Study on the optimal design of the levitation system of electrodynamic suspension(EDS) trains

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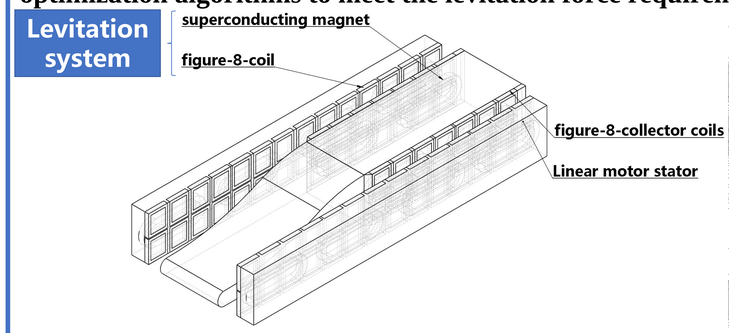
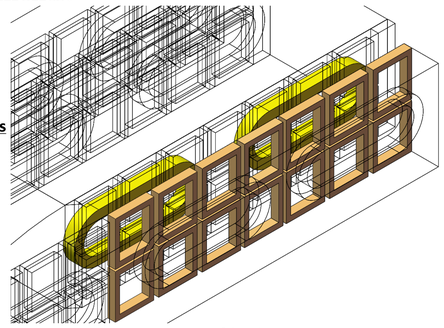
1.Intrduction

Based on the research and development results of superconducting electrodynamic suspension(EDS) trains, this paper establishes the field-path-motion coupling model and 3-D finite element model of the suspension system part of this technology, and uses the appropriate optimization algorithm to design the parameters of superconducting coils and figure-8-coils, so as to reduce the amount of wire used by both and to reduce the construction cost of EDS trains.

Tfurther promote EDS train, it is necessary to reduce its high construction costs. As an important consumption for EDS trains, a reduction in the amount of current wire used will largely reduce the cost. The cost of EDS trains will be greatly reduced by minimizing the amount of wire used in the superconducting and figure-8-coils, which consume the most wire in the levitation system, through optimization algorithms to meet the levitation force requirements.

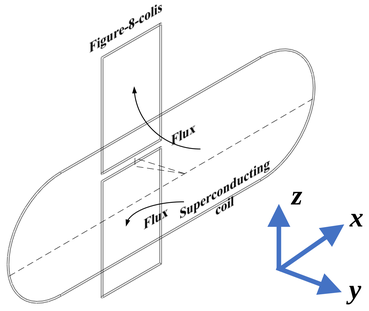


■ Superconducting EDS train

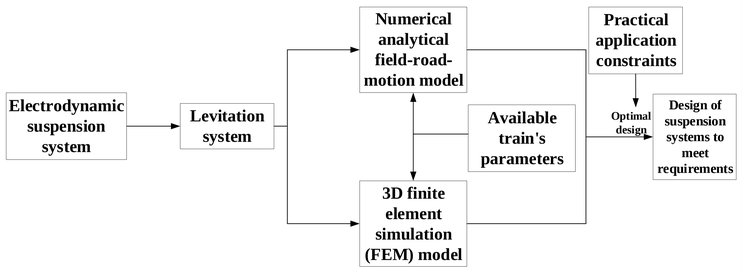


■ Structure of levitation system

2. Technology Route



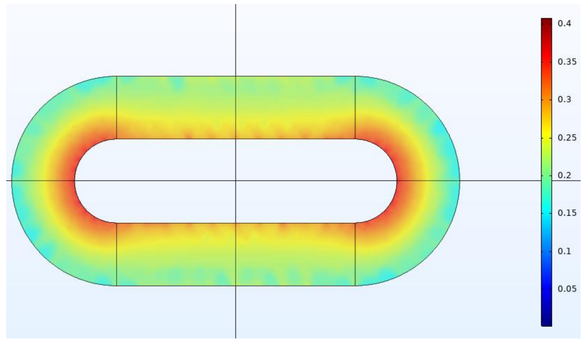
■ Principle of levitation system



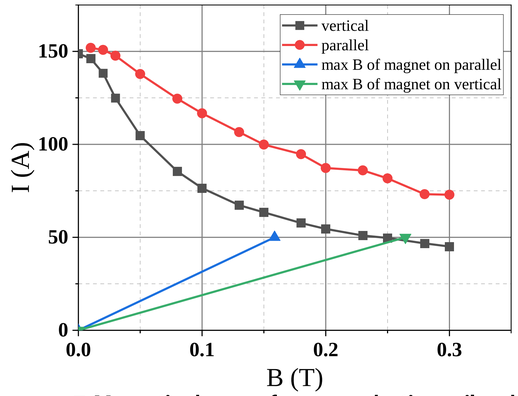
■ Technology route

When superconducting coil and figure-8-coils are in relative motion, there will produce induced current in figure-8-coils that transfer upper and lower parts of figure-8-coils into two electromagnets with opposite poles, which makes superconducting magnet levitated by the force produced by two electromagnet and itself. Based on the relevant parameters, a numerical analysis model of the field-path-motion of the levitation system is established, and a numerical equivalent circuit is calculated to solve the electromagnetic force; a 3-D finite element model by COMSOL and MagNet of the magnet of the superconducting coil and figure-8-coils is built.

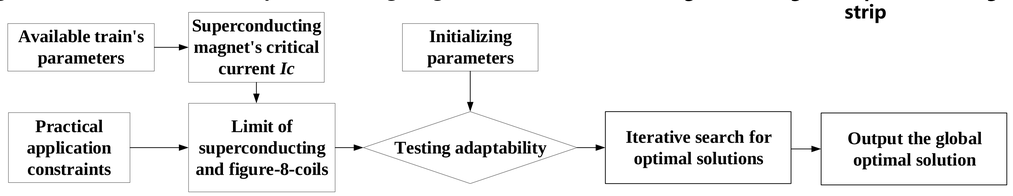
3. Optimal design



■ Magnetic field distribution of superconducting magnet



■ Magnetic change of superconducting coil and strip



■ Optimal process

Based on the numerical analysis model and 3D finite element simulation model, and the data of the MLX01 superconducting maglev train, the optimization algorithm, which can optimize multiple covariates to obtain the target results, is used to calculate the parameters of the superconducting coil and figure-8-coils under the constraints of the actual train application, including the size of the superconducting coil and figure-8-coils, the arrangement scheme on both sides of the car, and the superconducting current control strategy. The parameters of the superconducting coils and the figure-8-coils include the size of the superconducting coils and figure-8-coils, the arrangement scheme on both sides of the train, and the superconducting current control strategy.

4.Conclusion

- **The bending radius of the superconducting coil does not have a significant effect on its critical current, so the space occupied by the superconducting coil can be reduced and the number of turns can be increased with a smaller bending radius.**
- **The larger the ratio of superconducting coil's length to figure-8-coils' length, the higher the magnetic levitation force on a single superconducting coil, but for the same area length, increasing the superconducting coil length means reducing the number of superconducting coils, which in turn reduces the magnetic levitation force in the entire area.**
- **The optimized levitation system provides the same magnetic levitation force as the original design, while reducing the amount of wire used and the cost.**