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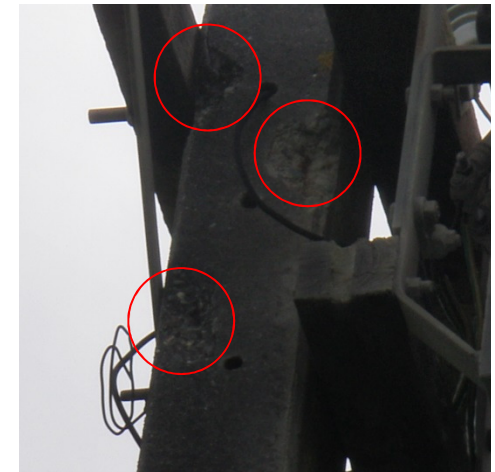
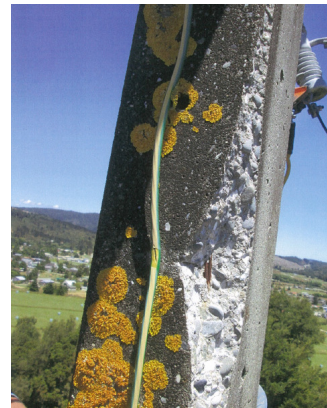
Concrete Specifications for Pre Stressed Power Poles

Corrosion of Reinforcing

- Concrete is permeable
 - Chloride salts penetrate, developing carbonation
 - Below ground, and above ground in coastal environments, generally worst affected
 - Carbonation results in cracking, further accelerating corrosion – Could be below ground and go unnoticed!



Corrosion of Reinforcing



How do we lower the permeability?

- Using supplementary cementitious materials (SCM)
- Using a lower water-to-binder ratio (0.4 – 0.5)
- Increasing concrete cover thickness
- Apply protective coating
- Galvanise the reinforcing
- Cathodic Protection
- Seal the base of spun concrete poles

Table 3.7 – Minimum required cover for a specified intended life of 100 years

Exposure classification	Cement binder type	Specified compressive strength f_c (MPa)						
		25	30	35	40	45	50	60 – 100
Minimum required cover (mm)								
A1	GP, GB or HE	35	30	30	30	30	30	25
A2	GP, GB or HE	50	40	40	35	35	35	30
B1	GP, GB or HE	55	50	45	40	40	35	30
B2	GP, GB or HE	-	65	55	50	45	40	35
C ⁽¹⁾	30 % FA	-	-	-	-	70	60	60
C ⁽¹⁾	65 % GBS	-	-	-	-	60	50	50
C ⁽¹⁾	8 % MS	-	-	-	-	-	50	50

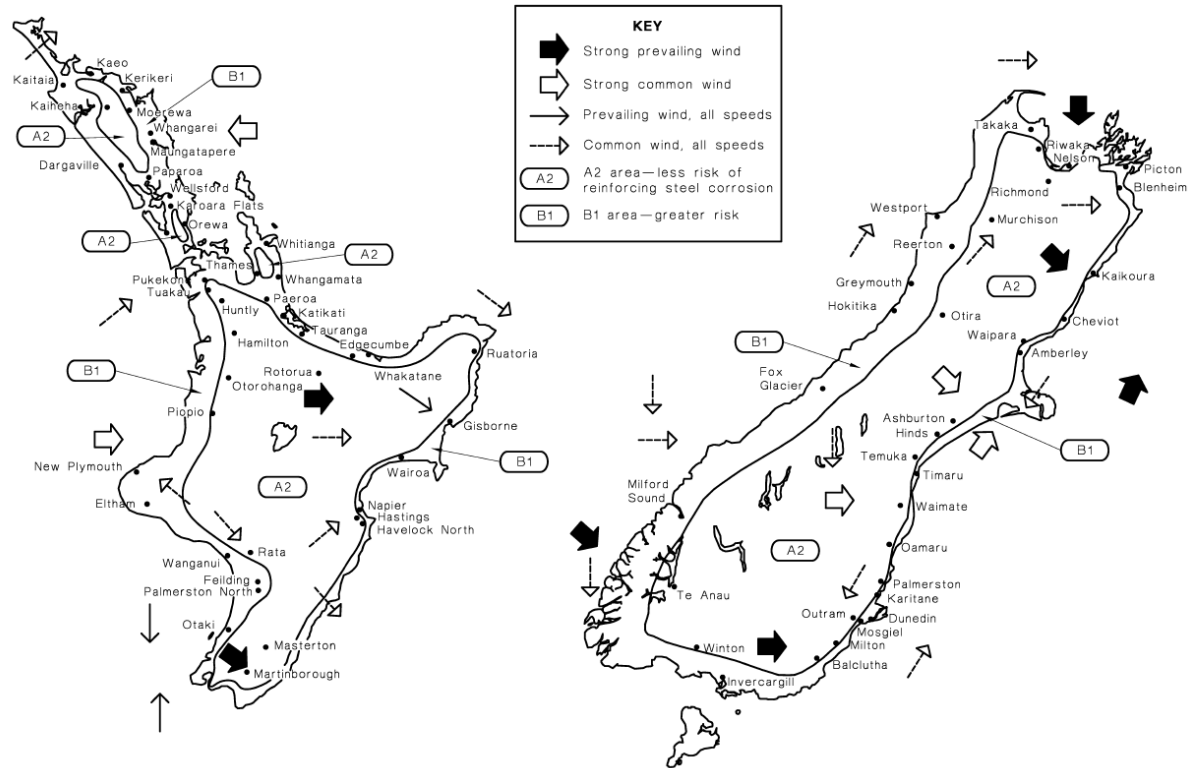
NOTE –
 (1) For zone C the total binder content shall be equal to or greater than 350 kg/m³ and water to binder ratio shall not exceed 0.45.
 (2) The minimum cover for the C zone shall be 50 mm.

NZS 3101: 2007 - Table 3.7

Applicable Standards

- AS/NZS 3101:2006 – The Design of Concrete Structures
- AS/NZS 4065:2010 - Concrete Utility Services Poles
- AS/NZS 4676:2000 – Structural design requirements for utility services poles

4676 defines Exposure classes for NZ. Exposure class 'C' is only considered for Active volcanic/geothermal areas or poles within 1 km from a coastline with prevailing onshore winds.



Exposure Classes (AS/NZS 4676)

- Coastal regions 500m from high tide – B2
- Near-coastal and Inland (Industrial) – B1
- Inland (non-industrial) – A2
- Active volcanic/geothermal areas, or poles within 1 km from a coastline with prevailing onshore winds, or aggressive soil/groundwater – C

What is the service life of poles in exposure class C?

As per AS/NZS 4676 – Table D2, the suggested nominal service life of a concrete pole with 19mm cover in exposure class C is 50 years providing it has been designed to inhibit corrosion.

NZS 3101 states a minimum cover of 50 mm of concrete with SCM to achieve an intended life of 50 years in exposure class C.

Which is correct?

TABLE D2
SUGGESTED RANGE OF NOMINAL SERVICE LIFE OF STEEL AND CONCRETE POLES

Exposure class	Suggested nominal service life (years)			
	Galvanized steel ⁽⁵⁾			Concrete
	200 g/m ²⁽¹⁾	400 g/m ²⁽¹⁾	600 g/m ²⁽¹⁾	C ⁽²⁾
A1	60–100+	100+	100++	100+
A2	25–60	60–100	75–100+	80–100
B1	12–25	25–50	35–75	60–80
B2	8–25	15–50	35–75	50–60
C ⁽³⁾	3–12 ⁽⁶⁾	6–25 ⁽⁶⁾	9–35 ⁽⁶⁾	50 ⁽⁴⁾

Table 3.6 – Minimum required cover for a specified intended life of 50 years

Exposure classification	Cement binder type	Specified compressive strength f_c (MPa)							
		20	25	30	35	40	45	50	60 - 100
		Minimum required cover (mm)							
A1	GP, GB or HE	25	25	20	20	20	20	20	20
A2	GP, GB or HE	40	35	30	30	25	25	25	20
B1	GP, GB or HE	50	40	35	35	30	30	30	25
B2	GP, GB or HE	-	-	45	40	35	30	30	25
C ⁽¹⁾	30 % FA	-	-	-	-	60	60	60	55
C ⁽¹⁾	65 % GBS	-	-	-	-	-	50	50	50
C ⁽¹⁾	8 % MS	-	-	-	-	-	60	50	50

NOTE –
(1) For zone C the total binder content shall be equal to or greater than 350 kg/m³, and water to binder ratio shall not exceed 0.45.
(2) The minimum cover for the C zone shall be 50 mm.

Supplementary Cementitious Materials

- **Fly Ash** – By-product of coal combustion
- **Amorphous Silica** – Constituent of sand or produced synthetically
- **Ground granulated iron blast-furnace slag** – By-product of iron or steel production



Amorphous Silica

Pole #	Price Increase with 8% Micro Silica	% Increase
1	\$15.00	2.2%
2	\$30.00	3.8%
3	\$25.00	3.1%
4	\$20.00	2.3%
5	\$45.00	1.5%

- Most common SCM in NZ
- High availability
- Low effect on Concrete composition
- Low cost – 1.5% - 3.8% increase per pole

Conclusion



- SCM's are proven in the construction industry and lab tests
- Will improve pole lifetime, dramatically in some locations, for minimal cost
- Poles that may be erected in exposure class C should be specified as such