Prerequisites for BIM-based Invoicing in NATM Projects

Leopold Winkler, Oleksandr Melnyk, Gerald Goger
Research Project „BIM in Tunneling“

• Research goal: Implementation of a BIM-based reference process, using data from ZaB

• Funding

• Research Team

• Industry partners
BIM-based Workflow

TIMS for invoicing according to ÖNORM  2203-1
Prerequisites for Digital Invoicing

- Configuration according to ÖNORM 2203-1
- Support Measure Types

<table>
<thead>
<tr>
<th>Construction / Configuration / Tunneling / Support Measure Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: Wire mesh – Outside with steel arch</td>
</tr>
<tr>
<td>Entry UOM: Unit</td>
</tr>
<tr>
<td>Tunneling Class:</td>
</tr>
<tr>
<td>Class Calculation: lining_area</td>
</tr>
<tr>
<td>Class UOM: Square meter</td>
</tr>
<tr>
<td>Support Factor: 1.0</td>
</tr>
<tr>
<td>Material</td>
</tr>
<tr>
<td>Material Calculation: product_weight / product_area * lining_area</td>
</tr>
<tr>
<td>Material UOM: Kilogram</td>
</tr>
</tbody>
</table>
Prerequisites for Digital Invoicing

- Configuration according to ÖNORM 2203-1
  - Support Measure Types
  - Support Measure Definitions

- Configuration according to ÖNORM 2203-1
  - Support Measure Types
  - Support Measure Definitions
6 Steps towards Digital Invoicing

1. Machine-readable Construction Data
2. Digital Checking and Mutual Confirmations
3. Cycle Diagram
4. Mapping on Tunneling Classes
5. Measurement Items
6. ONRE Exchange
Rights Management

- Many-to-many relation between Users and Role
- Role-based access rights
- CRUD: Create, Read, Update, Delete
Digital Checking and Confirmation of Tunnel Rounds

• Site manager / Client (Supervisor)

• Manager view:

Draft ➔ Confirm Manager ➔ Confirm Client

Confirmed Manager ➔ Cancel Manager ➔ Confirm Client

Confirmed

2nd ATC² – Symposium – Digitization in Tunneling
Thursday, 02.12.2021
Mapping of Tunneling Classes

Fragile Mapping with spreadsheet programs

= Wenn (UND (CM48<7; CL48="mech.")); Wenn (UND (3,8<CN48; CN48<6,4); "7/5,1 mech."); Wenn (UND (6,4<CN48; CN48<9); "7/7,70 mech."); Wenn (UND (9<CN48; CN48<11,6); "7/10,30 mech."); Wenn (UND (11,6<CN48; CN48<14,2); "7/12,90 mech."); Wenn (UND (14,2<CN48; CN48<16,8); "7/15,50 mech."); Wenn (UND (16,8<CN48; CN48<19,4); "7/18,10 mech."); Wenn (UND (19,4<CN48; CN48<22); "7/20,70 mech."); Wenn (UND (22<CN48; CN48<24,6); "7/23,30 mech."); Wenn (UND (24,6<CN48; CN48<27,2); "7/25,90 mech."); Wenn (UND (27,2<CN48; CN48<29,8); "7/28,50 mech."); Wenn (UND (29,8<CN48; CN48<32,4); "7/31,10 mech."))

Confirm tunnel Rounds

Determine actual Tunneling Class

Map on contractual Tunneling Classes

Create measurement item

Model classes
- Standard Cross Section: Rating area
- Support Definition: partial drift, round length, Line 1A / Line 2
- Support Measure Types: Material, support factor
- Tunnel Round: Quantities

Model class
- Tunneling classes: 1st Organizing Number, 2nd Organizing Number range

Process of mapping

• Standard Cross Section:
  - Width
  - Height
  - Opening area

• Support Definition:
  - Drift type
  - Round length
  - Line 1A / Line 2

• Support Measure Types:
  - Material
  - Support factor

• Tunnel Round:
  - Quantities

Model class
- Tunneling classes:
  - 1st Organizing Number
  - 2nd Organizing Number range

Create measurement item

02.12.2021

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Time Saving Potential

- Documentation process

<table>
<thead>
<tr>
<th>Activity</th>
<th>Paper based</th>
<th>Digital</th>
<th>Time Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data acquisition</td>
<td>14 – 75 %</td>
<td>0 – 8 %</td>
<td>99 %</td>
</tr>
<tr>
<td>Data evaluation</td>
<td>23 – 73 %</td>
<td>87 – 97 %</td>
<td>52 – 57 %</td>
</tr>
<tr>
<td>Data delivery</td>
<td>2 – 13 %</td>
<td>3 – 13 %</td>
<td>67 – 83 %</td>
</tr>
<tr>
<td>Daily Documentation</td>
<td>100 %</td>
<td>100 %</td>
<td>63 – 87 %</td>
</tr>
</tbody>
</table>

- Invoicing process up to 90%

Direct Time Saving Potential of TIMS

- Documentation Time on- and off-site

Further Research

Frontend
- Mobile Device
  - REST
- Desktop Computer
  - RPC
- Equipment
- Augmented Reality

Backend

Server
- API
- Access Control
- Workflow Engine
- View Engine
- Report Engine
- I18n
- ORM

Tunneling Models

Database

Evolving As-built Model
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