



# Ground Stay Anchor Testing & Design Implications

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# Introduction - Antony

- Reticulation Manager
- Connetics 2003
- Energex and Ergon networks Australia

# Introduction - Andrej

- Andrej Kujikis
- Principal Lines Engineer – Lumen
- Transpower  
(5 years)
- Canada, Ireland, Scotland  
(SSEPD)
- Back to NZ with Lumen  
(1.5 years)



# Today we'll discuss

- Suitability and performance of hardwood and alternative ground anchors
- Testing Summary and Outcomes
- Design Implications and Considerations

# Testing Objectives

- Anchors to be installed to replicate field conditions
- Measure pull out capacity of anchors
- Compare the capacity of different anchor types
- Identify failure mechanisms
- Compare practical field implications

# Anchor Types

## Standard Construction Anchors

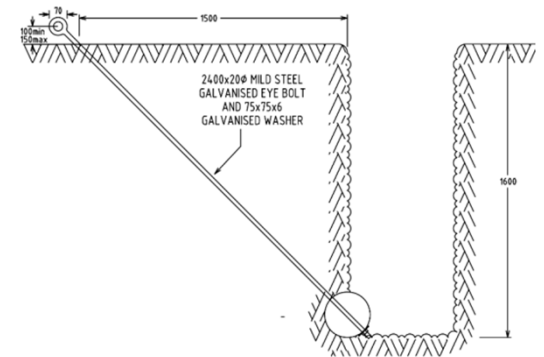
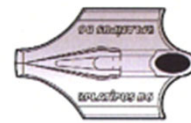
- One concrete anchor block and three hardwood blocks of varying dimensions
- Mild steel galvanised anchor rods

## Platipus Percussion Driven Earth Anchors

- 3m long plastic impregnated tendons

# Anchors Evaluated

- Standard Anchors
  - Busck FB450 concrete anchor and 1.38m 20mm  $\varnothing$  eye bolt
  - 2m hardwood block and 2.0m 20mm  $\varnothing$  eye bolt
  - 2m hardwood block and 2.4m 20mm  $\varnothing$  eye bolt
  - 3m hardwood block and 2.7m 24mm  $\varnothing$  eye bolt
- Percussion Driven Mechanical Anchors
  - Platipus B10
  - Platipus B8
  - Platipus B6
  - Platipus B4



# Considerations

- Environmental constraints
- Ground conditions
- Equipment
- Reinstatement
- Pull out capacity
- Time and cost

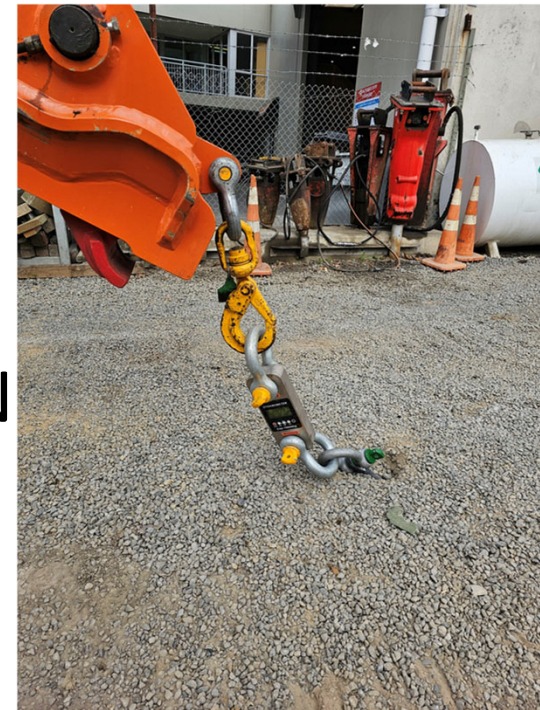


# Test Site Ground Conditions

- NZGD records identified CPT, SPT and borehole tests carried out in close proximity to the test site
- Moist, poorly graded, loose fine sand to ~2000mm depth
- Scala Penetrometer Tests indicated 100mm fall per blow at 1600 – 2000mm
- No groundwater encountered during installation of the standard anchors
- SPT results indicate relatively weak soil conditions

# Testing Methodology

- 25T excavator used for pull out testing
- Calibrated wireless dynamometer
- Incremental loading applied
- Maximum available applied load = 100kN



# Testing Videos



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# Test Results

## Standard Anchors

- No failure observed at 100kN test limit
- Minimal displacement

## Percussion Driven Mechanical Anchors

- B10 – 79kN
- B8 – 74kN
- B6 – 76kN
- B4 – 73kN

All failures were from tendon fracture

# Summary – Standard Anchors

- Standard anchors were unable to be tested beyond the 100kN capacity limit of the testing apparatus
- Minimal displacement observed
- Installation of these anchors requires substantial excavation and reinstatement of the surrounding ground
- The concrete anchor block option offered lower bearing capacity resistance (57kN)\*

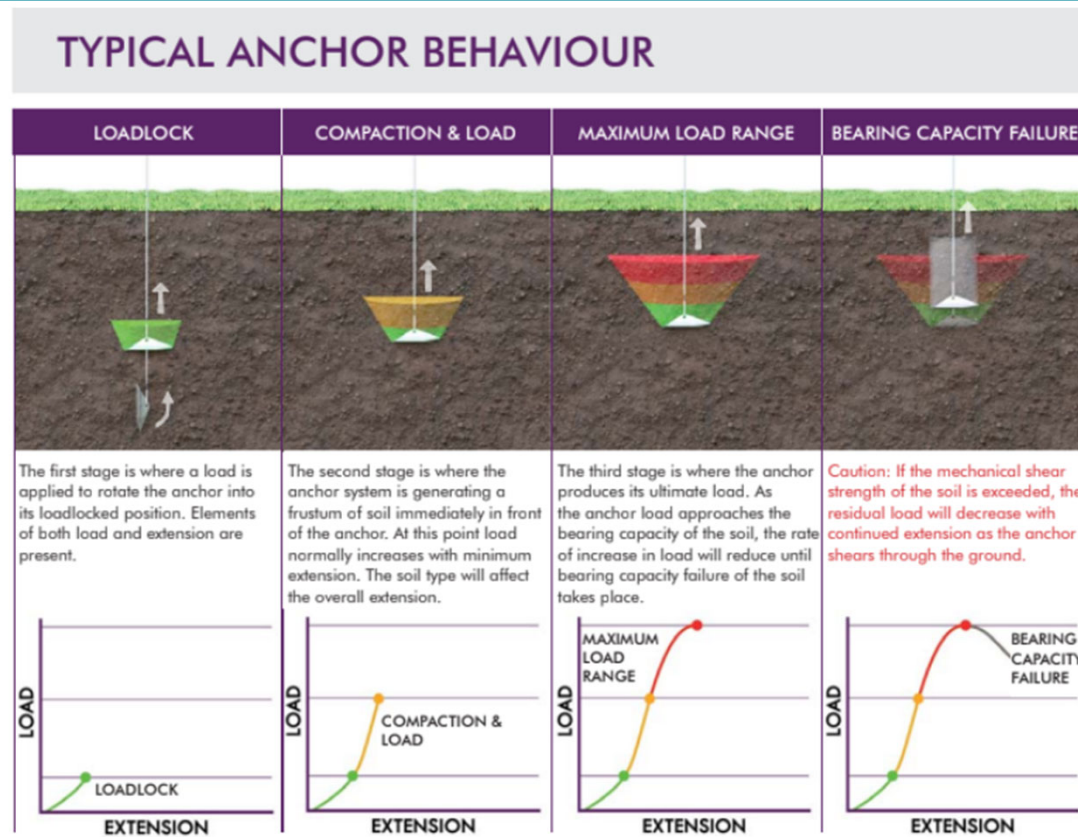
# Summary - Percussion Driven Mechanical Anchors

- All anchors failed between 73kN to 79kN
- The failure mode for all units was the fracture of the wire tendon and not geotechnical pullout\*
- The failure mode indicates that the geotechnical holding capacity could be achieved with upgraded wire tendons or solid rods
- This system offers a distinct advantage regarding installation efficiency with minimal environmental disturbance

# Design Implications

GROUND ANCHOR	CAPACITY AT 100MM DISPLACEMENT
Concrete anchor block – 1200 x $\phi$ 20 eye bolt	57kN - failed
2000 x $\phi$ 300 hardwood – 2400 x $\phi$ 20 eye bolt	100kN
3000 x $\phi$ 300 hardwood – 2700 x $\phi$ 24 eye bolt	100kN
2000 x $\phi$ 300 hardwood – 2000 x $\phi$ 20 eye bolt	75kN
B10 Platipus Bat anchor – 3m long tendon	15kN
B8 Platipus Bat anchor – 3m long tendon	15kN
B6 Platipus Bat anchor – 3m long tendon	8kN
B4 Platipus Bat anchor – 3m long tendon	8kN

# The Expected Load Curve

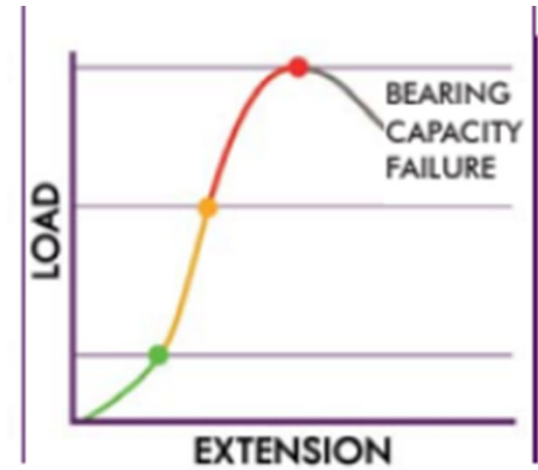
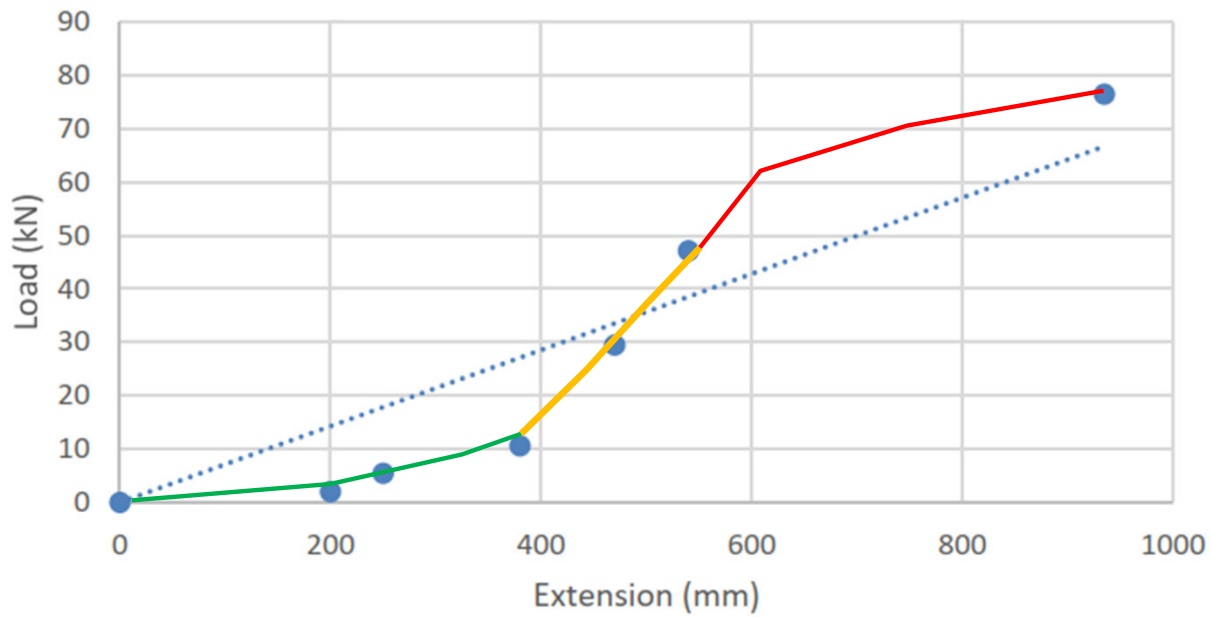


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# Tested Load Curve – B6

Platipus B6 testing

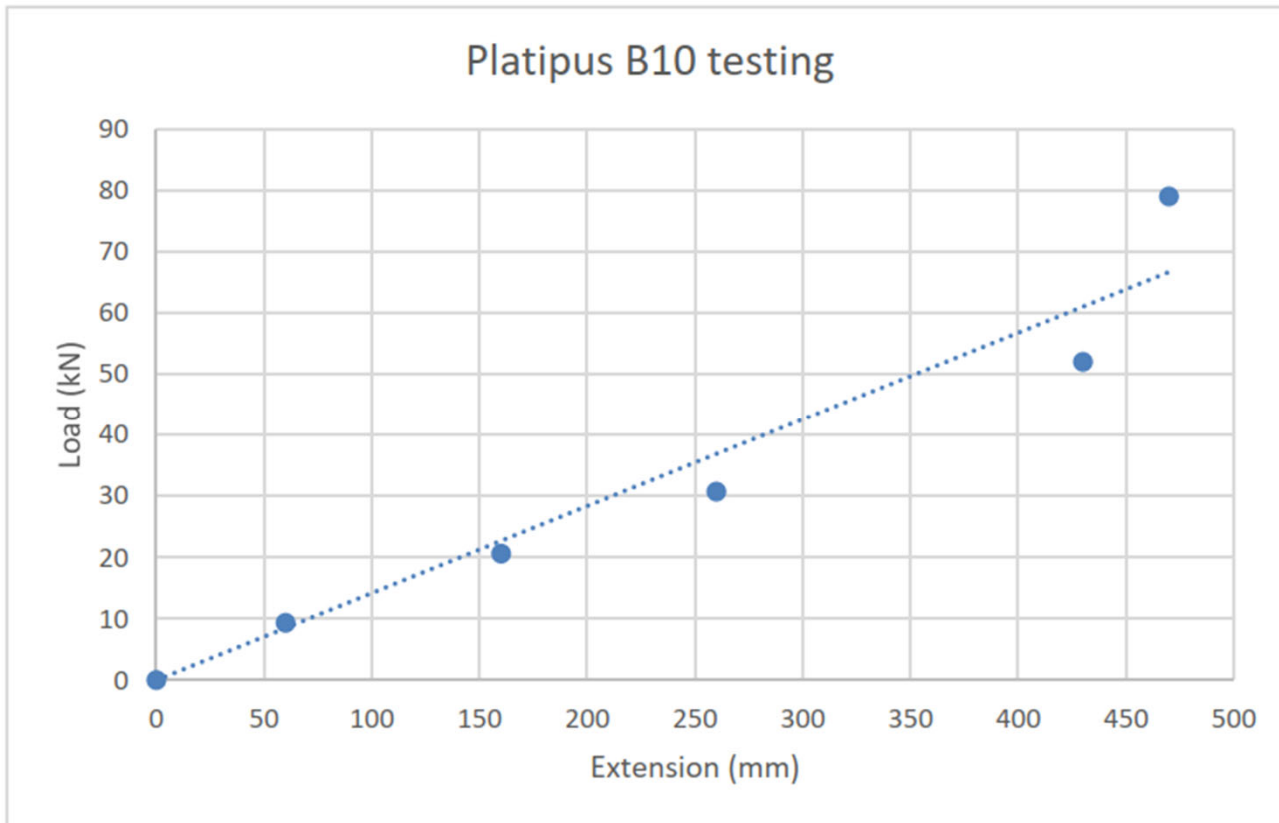


Slide 17

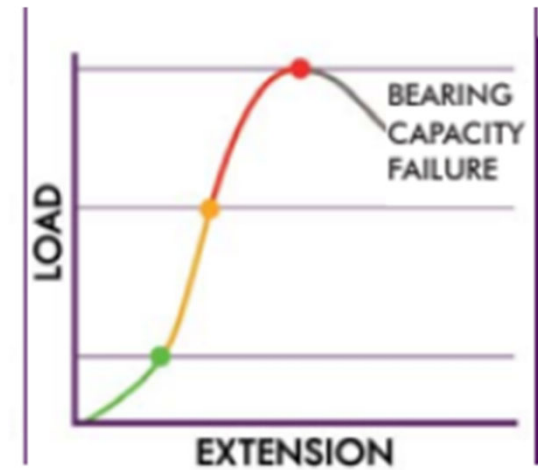
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# Tested Load Curve – B10



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# Typical Scenario – 30° Deviation

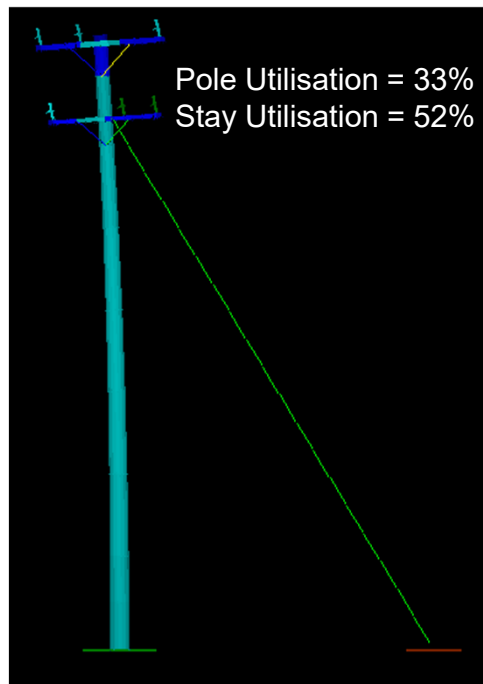
- Orion's Humble Str. CB110
  - OB3.1 , 33/11 kV, ACSR Dog
  - Site Elevation 172m (35mm Snow)
  - 14m 20 kN U HW
  - Replace w/1x guy, 7/3.15 Ø9.45mm
  - Guy angle -> 60° (site constrained)
  - 41m Ahead/33 m Back Spans



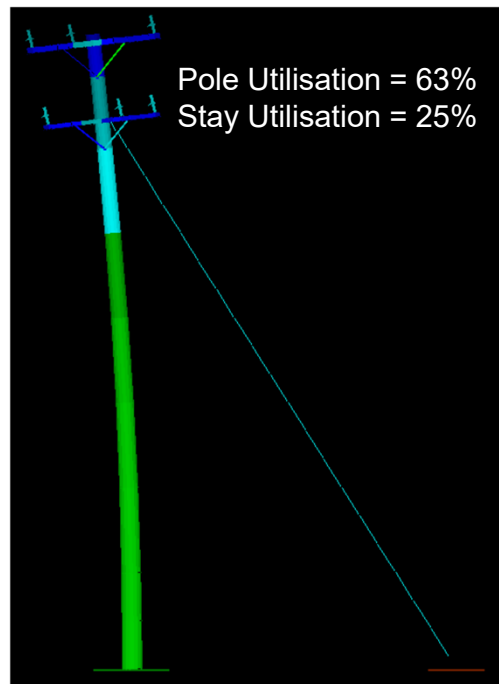
# Typical Scenario – CB110

## 20 kN U Hardwood Pole

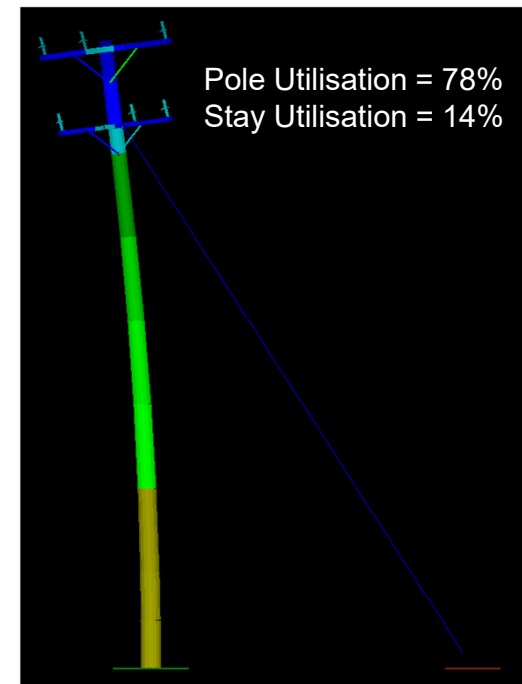
2000x300  
HW Anchor



B10 Anchor



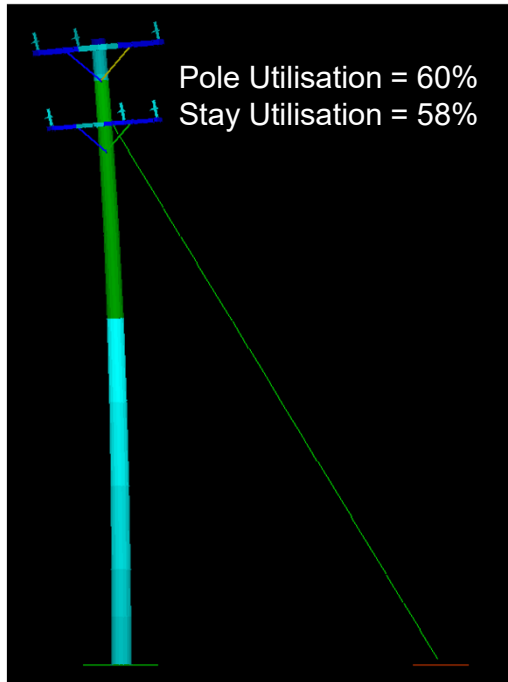
B4 Anchor



# Typical Scenario – CB110

## 12 kN U Softwood Pole

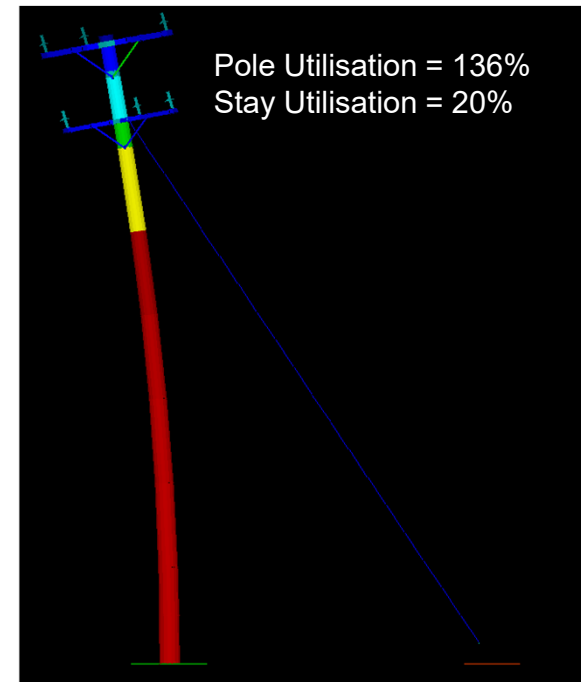
2000x300  
HW Anchor



B10 Anchor



B4 Anchor



# Summary – CB110

- Reducing the anchor stiffness will increase the pole loads and pole deflections.
- Higher utilisation poles have less tolerance for defects and degradation.

# Practical Implications to Consider

- Mechanical Anchors may be more sensitive to installation techniques when compared to standard anchors. I.e. higher installation quality/oversight required.
  - Ensure anchors are pulled out/activated?
  - Proof load prior to commissioning?
- If the installation is imperfect, how much pole deflection are you happy to accept?
  - Concrete and softwood poles may be more susceptible than hardwood poles.
- How much capacity do you expect from your guy wires/anchor system?

# Questions



FB450 failure site

# Notes

- Platipus anchor load calculator is based on Geotechnical failure
- Tendons were all plastic impregnated and 3m in length
- Tendons can be easily changed out for longer lengths
- BAT anchors were used as they are designed to achieve higher loads in soft cohesive soils
- Wire tendons can be replaced with solid rods
- Foundation rotation has not been considered
- Learnings:
  - Extension was not recorded accurately
  - Use of a theodolite to measure extension at various intervals
  - All anchors outperformed expected results
  - 2m long hardwood blocks look to be sufficient
  - Mechanical anchors performed well in poor soil conditions and within the manufacturer's load ranges
  - Large mechanical anchors are not required
  - Higher grade tendons could be used if required