Modeling Soil-Structure Interaction by Coupling the Integral Transform Method and the Finite Element Method

Franziska Mittermeier*, Hoa Nguyen, Quirin Aumann, Francesca Taddei and Gerhard Müller

* Chair of Structural Mechanics
Technical University of Munich
Arcisstraße 21, 80333 Munich, Germany
e-mail: franzi.mittermeier@tum.de

ABSTRACT

The simulation of soil-structure-interaction requires a proper representation of the coupling between the semi-infinite halfspace and finite structures on its surface. We present a strategy for coupling the Integral Transform Method (ITM) and the Finite Element Method (FEM), to cope with the characteristics of the two subsystems soil (halfspace) and structure.

The ITM [1] is an effective method to describe the halfspace as it can model the radiation of ground waves towards infinity. However, the method comes up against borders when finite structures with complex geometries have to be modeled. On the other hand, the FEM is suitable to model complex structures of finite extent and reaches its limits when radiation towards infinity has to be considered. Hence, describing soil-structure-interaction by coupling the ITM and the FEM exploits the strengths of both approaches.

In order to couple both methods, the ITM is enhanced by a strategy to derive the dynamic stiffness matrix of the halfspace surface. The deflections of the halfspace surface under unit loads are evaluated using the ITM in order to obtain the dynamic flexibility matrix of the halfspace surface. In comparison to [2] we introduce a discretization dependent scaling factor for the unit loads allowing for the computation of the dynamic stiffness matrix of the halfspace surface without introducing auxiliary foundations. Symmetry properties are exploited in order to reduce the calculation effort. Inverting the dynamic flexibility matrix provides the dynamic stiffness matrix.

Having determined the dynamic stiffness matrix of the halfspace surface using the ITM and having calculated the corresponding matrices for the finite structures using the FEM, the subsystems can be coupled by assembling the matrices at the coupling interface. This allows for the investigation of systems consisting of a halfspace with arbitrary structures on its surface under harmonic loadings. However, the method is yet only applicable for linear analysis and implies that the elastic halfspace consists of homogeneous and isotropic horizontal layers.

Using the coupled system various investigations can be performed. Among that, the efficiency of wave impeding blocks as vibration reduction measures [3] can be assessed.

REFERENCES

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