Bentley®
Advancing Infrastructure

CASE STUDY

Hyundai Engineering Leverages 3D Modeling and AI to Automate Design of Civil and Architectural Structures

Using STAAD® Accelerates FEED by 30% and Significantly Reduces Outsourcing Costs

DEVELOPING STRUCTURAL DESIGN AUTOMATION PROGRAMS

To minimize time spent on simple repetitive engineering tasks and allow engineers to focus on quality and creative engineering, Hyundai Engineering initiated a project to develop an automated design system for plant steel structures. "In particular, we aimed to effectively respond to frequent design changes by developing a program for design information exchange between relevant departments and automatic designs for steel frame construction planning of chemical and electric power plants," said Kim Dongwon, manager of the smart plant technology team at Hyundai Engineering. They focused their efforts on shelter and pipe rack designs for these plants, seeking to streamline information exchange and automate design processes using artificial intelligence (AI) and machine learning.

Hyundai Engineering designed shelter structures that are one to three levels high where various mechanical devices are temporarily or permanently located in plant projects. Pipe racks are raised structures used in industrial facilities to support pipes, conduits, and cable trays. Both elements play a critical role in industrial plant design. As the plant design process typically involves multiple engineering changes throughout the design stage, revisions to the shelter and pipe rack designs are necessary to meet the modified plant design specifications. To help simplify and accelerate structural design methods, as well as meet evolving demands, and other emerging industries, Hyundai Engineering is researching and developing AI-based design automation technology.

MANUAL WORKFLOWS, COLLABORATION, AND CHANGE MANAGEMENT

The general structural design workflow for industrial plants typically involves engineers using a structural analysis program and manually entering design conditions and loads to conduct structural analysis. This process involves time-consuming, manual data entry for the application, and calculation of structural loads that is error-prone, resulting in countless design changes. "This process was a very tedious and complicated one, requiring enough time to review human errors, which led to an increase in task burdens that were amplified along with the change of designs," said Dongwon. Standardization also becomes difficult due to the need for subjective judgment of designers, depending on the structure and the varying design criteria for each project. The lack of standardization and frequent design changes result in increased time and costs to deliver a project.

Hyundai Engineering realized that to optimize change management and industrial plant project execution, they required crucial collaboration among piping, electrical, instrumentation, and mechanical disciplines. The collaboration is important because the information derived from these disciplines substantially contributes to the structural design aspects for civil and architectural infrastructure. "Constant revisions led to registrations of design information (e.g., pipe weight) and examinations and updates of the changes from multiple teams; sometimes, the same work [had to] be repeated," said Dongwon. The smart technology team sought to standardize and streamline plant engineering

PROJECT SUMMARY

ORGANIZATION
Hyundai Engineering

SOLUTION
Structural Engineering

LOCATION
Seoul, South Korea

PROJECT OBJECTIVES
- To integrate 3D modeling with artificial intelligence to automate civil engineering structural design processes.
- To develop a smart digital system that can be used throughout the future of engineering plant design.

PROJECT PLAYBOOK
STAAD

FAST FACTS

- Hyundai Engineering is automating shelter and pipe rack designs for industrial plants to improve change management and construction planning.
- The project required cohesive integration among diverse disciplines, standardizing and automating previous manual workflows.
- The smart technology team combined STAAD and AI to incorporate automation, prediction, and optimization into plant engineering processes.

ROI

- STAAD reduced design and analysis time by 30% to 60%.
- Design automation is estimated to save USD 1,931,811 in outsourcing costs.
- Through AI and machine learning, Hyundai Engineering generated 27 million prediction models from a database of 1,680 design cases.

"The automated civil engineering construction design system provides more efficient and accurate design information and plays a crucial role in improving the performance of structures."

– Kim Dongwon, Manager of the Smart Plant Technology Team, Hyundai Engineering

workflows by using intelligent digital solutions to cohesively integrate diverse disciplines, automate designs, and eliminate repetitive tasks for steel frame construction planning of industrial plants.

ADVANCING STAAD APPLICATION WITH MACHINE LEARNING

Partnering with Bentley, Hyundai Engineering selected STAAD to integrate 3D modeling and AI, automating and streamlining design workflows and creating designs through machine learning predictions. They began with developing an automatic design system for steel structures, focusing on pipe racks and shelters. The design process encompassed structural components, such as cables and trusses, as well as structural member connections. Therefore, the team was required to integrate data, such as weight, for the plumbing, mechanical, and instrument teams into the 3D model. Hyundai Engineering used STAAD and incorporated an AI-based algorithm that eliminated manual data entry and automatically imported the weight and/or other relevant data for the different disciplines into the model, creating an automated design program. "When such data is synchronized to the automation program, the weights, such as pipe load and cable tray load, are applied automatically to the STAAD model," said Dongwon. "The design work that was conducted by the individual engineer can now be digitalized and managed through a unified best practice."

The AI-based structural design begins with automated shelter modeling, progresses to database construction, which can be tailored according to structural dimensions, and culminates by predicting recommendations for trusses, rolled beams, and/or column distances. Prior to automation, the shelter's roof structure was determined based on existing manual design estimations. However, after the automation process, countless scenarios can be digitally examined to determine the optimal roof system.

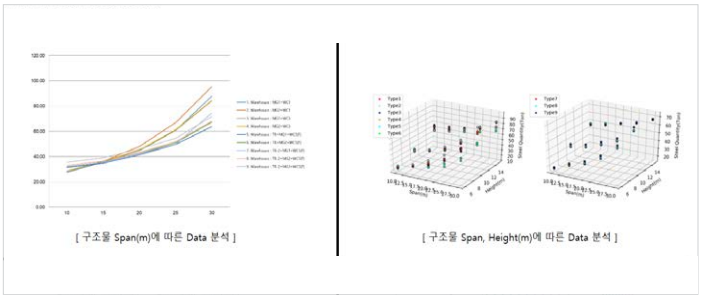
The 3D modeling and AI automation design program that Hyundai Engineering developed incorporates automation, prediction, and optimization processes into plant engineering practices, expanding Bentley's application through machine learning, actively utilizing digital technology from two engineering perspectives. "First, the design variables and results from the automation are established as a database and run for machine learning to be expanded as an AI design. Second, the design information that was exchanged as drawings and documents between relevant departments is now under unified management in the form of 3D model data," said Dongwon.

SMART TECHNOLOGY DRIVES SAVINGS AND STANDARDIZATION

Hyundai Engineering's newly developed smart design system for civil and architectural plant structures increased work efficiency, reducing the time spent by engineers on manual, repetitive tasks. The automated program saved design variables in a digital database, which, when combined with machine learning technology, led to the creation of a true AI design with the ability to produce identical results consistently through repeated tasks. "When an ultimate AI design is realized by using machine learning, the results can be deduced faster than when the engineer performs the task manually," said Dongwon. The result was a precise, integrated solution of 3D modeling with intelligent digital workflows that provided accurate design information and accelerated front-end engineering (FEED) design by at least 30%. It also optimized the volume of construction, reducing the construction design costs by over 20% by eliminating design-time errors. Based on 50 bidding projects, 25 FEED projects, and 20 execution projects over five years, Hyundai Engineering estimates saving almost USD 2 million in outsourcing costs.

The benefits of Hyundai Engineering's smart technology solution not only lie in accelerated workflows and cost reduction, but also in its capability for expansion and standardization, creating AI designs through machine learning predictions that can be used in future projects. Using the shelter AI-design automation program, the team created a database of 1,680 scenarios, generating 27 million prediction models. For pipe rack design, weight and geometry data within drawings and documents can be unified through a 3D model in a digital database, leading to streamlined, standardized, and intelligent design processes. "Now, engineers can determine their structure systems based on the database instilled with Hyundai Engineering's practice instead of relying on their personal experience and senses," said Dongwon.

Hyundai Engineering is automating shelter and pipe rack designs for industrial plants to improve change management and construction planning.



STAAD reduced design and analysis time by 30% to 60%.

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