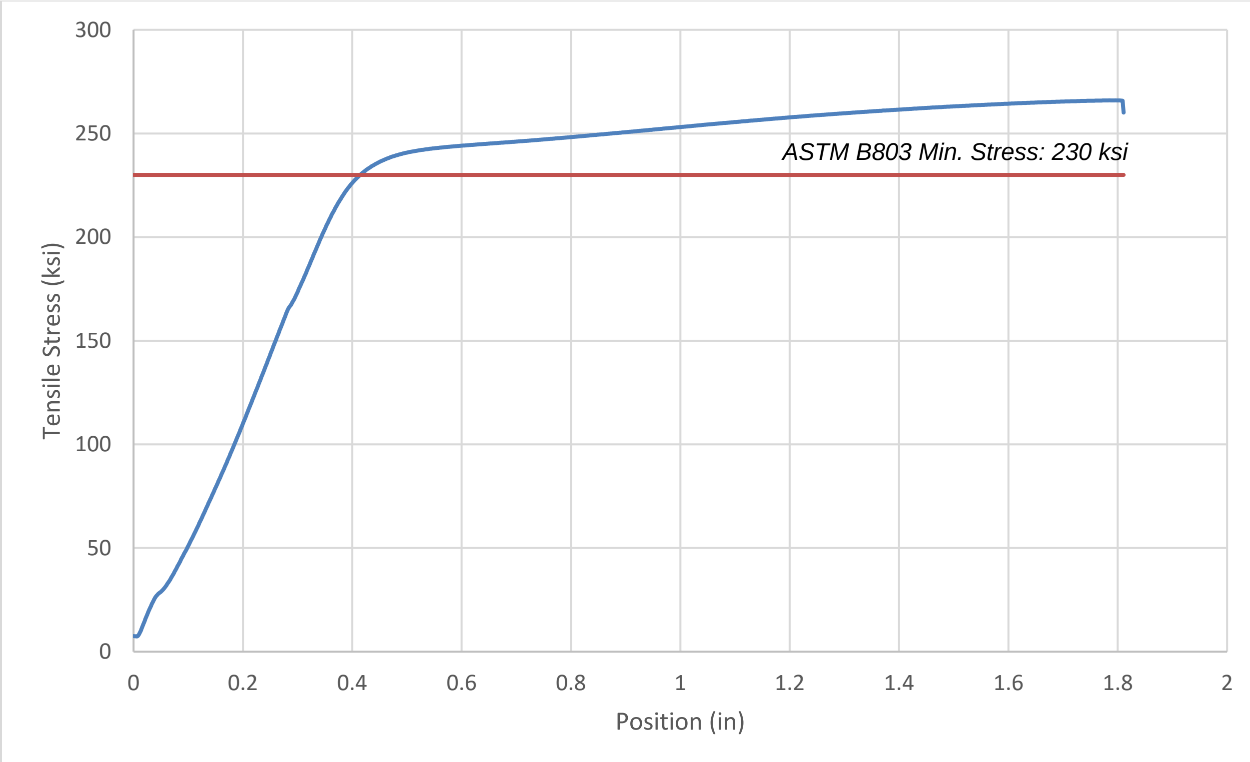

Figure 7: Typical Force-Deflection Curve

5.0 CONCLUSION

After being subjected to crush loading, all samples passed the requirement set for tensile strength by ASTM B803. All crush testing was done in compliance with Cigre TB 426.

6.0 EQUIPMENT

Tinius-Olsen UTM CQ-0013

7.0 STANDARDS

Cigre Technical Bulletin 426, "Guide for Qualifying High Temperature Conductors for Use on Overhead Transmission Lines"

ASTM B803/B803M-22 Standard Specification for High-Strength Zinc-5% Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Use in Overhead Electrical Conductors