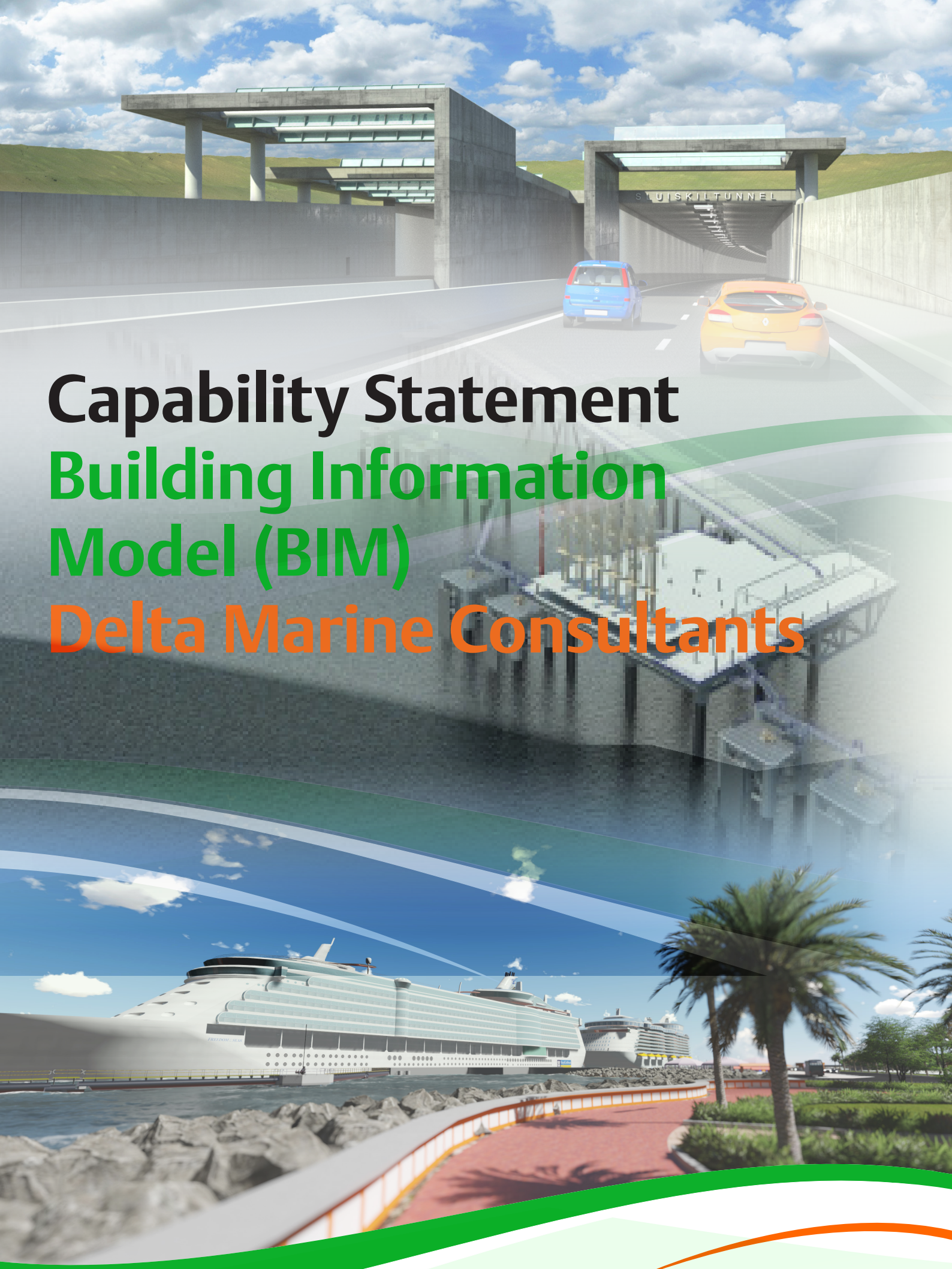


Capability Statement
Building Information Model (BIM)
Delta Marine Consultants

Delta Marine Consultants

Delta Marine Consultants

Delta Marine Consultants (DMC) was founded in 1978 for the purpose of providing consultancy, project management and engineering design services to clients on a worldwide basis. The company has expertise in the fields of urban infrastructure, large-scale transport infrastructure, ports and harbour development and coastal engineering. The company holds strong links with the construction industry through its parent company, the Royal BAM Group. This contributes to the ability to provide solutions to practical problems and to blend innovation with reliability in design.

DMC has been rebranded into 'BAM Infraconsult' and is working under that name in the home market. DMC is still used as a trade name for international projects and referred to as such in this Design Capability Statement.

DMC has well over 400 employees working in various offices worldwide. The head office is in Gouda (the Netherlands) and apart from several other offices in the Netherlands, offices are also located in Singapore, Dubai, Jakarta, Panama and Perth. DMC is or has been active in a great number of other countries on a project basis, often together with BAM contracting companies.

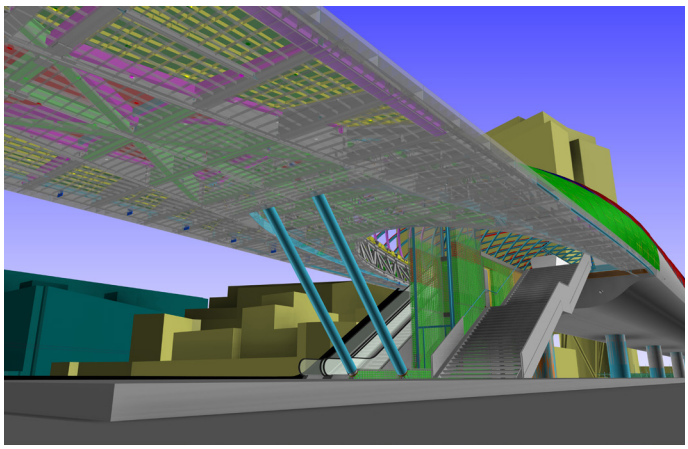
Our Core Business

In a rapidly changing world the complexity of infrastructural projects is increasing. These projects are often large-scale and multi-disciplinary in character. The combination of Building Information Modelling (BIM), LEAN methodologies and concurrent engineering allows a more sustainable, safer, faster and more cost-efficient management during the design, construction, and maintenance of projects. The BIM department at DMC supports these developments by playing a prominent role in the field of 3D / BIM models throughout the entire construction process. Along with the colleagues at our offices in Jakarta and Singapore we supply these BIM services to the projects of the Civil Sector, Royal BAM Group nv.

With its Strategic Agenda the BAM Group strives to be the 'best in class' in construction projects. For this objective to be achieved we use BIM to create a virtual environment where we can simulate the construction process. We use BIM in the tender and construction phase.

This practice leads to:

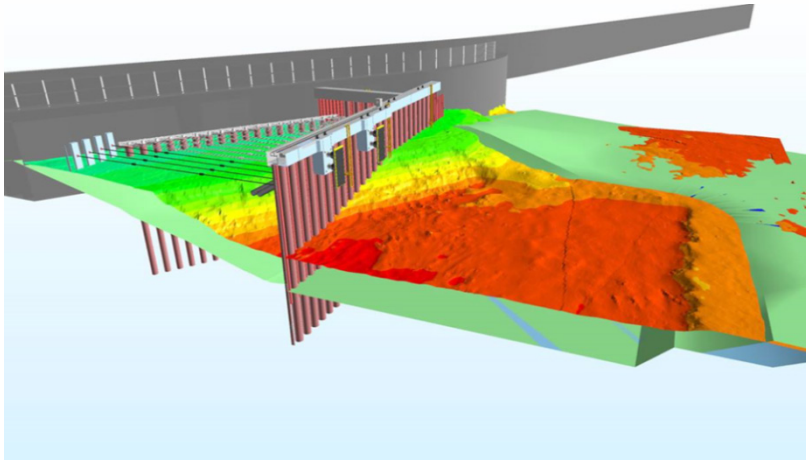
- A cost effective concept that complies with the customer's requirements,
- A safe, relatively short and precise realization phase, with no fail-costs,
- A structure that is maintainable throughout its lifespan.



3D / BIM modelling

At DMC we use BIM to create an intelligent, multi-disciplinary and multi-dimensional model of a given project. DMC has modelling capabilities in the field of Structural Modelling, MEP, formwork, roads and earth works.
3D / BIM models are used during the tender phase to optimize the design and meet the client's demands. In the construction phase, the 3D / BIM models are then developed further to generate information such as, drawings, schedules, material take-offs, clash detection, program and cash flow analyses. During the construction phase new information representing the project 'as-built' will be added to the model to ensure its future use as an Asset Information Model. For the long term this model can be used for asset management purposes and performance analyses.

To create the 3D / BIM models we use various software programs such as Revit, SolidWorks, Inventor, Civil3D, Allplan, Tekla, Infraworks, Vico, Autodesk Navisworks, and Solibri Model Checker.



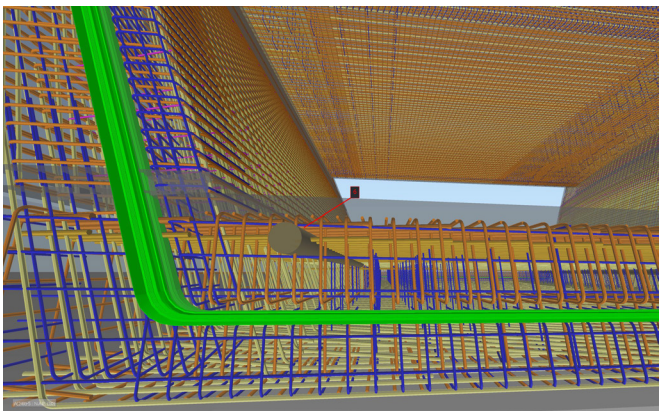
Quay wall Liverpool, United Kingdom. 3D structural model including bathymetry/geotechnical profiles.

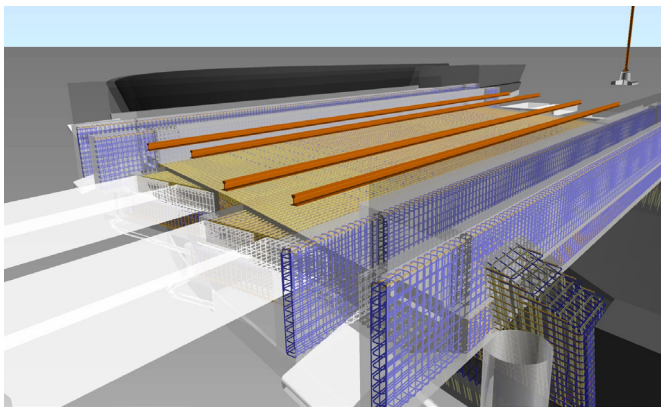
DMC supports the concept of open data-sharing solutions that would optimize design, construction and maintenance processes. We comply with international standards such as PAS 1192.

3D rebar models

DMC supports the developments in structural modeling such as modeling concrete reinforcements in 3D. Adding rebaring to the BIM model can help the designer and contractor to better understand complex reinforced concrete details. That allows them to solve contrains and clashes already in the design phase of the project instead of during construction .

The models remains fully integrated, intelligent and flexible up to the last stages of the construction process.

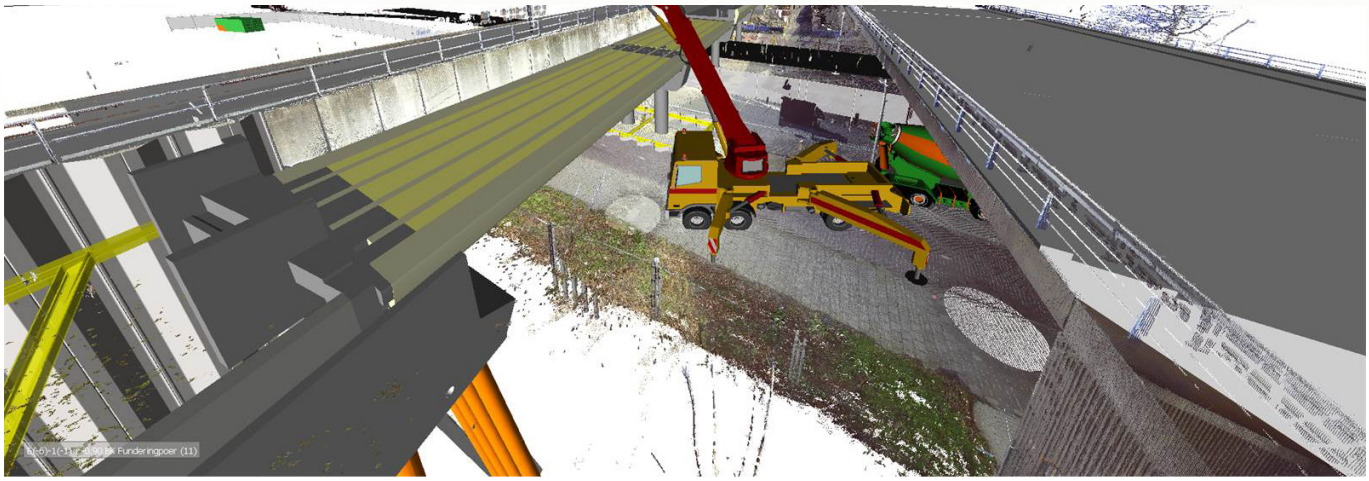




Underpass in Ede, the Netherlands. 3D rebar models

Point Clouds

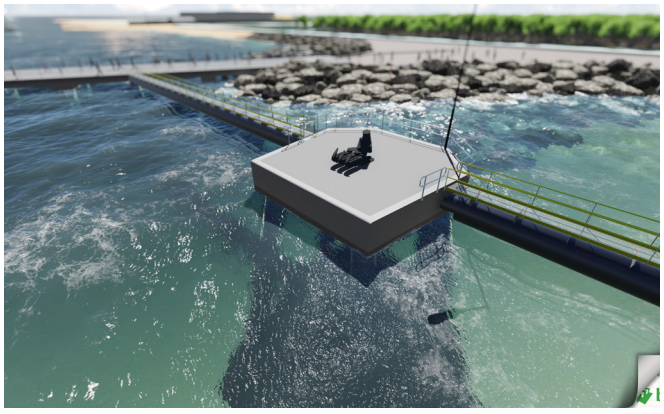
At DMC we use Point Cloud laser scans to further aid the design and construction processes. A point cloud is a collection of points in a three-dimensional coordinate system that is created as the result of a 3D laserscan. They can be made within a range of resolutions, which will define the accuracy of further use. Point clouds provide a fast way to map out the existing context or environment in projects (reducing cost due to more accurate design and project preparation), as well as to compare the as-built objects with the virtual 3D model. They can also be used to capture the progress of the construction. Within DMC we have built extensive experience with using this technology on a number of projects.



Project 'Amsterdam OV-SAAL', between Schiphol and Duivendrecht, the Netherlands. Point cloud scans were used to accurately document the location and dimensions of existing structures.

Visualizations

Design visualizations are a powerful tool for communication with both clients and stakeholders. At DMC we have extensive experience with creating photo realistic still images and fly through videos. These visuals help to understand the complexity of projects and visualize the design alternatives and optimizations.



Curaçao Mega Cruise Ship Terminal, Willemstad, Curaçao

4D Modelling

One of the most important advantages of using BIM is that several dimensions of information can be added to the project. 4D BIM adds the dimension time to the 3D / BIM model.

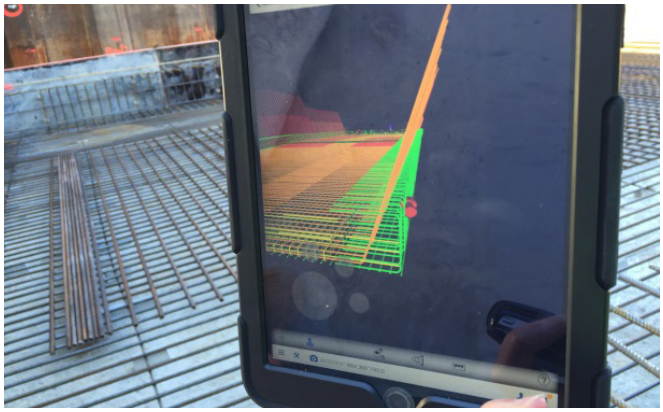
Based on the construction model, we can simulate and optimise the building process of the project in the safety of a virtual environment where all risk factors can be evaluated and communicated up-front. Together with the construction planning data, these simulations comprise a robust and reliable planning tool that ensures an efficient and fluent construction process.

Geographical Information System

A geographic information system (GIS) lets us visualize, question, analyze, and interpret data to understand relationships, patterns, and trends. DMC has a standard basic set of maps that can be used for any project. A dedicated group of GIS specialists supports most of the Dutch projects with actual and reliable geographical information.

BIM 360 Field

BIM360 Field is a mobile application, specially designed for on-site work, which combines safety and building quality information in a single 3D model. Using this application we are able to review our digital models outside the office and compare them, while working at the construction site, with the physical structure. Traditional building practices require a construction worker to extrapolate a 3D image out of 2D technical drawings, which requires time and carries certain fault risks. With BIM360 Field a construction worker could directly view the model on a portable device and have access to all relevant information at all times. BIM 360 has proven to be a greatly advantageous building tool that contributes to a safer, more efficient and exemplary building process.



Underpass in Ede, The Netherlands.BIM360 Field was used to review rebar positioning on the construction site.

BIM Coordination

DMC believes that with BIM we can build a better product for end users. BIM is assisting on being in control of the Design and Construction process and simulates the construction process to create a safer working place. When using BIM we coordinate the work between disciplines to create synergy and avoid duplication. Using BIM enables more efficient and effective collaboration.

To avoid construction conflicts the BIM model is used for clash detection and to manage interfaces. This allows the project team to work more efficiently and potential risks are identified at an early stage.

BIM Coordination model Ichtys.

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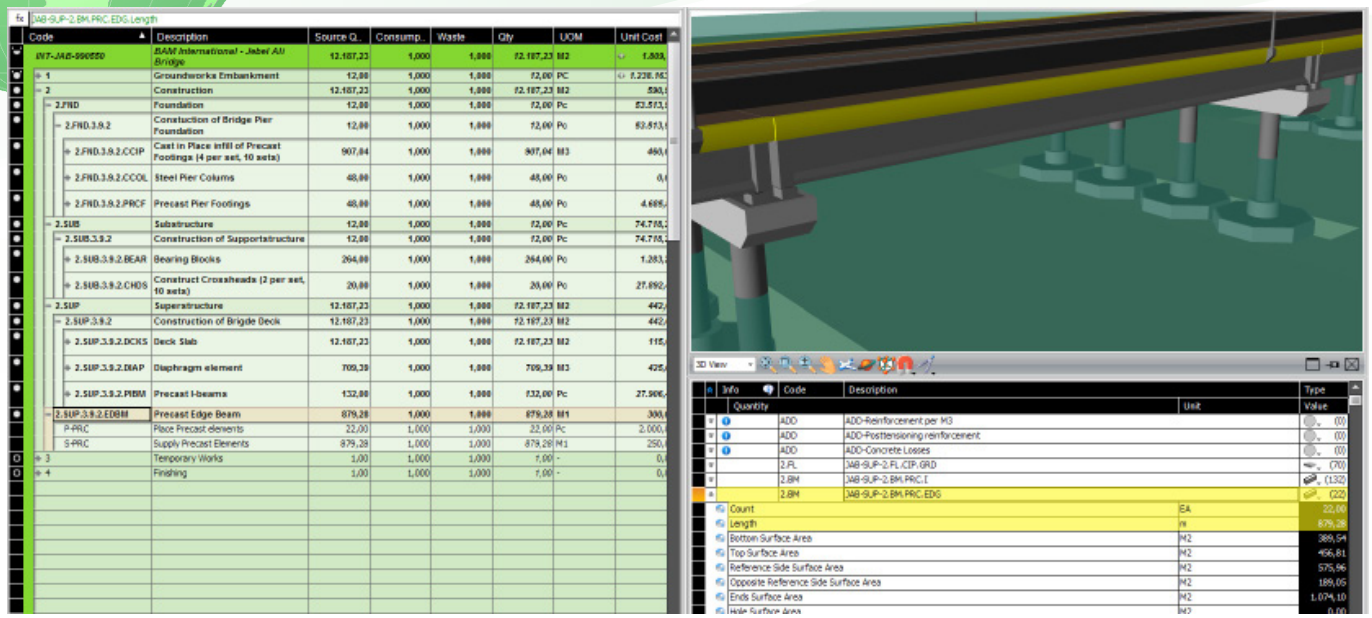
The BIM model is to be kept up to date in order to serve as a reliable basis for decisions during the life cycle of the project. This means that also during construction the BIM model acts as a central source of information. As all parties involved in the project have access to the BIM model, they will utilize exactly the same information. Consequently and as our experience has proven on numerous occasions communication then becomes much easier.

Examples

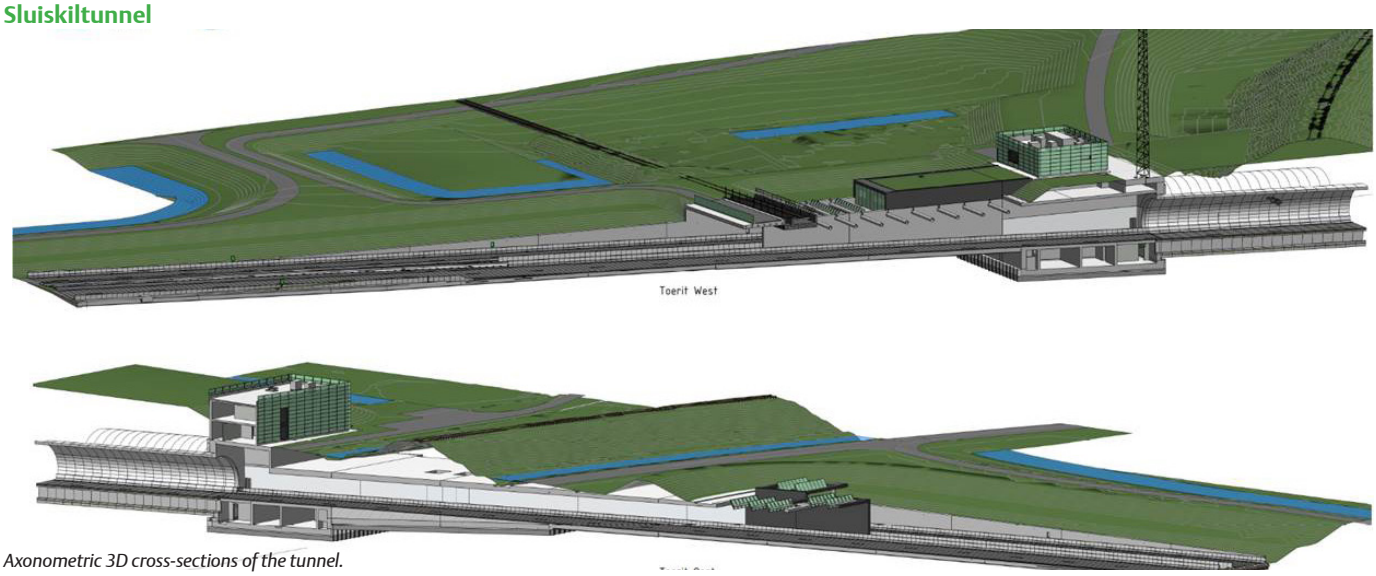
Jebel Ali Terminal 4 Bridge



5D BIM model

During the tender phase a 5D quantity take off / cost calculation model has been made. Due to the close cooperation between the structural engineer, the specialist BIM and the cost estimator, it was possible to reduce the lead time of the design / calculation phase.

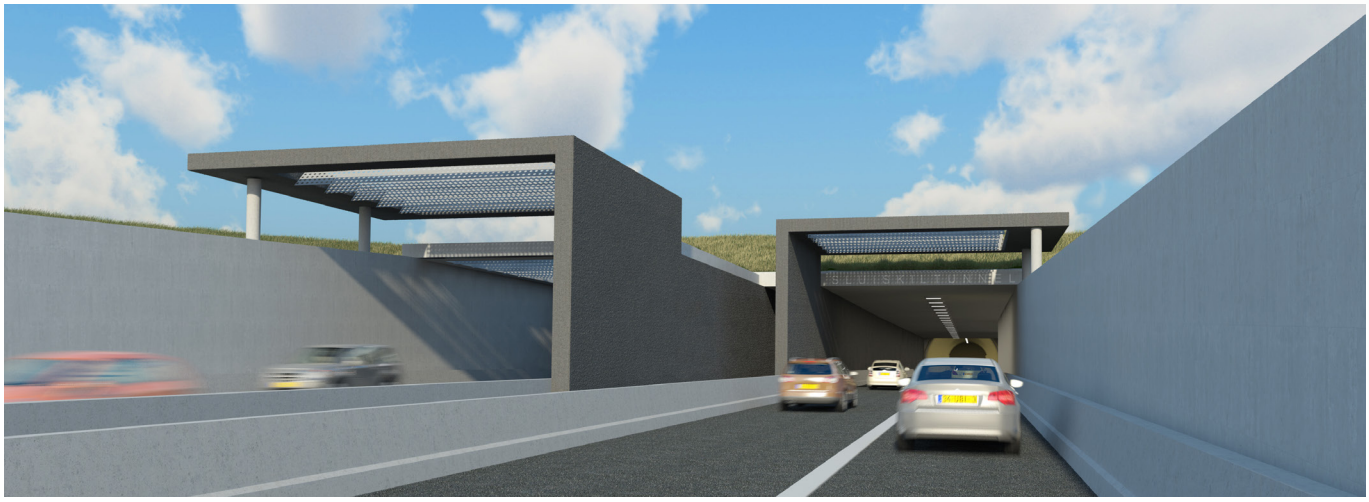
Sluiskiltunnel



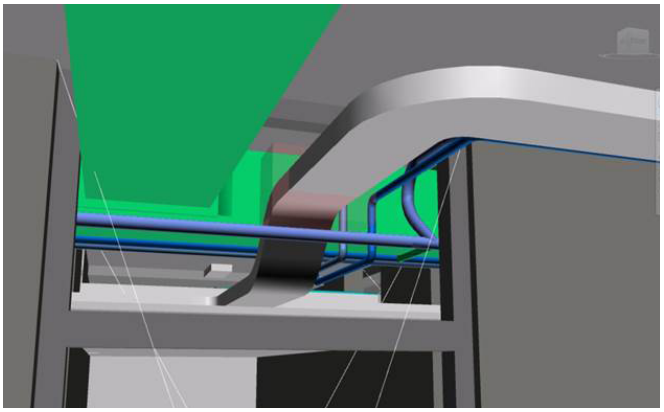
Axonometric 3D cross-sections of the tunnel.

Delta Marine Consultants

The Sluiskiltunnel is a tunnel in the delta province of Zeeland under a busy waterway that was built to accommodate the road traffic and eliminate waiting times due to frequent bridge openings. With a total length of 1330m the tunnel consists of two bored tunnels of 11m in diameter and the supporting service structures. Elements such as the tunneling shields, storm water drainage and expansion joints were all modeled using 3D / BIM software. By modelling and carefully itemizing all concrete recesses accommodating technical and mechanical facilities, the tunnel was designed with the optimization of all service installations in mind. The result: a multidisciplinary and integrated design that allowed for clash detection between the digital models from structural, electrical and mechanical engineering. With the help of BIM we were able to deliver a competitive offer to the client and to execute the project within budget.



The tunnel entry as seen from a driver's perspective.



Mechanical installations in the 3D / BIM model as compared to their actual positioning at the construction site.

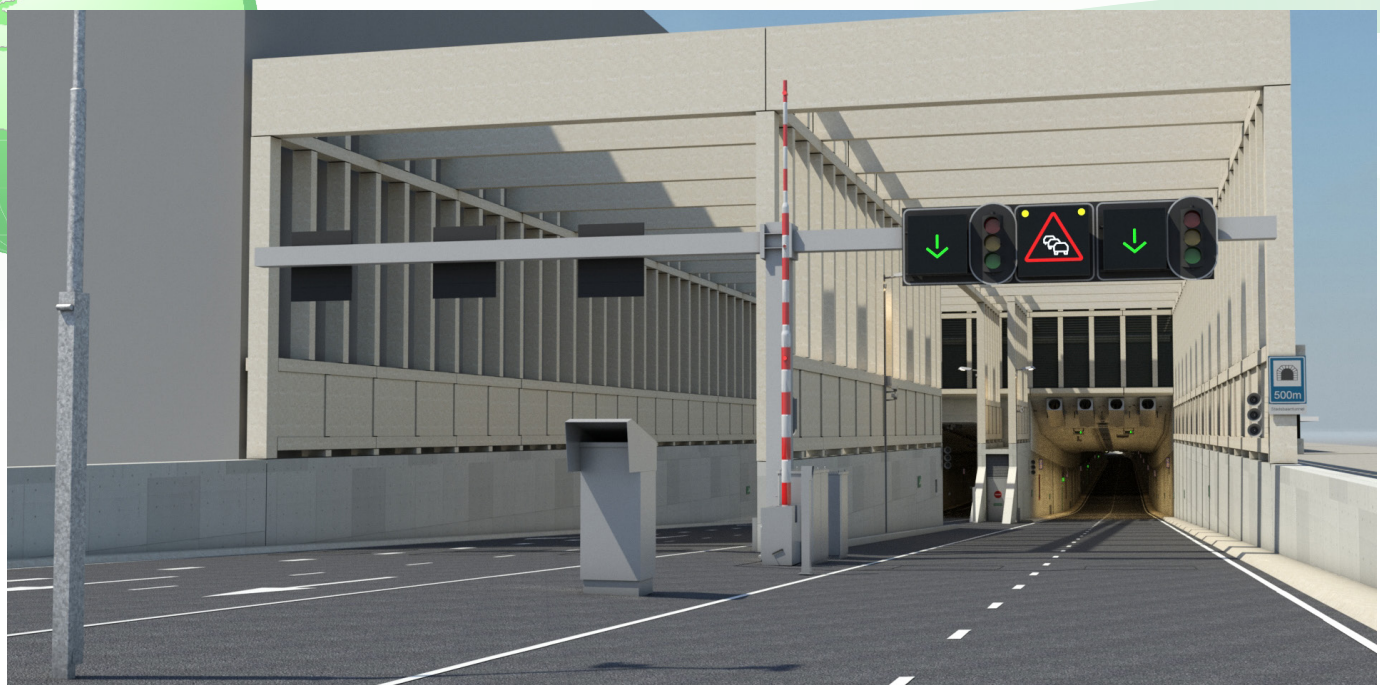
3D simulations were used in the planning and execution of the boring and construction of the tunnel.

The Leidsche Rijn Stadsbaantunnel

The 500 meters long Stadsbaantunnel is an underpass constructed parallel to the A2 main highway and under the upcoming Leidsche Rijn shopping and business district in Utrecht, the Netherlands. This project was realized in compliance with the requirements of the municipality Utrecht, which included 4D (program) simulations and a high quality virtual reality model. Thanks to the comprehensive 3D / BIM model JV BAM/Siemens was able to generate surveillance camera simulations which helped determine the positioning of mechanical installations for optimal viewpoints.
Furthermore the visualizations and drive-through simulations, which included details such as fire and safety equipment and emergency exits, have enabled the fire department to sketch evacuation plans ensuring the complete safety of the tunnel.

Visualization of the tunnel entry prior to construction shows all mechanical and technical installations

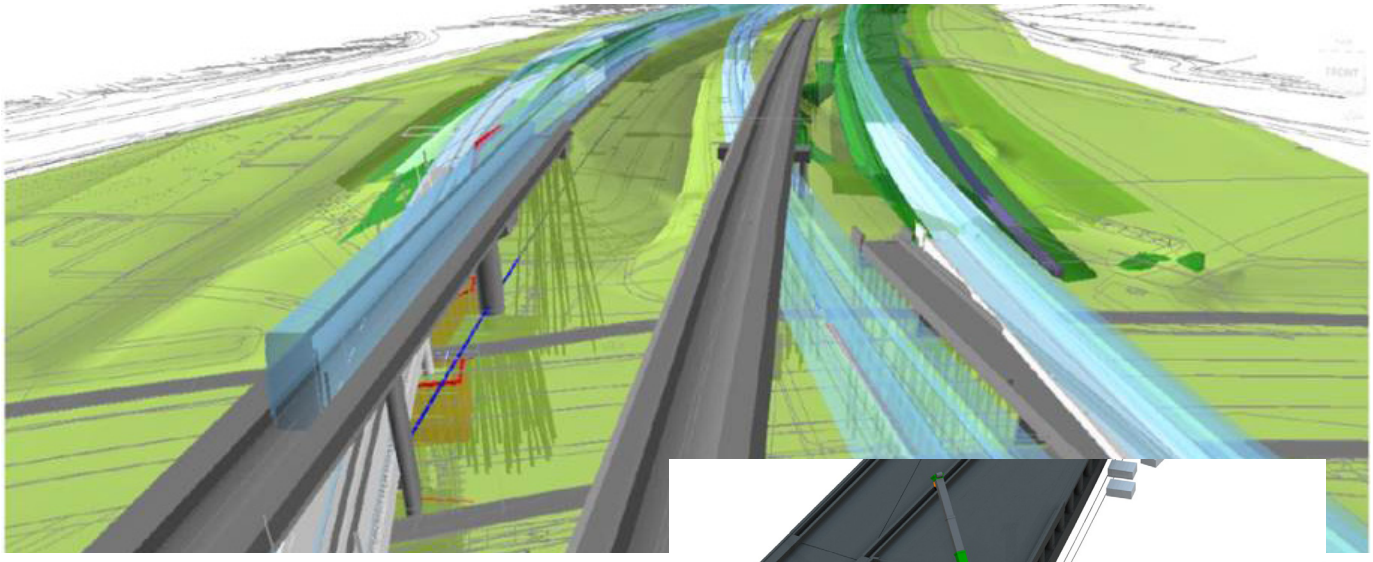
Photo-realistic visualization from within the tunnel generated from the 3D / BIM model and the final result of construction



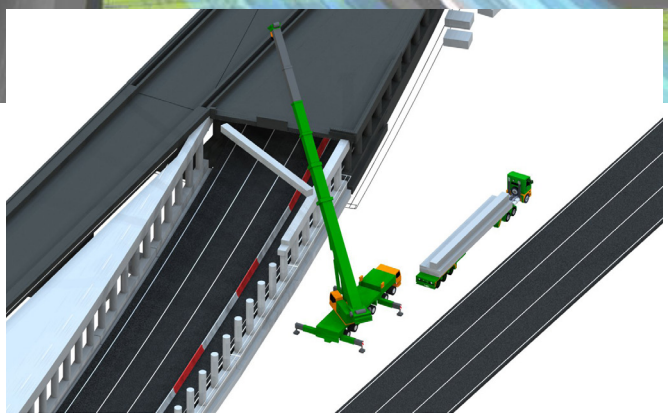
Tunnel entry, South end.

Amsterdam OV-SAAL

The project 'OV-SAAL' is situated along one of the busiest rail and highway networks in the Netherlands situated between Schiphol and Duivendrecht. It is comprised of several fly-over intersections of the inter-city rail network and the A10 motorway.
The extremely dense traffic flow in that area has been a main consideration and a limiting factor in the construction phase of the project. However using accurate 4D simulations generated from the 3D / BIM model, we have been able to plan and execute the construction phase with a minimal margin of error.



3D and 4D simulations were generated, providing high level of insight during the design, planning and construction phases.



4D construction simulation

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