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Estimation of Water saturation in Porous Media by Imaging technique

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A variety of non-destructive, non-invasive laboratory techniques currently are utilized for the measurement of water saturation in porous media. Common examples include: gamma-ray attenuation. X-ray transmission and light transmission/reflection; of these techniques, light transmission requires the least amount of specialized equipment and is by far the lowest cost alternative.
In this research we develop a light transmission technique and we assess the experimental error associated with the calibration and experimental methodology. The experimental apparatus, here considered, is constructed of a transparent Perspex chamber of internal dimension 0.2 x 0.28 x 0.01 m, simulating a quasi-2D porous media, and is filled with transparent glass beads. The thickness of the chamber is sufficiently thin to let the possible effects of non-homogeneity be mediated all along the thickness. The model is illuminated by a diffuse-backlight source whose wavelength peak is tuned to match the absorption band of the water. In order to establish the relationship between the image intensity, detected by the CCD camera, and water content (water saturation) in the physical model, a calibration over the whole imaged area was conducted. Different source of error has been investigated: error on the recorded light intensity, error of the parameter estimation of the calibration algorithm, uncertainty on the size of the averaging volume needed for the estimation of the water saturation.
The water saturation is estimated under hydrostatic condition and steady water injection in the unsaturated zone. The imaged saturation field is compared with analytical solution of vertical distribution of saturation in a simple hydrostatic case.