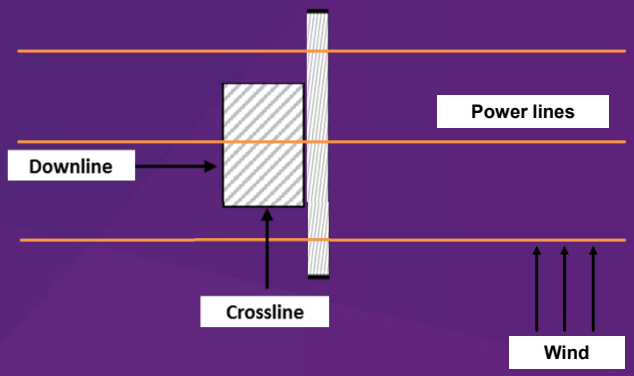
POWERCO

A Statistical Survey of Powerco Network Prestressed Pole Strength

Crossline Test and Downline Test



Presented by: Kevin Chang

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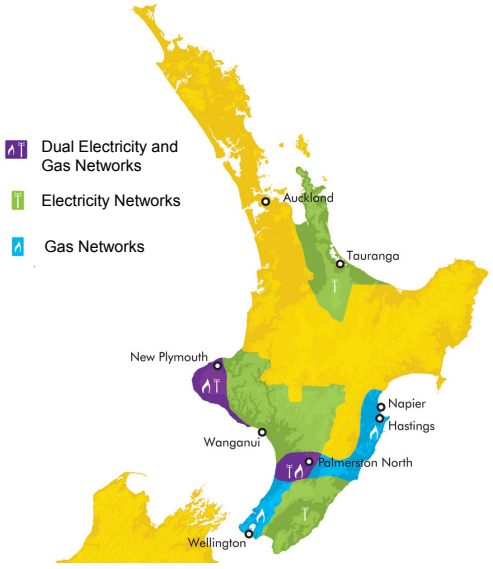
Powerco Limited

- One of the only two dual distributors in New Zealand (electricity and gas)
- The NZ longest electricity distribution network (30,000 km)
- The NZ largest energy distribution area (39,000 km^2)
- Around 264,000 poles across Powerco's network



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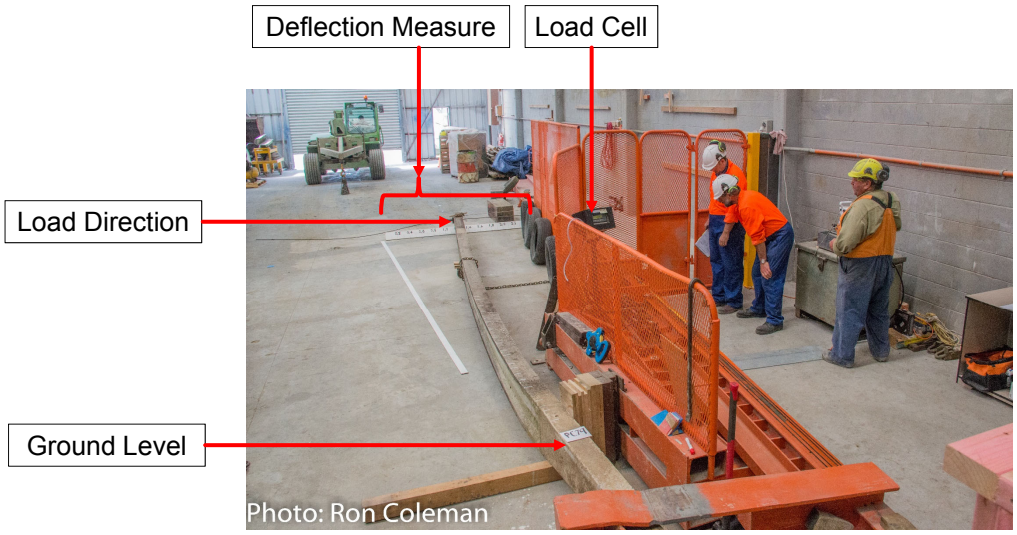
Busck's Pole Testing Facility



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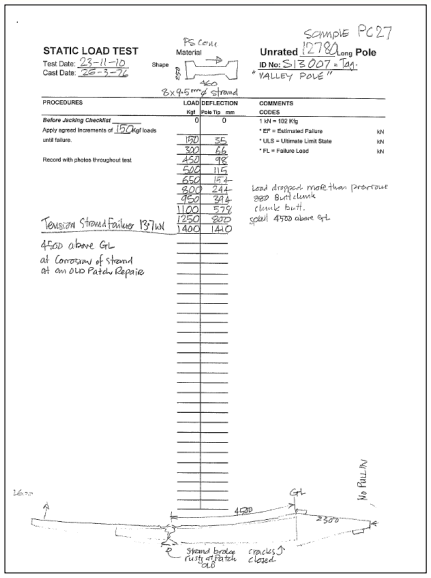
Pole Test Data Sheet

- A pole test data sheet contains:
  - Loading force information
  - Deflection information
  - Test date
  - Cast date
  - Pole height
  - Pole ID
  - Sketches of the pole



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Objective

- Analyse Powerco destructive pole testing results to give selected pole types a safety rating.
- Analyse the testing results against Powerco's current standard for pole strength and deflection.
- Comment on the method used to calculate safety ratings from the industry standard.
- Provide comments on the observations of pole testing.
- Provide recommendations from test results and future testing.

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Coefficient of Variation and the Corresponding Divisor AS/NZS 4676-2000

- Safety Max Strength = Lowest Test Result / Divisor
- Minimum values of coefficient of variation when no CoV available: Steel – 5%, Concrete – 5%

VALUES OF MULTIPLIER FOR TEST LOAD FOR ESTIMATED COEFFICIENT OF VARIATION

No. of similar units tested[1]	Coefficient of variation of structural characteristics					
	5%	10%	15%	20%	25%	30%
1	1.20	1.46	1.79	2.21	2.75	3.45
2	1.17	1.38	1.64	1.96	2.36	2.86
3	1.15	1.33	1.56	1.83	2.16	2.56
4	1.14	1.30	1.50	1.74	2.03	2.37
5	1.13	1.28	1.46	1.67	1.93	2.23
10	1.10	1.21	1.34	1.49	1.66	1.85
30	1.07	0.15	1.24	1.34	1.46	1.60
50	1.05	1.10	1.17	1.24	1.33	1.42
100	1.00	1.00	1.00	1.00	1.00	1.00

MINIMUM VALUES OF COEFFICIENT OF VARIATION (CV) FOR DIFFERENT MATERIALS AND ACTION EFFECTS

Material	Minimum CV%			
	Steel	Concrete	Timber	
Method of manufacture or assembly	All welded	Spun or cast	Stress graded	Visually graded
Bending	5	5	25	30

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Steps of Calculating CoV and Safety Limit

1. Find the standard deviation and mean of the failure forces
2. Coefficient of Variation = standard deviation / mean
3. If only 1 testing data exists, then it has no standard deviation. Hence, 5% of CoV from the standard should be used.
4. Use the CoV calculated and the testing sample number to find the corresponding divisor in the table.
5. Safety Maximum Strength = Lowest Test Result / Divisor

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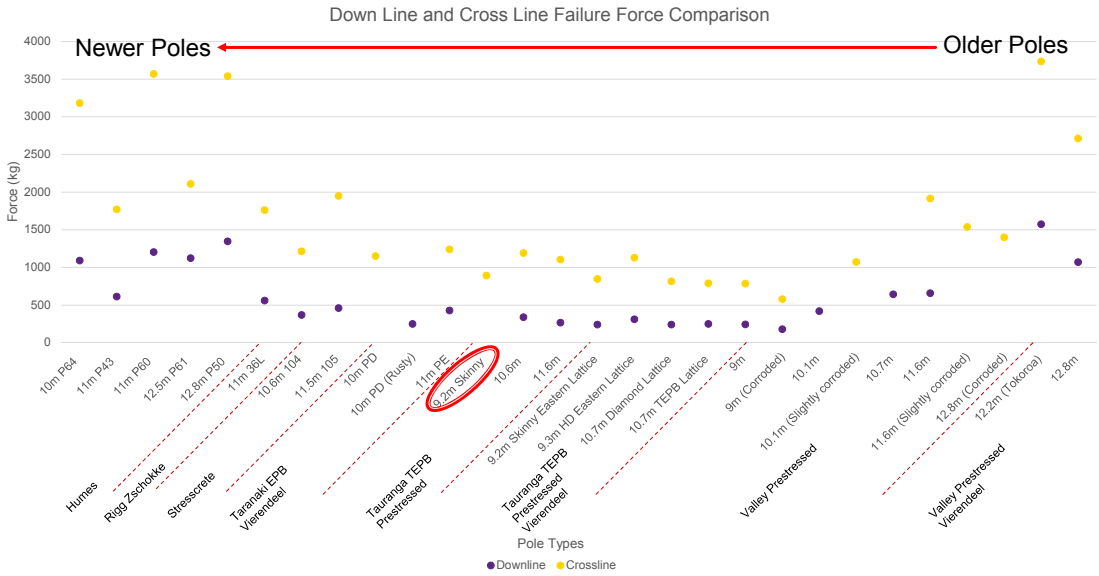
Down Line and Cross Line Failure Force Comparison



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Safety Limit According to Testing Results AS/NZS 4676-2000

- Red means only 1 testing data, so 5% minimum value of coefficient of variation was used.

Safety Limit

		Down Line		Cross Line	
		C of Variance	Strength (kg)	C of Variance	Strength (kg)
Humes	10m P64	5%	908.33	5%	2652.00
	11m P43	5%	510.00	15.9%	924.00
	11m P60	5%	1003.00	5%	2975.00
	12.5m P61	5%	935.00	5%	1757.80
	12.8m P50	5%	1122.00	5%	2949.50
Rigg Zschokke	11m 36L	5%	466.67	5%	1466.67
Stresscrete	10.6m 104	5%	306.00	5%	1011.50
	11.5m 105	5%	383.33	5%	1625.00
Taranaki EPB Vierendeel	10m PD (Rusty)	5%	208.33		
	10m PD			5%	958.33
	11m PE	5%	355.83	5%	1033.33
Tauranga TEPB Prestressed	9.2m Skinny			5%	741.67
	10.6m	16.2%	176.47	3.4%	1038.21
	11.6m	12.8%	171.21	2.7%	981.63
Tauranga TEPB	9.2m Skinny Eastern Lattice	7.2%	188.52	3%	745.45
Prestressed Vierendeel	9.3m HD Eastern Lattice	5%	258.33	5%	941.67
	10.7m Diamond Lattice	5%	200.00	9.5%	558.82
	10.7m TEPB Lattice	5%	208.33	5%	658.33
Valley Prestressed	9m	4.6%	204.91	9.3%	612.86
	9m (Corroded)	5%	149.60	5%	482.80
	10.1m	5%	348.50		
	10.1m (Slightly corroded)			5%	892.50
	10.7m	5%	535.50		
	11.6m	3.7%	565.96	6.1%	1545.43
	11.6m (Slightly corroded)			5%	1281.80
	12.8m (Corroded)			5%	1166.67
Valley Prestressed Vierendeel	12.2m (Tokoroa)	2.2%	1434.61	2.5%	3366.94
	12.8m	5%	891.67	5%	2261.00

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Pole Climbing Cautions

The following poles are cautioned with downline rating under 400kg and/or crossline rating under 800kg, these poles are recommended for special attention when climbing especially when unbinding conductors. The Valley 9, 10.1, 10.7, 11.6 and 12.8m poles are cautioned due to internal corrosion.

Safety Limit

		Down Line Strength (kg)	Cross Line Strength (kg)
Stresscrete	10.6m 104	306.00	1011.50
	11.5m 105	383.33	1625.00
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	12.8m (Corroded)		1166.67

A Valley Pole

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Allowable Pole Deflection Ratio and Minimum Ultimate Limit State (ULS) 393S082A Powerco New Poles Standard

- Allowable Pole Deflection Ratio:
  - No less than 10%
  - No more than 15%
  - When at the poles Breaking Load (BL) limit

Nominal Overall Pole Length (metres)	Minimum ULS (kN)	
	Crossline	Downline
7.5	17	5
9.5	13	4
10.0	18	8
11.0	20	7
12.5	21	7
14.0	32	8
15.5	32	8
17.0	32	8
18.5	32	8

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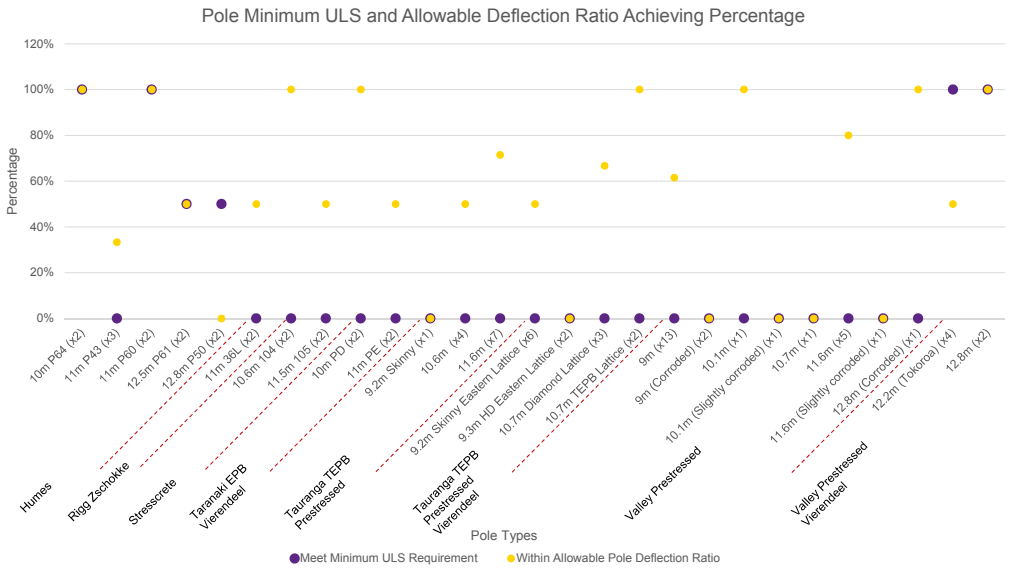
Allowable Pole Deflection Ratio and Minimum ULS 393S082A Powerco New Poles Standard



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Valley Poles (9, 10.1, 10.6, 11.6, 12.8)

- The Valley prestressed poles have two corrosion issues, which can be present without a visual indicator.
  1. The pole contained a flat concrete block, which is too smooth to bond with the cement mixture. This allows moisture to seep in and cause corrosion of the steel.
  2. Insufficient concrete cover has allowed internal corrosion of the steel.
- The Valley 9 pole has up to 5 variations, but they used the same spreader block and the same corrosion problems still exist.

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Valley 9m Pole

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Valley 10.1m Pole

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Valley 11.6m Pole

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Conclusion

- The Humes, Stresscrete and Riggs Zchokke poles tested were all in new unused condition, therefore age degradation factors have not affected these poles.
- Concrete cover over steel are factors in pole internal corrosion, and pole design such as the spreader block on Valley poles may cause corrosion.
- The limited number of samples for each pole type has an impact on the CoV factor, and a low quantity of test samples can alter the ULS value.
- Testing visibly corroded or damaged poles is not useful for obtaining an ULS value for good conditioned poles.

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Conclusion Continued

- All the Tauranga TEPB poles are weak.
- The Stresscrete (BP) 104, and 105 poles are weak downline.
- The Taranaki Vierendeel poles are weak downline.
- More testing on all the Valley poles is recommended, age and geographic location profiles may be able to be plotted.
- Any rust staining, damaged, or visible corrosion to the steel tendons of prestressed (including Vierendeel) poles should be defected and treated with caution.

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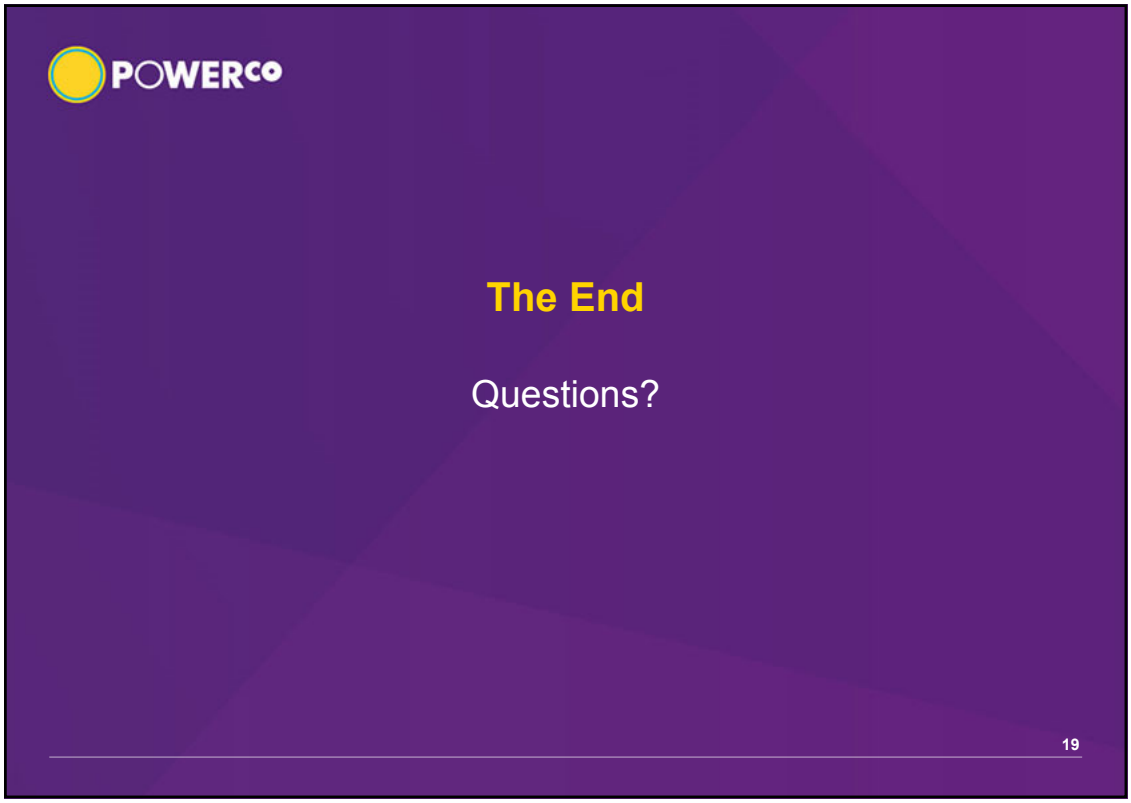

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