

PROJECT SUMMARY

Project Overview:

Rehabilitation of the Grand Palais

Organization:

EPMOC (Public Contracting Authority for Cultural Works)

Location:

Paris, France

Project Manager:

Perrot and Roubert Agencies

Design Office:

SETEC

Software Used:

STAAD.Pro®

HISTORIC MONUMENT REVITALIZED

RICH TRADITION OF THE GRAND PALAIS MAINTAINED WITH USE OF MODERN TECHNOLOGY

When it was completed for the World Fair in 1900, the Grand Palais was a feat of technology for its time offering a very large glass covered area without intermediary supports. The highly decorated framework weighed 5,500 tons and took 3 years to complete (1898 to 1900). Its architects, Deglane, Louvet and Thomas were confronted with a complex order: to design a palace with monumental proportions in the historical environment of the Champs-Élysées. This palace would be used at the same time as a lounge for the Fine Arts, a show room for agricultural machinery and cars and as a track for horse shows.

jet grouted columns (2100 of them ranging from 1.0m-1.40m in diameter). To transmit these loads, the soles in masonry walls are surrounded by armed concrete blocks secured by pre-stressed DYWIDAG Bars. The bars are installed in cement grouted metal sheaths to ensure proper corrosion protection. The slurry trench walls consist of nine 500m² panels each 0.82m thick with a height between 15-19m.

EIFFEL and DSI France performed the complete installation of the pre-stressing system (installation and grouting) with all the difficulties that such a

FAST FACTS

- The Grand Palais was originally completed in 1900 for the World's Fair.
- Due to erosion of the existing pile foundations the structure had settled 14 cm.
- Rehabilitation included transmitting the loads from the existing foundations to trench walls and grouted columns.
- Restoration of the 700 tons of structural members and the glass canopy was also performed.
- The flexibility of STAAD.Pro allowed for design of the frame and substructure as well as the glass.

The crews faced constant challenges in adapting their work to the confined work areas and found solutions to anchor the bars into non-accessible parts of masonry.

The construction consisted of a metal framework equipped with a coating of stone. The entire project has a surface area of 35,000m² on the ground, extending to a height of 40m. To site such a building on ground that was primarily unstable clay the designers chose a pile foundation. Over time, the ground water level increased due to movements of the Seine River which began to erode the pile caps. Currently, the southern part of the building has settled over 14 cm in the past century.

To stop this settlement, the Public Contracting Authority for Cultural Works began rehabilitation works underneath the existing structure, that consisted of transmitting the vertical loads from the existing masonry to slurry trench walls and



Project included renovation of the metal framework and glass canopies

"Each rivet used in the steel work was forged the same way it was originally done in 1899."

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complex building site presents. The crews faced constant challenges in adapting their work to the confined work areas and found solutions to anchor the bars into non-accessible parts of masonry.

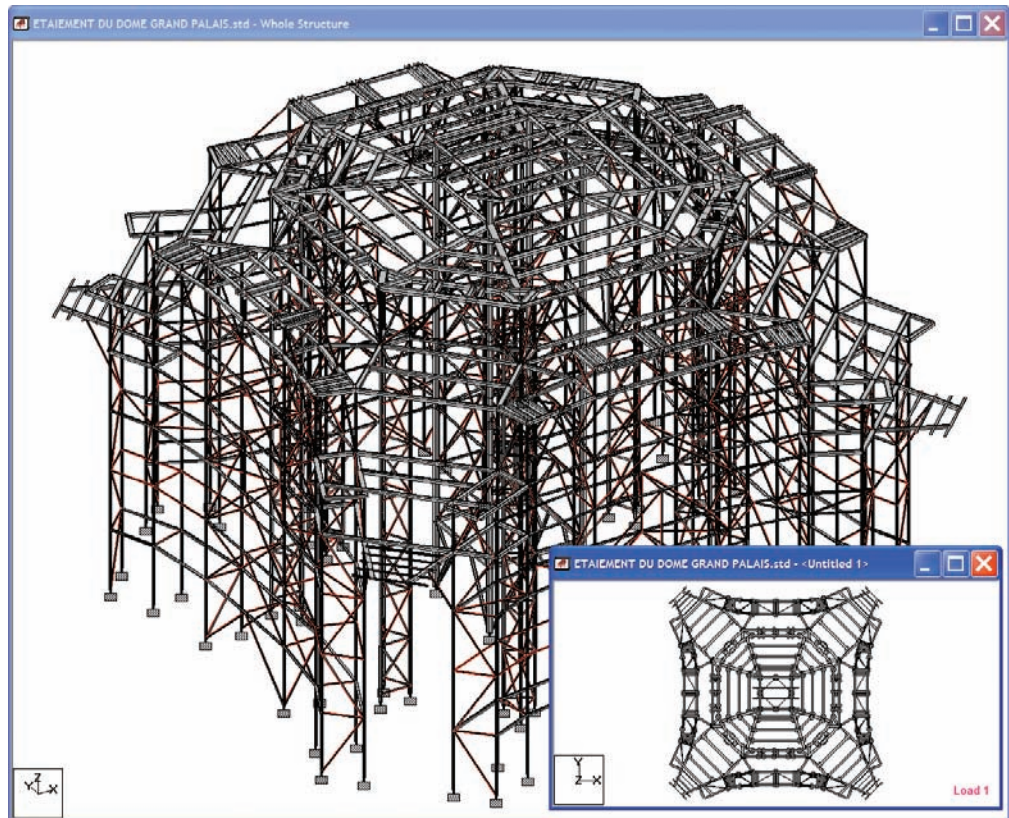
EIFFEL also won the contract for the complete renovation of the metal framework and glass canopies of the Grand Palais. EIFFEL was responsible for replacing the anchor points for the pillars, renovating the entire metal framework (after reinforcement), shoring and jacking for the dome and adding in new glass panels (17,000m²). This was to be done after the foundation work was complete.

The challenge in repairing the metal framework, nave and canopies was to prop up the existing dome which weighed over 500 tons. After designing the scaffolding to prop up the entire dome, the metal cupola of the Grand Palais, a victim of its age and the settlement of its foundations, was raised a few centimeters allowing the restoration of the structural members (total of 700 tons) and

the replacement of the canopy by more resistant laminated glass. STAAD.Pro[®] was used to design the frame and substructure and model the unique behavior of the glass.

The intent of the project was to maintain the rich tradition of this historic monument, but simultaneously use modern technology to achieve this goal. The installation of instruments (Cyclops monitoring system installed and developed by SolData, a subsidiary of Solétanche Bachy) to monitor compressions in the columns and walls in real time as well as oxidation in the reinforcement were examples of modern technology used to restore this monument. However, in contrast, each rivet used in the steel work was forged the same way it was originally done in 1899.

EIFFEL and DSI's experience in the field, combined with a close relationship with the customer, made it possible to conclude its work on this complex building site on time while maintaining an exceptional level of quality.



STAAD.Pro was used to design the frame and substructure and model the unique behavior of the glass.