Bentley®

On the Road to Better Design
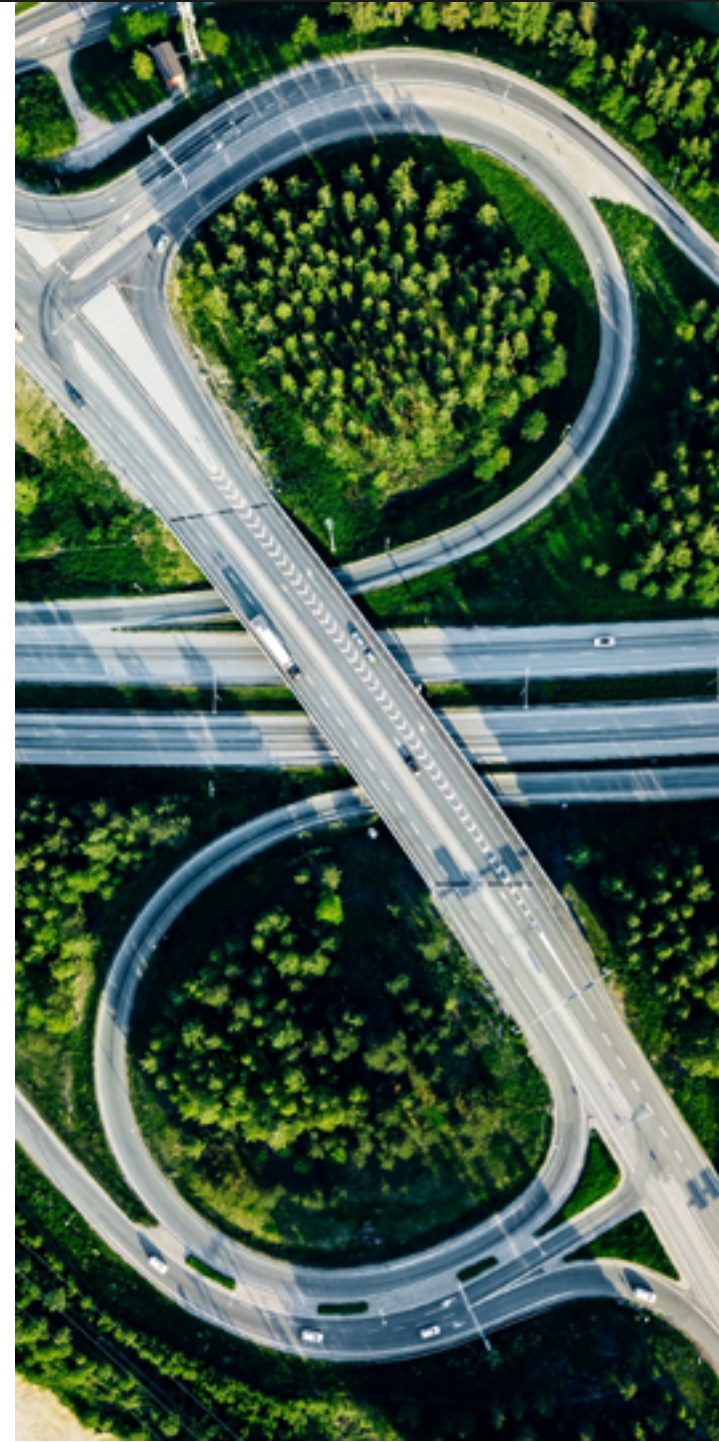
Optimize how you plan, design, build, and manage road and highway projects using digital delivery

Table of Contents

Page

"You can't go back and change the beginning, but you can start from where you are and change the ending." – C.S. Lewis

The way that we design and deliver contracts, as well as the way that we plan our infrastructure, needs to change so that we can deliver the kind of modern, multimodal, and safe transportation systems that our communities need.

With the increased volume of road and bridge projects, shorter duration requirements, and limited engineering workforce capacity, design efficiency and productivity are critical.

Now is the time for more efficient and cost-effective technologies to build, maintain, monitor, and repair roads, bridges, and other infrastructure.

There Is a New Road Ahead

Just as CAD replaced hand drafting plans decades ago, a new technology is emerging for infrastructure planning, design, construction, and asset management: digital delivery for infrastructure. As transportation agencies across the world explore the challenges and benefits of this change, we are offering expert advice on going digital that owners and engineers need to make the most of this new technology.

Making the move can be daunting, but it sounds more difficult than it is. Digital delivery can improve design accuracy and help find constructability issues earlier in the design process, which can avoid costly delays. By blending traditional engineering workflows for plan, profile, and cross-sections with 3D modeling and BIM workflows, the right technology solutions work the way that you work, making the transition easier than ever. In other words, you can start your design in a 2D environment and watch the 3D model auto-generate. Whether your company is working directly on a road or highway or you are partnering with another firm to get the job done, tailor-made software for the work you do is a game-changer.

Digital Delivery Is Changing Road and Highway Design

Innovative digital technology is designed to enhance the value that you deliver to all phases of a road or highway project, from conceptual design through construction. Develop a more positive direction for your transportation projects and reduce construction risk by considering design concepts in the context of the real and unique project conditions.

Better planning from the start with real-world design sets you up for success.

Multidiscipline Coordination

The ability to work in one workspace with several different services that would typically work in silos (such as geotechnical, road, drainage, utilities, bridge, and tunnel) allows each discipline to move as one in real time. Using the same set of assumptions and information, during every stage of the project, means better coordination, collaboration, and design consistency between conceptual and detailed design, right into construction and infrastructure asset management. Ultimately, you build and operate in a 3D world, so you need to design in an environment that best replicates those conditions.

Many disciplines with one solution, one workspace, and one set of information produces one successful project.

Moving from 2D CAD to 3D BIM Workflows

Moving from 2D to 3D workflows is a decision that firms often push down the road. Many designers fear a big learning curve that will reduce their design efficiency. It does not have to be an all-or-nothing approach. The right 3D modeling software will offer an integrated approach to both 2D and 3D design. You can work using intuitive and traditional design methods while benefiting from the advantages of the new technology. With a design-driven approach that connects your designs to plan set production, a connected workflow supports the production of high-quality drawings, including multidiscipline documentation sets, which are consistent across the entire project, saving you significant time and, therefore, money.

Say goodbye to outdated paper plans and last-minute on-site change orders and hello to consistency, efficiency, and quality.

Minimize Errors and Costly On-site Changes

In today's industry, most design reviews are done with paper or PDFs. Traditionally, clashes are detected by the manual process of overlaying 2D drawings. However, digital delivery can bring models from all the disciplines together and compare them, detecting clashes before they are found on the construction site. Automatic clash detection is an important approach to determining design errors or omissions. Working in a 3D environment allows you to immediately see potential conflicts. Whether it is a conflict between design disciplines, utilities, or physical constraints, these potential problems are more apparent earlier in the project lifecycle.

Reduce risk and find potential conflicts earlier with automated clash detection.

Deliverables for Today and Tomorrow

Delivering 2D plan sets remains key for your business today. Connecting design to documentation with automated drawing production means that once the drawing sheets are set up, engineers can concentrate on the model—without having to worry about the ripple effect that last-minute design changes might have on documentation. Whether you need to produce traditional 2D deliverables, advance to 3D modeling, or leverage a full digital twin, having a complete digital replica of physical assets replaces inefficient and inaccurate methods of record or as-built drawings. Understanding the future needs of infrastructure and existing conditions for future updates ultimately saves time and eliminates guesswork.

Save time and money with automated accurate drawing production.

Double the productivity of road network design with software for streamlining design, analysis, and multidiscipline collaboration. We will show you how.

Lead the Way - Scope, Process, Results

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

Plan	Design	Analyze	Construct	Operate
Collect field data	Design highway, interchange, and municipal roadway facilities	Complete site investigations	Supervise construction	Streamline the maintenance, rehabilitation, and decommissioning of road and highway assets
Generate conceptual design	Implement geometric design	Analyze earthwork and alignments		
Develop traffic control plans	Create grading and drainage designs	Analyze traffic and visibility		
Coordinate with utility companies	Design utility protection and relocation	Analyze drainage resilience		
Provide quantities and costs in the planning phase	Complete construction staging design			
Generate visuals for public engagement				

You need software that is built to address the way you work and compatible for who you work with. We are going to tell you exactly what that means.

Road and Bridge Conceptual Design

OpenRoads™ ConceptStation

Get Projects Started Faster

Accelerate data collection with built-in geocoordination services to find, download, import, and georeference contextual information that supports 3D design modeling workflows, including point clouds, 3D reality meshes, terrain data, images, and GIS information.

Simplify 3D Modeling

Simplify 3D modeling with easy-to-use engineering sketching capabilities to quickly conceptualize road and bridge infrastructure. OpenRoads ConceptStation offers roadway and bridge design capabilities to help road and land development engineers create intelligent models in context.

Understand Financial Implications Early

Explore conceptual design options with real-world data and cost analysis to improve project results. Generate accurate project estimates to quickly understand the financial implications of design options and carry early decisions directly into design.

Visualize a Quicker Approval Process

Seeing is believing. Deliver real-time visualization of actual design content without the need for a dedicated visualization specialist. Traditional 2D layouts can be confusing for non-project team members and the public. Get to yes faster! Shorten the review process and rapidly respond to change requests by easily making design changes on the fly that automatically update deliverables.

Check out the capabilities list to understand how easy concepts can be.

OpenRoads ConceptStation Capabilities At-A-Glance

OpenRoads™ ConceptStation

Assemble Context Data

- Assemble context data, including terrain models, raster, images, GIS, and DGN
- Reference reality meshes
- Gain reality data services
- Incorporate aerial imageries with Bing Maps

Conceptual Design Roads

- Place roads following AASHTO standards
- Find best-fitting road alignment on existing ground vertically
- Determine superelevation
- Edit horizontal and vertical alignment
- Place and edit lane marking
- Design, place, and edit intersections
- Design, place, and edit ramps
- Place and edit city furniture, including guardrail and street lights
- Create visualizations with LumenRT™

Conceptual Design Bridge

- Complete bridge placement with two simple clicks
- Determine number of supports automatically from the bridge length
- Set girder type, support type, abutment type, wing walls
- Set bridge deck template
- Determine superelevation automatically
- Easily edit conceptual bridge designs to change girder type, support type, abutment type, and wing walls
- Change number of spans/supports and number of girders
- Rotate supports and move/skew abutment
- Change bridge deck template
- Create visualizations with LumenRT

Estimate Cost and Quantities

- Project cost overview
- High level overall design cost
- Includes allowance by default
- Detailed quantities/ cost, listing cost items, and associated quantities

Interoperability with Detailed Design

- Export to OpenRoads Designer or MicroStation®
- Export DGN, TIN, ALG, IRD, ITL, RWK
- Support geometry, template, template drop transition, super elevation, terrains, and cross sections

Detailed Road Design and Analysis

OpenRoads™ Designer

All the Capabilities You Need for Detailed Road Design

What if you could combine all the elements of road design and engineering into one comprehensive affordable road product? You can! Learn, adopt, and use one application. With OpenRoads Designer, get everything you need for plan and construction documentation, surveying, stormwater design and analysis, visualization, geotechnical, underground utilities, and more.

Simplify Change Management

Evaluate multiple road alignment options to optimize each road design to its most economically safe alternative. Save time and effort during design creation and revisions with automated design updates. Imagine you are halfway through a roadway design project and the profile needs adjustments to a vertical curve and the grades. Instead of spending hours adjusting the profile and all the related design elements, designing with OpenRoads and its dynamic relationships between horizontal and vertical design elements will keep your project in sync, allowing you to instantly see the impact to cut and fill and right-of-way.

Reduce Errors with Rule-based Design

Compare the design of road elements against recognized industry standards or client defined standards. As designers work to lay out designs, the application provides notifications to alert you when standards are not met. This capability provides many benefits, including greater time savings, reduced rework due to fewer review comments, more consistency, and, above all, sound engineering design.

Connect Design to Documentation

Civil engineers typically design for code compliance, not for constructability. But incorrect interpretation of design intent made in the field because of unclear documentation can lead to delayed schedules, change orders, and RFIs after construction begins. By generating construction documents directly from the design model, OpenRoads Designer ensures accurate, up-to-date deliverables. Create plans, profiles, and cross-sections for roads, land development, and other civil designs.

OpenRoads Designer Capabilities At-A-Glance

OpenRoads™ Designer

Survey

- Read/write standard raw survey formats
- Survey data reduction
- Feature coding for custom survey feature connectivity, display, and annotation
- Create adjustments for least squares, compass, crandall, and transit
- Gain dynamic graphical and tabular editing of survey field book data
- Utilize terrain modeling
- Export common data formats

Site

- Integrate reality data (point clouds, reality mesh, terrain data, imagery, and geospatial information)
- Create, design, and analyze surfaces
- Lay out parcels
- Get insight into grading
- Gain horizontal and vertical alignments
- Visualize profiles and cross sections
- Utilize terrain modeling and analysis

Road

- Access horizontal and vertical geometry
- Create profiles and cross-sections
- Design advanced roundabouts
- Complete roadway and site feature modeling and analysis
- Visualize earthwork and quantities
- Utilize civil cells for standard compliance and templates and automation
- Visualize design in real time

Drainage and Utilities

- Allocate and estimate stormwater loads
- Complete H&H modeling and analysis
- Utilize culvert design and analysis
- Use stormwater network design and analysis
- Practice sanitary network design and analysis

Plan Production and Documentation

- Generate plans, profiles, and cross-section sheets
- Complete quantity and earthwork calculations
- Create construction documentation
- Hand over BIM deliverables
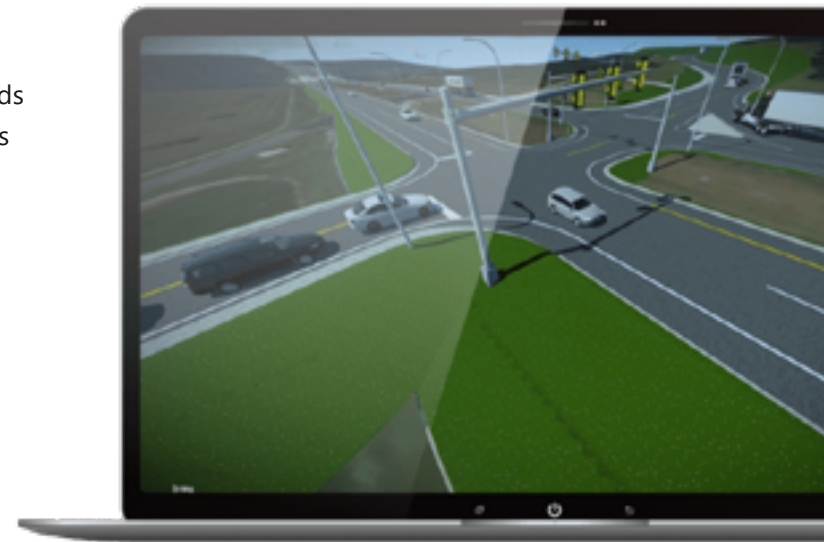
Integrated Design and Data for Every Project Phase

With a comprehensive set of applications, engineers can worry less about technology inefficiencies and focus more on engineering optimum solutions. Whether your team works directly on every portion of the workflow, or you need to work 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
OpenRoads ConceptStation	OpenRoads Designer	OpenRoads Designer	OpenRoads Designer	OpenRoads Designer
OpenRoads Designer	OpenBridge Modeler	OpenTunnel Designer	OpenBridge Modeler	OpenTunnel Designer
OpenBridge Modeler®	OpenTunnel® Designer	OpenFlows	OpenTunnel Designer	OpenBridge Modeler
	OpenFlows™		Use the applications to reference model/documents and verify accuracy of construction	Use the applications to hand off the digital model for future maintenance

Read on to discover the capabilities that you should be looking for across the project lifecycle and how the right applications working together seamlessly will enable an effective workflow.

Bridge Modeling
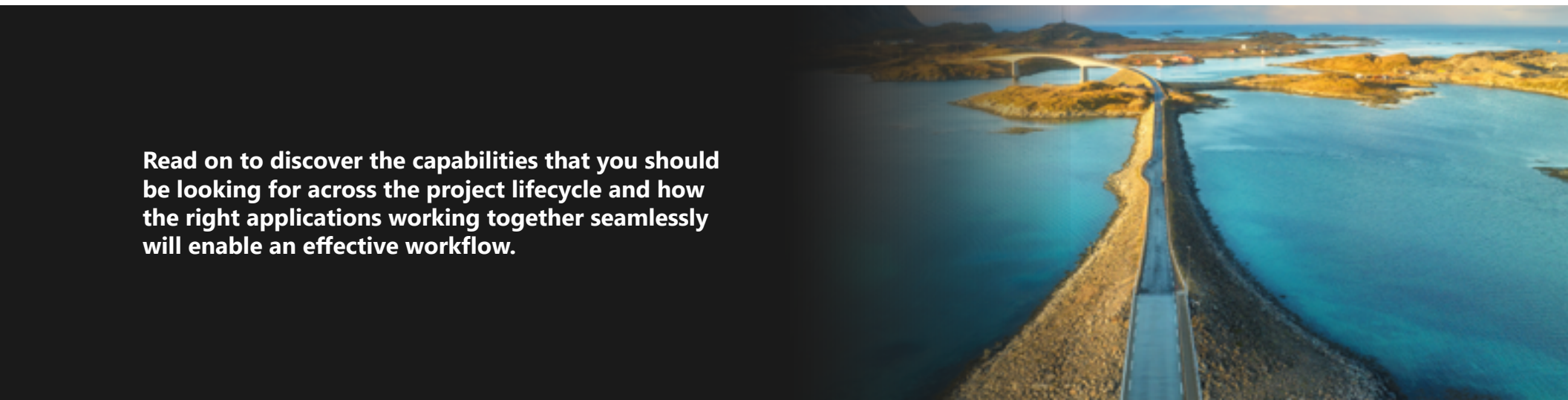
 OpenBridge Modeler®

Create Physical Bridge Models Easily and Accurately

Gone are the days of needing scripting and visualization specialists. OpenBridge Modeler produces intelligent models with engineering content properties for various bridge components. These models include concrete compressive strength, structural steel grade, standard beam designations, rebar details, and more.

Work with Civil Geometry, No Data Translations Required

The application has direct access to Bentley's civil design data. This accessibility allows you to visualize and evaluate bridge geometry and how it interacts with the alignment, terrain, drainage, and surrounding structures from the start of your project. The multidiscipline, consolidated project view makes it possible to identify constructability issues and conflicts prior to construction.

Reduce Tedious Manual Work with Dynamic Change Management

OpenBridge Modeler's built-in relationship between bridge components enables dynamic change management, saving time and preventing frustration. Have an alignment or profile change? Watch as it automatically updates the entire bridge geometry. Is there a change to the deck cross slopes? Watch as the beam and elevations update automatically.

Automate Documentation and Reports

OpenBridge Modeler generates a variety of reports, such as deck elevations, beam-seat elevations, material quantities, cost estimates, and input echo reports to facilitate the evaluation of multiple bridge alternatives, construction sequences, and costs.

Tunnel Design and Analysis

OpenTunnel Designer

Comprehensive 3D Physical Tunnel Modeling

Designing tunnels is already complex without the added complications of using design software built for other industries. OpenTunnel Designer enables faster and more accurate modeling of the full excavation shape, excavation tracks, tunnel lining, and reinforcement with native modeling capabilities. They include concrete compressive strength, structural steel grade, standard beam designations, and rebar details.

Work with Civil Geometry, No Data Translations Required

OpenTunnel Designer allows direct referencing of DGN models from highway alignments, profiles, and ground information created with OpenRoads and OpenBridge® as LandXML and IFC files. It allows you to visualize and evaluate road geometry from the start of your project. With thousands of decisions and changes for design, aesthetics, structural integrity, material choices, and safety, it is essential for teams to have open access to data to reduce errors and complete projects efficiently.

Perform Geotechnical Analysis

Maximize productivity and save time by creating multiple analytical models in minutes not days. Simply specify stations for the cross section as the basis of your 2D analytical model, or send entire tunnels from your 3D BIM model to PLAXIS* with the push of a button, no coding required.

Automate Documentation and Reports

Streamline your plan production process. Plan, profile, and cross-section drawings can easily be created using OpenTunnel Designer's powerful drawing production capabilities. Keep your projects on track with tunnel-specific reports based on the latest changes for up-to-date, accurate costing and quantities.

*Additional software subscription required

Hydraulics and Hydrology

 OpenFlows™

Hydraulics and Hydrology Applications for All Roads, No Matter the Complexity

The hydraulics and hydrology aspect of a road project can be a complex undertaking. Is your team working on a project involving drainage design? Look no further and plan intelligently with interoperable hydraulics and hydrology capabilities to ensure design accuracy and environmental impact mitigation by using OpenFlows for drainage design and analysis. See the full picture and manage conflicts in advance of on-site work. Reference the proposed and existing drainage, and proposed and existing utilities, to perform the clash detection or to compare the position of, for example, stormwater lines with the water lines.

Engineering Software to Streamline Your Modeling Process

Most of the OpenFlows drainage functionality is available inside OpenRoads, giving you the best of both worlds in one product. It also enables you to avoid the worry of data loss when transferring between civil and specialist hydraulics packages. If you need to work on larger, more complex projects, OpenFlows CivilStorm®, with its built-in hydraulics and hydrology applications and a variety of wet-weather calibration methods, empowers you to perform comprehensive simulation of complex stormwater systems.

User-friendly Calculators and Hydraulic Toolbox for Your Engineering Needs

If you do not need a full BIM solution, you can analyze cross-drain systems, bridge and roadway overtopping with OpenFlows CulvertMaster® by selecting from a library of standard culvert shapes, materials, and entrance conditions. You can also provide reliable calculations on a wide variety of hydraulic elements, such as pressure pipes, open channels, weirs, orifices, and inlets with OpenFlows FlowMaster®.

Capabilities At-A-Glance

OpenBridge Modeler

- Reference roadway information and ground data
- Model comprehensive 3D physical bridges
- Utilize 2D views with dimensions using dynamic views
- Include U.S. customary and metric (SI) units
- Access user customizable libraries
- Use cross-section template for complex geometry
- Utilize superstructure and substructure modeling
- Model bridge components
- Implement rule-based and constraint-driven modeling
- Create custom components
- Use ProConcrete™ rebar modeling capabilities
- Detect clashes and clearances
- Implement a variety of reporting formats
- Create lifelike renderings with LumenRT™

OpenTunnel Designer

- Model comprehensive 3D physical tunnels
- Complete cull excavation shape, excavation tracks modeling
- Develop tunnel lining modeling for conventional and TBM tunnels
- Implement parametric, intelligent tunnel components
- Work with rule-based and constraint-driven modeling
- Access solid and transparent views
- Create material quantities reports, input reports, cost estimate reports
- Implement direct data exchange with MicroStation®, OpenRoads, OpenRail™, OpenBridge, ProStructures™, and PLAXIS®
- Connect to PLAXIS 2D and PLAXIS 3D to perform geotechnical analysis
- Import geomodeling data from Leapfrog
- Utilize the following file formats: DGN, XML, LandXML, IFC, and PY
- Develop automated plan production

OpenFlows CivilStorm

- Develop comprehensive stormwater modeling and analysis
- Perform comprehensive analysis of all aspects of stormwater systems
- Analyze pressure and free-surface flow conditions for networks of channels and closed conduits, model complex pond outlets for a variety of tailwater conditions, and use weirs, orifices, culverts, risers, and inlet boxes in their design
- Provides support for multiple background layers, data conversion utilities for use with CAD, GIS, and databases, and unlimited undo and redo
- Import/export OpenRoads Designer's storm and sanitary file
- Easy model management with scenarios
- Configure, run, evaluate, visualize, and compare an unlimited number of scenarios within a single file
- Compare alternative designs or proposed rehabilitation methods for a variety of system conditions

OpenFlows CulvertMaster

- Implement culvert hydraulic analysis and design
- Utilize HDS-5 methodology
- Access pressure or partial (free surface) flow conditions
- Work with a gradually varied flow algorithm
- Use flow profile methods
- Work with culvert section shapes, such as box, circular, arch, and horizontal and vertical ellipse
- Work with outlet channel sections
- Use roadway or broad-crested weir
- Create watershed area calculations
- Work with the peak flow method, including the rational method and SCS graphical peaks
- Develop a method, user-defined peak flow rate
- Analyze rainfall data input using intensity-duration-frequency (IDF) equations, IDF tables, and Hydro-35
- Create summarized and detailed reports of inputs and outputs
- Utilize rating tables

OpenFlows FlowMaster

- Design and analyze any type of hydraulic structure
- Manage data easily using the Project Explorer and engineering libraries
- Utilize a hydraulic calculator for open channels, pipes, weirs, inlets, and orifices
- Perform pressure pipe design
- Design and analyze inlet and gutter, open channels, weirs, and orifices
- Utilize the following flow algorithms: uniform, critical, and gradually varied flow
- Utilize friction-loss methods: Kutter; Manning; Darcy-Weisbach: Swamee and Jain; and Darcy-Weisbach: Colebrook-White, Hazen-Williams
- Create summarized and detailed reports of inputs and outputs
- Develop advanced tabular reporting
- Use rating tables
- Work with rating curves
- Create gradually varied flow profile graphs and tables
- Use cross-section plots

Engineers Like You Use OpenRoads

JMC2 Civil Engineering

Torrence, Calif. Downtown Pedestrian Improvement Project

- A complete rebuild of all driveways, sidewalks, drainage systems, water lines, and street lighting brought the street up to current ADA standards.

- Bentley's highly accurate 3D design software helped JMC2 decrease design time by 20% and save USD 50,000, a cost-saving that was passed back to the client.

- For modeling water flow and pipe sizing, JMC2 created a digital twin of the replacement water system along the half-mile stretch of Cravens Avenue under redesign.

Sai-Systra Group

Mumbai Coastal Road Project (South) Package – II

- Mumbai embarked on a USD 1.8 billion highway project to ease traffic congestion and curb the amount of toxic air pollutants admitted into the atmosphere.

- Using 3D drive-throughs in OpenRoads Designer enabled SYSTRA to identify interferences between the seawall and the structures, saving 20% in resource hours.

- The dynamic nature of the 3D model enabled them to effortlessly define and modify the plan, saving them 50% in design time.

Foth

Transformed, Connected, and Revitalized Cedar Falls, Iowa Corridor

- Foth implemented a comprehensive 3D BIM and reality modeling solution to deliver an innovative, multimodal roadway design configuration for the city of Cedar Falls, projected to realize USD 32 million in ROI for the owner over the next 25 years.

- Bentley's open applications facilitated coordinated modeling to reduce conflicts and expedite design by an estimated 50%, saving over USD 500,000 in construction costs.

- The corridor redesign which included six new roundabouts, bike lanes, and bus stop turnouts has provided an 18% reduction in crashes and an 89% reduction in injury crashes.
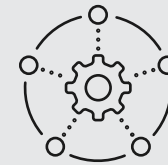
Innovative Digital Solutions Will Keep You in the Driver's Seat, Enabling a Better Strategy

We hope this e-book has inspired you with technology solutions that allow you to continue to build and advance your community's infrastructure through innovation.

See potential problems and resolve them in advance when project changes are easy and cost efficient.

Bentley's civil complete solution set provides all the applications that you need in one place, from one company, designed to work together and to work the way you do.
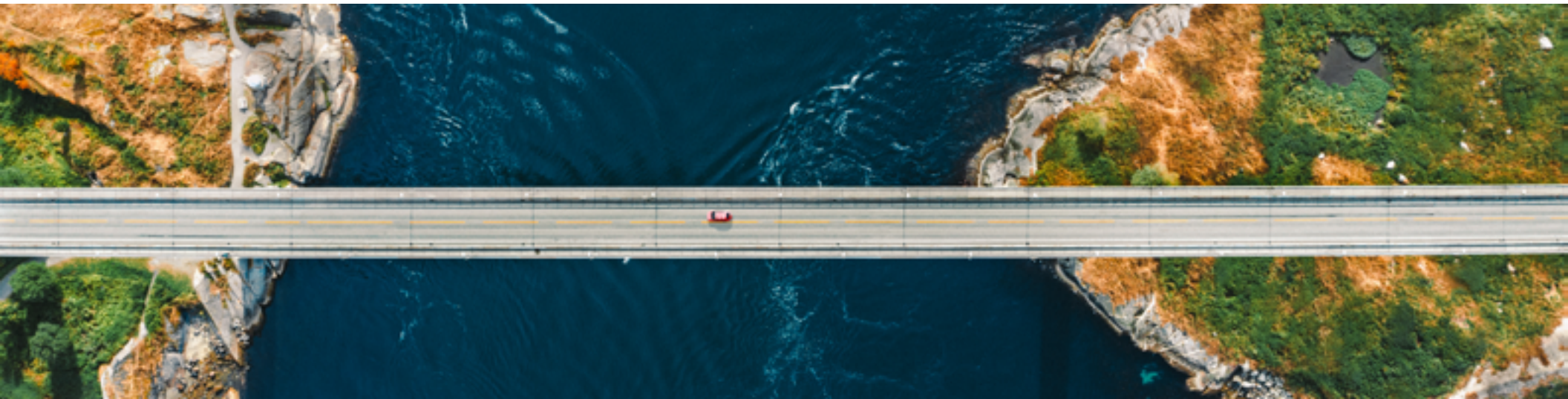
Getting Started

Bentley makes it easy for organizations to find the product license that offers the best options, affordable price, and the training needed to be successful through Virtuosity™, Bentley's eStore for practitioner licenses.

Whatever subscription is right for you, you will get access to our expert services, where you will have one-to-one mentoring by Bentley project experts, personalized training for your team, and on-demand learning. We call this bundle Virtuosity's Virtuoso Subscription, and it ensures that your workforce can quickly learn the latest technology and workflows while minimizing downtime and project costs.

> "
>
> I knew we needed specialized software to make this proposal standout, so initially,
> I was simply looking for cost-effective software licensing options. But that search opened the door
> to new resources as well as training and education opportunities that we had never considered.
>
> *Adrian Troncoso, Vice President, Alliance Group Enterprise (TAGE) Inc.*

Find out how Virtuosity project-specific training helped an engineering firm meet its tight deadlines.

| Read the story | Shop OpenRoads now | Chat with an expert |