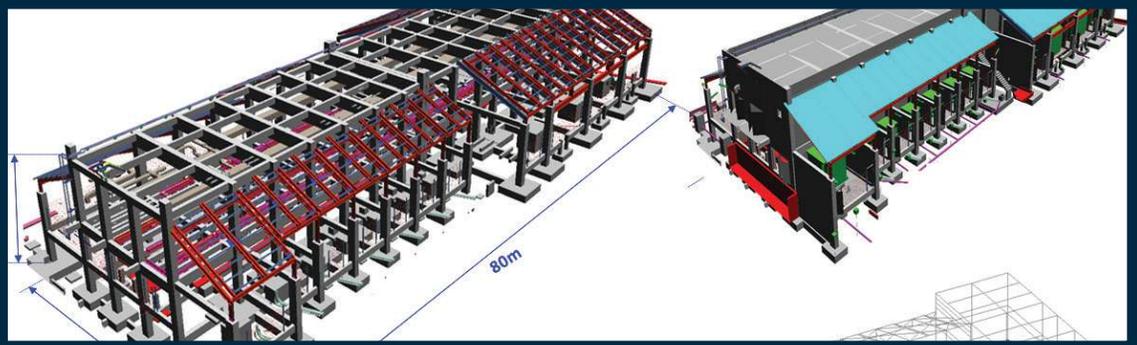


**Bentley**  
Advancing Infrastructure



## Project Summary

### Organization

Toyo Engineering

### Solution

Manufacturing

### Location

Malaysia

### Project Objectives

- Deliver a large-scale, steam cracker complex in Malaysia.
- Complete conceptual and detail design within an 18-month timeframe.
- Design concrete plant structures in compliance with European codes with Malaysian annexures.

### Products Used

STAAD.Pro®, STAAD® Advanced Concrete Design

## Fast Facts

- Toyo implemented integrated engineering and analysis processes to deliver its largest ethylene plant project located in Malaysia.
- Bentley software's seamless integration optimized engineering and design of RCC structures, ensuring process standardization and uniformity of deliverables.
- Toyo applied advanced engineering design codes using Bentley technology to comply with new European standard codes consistent with local design regulations.

## ROI

- Bentley's technology enabled the team to complete the project within 18 months.
- Performing iterative and complex design checks and synchronizing drawings saved 30 percent in engineering hours.
- The integrated workflow facilitated design optioneering and enabled parallel work on site to save 10 percent in construction time.

# Toyo Pioneers STAAD Advanced Concrete Design to Deliver Its Largest Ethylene Plant Project

Bentley's Integrated STAAD Technology Reduced Engineering Time by 30 Percent and Set New Concrete Standards

## Malaysia's Massive Petrochemical Initiative

Having constructed more than 40 greenfield ethylene plants worldwide, Toyo Engineering (Toyo), a global leader in engineering and construction for industrial facilities, was awarded a contract to deliver a large scale steam cracker complex in Malaysia. The plant is an integrated refinery and petrochemicals project. It is the largest liquid-based greenfield downstream in Malaysia, and a petrochemical complex capable of producing ethylene used to manufacture polymers that are found in many industrial and consumer markets.

Toyo was responsible for the detailed engineering, procurement of equipment and materials, construction, and commissioning of the facility on a turnkey basis. To design the complex required detailed engineering across multiple disciplines that were globally dispersed. To meet quality requirements in compliance with strict local and European design codes, optimize engineering analysis, and ensure design accuracy on a tight timeline, Toyo required integrated and automated workflows and processes to deliver its largest ethylene plant project.

## Integrated Technology Streamlines Workflows

Given the sheer size of the project, the ethylene plant required complex engineering analysis for various structural elements ranging from pipe racks and buildings, to equipment and associated infrastructure facilities. Different design disciplines needed to collaborate in real time across multiple locations in a coordinated environment to ensure standardization in the quality and formats of the deliverables. The seamless integration of Bentley's STAAD.Pro and STAAD Advanced Concrete Design 3D structural analysis and design applications enabled the multidiscipline project team to simultaneously share synchronized model data and update designs and drawings in one integrated set of applications. The solution allowed for iterative, multidiscipline design checks among the team, enhancing design productivity and streamlining workflows to reduce duplication of effort and eliminate errors.

Using Bentley's integrated structural design applications accelerated the entire workflow by 30 percent while ensuring standardization of processes and uniformity of deliverables across multiple locations. The innovative solution enhanced consistency and quality of the designs, drawings, and reports. Stated Ajay Marathe, lead engineer, civil and structural, Toyo Engineering, "Iterative and complex design checks were possible with a single run. This synchronized the delivery of drawings, which resulted in a 30 percent reduction in resource hours." The integrated workflow also facilitated design optioneering for optimal selection of construction material and enabled parallel work on site to save 10 percent in construction time.

## Automation Optimizes Accuracy and Efficiency

Bentley's structural design and analysis applications not only provided a collaborative work environment, but also automated otherwise manual tasks. The team needed to perform checks related to sizing, design, crack width, stress levels, and buoyancy, among others, using more than 700 different load combinations simultaneously to determine the overall behavior in each of these combinations. Using STAAD Advanced Concrete Design the team generated on-demand reports at various levels of detail to efficiently understand the concrete behavior subject to the varying loads. This cutting-edge technology enabled Toyo to quickly define the load combinations, iteratively check the design, and automatically adjust the sizing of the foundation in accordance with each of the load criteria.

Like many industrial structures, the ethylene plant contained columns with transverse and longitudinal beams at different levels, requiring engineers to take specific precautions and perform tedious calculations to ensure design accuracy of the columns. STAAD Advanced Concrete Design's "Merge Levels" command managed these variations automatically, saving significant time for engineers and minimizing potential error resulting from an otherwise manual calculation. Similarly, the team was able to perform design checks on the concrete to prescribed crack width limits at the click of a button while ensuring the highest level of accuracy in the computations.

*“Seamless integration of STAAD.Pro and STAAD Advanced Concrete Design has completely turned around the detailed engineering of RCC structures, delivering automation, accuracy and consistency.”*

*– Ajay Marathe, Lead Engineer  
– Civil & Structural,  
Toyo Engineering*

**Find out about Bentley at: [www.bentley.com](http://www.bentley.com)**

**Contact Bentley**  
1-800-BENTLEY (1-800-236-8539)  
Outside the US +1 610-458-5000

**Global Office Listings**  
[www.bentley.com/contact](http://www.bentley.com/contact)

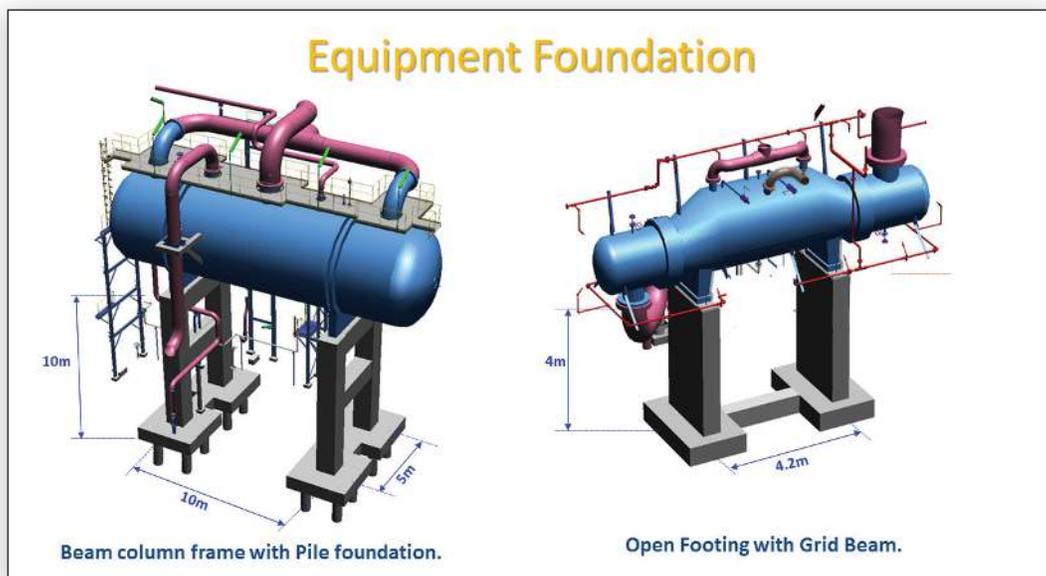
Using STAAD Advanced Concrete Design to design and detail the beams for bi-axial and axial force allowed Toyo to introduce top and bottom reinforcement across the length of the beam. The software checked the bi-axial behavior and automatically generated 3D interaction charts for the suggested reinforcement profile. The ability for Toyo to automate engineering calculations, drawing production, and report generation optimized design accuracy and efficiency that helped the team complete the conceptual design and detailed engineering within 18 months, and obtain early approval by the client.

### **Setting New Country Standards for Concrete Design**

One of the unique challenges facing Toyo was designing the ethylene complex to meet new European standards in combination with current local Malaysian codes, the Malaysian Annexure. Given that European standards were new in Malaysia, there was no precedent for applying these

codes, which also mandated different material safety factors for different types of load combinations. The team was also confronted with having no applications available that catered to the Malaysian Annexure.

Working collaboratively with Bentley’s development team, Toyo developed and applied the new European standard codes consistent with local Malaysian regulations. This enabled the engineers to deliver the project within the tight timeframe, consistent with Toyo’s high standards. STAAD Advanced Concrete Design’s built-in feature for designing foundations within varying safe bearing capacities enumerated in the European standard codes accelerated design and eliminated potential noncompliance. Using STAAD Advanced Concrete Design facilitated concrete design in compliance with the European standard codes as per the Malaysian Annexure. The team developed new European standard codes for Malaysia, delivering the first project that applied advanced engineering design codes in the country and setting new country standards for concrete design.



*Effective utilization of STAAD Advance Concrete Design creates a one-stop solution for RCC Design.*