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Advancing Infrastructure

CASE STUDY

L&T Construction Creates India's Largest Wastewater Treatment Plant to Help Clean the Yamuna River

Structural Analysis and Design with STAAD® Helped Develop Strong Foundations for Complex Tank Systems over Unstable Soil

TREATING A SACRED RIVER

New Delhi is not only the capital of India, but it has also been one of the country's most significant cities for over a century. Founded in 1911 as the new seat of government, it took 20 years to build the city's grand architecture, which blends British classical and traditional Indian styles. After India gained its independence in 1947, New Delhi has grown to become the largest center of commerce in northern India.

Despite the city's status and continued development, it has long suffered from significant pollution. In particular, the Yamuna River, which runs through the city and is considered sacred by Hindus, suffered from massive amounts of sewage. Though the city did have a wastewater treatment plant in the area, it became obsolete and drained wastewater into the river without treatment.

As part of the local government's efforts to fight pollution in the city, they moved to replace the current wastewater plant with the Coronation Pillar Wastewater Treatment Plant. The INR 5.15 billion facility can treat 318 million liters of sewage per day, making it the largest wastewater plant in India. L&T Construction assumed design, construction, and operation duties. "By replacing the old plant, we aim to improve the overall efficiency and effectiveness of sewage treatment, ensuring responsible disposal of treated water into Yamuna River," said Mathimaran M, senior engineering manager at L&T Construction.

COMPLEX TANKS FOR INNOVATIVE TECHNOLOGY

The new wastewater facility goes far beyond simply eliminating the flaws and degraded performance of its predecessor. Coronation Pillar incorporates the anaerobic-anoxic-aerobic (A2O) process, which moves wastewater through a series of three tanks to remove nitrogen, phosphorus, and other biological elements. The process can treat water faster and more cost-effectively than other methods. Additionally, the plant incorporates a 3-megawatt biogas power generation facility, which generates carbon-free electricity directly from treatment biproducts to meet 70% of the plant's power requirements.

However, L&T Construction quickly determined that incorporating these innovative technologies could become difficult. As available space was limited and much of the facility lies underground, they initially struggled to place and connect each element. The tanks and framed structures formed complex geometries, making structural analysis a challenge. "Prior to adopting STAAD, manual spreadsheets were used for analysis, but they did not yield satisfactory results for combined tank and frame structures," said Mathimaran. "Manual analysis struggled to simulate the behavior of the combined structure effectively." Additionally, the design team discovered that the soil on the site was prone to liquefaction and excessive settlement due to earthquakes, which required using numerous and relatively expensive vibro stone columns for support. L&T Construction had to move beyond traditional methods to ensure a safe, effective structural design for the wastewater plant.

PREDICTING BEHAVIORS OF COMPLEX SHAPES

A longtime user of Bentley applications, L&T Construction knew that they could advance to digital design and analysis with STAAD. They used the application to determine how to develop effective structural support for the unusually shaped elements, as well as incorporate all components in a single area, rather than build the power generator on an adjacent site. Since the bioreactor consists of eight parts connected with

PROJECT SUMMARY

ORGANIZATION
L&T Construction

SOLUTION
Structural Engineering

LOCATION
New Dehli, India

PROJECT OBJECTIVES
- To construct India's largest wastewater plant and reduce water pollution in New Dehli.
- To create a structural design that could accommodate new technology in a tight space.

PROJECT PLAYBOOK
STAAD

FAST FACTS

- The INR 5.15 billion Coronation Pillar Wastewater Treatment Plant uses A2O technology to treat 318 million liters of sewage per day.
- Limited space, unstable soil, and unusual tank designs made designing support structures challenging.
- L&T Construction used STAAD for structural design and analysis, helping them determine the best foundations and framing.

ROI

- By determining how to support all elements on a single plot of land, L&T Construction reduced the project footprint by 32,400 square meters.
- Digital structural analysis determined how to lower the number of vibro stone columns needed to safely support the facility, reducing costs by 5%.
- L&T Construction's digital workflows streamlined structural design and reduced the overall time needed for design and analysis by 10%.

"STAAD improved the quality of deliverables by generating comprehensive reports, detailed calculations, diagrams, and drawings. This has enhanced communication of design intent to the assessors."

– Mathimaran M, Senior Engineering Manager, L&T Construction

expansion joints, L&T Construction used STAAD to capture the structural influences of the joints along with the conditions of the numerous interior partition walls, then analyze their combined behavior under a variety of loads. "Manual design yielded results that failed to reflect actual scenarios due to the absence of precise codes and manuals for matching boundary conditions and load patterns," said Mathimaran. As a result of the analysis, they determined that a wall footing and grade slab would provide better performance than a regular raft foundation.

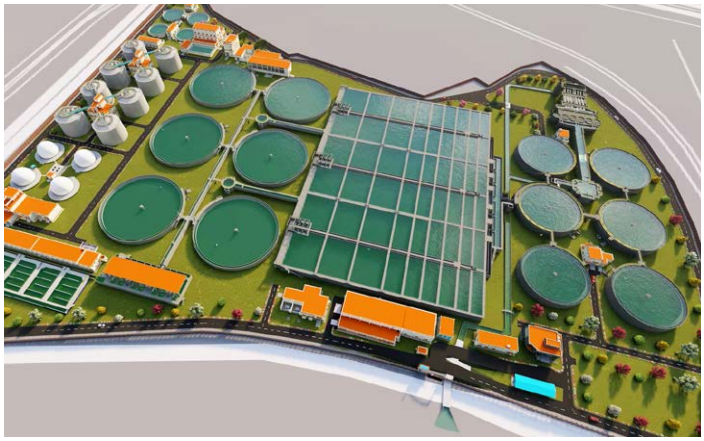
The wastewater treatment tanks include sludge digesters, which are circular tanks with conical domes on top. Manual methods could not accurately predict the behavior of this design, as the top of the circular wall was fixed due to the dome. By using STAAD's finite element analysis and modeling capabilities, the team obtained accurate structural behavior results and used them to optimize structural component sizes. L&T Construction also used the application to account for the stiffness of the walls and columns together instead of separately, reducing stress and movement on the raft foundation.

IMPROVING DESIGNS WHILE SHRINKING THE FOOTPRINT

By incorporating the bioreactor in the same plot of land with the rest of the plant components, they no longer needed to build on a secondary plot of land totaling 32,400 square meters. "STAAD software was influential in achieving land savings of 17.8% in a city like Delhi, where land is an extremely expensive capital," said Mathimaran. Using a single site also eliminated the various pipes, cabling, and other connections necessary to bridge the 80-meter gap between the proposed secondary site and the main plant site. In addition to significantly reducing the footprint of the plant, the digital structural analysis and design also lowered the number of vibro stone columns needed to safely support the facility, reducing costs by 5%. By using digital analysis, designers quickly evaluated multiple design options and determined the safest, most economical structural size, lowering the amount of time needed by 75%, compared to manual options.

With STAAD's finite element modeling, L&T Construction streamlined structural design and reduced the overall time needed for design and analysis by 10%. In the process, the team improved the quality of deliverables and produced clear reports and drawings that improved the communication of design intent to stakeholders. "[Visualization] fosters effective coordination and communication within project teams, enhancing overall project efficiency and success," said Mathimaran. Coronation Pillar Wastewater Treatment Plant was completed in 2023 and is providing more reliable drinking water while greatly lowering pollution in the Yamuna River. Its biogas generator greatly reduces the plant's reliance on the New Dehli grid, eliminating the equivalent of 14,450 tons of carbon dioxide emissions per year.

By determining how to support all elements on a single plot of land, L&T Construction reduced the project footprint by 32,400 square meters.



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