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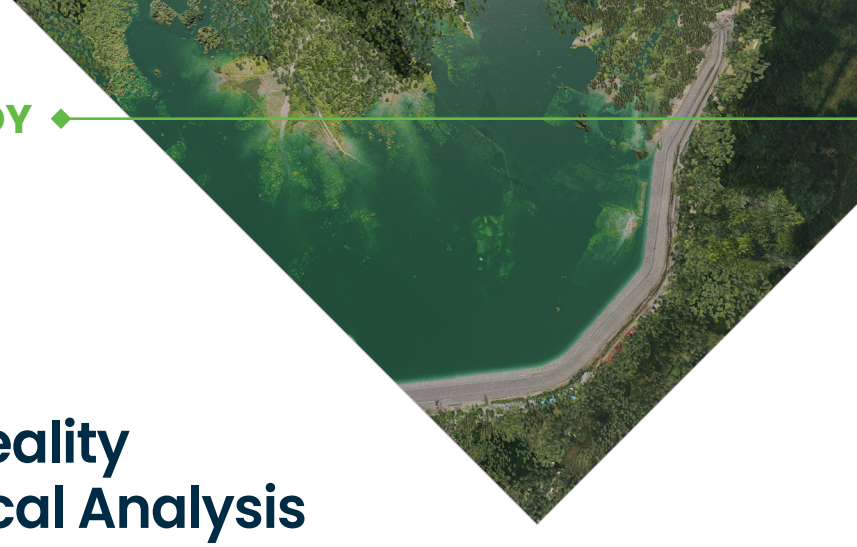
CASE STUDY



PT Hutama Karya Uses Reality Modeling and Geotechnical Analysis to Design a Long Dam

Bentley and Seequent® Software Helped Them Incorporate Sandy Soil as a Fill Material, Minimizing Quarry Excavation

IMPROVING LIVING STANDARDS WITH A NEW DAM

The Nganjuk District of East Java, Indonesia, experiences intense rainfall every year. Because the upstream area of Semantok River lacks any rainwater infiltration, Nganjuk experiences frequent flooding. To alleviate the problem, the Ministry of Public Works and Housing of Indonesia initiated the development of the USD 87.9 million Semantok Dam. The dam, now operational, reduces flood (Probable Maximum Flood or PMF) discharge from 822 cubic meters per second to 328 cubic meters per second and ensures water availability in both rainy and dry seasons. Additionally, the dam irrigates 1,900 hectares of agriculture, which significantly boosts rice production, the primary source of income for the district, and provides an array of other benefits for the area. "The presence of this dam will reduce floods, increase raw water supply, enhance irrigation capability, improve planting, and develop tourism as a new economic center in East Java," said Amy Rachmadhani Widyastuti, BIM development manager for PT Hutama Karya.

The ministry tasked PT Hutama Karya, a state-owned construction company, with developing Semantok Dam. Though the organization's development portfolio includes multiple dams across Indonesia, Semantok Dam, with a capacity of 33 million cubic meters of water, is among the largest they have developed. At a total length of 3.1 kilometers and a height of 31.56 meters, the dam is said to be the longest in southeast Asia. Building the large structure within the 1,800-day deadline presented a significant challenge.

WORKING WITH BRITTLE, LOOSE SOIL

As PT Hutama Karya began to validate the design of Semantok Dam for construction, they quickly discovered the unusual terrain presented various problems. The consultant engineers initially developed a grouting system as the foundation for the main part of the dam, however, Hutama Karya discovered the brittle and loose sandy soil layer would cause persistent water leaks over the maximum amount permitted. As a result, PT Hutama Karya needed to undertake soil analysis to determine alternative design methods and ensure the dam would be strong enough to contain water from intense rains without flooding.

In the design phase, the engineers planned to use rock fills for the primary material for the dam. Though innovative, that plan became tough to accomplish, as the nearby quarry could not produce enough rock for the long dam without deep, damaging excavation. Since creating a quarry off site would be cost-prohibitive, PT Hutama Karya opted to use random soil in the area as fill material, which required redesigning the dam slope as the soil would perform differently than rock fills. The organization also wanted to employ real-time, remote monitoring to gain a holistic overview of the project and improve decision-making and safety. "As a national strategic project, the Semantok Dam's stakeholders were very concerned with output and outcomes in all project phases. We are constantly reminded that building a dam is also building the risk of disaster, so all possible innovation to mitigate the risks should be considered," said Akhyaarul Azzaqy, project manager at PT Hutama Karya.

PROJECT SUMMARY

ORGANIZATION
PT Hutama Karya (Persero)

SOLUTION
Geotechnical

LOCATION
Nganjuk, East Java, Indonesia

PROJECT OBJECTIVES
- To develop an unusually long dam to control flooding and irrigation in East Java.
- To determine how to incorporate sandy soil as a fill material while ensuring operational safety.

PROJECT PLAYBOOK
ContextCapture™, GeoStudio®, PLAXIS®, SYNCHRO™

FAST FACTS
- PT Hutama Karya needed to build a 3.1-kilometer-long dam with a capacity of 33 million cubic meters of water – said to be one of the longest in South East Asia.
- The team wanted to incorporate soil as fill material for the dam, but they had to ensure the structure's safety.
- They determined reality modeling and geotechnical analysis could help them develop the best possible design for the site's conditions.

ROI
- Adjusting the slope design to ensure strength and safety helped the organization avoid an estimated USD 1.8 million in rework while ensuring continued safety.
- Geotechnical analysis eliminated the need to construct a grouting foundation and reconstruct the secant pile, saving USD 2 million.
- Using SYNCHRO to define each step of construction and gain a holistic view of the project improved efficiency by 183 days, saving USD 646,000.

"Our BIM innovation using Bentley applications [on the] Semantok Dam has not only assisted us in solving engineering problems, but also created a more sustainable infrastructure towards a healthier environment, human welfare, and economic growth."

– Amy Rachmadhani Widyastuti, BIM Development Manager, PT Hutama Karya (Persero)

Adjusting the slope design to ensure strength and safety helped the organization avoid an estimated USD 1.8 million in rework while ensuring continued safety. *Image courtesy of PT Hutama Karya (Persero).*

Geotechnical analysis eliminated the need to construct a grouting foundation and reconstruct the secant pile, saving USD 2 million. *Image courtesy of PT Hutama Karya (Persero).*

GOING DIGITAL TO OPTIMIZE DESIGN

PT Hutama Karya determined that they could solve their design issues and optimize the dam by using reality modeling and geotechnical design applications from Bentley and Seequent, The Bentley Subsurface Company. They first undertook a laser scan of the project area, created point clouds, and molded them into a digital replica of the site by using ContextCapture. The digital replica helped the project team understand the existing condition of the field and plan local quarry locations, minimizing the excavation depth to limit the impact on the environment. The team then imported reality modeling data into their bespoke project management information system, giving the project manager insight into real-time conditions.

Next, the organization then augmented the reality model with geotechnical analysis via PLAXIS, enabling them to simulate foundation options and test the groundwater flow. PLAXIS enabled them to model soil fill within the proposed dam design and test its performance within the area's terrain. Though the initial slope design did not meet safety requirements, they used GeoStudio to evaluate other slope designs, eventually realizing that a greater slope on the left side of 1:3 combined with a lesser slope of 1:2.75 on the right side would meet safety requirements for both construction and operations while incorporating the sandy soil as fill. "It is true that the main dam body design will be wider than the initial design, but we will not need to excavate the substructure as deep as the initial design, since the foundation bearing capacity is adequate enough," said Azzaqy. Lastly, to ensure the changes to the design would not impact the tight deadline, PT Hutama Karya simulated the construction with SYNCHRO. In addition to testing the construction feasibility of the new design, the application helped them plan the construction process.

IMPROVING DECISION-MAKING SAVES TIME AND MONEY

Creating a reality model of the project area helped the design team understand the terrain and plan the quarry. They produced the model with point cloud data in three days, almost three times faster than the eight days that conventional methods would require for design validation. Real-time data produced by the combined reality model and PT Hutama Karya's planning system enabled the project manager to improve construction planning and decision-making. The organization regularly updated the survey data and combined it with geospatial data and the BIM, creating a true digital twin during construction. Harnessing that data to help define each step of construction and gain a holistic view of the overall project improved efficiency by 183 days, saving USD 646,000 while improving the quality of the dam.

Using geotechnical analysis to determine how to safely construct the dam by using soil as the fill material significantly improved construction efficiency. The analysis also helped them develop alternative methods for safely strengthening the dam's substructure, including deepening the dam trench, cutting off the wall systems with a secant pile, and applying support blankets and liners of clay. As a result, PT Hutama Karya eliminated the need to construct a grouting foundation and reconstruct the secant pile, saving USD 2 million. Additionally, adjusting the slope design to ensure strength and safety helped the organization avoid an estimated USD 1.8 million in rework, while ensuring continued safety. "Our digital construction innovation using Bentley products [on the] Semantok Dam has not only assisted us in solving the engineering problems with high-accuracy data, but also created a more sustainable infrastructure towards a healthier environment, improved well-being, and boosted economic growth," said Rachmadhani Widyastuti.