

Use Case 12b: Geotechnical Model for tender, time and cost estimation

Purpose

In current tunnel procurement procedures, the client issues the contractor a set of tender documents consisting typically of information to tenders, conditions of contracts, specifications, a bill of quantities and drawings.

One important document is the geotechnical baseline report (GBR), providing a clear definition of “Foreseen physical underground conditions” in the contract. It is also the central tool for adjustment of construction time and cost from the assumptions made in the bid to the physical conditions actually-encountered during construction. In the [FIDIC Emerald Book](#), the Geotechnical Baseline Report (GBR) takes this role.

A model of the anticipated ground conditions as described in this use case is seen as an application or translation of the GBR into a 3D geometrical representation, forming a structured container for the underlying information. The procurement method and the allocation of ground related risks defined in the contract is of high importance for the role and content of this model.

The underlying exchange scenario that IFC-Tunnel should support is the exchange of models from the client/designer to the contractor’s model viewer and tendering applications.

The model will be used further on during construction and updated to reflect the encountered conditions or revised prognosis. These updates will be based on additional factual data, e.g. from geological documentation (described in Use Case 15b) and investigation (described in Use Case 1b), and construction schedule and cost estimates can be revised (Use Cases 10 and 11).

Requirements for IFC-Tunnel:

The geotechnical tender model depicts on which base the excavation methods, support types, ground improvement, groundwater management and other measures were defined. It needs to clearly define which classification systems have been used and on which base data it was defined (relation to Use Case 1b and 2b).

Several aspects of **uncertainty** need to be considered and described (quantitative or qualitative).

The detailed georeferenced geometry of ground types, like the expected location of a fault zone, (as defined for structural analysis and provided in use case 2b) can usually not be provided for the whole alignment of long and deep tunnels and/or complex geological conditions.

A simpler geometry (referred to as ground sections) can envelope zones of similar ground behaviour, including for example:

- composition of ground types (percentage)
- characteristic setting of discontinuities and faults
- overburden
- expected deformations/settlements
- failure types
- hydrogeological conditions (rock mass permeability)
- degree of uncertainty (limited knowledge)
- other information relevant for definition of construction methods (e.g. specific for TBM)

The geometrical uncertainty of the boundaries between these ground sections can be defined by attributes, if necessary, and needs to be specified in the GBR.

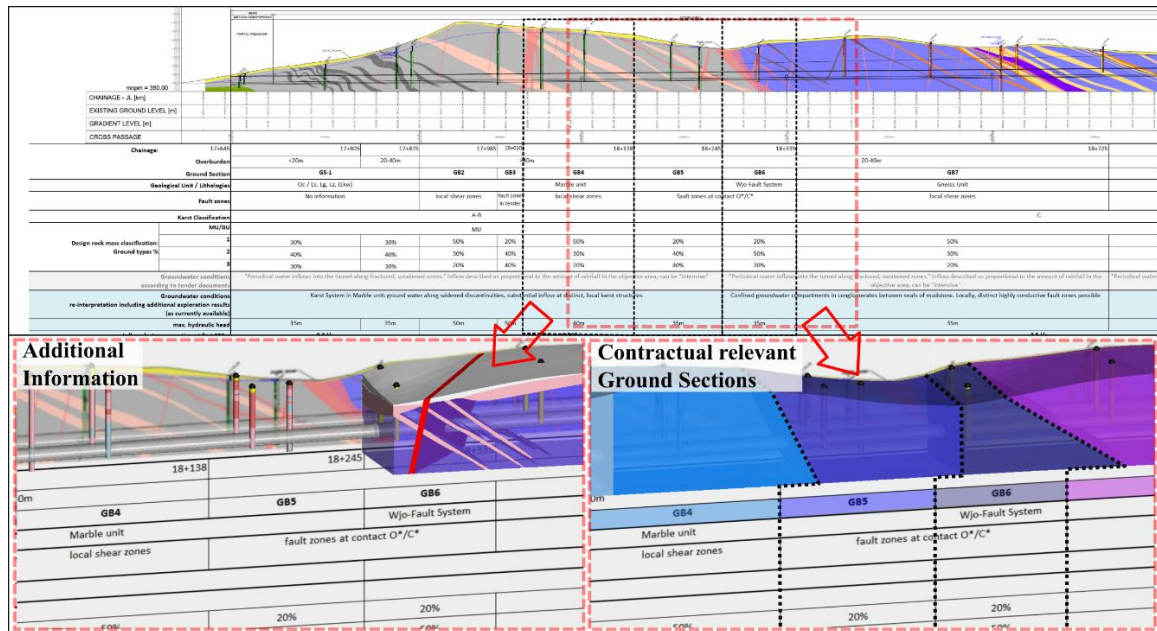


Figure 1: Typical longitudinal section, model of “ground sections” (right, use case 12b) and detailed model for structural analysis (left, use case 2b) © iC group

Statements in the GBR on physical behaviour should be represented by associated attributes of the model. Quantitative terms should be used (e.g. water inflow instead of permeability, ...), with the ability to be confirmed by measurements during construction.

Attributes should be defined as a range to respect the uncertainty (related to clauses on “foreseen / differing ground conditions” in the GBR).

For time and cost estimates, the modelled elements (ground sections) need to be supplied by or linked to associated construction methods, support types and the related time and cost attributes.

Geometry: Volume representations by solids/triangulate face sets are recommended, to allow for model queries by intersection with alignments, models of tunnel/shaft/slope excavations etc.

Semantics: Ground sections are defined project-specific and are linked to the definition of excavation- and support types and other measures, the corresponding structural analysis and the used geotechnical design model (**Use Case 2b**).

Beside the GBR, tender documents usually include additional factual data of site investigation results, referred to as “geotechnical data report” (GDR), according to the FIDIC Emerald Book. The handling of such datasets, which represent the database used for the GBR and the interpreted geotechnical model of the subject use case, are described in **Use Case 1b** and can include IFC-data, but also other digital formats (like GeoSciML, AGS or other database formats). Adding these factual data in digital form (= not pdf but native/database) to the tender documents allows the bidders a much more efficient interpretation and cost estimation.

The here described tender model shall act as an input for **Use Case 10** - quantity take-off and **Use Case 11** - construction sequence modelling, e.g. for an assessment of the effects of uncertainty in the model.

Geological and geotechnical information collected during construction (**Use Case 15b**) will be used to update the model during construction and finally develop an as-built model. The processes and information exchange for these updates and variance analysis need to be clearly defined in modelling guidelines and the BEP.

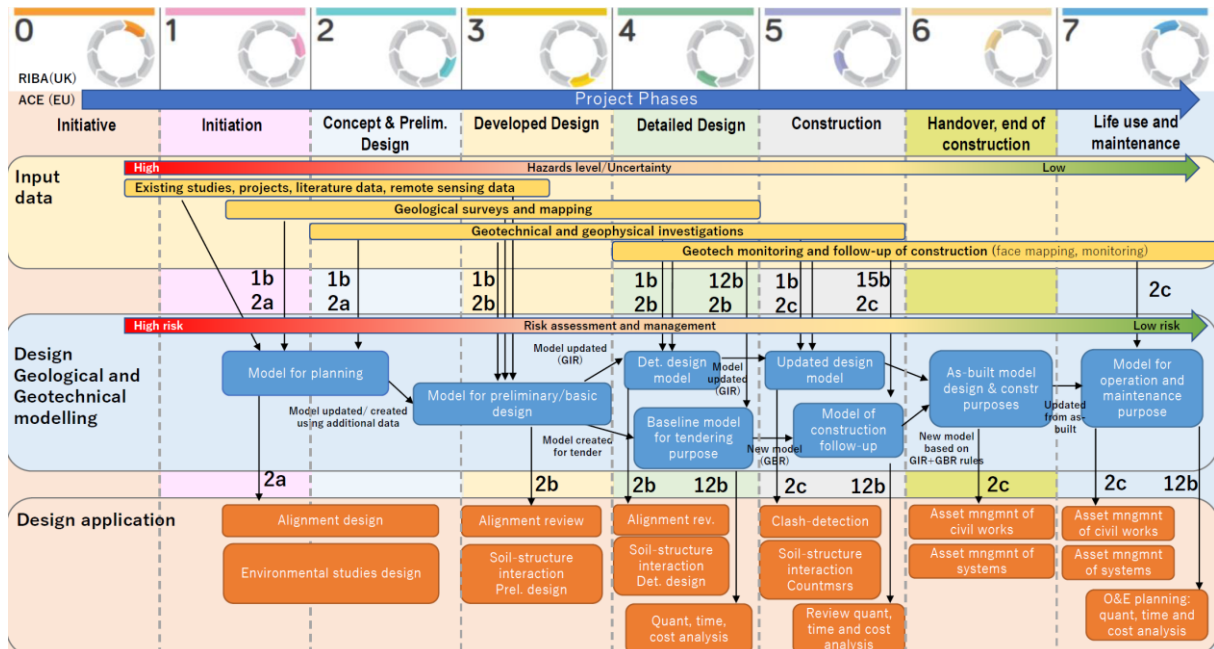


Figure 2: Process map of geotechnics-related use cases