Electromagnetic Simulation for aerospace, automotive, marine and defense industries

EM simulation on critical buildings is now possible.

EM waves propagation in sensitive buildings

This use case presents an approach to take into account the propagation of EM waves by numerical simulation (Lightning strike of buildings, communication networks, military environments (IEMN, MFP, ...)) in a sensitive building (hospitals, production plants of energy, military buildings, ...).

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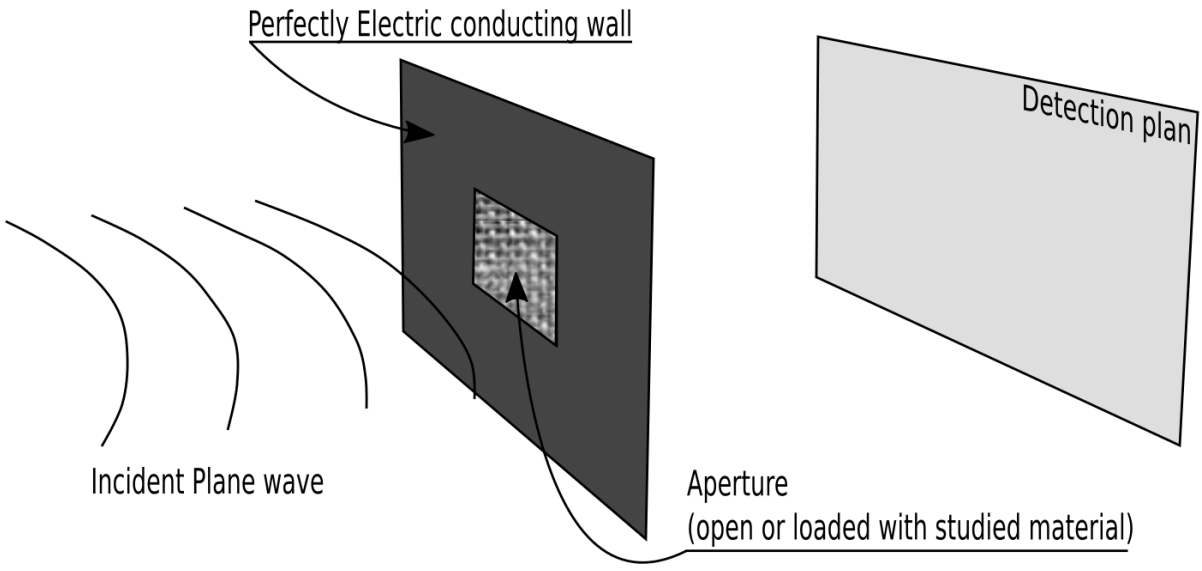
Two mechanisms of penetration / propagation of electromagnetic waves occur in buildings:

• The diffraction of waves through apertures (windows, doors, joints in walls) depending on the frequency ;
• The diffusion of the field through walls.
• The following demonstration shows the ability of 3D electromagnetic modeling tools to take handle these two mechanisms.

The configuration of the use case is shown below.

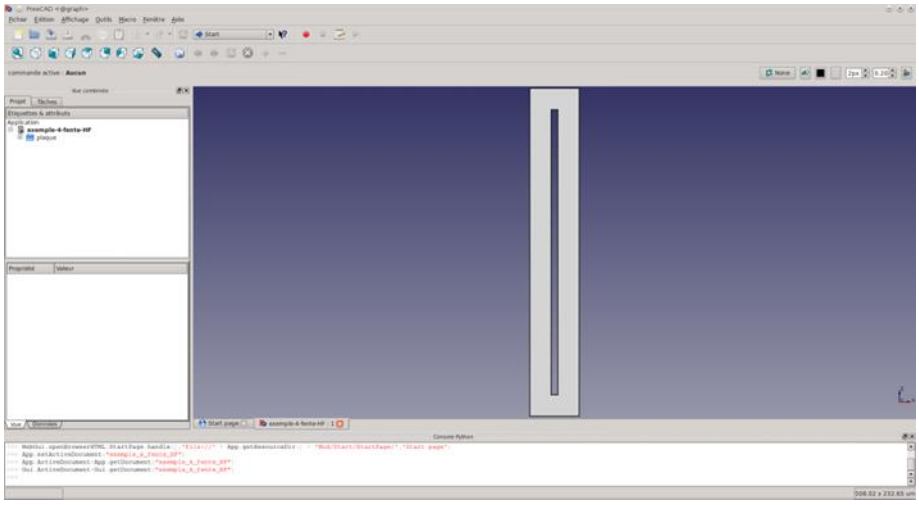


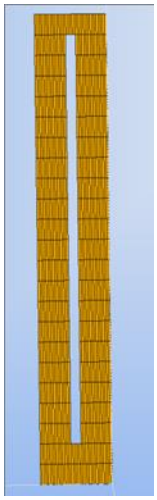
From this configuration, two computation models are setup, each addressing one of the above mechanisms:

• The diffraction of an electromagnetic wave by a rectangular aperture (like joint between walls) in a conducting wall,
• The diffusion of an electromagnetic wave through a reinforced concrete wall.

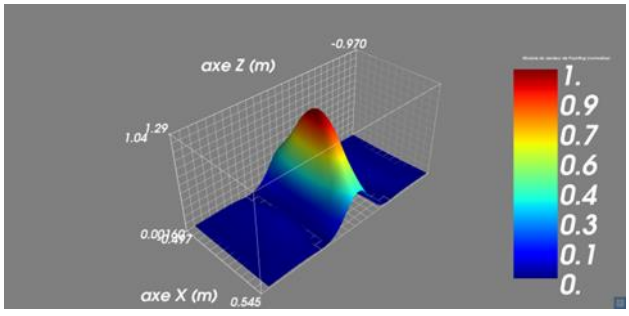
The diffraction of an electromagnetic wave by a rectangular aperture in a conducting wall

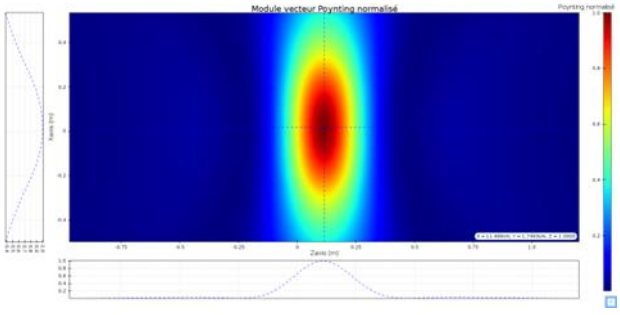
The simulated model is shown below: an infinite plate with a very elongated rectangular aperture of 0.5cmX20cm (like a joint between 2 parts of walls).



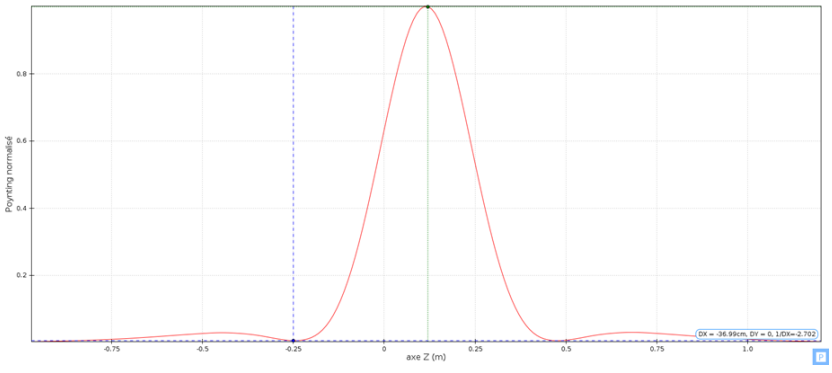


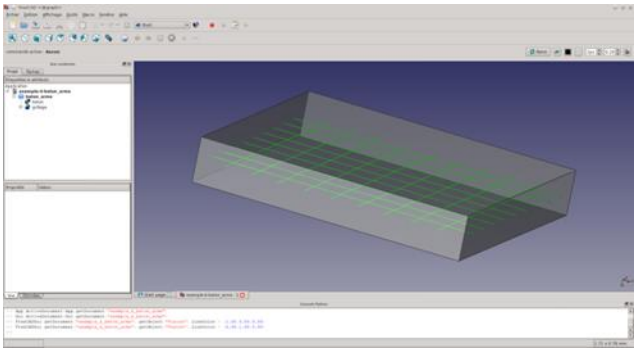
The normalized Poynting vector is shown in a plane parallel to the wall at a distance of 60 cm. The results are given at 3GHz.



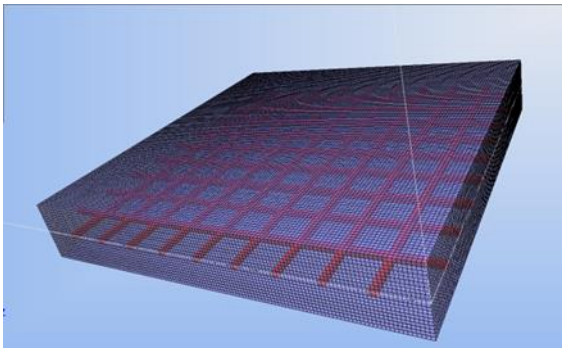


This simple configuration can be handled by analytical formulas of diffraction, giving in particular the positions of the first zero of the diffracted field relative to the center of the aperture.
We can determine the distance between the center and the first zero. For the plan of calculation of the fields situated at 60cm, we obtain the value of 37 cm approximately which is confirmed by the corresponding formulas.
This first zero is at 50 cm at 3GHz for the considered type of aperture if the measurement is performed on a plane very far from the plate (a few meters).





CAD model



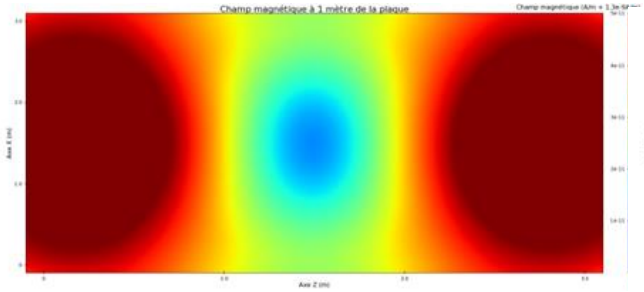
Calculation model

The simulated model is shown above. It is a 3m x 3m reinforced concrete plate with the following characteristics:

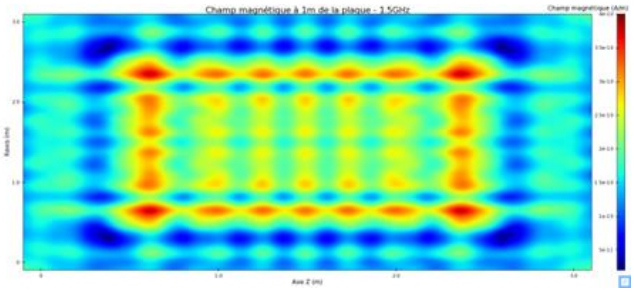
• A 16cm thick layer containing a concrete mesh (relative permittivity = 6, electrical conductivity = 0.06 S / m)

• Steel reinforcement in the middle in the direction of its thickness, the size of the cell is 10cm.

Below is the magnetic field diffused through the plate at a distance of 1 meter for the frequencies 1 MHz (top of the lightning spectrum) and 1.5 GHz (frequencies for mobile communications)



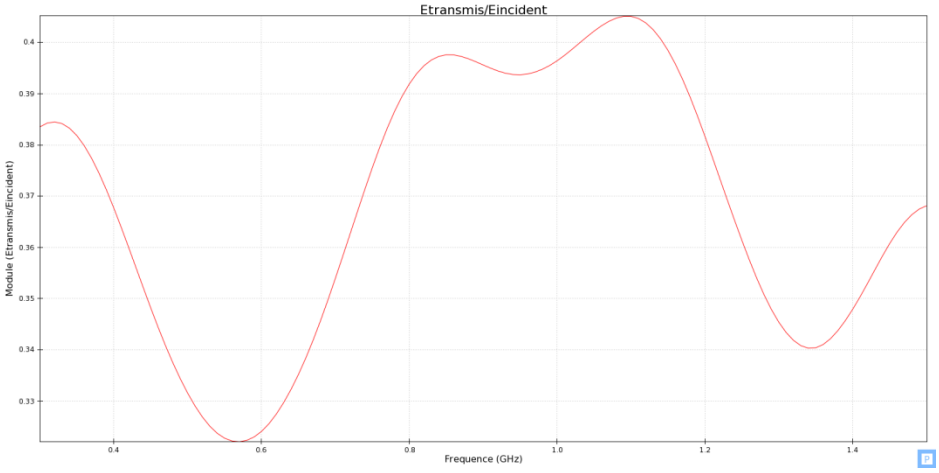
Module Magnetic field module at 1m from the plate – 1MHz



Module Magnetic field module at 1m from the plate – 1,5GHz

The magnetic field is lightly disturbed by the plate and the reinforcing bars at 1 and 3MHz (the color scale has a minimum of 1.3 nA / m and a maximum of 1.35 nA / m), this is normal because the wavelength at these frequencies is very large relative to the dimensions of the plate. The field is disturbed at 600 MHz and 1.5 GHz, This effect is due to the wave diffraction by the steel bars.

It is shown below the ratio E_transmitted / E_incident for a frequency band ranging from 300 MHz to 1.5 GHz. The calculation point is 2 meters from the concrete slab and centered in the plane parallel to the slab.



Module of the field transmitted by a concrete plate on the incident field according to the frequency

We can see two absorption intervals of the EM wave: around 570 MHz and 1.35 GHz. These absorption intervals are located at wavelengths of 20 cm and 10 cm (taking into account the relative permittivity of the concrete), it corresponds to the dimensions of the reinforcing steel bars.

Conclusions

The above simple configurations displayed in this presentation can be transposed to the scale of a building or several buildings thanks to:

- BIM objects which are generalizing in the world of architecture and building construction, making available the required data for EM modeling of buildings.
- Availability in AXS-E3 database of EM characteristics of materials.
- Reduced computing resources which allows the modeling of complete buildings: a few minutes of calculation for the above cases.

AXS-E3 is thus a solution to define a suitable design and technical specifications of buildings implied by functional EM specifications.

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