

Atelier P.H.A. s.r.o.

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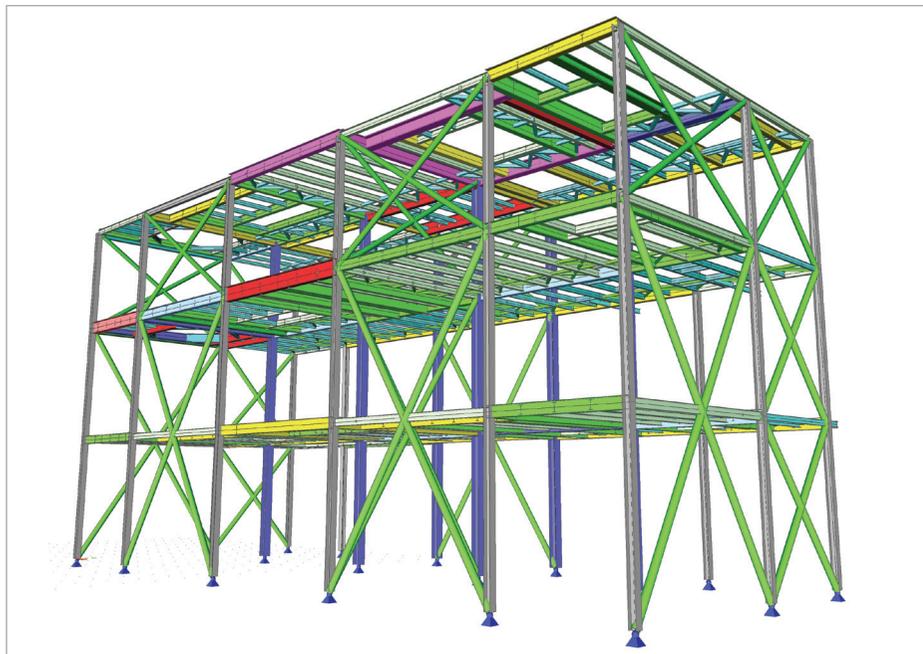
Atelier P.H.A. was founded in 1990. The structural engineering group has been a part of Atelier P.H.A. since 1994.

P.H.A. deals with design tasks, preparation and implementation of investment projects, engineering activities and is an expert in the field of construction and real estate investments. They prepare expert opinions and participate in the exploration of load-bearing structures in existing constructions. Participation in opinions carried out on structures after the 2002 flood, opinion on the condition and measures taken on load-bearing structures in industrial,

high-rise apartment buildings, apartment building regeneration, opinions on the impact of emergency situations - fires, flooding - on load-bearing structures, building passports during reconstruction etc.

P.H.A. can take part in cross-border projects in accordance with most standards: Eurocode, Fema-350, UBC97, СНИП and other specific national codes.

P.H.A. regularly participates in professional seminars, as well as structural engineer meetings and conferences, lectures and publications in professional newspapers.



Software: Scia Engineer

Extension of Procter & Gamble Plant - Dammam, Saudi Arabia

Building geometry and structural system

Total steel weight: 151 tons
Dimensions height: +16 m
Overall length: 26 m
Overall width: 10 m

The design was based on Eurocode standards. The structure is built inside the existing building and is prepared to support the structure for technological processes.

The static system of the structure is in transverse and longitudinal direction stabilized by bracings.

Design software

The static analysis was calculated using a 3D model in Scia Engineer with the Linear, Dynamic-seismic and Steel modules.

Foundations

The structural design of the basements was made by a local company based on the outputs of our analyses.

Wind loads

Wind load design was applied to the external surface of the building. There was no wind impact on the interior structure.

Technological loads

Technological loads were given by a mechanical part of the project. Weights of equipments were considered in two cases: a full and an empty one. These loads were combined for adverse effects on the structure. Horizontal forces in the model represented support-reactions of piping, bucket elevators and hoists.

Seismic loads

Seismic design was based on Eurocode EN1998
Parameters: Subsoil type - D

- Direction - horizontal
- Coeff accel. a_g - 0.4
- a_g - design acceleration - 3.92266
- q - behaviour factor - 4
- S soil factor - 1.35

Mass participated values were more than 90% so we could assume that the calculation included significant higher modes. Seismic load was input by elastic response spectrum using 121 eigenmodes until frequency 30 Hz.

Structural 3D modelling

The design process has been worked out in Scia Engineer. The structure has been completely modelled by 14.633 1D beam elements in 3D. Technology, live, dead and seismic loads have been applied to the load-bearing structure.

The calculation included several steps:

1. A linear calculation using a 3D frame model for the gravity loads (self weight, dead load, live load, technological load).
2. A dynamic-seismic analysis using a CQC type of the evaluation with a 5% damping.
3. A check of steel elements using a steel module for gravity load. The check of steel elements for seismic loads was calculated separately according to EC8.

Parameters of the structure were modified step by step according to the technological demand. The static system of the building is formed by frames with concentric diagonal bracings (dissipative zones in tension diagonals only) in transverse and longitudinal direction.

The system of bracing was an active tension diagonal bracing, in which the horizontal forces can be resisted by the tension diagonals only, neglecting the compression ones.

Conclusion

It was necessary to check a lot of different possibilities to find an optimised and economical solution. The project has been successfully completed and has become operational.

Project information

Owner Procter & Gamble
Architect Chemoprag 3D
Engineering Office Atelier P.H.A. s.r.o.
Construction Period From January 2009 to February 2010
Location Dammam, Saudi Arabia



Short project description

This project represents an extension of the P&G plant of Dammam, Saudi Arabia. The building is designed to produce industrial agglomerates. The dimensions are 26 m x 10 m and the building is 3 storeys high. The main challenge of the project was the coordination of technology and seismic dimensioning according to the Eurocode and the local Saudi Arabia code. The static system of the building is formed by frames with concentric diagonal bracings in transverse and longitudinal direction. The static analysis was performed using a 3D model realized in Scia Engineer to optimize the weight of the load-bearing steel structure.

