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Evaluation of Resistivity Measurement of Masonry by Numerical Simulation

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Summary

Geo-electrical resistivity maps are being used for the evaluation of brick and stone masonry. They provide information about the inhomogeneities and the geometrical boundaries of the structure. Only the information of the inhomogeneities is of interest for the evaluation of the internal condition of the structure. Therefore, the influence of the boundary conditions on the measurements needs to be eliminated. This paper discusses the comparison of laboratory measurements on a well-known physical model consisting of a sandbox of 2.5 m x 2.5 m x 0.35 m with embedded blocs and the results of a numerical model which simulates the measurements. The moisture content of the materials influences the measurements and is taken into consideration. The geometrical boundaries, the moisture content as well as the dimensions and localisation of the inhomogeneities are known characteristics which are used as input of the numerical model.

1 Experimental research - physical model

The physical model used in this research consists of an insulated sandbox with embedded blocs (fig 2). The physical model simulates a wall of which the geometrical boundaries, the localisation and dimensions of the inhomogeneities, the electrical properties and the moisture content of the masonry are well known. The inhomogeneities are simulated by insulated cubes with varying dimensions which are burried in the sand at a certain depth. The measurements are done with the electrode configuration of the Wenner-spread (fig 1).

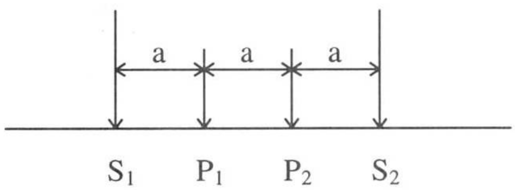

Fig. 1: Electrode configuration of the Wenner spread

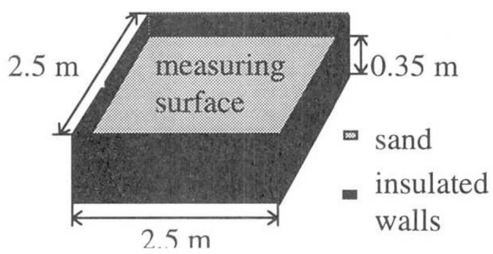

Fig. 2: Physical model: insulated sandbox

The material in the model is sand with a moisture content of 5%. Due to gravitational water movements the moisture content of the sand does not remain at 5 % over the whole model, but increases with depth. This means that the resistivity of the sand will decrease with depth. Previous research has shown that the moisture content has a big influence on the resistivity measurements. This influence is determined by taking cores out of the model and measuring the resistivity profile over the core length.

2 Simulations

The simulations are made using a finite element model. For the sandbox without inhomogeneities, we only refined the model in the vicinity of the measuring points (fig 3). Submodelling is used for the simulation of the sandbox with a cube placed at the centre.

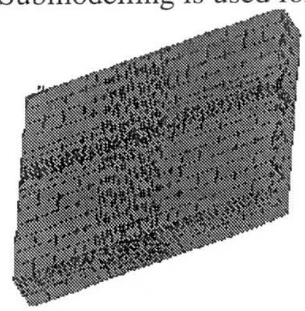

Fig 3: Finite element model

Some typical results of the measurements and the simulations are given in figure 4.

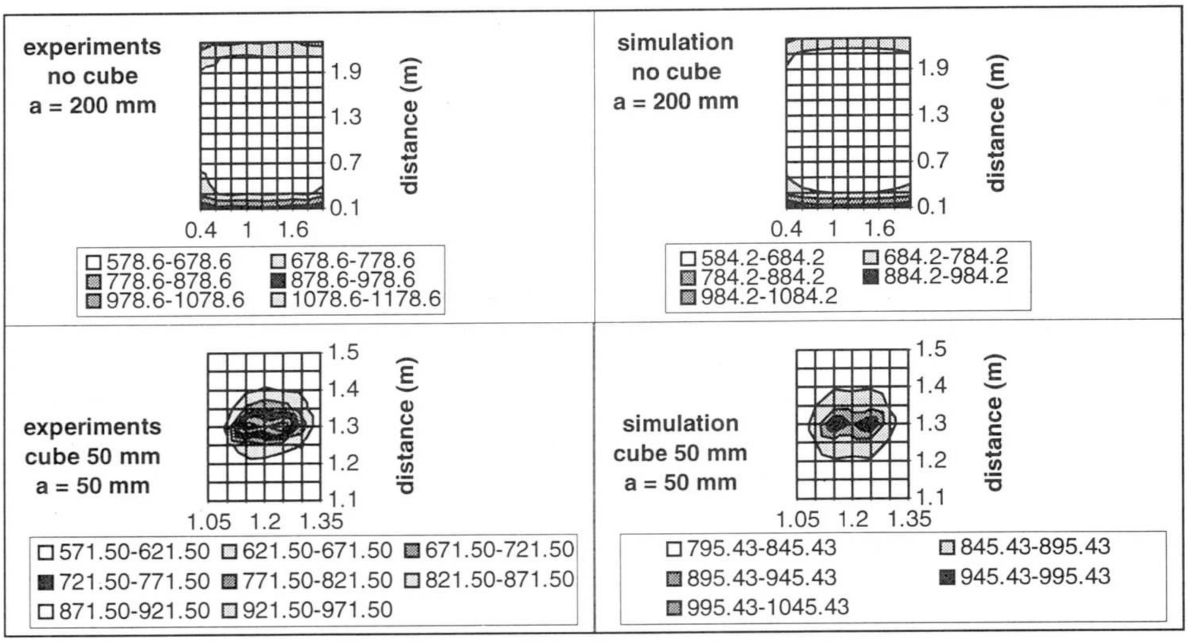

Fig 4: Comparison between experimental research and simulations (values in ohmm)

From this research we may conclude that the numerical model is able to simulate the influence of the geometrical boundaries and the inhomogeneities. It is accurate enough to be used for calibration and filtering of site measurements.