# Parametric information modelling of mechanised tunnelling projects for multi-level decision support

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**Abstract.** This paper presents a concept for parametric modelling of mechanized tunnelling within a state of the art design environment, as a basis for the design assessment on different levels of details (LoDs). To this end, a parametric representation of each system component (soil with excavation, tunnel lining with grouting, Tunnel Boring Machine (TBM) and buildings) is developed in the information model for three LoDs (high, medium and low) and used for the automated generation of the numerical models of the tunnel construction process and soil-structure interaction. The platform enables a flexible, user-friendly generation of the tunnel structure for arbitrary alignments based on predefined structural families for each component, supporting the design process and at the same time providing an insight into stability and safety of the design. This model, with selected optimal LoDs for each component w.r.t. the objective of the analysis, is used for efficient design and process optimisation in mechanized tunnelling. Efficiency and accuracy are further demonstrated through error-free exchange of information between Building Information Modelling (BIM) and the numerical simulation and with significantly reduced computational effort. The results reveal that this approach is a major step towards the sensible modelling and numerical analysis of complex tunnelling project information at the early design stages.

## 1. Introduction

With increasing urbanisation and mobility, the need for underground tunnel facilities becomes evident. The efficient and safe design and construction of mechanised tunnels involves complex data management incorporating information not only about the tunnel structure, but also about the existing built infrastructure, the ground and the boring machine. In early design phases, crucial decisions have to be made, for example, on the alignment of the tunnel track in order to minimise the risks of settlement induced damages to existing buildings. This task can now be supported by sophisticated, process-oriented finite element (FE) analysis. However, the required FE models are characterised by a high degree of detail at high costs of preparation and computational effort preventing them from being readily applied during what-if scenario analyses at early design stages.

The appraisal of different design alternatives is essential for ensuring optimal designs. Assessing the effects of various alternatives for tunnelling projects on the surrounding environment is a multi-disciplinary and complex problem. The current state of the art process is cumbersome and requires significant computing resources and time (sophisticated simulations including all details can take days or weeks to complete). This often leads to sub-optimal solutions and could possibly result in a solution that is not ideal in terms of its effect on the existing infrastructure. However, in the conceptual phase, a designer often only needs approximate estimations for many different scenarios, e.g. tunnel track alternatives. To ensure a seamless workflow, the computation time should be minimised. If preliminary analysis (with consideration of uncertainties) indicates the potential for hazards, a more detailed evaluation of the model is required.

BIM has gained increasing attention in complex infrastructure projects, simplifying the planning and analysis and increasing productivity in design and construction. In tunnelling applications, the BIM concept has been used to create a tunnel information modelling