

ROADS AND HIGHWAYS DEVELOPMENT

GOING DIGITAL WITH BENTLEY'S GEOTECHNICAL APPLICATIONS

BENTLEY'S GEOTECHNICAL APPLICATIONS
LET YOU DIG DEEPER FOR SAFER SOLUTIONS

Bentley®



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ROADS AND HIGHWAYS DEVELOPMENT – **THE CHALLENGES**

When you have spent 10% of your project costs, you have already determined 80% of the entire project's cost. Therefore, it's important to know what you are doing before you start.



Project delivery and road maintenance are among the most critical factors for addressing challenges in road infrastructure development, according to McKinsey & Company.

The consultancy firm's research reveals that project delivery is affected by low productivity and limited technology investment. In addition, the organization identified greater attention to early-stage planning and innovation as the most significant opportunities to improve low productivity.

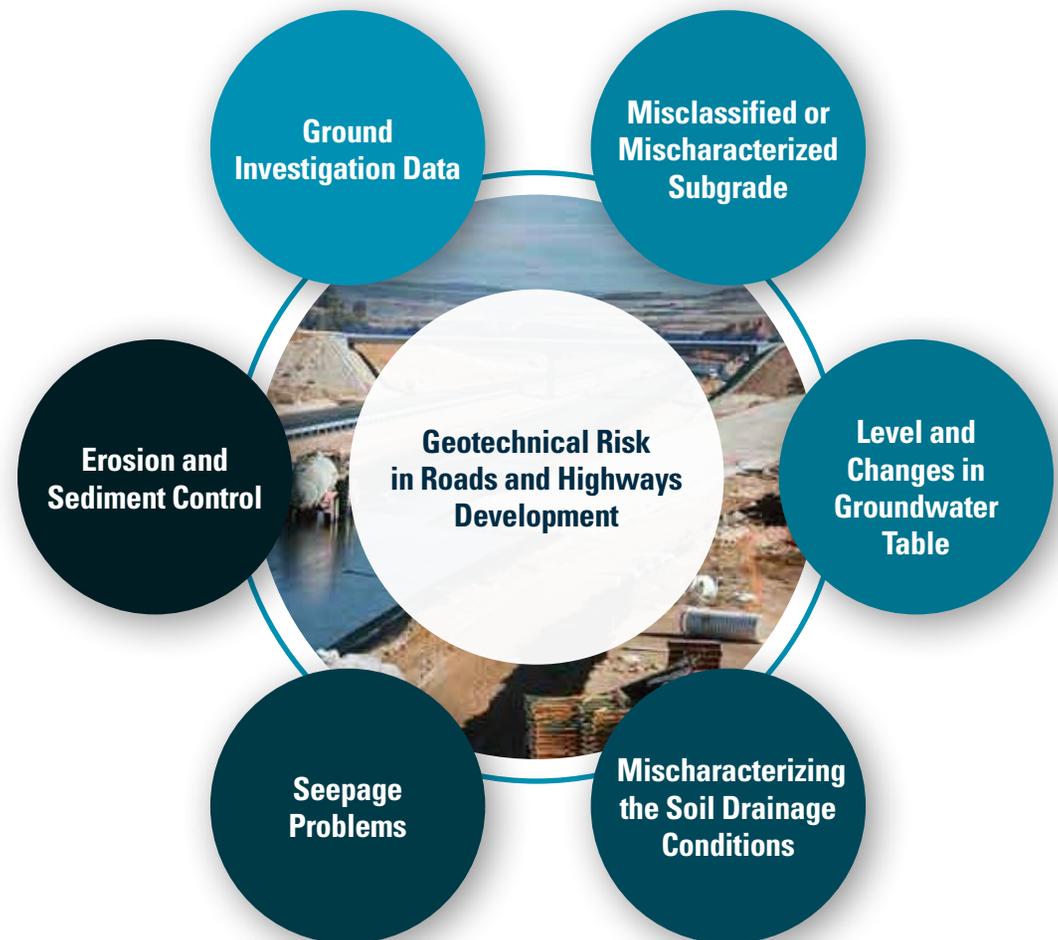
Early-stage planning is dependent on quality of subsurface information, and project delivery risk is fundamentally connected to the geotechnical engineering risk.

THE GEOTECHNICAL CHALLENGES FOR ROADS AND HIGHWAYS

The development of roads and highways poses specific challenges for construction companies and for geotechnical engineering.

According to research by Mott MacDonald and Soil Mechanics, Ltd. in the UK, 75% of projects had cost overruns that were over 10% of the original contract price. They also found that geotechnical caused 50% of the total cost overruns. According to the same research, the most common geotechnical causes for cost overruns included seepage and groundwater, encountering materials different in classification from the predicted materials, and withdrawal and replacement of supplementary inappropriate materials.¹

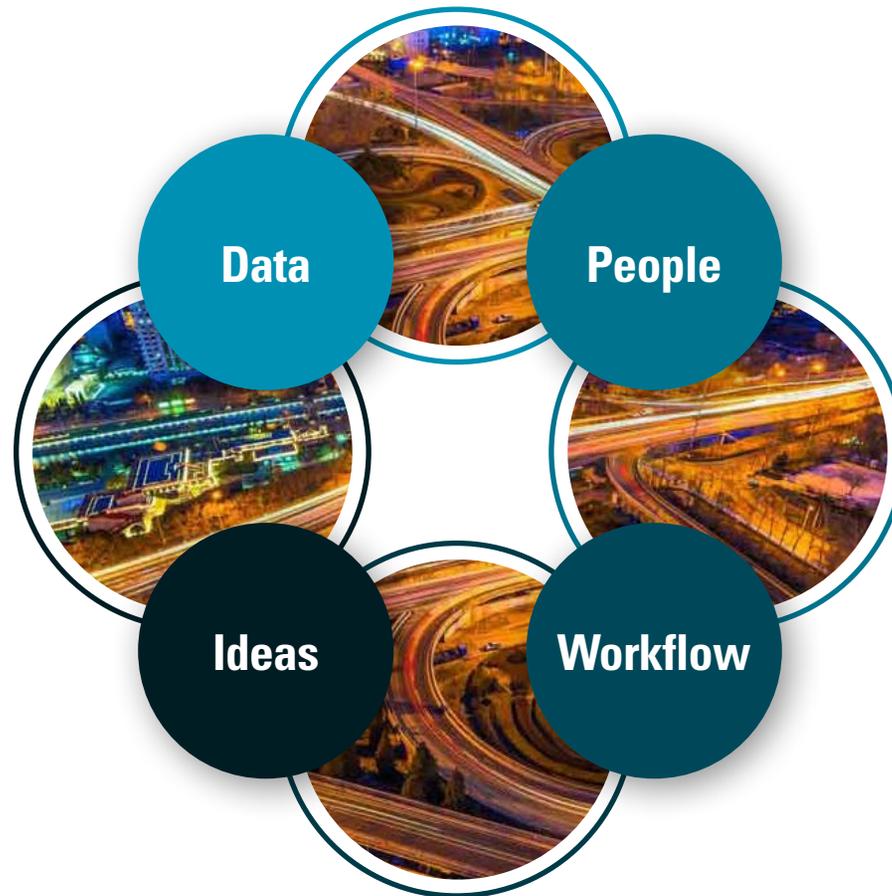
Additionally, during the asset lifecycle, road failures can result from events like earthquakes, storms and floods, landslides, sinkholes, and extreme weather and temperatures.



¹ Study of the Efficiency of Site Investigation Practices, Mott MacDonald and Soil Mechanics Ltd., 1994.

INNOVATING WITH BENTLEY IN ROADS AND HIGHWAYS DEVELOPMENT

Bentley Systems provides the digital BIM capabilities to connect data, people, workflows, and ideas for efficient project delivery in roads and highways development.



THE DIGITAL SOLUTIONS FOR ANY GEOTECHNICAL CHALLENGE

Whether you are an investor, contractor, project manager, or geotechnical engineer, Bentley's geotechnical solutions can provide you with the digital geotechnical applications to transform your construction operations for better productivity and efficiency.



"We produce the world's most accurate and accessible geotechnical analysis solutions, backed by world-class geotechnical expertise, to produce safer structures and environments for all."

— Raoul Karp, Vice President, Engineering Simulation, Bentley Systems

Through its five brands and digital solutions for every stage of the workflow, Bentley's geotechnical team innovates the most comprehensive suite of digital applications for the geotechnical professional.

From data gathering, storage, and information management, to the most robust analysis, planning, and model design, to construction and operations management, Bentley has you covered with trusted geotechnical software solutions, know-how, and training for every type of geotechnical project.

THE DIGITAL GEOTECHNICAL WORKFLOW

Geotechnical Subsurface Digital Twin Workflows

Applications span the entire asset lifecycle. Users at all stages can make better-informed decisions for better outcomes.

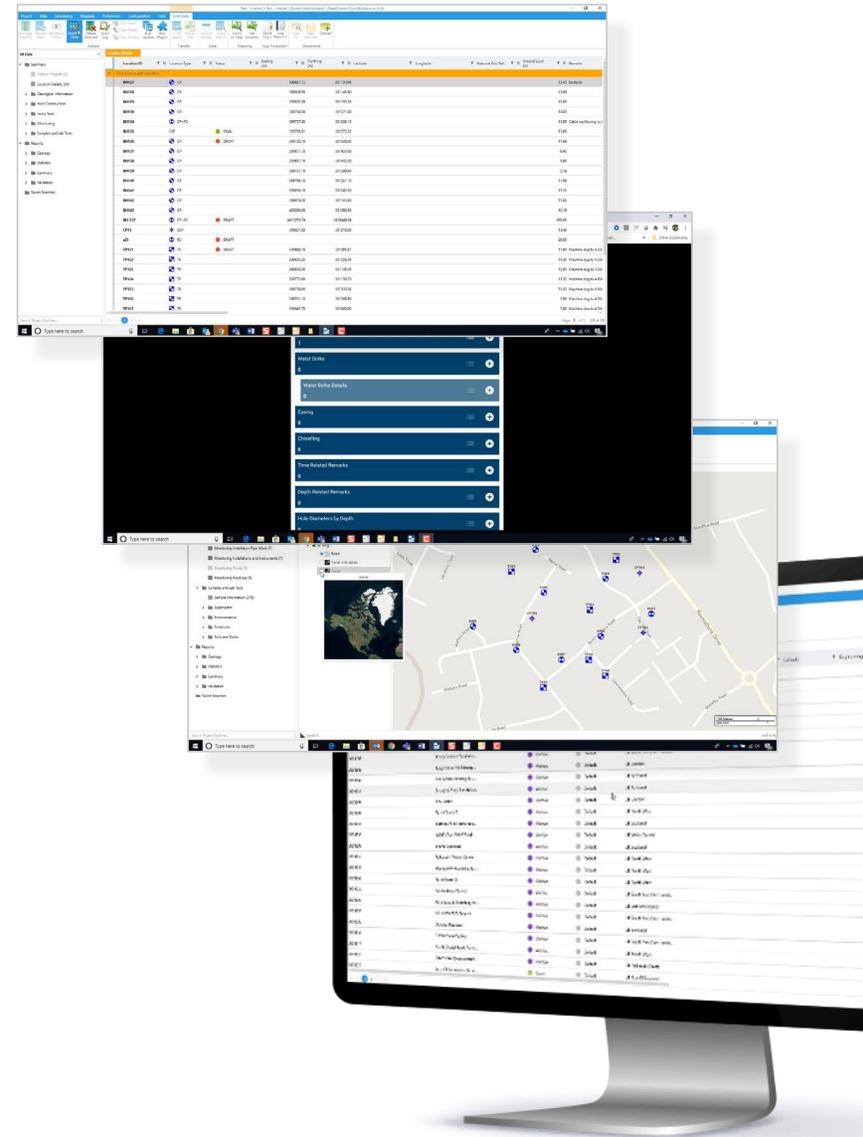


GEOTECHNICAL PLANNING

- Boring and well logs management for virtually any subsurface type
- Fully compliant borehole logs
- Mobile data collection for consistent data entry
- Laboratory management system built specifically for geotechnical and construction laboratories
- Powerful and customizable reporting of geotechnical data
- Collaboration and data access management
- Centralized geotechnical data repository for both current and historic projects
- Interoperability with Bentley's geotechnical applications
- Extensible platform enabling integration with third-party systems and applications

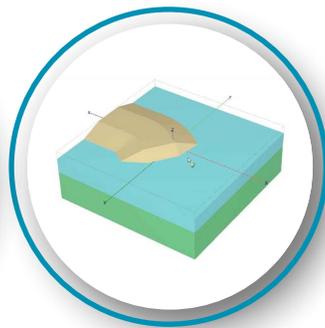
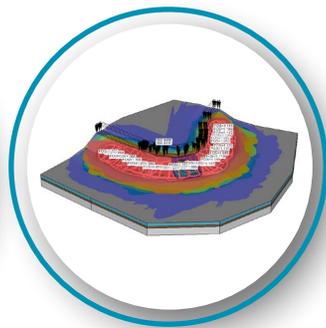
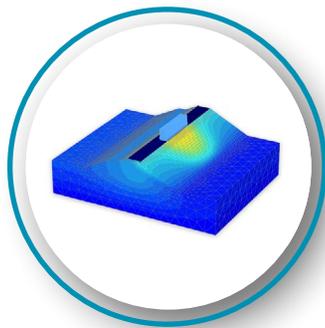
“OpenGround® Cloud improved the workflow for all members of the team. The various add-ins are faster within the cloud version of the database, which is useful when dealing with large datasets like cone penetration test data.”

– Cedric Alleno, Ground Engineering Lead, Lower Thames Crossing



GEOTECHNICAL ANALYSIS IN ROAD DEVELOPMENT

- Embankments
- Prediction of induced excess pore pressures due to construction and loading
- Estimated consolidation time to dissipate excess pore pressures
- Landslide analysis
- Tunnels
- Bearing capacity analysis
- Settlements, including prediction of differential and long-term settlements due to creep or consolidation
- Seismic (liquefaction) and earthquake simulation
- Vibration analysis
- Pile driving and wave propagation to adjacent structures
- Temperature effects on structures
- Flow through an embankment
- Factor of safety and slope stability analysis, as well as the effect of rain and flooding



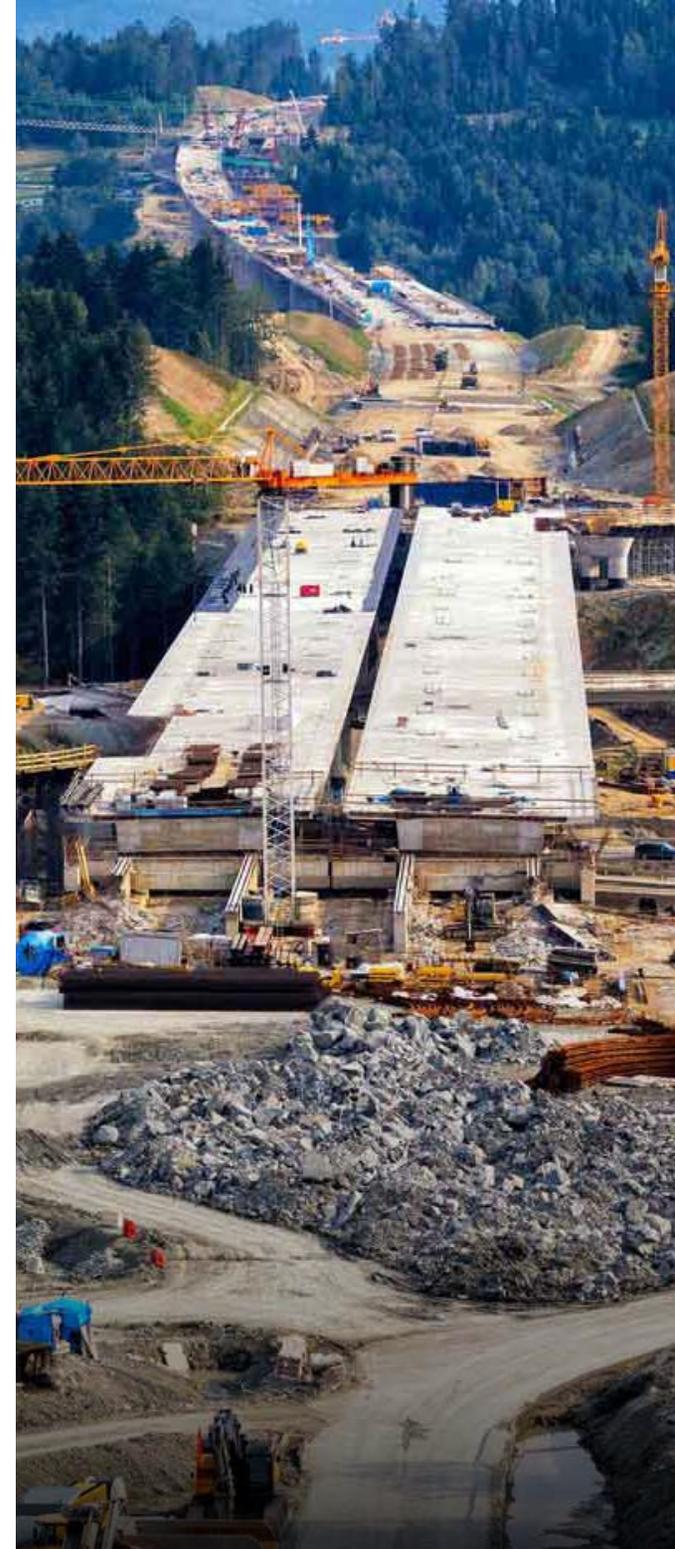
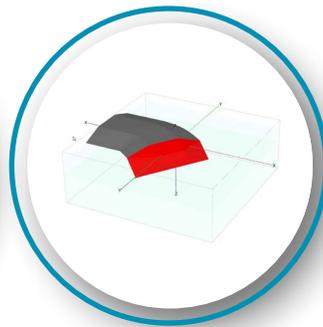
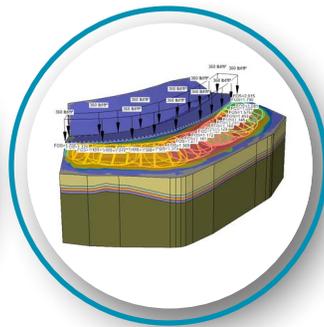
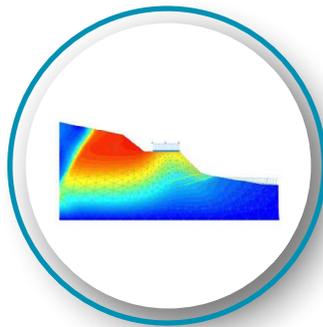
GEOTECHNICAL ENGINEERING IN ROAD CONSTRUCTION

“The 3D approach [using PLAXIS®] made it possible to take into account the obvious three-dimensionality of the problem and to more correctly simulate the phasing of the work and the soil and structure interactions between the different structures.”

— JP Janin, Technical Engineer, Setec-Terrasol

Bentley’s geotechnical solutions allow for unrivalled construction modeling capabilities, real-time collaboration, and fast reaction to changes in real-world conditions through OpenGround Cloud.

- Modeling the construction process, as well as related structures
- Tunnels
- Embankments
- Drainage systems
- Bridges and bridge abutments
- Retaining walls



GEOTECHNICAL OPERATIONS AND ROAD MAINTENANCE

“With the digital approach, we can optimize the cost, speed up the project schedule, and get an accurate design. Bentley’s BIM solution is the right one to face the challenges.”

– Romi Ramadhan, BIM Manager, PT. Wijaya Karya

Bentley’s geotechnical digital solutions provide the capabilities for geotechnical lifecycle management of your asset.

- Monitoring data and ground changes over time
- Vibration and load bearing analysis
- Embankment stability under dynamic loading
- Groundwater flow changes and seepage
- Time-dependent phenomena, such as consolidation and creep of soil
- Reporting and geotechnical information management



AMAZING GEOTECHNICAL STORIES

GEOTECHNICAL ANALYSIS

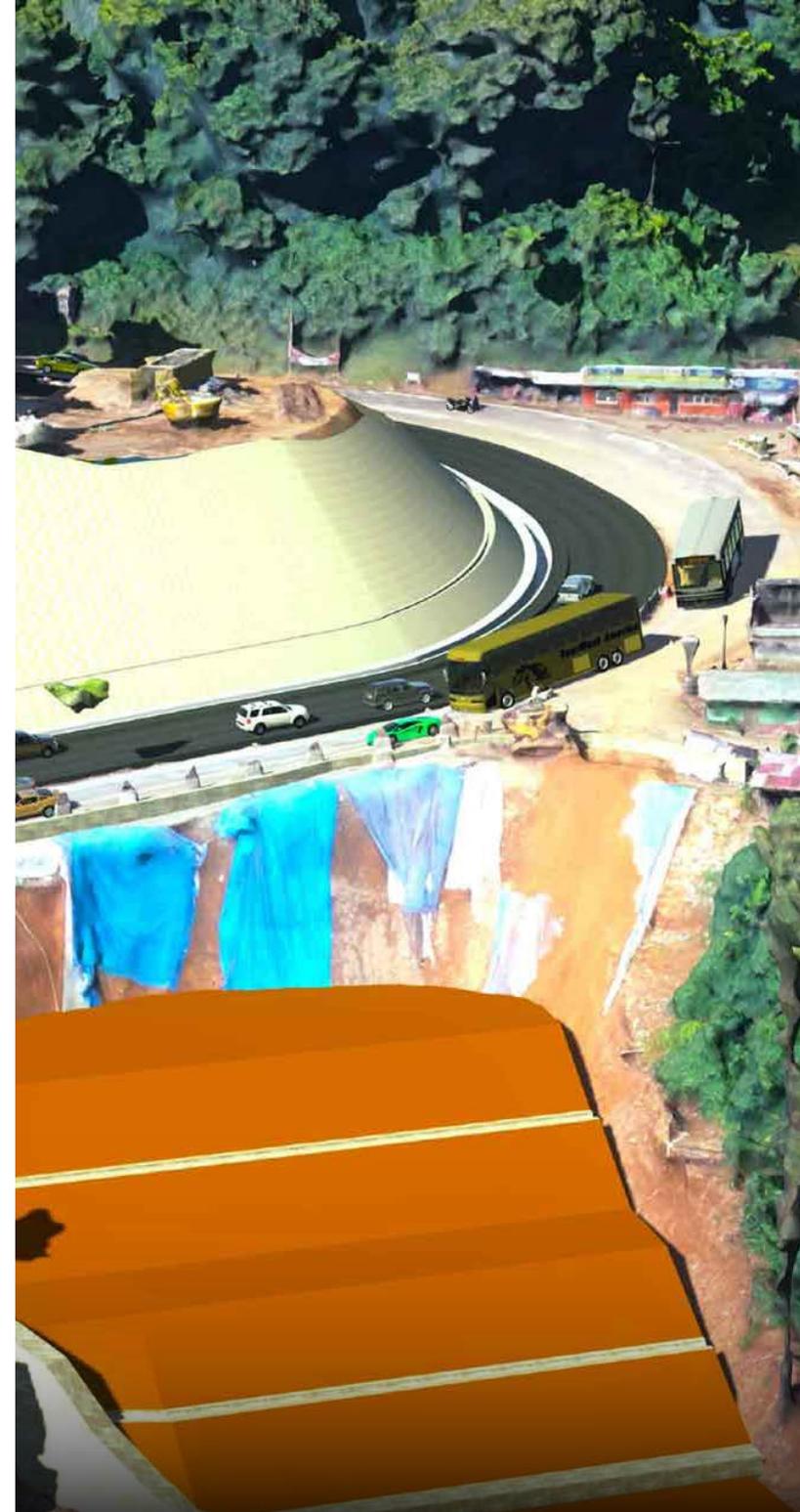
Landslide Disaster Protection on the National Road Network

PT. Wijaya Karya (WIKA)

Cianjur, West Java, Indonesia

When a catastrophic landslide worsened an already-bad traffic situation on West Java's main thoroughfare. PT. Wijaya Karya (WIKA) provided an effective feasibility study and performed preventive measures at the site. The estimated USD 2.9 million project presented numerous site and environmental challenges that required implementing an integrated design technology to meet the five-month delivery deadline.

Using unmanned aerial vehicles to capture site images, the team surveyed the site, performed ground extraction from a 3D reality mesh, and generated a digital terrain model. The team used robust architectural 3D modeling software to quickly design the site, corridor, and ancillary structures and identified and resolved issues prior to construction. Using integrated software applications, the team reduced design and construction time by 30 percent, saving three months to help WIKA meet the accelerated five-month deadline. **Project Playbook:** [ContextCapture](#), [gINT](#)®, [LumenRT](#), [Navigator](#), [OpenBuildings™ Designer](#), [OpenRoads™](#), [PLAXIS](#), [ProjectWise®](#), [ProStructures](#)



AMAZING GEOTECHNICAL STORIES

GEOTECHNICAL INFORMATION MANAGEMENT

Improved Collaboration Helps LTC-CASCADE Deliver Largest UK Road Infrastructure Project

LTC-CASCADE JV

Kent/Essex, United Kingdom

At a projected cost of GBP 6.8 billion, Lower Thames Crossing is unprecedented in size and scale, making it the longest road tunnel in the UK. At 16 meters in diameter, it is also one of the world's largest diameter bored tunnels. LTC-CASCADE required enormous geological and geotechnical investigation along the entire route, both north and south of the River Thames, as well as under it. Key areas of interest include a protected wetland in Kent, boring the tunnel under the river, and historical land development in the north.

To remedy these challenges, the project team implemented project workflow solutions that allow for seamless integration with current data, and easily manage and share information among multiple organizations, geographies, and specialists. The team deployed OpenGround Cloud as it directly integrates with OpenGround Cloud Professional, Excel, and AutoCAD Civil 3D, while having the ability to connect to other apps using the Web API. OpenGround Cloud helped the team eliminate outdated solutions and implement a cost-effective and quick technological upgrade with the latest geotechnical software. [Project Playbook: OpenGround Cloud](#)



AMAZING GEOTECHNICAL STORIES

GEOTECHNICAL ENGINEERING

Design and Build of Harbour Road 2

PT. Wijaya Karya (Persero) Tbk

North Jakarta, Indonesia

When PT. Wijaya Karya (WIKA) assumed design duties for the Design and Build Project Harbour Road 2 in North Jakarta, Indonesia, the project team quickly realized that 2D design methods would not deliver the large and complex toll road development on time and under budget. Due to limited space, heavy traffic, underground pipelines, and numerous intersection points, the development will include a 3.95-kilometer double-decker bridge along the Ancol River, which would become the longest double-decker bridge in the world. Here is how WIKA engineers used 3D and 4D geotechnical and BIM solutions to save 10% of construction budget and four months off the project time frame. **Project Playbook:** [ContextCapture](#), [gINT](#), [LEAP®](#), [LumenRT](#), [Navigator](#), [OpenBridge®](#), [OpenRoads](#), [PLAXIS](#), [ProStructures](#), [RM Bridge](#)



BENTLEY'S GEOTECHNICAL **DIGITAL SOLUTIONS**

Bentley's geotechnical engineering software is used by geotechnical professionals and is ubiquitous for geotechnical projects in infrastructure and building construction, mining, offshore, oil and gas, environment, dams, and reservoirs.

PLAXIS

PLAXIS is the most sophisticated and complete geotechnical engineering software solution for 360-degree analysis, modeling, and design.

PLAXIS is renowned as a robust, reliable, and user-friendly finite element software solution for analysis of soil and rock deformation and stability, as well as soil structure interaction and groundwater and heat flow. With its industry leading computational procedures, PLAXIS provides a comprehensive solution for design and analysis of soils, rocks, and associated structures.

OpenGround

OpenGround is a comprehensive solution for collecting, reporting, managing, visualizing, analyzing, and accessing geotechnical data. Our advanced digital workflows combine both subsurface and surface data into one cohesive design to provide engineers with better collaboration and efficiency. The improved access and reliability saves time and money in the planning, design, analysis, construction, and operation of infrastructure projects.

BENTLEY'S GEOTECHNICAL **DIGITAL SOLUTIONS**

gINT

gINT's suite of software solutions allows you to manage and report on your geotechnical subsurface data with a wide range of reports. gINT improves productivity with centralized data management and reporting for geotechnical subsurface projects, as well as streamlines processes with accessible, interoperable data for subsurface reporting for soils, borelogs, and lab tests.

Keynetix™

Keynetix's geotechnical software solutions ensure consistent information management along all stages of the data journey, from planning through to site work and reporting. Keynetix technology allows you to have a single source of truth for your data for greater project efficiency. Regardless of whether it is a single borehole exploratory hole or the most complex construction project, our intelligent data management applications ensure trusted, accessible data from on-site logging to national archive.

GEOTECHNICAL ENGINEERING

Embrace confidence, credibility, and control in your geotechnical applications. With Bentley's geotechnical engineering software, users can access a complete digital workflow. By utilizing our applications users can rely on secure solutions for data-driven decisions through enhanced collaboration – when and where it is needed. Users can add layers of safety and reduce risk by accessing a connected data environment where applications offer advanced interoperability and integration. Advanced expertise and methods of sound computation are delivered by a trusted team of experts, ensuring they are easier to use and provide more robust 3D modeling and analysis.

Use our applications to plan, design, analyze, construct, and operate for increased safety and reliability in projects.

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