3M

795-kcmil, 3M Brand Composite Conductor Compression Dead End Evaluation Mechanical Holding Strength

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795-kcmil, 3M Brand Composite Conductor
Compression Dead End Evaluation
Mechanical Holding Strength

Summary

Two-piece steel and aluminum compression fittings from Alcoa Conductor Accessories were successfully installed and tensile-tested on 795-kcmil 3M Brand Composite Conductor. Tests showed the fittings exceed the requirement set forth by ANSI C119.4 (1998) – section 4.4.3 for full tension connectors, that states the connector should hold at least 95% of the conductor's rated breaking strength.

Samples

795-kcmil 3M Brand Composite Conductor cut to lengths of 10ft (3.05m) and 40ft (12.2m), each having one end terminated with an Alcoa Conductor Accessories compression dead-end fitting catalogue number B9085-B, and the other end fitted with a resin termination. The shorter samples were tested in August 2002, and the longer ones in February 2003. The longer samples intentionally had slack introduced into the aluminum layers to simulate a poor quality of dead-end installation.

Equipment Used

An Alcoa Conductor Accessories two-piece steel forging and an aluminum dead end were pressed onto the conductor using a 100-ton press. The dead-end catalogue number was B9085-B, and 10040AH dies were used for the aluminum sleeve and 10018SH dies for the steel. Tension tests on the 10ft long samples were performed at the Xcel Energy test laboratories in Minneapolis, MN, using a horizontal tensile machine with a Sheffer Hydraulic ram. The load cell was a BLH Type T2P1 load cell with a maximum capacity of 50,000 lbs. The digital readout was a Daytronics Model 3270P, accurate to 10 Lbs. Tension tests on the 40ft long samples were performed at Kinectrics Inc., in Toronto, ON, Canada.

Conductor & Accessory Spec

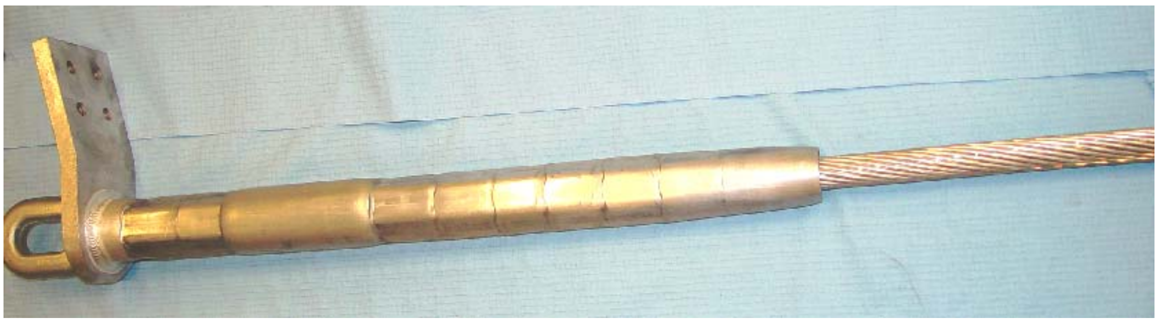
See Appendix A

Procedure

Samples of 795-kcmil 3M Composite Conductor were cut to lengths of 10ft (3.05m). Dead end sleeves were installed at one end and a resin fitting at the other end. Samples were preloaded to about 25% RBS and left under load for 10 minutes before reloading at a rate of approximately 5000 Lbs/minute to failure. The load was displayed on a counter and recorded manually along with notes of acoustic cracking noise or other observations. After testing the failure location was recorded, and aluminum strands were removed and the sleeves machined open to determine the failure location and any details of failure. The test requirement set by ANSI C119.4 (1998) – section 4.4.3 for full tension connectors, is that the connector should hold at least 95% of the conductor's rated breaking strength.

Dead-End Design

The design drawing for an Alcoa Conductor Accessories dead-end, catalogue number B9085-B, is shown in Appendix B. It shows both the core and overall conductor gripping. The steel forging contains an aluminum insert to cushion the core material. Otherwise the assembly is similar to Alcoa Conductor Accessories ACSR-type compression dead-ends.



An example of a fully assembled, compression dead-end ready for testing, using the Alcoa Conductor Accessories two-piece dead-end approach.

Test Results

The following table summarizes the load to failure, failure location and comments:

Accessory Type	Failure Load		%RBS	Comments
	(Lbs)	(kN)		
Dead-end B9085-B	31600	140.6	101	10ft gauge length. Failed within gage- at 1/3 gage length
Dead-end B9085-B	31420	139.8	101	10ft gauge length. Failed within gage- 13" from epoxy end- 5 outer Al strands did not break
Dead-end B9085-B	31640	140.7	102	40ft gauge length with intentional slack. Failed in gage at 4ft from dead end
Dead-end B9085-B	30368	135	98	40ft gauge length with intentional slack. Failed in gage 3ft from dead end
Dead-end B9085-B	31002	137.9	100	40ft gauge length with intentional slack. Failed in gage at 4ft from dead end

RBS = 31,134 Lbs

Conclusion:

An Alcoa Conductor Accessories two-piece steel forging and aluminum dead end body was successfully designed, fabricated, and tested for use with 795-kcmil 3M Composite Conductor. The terminations supported the conductor rated breaking strength, thus proving the capability to support the designed load of the conductor. This exceeds the requirement set forth by ANSI C119.4 (1998) – section 4.4.3 for full tension connectors, that states the connector should hold at least 95% of the conductor's rated breaking strength. Additionally, the dead-ends passed the ANSI requirement even when poor installation techniques were intentionally used, which created slackness in the aluminum layers.

Acknowledgement

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Disclaimer

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Department of Energy.

Appendix A: 795-kcmil, 3M Composite Conductor Specification

Conductor Physical Properties		
Designation		795-T16
Stranding		26/19
kcmils	kcmil	795
Diameter		
indiv Core	in	0.082
indiv Al	in	0.175
Core	in	0.41
Total Diameter	in	1.11
Area		
Al	in^2	0.624
Total Area	in^2	0.724
Weight	lbs/linear ft	0.896
Breaking Load		
Core	lbs	18,556
Aluminum	lbs	12,578
Complete Cable	lbs	31,134
Modulus		
Core	Msi	31.4
Aluminum	Msi	7.4
Complete Cable	Msi	10.7
Thermal Elongation		
Core	10^-6/F	3.5
Aluminum	10^-6/F	12.8
Complete Cable	10^-6/F	9.2
Heat Capacity		
Core	W-sec/ft-C	22
Aluminum	W-sec/ft-C	324

Conductor Electrical Properties		
Resistance		
DC @ 20C	ohms/mile	0.1100
AC @ 25C	ohms/mile	0.1126
AC @ 50C	ohms/mile	0.1237
AC @ 75C	ohms/mile	0.1349
Geometric Mean Radius	ft	0.0375
Reactance (1 ft Spacing, 60hz)		
Inductive Xa	ohms/mile	0.3986
Capacitive X'a	ohms/mile	0.0912

Appendix B: Alcoa Conductor Accessories Dead-End B9085

(drawing is reproduced with permission from ACA)