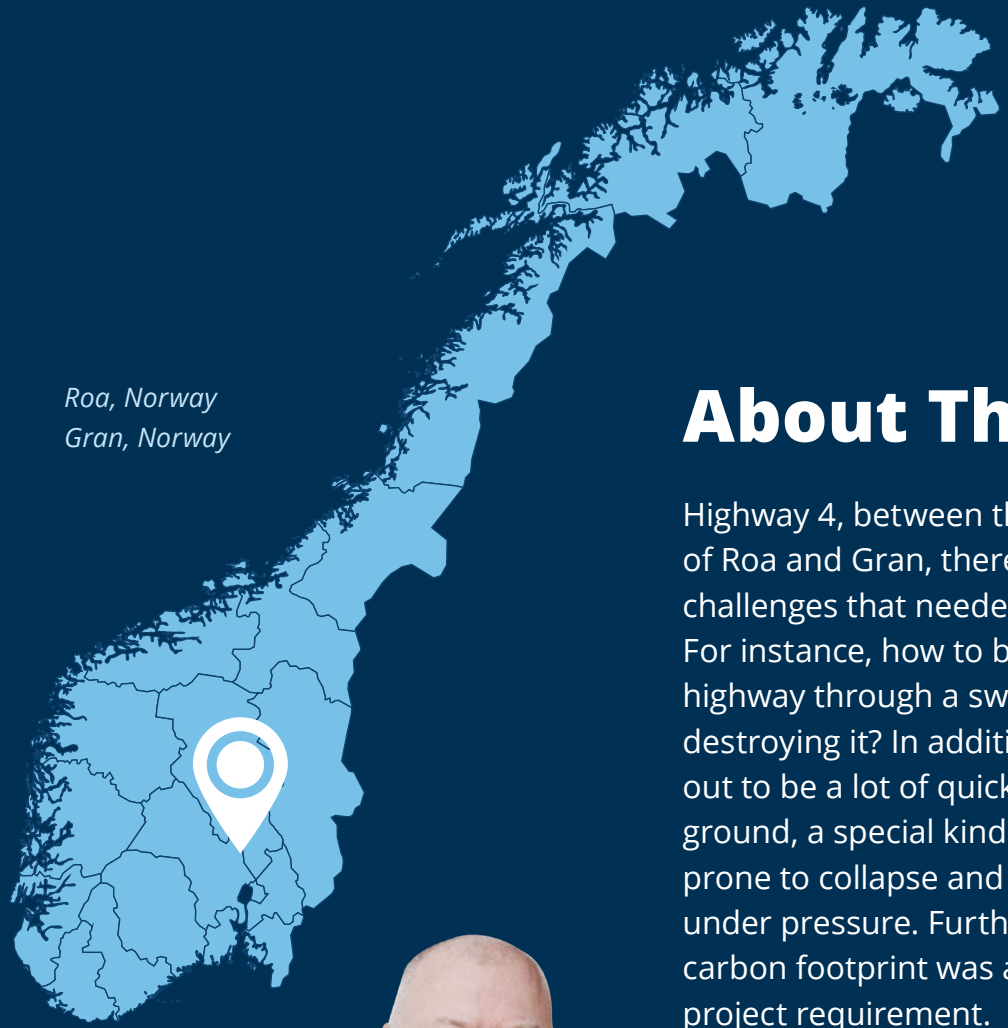
Customer Story

Interdisciplinary Collaboration

Lower Carbon Footprint, Early Project Delivery

Trimble® Construction



Roa, Norway
Gran, Norway

About The Project

Highway 4, between the municipalities of Roa and Gran, there were several challenges that needed to be solved. For instance, how to build a four-lane highway through a swamp without destroying it? In addition, there turned out to be a a lot of quick clay in the ground, a special kind of clay that is prone to collapse and become liquid under pressure. Furthermore, a limited carbon footprint was an important project requirement.

As the company responsible for the engineering, COWI realized that geotechnics would be laying the framework for the job. How demanding the ground conditions were would limit the possibilities in terms of execution.

“We stabilized the swamp area with a special geotechnical solution, for which we were dependent on a close cooperation between the geotechnicians and construction teams. This solution has been the key to success on the project,” says project director at COWI, Frode Geir Bjørvik.

Frode Geir Bjørvik,
Project Director at COWI

Model-based cooperation across borders

To tackle the challenge, an interdisciplinary team was set up across national borders: COWI's Danish geotechnicians in Ålborg were responsible for investigating the ground conditions and the team responsible for structures was located in Trondheim, Oslo and Kristiansand, Norway.

"We use the resources that are best suited for the job, regardless of where they are located. This requires good collaboration tools," Bjørvik points out.

On the project, Trimble Quadri was used as a collaboration solution both by the designer and the team from contractor Hæhre-Isachsen on the execution side.

"Quadri is a fantastic tool for us. The model-based way of working also makes the internal collaboration easier," says Bjørvik. "Having the design model in Quadri facilitated the work of finding the right solutions and making adjustments along the way. This is particularly valuable when you choose a non-traditional approach, as we did in this case."

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What is Quadri?

Trimble Quadri is a common data environment for both GIS & BIM data. It provides an object-, network-, and process-oriented model platform for infrastructure projects, supporting all phases and disciplines involved.

Using applications from different vendors, users can collaborate by continuously sharing models in a multi-user BIM environment. All changes are tracked on person, object- and task level. This secures a consistent and information rich model where it's easy to harvest constructible data in open formats, for a fully model based design and construction process.

Quadri collaboration platform is a well proven technology used in thousands of infrastructure projects in the last 10 years.

Challenging foundation

Overall, the biggest challenge was to put in the foundations for the bridges and roadway. Instead of replacing the swamp masses or constructing a larger bridge over the swamp area, a network of around 2,000 lime cement columns was created to stabilize the soil. Even if the solution is invisible, it still provides a stable surface for the road. The solution also helped CO2 emissions to be more than 30 per cent lower as compared to traditional road construction.

“It’s been important for us to find ways of working that ensure that we have secure interfaces, between technologies and people,” says Bjørvik. “Due to the varying ground conditions, geotechnics must be the starting point. Those teams deliver data as input for the structural engineers so they can start the process of finding out what is optimal in terms of cost, CO2 emissions and health & safety,” he continues.

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The various layers in the ground were modeled in Quadri, which in turn were based on ground investigations analyzed in Trimble Geosuite in which the depth and material of the ground condition layers were mapped. This data was then combined with previously acquired data from superficial deposit maps and other investigations in order to create a complete model of the ground conditions. The geotechnicians interpreted the results to determine the mass type in the various layers. This information was then entered into the model.

“It’s important to maintain control over any high risk zone in terms of where we can dig, so that the ground does not collapse, etc. This is crucial information for the contractor when considering mass replacement. They also need to know where stabilization of the swamp is needed before work commences,” Bjørvik elaborates.

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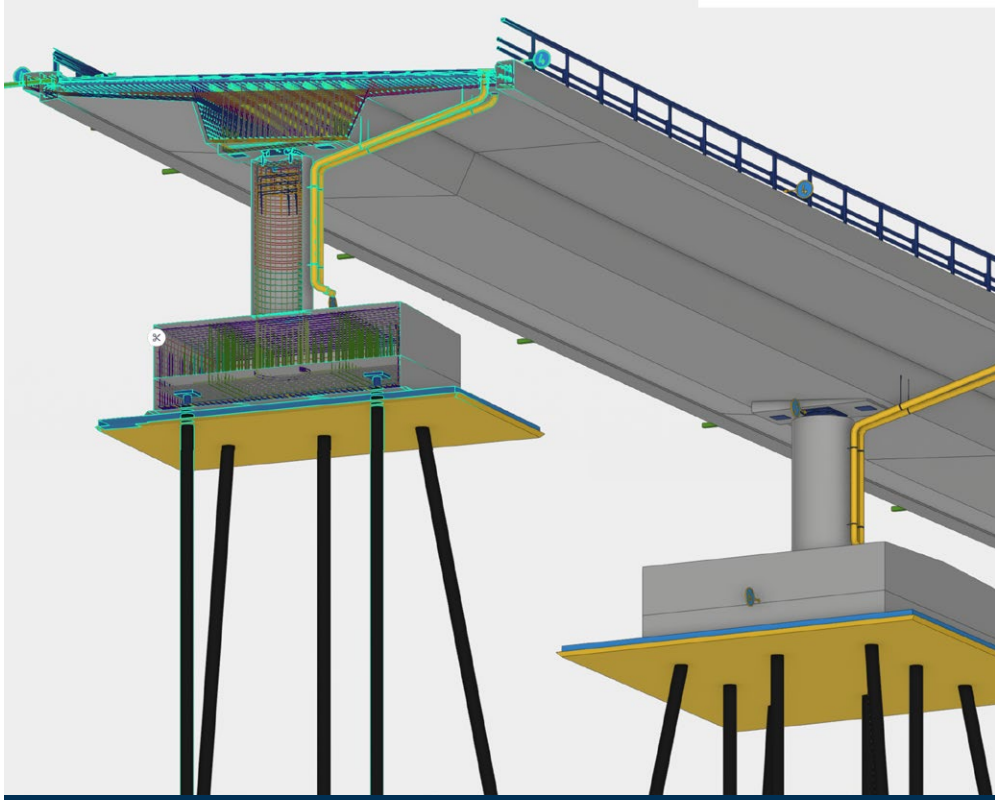
Simultaneous design and build, using a common platform

“By establishing the conceptual design quickly, it’s easier to see the challenges you will be facing in the execution, and in what order you should address them. We already had conceptual models in the tendering phase during which we considered multiple solutions, especially for tackling the geotechnical challenges. What we came up with has proven to be feasible, and it has worked very well in practice,” says Bjørvik.

Already in an early stage, the geotechnicians shared their models with the bridge and road engineers. Civil engineer for bridges at COWI, Audun Øvstebø, believes that the ability to work in parallel and make rapid adjustments have been the true success factors in the implementation of the project.

“Geotechnical engineering is taking place at the same time as the designing of a bridge. This requires an optimal and efficient parametric workflow,” he says.



Both Trimble Quadri and Tekla Structures have software connectors to the widely used parametric design toolGrasshopper 3D. Thus, the Tekla models can be updated parametrically from Grasshopper based on updated road geometry from Quadri.

“If, for example, due to geotechnical conditions, you need to add two extra columns, and the ten that were already planned around those two, are to be repositioned, there’s no problem adding those new ones. Changes from geotechnics are incorporated immediately, and then these can lead to new analyses that are communicated back,” he continues. “The common understanding of what is going on is important when there are many changes taking place close to delivery. Working simultaneously on the design while construction is happening, requires that the models need to be clearly marked with the Model Maturity level that they have reached.”

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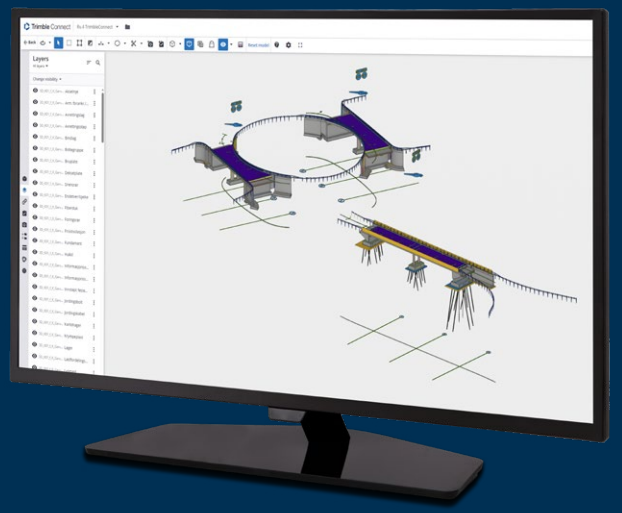
Detailed and solution-oriented

The geotechnical models in Quadri have established the basis for all technical decisions. “The models have made it easier to stay in control, and have been of great help to the engineers when it comes to stake-out data and progress planning,” says geotechnician Kenneth Christiansen.

This is the first project where the Ålborg office of COWI has provided such detailed information about the ground conditions into the model. Instead of delivering a stack of drawings, the geotechnicians at Highway 4 delivered everything in Quadri. It ensures a common understanding that’s not as easy to achieve working the traditional way.

“We’ve also shared our thoughts about the design with the contractor, to get immediate input on its feasibility, and to get an idea of whether it might be possible to do certain aspects easier and faster. If something has to be moved because a structure or a road has changed, then there is a continuous process in place to take all variables into consideration,” geotechnician Kristoffer Lauridsen explains.



"As an example, it turned out that a projected culvert would break the zoning plan. We were able to move the road in a way that it is now located on a type bridge. Since we made this discovery so early in the process, we avoided consequences for the overall progress," says Øvstebø.

By being able to efficiently change the plans before the culvert had been designed, both time and work were saved. The geotechnicians were also involved in the discussion to decide on the mixing ratio for the cement in the columns that stabilize the swamp area.

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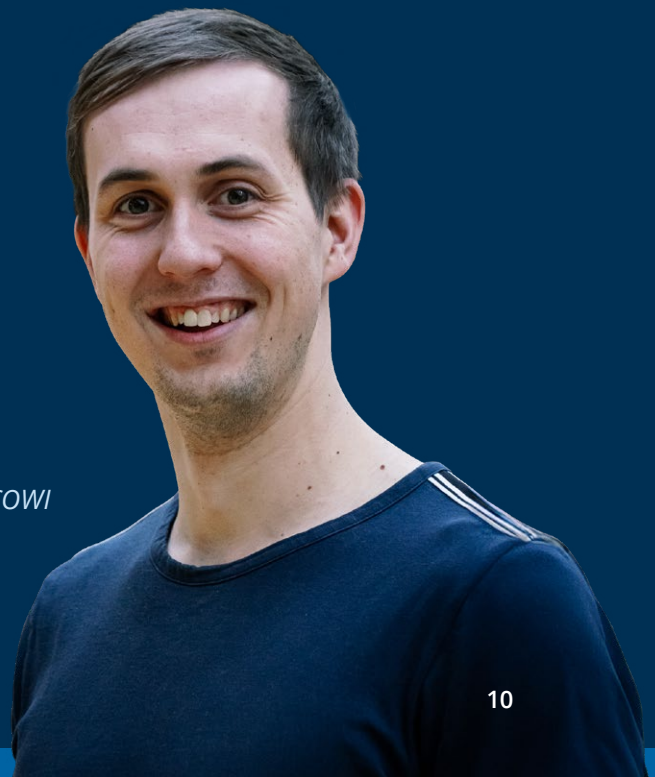
Civil engineer for bridges at COWI

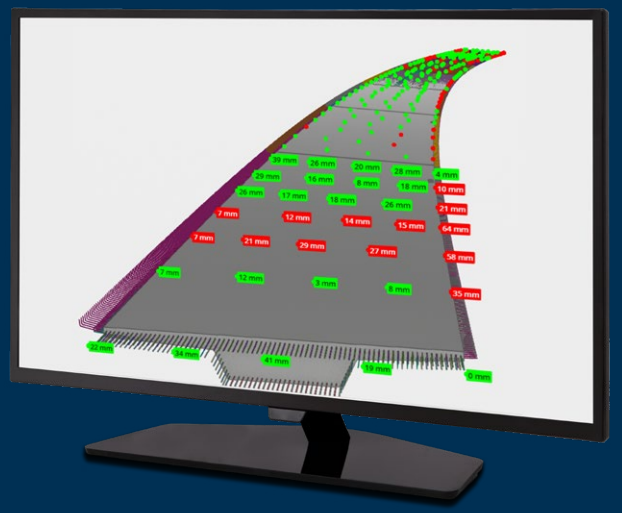


Efficient workflow from design to field

Both COWI and contractor Hæhre-Isachsen used Quadri and collaborated in this same model environment from the tendering phase onwards.

“The Norwegian Public Roads Administration uses a separate model viewer so we have set up a delivery from Quadri with automatic exports to their system, so they also had updated models to look at,” Bjørvik explains.

From the collaboration model, stake-out data can be obtained by creating delivery packages in the IFC file format, which are then used in production. Since the platform-agnostic IFC format can be used across all BIM solutions on the project, the contractor used Trimble Connect to retrieve stakeout data for the structures.



A well-known challenge that the industry has struggled with when working model-based, is ensuring that those who are out in the field using the models on tablets get the necessary information, such as measurement annotations. On the Highway 4 project, COWI used Trimble Connect's API to automatically calculate deviations between the measured points and the model to add measurement annotations.

"We have continued developing this in Trimble Connect. In our next project we automatically add measurement annotations to cross-sections or position of reinforcement. In this way, we make the models more suitable for use by the construction workers on site. This also eliminates much of the current manual work of creating views," says Øvstebø.

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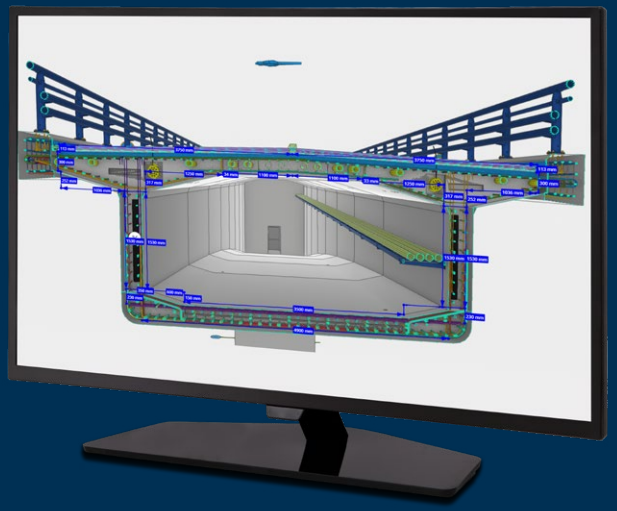
More rewarding working days

The model-based process also means a more rewarding working day.

“You get rid of the routine work that you used to spend an awful amount of time doing. Reinforcement drawings, and endless revisions of reinforcement drawings, are some of the things that could be frustrating. By using the digital workflow, whether you work inTekla or Grasshopper, you acquire a lot of knowledge that can be reused later,” says Øvstebø.

“The interesting thing with projects like this is that, together with the contractor, you increase the level of knowledge about constructability, progress and cost,” states Bjørvik.

The model-based engineering has contributed to great, non-traditional solutions developed jointly in a common environment. The result is that the 4.4 km long Highway 4 project can open several weeks ahead of schedule.



Roa, Norway
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Highway 4 Roa-Gran

- New four-lane motorway that will increase capacity and reduce the risk of accidents on the Roa-Gran stretch.
- The client is the Norwegian Public Roads Administration. Turnkey contracted with the combination of Hæhre-Isachsen as contractor and COWI as designer.
- The budget is just over NOK 700 million.
- Construction start: September 2021, opening November 2023.

Solutions

- Trimble Quadri
- Trimble Connect