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Effect of Combination Twisting with Bending Characteristics on Critical Current of Quasi-Isotropic HTS Strand

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Introduction

Quasi-isotropic strand is one of the commercial coated conductors (CC) and consists of four sub-strands by stacking a number of CC with symmetrical arrangement. In the application of conductor and cable, the cable bending and twisting are essential, the twisting is one of the most effective technique for uniform current distribution to reduce AC losses of the cable and improve its stability. In this paper, the electro-mechanical characterization of the quasi-isotropic strand (Q-IS) was studied by simulation and experiment under conditions of bending, twisting and combination of both by a dummy strand. The experimental results are agreement with the simulated ones.

Dummy Strand Fabrication

Fig. 1 (a) Cross-section view of the quasi-isotropic superconducting strand. The total cross section of the strand is 5 mm × 5 mm, and the cross section of the tapes is 4 mm × 4 mm. The thickness of copper sheath is 0.4 mm, and the thickness of the aluminum foil is 0.1 mm. (b) The terminal view of the quasi-isotropic strand. The number of YBCO tapes is 72

Fig. 2.. View of the experimental dummy strand

Table. I. TAPE PARAMETERS

Items	Value
Width of REBCO tape/mm	2
Thickness of REBCO tape/mm	0.7625
Width of SS tape/mm	2
Thickness of SS tape/mm	0.2

Bending Simulation and Experiment

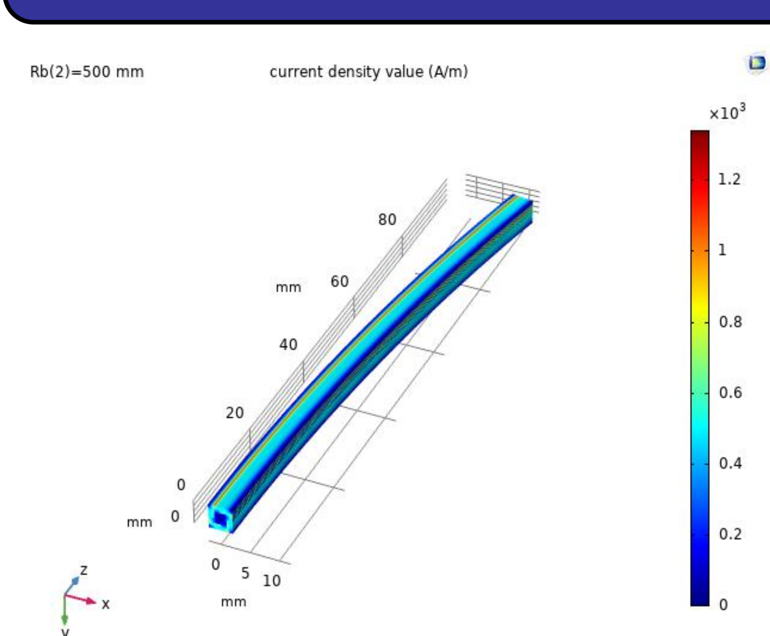

Fig. 3. Current density of dummy strand with a bending radius of 500mm.

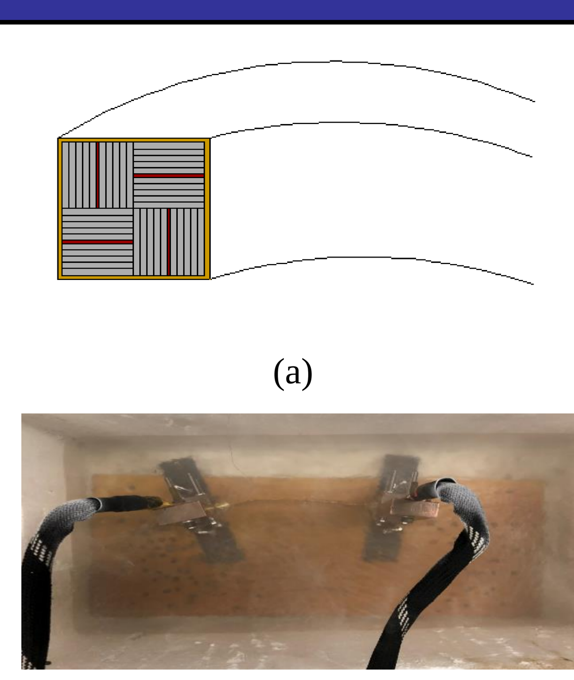

Fig. 4 Dummy strand bending along the side of dummy strand with a bending radius of 500mm .

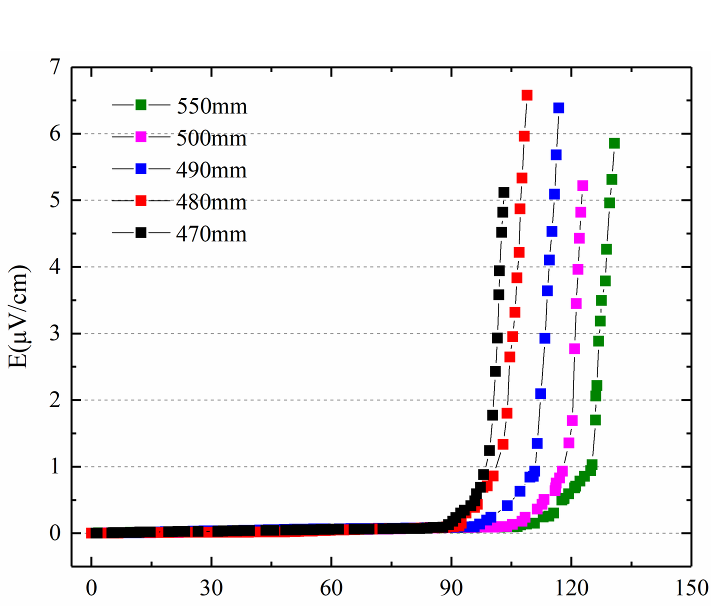

Fig. 5 E-I curve of different bending radii of dummy strand along the side.

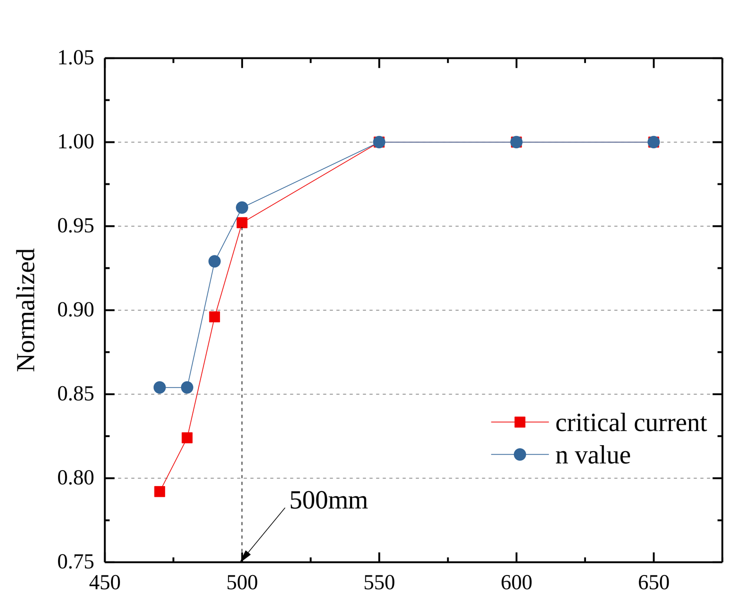

Fig. 6. Superconductivity attenuation charts of dummy strand bending along the side with different bending radii.

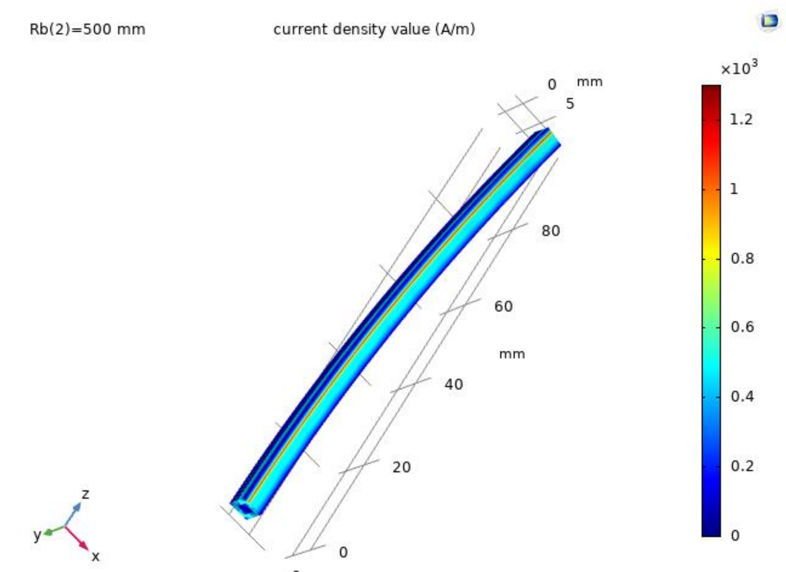

Fig. 7. Current density of dummy strand with different bending radius 500 mm when bending along central diagonal.

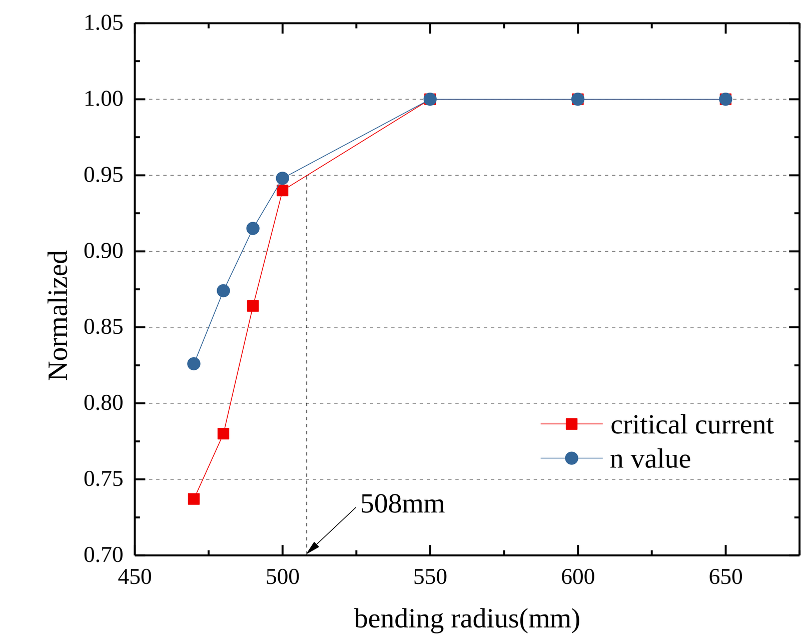

Fig. 9. Superconductivity attenuation chart of dummy strands bending along central diagonal with different bending radii.

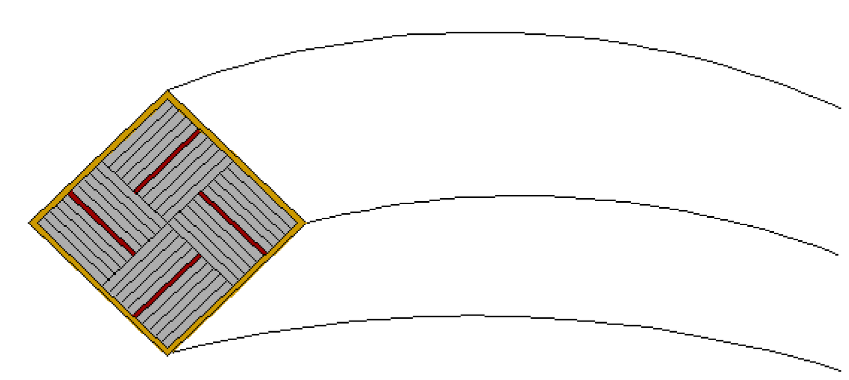

Fig. 8. Temperature variations at different locations of the quasi-isotropic superconducting strand under heat disturbance energy Q=14.66 J (quench).

The critical bending radius of the dummy strand bending along the diagonal line is 508 mm.

Twisting Simulation and Experiment

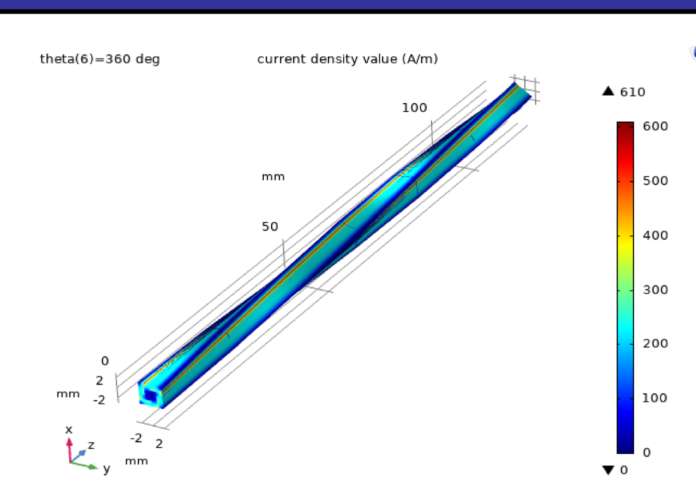

Fig. 10. Simulation diagram of torsion dummy strand at critical twist pitch.

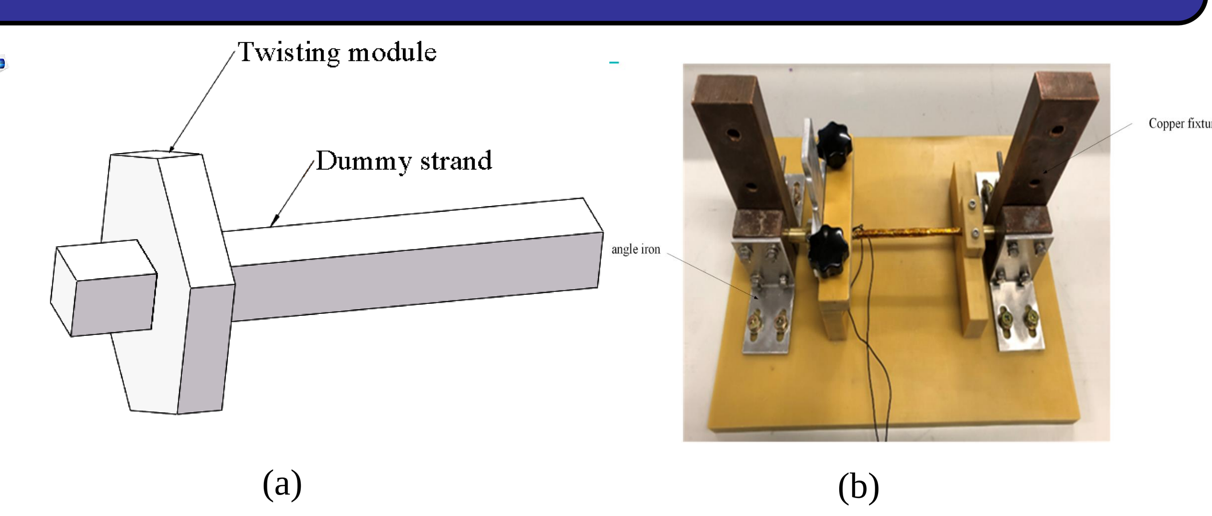

Fig. 11. **(a)**Sketch of twist module;(b)Sketch of assembly completion twist mold.

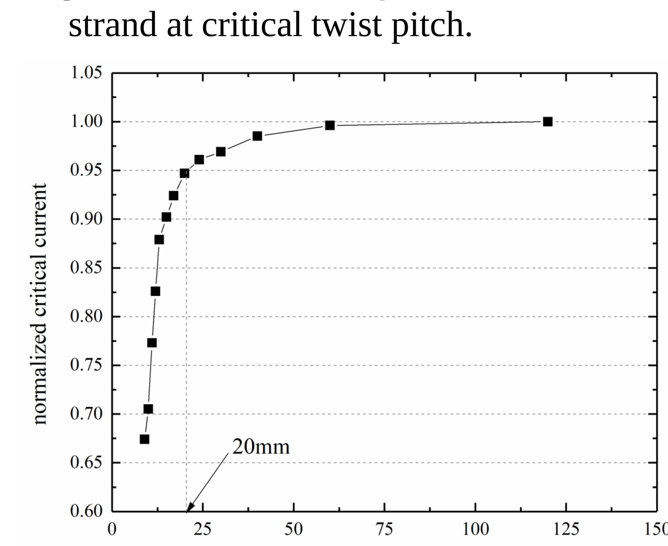

Fig. 12. Critical current curve of different twist pitch.

When the twist pitch is less than 13 mm, the critical current attenuates rapidly, indicating that the inner strip of dummy strand has been damaged severely.

Combination of Bending and Twisting

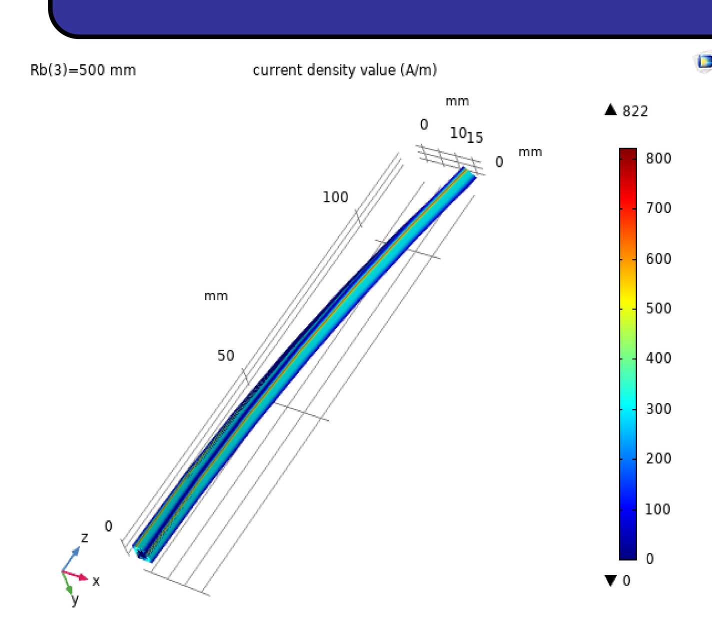

Fig. 13. Bending and twisting simulation with a radius of 500 mm.

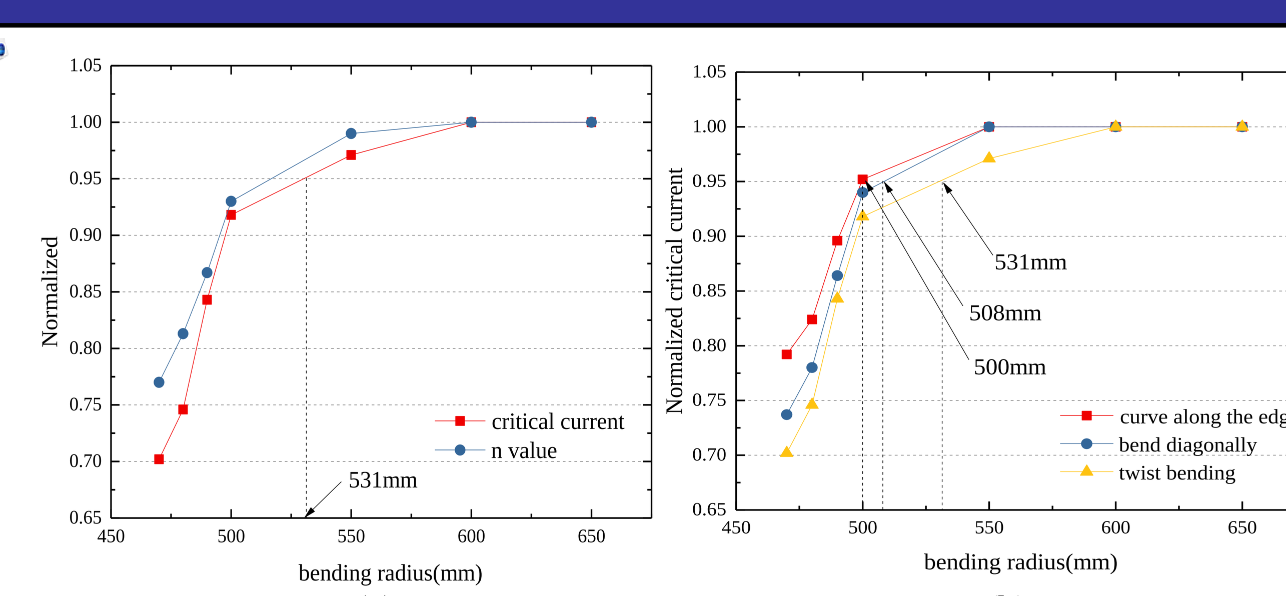

Fig. 14. (a)Superconductivity attenuation diagram of dummy strand twisted at 120 degree with different bending radius;(b) Normalized critical current under different bending deformations.

The critical bending radius of dummy strand bending along both the side of dummy strand and central diagonal line are smaller than that of the twisting and bending.

Conclusion

- Simulation results are in good agreement with the experiment.
- Rank of mechanical deformation effect on critical current: combination of twisting and bending>bending along the diagonals> bending along the sides.