ADDED VALUE OF MULTISCALE MODELING OF CONCRETE: EXEMPLARY ASSESSMENT BY MEANS OF STRUCTURAL ANALYSIS OF SEGMENTAL TUNNEL RINGS

Jiao-Long Zhang[1], Herbert Mang[1,2], Yong Yuan[1], and Bernhard L.A. Pichler[2]

[1] College of Civil Engineering of Tongji University, Siping Road 1239, 200092 Shanghai, China, Jiaolong_Zhang@tongji.edu.cn, yuany@tongji.edu.cn, https://geotec.tongji.edu.cn/en/

[2] Institute for Mechanics of Materials and Structures of TU Wien, Karlsplatz 13/202, A-1040 Wien, Herbert.mang@tuwien.ac.at, Bernhard.Pichler@tuwien.ac.at, https://www.imws.tuwien.ac.at

Key Words: *Multiscale Model, Mechanized Tunneling, Real-Scale Test, Multiscale Structural Analysis, Conventional Structural Analysis.*

This contribution is devoted to an assessment of multiscale modeling of concrete. Such an assessment follows from a methodology proposed in the joint research project between the Institute for Mechanics of Materials and Structures of TU Wien and the College of Civil Engineering of Tongji University. It is entitled "Bridging the gap by means of multiscale structural analyses" [1]. The methodology requires a comparison of experimental data with results from both multiscale structural analysis and conventional structural analysis. Herein, the experimental data is taken from a bearing-capacity test on a real-scale segmental tunnel ring, consisting of six reinforced concrete segments [2]. Both multiscale structural analysis and conventional structural analysis are performed in the framework of nonlinear hybrid analysis [3]. Multiscale structural analysis involves a micromechanics-based multiscale model for description of material properties of concrete. As regards the conventional structural analysis, the material properties of concrete are obtained from formulae in codes of practice [4-5]. Comparison of the experimental data with the analysis results shows that multiscale structural analysis provides more reliable predictions of crack opening displacements than conventional structural analysis does. It is concluded that the added value of multiscale modelling of concrete is significant for the long-term durability of segmental tunnel linings.

REFERENCES

[1] H. A. Mang, *Bridging the gap by means of multiscale structural analyses*, Research project supported by the Austrian Science Fund (FWF) P281 131/N32, 2015.

[2] X. Liu, Y. Bai, Y. Yuan, and H. A. Mang, Experimental investigation of the ultimate bearing capacity of continuously jointed segmental tunnel linings. *Struct. Infrastruct Eng.* 12, 1364–1379, 2016.

[3] J.-L. Zhang, H. A. Mang, X. Liu, Y. Yuan, and B. L.A. Pichler, On a nonlinear hybrid method for multiscale analysis of a bearing capacity test on a real-scale segmental tunnel ring. *Int. J. Numer. Analytical Methods Geomech.*, 32(7), 1343-1372, 2019.

[4] J.-L. Zhang, E. Binder, H. Wang, M. Aminbaghai, B. L.A. Pichler, Y. Yuan, and H. A. Mang, On the added value of multiscale modeling of concrete, *Front. Struct. Civ. Eng.,* 2021, https://doi.org/10.1007/s11709-021-0790-0.

[5] J.-L. Zhang, E. Binder, X. Liu, Y. Yuan, H. A. Mang, and B. L.A. Pichler, Assessment of the added value of multiscale modeling of concrete for structural analysis of segmental tunnel rings，in: *Encyclopedia of Materials: Composites*, D. Brabazon (ed.); Elsevier, Vol. **3**, pp. 69-78, 2021.