Light at the Beginning of the Tunnel

Integrated design and engineering software
for each phase in the workflow

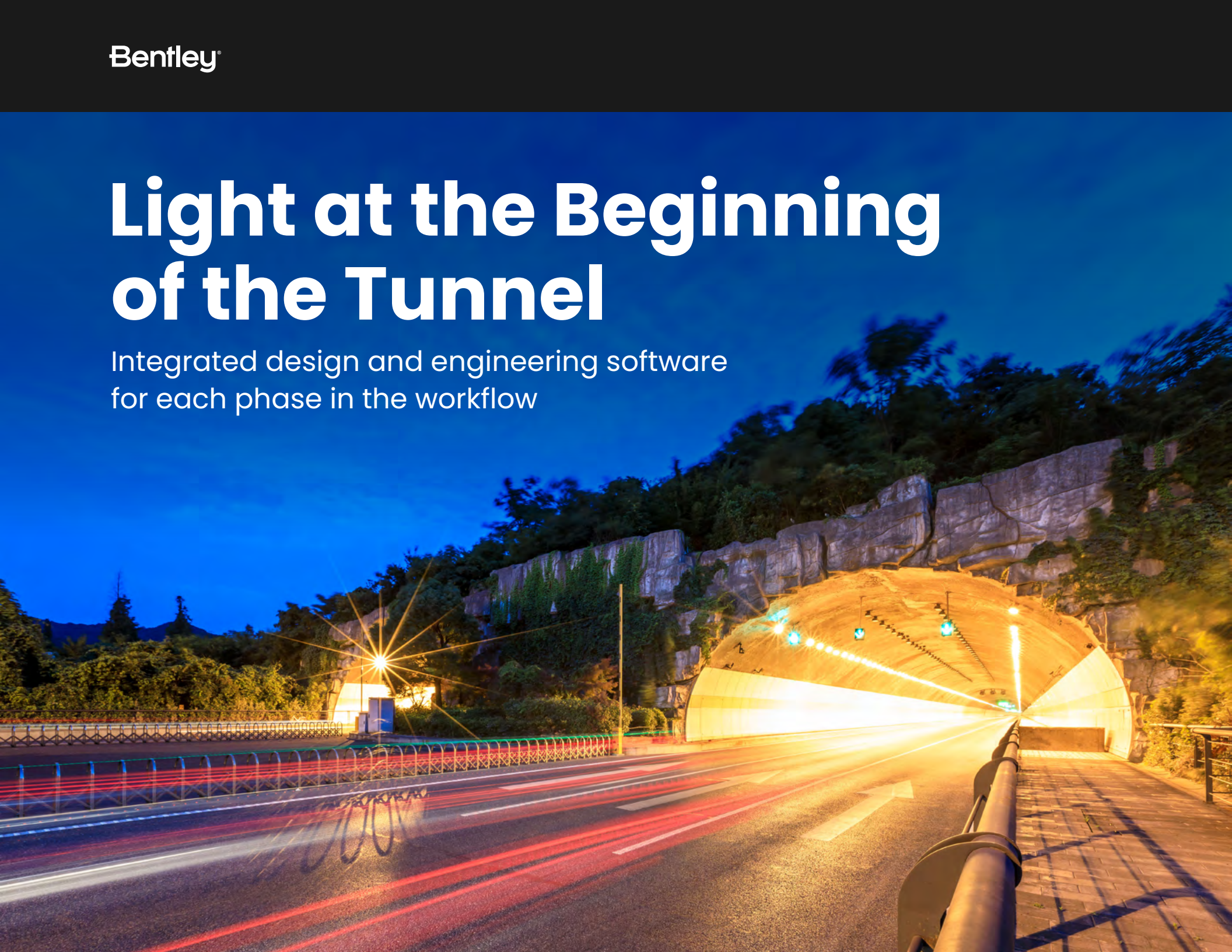# Table of Contents

Purpose-built Digital Solutions for Tunnel Design Are Providing Light from the Very Beginning

As a designer or engineer, you've likely faced the difficult task of attempting to design tunnel projects with software made for other industries and types of infrastructure. Completing a project has necessitated the use of disparate applications, coding specialists, and lengthy workarounds. The result is decreased productivity and accuracy, not to mention decreased motivation. If you feel like "the light at the end of the tunnel" has been turned off, there is hope.

Connecting an Interdisciplinary Workflow

Tunnel construction is becoming more common due to advancements in equipment and techniques, as well as the opportunities that tunnels offer for connecting communities. As tunnels are expected to be more sustainable assets, with a longer life expectancy than a surface facility (125 years versus 75 years), tunnel lifecycle management is top of mind for stakeholders. Long-term effects and risks must be considered during the early planning and design phases to optimize engineering and ensure safe and sustainable tunnel assets. There is now a comprehensive solution for tunnel planning and design that can bring together different disciplines within one interoperable workflow.

Changing tunnel requirements means changing how they are designed and engineered.

Tunnel Engineering Challenges Require Tailored Software

Tunnel design is interdisciplinary, including engineering, geotechnical, and hydrogeology. However, the industry has fragmented and relies on several non-tunnel specific applications, causing technical and operational challenges. Current BIM workflows include solutions that do not integrate with one another. Given that tunnel design and construction, from preliminary engineering to detailed design and drawing generation, require multiple iterations within the same processes to accommodate changes in information, these challenges are multiplied and magnified. Addressing these issues requires an all-in-one workflow so that you have more time to comprehensively analyze your project for potential errors and create alternatives for optimum design, safety, and performance prior to construction.

Tunnel-specific solutions enable teams to identify potential problems and resolve them in advance, when project changes are easier to manage and more cost efficient.
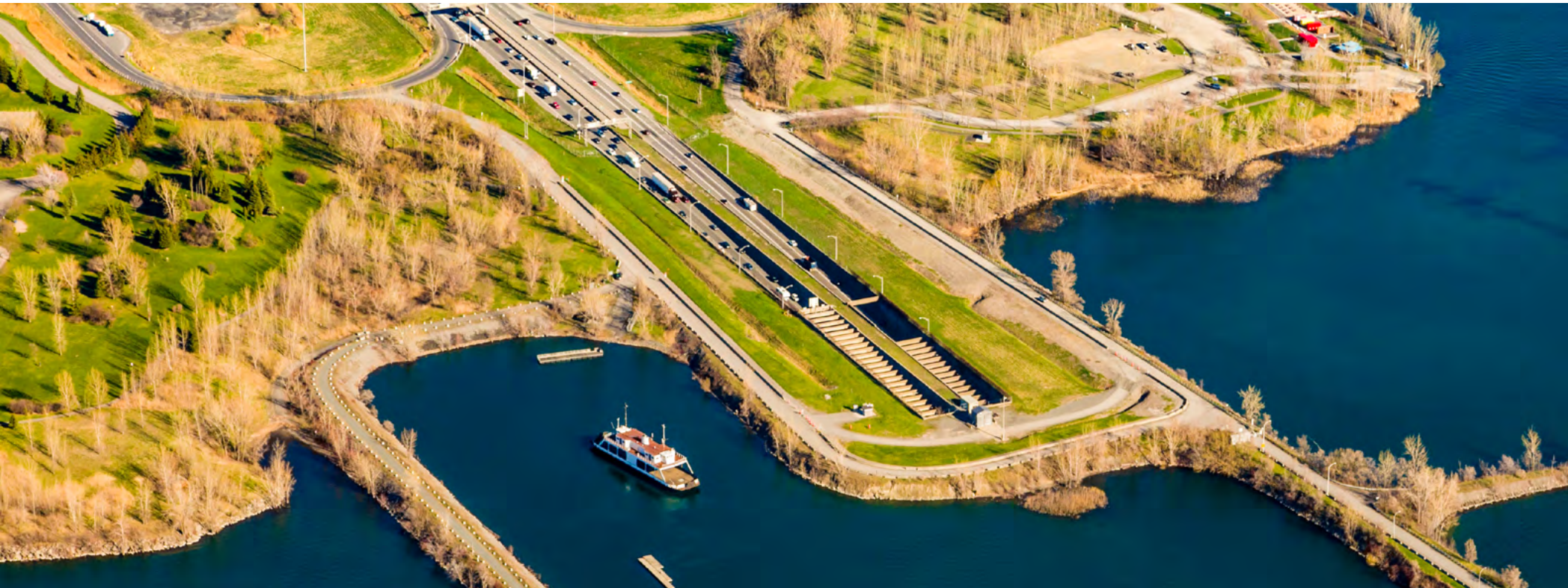
Integrating Design and Engineering Disciplines

Underground structures are in direct connection with soil layers—this simple fact makes tunnel design a multidiscipline effort.

The subsurface conditions and the sizes and types of tunnels change from project to project, but one aspect is constant: tunnel design and construction require knowledgeable and experienced civil and geotechnical engineers, structural engineers, and other disciplines to deliver a project. Overcoming each challenge and providing the ideal solution as urban environments densify require seamless communication and collaboration between multiple engineering disciplines. Individuals with different backgrounds and specialties need to work collaboratively to develop a project that meets client expectations and offers the highest added advantage to communities and society.

The ability to share and consume project data across disciplines in a connected data environment means you can deliver projects that are optimized, accurate, and timely. Leading engineering firms are taking advantage of innovative collaborative software applications that support the integration of design and engineering disciplines.
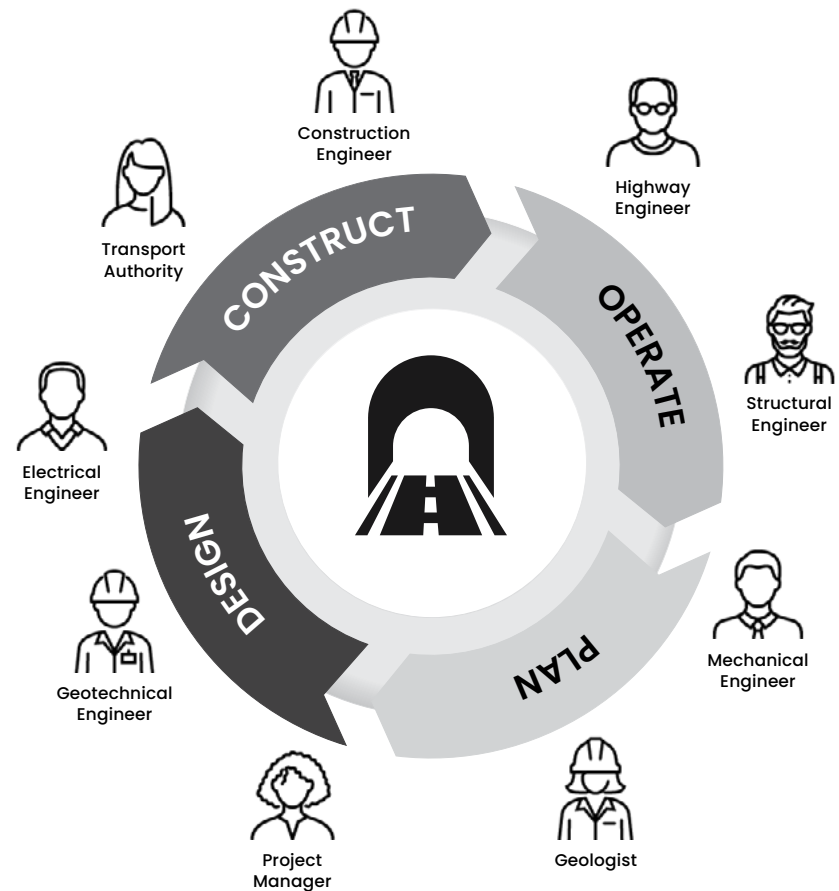
Lead the Way – Scope, Process, Results

As a tunnel engineer, we know you wear many hats. Your scope of work includes an array of responsibilities, across many phases, and with a diverse group of stakeholders. Your digital solution needs to support an efficient, comprehensive, and collaborative workflow from start to finish. That's why Bentley created a complete set of tunnel design and engineering solutions.

Plan	Design	Analyze	Construct	Operate
Collect field data	Design and maintain tunnel structures	Analyze soil interaction	Manage the fabrication process	Streamline the maintenance, rehabilitation, and decommissioning of tunnel assets
Generate conceptual design	Minimize environmental impact	Evaluate multiple design solutions	Supervise construction	
Model reinforcement	Minimize risks	Identify clashes	Plan and visualize the construction process	
Model singularities				

You need software built to address the way you work and ensure compatibility with your partners. Here is how Bentley applications can help.

Tunnel Modeling, Analysis, and Design

OpenTunnel® Designer

Get the Right Software for the Job

Produce intelligent, parametric models that are rich in engineering content for various tunnel components. Model the full excavation shape, excavation tracks, tunnel lining, and tunnel reinforcement. Model, analyze, and design as a true 3D solution, as well as perform clash detection with other structures, objects, and utilities to eliminate problems before they occur.

A Connected Workflow Enables Efficient Collaboration

Easily exchange information with Leapfrog®, PLAXIS®, OpenRoads™, OpenRail™, OpenBridge®, and ProStructures™. If reference data changes, the parametric and rule-based tunnel model automatically responds to those changes. OpenTunnel Designer and PLAXIS are interoperable, enabling an all-in-one workflow for modeling, design, and analysis. With your already existing model in OpenTunnel, generate your analytical model in PLAXIS with the click of a button.

Simplify Your Design Process

Reuse data from various stakeholders, maintaining relevant and up-to-date geometry within a single model. Save valuable design time as your model updates automatically to any change made in the tunnel template or alignment geometry. Comprehensive and automated design features remove the need for scripting specialists and multiple applications. Matched with dynamic change management, OpenTunnel Designer mitigates rework and reduces time delays with all team members working in one intuitive application.

Improve Deliverables Production

Modeling in a 3D environment helps rapidly verify tunnel geometry. The tunnel is visualized in plan, elevation, and cross-section views. OpenTunnel Designer also facilitates evaluation of multiple tunnel alternatives, as well as generation of cost reports and well-organized analysis and design reports. Reports can be printed to PDF, saved as HTML files, or exported to spreadsheets. You can generate iTwins to convey rich project information to stakeholders.

Check out the capabilities list to understand why this is the only solution you need.

OpenTunnel Designer Capabilities At-a-glance

Ease of Use	Tunnel Modeling and Visualization Capabilites	Versatile Reporting Options	Integration with Other Software	Automated Analytical Model Creation
• Intelligent graphical user interface • U.S. imperial and metric units • Comprehensive 3D physical tunnel modeling • User-customizable libraries • Intuitive dialogue-driven workflows	• Conventional and mechanized tunnel types • Full excavation shape and excavation tracks modeling • Tunnel lining modeling • Tunnel reinforcement • Interior objects as extrusion or cells • Parametric, intelligent tunnel components • Intuitive, dialogue-driven workflows • Rule-based and constraint-driven modeling • Clash detection • Solid and transparent views • Lifelike rendering by loading the tunnel model in Bentley LumenRT™ • Reference bridge, roadway, and railway information, along with ground data	• Customized and dynamic reports • Plan, profile, and cross-section drawings • Material quantities reports • Input reports • Cost estimate reports • File formats: PDF, MS Word, MS Excel, HTML	• Direct data exchange with MicroStation®, OpenRoads, OpenRail, OpenBridge, ProStructures, and PLAXIS • Import geomodeling data from Leapfrog • File formats: DGN, XML, LandXML, IFC, and PY	• Send soil layer geometry with analytical properties to PLAXIS • Send tunnel and reinforcement geometry with analytical properties to PLAXIS • Full 4D analysis in PLAXIS 2D/3D

Integrated Design and Data for Every Project Phase

With a comprehensive set of applications, engineers can stress less about technology inefficiencies and focus more on engineering optimum solutions. Whether your team works directly on every portion of the workflow, or with other organizations, Bentley has a software solution for you and your partners that easily shares, consumes, and references data for a seamless and collaborative experience.

Plan	Design	Analyze	Construct	Operate
OpenTunnel Designer	OpenTunnel Designer	PLAXIS	OpenTunnel Designer	OpenTunnel Designer
OpenRoads Designer	OpenRoads Designer	STAAD.Pro®	OpenBridge Designer	OpenBridge Designer
OpenRail Designer	OpenRail Designer	OpenBridge Designer	SYNCHRO™ 4D	iTwin® Design Review
OpenBridge Designer	OpenBridge Designer		Use the applications to reference models and documents to verify accuracy of construction.	Use the applications to hand off the digital model for future maintenance.
	ProStructures			

Read on to discover the capabilities you should be looking for across the project lifecycle, and how Bentley's collaborative, interoperable applications enable a streamlined and effective workflow.

Geotechnical Design and Analysis

PLAXIS®

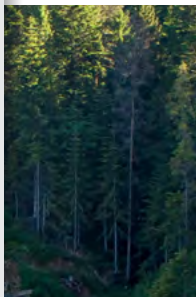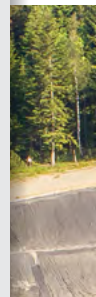### Enable an All-in-one Workflow with PLAXIS

OpenTunnel Designer and PLAXIS are interoperable, enabling an all-in-one workflow for modeling, design, and analysis. With your existing model in OpenTunnel Designer, generate your analytical model in PLAXIS with the click of a button so you have more time to identify errors and create alternatives for optimum design, safety, and performance prior to construction.

PLAXIS 3D Ultimate

Extend the capabilities of PLAXIS 3D Advanced to analyze the effects of vibrations in the soil, such as earthquakes and moving traffic loads. Simulate complex hydrological conditions through time-dependent variations of water levels or flow functions on model boundaries, as well as soil boundaries.

PLAXIS 3D and PLAXIS 3D Advanced

PLAXIS 3D includes the most essential functionality to perform everyday deformation and safety analysis for soil and rock, making it easy to model in 3D. PLAXIS 3D Advanced includes everything that is included in PLAXIS 3D, plus enhances your geotechnical design capabilities with more advanced features and material models. You can consider creep or flow-deformation coupling through consolidation analysis. Solve your problems faster with PLAXIS 3D Advanced by leveraging the multicore solver.

Modeling and Reinforcement Detailing

ProStructures™

Perform Detailing with ProStructures

ProStructures includes ProSteel™ and ProConcrete™, providing comprehensive steel and concrete design detailing that delivers parametric structural components to increase productivity and profitability. With ProStructures, you can create and automatically update 3D models that include structural steel and reinforced concrete structures. OpenTunnel Designer integrates with ProStructures, providing a holistic view of your project to easily identify clashes and streamline your tunnel design workflows, including physical modeling, analysis, and easy plan production.

Produce High-quality Steel Detailing and Fabrication Designs with ProSteel

Confidently deliver an intuitive 3D modeling system that is perfectly suited to arrange complex steel structures, extract engineering, fabrication, and erection drawings, and automatically update the 3D model to reflect any changes. Produce drawings for every steel shape, connection, and platework from the 3D model, and generate and update in-drawing, external reports, and bills of material.

Intuitively Model Parametric Concrete Structures with ProConcrete

Model objects of any shape, with any combination of reinforcing. You can reduce documentation production time and eliminate errors and design flaws. Quickly create accurate 3D rebar models, placement drawings, fabrication details, bar bending schedules, concrete quantities, and material reports with automatic updates to reflect model changes.
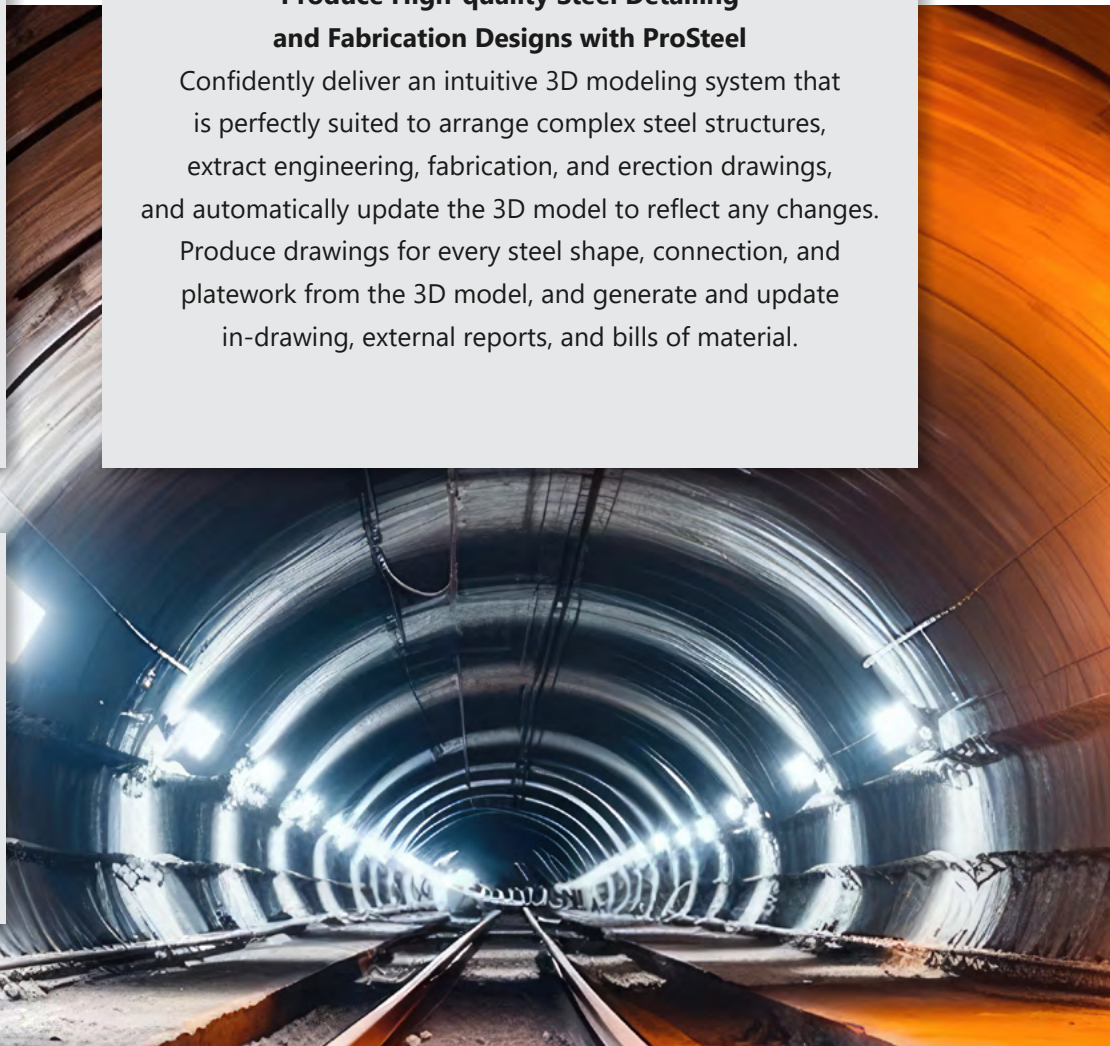
Multidiscipline Civil Design

OpenBridge® Designer   **OpenRoads® Designer**   **OpenRail® Designer**
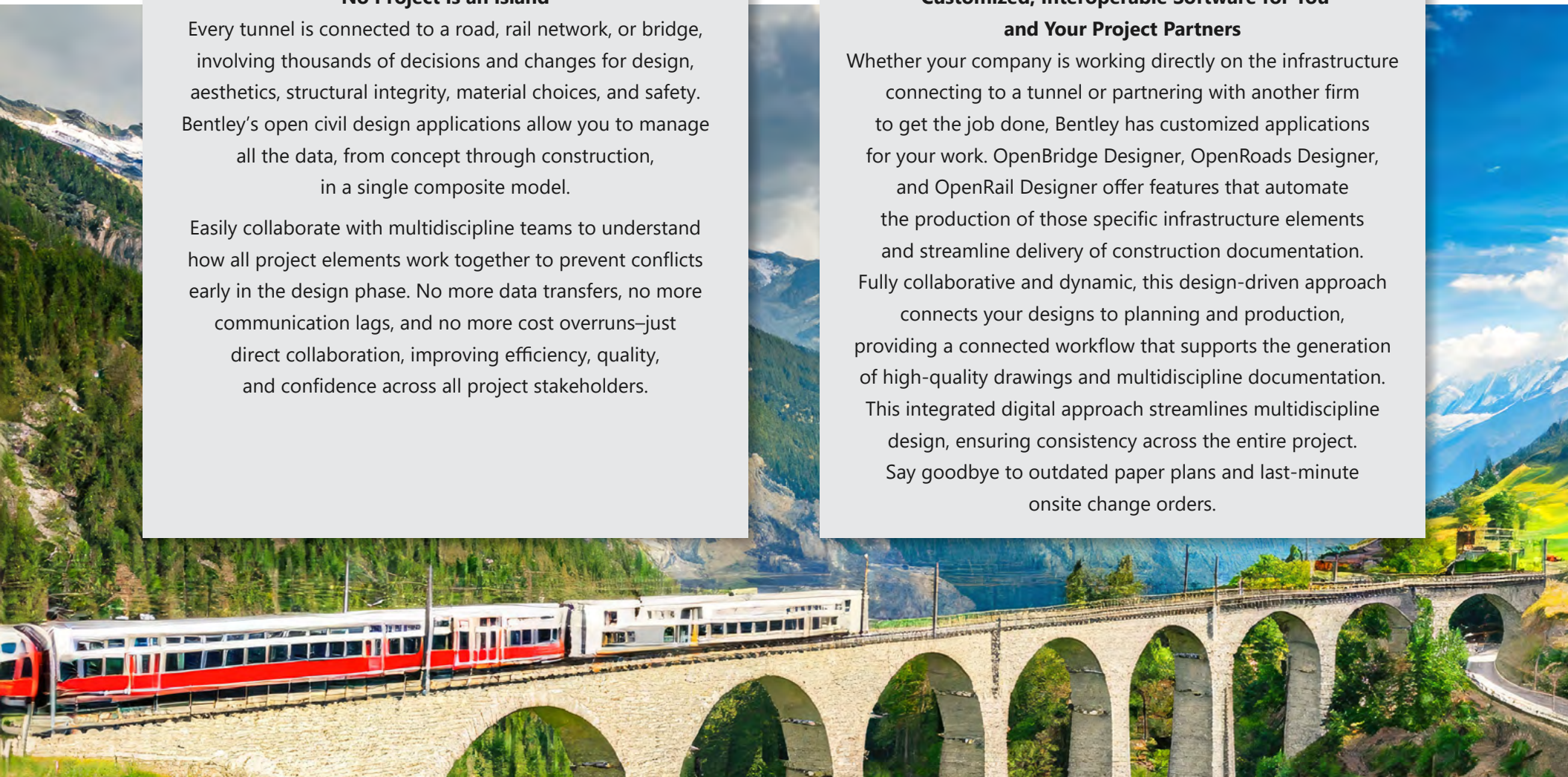
No Project Is an Island

Every tunnel is connected to a road, rail network, or bridge, involving thousands of decisions and changes for design, aesthetics, structural integrity, material choices, and safety. Bentley's open civil design applications allow you to manage all the data, from concept through construction, in a single composite model.

Easily collaborate with multidiscipline teams to understand how all project elements work together to prevent conflicts early in the design phase. No more data transfers, no more communication lags, and no more cost overruns–just direct collaboration, improving efficiency, quality, and confidence across all project stakeholders.

Customized, Interoperable Software for You and Your Project Partners

Whether your company is working directly on the infrastructure connecting to a tunnel or partnering with another firm to get the job done, Bentley has customized applications for your work. OpenBridge Designer, OpenRoads Designer, and OpenRail Designer offer features that automate the production of those specific infrastructure elements and streamline delivery of construction documentation. Fully collaborative and dynamic, this design-driven approach connects your designs to planning and production, providing a connected workflow that supports the generation of high-quality drawings and multidiscipline documentation. This integrated digital approach streamlines multidiscipline design, ensuring consistency across the entire project. Say goodbye to outdated paper plans and last-minute onsite change orders.

Capabilities At-a-glance

PLAXIS	ProStructures	OpenBridge Designer	OpenRoads Designer	OpenRail Designer
• CAD import and export • Cross and parallel permeability in interfaces • Definition of rock bolts and girders • Define excavation sequence • Automatic generation of staged construction phases for tunnels • Design arbitrary geometries combining NURBS curves and polycurves • Automate processes with full-command line support and remote scripting application programming interface (API) • Versatile material models • Well-proven and robust calculation procedures • Automatic regeneration of construction stages for geometric changes • Advanced data slicing and project output review with PLAXIS 3D Output Viewer • View the complete list of PLAXIS product tiers and capabilities	• Includes ProSteel and ProConcrete • Supports multiple national and international design standards • Use standard parametric and easily modified reinforced concrete objects • Model rebar of any shape and complexity • Face-based rebar modeling updates user reinforcement when concrete shape changes • Standard parametric connections • Element modification capabilities • Structural parametric objects for quick modeling • Extract fabrication, placing, erection, and general arrangement drawings • Generate bar bending schedules and bills of material in single or batch process • Output file formats: IFC, ISM, iTwin, and 3D PDF	• Comprehensive 3D physical and analytical bridge modeling • Cross-section template for complex geometry • Supports all bridge types • Superstructure and substructure modeling • Parametric, intelligent bridge components • Clash detection • Reference roadway information and ground data • Direct data exchange with OpenTunnel, MicroStation, OpenRoads, OpenRail, ProStructures, and more • Versatile reporting options • Automated drawing generation • Full 4D analysis • Supports any structural model, any materials, and any erection method • Supports 20+ international codes	• Download, create, analyze, and adjust survey data • Use purpose-built features for advanced alignment, profile, geometry design, and editing • Create a best-fit alignment based on existing road centerline or road edge survey data • Automate intersection and roundabout design based on road geometry defined by alignment, profile, and super-elevations • Design and edit roadway cross-sections • Create 3D models for utilities, storm, and sanitary drainage • Build utility models directly from survey data and identify conflicts • Automate the production of high-quality drawings, including multidiscipline documentation • Integrate with Bentley LumenRT to create models and high-impact visuals and animations	• Includes all OpenRoads Designer capabilities • Model and design metro, light rail, commuter rail, or high-speed rail projects • Download, create, analyze, and adjust survey data • Perform regression analysis, horizontal and vertical alignment modeling, cant design, and turnout placement to international standards • Create 3D models for utilities, storm, and sanitary drainage • Build utility models directly from survey data and identify conflicts • Automate the production of high-quality drawings, including multidiscipline documentation • Integrate with Bentley LumenRT to create models and high-impact visuals and animations

Hear What Our Users Have to Say

Meet Federico Foria
Geology and Hydraulics
Department Manager, ETS

Compared to other BIM applications
in the as-built generation and maintenance
interventions of a standard application,
we can estimate 50% time saving to build
the same model. In the case of long
and complex tunnels, time-saving
could be even larger.

Meet Christine Remonnay
Design Drafter, Setec Terrasol

With OpenTunnel, the design can
be made directly by the drafter,
and the engineer can concentrate on the
calculations in PLAXIS and the design
of the work. It is a way to save time
and optimize everyone's work.

Meet Jean-Pierre Janin
Manager (2020–2022),
Underground Structures Unit,
Setec Terrasol

OpenTunnel is a powerful application
for designing tunnels and all associated
structures. The automatic implementation
of the reinforcement is also an indispensable
tool that we use very regularly, which
allows us to save a lot of time
and to test several solutions.

Bentley®

Tunnels Have Never Been More Sophisticated, and Tunnel Design and Engineering Has Never Been Simpler, Faster, or More Intelligent

OpenTunnel Designer, the first worldwide integrated product specifically developed for BIM tunnel projects, is providing the light at the beginning of the tunnel. Bentley's complete civil solution set provides all the resources you need in one place, from one company, designed to work together for you.

Getting Started

OpenTunnel Designer helps firms close their productivity gap by streamlining processes, improving productivity, and enhancing communication throughout the entire project lifecycle. Leveraging a common data environment enables an efficient data handover from design to construction by linking people and processes across various disciplines, and produces insights that mitigate risk, rework, and cost overruns.

Start maximizing the potential of digital project delivery by creating visibility and insights to make data-driven decisions that deliver sustainable and resilient infrastructure to better serve stakeholders, clients, and communities.

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