PARIS
MUSEUM OF PUBLIC WORKS – PALAIS D'IENA

CURRENTLY NATIONAL ADVISORY COUNCIL FOR ECONOMIC, SOCIAL AND ENVIRONMENTAL AFFAIRS

RESTORATION OF THE FACADES OF THE PALAIS D'IENA

Project: Concrete restoration
Name: Palais d'Iéna
Adresse: France, 75016 Paris
Volume: Total facings surface = 7,770 m² - Restored area = 315 m²
Length: 300 meters of façades
Construction period: 1937 – 1947
Restoration project: 2014
Restoration work: oct. 2014 – nov. 2016

History and description of the project

The Museum of Public Works is a vast building designed by the famous architect Auguste Perret. Perret who received a classical education, mainly demonstrated his creativity using reinforced concrete. The "Palais d'Iéna" most remarkable features are the primary structure with 20 meter spans, within which a secondary frame with porticoes and floors develops, allowing for remarkable wide spaces: vast hypostyle main hall, masterpiece grand stair, conference aula. Unique are also the quality of execution details and the colorful harmony of concrete, of which Perret was a precursor.
The 300 meter-long façades consist of a substructure opened on 12 bays and a colossal order formed of cone-shaped columns of 13 meters high with a capital, inspired by Egypt. The rotunda of the monumental entrance takes up this principle of composition with columns, carrying the architrave and a wide cornice. Claustras made of prefabricated triangles, laying on their tip and slightly inclined, constitute a remarkable perspective, in harmony with the frame and the filling panels, nuanced green, ochre and pink, contrasting with the concrete structures that were hammered, with smooth or hatched cement edges. The courtyard façade consists of spans separated by important square pillars. Contrary to the facade on the avenue, some structures are made of rough concrete, with board marks.
Construction took place from 1937 until 1947. In 1993 the palace was listed as historical monument.
After seventy-years ageing in Paris urban context, local spalling, rust spots and dirt had to be removed so that the building, currently housing the National advisory council for economic, social and environmental affairs, could recover performances in full respect of its architectural and historical value. Researches on the history, implementation and original descriptions of the construction work provided precise information on the mix-design and execution of the concrete monument, enabling a unique restoration project.

300 words

Restoration work

To restore Palais d'Iéna façades beyond a simple renovation, an exhaustive preliminary technical study analyzed the causes of the degradations and their consequences.

Despite a remarkable concrete quality, the facades required a durable restoration, to regain the original exceptional appearance. The columns were partly spalled and blackened. The bases were heavily decayed exposing the bars. Previous recent repairs had already burst. Pollution and rainwater had caused black crusts and calcite concretions.
A meticulous record of the 300 meters of façades details and apparent alteration was performed and rectified photographs were taken. The laboratory diagnosis revealed that the concrete was quite homogeneous, with a good compactness, but a great disparity of the concrete covers. So that the carbonation depth of the concrete, even if quite limited for a monument of that period (20 to 30 mm), had reached the less covered bars, inducing their corrosion. Exogenous sulfate pollution due to the urban environment was also observed.
The restoration protocol was then established on the basis of these observations and analyses, forecasting their evolution and taking into account the deontological recommendations for historical monuments. Various cleaning tests, including wet and dry abrasive projection, chemical pads and gels, water-based techniques were the subject of special analyses by checking that the intervention would not alter the concrete skin. To reconstruct concretes of the same nature, and appearance similar to those of origin, compliant with current standards but without the use of commercial prefabricated mortars which appearance would have been incompatible with the preservation of a historical monument, specific repair concretes were formulated taking into account the composition (binder, aggregates) and characteristics (color, texture, porosity…) of the parent concrete and the pollutions observed. For the aggregates, Seine gravel were introduced in the mix for the frame, flint for the frame and columns, green porphyry, pink marble for filling panels, Euville stone and Vosges red stone for claustras. The performances of the repair concretes were characterized (shrinkage, bonding…) and samples of raw and hammered concrete were realized, followed by suitability tests.
The restoration company developed a specific protocol and phasing of the work to reproduce the hammered concrete. It consisted in removing the rust from the soft iron reinforcing bars, eliminating the decayed concrete beyond the reinforcement a little farther than usually in order to be able to pour the newly formulated concrete, to fix formworks to the scaffolding, to pour the concrete with a few centimeters extra thickness from the surface, to stop for a few weeks waiting for the concrete setting and finally to hammer it. For the raw concrete specific formworks were used to reproduce the original board marks.
Finally, remains of an ochre-yellow wash made of natural earth and cement that covered the entire structure were discovered. For the first time, the wash was restituted according to the wish of Auguste Perret, to make the concrete, that he highlighted the qualities, less austere.
Experimental evaluation of a new generation of hydrophobic treatments was implemented in the courtyard with an innovative monitoring.

499 words

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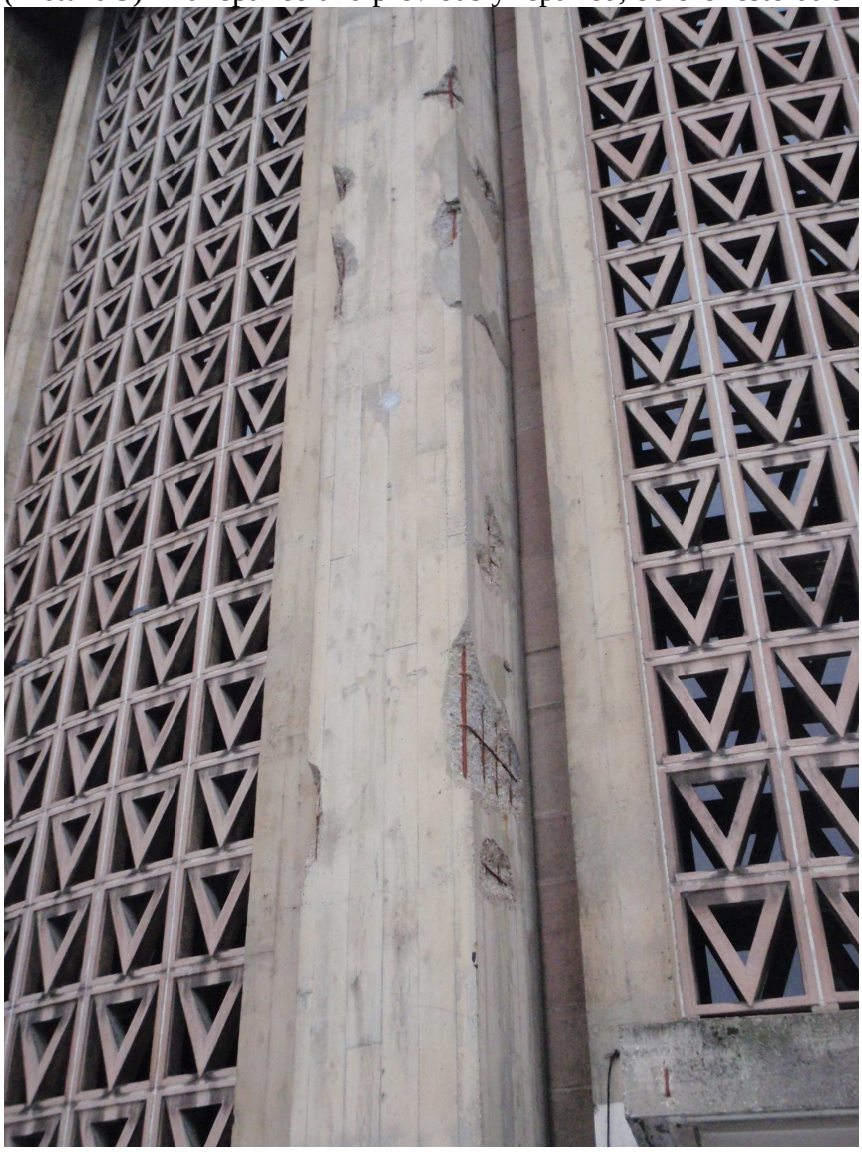
ILLUSTRATIONS

(Picture 1) Entrance rotunda after restoration work

(Picture 2) Column spalled, before restoration

(Picture 3) Pilar spalled and previously repaired, before restoration



(Picture 4) Core sampling to evaluate the carbonation depth

(Picture 5) Column, after restoration

(Picture 6) Capital, after restoration

(Picture 7) Claustra, after restoration

(Picture 8) Courtyard façade after restoration and restitution of the ochre wash

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