Study Committee B2

Overhead Lines

Paper 10976_2022

Development of Aluminium Tower for 420 kV AC line to reduce environmental impact and safety risks under construction

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Motivation

- Reduce helicopter use in construction
- Lower environmental impact
- Reduce construction costs
- Improve safety

Method/Approach

- Reduced tower weight reduces helicopter use
- Aluminium lighter than steel
- Weight saving tower geometries with fewer parts
- Quicker assembly reduces construction cost
- Holistic approach: quality, safety, cost, environment

Objects of investigation

- Aluminium properties in structural design
- Technical solutions for assembly and production
- Environmental impact steel versus aluminium

Discussion

- High strength-to-weight ratio of aluminium
- Great flexibility in cross section design
- Much lower buckling capacity when slender
- Bolted connections better than welding
- Increased susceptibility to Vortex-Induced Vibrations

Conclusion

- Tower weight reduced by 40%
- Helicopter reduction estimated 15-30%
- CO2-emissions halved

Experimental setup & test results

- Buckling tests of profiles
  - Eurocode up to 10 % conservative
- Wind tunnel testing of profiles for vibration
  - Use asymmetrical cross-sections
- Full scale test of tower prototype
  - 130 % of design load

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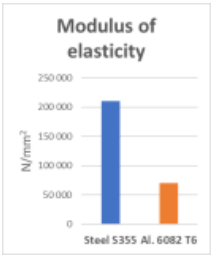
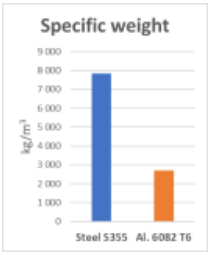
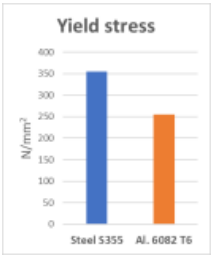
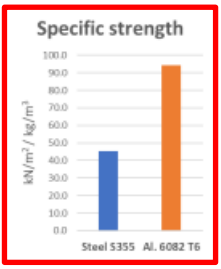
continued

Properties Steel versus Aluminium



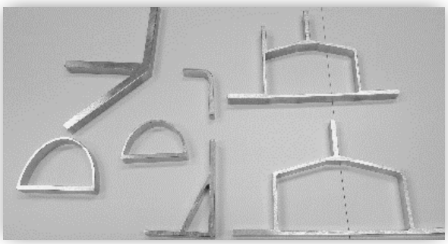




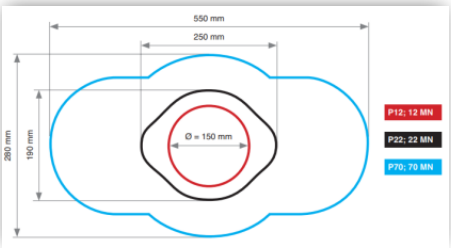


High flexibility for cross-section design

- Theoretically, any shape can be created
- In practice, some rules apply that constrain the shape design:
  - Dimensions
  - Thicknesses
  - Area of voids
  - Asymmetries
  - …



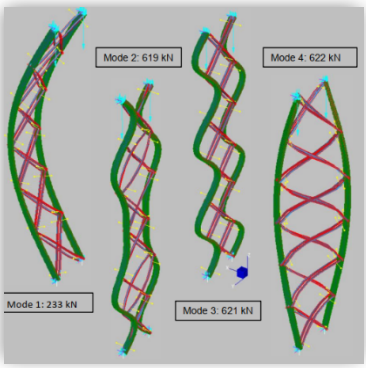
Example of profiles cross-sections developed for the prototype tower



Example of dimension limits for profile extrusion (for 3 different press sizes)

Aluminium not optimal for slender members

- Buckling capacity drops quicker than for steel in function of slenderness
- Must be compensated by using more material and place it as far as possible from the neutral axis
- Less efficient usage of material (low stresses)
- Reduced weight gain for slender member



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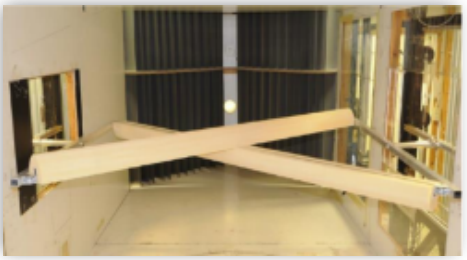
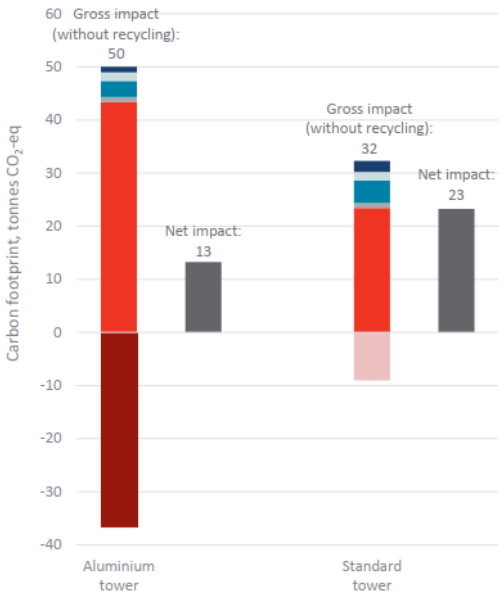
Higher susceptibility to vibrations

- Longer lighter members -> increased risk for Vortex-Induced Vibrations
- Asymmetry of cross-section shape is beneficial
- Half-moon profile in cross-bracing well suited



Reduced carbon-footprint



- Half of CO2-emissions with aluminium towers (compared to steel towers)
- Most of the gain comes from recycling at the end of the lifetime of the transmission line
- Reduction of emission depends on the origin of the aluminium (outside Europe, Europe or Norway)