PKGroup

SMART CONSTRUCTION

AB Panevėžio Keliai

VIRMANTAS PUIDOKAS,

DIRECTOR GENERAL OF AB PANEVĖŽIO KELIAI

We are a company that expended perhaps the most effort in promoting good project implementation practise in the Lithuanian road sector. It is not just about concentrating design and construction processes with a single supplier, but also exploring 3D design and digital models in construction, which enabled us to make use of the automated machine control systems. The compound adaptation of these technologies determined our success in the Lithuanian Product of the Year 2015 contest, where the Lithuanian Confederation of Industrialists awarded our company with three gold medals.

Construction site at Žemaitkiemis junction in Ukmergė district on highway A2 Vilnius–Panevėžys. Construction of support columns for the new pedestrian overpass.

VILIUS GRAŽYS,

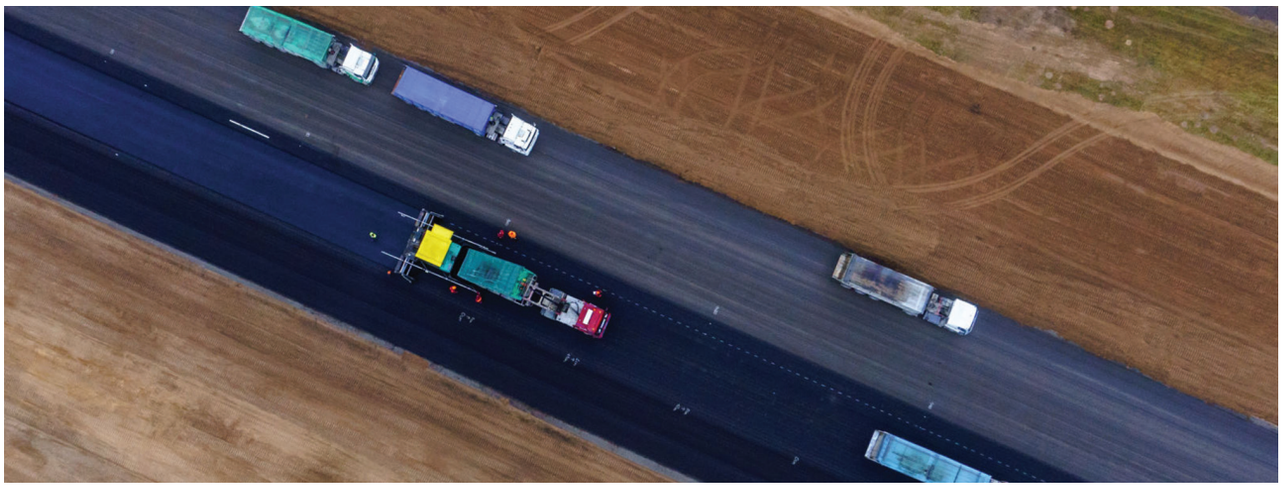
AB PANEVĖŽIO KELIAI TECHNICAL DIRECTOR

AB Panevėžio Keliai company must possess the latest technologies. I am not referring to the technological division specifically – if we are not developing new technologies then the engineers are not improving their intellectual level. Look around you: time and circumstances call for innovations. Of course, our engineers decide exactly what kind of technologies we require.

I cannot say that we Lithuanians are overly conservative. First we have to understand, see and touch, so the beginning is often sluggish. But when an innovation is implemented, we question ourselves why this was not done sooner. The purpose of all the technological advancements is lowering production costs and improving quality. Environmental safety problems and occupational health and safety issues are being addressed as well. This is exactly what we should be focusing on.

Before we can fully understand the need for new technologies, let us take a look back into history. All books concerning the history of roads agree on one basic requirement: the road must first of all be passable. For this reason we developed certain technologies, various asphalt mixtures, machinery. When the roads became passable, a new requirement was put forward: major roads must be paved. This revelation brought about a new wave of technological developments.

There is always a road construction problem that must be solved. Everything is done for the benefit of the people – drivers and passengers. During the independence movement we had an obsession with levelling. We levelled all major roads. Other technologies soon followed: different types of mixtures, asphalt pavers, rolling schemes, roller tracking systems. Then another goal was set – more robust road surface. This required advanced technologies too. What I want to say is that life itself dictates the need for innovations.

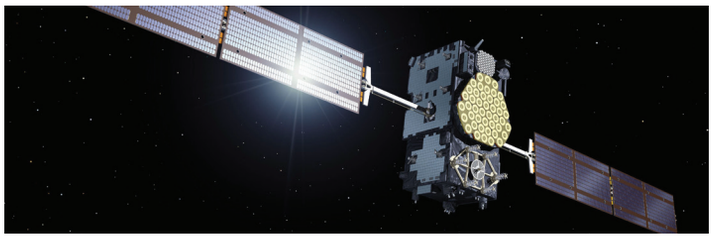


Asphalt-concrete paving works on the runway of Kyviškės Flight Training Base under VGTU Antanas Gustaitis Aviation Institute.

STAGES OF BUILDING INFORMATION MODELLING (BIM) AND AUTOMATED MACHINE CONTROL SYSTEM (ACS) ADAPTATION IN PRODUCTION PROCESSES. DESIGN

PREPARING A NETWORK OF GEODETIC MARKERS

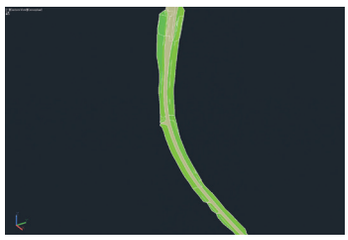
Geodetic survey, marking, positioning of automated machine control systems during the construction works and 'as built' geodetic measurements are taken using the provided geodetic base. A network of survey marks is set up at the construction site in accordance with the provided geodetic base, followed by setting up a GNSS reference base that ensures highly accurate measurements throughout the construction site.

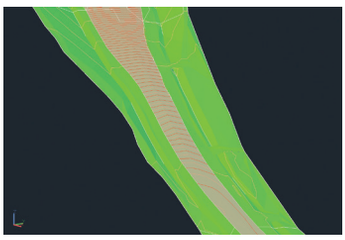


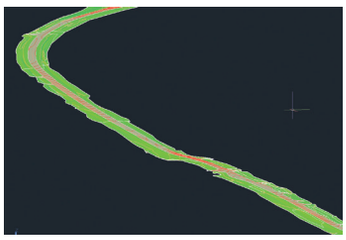
In order to ensure the most efficient use of the digital road model in construction processes, a GNSS reference base is set up on site to continuously monitor and adjust the altitude and location data sent by the satellites and the machines on the ground.

TOPOGRAPHIC AND GEOLOGICAL-ENGINEERING SURVEY

Topographic survey must be carried out prior to the geological-engineering survey. Then, the designer can assess the existing geological properties of the area and suggest the most appropriate construction materials for each structural layer.



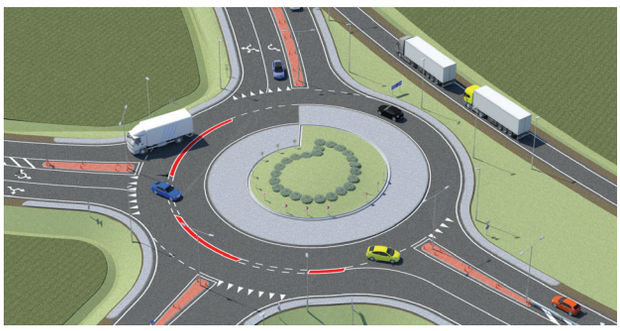




A digital surface of the area is prepared on the basis of the survey data.

PRE-DESIGN PROPOSALS AND ECONOMIC ASSESSMENT

When design and contract work is entrusted to a single supplier, they can offer various design solutions. The proposed solutions are visualised on a 3D map of the area, giving the client a chance to assess their effectiveness not only through the economic point of view but also in terms of integration into existing infrastructure, traffic organisation and safety measures, and other aspects.



Pre-design proposals for the reconstruction of main road A17 Panevėžys city bypass and main road A10 Panevėžys–Pasvalys–Riga intersection into a turbo roundabout.

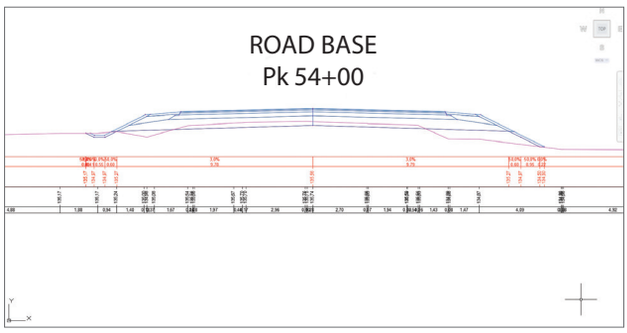
STAGES OF BIM AND ACS ADAPTATION IN PRODUCTION PROCESSES. DESIGN

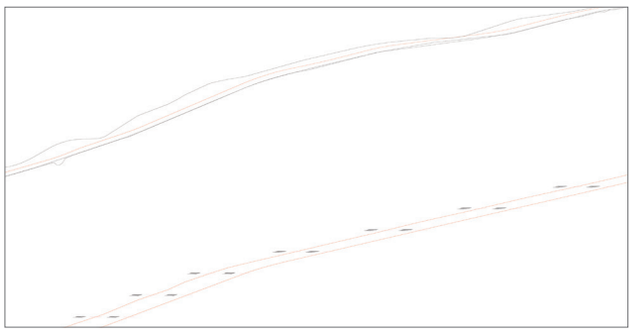
PREPARATION OF THE TECHNICAL WORK PROJECT

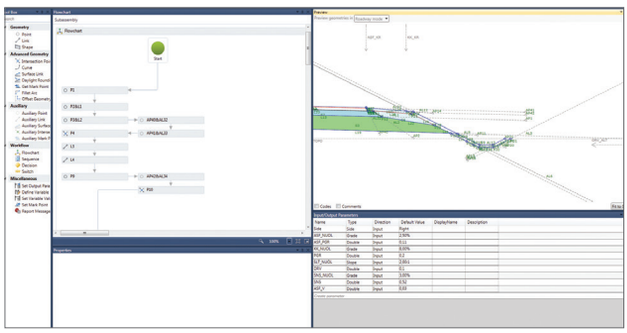
The technical work project is developed in 3D environment using the topographic survey data and the client's specifications. A technological project outlining the work sequence, machinery and raw material requirements is prepared on the basis of the technical work project.

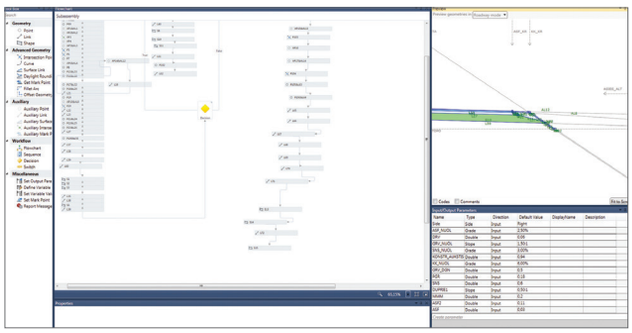
BIM application begins in the pre-design proposal stage. A comprehensive model is compiled concurrently with the technical work project and elaborated in greater detail during the technological project preparation stage, becoming an integral part of it.

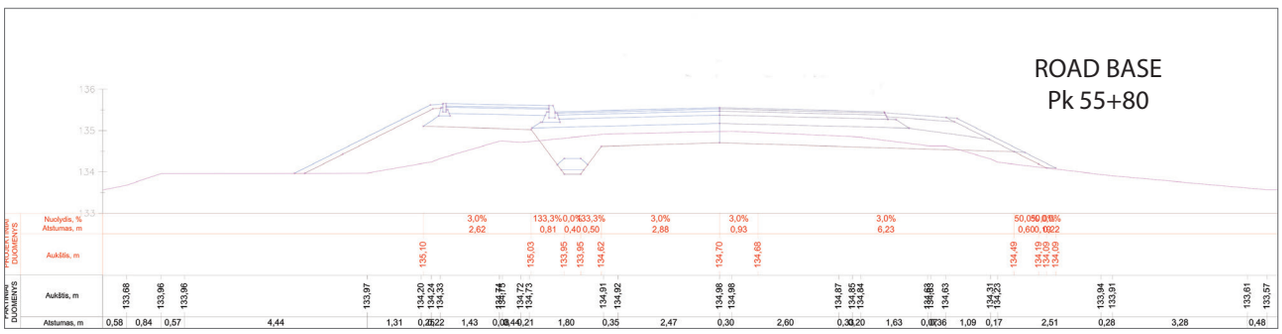
Project design contains the road alignment with longitudinal profiles. Cross sections are programmed for the creation of dynamic road corridor. Once completed, the digital road model serves as a basis for creating digital surfaces of each structural layer.











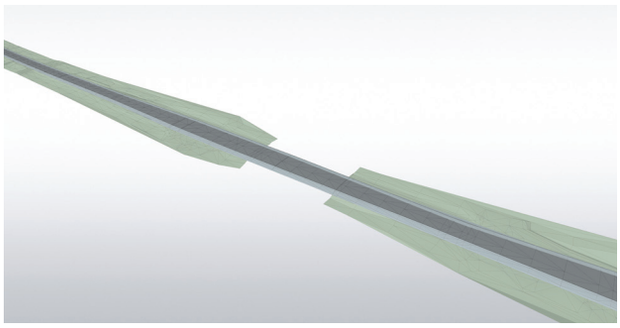
Cross sections are programmed for the creation of dynamic road corridor. Once completed, the digital road model serves as a basis for creating digital surfaces of each structural layer.

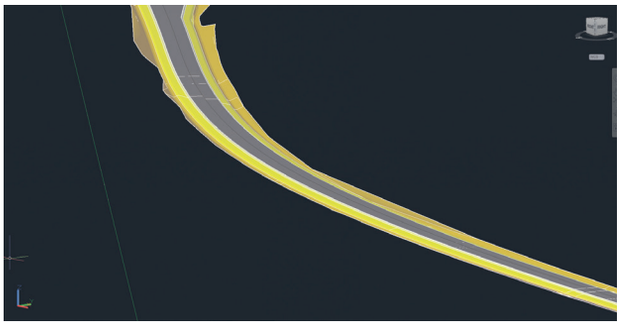
TOMAS BAČIŪNAS,

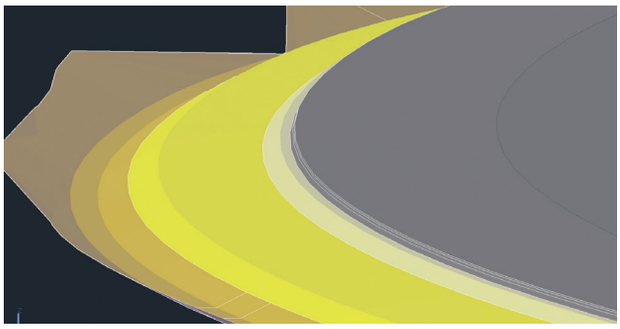
HEAD OF AB PANEVĖŽIO KELIAI TECHNOLOGICAL DIVISION

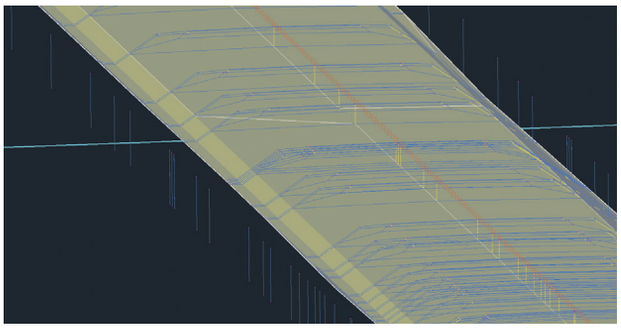
Digital road model is a link between design and construction works. In other words, before building the road in real life, we 'build' it on a computer. Designers prepare the digital road model, while ACS specialists adapt it to specific tasks on a construction site. The digital model is also useful when calculating the material quantities and production costs.

Before this development, one specialist had to collect the project, print it and read it, then another specialist had to interpret it and compile the geodetic log. Afterwards someone had to transport all of this to the construction manager at the site. The foreman had to get acquainted with it first, then hand it over to the machine operator. This long chain of people has now been replaced by a data packet transferred through the internet. The designer's project can be reviewed and approved by the project managers and forwarded to production. This saves time and greatly reduces the likelihood of human error.









Reconstruction of the regional road of national significance No. 115 Ukmergė–Molėtai, sections 2.430–12.850 km and 12.850–19.100 km. The technical work project served as a basis for designing seven road alignments with longitudinal profiles. More than twenty cross sections were programmed to create the dynamic road corridor, which was then used to create digital surfaces of each structural layer.

STAGES OF BIM AND ACS ADAPTATION IN PRODUCTION PROCESSES. CONTRACT WORKS

PRINCIPLES OF AUTOMATED CONTROL SYSTEMS (ACS)

Digital road model and accurate geodetic base enable the use of automated machine control systems (ACS). This modern technology allows the builders to automate a significant portion of the construction tasks, including road base formation, installation of structural road elements and paving. ACS is fully functional only with precise geodetic positioning of the site parameters.

Automated control systems used by AB Panevėžio Keliai are composed of GNSS receivers, sensors and computers installed in the machine operator's cabin. ACS can be installed on various road construction machines, such as excavators, bulldozers, pavers and rollers.

The sensors and antennas mounted on the machines pinpoint their exact location. To ensure maximum accuracy, machines operating within the ACS network maintain a connection with the satellites and the reference base set up at the construction site. In-cabin computers contain the digital road model with the construction layers relevant to the task at hand. Machine operators can observe the digital road model on-site, tracking their machines and task performance in real time.

The system accurately tracks machine movements within the 3D road model, resulting in virtually flawless execution of the construction tasks. It conserves time and raw materials, and allows to synchronise the work process.

The greatest benefit of the digital road model and ACS in terms of work quality is self-control, which ensures accurate project implemetation, rational use of raw materials and optimal time management. For example, earthworks executed through the usual means are often flawed and corrections consume time, materials and human resources. When ACS network is in use, one person carrying a portable GNSS rover can replace a whole team of workers with levelling tools.

ACS is installed on road construction machinery and positioned at the site using GNSS network. The digital road model is then uploaded on the in-cabin computer so both the operator and the designer can see the simulated road section and the machinery's position in it.

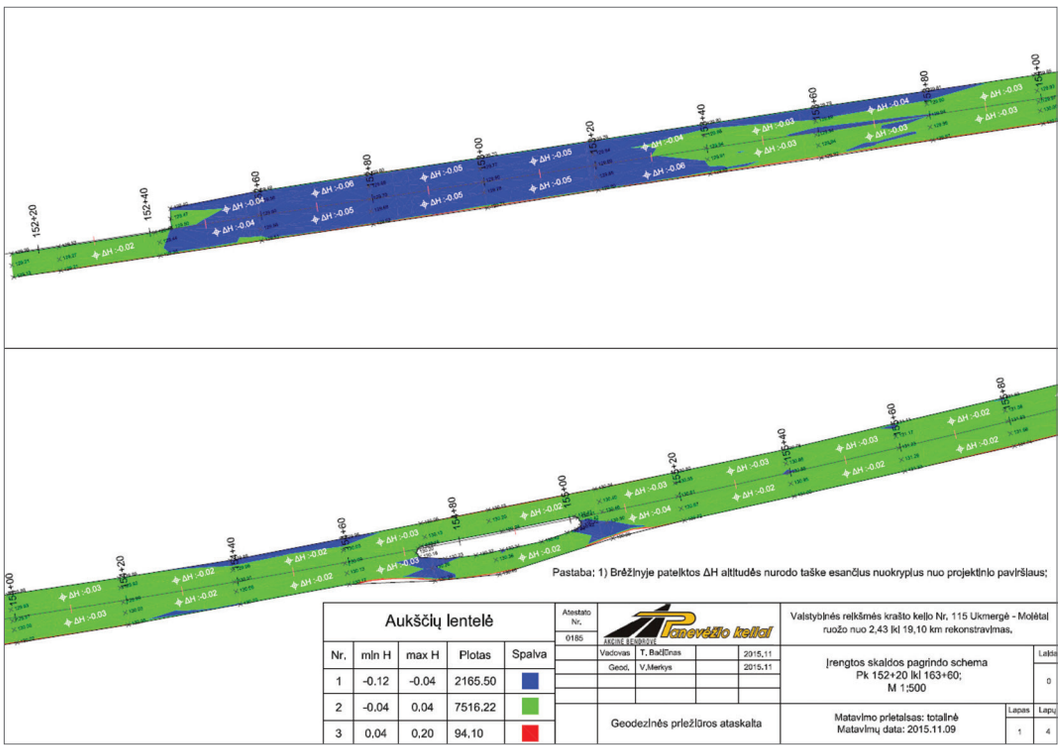
STAGES OF BIM AND ACS ADAPTATION IN PRODUCTION PROCESSES. CONTRACT WORKS

CONSTRUCTION MANAGEMENT AND QUALITY CONTROL

Digital road model is a useful tool for planning work implementation schedule and earthworks. Project management team can analyse the workload in detail in different cross sections.

ACS enables the direct use of digitally prepared structural elements in construction while avoiding a number of intermediary information transfer steps and decreasing the likelihood of human error.

In addition to the ACS, each completed construction layer is geodetically measured. The resulting digital surface is compared to the respective surface portion in the project design. Comparative diagrams use different colours to distinguish between areas with acceptable deviations and areas that require corrections. These diagrams provide the construction manager with enough information to quickly resolve these issues and assure the project quality.



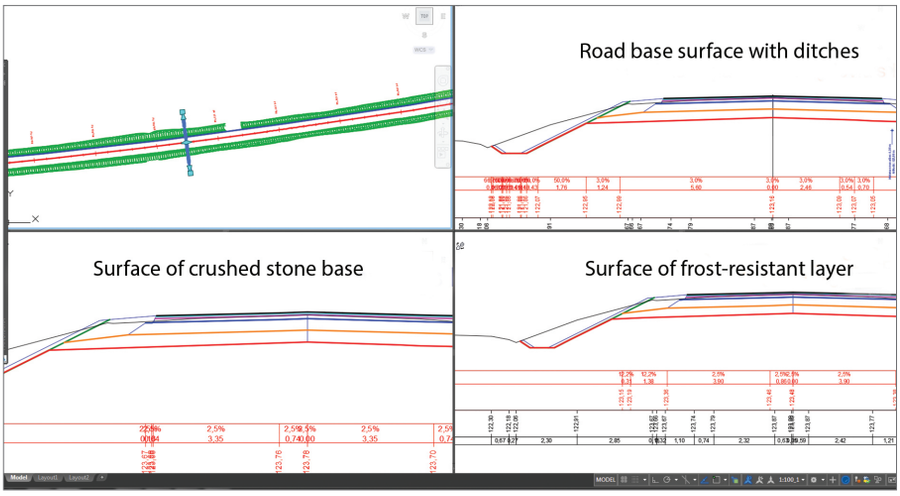
Comparative diagrams use different colours to distinguish between areas with acceptable deviations and areas that require corrections.

Each completed construction layer is geodetically measured. In the photographs: reconstruction of Vėžionys–Dainava–Pabradė–Butrimonys road. A single asphalt-concrete layer (6 cm thick) was laid on the road section from 17.900–22.500 km.

STAGES OF BIM AND ACS ADAPTATION IN PRODUCTION PROCESSES. CONTRACT WORKS

CONSTRUCTION MANAGEMENT AND QUALITY CONTROL

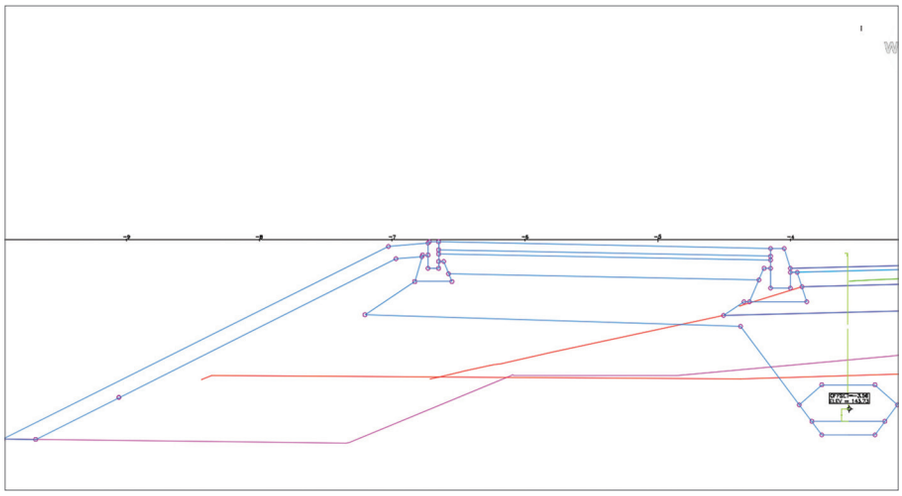
All the information regarding road design and factual data is actively exchanged between project members. LandXML format is used to transfer linear and spatial data of the construction elements.
'Digital Geodetic Book' standard was created within the company to provide easy access to the information about the relevant digital construction layers. All interested parties can check the designed cross section data at any road alignment station.



'Digital Geodetic Book' standard was created within the company to provide easy access to the information about the relevant digital construction layers.

BIM CAN HELP SOLVE CONSTRUCTION PROBLEMS AND RESOLVE INCOMPATIBILITY OF ENGINEERING SYSTEM

Example. Road structure drainage was designed in one section of the road. When preparing the digital road model, drainage position had to be corrected in the 3D environment. Digital road base and frost-resistant layer surfaces were adjusted accordingly.

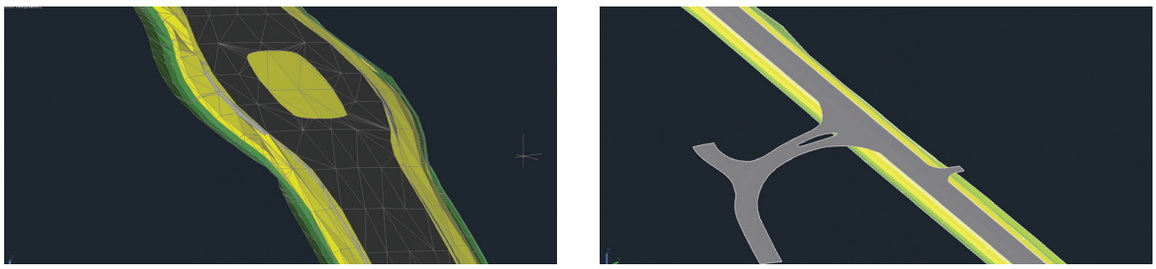


When preparing the digital road model, drainage position had to be corrected in the 3D environment. Digital road base and frost-resistant layer surfaces were adjusted accordingly.

STAGES OF BIM AND ACS ADAPTATION IN PRODUCTION PROCESSES. FINAL TASKS

'AS BUILT' MODEL FORMATION

On completion, each structural layer (road base, frost resistant layer, crushed stone base, every asphalt-concrete layer) is geodetically measured. The measurements are saved as cumulative 'as built' surfaces and handed over to the client along with the associated documents and executed work logs. The data can be used for road maintenance or design of adjacent roads and structures.



Reconstruction of national road No. 115 Ukmergė–Molėtai. Geodetic measurements are saved as cumulative 'as built' surfaces and handed over to the client.

MODERN DESIGN AND CONSTRUCTION MANAGEMENT TOOLS IN THE CONTEXT OF SUSTAINABLE CONSTRUCTION

We understand sustainable construction as conservation of energy and resources, adaptation of environmentally friendly materials and technologies and prolonging of building's life-cycle.

BIM and automated control systems significantly shorten construction time. Moreover, construction works consume no more materials than absolutely necessary, because project tasks are flawlessly executed through automated and digitised construction processes.

Shorter construction time produces less greenhouse gases and particulate matter. Meanwhile, road users experience fewer delays when going through a particular road section because they gain access to a fully completed product much faster.

Automated construction processes free the workers from tiring manual labour and decrease the likelihood of psychosocial occupational hazards. These factors carried much greater risk when work quality had to be investigated through less sophisticated means, such as focusing on details, relying on visual inspection to compare the structure's conformity to original project design, and so on.

We understand sustainable construction as conservation of energy and resources, adaptation of environmentally friendly materials and technologies and prolonging of building's life-cycle.

AB PANEVĖŽIO KELIAI

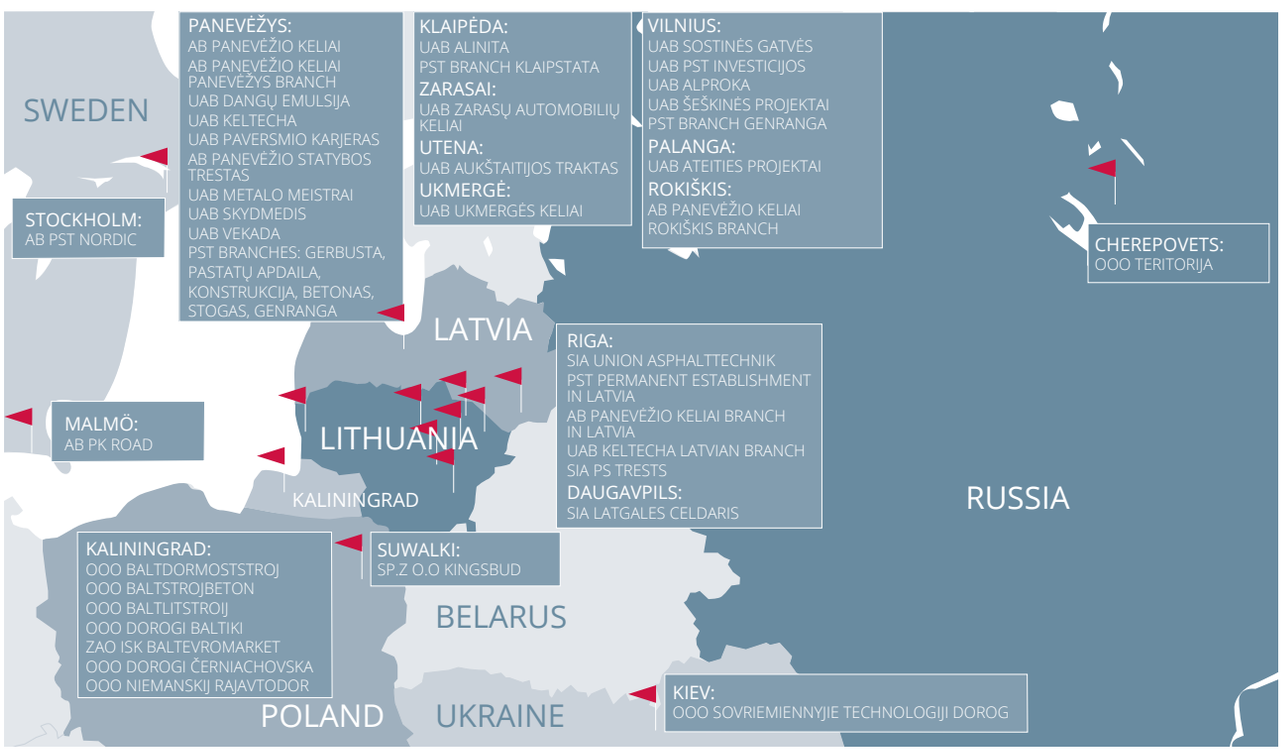
AB Panevėžio Keliai group of companies is one of the largest road and railway design, construction and reconstruction companies in the Baltic states. Established in 1965, the company has since developed a network of production bases in Lithuania, Latvia, Russian Federation and Ukraine.

Certified contractor for constructions of exceptional significance AB Panevėžio Keliai works in the field of transport infrastructure. The company is constantly implementing design and construction works on the roads of Trans-European Network (TEN-T) corridors, including the Via Baltica highway and European highways E67, E28, E77, E85, E262 and E272.

The company has a solid portfolio of progressing and completed projects in the railway sector: building and reconstructing railway tracks, bridges and viaducts on the international Crete transport corridor branches IX, IX-B and IX-D, as well as standard European gauge railway construction – Rail Baltica project.

AB Panevėžio Keliai project – Vilnius southern outer bypass – received a gold medal in the Lithuanian Product of the Year 2014 contest. The company was also presented with the Innovation Award for the creation and adaptation of new technologies. Moreover, AB Panevėžio Keliai received a Latvian national award for excellent work quality.

In the Lithuanian Product of the Year 2015 contest Lithuanian Confederation of Industrialists awarded AB Panevėžio Keliai with three gold medals. The prestigious award was an official recognition of the company's modern work organisation methods, referring to the projects implemented in accordance with the FIDIC Yellow Book requirements approved by the International Federation of Consulting Engineers. FIDIC Yellow Book outlines contract conditions when design and construction works are implemented by a single supplier. This method was tested in practise with EU-funded projects as well. Another work implementation method developed by AB Panevėžio Keliai that caught the attention of the award selection committee and the clients is the integration of 3D design and automated machine control systems.



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