Study Committee B2

Overhead lines

10963_2022

World longest span with ACSR Conductor – Design challenges

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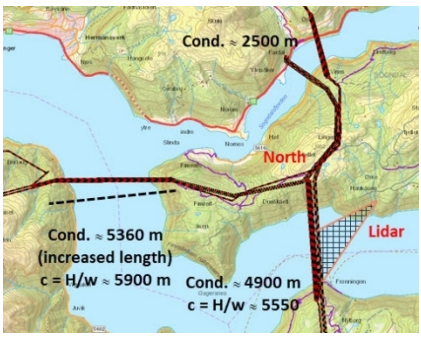
Motivation

- Increased transmission capacity of 420 kV line Aurland-Sogndal, required capacity ≥ 3688 A
- Two transmission lines included in the project; both are crossing Sognefjorden, the largest and deepest fjord in Norway with a length of 205 km and maximum depth of 1308 m. Crossings economically most viable solution.



Possibilities investigated

- Going around the fjord with the transmission line is not economically viable
- Use of existing conductor design: It was investigated is it possible to use the existing conductor, LIDAR wind speed measurements and strength calculations
- Design of new conductor: Due to ampacity and mechanical strength limitations new conductor design needed.

New conductor length requirement

- Internal rules do not allow for long crossing to be designed with mid-span joints.
- With extra length needed for the stringing this gives **drum lengths of approximately 5,8 km**. This is outside the normal lengths and weights of most conductor manufacturers, and it creates a challenge with respect to drum size and weight.

Conductor development process

- To secure the supply of an adequate conductor, a tender for development of the conductor and associated fittings was published in mid-2019.
- Besides for the Aurland-Sogndal project the developed conductors can be used on other projects where the existing conductor AACSR Teist would be a bottle neck.

Developed conductors

- To secure the supply of an adequate conductor, a tender for development of the conductor and associated fittings was published in mid-2019.
- Two different solutions were developed by companies that won the tender.

Property	Conductor 1	Conductor 2
Overall diameter	Ø 50,30 mm	Ø 52,16 mm
Mass per unit length	6928 kg/km	6757 kg/m
Ampacity at maximum continuous operating temperature of 210 °C	4122 A	3705 A
Rated tensile strength	874,9 kN	1030,88 kN
Construction		

Future work and challenges ahead

- Parallel to the design of the crossing, an R&D project to develop a vibration measurement and monitoring system is started in cooperation with an external partner.
- Vibration damping presents one of the biggest challenges for very long spans
- Due to very large drums and high forces stringing needs to be planned with care

Conclusion

- Besides conductor and fitting development, lot of other aspects that needed to be covered as well in the time planning, like a new tower design, purchase and design of some new stringing equipment.
- The process includes multiple parties for different countries and needs to be well planned, with buffers for possible delays.

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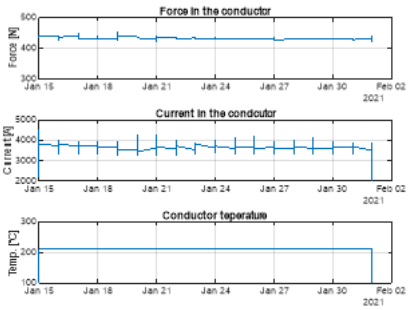
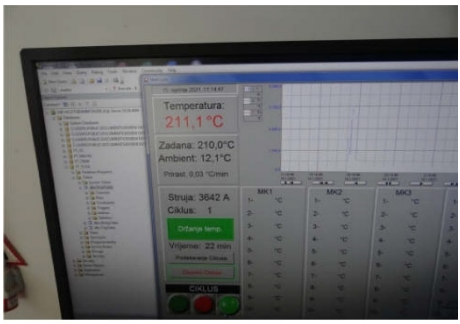
Type tests for conductors and fittings

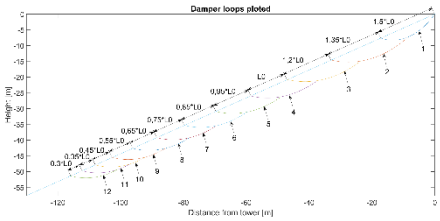
- Both conductors are Thermal Resistant Aluminum Conductors Steel Reinforced (ZTACSR), use a so called "Giga high strength steel" (5MS8A) for the core, and AT3 thermal aluminum wires
- Most of the tests were according to relevant standards or slightly modified (for steel wires)
- Some additional tests were performed, such as:
  - Thermal stability test (cond. And fittings 400 hours at EDS at max. temp.) or Heat Cycle at EDS





Vibration damping design

- Bretelle loop dampers are the most used damper type in Norway because they tolerate dynamic loads caused by ice sheading.
- Long crossing are damped with a combination of end-damping with loop dampers, and in span Stockbridge dampers (Statnett has 30 spans longer than 2 km).
- With external partners an R&D project is started to develop a vibration measurement system.
- Measurements to be done after installation of dampers, possibly modifications after result analysis.



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Fitting development

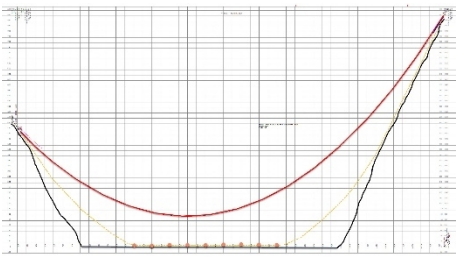
- Different types of conductor fittings needed to be developed and type tested, dead-end clamps, mid-span joints, repair fittings, bretelle clamps, dampers.

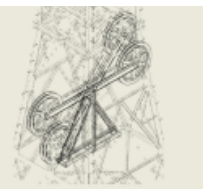
Tower development

- New strength class of towers was needed.
- Because of terrain topography towers are not very high (up to 33 meters).

Stringing challenges

- Span length of up to 5360 m (longer that said in the article) and horizontal tension of up to 430 kN present challenges.
- During stringing the conductor need to be lowered to the sea where it rests on buoys.
- Some special stringing equipment needed to be custom designed and ordered.





Conclusion

- Vibration damping of such long spans with high tension is one of the biggest challenges. Development of a new vibration recorder, which can be used on fjord crossings, will reduce the risk.
- There is a limited number of conductor manufacturers in the world that can produce conductors in lengths that were required for this project.
- Development process for a new fjord crossing conductor and fittings requires a relatively long time for design and testing.
- There was a lot of other aspects that needed to be covered in the time planning, like a new tower design, purchase and design of some new stringing equipment, and development of other fittings.
- Planning with good time buffers is advised.