Electric Utility - Overhead Conductor Stress-Strain Curves and Coefficients

Stress-strain curves that are generated for overhead conductors are meant to be an approximation of the physical performance of the tensile and elongation characteristics of the stranded conductor. Repeated stress-strain testing will generate a family of curves that will resemble each other but will have some degree of variability and will not be exact duplicates. The differences are the result of normal conductor manufacturing process variation as well as the inherent experimental error introduced when performing the stress-strain testing and in interpreting the data. The sag and tension stress-strain coefficients that are established, factor in the effects of long-term creep of both the aluminum and the steel core material. The creep information is based on extrapolated 1000 hour laboratory creep testing that is performed on a representative conductor construction.

Historically stress-strain coefficients for heterogeneous conductors, such as ACAR, AWAC, ACSR and ACSS, each used a common data set across a specific stranding configuration. No adjustment was made to the stress-strain coefficients or to the final modulus of elasticity values to compensate for the actual aluminum and steel cross-sectional area. This approach did not capture the specific conductor design characteristic details. General Cable builds stress-strain coefficients (wire files) starting with a parent coefficient data set, and then area corrects the values applying the individual conductor construction cross-sectional area values to create a converted component set of coefficients. This approach results in a slight variation in the actual coefficients expressed for different conductor sizes with the same stranding configuration. When the parent file is not available for the exact number of aluminum wires a parent file with the closest number of wires is chosen. The same approach is used to determine the value for the final modulus of elasticity for the aluminum and the steel components.

For the heterogeneous round wire conductor constructions, the method breaks the conductor into two components and separately determines what the individual converted component data set will be. For example, 795 kcmil 26/7 Drake ACSR/GA2 utilizes the parent file of stress-strain coefficients for the representative 26/7 aluminum stranding and also for the representative 7w steel stranding and strength type. Each file of stress-strain coefficients will include a reference notation for the parent file designation and the percent area the aluminum component represents in the overall conductor. For the Drake ACSR/GA2 conductor stress-strain coefficient file, it references “A7/C26/0.8601” which points back to the parent coefficient file “A7” for the regular strength steel core; “C26” for the 1350 ACSR aluminum wires; and that the aluminum represents 86.01% of the total conductor area. (See Chart 1)

For heterogeneous Trapezoidal (TW) conductor constructions, the method is similar to what is done for the round wire construction except the aluminum coefficients are selected based on the round conductor parent file with the same number of aluminum strand wire layers and the closest number of aluminum strand wires. For the steel core the parent file is selected based on the number of steel strand wires and the strength type. For the 795 kcmil 20/7 Drake ACSR/TW/GA2 conductor stress-stain coefficient file it references “A7/C18/0.8601” which points back to the parent coefficient file “A7” for the regular strength steel core; “C18” that would correspond to an 18/1 type of 1350 round wire ACSR construction (2 layers of aluminum and closest match to the 20 wires); and that the aluminum represents 86.01% of the total conductor area. (See Chart 2)

To download General Cable conductor wire files that may be used by the Power Line Systems PLS-CADD family of programs please visit http://plscaddwirefiles.generalcable.com.

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Stress-Strain Curves and Coefficients

795.0 kcmil 26/7 Drake/ACSR/GA2

Stress-Strain Coefficients (psi)[1]:

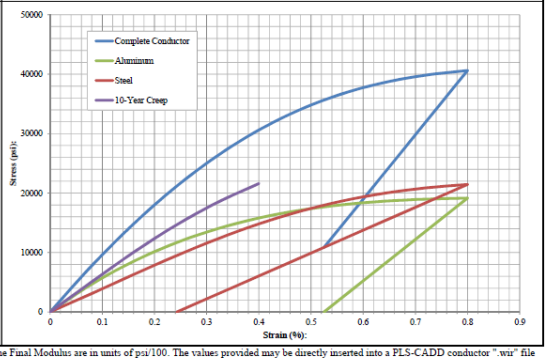
$$\sigma(\varepsilon) = \sum_{i=0}^{4} c_i \varepsilon^i$$

		c_0	c_1	c_2	c_3	c_4	E_f	
Aluminum		0	64259.0	-73971.4	30809.2	-1648.8	69669.1	One-hour
		0	26661.8	5568.4	-109305.7	109740.1		10-Year Creep
Steel		0	37454.0	22543.0	-73392.7	35739.8	38506.8	One-hour
		0	35799.2	19993.6	-65408.1	35041.1		10-Year Creep

Coefficient of Linear Expansion: Steel 0.00064 /°F/100 Aluminum 0.00128 /°F/100

Heat Capacity: Steel 41.3 J/(ft-°F) Aluminum 180 J/(ft-°F)

Stress-Strain Curves[2]:



[1] Stress-Strain Coefficients and the Final Modulus are in units of psi/100. The values provided may be directly inserted into a PLS-CADD conductor ".wir" file using the US units format.
[2] Based on curve set A7/C26/0.8601 at a reference temperature of 68°F. See http://plscaddwirefiles.generalcable.com for access to other existing conductor

CHART 1

This is the Stress-Strain and Creep Curve information for generated for a 795 kcmil 26/7 Drake ACSR/GA2 conductor, derived from coefficient parent curves "A7/C26/0.8601"

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Stress-Strain Curves and Coefficients

795.0 kcmil 20/7 Drake/ACSR/TW/GA2

Stress-Strain Coefficients (psi)[1]:

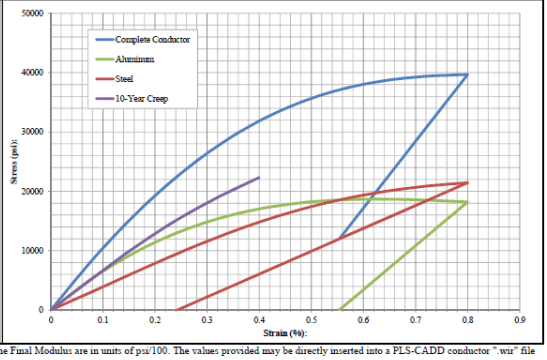
$$\sigma(\varepsilon) = \sum_{i=0}^{4} c_i \varepsilon^i$$

		c_0	c_1	c_2	c_3	c_4	E_f	
Aluminum		0	73968.1	-91243.0	29839.2	5287.9	73968.1	One-hour
		0	29574.3	15812.8	-195888.0	245028.6		10-Year Creep
Steel		0	37459.1	22546.1	-73402.8	35744.7	38512.1	One-hour
		0	35804.1	19996.3	-65417.1	35045.9		10-Year Creep

Coefficient of Linear Expansion: Steel 0.00064 /°F/100 Aluminum 0.00128 /°F/100

Heat Capacity: Steel 41.3 J/(ft-°F) Aluminum 180 J/(ft-°F)

Stress-Strain Curves[2]:



[1] Stress-Strain Coefficients and the Final Modulus are in units of psi/100. The values provided may be directly inserted into a PLS-CADD conductor ".wir" file using the US units format.
[2] Based on curve set A7/C18/0.8601 at a reference temperature of 68°F. See http://plscaddwirefiles.generalcable.com for access to other existing conductor

CHART 2

This is the Stress-Strain and Creep Curve information for generated for a 795 kcmil 20/7 Drake ACSR/TW/GA2 conductor, derived from coefficient parent curves "A7/C18/0.8601"