"BIM-BASED PAVING"

BIM-based design of asphalt paving to optimize the renovation procedures

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Finnmap Infra is a private consulting company specializing in infrastructure and environment engineering. We operate in Finland, Sweden, Germany and Russia and we also participate in bi- and multilateral projects in developing countries.

Our services cover the entire range of design and site supervision tasks necessary to develop a functional environment: roads, highways, railways, utilities, geotechnics, bridges, land use and environmental studies.
Contents of the presentation

- What is BIM?
- Why "BIM-based paving"?
- Main steps in "BIM-based paving"
- Initial data and its analysis
- BIM-based designing of paving
- Automated / assisted machine controlling
- As-built data
- "BIM-based paving" in Finland 2015
What is BIM

“Building Information Modeling (BIM) is a (3D) digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle.” (National Building Information Model Standard Project Committee, USA)

BIM = Building Information Model → Built environment Information Management
AIM = Asset Information Management

Information is intelligent:
- Information is saved and transferred in open format
- Information is harmonic so that it can be utilised efficiently
- Information can be used for several purposes
- Information involves data about itself (meta data)

Information has several use cases
Information has several user groups

BIM is more than a technics!
The use of BIM is not yet at a level where all known benefits can be realised!
Possible ways of use the BIM

Source: Niklas von Schantz, Ramboll
BIM in road maintenance

In recent years utilization of BIM and 3-D control of machines have increased a lot in new road construction.

Development has been much slower in the field of road maintenance and rehabilitation.

In Finland special effort to study and develop the BIM processes in road maintenance has been active since 2010 – as a minor part of PRE InfraFINBIM research program

BIM is a tool to share and utilize data during the life-time of a structure → so it should also cover the road maintenance period.

• Design phases and construction time data could be combined with the data gathered during maintenance actions.

• By comparing and analyzing the data it is possible to make good decisions for future maintenance actions.

The easiest way to start utilising BIM in maintenance is to connect the already existing databank information to geo-spatial location.
Targets for BIM in paving

- Better process to allocate funds for the most problematic stages of the road (optimization of the renovation works)

- To repair the road geometry to achieve specific aims (e.g. to make longitudinal or transversal slopes better)

- To achieve better quality for asphalt surface or structure compared to traditional process

- To use less asphalt mixtures / to use more recycling → to save money

- To make paving cycles longer

- To develop tendering process (more efficiency in competitive tendering, when invitations for tenders become more specific → more accurate mass volumes → smaller risks, fewer unclarities)

  Cost efficiency – more or better with same cost
Determination of paving costs

The traditional costs fixing dilemma in construction process:

• Possibilities to affect costs and results are mainly fixed at early phases in a project.
• Costs (for changes) are formed during construction.

Costs in paving project:

• Paving is essential in road maintenance.
• Paving is expensive action in maintenance.
• Traditionally paving is rather poorly designed.
• BIM is good tool to make changes in traditional process
Main steps in "BIM-based paving" method

1. Survey of road surface = mobile laser scanning
2. Check of thicknesses of road layers ≈ measurements, design data, …
3. Handling the initial data and making analysis of prevailing condition of road
4. Model based design of paving tasks
5. Milling and paving by using automated machine guidance
6. Measurements after paving/during paving
7. Analysing the changes in road condition
"BIM-based paving" method
Mobile laser scanning

Measurement

- Mobile laser scanning (land mobile mapping)
- Several devices and types (e.g. Trimble, Riegl, Lynx…)
- Absolute and relative methods
  - absolute (global) – global coordinate reference signal points → automated machine control system
  - relative – in relation to the existing surface → "asisted" machine control system

Processing the mobile scanning data

- Raw point cloud after measurement
- Classifying the points
- Matching several measurements
- Searching and digitalizing road lines → Road surface model

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BIM-based paving

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Processing the laser scan data
Point cloud video
Road structure data

Measurements

• GPR, FWD / TSD

• Common coordinate system for all data
  • global is best but well-defined and clearly marked local system is sufficient

• To check measurement results some core samples are needed

• Old, design drawings and historical information of road maintenance tasks would be valuable.

Handling the results

• The "bottom surface" of asphalt layers are designed/modelled using some margin of certainty

• As a result there are surface models of asphalt layers (all layers in the structure)

• Layer surface models are used as initial data for BIM to check the possibilities to realize the BIM designed actions
Analizing the surface conditions

Graphical views
Analyzing the prevailing condition

Calculating the critical values in road section

Cross slope (regression line)

Maximum rut depth
Analyzing the prevailing condition

Calculating the critical values in road section

Height of bump

Height of rut

"Water rut", left

"Water rut", right

Poikkiprofilin vasen puoli

1,90 m

Poikkiprofilin oikea puoli

1,90 m

3,20 m

3,20 m
Analyzing the prevailing condition

Spreadsheet analysis
BIM-based design

Software

- Bentley InRoads ja Microstation (PowerCivil)
- Terrasolid TerraScan
- Microsoft Excel & VBA-coding

Process

- Digitalizing horizontal geometry (border lines, middle line)
- Designing vertical geometry (according InRoads / Excel regression analysis)
- Designing cross slopes
- Combining geometry designs and iterating the solution
BIM-based design
Mobile scanning after paving

When the road is also scanned after paving, it is possible to compare as-designed and as-built models:

- average cross slopes in the whole site
- maximum changes in cross slopes
- "speed" in cross slope changes (cm / 10m)
- changes in longitudinal slopes
- unevenness (IRI / measured & calculated deviation)
- rut depths
- improvements with individual pavement failures ("boat floor" places, unevenness points…)
- differences between layer levels (milling, final surface)
- mass volumes (milled & laid asphalt masses)
As-designed vs. as-built

Cross slope (%) vs. Distance (m)

BIM-based paving  NVF34 Seminar 3.9.2015
Visualizing the results

Original surface

Repaired surface
Demonstration video
The benefits of the method

When using the BIM-based paving it is possible to:

- Consider the circumstances of the site → allocate tasks to the problematic places
- Correct the failures with best possible method (or using the preferred quality)
- Optimize the mass volumes (milling, overlaying, surfacing asphalt)
- Reduce routine works (manual guidance and measurements)
- Improve the accuracy and efficiency of the work (less mistakes)
- Improve the quality and safety of the work
- Achieve better cost-effectiveness for order and for contractor (life cycle costs!)
- Realize the work by visualizing the results
"BIM-based paving" in Finland 2015

Year 2015 facts in Finland:

- Only some BIM-based paving projects will be done, altogether about 20 km
- Interest towards method is increasing – several projects have been discussed
- Mobile scanning has been done on several road sections
Views to future

• BIM-based design will become more common in paving and in road maintenance
  • BIM-based data and databank data will be utilized much more and designing will be much more effective

• Methods of BIM-based paving will be developed

• The procedure of BIM-based paving will be fixed
  • BIM will integrate to procuration processes also in maintenance projects

• Mobile scanning will develop and become more common

• Use of common models (Here, Google, other instances) will become possible

• Automated machine guidance will develop further and become more common
  • GPS-based x-y-z control
  • relative control to prevailing surface level
  • all kind of machines
  • machines will start to collect quality data, too
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