Costain-Carillion JV Implements BIM Process to Deliver GBP 160 Million A5-M1 Link Road
Bentley Technology Provides Innovative Solutions That Push the Limits of BIM for Transportation Infrastructure

A Pioneer Project for Highways England
To relieve traffic congestion and unlock growth in the local Dunstable area, Highways England proposed the Northern Dunstable Bypass, linking the A5 trunk road to the M1 motorway via junction 11A, at the eastern end of the link road. This dual, 4.5-kilometer carriageway includes three new junctions, a new roundabout, and seven new bridges. It is the first infrastructure project linking a new junction to an existing smart motorway where variable speed limits and hard shoulder running are used to manage traffic flow. Costain-Carillion Joint Venture (CCJV) was formed to design and construct the transportation system that will improve road safety and travel time by eliminating the need for long-distance travel on the A5 through Dunstable.

While the project was not a United Kingdom (UK) “Early Adopter” BIM initiative, the team selected a collaborative BIM approach and digital processes to enhance decision making and realize construction savings. HDB Associates (HDB) was commissioned to help implement the BIM procedures in parallel with the traditional 2D designs, which are already nearing completion. The team needed to incorporate the 2D models into the BIM process as well as integrate temporary works, project constraints, and traffic management as active elements within the 3D model. A key objective of the project was to create information models that supported sufficient attribute data to ensure 4D (construction sequencing), 5D (cost information), and future 6D (asset information) modeling deliverables could be met. To accommodate these challenges among a team where many members had no previous BIM experience, CCJV relied on the flexibility and interoperability of Bentley technology to deliver this groundbreaking infrastructure project for Highways England.

BIM Advancements Drive Standards
With the project well underway prior to implementing the use of BIM, CCJV faced the challenge of educating and engaging team members, to ensure that the collaborative BIM approach was incorporating and building on 2D design work already accomplished, and producing models from 2D drawings without compromising the production of traditional deliverables. Following its four factors of a successful BIM project – people, collaboration, process, and technology – CCJV used Bentley’s civil design, modeling, and information management applications to introduce its BIM methodology and produce a fully federated 3D model of the scheme that could be maintained throughout the project lifecycle.

Teaming with Bentley provided considerable assistance enabling CCJV to take full advantage of key technologies including Bentley Class Editor, OpenRoads, and Subsurface Utility Engineering (SUE). This, combined with lessons learned from other projects, was helpful in developing an effective BIM approach embraced by all stakeholders. Furthermore, creating BIM processes and tools and working backwards from the familiar traditional requirements helped bridge the gap between conventional design deliverables and new BIM initiatives. For example, producing 5D costing reports from the models in the same format as the traditional bills of quantities, output on spreadsheets, was a tool and format familiar to the entire project team. This tactical approach to BIM built trust and accelerated full engagement in the 3D federated modeling process.

Effective Data Management
To establish BIM Level 2 compliance and adopt Highway England’s draft standard Advice Note, CCJV needed to implement a collaboration tool to control the project models and documents. The JV team selected ProjectWise® and
deliverables.
“Bentley’s ambition to push technological boundaries and its ability to adapt to a changing environment has enabled the CCJV BIM team to develop a model that encourages a collaborative approach to both planning and efficiency.”

– Adam Goodall
Construction Manager,
Costain-Carillion Joint Venture

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configured the software to include the requirements of the Advice Note. ProjectWise provided a connected data environment and significant improvement over earlier collaborative processes used during the design stage, establishing a single source of truth for all project information. Bentley's data sharing and information management technology instilled clarity within the workflows needed to check, review, and issue documents and models. “Although ProjectWise was new to most of the staff, its ease of use soon made it a powerful tool within the project,” said David Bennison, director of HDB Associates.

Using ProjectWise together with Bentley’s design and analysis applications allowed the team to use the DGN file format for all the models across all disciplines for an effective federated process. The coordinated models improved information mobility, enhanced efficiency, and allowed for robust design practices to check buildability at the early project stages. Working in a collaborative environment streamlined workflows and accelerated information sharing among all stakeholders for effective data management throughout the project.

Leveraging Technology to Support Attribute Data

“The use of Bentley software was groundbreaking on many aspects of the project, particularly with the way the model attribute data was added and stored,” stated Bennison. OpenRoads, MXROAD®, and SUE used feature definitions to control the look of the models and objects, and their associated data, all of which were imported into MicroStation® to facilitate the federated modeling process.

While current standards of classifying project data relied on a three-tiered approach incorporating containers, files, and layers, CCJV needed a more flexible and agile approach to meet the challenges of producing 3D models that supported attribute data for 4D, 5D, and future 6D modeling processes, and satisfied the need to exist in parallel with the traditional information. CCJV created a classification system using Bentley Class Editor, which had all the functionality necessary to develop and maintain the required information. The models were split into three categories: 1) data to ensure each item had a unique ID, 2) additional asset information common to all objects, and 3) a specific set of properties depending on the type of item (i.e., sub-base object or drainage object). These models with attributed objects facilitated design and multi-discipline reviews. The ability to link attributed data within each model using Bentley applications provided the information required to produce cost reports and enable facility management in alignment with the 4D and 5D deliverables, as well as allow for the production of 6D asset models in the future.

Converting 2D Drawings and Schedules into 3D Models

The JV team converted the traditional documents and drawings into models using MXROAD, creating MicroStation files using surface models as a reference. This type of approach was successful for modeling things like lighting columns, traffic signs, and drainage systems. Hundreds of columns were modeled quickly and efficiently, with built-in consistency checks and automated workflows.

To create traffic sign models, CCJV used a similar approach, except that most of the information was obtained from an existing Excel sign schedule rather than a 2D drawing. The use of the schedule enabled all required attribute data for the signs to automatically be added during the modeling process.

Finally, with drainage being a significant element of any infrastructure scheme, it was imperative that the team determine an efficient method to create the 3D models and required attribute data. Using Bentley’s civil design applications, CCJV implemented an automated workflow to convert the earlier completed drainage designs into 3D models and attributed MicroStation files. The flexibility and interoperability of Bentley applications facilitated the development of innovative processes for effective and efficient production of the final project deliverables.

Federated Modeling Optimizes ROI

Using Bentley applications, CCJV integrated project constraints, temporary works, and traffic management into the modeling process. The 3D models were used for design reviews, clash detections, buildability checks, and site briefings, invaluable to the project given the constrained nature of working on the M1, the integration of a new separate junction, and the need to minimize adverse effects on motorway travelers.

Having a construction-ready, user-friendly federated model capable of being manipulated onsite in real time optimized planning and collaboration. The temporary phasing models allowed the construction team to adjust beam lifts over the carriageway to help manage traffic flow during construction, reducing road closures from 14 to nine on one of England’s busiest motorways. Moreover, by modeling the topography of existing roads, the team optimized earthworks such as cut-and-fill ratios for road replacements, reducing costs and minimizing the impact on the surrounding environment.

Using a federated BIM process, CCJV improved information mobility, coordination, and planning resulting in substantial construction savings, minimizing risk and the need for post-construction changes.