



## **Benesch Pilots AI/ML and Digital Twin Technology to Streamline Traditional Pavement Assessment Workflows**

*Using Bentley's iTwin Applications Facilitates Data-centricity, Industrializing Industry Pavement Management Practices*

- *Traditional pavement management practices and technology lack efficiency and comprehensiveness, failing to maximize asset value.*
- *Benesch initiated a research and development project, exploring the integration of artificial intelligence, machine learning, and digital twins for a more data-centric approach to pavement crack detection workflows.*
- *Leveraging iTwin® with artificial intelligence and machine learning technology automated digitization and integration of crack linework data within the digital twin, saving more than 75% in manual field work.*
- *Their success was predicated on harnessing the power of artificial intelligence and machine learning within Bentley's digital twin applications to manage pavement assets.*

### **Advancing Technology for Pavement Crack Detection**

Most public agency assets, such as bridges and transit networks, include pavement, requiring crack detection survey and maintenance to ensure structural integrity throughout their design life. However, current inspection methods for collecting crack and joint data are time consuming, resulting in shutdowns that negatively impact infrastructure owners and operators, as well as the public. “Typically, it means that analyses are not conducted for the entire pavement, but rather completed via sample section to find averages and [that average is then projected] through the rest of the asset,” said Bret Tremblay, technical manager at Benesch, a multidiscipline firm within the architecture, engineering, and construction (AEC) industry offering professional services across a broad range of markets. While this approach fosters quantity overruns and change orders, it has become standard industry practice.

To address these shortcomings, Benesch initiated a research and development project to implement more efficient data collection workflows and resolve client issues related to extended closures during routine inspections. “Nearly every valuable public agency asset involves pavement, and traditional pavement maintenance practices and technology fail to maximize the value of that asset,” said Tremblay. Benesch had a vision for what technology would need to do to meet the needs of their customers and began collecting data at three different active project sites to test and advance current technology capabilities to optimize detection methods.

### **Addressing the Digital Data Gap**

As existing pavement sections continue to deteriorate on roadways, bridges, airports, and in parking lots, the demand for inspection and maintenance continues to rise. “Oftentimes, that work is pushed out past the life of the asset, leading to further deterioration that cannot be kept up with,” said Tremblay. The advent of drone technology to capture high-resolution aerial orthophotos has allowed for tracing cracks directly on images, saving time during digitization. However, this digital approach still falls short of meeting industry needs, as assets are still being used beyond their design life. While data is captured digitally and more efficiently than boots-on-the-ground inspections, there remains a data

utilization gap where the captured data is not being used to its fullest potential.

While engineering teams can visualize the cracks in a digital environment via the aerial photos, there is a disconnect when it comes to analyzing or classifying those cracks based on a condition assessment, which still requires an on-site survey. Benesch sought to bridge this gap, streamlining data collection, analysis, and utilization, unlocking the full capabilities of digital data. They wanted to adopt a data-centric approach, where visual digital data can be made available in real time to the right person at the right time for more timely informed decisions, leading to better outcomes that ensure structural integrity and public safety. To achieve this goal, they realized that they needed a digital twin solution capable of harnessing the power of cutting-edge Internet of Things (IoT), artificial intelligence (AI), and machine learning (ML) technology.

### **Leveraging AI and Digital Twins**

“We saw our customers struggle with this [condition assessment] capability gap and knew that partnering with Bentley would enable us to make the necessary breakthrough,” said Tremblay. Benesch selected Bentley’s iTwin Capture Modeler (formerly ContextCapture), AssetWise®, and iTwin applications to pilot their digital innovation, creating digital twins of their three selected project sites. Leveraging their partnership with Bentley, they explored the integration of AI/ML into their field data collection workflows, specifically targeting crack detection in pavement. “By using a combination of Bentley’s [iTwin Capture Modeler], AssetWise, and iTwin Experience, we were confident we could develop workflows with pavement crack detector technology that would harness the power of AI/ML to streamline the entire crack detection process, from field data collection to analysis, and feed into Bentley’s digital twin,” said Tremblay.

As the first step in generating their digital twins, Benesch flew the entirety of each project site via an automated flight plan and used the drone-captured images in combination with the AI-based detection sensors, allowing them to extract and analyze data on crack detections. The AI/ML-based pavement crack detector automated the digitization of crack linework data and fed the data through the digital twin model, providing a visual, real-time, and reliable analysis of the crack data from the project sites. Leveraging Bentley’s iTwin applications, Benesch utilized the digital twin to augment the pavement crack detection inspection, tagging condition notes directly in the model and remotely reviewing the condition of the asset. The AI/ML digital defect detection automated identification and classification of the crack defects in the field, and the inspection data required to correct the issues created results that were allowed to be seamlessly handed over to maintenance, design, and construction teams.

### **Data-centric Workflows Industrialize Industry Practices**

Compared to manual processes, AI workflows saved significant time and provided higher-quality data. Combined with Bentley’s iTwin applications, the new crack detection solution automated digitization of the crack linework data, saving more than 75% in time spent on site. It is projected to save money when inspecting 100 airports, while greatly minimizing impacts to traffic and/or airport operations. The digital twin and crack detection technology allowed teams to do more than simply extract a pavement crack from a single photo. It offered a holistic virtual view, delivering efficiencies in safety and accuracy, eliminating dangerous and error-prone manual works, and reducing client operations shutdowns due to on-site inspections and remediation. “We at Benesch are excited about how we can utilize this technology and workflow to view and compare historical results of a single asset over its lifespan, see if these cracks are expanding over time, and get a better health assessment of the asset. This will allow us to provide our clients with data driven decisions on how to approach maintenance,” said Tremblay.

Working in an immersive digital twin environment fueled by AI/ML facilitated digital data-centric workflows that shifted asset management perspectives from a fragmented approach to a single source of truth, providing an understanding of the entire structure for better decision making. Over time, as Benesch implements this technology for their clients, they expect to see optimized maintenance of critical transportation infrastructure, leading to a safer environment for everyone.

“We see this product not only benefiting Benesch, but the entire AEC industry,” said Tremblay. By embracing these modern technologies that harness AI/ML, the AEC industry can mitigate risk of human error where it matters most with infrastructure data. Benesch’s ground-breaking automated pavement crack data collection workflow will change industry practices managing pavement assets. “This product, even in its early testing phase, is the first of its kind to exist, with Bentley and with other technologies. We predict this could be a game-changer for inspection data collection within the AEC industry,” said Tremblay.



Runway crack detection of entire surface completed after 1-hour drone flight. Cracks detected utilizing A.I./ML, which pulled from digital twin mesh surfacing shown above.

### [Image link](#)

**Image caption/courtesy:** Benesch selected Bentley’s iTwin Capture Modeler, AssetWise, and iTwin applications to pilot their digital innovation, creating digital twins of their three selected project sites. *Image courtesy of Benesch.*

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