

Reading a PLS-CADD Stringing Chart: A Plain-Language Guide

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What a stringing chart does

A stringing chart tells the line crew how much sag a wire must have, and how hard it must be pulled, at the temperature on the day it is installed.

Wire is not a fixed length. On a hot afternoon it expands and hangs lower; on a cold morning it shrinks and pulls tighter. If the crew clamps the wire at the wrong sag, it can end up too low (a clearance problem) or too tight (a strength problem). PLS-CADD calculates the right values for every span, and the stringing chart is the table the crew takes to site.

This article reads one PLS-CADD report for structures 1 to 4 of a 380 kV line. It covers the phase conductor (795 kcmil Condor ACSR) and the OPGW, the earth wire with optical fibre inside.

The line in this report

Structures 1 to 4 form one tension section of three spans, strung as a single unit with a ruling span of 365.3 m. Circuits 1 and 2 carry Condor conductor and circuit 3 is the OPGW.

Spans

Span	Horizontal length (m)	Height difference between ends, Condor (m)	Height difference between ends, OPGW (m)
1 to 2	335.8	3.20	3.32
2 to 3	418.5	20.70	20.70
3 to 4	318.0	13.17	13.05

The OPGW span 3 to 4 is listed as 317.9 m. The minimum and maximum spans are 318.0 m and 418.5 m.

Cable and sagging data

Item	Condor ACSR (circuits 1 and 2)	OPGW (circuit 3)
Cable file	795 kcmil 54/7 Condor ACSR, 120 kN	OPGW 120 kN
Voltage (kV)	380	380
Phases x wires per phase	3 x 4	2 x 2 (as listed by PLS-CADD)
Ruling span (m)	365.3	365.3
Sagging condition	Initial RS at 15.6 °C	Initial RS at 15.6 °C
Horizontal tension at 15.6 °C (N)	13,840	19,879.6
Catenary constant at 15.6 °C (m)	946.3	2,139.9
Weather case governing the sagging	80C, NW	-1C, NW
Catenary constant after creep (m)	851.3	2,110.7
Total cable length (m)	12,792.9 (circuit 1), 12,792.8 (circuit 2)	4,297.0

Total cable length is for all wires in the section and excludes the strain insulators. It is the number used to order drum lengths. Circuits 1 and 2 are identical in every sag and tension value, so this article shows the Condor once.

Key terms in plain words

Term	Plain meaning	Why it matters
Mid-span sag	Vertical drop of the wire below the straight line between its two attachment points, at the middle of the span	The number the crew sets and measures on site
Horizontal tension	The sideways pull in the wire, the same in every span of the section	Sets the load on towers and the wire's safety margin
Catenary constant	Horizontal tension divided by the wire's weight per metre	One number that describes the curve: larger means flatter and tighter
Ruling span	One equivalent span that represents all spans between two strain towers	Lets one tension and one chart serve the whole section
Height difference (vertical projection)	How much higher one end of the span is than the other	Needed because uphill and downhill spans sag differently
Initial	The wire as first installed, before any permanent stretch	The condition used when stringing
Creep	Slow permanent stretch of the wire over the years	Makes the wire sag more after some time
Wave time	Time for a shake pulse to travel along the span and back	A field check that the sag is right

For a flat span the sag follows a simple rule, where L is the span length and C is the catenary constant:

$$\text{sag} \approx \frac{L^2}{8C}$$

Check it on span 1 to 2 at 30 °C: 335.8 squared divided by (8 x 927.3) is about 15.2 m. The report gives 15.24 m, and the small difference is the effect of the height difference between the ends. The rule also shows why sag grows with the square of the span: a 25% longer span sags about 56% more.

Conductor stringing chart (Condor ACSR)

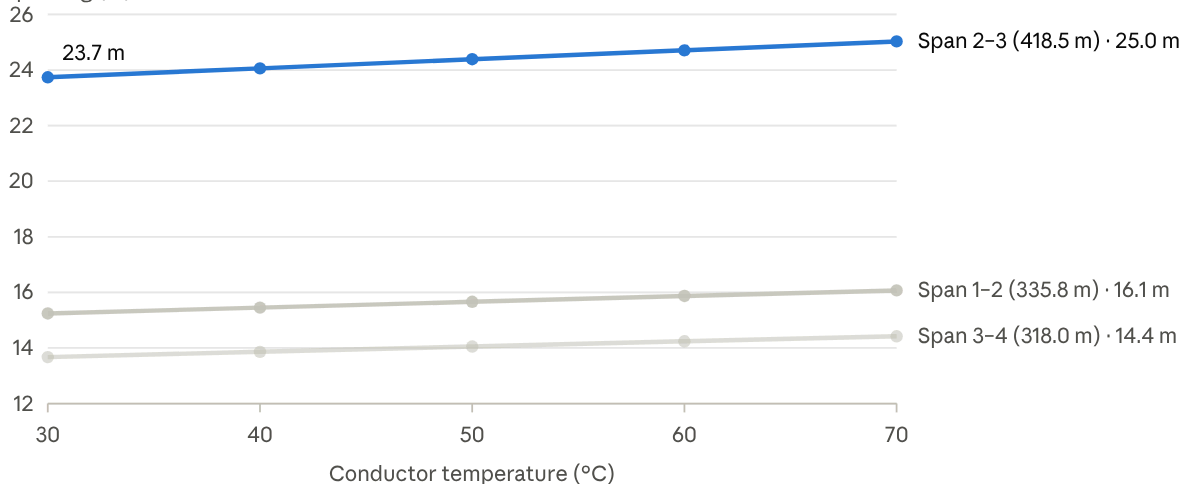
For the Condor, a hotter wire sags more and pulls less in every span. The table is the data exactly as PLS-CADD reports it for section 1 (circuit 2 is identical), and the chart shows how the sag moves with temperature.

Quantity	Span (length)	30 °C	40 °C	50 °C	60 °C	70 °C
Mid-span sag (m)	1 to 2 (335.8 m)	15.24	15.45	15.66	15.87	16.07
Mid-span sag (m)	2 to 3 (418.5 m)	23.74	24.06	24.39	24.71	25.03
Mid-span sag (m)	3 to 4 (318.0 m)	13.67	13.86	14.05	14.24	14.42
Wave time (s)	1 to 2	21.15	21.29	21.44	21.58	21.72
Wave time (s)	2 to 3	26.39	26.57	26.75	26.93	27.10
Wave time (s)	3 to 4	20.03	20.17	20.31	20.44	20.57
Horizontal tension (N)	all spans	13,561	13,377	13,201	13,029	12,865
Catenary constant (m)	all spans	927.27	914.68	902.60	890.86	879.64

The longest span sags most, and every span sags more as the wire heats

Span 2-3 (418.5 m): 23.74 m at 30 °C rising to 25.03 m at 70 °C

Mid-span sag (m)



PLS-CADD stringing chart report, section 1 (Condor, Initial RS) · 3 spans x 5 temperatures

How to read it. Pick your span, then move along its row. Each step to the right is 10 °C hotter. In the longest span (2 to 3) the sag rises 1.29 m between 30 and 70 °C, about 3 cm per degree, so a 5 °C error in the wire temperature is a sag error of about 16 cm.

The tension row tells the same story from the other side. It falls from 13,561 N to 12,865 N, about 5%, as the wire expands and hangs looser.

Wave time grows with span length and temperature, because a pulse takes longer to travel a longer, looser span and return. That is why span 2 to 3 has the largest values.

OPGW stringing chart

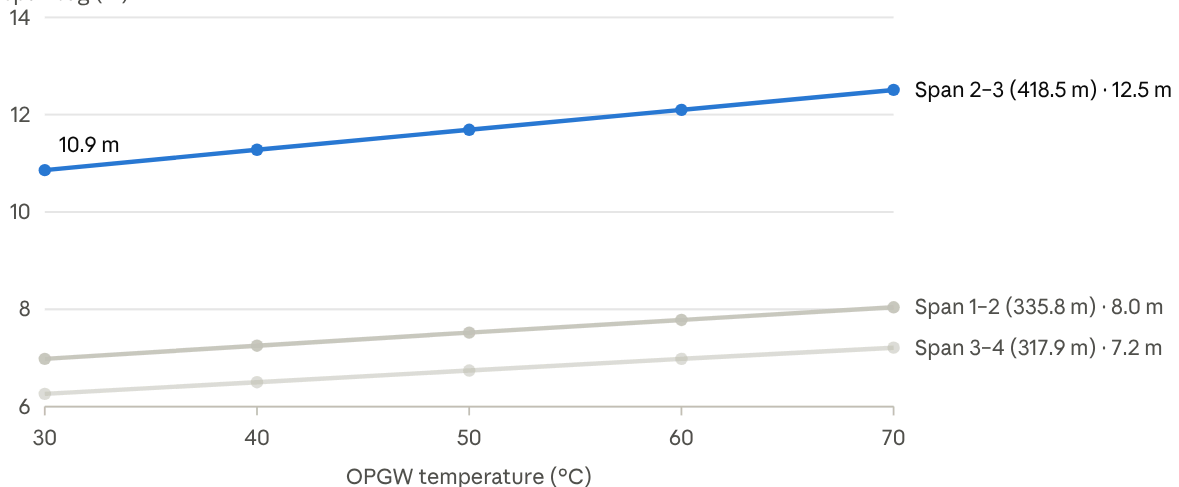
The OPGW reads exactly like the Condor chart, but it is strung much tighter, so its sag is smaller and its tension is higher. The table is section 3 of the report.

Quantity	Span (length)	30 °C	40 °C	50 °C	60 °C	70 °C
Mid-span sag (m)	1 to 2 (335.8 m)	6.98	7.25	7.52	7.78	8.04
Mid-span sag (m)	2 to 3 (418.5 m)	10.86	11.28	11.69	12.10	12.51
Mid-span sag (m)	3 to 4 (317.9 m)	6.26	6.50	6.74	6.98	7.21
Wave time (s)	1 to 2	14.31	14.58	14.85	15.11	15.36
Wave time (s)	2 to 3	17.85	18.19	18.52	18.85	19.16
Wave time (s)	3 to 4	13.55	13.81	14.06	14.31	14.55
Horizontal tension (N)	all spans	18,770	18,074	17,432	16,838	16,293
Catenary constant (m)	all spans	2,020.43	1,945.52	1,876.46	1,812.53	1,753.78

The OPGW sags about half as much as the conductor, and also grows with heat

Span 2-3 (418.5 m): 10.86 m at 30 °C rising to 12.51 m at 70 °C

Mid-span sag (m)



PLS-CADD stringing chart report, section 3 (OPGW, Initial RS) · 3 spans x 5 temperatures

How to read it. In the longest span (2 to 3) the OPGW sag rises 1.65 m between 30 and 70 °C, about 4 cm per degree. That is a 15% change, against about 5% for the Condor. Its tension falls by 2,477 N, or 13.2%.

The report lists a different governing weather case for the OPGW (-1C, no wind) than for the Condor (80C, no wind), so the two wires are controlled by different limiting conditions. The OPGW also keeps a lower sag than the phase conductors, which helps it stay above them at mid-span.

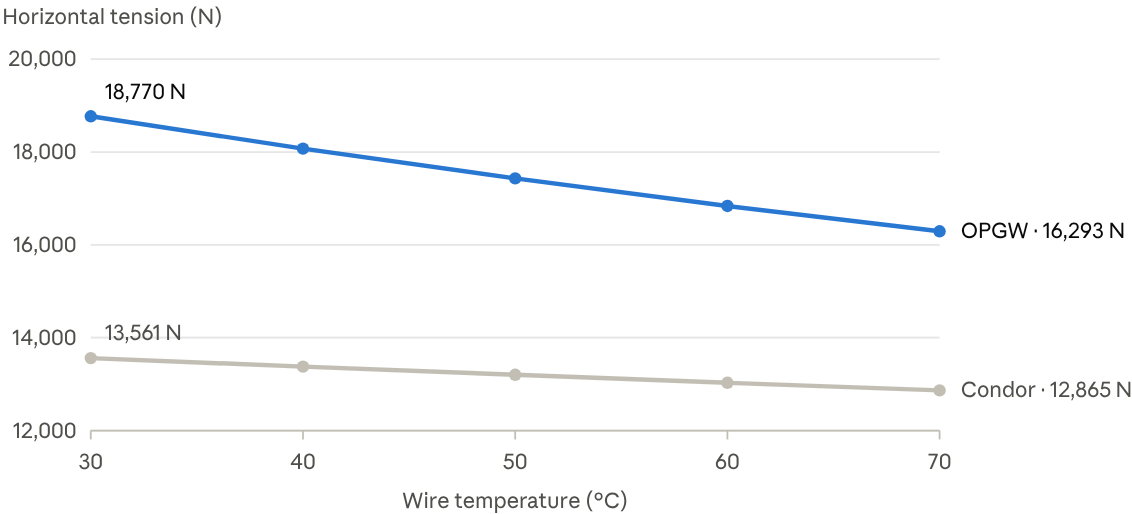
Conductor and OPGW compared

The OPGW is pulled harder than the Condor, sags about half as much, and gives up tension faster as the wire heats.

The OPGW loses tension faster than the Condor as the wire heats

OPGW: 18,770 N at 30 °C falls to 16,293 N at 70 °C, down 13.2%

Condor: 13,561 N at 30 °C falls to 12,865 N at 70 °C, down 5.1%



PLS-CADD stringing chart report, sections 1 and 3 (Initial RS) · horizontal tension at 5 temperatures

The table compares the sag of the two wires in each span at the two ends of the chart.

Span	Condor / OPGW sag at 30 °C (m)	OPGW as a share of Condor at 30 °C	Condor / OPGW sag at 70 °C (m)	OPGW as a share of Condor at 70 °C
1 to 2	15.24 / 6.98	46%	16.07 / 8.04	50%
2 to 3	23.74 / 10.86	46%	25.03 / 12.51	50%
3 to 4	13.67 / 6.26	46%	14.42 / 7.21	50%

The share rises with temperature because the OPGW sag grows faster in percentage terms. Its tension also changes more with temperature, so a wrong temperature reading matters more when stringing the OPGW than when stringing the Condor.

Creep and the final conditions

The stringing chart shows the wire as installed, but over the years the wire stretches permanently and sags more. PLS-CADD reports that stretch as an equivalent temperature rise: the wire behaves as if it were that many degrees hotter.

Equivalent temperature increase (°C)	Condor, circuit 1	Condor, circuit 2	OPGW
Final after creep (20C, no wind)	13.6	13.4	19.8
Final after load (-1C, 430 N/m ² wind)	2.6	2.6	2.8

The report also shows the Condor's catenary constant falling from 946.3 m (initial) to 851.3 m (after creep). That is about 10% lower, which means roughly 11% more sag. For the OPGW the constant moves only from 2,139.9 m to 2,110.7 m, about 1.4% more sag.

The practical rule: crews string to the Initial chart, but clearances to ground, roads and other lines must be checked on the final condition, because that is the sag the line will have for most of its life.

Worked example: stringing at 45 °C

Suppose the wire temperature is 45 °C. The chart has no 45 °C column, so take the midpoint between the 40 °C and 50 °C columns. The change across 10 °C is nearly a straight line, so this is accurate for field use. The example uses the longest span, 2 to 3 (418.5 m).

Wire	Sag at 40 / 50 °C (m)	Sag to set at 45 °C (m)	Tension at 40 / 50 °C (N)	Tension at 45 °C (N)	Wave time at 40 / 50 °C (s)	Wave time at 45 °C (s)
Condor	24.06 / 24.39	24.23	13,377 / 13,201	13,289	26.57 / 26.75	26.66
OPGW	11.28 / 11.69	11.49	18,074 / 17,432	17,753	18.19 / 18.52	18.36

1. Measure the wire temperature, not only the air temperature. A wire in direct sun can be several degrees hotter than the air.

2. Pick the span the crew will observe and read its sag for that temperature.
3. Pull the wire until the mid-span sag matches, using sag targets on the towers or the wave-time check.
4. Clamp in. Because the section is designed on its ruling span, the other spans settle to the right sag by themselves.

Summary

- Hotter wire sags more and pulls less. This holds for both wires, in every span.
- The whole section has one tension at a given temperature. Sag differs by span because it grows with the square of the span length.
- The OPGW sags about half as much as the Condor (46% to 50%) because it is pulled much tighter, and its tension is more sensitive to temperature.
- The chart is the Initial condition. Final sags after creep are larger, so check clearances on the final condition.
- On site, use the wire temperature, interpolate between columns, and confirm with the wave-time check.