eea | Electricity Engineers' Association

ASSET MANAGEMENT

2017

Asset Management Forum
Welcome
Wednesday 21 June

EEA.CO.NZ

Programme Day 2

8.00am	**Tea & Coffee**	
8.30am	Opening Remarks: **Mike Whaley — EEA AMG Chair**	
8.35am	Theory of Conductor Aging Characteristics	**Mike Whaley** — EEA AMG Chair
8.50am	Conductor Conditions Assessment Working Group	**Dan Tombleson** — LineTech Consulting
9.05am	Northpower Conductor Testing Regime	**Russell Watson** — North Power
9.20am	Conductor Testing Facilities	**Aaron Tai** — Electropar
9.35am	Conductor Testing	**Joshua Butterfield & Cheeyew Ng** — Prysmian
9.45am	Southern Power Companies Overhead Line Design Forum	**Carl Rathbone** — PowerNet
10.00am	**Morning Tea**	
10.20am	Pole Tagging — Workshop	**Mike Whaley** — EEA AMG Chair
10.40am	Pole Stapling programme	**Bradley Singh** — Wellington Electricity Lines
10.55am	Concrete Pole Strength Analysis	**Mike Whaley** — Powerco
11.15am	Concrete Specifications for Pre Stressed Power Poles	**Rodger Griffiths** — Westpower / Mitton Electronet
11.30am	Pole Foundation Testing — Proposal for Industry Collaboration	**Carl Rathbone** — PowerNet
11.50am	Day 2 Closing Remarks	**Juliet Clendon** — EEA Technical Advisor
12 o'clock	**Close of 2017 Forum**	

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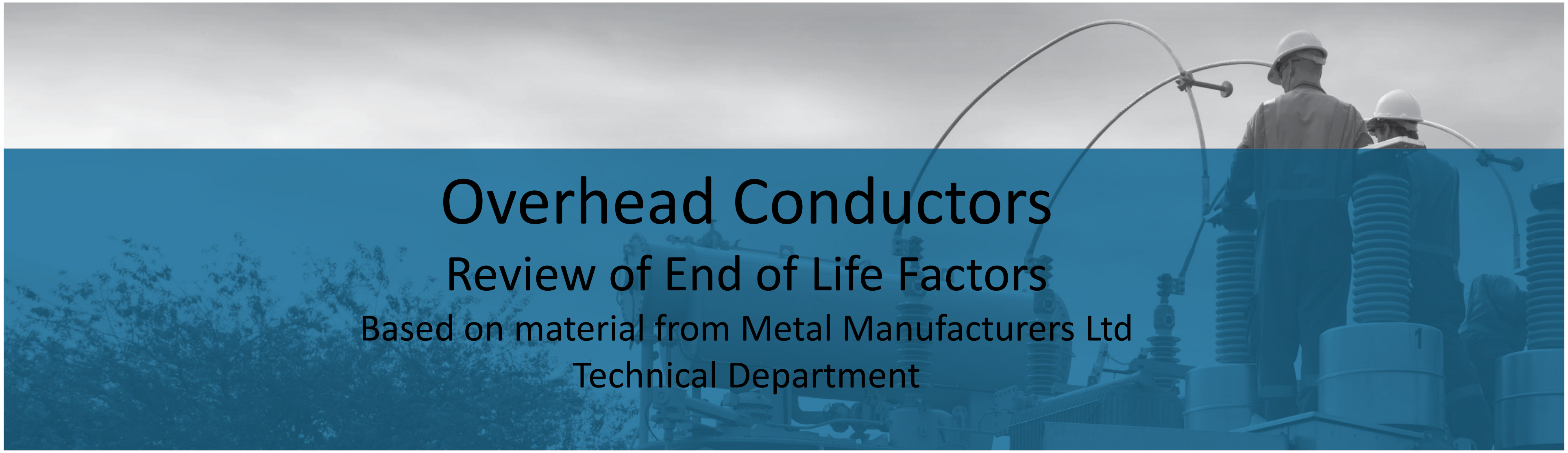

Overhead Conductors

Review of End of Life Factors

Based on material from Metal Manufacturers Ltd
Technical Department

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Overhead Conductor lengths in NZ

	Circuit Length (km)
Transmission HVDC (& earth electrode)	1,180
Transmission HVAC	15,400
Total Transmission	16,580
Subtransmission	9,697
Distribution	75,296
Low Voltage	26,950
Total Distribution	111,943
Street Lighting (OH & UG)	14,191

Source: 2016 ID for Transpower, 2015 ID for distribution

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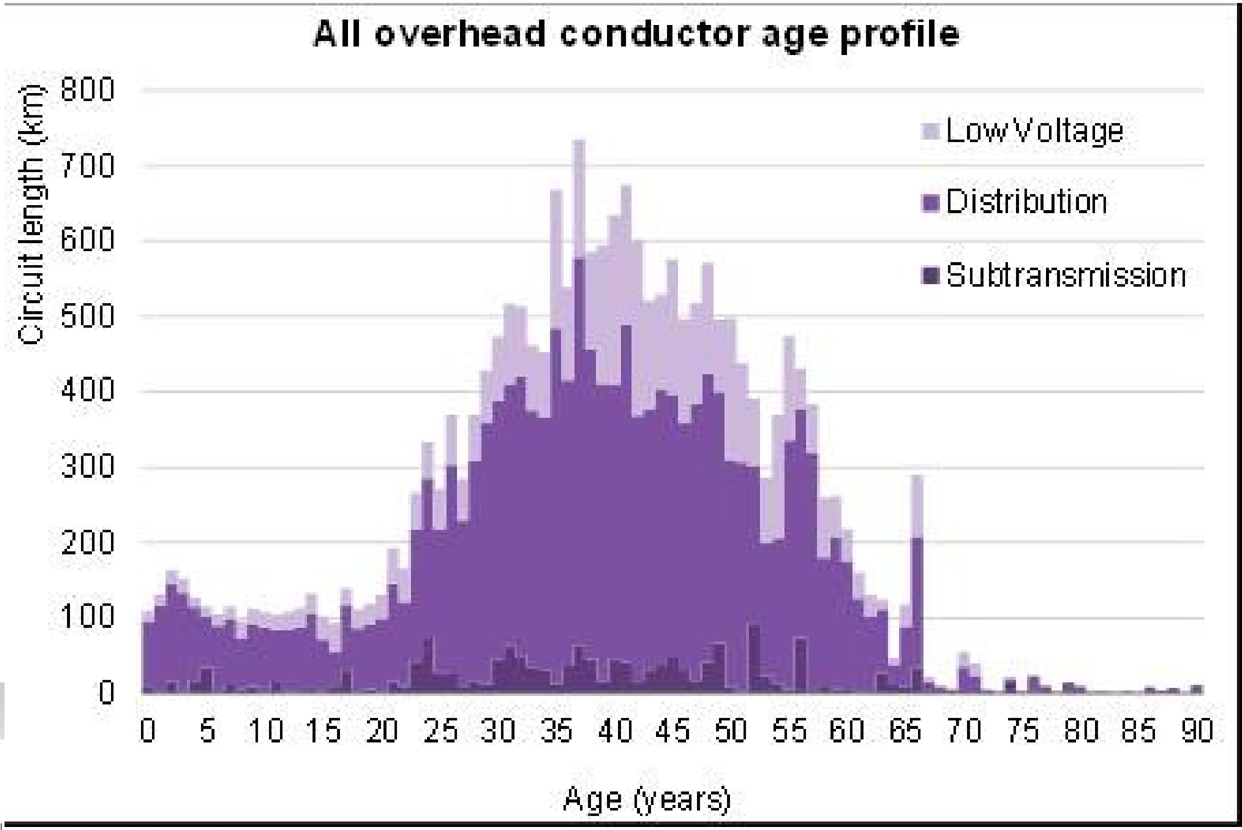
2005 Greymouth tornado, Ministry of Civil Defence and Emergency Management

Age Profile

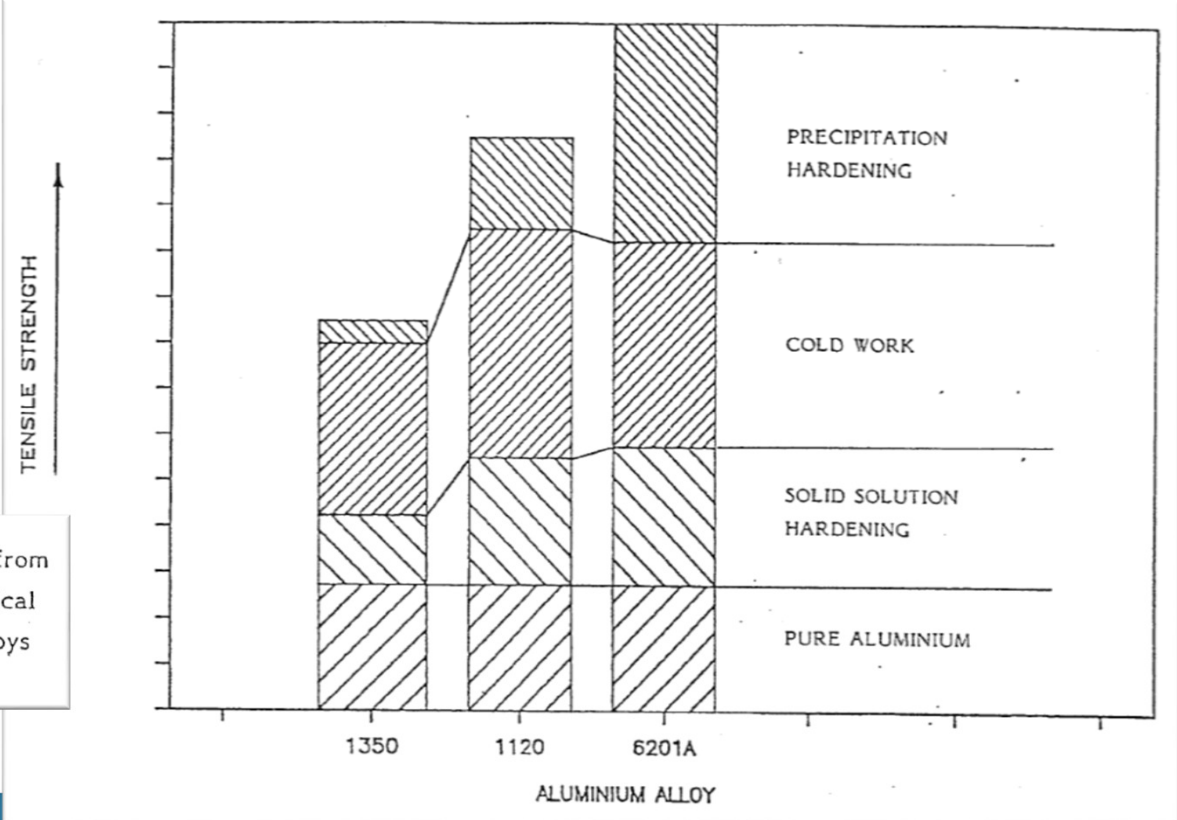

All overhead conductor age profile
Circuit length (km)
800
700
600
500
400
300
200
100
0
Low Voltage
Distribution
Subtransmission
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
Age (years)

Prevalent Conductor Types

AAC (1350 alloy)
AAAC (1120 alloy)
AAAC (6201A alloy)
ACSR (1350 alloy with steel core)
Aluminium clad steel
Hard drawn copper
Galvanised steel

Aluminium Alloy Strength

The strength of metals is the sum of contributions from several mechanisms. This schematic illustrates typical components of strength of the three aluminium alloys commonly used in stranded conductors.



Conductor Specifications

Deciding on your standard conductors

Grease or no grease? If so, what type of grease?

Identification of alloy type.

Treatment of steel core – galvanised or aluminised

Fittings – sleeves/ joints, deadends, terminations

Influences on End of Life - Conductor Damage

Contact with foreign objects like storm debris, vehicles

Conductor clashing causing arcs that damage conductor strands

Lightning strikes, fires

Gun shot damage

Loose clamps causing abrasion damage

Influences on End of Life - Annealing

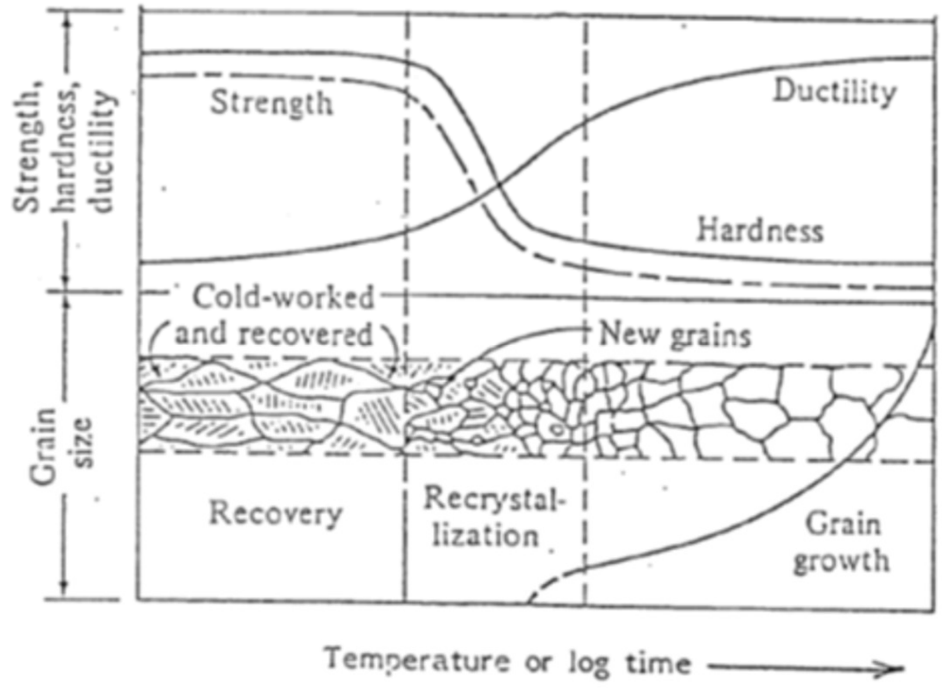
Occurs over temperature and time, affecting strength, resistivity and ductility

Involves diffusion of atoms within the crystalline structure

Often follows a three stage process:

1. Recovery phase
2. Re-crystallisation phase
3. Grain growth phase

Annealing Process



Schematic of the effect of annealing on the grain structure of cold worked metals.

Influences on End of Life - Corrosion

- Usually involves a complex combination of corrosion of individual wires, crevice corrosion and electromechanically enhanced corrosion.
- Corrosion susceptibility depends on the exposure materials:
  - Chlorides in coastal areas
  - Sulphur dioxide in industrial areas
- Wash from other metal salts such as copper
- Loss of galvanising on steel core.
- Grease is applied to prevent these chemicals from contacting the conductor in aqueous solution.

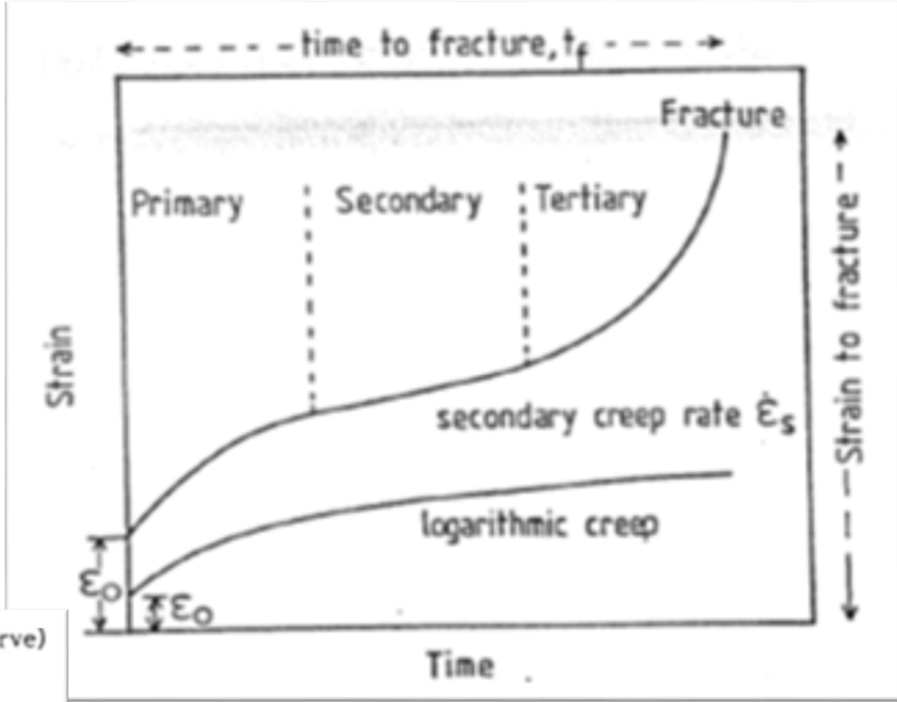
Influences on End of Life - Creep

An inelastic time dependant elongation

May cause lines to sag within ECP34 limits over time

Of concern mostly to transmission system circuits with long spans and long life towers

Includes strand settlement, strand embedment and metallurgical creep



Schematic of strain/time behaviour. Logarithmic behaviour (lower curve) is observed in the temperature range 0.3-0.4 T_m. Three stage creep (upper curve) is observed above about 0.4 T_m.

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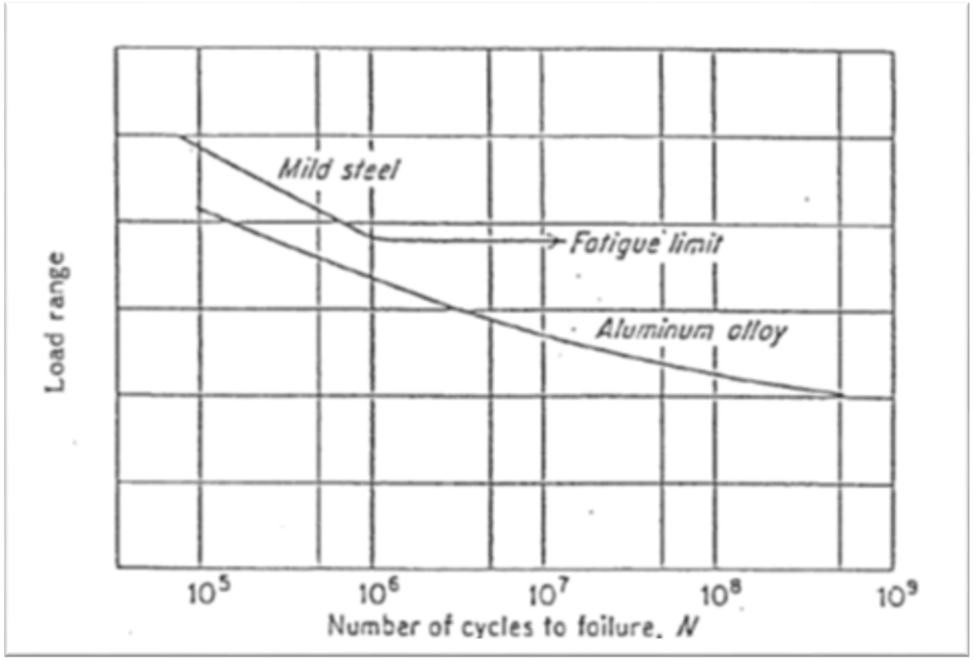
Influences on End of Life - Fatigue

Cyclic (dynamic) stresses superimposed on normal (static) stresses, after time cause fatigue cracks and eventual failure.

Static Stresses	Dynamic Stresses
Support, connection, termination hardware	Wind induced vibration
Conductor tension	Aeolian vibration
Conductor bend angle on clamps	

S – N Curves



Schematic of fatigue properties of metals. Aluminium and copper do not show a limiting fatigue stress, and fatigue strength is usually characterised by the fatigue stress at 10^8 cycles. This diagram is known as the S - N curve.

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Influences on End of Life - Fretting

Wear and corrosion at contact surfaces, such as between strands or at fittings.

Under load, repeated surface motions causes microscopic damage on surfaces.

Three stages:

1. Fretting formation
2. Crack initiation
3. Crack propagation

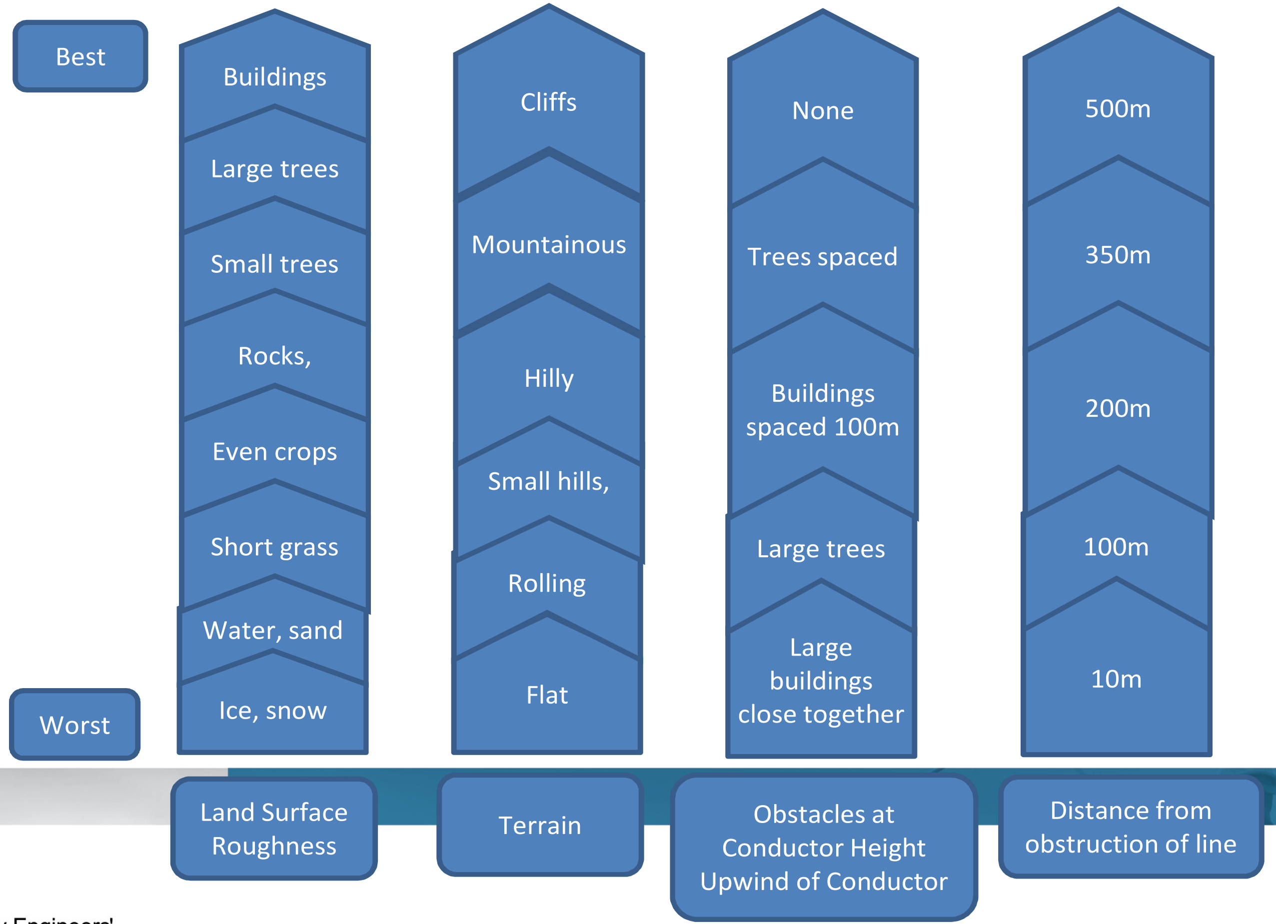
Typically manifests as a crack 45^{o} to stress axis.

Fretting

Usually most severe where mismatches of stress between strands occur at ends of fittings, terminations, suspension points, joints where static and dynamic loadings are the highest

Aeolian vibration versus conductor's self damping abilities

Aeolian effects



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Influences on End of Life - Conductor Fittings

Using the right conductor sleeves and other fittings helps prolong conductor life

Gaskets and compounds in the fittings need resilience to electric fields

Single compression sleeve vs two piece sleeves

Long life vs ease of installation

So what does this all mean?

We've looked at some of the context around the magnitude of conductor renewal and some theory around conductor end of life

Industry survey in July 2015 indicated a gap in industry knowledge of how conductors age

We have set up a working group tasked with investigating and compiling the extent of industry knowledge of conductor aging process

Topics in this morning's agenda will cover this topic further.