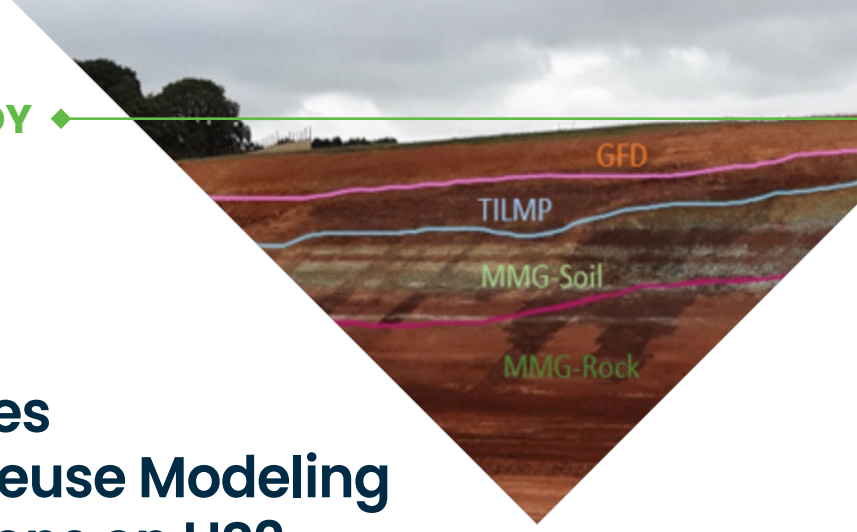
Bentley
Advancing Infrastructure

CASE STUDY



Mott MacDonald Optimizes Earthwork and Material Reuse Modeling to Reduce Carbon Emissions on HS2

Seequent and Bentley Applications Establish 3D geoBIM Analysis to Help Progress Mass-haul Strategy

REDUCING EMISSIONS ON A MEGA PROJECT

High Speed 2 (HS2), a new high-speed rail line that connects London to Manchester, England, is the largest infrastructure project currently being developed in Europe. Even individual portions of the project could be considered mega projects in their own right. For example, the 90-kilometer route from Long Itchington to Handsacre (Phase 1 Area North), delivered by the Balfour Beatty Vinci Integrated Project Team (IPT), includes the development of over 100 mainline assets.

Rail projects typically involve a significant movement of earthworks. On this project, the team determined that over 21 million cubic meters of material, equivalent to 8,400 Olympic-sized swimming pools, would need to be excavated as part of the Area North works. The process of excavating, transporting, treating, and placing the material are a significant source of carbon dioxide emissions.

Additionally, COP26, the 2021 environmental conference hosted by the United Nations, put a renewed focus on how engineers can contribute to climate change mitigation, and HS2 has committed to reducing carbon emissions by at least 50% during construction and operation. The project team realized that with better understanding and visualization there was an opportunity to optimize the mass-haul strategy and greatly reduce the emissions produced by the construction process.

SHORTCOMINGS OF TRADITIONAL GEOTECHNICAL ANALYSIS METHODS

"An accurate understanding of the material types for the re-use of materials in earthworks is a prerequisite for the efficient delivery of construction and optimal use of materials," said Jonny Neville, senior engineering geologist and information manager with Mott MacDonald. By finding ways to reuse the excavated material, such as within the foundation of other assets, rather than hauling it away for disposal, the contractors can greatly reduce the material transported on public roads. Additionally, reusing material excavated from the site would eliminate the need to import material from outside of the project site, further reducing the need to haul away newly excavated raw materials.

Conventional methods for assessing the suitability of reusing excavated material focus on a statistical review of ground investigation data compared to 2D specification of earthworks documents. However, that method did not clearly indicate how material would be distributed across assets in 3D, which could introduce risks, inflate costs, and hamper carbon reduction efforts. In addition to requiring a more accurate way to assess and plan earthworks, the project team needed to unify the work of large, multidiscipline teams working across many offices, companies, and time zones, as well as manage multiple phases of ground investigation with over 45 separate contracts.

BRINGING 2D MATERIALS ESTIMATIONS INTO 3D

The project team determined that the best way to optimize earthworks and greatly reduce the amount of material hauling was to create a new geoBIM assessment technique that used applications from Bentley and Seequent, The Bentley Subsurface Company, to integrate geological information and building information modeling. To create the solution, they first connected the HoleBASE geotechnical database with OpenGround Cloud, which provided full interoperability with an array of design applications. Next, they chose Leapfrog Works to undertake material reuse analysis, as it

PROJECT SUMMARY

ORGANIZATION
Mott MacDonald

SOLUTION
Geoprofessional

LOCATION
Birmingham, West Midlands, United Kingdom

PROJECT OBJECTIVES
- To optimize earthworks construction, reducing the need for mass haul and increasing the amount of material reuse.
- To help reduce emissions on the construction of High Speed 2.

PROJECT PLAYBOOK
Keynetix™, HoleBASE™, Leapfrog® Works, OpenGround® Cloud, OpenRoads™, ProjectWise®, Seequent® Central

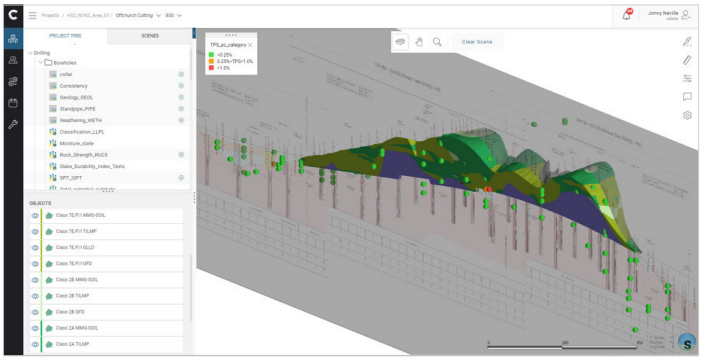
FAST FACTS
- The software helped the team determine how to reuse excavated materials to lower carbon emissions further by limiting the amount of new material being transported to the site.
- Previous methods of geotechnical analysis did not clearly indicate how material would be distributed in 3D, which could introduce risks, inflate costs, and hamper carbon reduction efforts.
- The project team used Seequent and Bentley applications to create a new geoBIM assessment technique to integrate geological information and building information modeling.

ROI
- The United Kingdom has committed to reducing carbon emissions by at least 50% during the construction and operation of the High Speed 2 mega rail project.

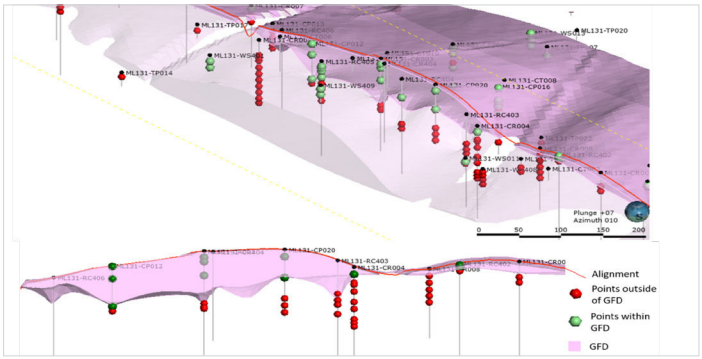
"The geoBIM technique can be readily applied to any infrastructure project that involves mass movement of material and is particularly beneficial when applied at the beginning of a project."

– Peter Fair, Geotechnical Data and 3D Ground Modeling Specialist, Mott MacDonald

Images courtesy of Mott MacDonald.



By optimizing the excavation process, the team greatly reduced hauling, resulting in significantly lower carbon emissions.



Determining how to reuse excavated materials further lowered carbon emissions by reducing the need for importing new material to the site.

enabled the team to visualize ground investigation from all datasets in 3D, undertake dynamic 3D geological modeling and 3D statistical numerical modeling, and incorporate designs from OpenRoads and surface topography into the analysis. Each analysis using Leapfrog Works produced a 3D geological model zoned by earthworks material reuse class prior to excavation.

Lastly, the project team published the analyses produced by Leapfrog Works on Seequent Central, a cloud-based geodata management and team collaboration solution. By using Seequent Central, the team could share data with all stakeholders, including real-time notifications and intuitive 3D views of all datasets. With this method, stakeholders could see proposals for cutting sections through the topography and extracting material volumes. They also used Seequent Central to establish staged approval processes and a clear audit trail.

OPTIMIZING EARTHWORKS TO REDUCE EMISSIONS

The project team used their Seequent and Bentley-enabled geoBIM technique on two pilot cuttings and immediately realized significant benefits. The analysis clearly indicates where each type of material would be potentially encountered, helping the construction team optimize mass-haul movements. "The construction team can optimize the mass-haul movements during the construction works through targeting specific excavations to obtain fill that meets the material class requirements for construction that is occurring elsewhere on the scheme," Neville said. As a result, they can prevent unnecessary stockpiling or additional material handling. Earthworks are further improved via more accurate volume estimations and the ability to model specific geometric earthwork profiles.

By lessening the need for material haulage, the project team has greatly reduced the emissions created by hauling vehicles and machinery. Furthermore, teams can now maximize the reuse of material on site while minimizing the amount of material deposited in landfills, lowering the import of fill material from outside the project area, and reducing the use of lime treatment, which results in further carbon savings. The geoBIM analysis has so far been undertaken on over 50% of the material due to be excavated on Phase 1 Area North, helping HS2 to meet the goal of reducing carbon emissions by 50%.