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THREE DIMENSIONAL RE-MESHING FOR REAL TIME MODELING OF ADVANCING PROCESS IN MECHANIZED TUNNELING

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Abstract. The simulation of the advancing process for arbitrary alignments during shield tunnelling requires a continuous adaption of the finite element mesh in the vicinity of the tunnel face in conjunction with a steering algorithm for the Tunnel Boring Machine (TBM) advance. Moreover, the finite element mesh should match the actual motion path of the shield machine resulting from the FE-analysis in each excavation step. For this purpose, a technique to automatize the process of mesh generation based on hybrid mesh approach in which a new computational mesh in the vicinity of the tunnel face will be automatically generated within the advancing process is introduced.
This contribution is concerned with the 3D automatic mesh generation of finite element models for numerical simulations of shield driven tunnelling processes [1]. Automating the remeshing procedure of the tunnel geometry would reduce the effort required for generating a 3D model and improve the quality of the mesh dramatically. A novel approach for hybrid mesh generation is proposed, which adapts the spatial discretization in the vicinity of the tunnel face according to the actual position of the TBM. This hybrid mesh attempts to combine full advantage of the numerical accuracy and practical aspects of structured hexahedra meshes, while the numerical error can be controlled by the chosen density and interpolation order of the unstructured tetrahedral mesh (generated by the tool TetGen [2]) within the excavation region denoted as region of interest. An appropriate algorithm based on Superconvergent Patch Recovery (SPR) for the transfer of internal variables is adopted. In addition, mesh refinement based on a suitable combined error indicator for elasto-plastic models is introduced. During the generation of an adapted discretization according to the actual stage of excavation, this indicator enables the remeshing technique to be driven by a set of criteria that are function of both the current position of the TBM and the discretization error. The developed adaptive FE-model for mechanized tunnelling is implemented into the object-oriented FE-code KRATOS. The applicability of the proposed approach for capturing the projected excavation path and to perform a large-scale simulation of a tunnelling process along curved alignments is demonstrated by means of selected examples.

REFERENCES

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