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Coupled Finite Element Analysis of Optical Ground Wire for Overhead Power Lines

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GOAL OF THE STUDY

This paper presents one new methodology for research of thermal sustainability of Optical Protection Ground Wire (OPWG) for Overhead Power Lines (OPL).

METHODOLOGY OF THE INVESTIGATION

In this method coupled transient electromagnetic and thermal 3D Finite Element Analysis (FEA) were used.

ELECTROMAGNETIC AND THERMAL MODELING

The problem was solved by taking into account real twisted cable geometry, skin and proximity effects, and environmental conditions concerning the impact of lighting stroke over OPWG. During problem solution first AC losses in wire, excited by standard lighting pulse model, were calculated using Transient electromagnetic FEA. After this distribution of cable temperature field was received. In the FEA of OPWG thermal sustainability, the coupled circuit and FEM model was used.

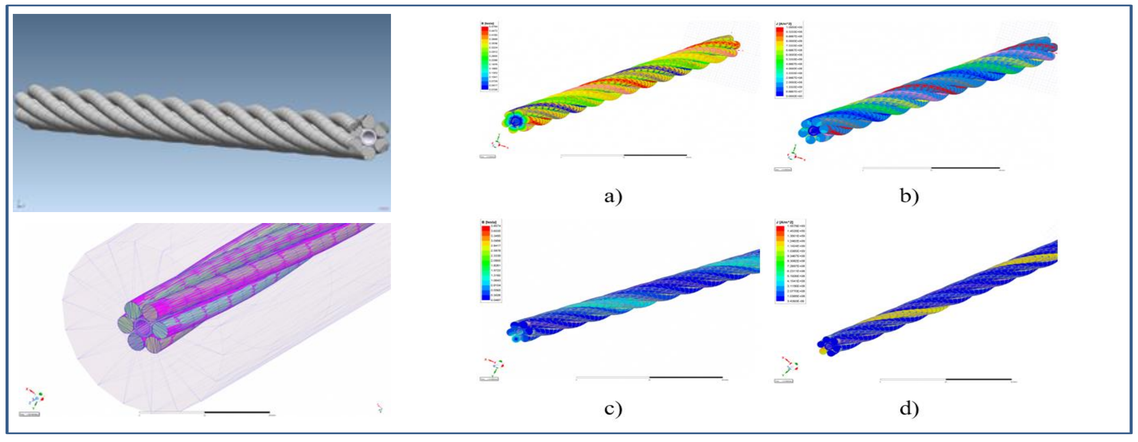


Fig. 1. Modeling and results from EM FEA, Case A: a) flux density; b) current density; Case B: c) flux density; d) current density.

COUPLED PROBLEM SETUP

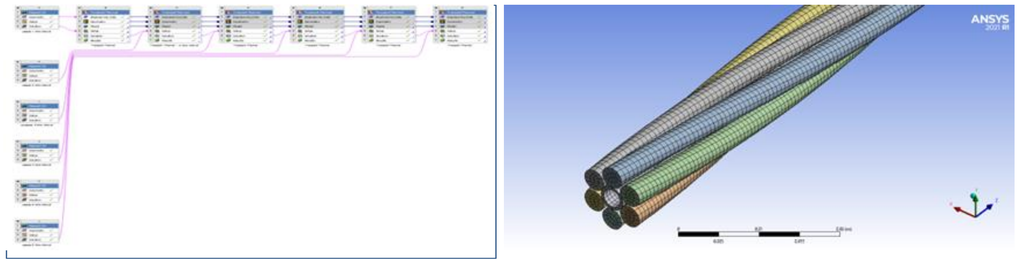
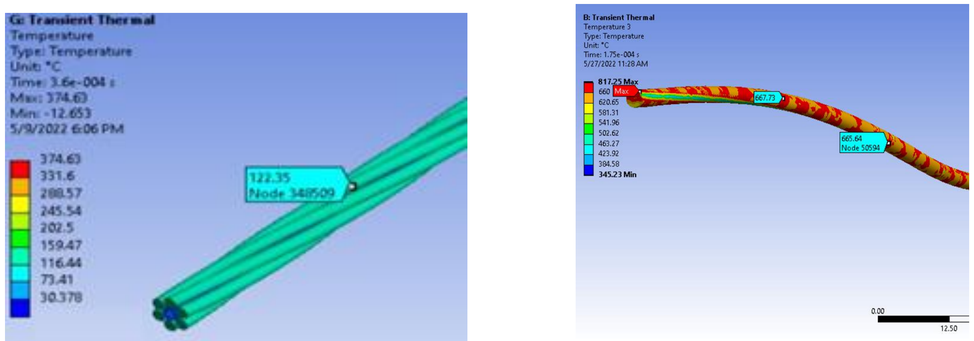


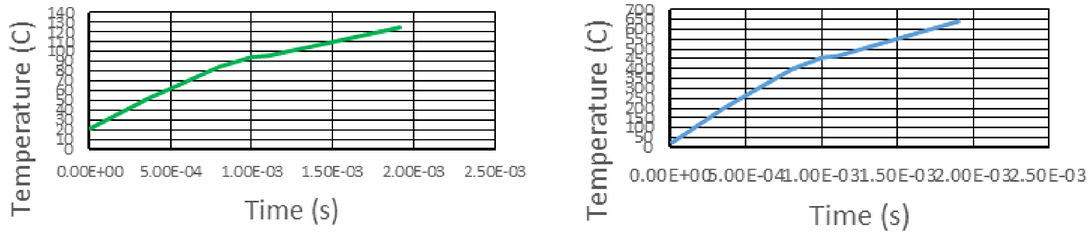
Fig. 2. Schematics in Ansys Workbench for coupled solution and thermal model

RESULTS FROM THERMAL FEA



a) b)

Fig. 3. Thermal FEA results: a) current in all six conductors; b) current in only one conductor.



a) b)

Fig. 4. Temperature versus time: a) current in all six conductors; b) current in only one conductor.

CONCLUSIONS

Simulations show that the thermal sustainability of OPWG tests does not allow it to withstand a direct lightning strike, which leads to its destruction. The integrity of the OPWG is violated even at the first pulse of lightning, due to the thermal impact of its current of 200 kA. The mechanical and thermal effects of lightning stroke over the OPWG are determined by the peak value of the current, the total charge, the charge in the pulse, and the specific energy.

The FEM models used to solve the coupled electromagnetic and thermal problems give adequate results and can be successfully used in the virtual study of the thermal resistance of OPWG.