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SIMULATION OF AN ADDITIVE MANUFACTURING PROCESS CONSIDERING PROCESS AND MATERIAL UNCERTAINTIES USING A VOXEL-BASED APPROACH

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During the last decade, additive manufacturing techniques have gained extensive attention. Especially extrusion-based techniques utilizing plastic, metal or even cement-based materials are widely used. Numerical simulation of additive manufacturing processes can be used to gain a more fundamental understanding of the relations between the process and material parameters on one hand and the properties of the printed product on the other hand. [1]

Hence, the dependencies of the final structural properties on different influencing factors can be identified. Additionally, the uncertain nature of process and material parameters can be taken into account to reliably control and finally optimize the printing process. Therefore, numerical models of printing processes demand geometric flexibility while being computationally efficient.

This study presents an efficient numerical simulation of an extrusion-based printing process of concrete, applying a voxel-based finite element method. Along with the progressing printing process, a previously generated FE mesh is activated step-by-step using a pseudo-density approach. Due to the voxel-based model the mesh is generated without an explicit geometry model, using only the printing path parameters. This workflow allows a flexible change of the structure's geometry without remeshing a sophisticated parameterized geometry model in the background.

Additionally, all material parameters vary spatially and temporally due to the time dependency of the curing process. The numerical efficiency of the model is improved using various numerical techniques, e.g. multi-level preconditioning, which is particularly suitable in voxel-element context, enabling an uncertainty quantification of a 3D concrete printing process.

REFERENCES

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