GMI SA Ingenieros Consultores Saves $50,000 in Water System Design Costs, Enhances Efficency of Workflows Using Bentley Software

PROJECT SUMMARY

Project:
Peru Cerro Verde Mine

Organization:
GMI SA Ingenieros Consultores

Project Objective:
Permanent freshwater supply for the new concentrator process

Be Awards Category:
Plant Structural Analysis, Design and Documentation

Software Used:
HAMMER® and Bentley AutoPIPE®

FAST FACTS

- The new freshwater system comprises an enhanced Rio Chili intake structure, three new pumping stations to supplement or supplant three existing stations, a sludge treatment plant, a water treatment system, and overland pipelines to the freshwater storage tank inside the concentrator facility.
- GMI had to prove it could decrease the number of man-hours usually budgeted to create drawings, calculations, and other project documents. To ensure its efficiency, GMI turned to new technologies, primarily Bentley's HAMMER and Bentley AutoPIPE.
- GMI saved approximately $50,000 on the project and was assured it could meet the engineering project's deadline by using HAMMER and Bentley AutoPIPE.

Peru's Cerro Verde mine, located 20 kilometers south of Arequipa, is a rich source of copper and molybdenum. Its principal owner-operator, Sociedad Minera Cerro Verde, replaced the mine's ore processing system with a concentrator that will triple copper production, significantly increase molybdenum production, and extend the useful life of the mine by 19 years. However, the new concentrator uses the primary sulfide method and separates copper and molybdenum concentrates by differential flotation. As a result, it required more freshwater than the site's existing water system could provide.

GMI SA Ingenieros Consultores won the contract to develop the basic and detailed engineering for a permanent freshwater supply for the new concentrator process. As part of the bidding process, GMI had to prove it could decrease the number of man-hours usually budgeted to create drawings, calculations, and other documents for this kind of project. To ensure its efficiency, GMI turned to new technologies, primarily Bentley's HAMMER® and Bentley AutoPIPE®.

A key project goal was to establish an efficient water supply system for the new primary sulfide plant while maintaining the water supply to the old plant facilities, limiting the impact to the mining operation. A second project goal was to prevent water hammer (fluctuations caused by a sudden increase or decrease in flow velocity) in the pipelines.

The mine's previous water supply system ran from an intake pumping station on the Rio Chili, about 10 kilometers from the Cerro Verde mine. That system pumped river water to two settling tanks to remove solids. The water then passed through two other pumping stations before it reached the mine. The new freshwater system comprises an enhanced Rio Chili intake structure, three new pumping stations to supplement or supplant three existing stations, a sludge treatment plant, a water treatment system, and overland pipelines to the freshwater storage tank inside the concentrator facility.

GMI expanded the old system by adding a new collection pump station (PS1A) that conveys freshwater to the water treatment plant. The plant's three parallel pumps take the water to a second new pump station (PS2A) where its discharge joins the discharge of the old pump station (PS2). The water is then carried through a pipeline composed of two parallel lines (12-inch and 24-inch, respectively). GMI designed a cross connection to join the two lines, creating a 30-inch pipeline toward the third new station (PS3A). The water will then be discharged to a storage tank located at the concentrator plant.

A team of 25 engineers performed the engineering for the Rio Chili pumping and pipeline system expansion. The services that GMI provided included architectural, geotechnical, civil, structural, mechanical, piping, and electrical engineering, and instrumentation design. It performed hydraulic calculations and transient analysis for all pump stations, reviewed the pipe sizing of overland pipelines, and supplied all documentation, which included drawings, calculations, installation specifications, and tender documents to obtain construction bids.

To prevent water hammer, GMI used HAMMER to perform highly accurate transient analysis. On past projects, GMI typically used spreadsheets to perform basic calculations, but the calculations provided only maximum values for pressure and water forces and often led to an overestimation in the design requirements. Lacking software to calculate transient pressures and forces, GMI could easily end up developing designs that were too conservative and, therefore, unnecessarily expensive.

Armed with the data provided by transient analysis, GMI was able to recommend specific devices to protect against transient events and assure normal operation of the pumping facilities. Moreover, these recommendations included only what was necessary to avoid any risk of damage to the system.

"Bentley technology enabled us to easily perform all the special calculations required for the project…and allowed us to check design results more directly"

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Similarly, GMI had previously relied on spreadsheets to calculate pipe stresses. Using Bentley AutoPIPE software on this project, GMI performed piping stress analysis and determined pipe sizing and the supports and anchors that were required. The software displayed the expected forces and reactions, and enabled the engineers to export those values for structural calculations.

The Bentley AutoPIPE model provided GMI with the support arrangement for the entire pipeline and could easily be exported to AutoCAD. In AutoCAD, GMI checked deviations and updated the drawings.

Using Bentley AutoPIPE, GMI determined the necessary support and anchor arrangement, minimizing volumes of concrete and the number of supports. By minimizing forces related to anchors, supports, and equipment, GMI achieved an economical installation and assured proper operation of the equipment.

Again using Bentley AutoPIPE, GMI was able to introduce more realistic (that is, not absolutely rigid) frame supports. The supports' modeled behavior when subject to displacements, forces, and reactions was more realistic using Bentley AutoPIPE. Clearly, this data saved GMI many reworks, since the induced displacement of supports is considered in the AutoPIPE model. Without this option, GMI would have had to input the support reaction forces to other software, potentially designing overly expensive supports.

By using stress analysis software with the AutoPIPE model, GMI accounted for dynamic effects such as wind or seismic movement, taking into account the relevant code requirements. AutoPIPE also gave GMI the ability to consider the effect of soil covering the pipeline. Given some basic soil properties, the software determines its effect on the pipe. This allows GMI to obtain valuable information by inputting soil properties into the model.

In addition, GMI used modal analysis, another Bentley AutoPIPE feature, to assure a natural resonance frequency of the system that was different from the pump motor frequency. This is another benefit of Bentley AutoPIPE's inclusion of the support system as well as the pipes in its model.

"Bentley technology enabled us to easily perform all the special calculations required for the project, where on previous projects we had to contract with external consultants in order to deliver these engineering services," said Esteban Rios Pita, mechanical engineer with GMI S.A., in charge of the engineering portion of the project. "In addition, Bentley software allowed us to check design results more directly."

Rios Pita continued, "Moreover, the stress analysis workflow became more efficient, and we shaved man-hours off design and reworks, with the time budgeted for the work being more than adequate. In fact, we tried several piping arrangement scenarios and chose the most efficient one in terms of feasibility, cost, and constructability. We also tried designs incorporating different material specifications to determine the proper pipe thickness."

GMI SA Ingenieros Consultores developed the engineering for a permanent freshwater supply for the new concentrator process which will triple copper production.

Anchor block calculations were executed by the civil engineers, and the reaction forces and moments were determined by piping-stress engineers. GMI took the information from Bentley AutoPIPE and exported it to an Access file, including all workable combinations according to the scenario under analysis. It was then able to customize reports and filter the main alternatives according to the applicable code.

Next, GMI delivered the Access file to the civil engineers, who used the values to design anchor blocks, while considering sustained and occasional loads. This increased efficiency, since it was easier for civil engineers to detect applicable loads and identify the anchor position inside the pipe model.

The same procedure was used for support calculations. The type of support used was identified in the exported AutoCAD file, and the forces were taken from the Access database. These values were used to design steel and concrete infrastructure.

In short, by adopting the new technologies in HAMMER and Bentley AutoPIPE, GMI produced engineering drawings faster than otherwise possible. And, because GMI created a tabulated database for reactions, moments and forces, it was able to perform anchor and support calculations in less time. Ultimately, by using HAMMER and Bentley AutoPIPE, GMI saved approximately $50,000 on the project and was assured it could meet the engineering project's deadline.

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