Installation of beams and arch reinforcements

1 *- Preparation of arch reinforcement*

2 *- Assembly of glass fibre reinforcements*

3 *- Formwork*

4 *- Filling with resin mortar*

5 *- Dismantling of the beams' formworks*

Construction of sandwich shell

6 *- Laying strips of woven glass fabric*

7 *- Impregnation of cellular boards*

8 *- Mounting of cellular boards*

MEANS

An extensive simulation study of the calculations has been performed through mathematical modelling. The model included the vault, central columns and walls.

RESULT

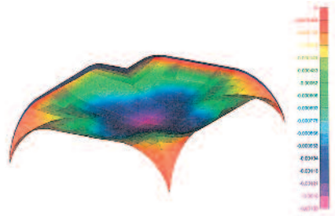
The detailed analysis of the characteristics of the various existing materials (Lavaux stone, mortar) and implemented materials (resins, resin mortar, composite sandwich shell, glass fibre reinforcements) required for modelling made it possible to determine the reinforcement that had to be put in place to remove the reinforced concrete girders and posts while keeping admissible stress values for the vault, i.e.:

- Stone vault's own weight based on an average thickness of 20 cm, subsided by about 5 cm in its centre
- Permanent loads of the wood floor consisting of a hardwood floor on sleepers, i.e. 50 kg/m^2 = 500 N/m^2, substituting the initial filling
- The service loads corresponding to a building open to the public, i.e. 500 kg/m^2 = 5000 N/m^2
- Preservation of the velum

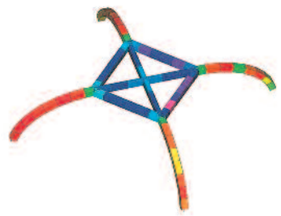
2 TYPES OF INTERVENTION

Installation of beams and "upper arch reinforcements" made of resin mortar reinforced with glass fibre rods (shown in red) connected to the existing structure.

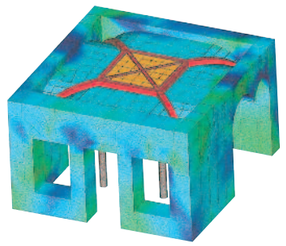
Construction of a composite sandwich shell (shown in yellow) above the central vault, consisting of 3 layers of high density cellular boards and 4 layers of strips of bidirectional fabric impregnated with a specific epoxy resin.



Vault deformation in meters after reinforcement

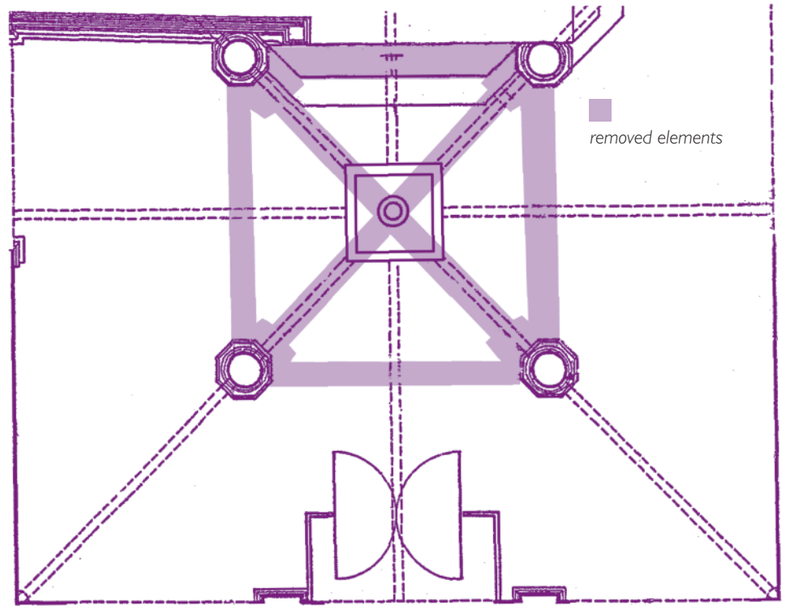


Bending moment in resin mortar beams



In red: arch reinforcements
In yellow: cellular boards

CONDITION PRIOR TO INTERVENTION



CONDITION AFTER INTERVENTION

Before:

Consolidation using reinforced concrete strengthening, the 4 columns with Doric capitals are lined with buttresses and the arching is relieved by cross-springers.

After:

The concrete pillars and arches have been dismantled after the RENOFORS processes have been implemented; only the 4 columns are kept and restored.

9 - *Laying of last strip of woven glass fabric*

Identification sheet

Client:
Town of Celles-sur-Belle

Architect:
François JEANNEAU – ACMH

Modelling and Technical Study:
UBC Ingénierie

Cost of strengthening intervention:
134,024 €

Completion time:
6 weeks – 2004

MESSAGE FROM THE CLIENT

The 17th century building, designed by the architect François Le Duc, known as "Toscane", was built on the ruins of an ancient abbey from the 12th and 15th centuries, patronized by illustrious figures among which King Louis the XIth.
The conventual building of an elegant architecture had its hours of glory when figures, such as "de la Rochefoucauld" and "Talleyrand-Périgord", passed trough and it was then sold as a national asset during the French Revolution. The presence of seminarians until 1970 did of course attempt to bring back some "soul" to these premises, but in vain.
The abbey is acquired by the town in 1971 and classified as a Historic Monument in 1977.
After extensive restoration work, RENOFORS was put in charge of bringing back the original appearance of the hall by installing reinforcements onto the upper part of the vault in order to remove the bearing points that were attached along the columns at the beginning of the 20th century. The success of this work today allows us to rediscover the original design by the architect F. Le Duc.
The abbey now is a place of tourism and culture. It's one of the most visited monuments in the Poitou-Charentes region (Western France).

Laurent Gobin
Heritage Conservation Attaché
(Celles-sur-Belle Town Hall)

MESSAGE FROM THE ARCHITECT

Designed in the 1680's by a talented architect, F. Le Duc known as "Toscane", the hallway and monumental staircase of the abbey building in Celles-sur-Belle provides a feat of architecture just like the brilliant composition of its garden facade.

Probably too ambitious for its span, from the beginning the cross-ribbed vault covering the hall could not have been built without four bearing points. These turned out too weak themselves, since they had to be strengthened with concrete reinforcements in the 20th century.

Thanks to the very innovative RENOFORS shell technique, we were able to recover the original design by F. Le Duc, giving back lightness and brightness to the whole.

Once again, the restoration of our monuments benefits from new methods leading us to what we all are searching for: conservation and development of authenticity.

François Jeanneau
Head Architect at the French Historic Monuments department

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