Implementing BIM concepts on Karavanke tunnelling project

Marko Žibert M.Sc.Civ.Eng. – Head of tunnelling, iC group Ljubljana
Stakeholders

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Implementing BIM concepts on Karavanke tunnelling project

Marko Žibert
With our global know-how and competencies on site as well as more than 450 colleagues and our experience in 100 countries we provide solutions for projects worldwide.

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Why using BIM? Are there any benefits?
Why using BIM? Are there any benefits?

- Improved communication with stakeholders
- Better decision making
- More predictability
- Basis for asset depreciation
- Background for future projects

- Improved communication of design intent
- Better collaboration
- More efficient design

- Enables prefabrication
- Avoids rework
- Improved field productivity through building it virtually
- Improved service to clients
- Better on-site coordination resulting in reduce RFIs and changes
- Reduced wastage by using data for estimating or sequencing

- Enhanced visualisation and simulation potential
- Improved transparency of progress
- Improved communication of design intent

- Enhanced visualisation and simulation potential
- Reduced disruptions in handover

- Accurate as-built documents
- More thorough information and ease of accessibility
- Linked to facility management systems

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BIM Implementation planning

Behind the Scenes

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Definition of processes (BIM Overview process map)
Definition of processes (BIM Coordination)
Definition of processes (Other detailed process maps)

4D Modeling

5D Modeling

Model-based revision

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Communication, Collaboration and Coordination

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Project organization in the design stage

7 joint-venture partners | 15 companies | 60 engineers | > 120,000 hours
Project organization on BIM side

BIM Manager

BIM Overall coordination

BIM Discipline/Trade coordination

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Project scope

- 8,000 m long tunnel
- NATM
- > 1,000 m overburden
- Complex geology
- 2 countries, 2 clients
- Apart from tunnel, many other structures are included in the design
<table>
<thead>
<tr>
<th>Summary of BIM related activities</th>
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<tbody>
<tr>
<td><strong>Start of activities:</strong></td>
</tr>
<tr>
<td>2014</td>
</tr>
<tr>
<td>2016</td>
</tr>
<tr>
<td><strong>No. of involved companies:</strong></td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td><strong>No. of partial models:</strong></td>
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<tr>
<td>160</td>
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<tr>
<td>29</td>
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<tr>
<td><strong>3D BIM and Coordination:</strong></td>
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<td><strong>4D BIM:</strong></td>
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<tr>
<td>✓</td>
</tr>
<tr>
<td>x?</td>
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<tr>
<td><strong>5D BIM:</strong></td>
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<tr>
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<td><strong>6D BIM:</strong></td>
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<tr>
<td><strong>LoD:</strong></td>
</tr>
<tr>
<td>300 - 400</td>
</tr>
<tr>
<td>300</td>
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<tr>
<td><strong>LoI:</strong></td>
</tr>
<tr>
<td>400</td>
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<td>500</td>
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</table>
The Strategy | SLOVENIAN SIDE

KARAVANKE TUNNEL

TRADITIONAL APPROACH

Project assignment

Design phase

Execution

Operation

3D BIM (Design team)

4D, 5D BIM (Design team)

3D BIM (Design team)

4D, 5D BIM (Contractor)

BIM STRATEGY, EIR

BIM EXECUTION PLAN (BEP)

BIM METHODOLOGY

BIM COORDINATION

4D, 5D BIM (Supervision)
The Strategy | AUSTRIAN SIDE

PLATFORM 4.0
ASI, ÖBV, OIAV, FMA

BIM PILOT PROJECTS
INFRASTRUCTURE, TUNNELLING

RAILWAY STATION LAVANTAL

GRANITZTAL TUNNEL

KARAVANKE TUNNEL
TRADITIONAL APPROACH
Design Construction → Operation

3D BIM, Coordination → 6D BIM

EIR, BEP

BIM METHODOLOGY

IFC INFRA
IFC ROAD
IFC RAIL
IFC BRIDGE
IFC TUNNEL

ASI, ÖBV, OIAV, FMA

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PARIS– 15 November 2017
Coordination – 5 Coordination models

Slovenian National Coordinate System

Austrian National Coordinate System

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Information modelling in tunnelling

GEOLOGY AND GEOTECHNICS

Driven by mining exploration logging, managing and interpreting data

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Information modelling in tunnelling
Information modelling in tunnelling

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Information modelling in tunnelling

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3D Geological modelling
3D Geological modelling – using geological data as a basis for complex numerical calculations

1. Create geotechnical model based on geological & design data

2. Create virtual drillholes describing discrete model

3. Generate ground model for further numerical calculations
Modelling of temporary support structures

"The devil is in the detail"
Spatial data analytics

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Spatial data analytics

Open GIS database

XML/GML conversion of parameters

Basis for BIM model of utilities

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BIM – modelling of permanent works

Early stage modelling goals:
- Investigate different scenarios
- Costs and time analysis
- Communication with stakeholders

Detailed design modelling goals:
- Detailed geometry mimicking construction process
- Quality assurance by 3C
- Quantity take off analysis
- Time scheduling and budgeting
Early stage of model development

Assembly: distribute parametric families over profiles

Create parametric families

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Early stage of model development

Distribute parametric families over profiles

Distribute niches and other interventions according to the requirements

All elements are governed by series of queries each defining the required parameters

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Early stage - 4D (costs) and 5D (time) Modelling
Early stage - Communication with stakeholders

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Detailed design stage - Model segregation
Detailed design stage - Model segregation

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Detailed design stage - 190 Partial models
Detailed design stage – Coordination workflows

Segregate generic model to discipline specific models

Create & Analyze detailed discipline specific models

Compile federated model

Each team uses its own design specific tools

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Detailed design stage – Efficient design coordination

Creation of Discipline Models
Detailed design stage – 1500 inconsistencies resolved in design stage
1. Creating „Selection sets“

2. QTO rules for each item in the BoQ → connecting „Selection sets“ to QTO rules
3. Scheduling by means of connecting BIM elements with time schedule

4. Checking simulations, reporting (S-curve, budgeting, etc.)
### Detailed design stage – 4D and 5D Modelling

#### Selection Sets – link to 3D models:

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<tr>
<th>name4</th>
<th>name5</th>
<th>type</th>
<th>ctype</th>
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<td>cpiObject</td>
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#### Element Planning – QTO rule sets:

<table>
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<tr>
<th>Code</th>
<th>Select Set</th>
<th>Description</th>
<th>Quantity Query</th>
<th>Activation Condition</th>
<th>UoM</th>
<th>Quantity</th>
<th>RN</th>
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<td>1.2.6.0001</td>
<td>Izdelava uvrtanih kolov iz</td>
<td>QTO[Type=&quot;Volume&quot;;UoM=&quot;m³&quot;]/QTO[Type=&quot;BaseArea&quot;;UoM=&quot;m²&quot;]</td>
<td>M1</td>
<td>60.000</td>
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#### QTO – (Quantity Take Off) geometric formulas:

<table>
<thead>
<tr>
<th>RN</th>
<th>Outline Specification</th>
<th>FN</th>
<th>Computation</th>
<th>Result</th>
<th>UoM</th>
<th>ifcID [Value]</th>
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<tr>
<td>1.2.6.001</td>
<td>Izdelava uvrtanih kolov iz</td>
<td>9  2</td>
<td>(10 \times 25 \times (1/2 \times 0.6 \times 0.149) / (25 \times (1/2 \times 0.6 \times 0.149))) = 10.000</td>
<td>M1</td>
<td>0QEOkgprTPVuH2Kqum5oWJ</td>
<td></td>
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</tbody>
</table>

#### BOQ – comparison of model based QTO and traditional (contractual) BOQs:

<table>
<thead>
<tr>
<th>RN</th>
<th>Outline Specification</th>
<th>Model based Quantity</th>
<th>Quantity – official BOQ</th>
<th>UoM</th>
<th>Unit Rate</th>
<th>Total Amount</th>
<th>VAT</th>
<th>Opomba postavke</th>
<th>Normativa</th>
<th>Comment Client</th>
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<tbody>
<tr>
<td>1.2.6.001</td>
<td>Izdelava uvrtanih kolov iz</td>
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<td>60.000</td>
<td>M1</td>
<td>390.00</td>
<td>23.400.00</td>
<td>22.00</td>
<td>+ kompletna</td>
<td>S 2 7</td>
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</table>
Detailed design stage – 4D and 5D Modelling

Mastering engineering challenges for 20 years

PREDOR KARAVANKE
5D SIMULACIJA
FAZA PGD

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