The Contact Behavior of the CORC Wires under Stretching and Triplet Cabling Process

MT 26 International Conference on Magnet Technology
Vancouver, Canada | 2019

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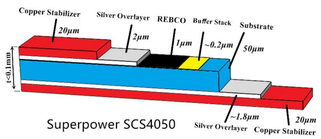
Introduction

The 2G HTS REBCO Tapes

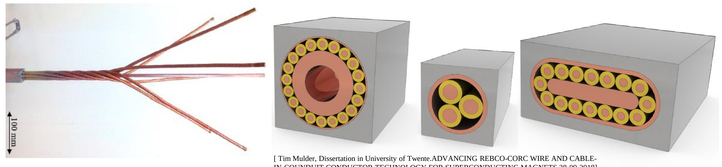


The CORC Cable

CORC (Conductor on round core)
The HTS tapes through multi-layered spiral wind around the center core form the CORC cable)

The CORC-CICC Cable

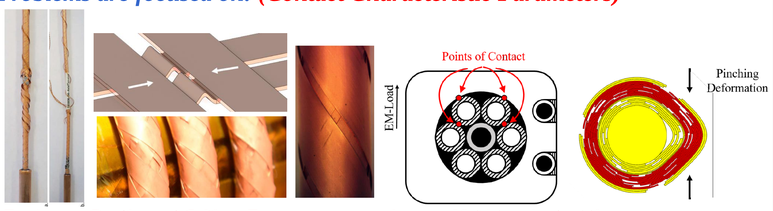
The Next Generation High Temperature Superconducting Magnet Cable .



[Tim Mulder, Dissertation in University of Twente.ADVANCING REBCO-CORC WIRE AND CABLE-IN-CONDUIT CONDUCTOR TECHNOLOGY FOR SUPERCONDUCTING MAGNETS.28-09-2018]

Problem

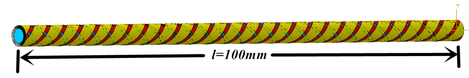
Problems are focused on: (Contact Characteristic Parameters)

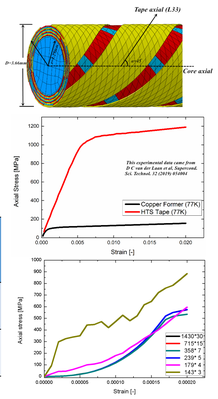


- The CORC contact characteristic parameters CCP (contact area, contact normal force and contact tangential force) are directly related to its response under mechanical loads such as tension, bending and transverse compressive.
- The multiple twisted cabling process is a multi-part, non-linear contact problem and the CCP are difficult to obtain experimentally
- The contact behavior of the CORC also has a significant effect on contact resistance.
- The electromagnetic force of the running superconducting magnet will also cause the CORC wires or cables to be squeezed to create a security risk.

Model

Geometry and Meshes (12 layers with 30 tapes)



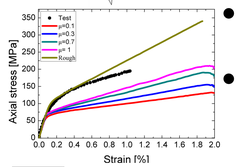


Parameters

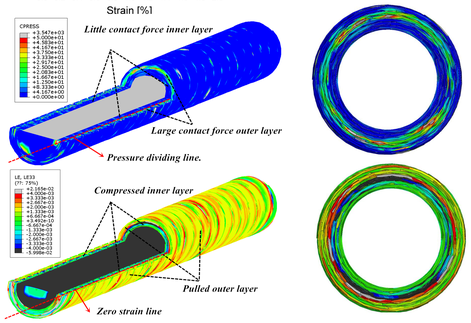
Parameters	Young's modulus of the Tape (77K)	Young's modulus of copper (77K)	Plastic yield stress of the tape	Plastic yield stress of copper	Poisson ratio of the tape	Friction factor	HTS tape (Thickness(h) ×Width(w))	Copper Core radius (r)	CORC wire length	helix angle (a)
Value	200	128	1030	100	0.25	0.1~1	0.045×2	1.29	100	45°
Unit	GPa	GPa	MPa	MPa	-	-	mm	mm	mm	degree

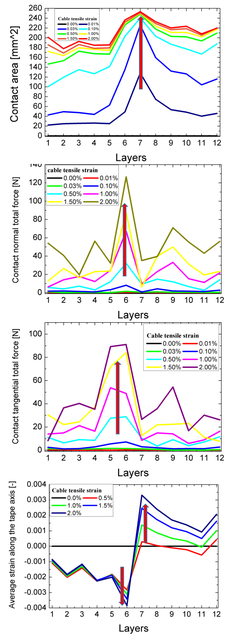
Results and Discussion

Uniaxial tensile process (Consider friction coefficient)



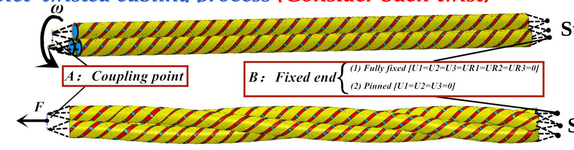
- When the interaction property is rough, it agrees well with the experiment.
- When the axial strain exceeds 0.4%, a large deviation occurs because slip effect.



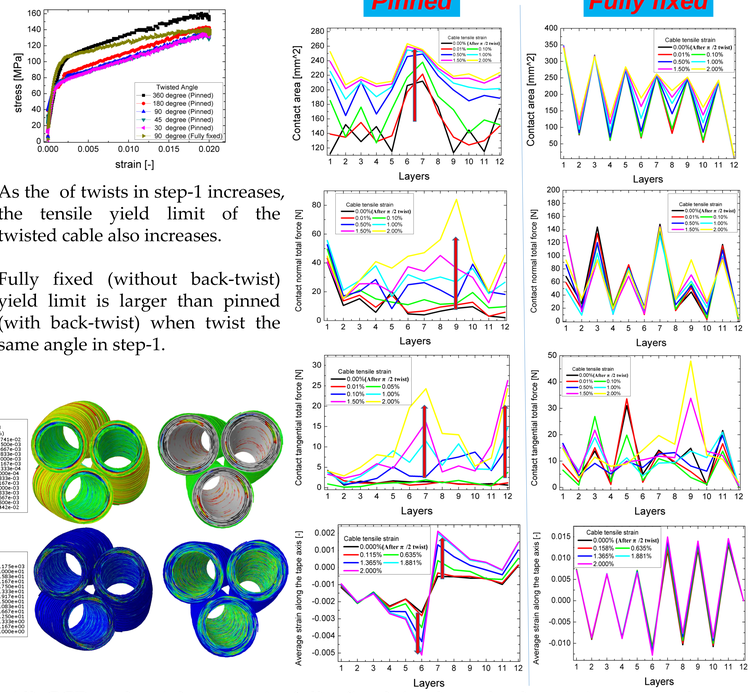


- When the CORC is axially stretched, the tapes in the middle layers are subjected to a larger contact force and its deformation is large.
- From the comparison of CCP distribution and axial strain distribution, it can be found that there seems to be some relationship between them.

Triplet twisted cablina process (Consider back-twist)



Pinned **Fully fixed**



- As the of twists in step-1 increases, the tensile yield limit of the twisted cable also increases.
- Fully fixed (without back-twist) yield limit is larger than pinned (with back-twist) when twist the same angle in step-1.

- All CCP and axial strains in fully fixed (without back-twist) case are larger than pinned (with back-twist).
- In pinned case, the CCP distribution is larger in the middle layers (the 5, 6, 7, 8th layers) from sawtooth configuration (The odd layer is different from the even layer).

Conclusion

- The CCP (contact area, contact normal force, contact tangential force) and average axial strain of each layers are given.
- The deformation of the middle layers are larger than the inner and the outer layers when the CORC wires is subjected to tensile load.
- The triplet twisted cabling must be with back-twist to make the deformation smaller.
- **The design and optimization of CORC wires and cables should refer to its internal contact characteristics.**