

## 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 - Cairo, Egypt

### Building geometry and structural system

- Total steel weight: 278 tons
- Dimensions: Height: +16 m
- Overall length: 36 m
- Overall width: 23 m

The design was based on Eurocode standards. The static system of the structure is in transverse and longitudinal direction stabilized by bracing.

### Design software

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

### Foundations

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

### Wind loads

The wind load design was based on Uniform Building Code, vol. 2. and modified to the local Egyptian code

- Wind basic speed 145 km/h
- Wind pressure 0.996 kN/m<sup>2</sup>

### Technological loads

The technological load was given by a mechanical part of the project. The weight of the equipment is 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

The seismic design was based on Eurocode EN1998 The parametres:

- Subsoil type - D
- Direction - Horizontal
- Coeff. accel. ag - 0.4
- ag - design acceleration - 3.92266
- q - behaviour factor - 4
- S soil factor - 1.35

The mass participated values were more than 90% so we could assume that the calculation included higher significant modes. The seismic load was input by the

elastic response spectrum using 121 eigenmodes until frequency value 30 Hz.

### Structural 3D modelling

The design process has been worked out in Scia Engineer. The structure has been completely modelled with 26.606 1D beam elements in 3D. Technology, live, dead and seismic loads have been applied to the load-bearing structure.

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 demands. The static system of the building is formed by frames with concentric diagonal bracing (dissipative zones in tension diagonals only) in transverse and longitudinal direction.

The systems of bracing were active tension diagonal bracings, 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 March 2010  
Location Cairo, Egypt



## Short project description

*This project relates to the extension of the P&G plant of Cairo, Egypt. The building is designed to produce industrial agglomerates. The dimensions of this structure are 36 m x 23 m and it is 3 storeys high. The main challenge of the project was the coordination of the technology and the seismic stress check according to the Eurocode adapted to the local Egyptian code. The static system of the building is formed by frames with concentric diagonal bracing in transverse and longitudinal direction. The static analysis was performed using a 3D model in Scia Engineer to optimize the weight of the load-bearing steel structure.*

