The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

# Wave Based Method for 2D Unsaturated Elastodynamic Soil under Harmonic Loading

**M. Lainer[1], Prof. Dr.-Ing. G. Müller[2]**

[1] Chair of Structural Mechanics, TUM School of Engineering and Design, Technical University of Munich, Arcisstraße 21, 80333 Munich, Germany, mirjam.lainer@tum.de, https://www.cee.ed.tum.de/bm

[2] Chair of Structural Mechanics, TUM School of Engineering and Design, Technical University of Munich, Arcisstraße 21, 80333 Munich, Germany, gerhard.mueller@tum.de, https://www.cee.ed.tum.de/bm

**Keywords**: *Wave Based Method, Unsaturated Soils, Poroelasticity*

The Wave Based Method (WBM) is based on the application of weighted wave functions, which fulfill the differential equations of a boundary value problem. By applying a weighted residual approach, residual error functions are established for the wave functions and evaluated along the boundaries of a WBM element. These residuals are used in order to derive the unknown weighting values for the wave functions.

In order to analyze unsaturated soil, a numerical model according to the WBM is formulated. For this, Biot's theory for elastic waves in a saturated continuum has to be modified. Considering an unsaturated soil domain, water and air are enclosed by the pores of a solid skeleton. In general it can be assumed that coupling effects between these three phases affect the propagation of elastic waves significantly. This means for a 2D domain, that three P-waves and one S-wave would have to be considered. According to Berryman, Thigpen and Chin [1] the number of dilatational waves can be reduced from three to two P-waves, by assuming that the capillary effects between the water and air phase are negligibly small for elastic waves in the low frequency domain. For this, the mixture of water and air is treated as one fluid, for which the material parameters, which go into Biot's model, have to be derived. The displacements within this composite fluid are then described by the sum of the displacements from the water and air phase.

Within this work, a partially saturated soil structure (BTC model) is compared with a saturated structure (Biot model) and also with a domain that is described by the Lamé equations (Lamé model). This permits the numerical evaluation of the influence of water saturation on the wave propagation for an elastodynamic problem. Moreover, it is investigated how the arrangement of soil layers with different degrees of saturation affect the system's response.

## REFERENCES

[1] J.G. Berryman, L. Thigpen, R.C.Y. Chin, Bulk elastic wave propagation in partially saturated porous solids. *The Journal of the Acoustical Society of America*, Vol. **84**(1), pp. 360–373, 1988.