Navigation and Quality of Construction Processes

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Engineering Surveys for Construction Works II

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Introduction

- Current status in construction processes:
  - frequently the surveyor delivers co-ordinates and other geometric information to the civil engineer
  - the surveyor does not participate at decisions based on his information
- Higher degree of automation leads to:
  - higher degree of safety requirements
  - more complex construction tasks
- Requirements:
  - assured quality for geometric information
  - realtime integration of geometric information into construction processes

Construction Process and Information Chain

IMAP – Principle

IMAPR – Principle / Construction Circle

Navigation & Quality of Construction Processes

Structure

- Introduction
- The Construction Circle
- Quality Model and Characteristics
- Quality Safeguarding for Construction Processes
- Conclusions and Outlook

Construction Process and Information Chain

Management of the Construction Process

Construction Process

Information:
- topography,
- development
- geo-technique based on GIS

Construction Phase

- Construction Process Control
- Management / Characteristic Circle of the Construction Phase Data

Analysis

Presentation / Visualisation

GIS

Information Management

Import / Acquisition

Management

Presentation / Visualisation
Tutorial 3: Positioning and map matching - Part 3: Positioning by multi sensor systems

Exemplary Realisation for High-Speed-Tracks

- Construction phase for high-speed slab tracks „Feste Fahrbahn“ for Köln-RheinMain (gravel is replaced by concrete)
- Surveying task: Setting out of slab tracks
- Adjustment possibility of slab tracks only within some mm

IMAPR for Slab Track Setting Out

Quality Model and Characteristics

- Quality characteristics in engineering geodesy: accuracy, reliability, sensitivity, separability.
- Current relevant quality characteristic in civil engineering: accuracy described by different tolerances.
- Proposed quality criteria on construction sites: (according to Wiltschko (2004) and various literature about automation in construction)
  - reliability (of the equipment), availability (of data or systems), completeness (of information), correctness, up-to-dateness, level-of-detail.

Lack of a complete quality model for construction processes!

Internal and External Geometry

- Internal geometry - shape of an object
- External geometry - position of an object

Additional remark: accuracy criteria demand for relationship between given tolerances and determined standard deviations: $\delta_1 = 0.2 \cdot \sigma_T$

Quality Safeguarding for Construction Processes

Quality assurance comprises
- a-priori evaluation,
- quality measurement and realtime evaluation,
- propagation of quality measures,
- realtime documentation of results and quality measures.

Safeguarding measures assure that the measured quality is in accordance with the planned quality (a-priori evaluation)!
Tutorial 3: Positioning and map matching - Part 3: Positioning by multi sensor systems

Quality Safeguarding Integrated into Construction of Slab Tracks

Quality Assurance
- safeguarding measure
  - external geometry
  - internal geometry
  - safety and reliability
- quality characteristic
  - external geometry
  - internal geometry

Construction Process Surveying Tasks
- planning of slab tracks
- construction
- fixing of slab tracks
- adjustment of slab tracks
- control network
- pre-setting out of slab track
- realtime setting out of slab track
- realtime control of slab track
- determination of tachymeter coordinates in control network
- use of metal pillars for setting out
- alignment method for setting out
- integration of construction circle for realtime control (fig. 4)
- realtime documentation of results

Acceptance Survey
- finalisation of construction

Quality Assurance
- external geometry
- internal geometry

Conclusion
- Demand for a complete quality model including inherent characteristics and parameters
- Integration of quality assurance including safeguarding measures into the construction process
- Safeguarding measures show positive effects for construction of slab tracks
- The IMAP-principle has to be upgraded by the action realisation respectively construction leading to the IMAPR-principle
- Construction phase is a construction circle following the IMAPR-principle leading to construction process control and quality driven control circles
- Participation in decisions of interdisciplinary projects like are construction processes!
- The surveyor as decision maker!

Outlook
- Navigation of construction processes by geometric information (delivered by the surveyor)
- Obtainment of required quality with as less time and cost effort as possible: “design-to-quality”-process
- Knowledge about and application of control systems and cybernetics is essential for surveyors to discuss at eye-level with civil engineers

Thank you very much for your attention!

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