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Simulation software analysis magnetic flux density near distribution power lines

IREQ takes full advantage of the Boundary Element Method field solver for the analysis of its open region problems

By Sylvain Gravel
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Hydro- Québec is a power utility owned by the province of Quebec. Hydro-Québec's Research Institute (IREQ) is the research arm of Hydro-Québec and one of North America's leading research and testing centers for the study of electrical power generation, transmission and distribution.

Anywhere electric power is created, electric and magnetic fields are produced. At lower voltages and currents the fields produced are normally of little concern. However, at high voltage or current levels the distribution of the electrical and magnetic fields must be carefully taken into account to improve equipment reliability and protect the public and the workers.

Sylvain Gravel is a senior researcher at IREQ. His team analyzed the magnetic flux density near a complex configuration of distribution power lines. As this class of problems exhibits no symmetry, a full 3D analysis model was required.

To solve these complicated magnetic structures, two completely different approaches can be used. One is formulating Maxwell's equations in differential form and the other is in integral form. The first is associated with Finite Elements and the second with Boundary Elements. Being an open region problem, it can be best analyzed through the Boundary Element Method (BEM) instead of Finite Element Method since it avoids the need of creating a mesh in an open space, even far from the area to analyze.

Gravel comments, "BEM software solves Maxwell's equations in integral form using an equivalent source Green's function approach so computational elements need only to be defined on the surfaces of interest and not inside of them."

By using FARADAY, an easy-to-use 3D eddy current solver created by INTEGRATED Engineering Software, IREQ is able to analyze the magnetic flux density values in 3D. IREQ has been using INTEGRATED's software since 1985 and FARADAY in particular since 1999.

"Faraday is ideally matched to the power line problems" Gravel explains, "This is one of the best applications we've had with FARADAY, it is very well suited for analyzing power lines because it deals with open boundary problems. We've arrived to very good results through this software."

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FARADAY computes the fields from the given distributed currents. Once a volume to analyze is defined and the field values computed, the isosurfaces of equal magnetic flux density can be plotted revealing their shape, exact position and extent in space in relation to the conductors.

For many open region problems the number of unknowns required by Finite Element techniques would become prohibitive. INTEGRATED Engineering Software offers both Finite Elements and Boundary Elements enabling the user to select the right technology for a given problem.

By using FARADAY in conjunction with an easy to use graphical interface, IREQ can readily view resultant magnetic fields. In addition, the geometry can be varied parametrically to obtain an optimal magnetic field configuration.

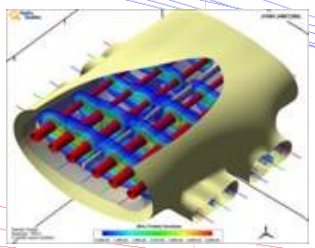
Gravel closes: "INTEGRATED offers us the right tools for analyzing open boundary problems, and we are very satisfied with FARADAY for these applications."

Note: The figures below were created with Tecplot 360 (Tecplot Inc.).

Images 1 and 2
Magnetic flux density surfaces around a complex distribution power lines configuration.

Images 3 and 4
This is a more academic problem: it represents the currents on an hollow steel column induced by a large 3-phase coil system. The zoomed version shows skin depth penetration inside the steel thickness.

Image1 Image2



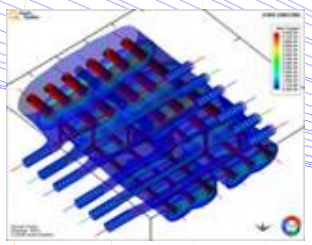
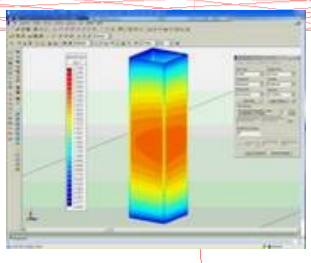
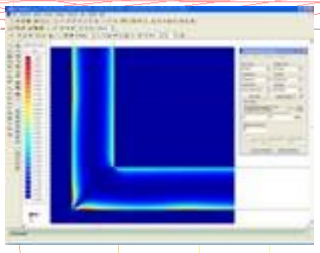


Image3 Image4





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