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Digital concrete physics: Prediction of the effective elastic material properties of concrete by pressure-dependent high-resolution X-ray Computed Tomography

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Over the past three decades, digital rock physics (DRP) has become a complementary part of the field of study to understand better the behavior of porous media at the micro-scale. In this study, we apply the established five-step DRP workflow to a concrete specimen (e.g., Wildenschild et al. 2002; Schlüter et al. 2014) : (1) Preparation of a high-resolution X-ray computed tomography (XRCT) volume, (2) tomographic reconstruction, (3) assessment and handling of the X-Ray artifacts (4) segmentation of pore and grain phases, respectively, and (5) solving equations due to the demanded properties.

Previous studies have shown that under elevated pressure conditions, XRCT can only provide visual evidence of compression under favorable conditions due to sub-resolution changes, while ultrasonic velocity measurements, for example, indicate compression of the porous medium more clearly (e.g., Madonna et al. 2012; Saenger et al. 2016; Liang et al. 2021). Therefore, we apply the results to a concrete specimen based on the published experience with pressure-dependent XRCT of rocks.

Our XRCT scans were performed under confining pressure conditions with a purpose-built X-ray-transparent pressure cell (Lebedev et al. 2017) at 0.1, 6.5, 13, 26, 36, and 46 MPa. After image post-processing, i.e., filtering and gray-scale threshold segmentation based on thin sections, the pore, and solid phases are analyzed qualitatively and quantitatively to predict the extent of potential compaction at elevated pressure conditions. Finally, the effective elastic material properties are modeled based on the segmented volumes at different pressure conditions and compared with the corresponding laboratory measurements for larger samples.

Participation

In-Person

References

Lebedev, M., Zhang, Y., Mikhaltsevitch, V., Inglauer, S., Rahman, T.: Residual Trapping of Supercritical CO2: Direct Pore-scale Observation Using a Low Cost Pressure Cell for Micro Computer Tomography. Energy Procedia. 114, 4967–4974 (2017). https://doi.org/ 10.1016/j.egypro.2017.03.1639

Liang, J., Lebedev, M., Gurevich, B., Arns, C.H., Vialle, S., Glubokovskikh, S.: High- Precision Tracking of Sandstone Deformation From Micro-CT Images. JGR Solid Earth. 126, (2021). https://doi.org/10.1029/2021JB022283

Madonna, C., Almqvist, B.S.G., Saenger, E.H.: Digital rock physics: numerical prediction of pressure-dependent ultrasonic velocities using micro-CT imaging. Geophys. J. Int. 189, 1475–1482 (2012). https://doi.org/10.1111/j.1365-246X.2012.05437.x

Saenger, E.H., Lebedev, M., Uribe, D., Osorno, M., Vialle, S., Duda, M., Iglauer, S., Steeb, H.: Analysis of high-resolution X-ray computed tomography images of Bentheim sandstone under elevated confining pressures. Geophysical Prospecting. 64, 848–859 (2016). https://doi.org/10.1111/1365-2478.12400

Schlüter, S., Sheppard, A., Brown, K., Wildenschild, D.: Image processing of multiphase images obtained via X-ray microtomography: a review. Water Resour. Res. 50, 3615–3639 (2014). https://doi.org/10.1002/2014WR015256

Wildenschild, D., Vaz, C.M.P., Rivers, M.L., Rikard, D., Christensen, B.S.B.: Using X-ray computed tomography in hydrology: systems, resolutions, and limitations. Journal of Hydrology. 267, 285–297 (2002). https://doi.org/10.1016/S0022-1694(02)00157-9

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