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RESTAURO MONUMENTALE E ARCHITETTONICO
CONSOLIDAMENTO STRUTTURALE

# CALDOGNO - VICENZA

# VILLA
# CALDOGNO NORDERA

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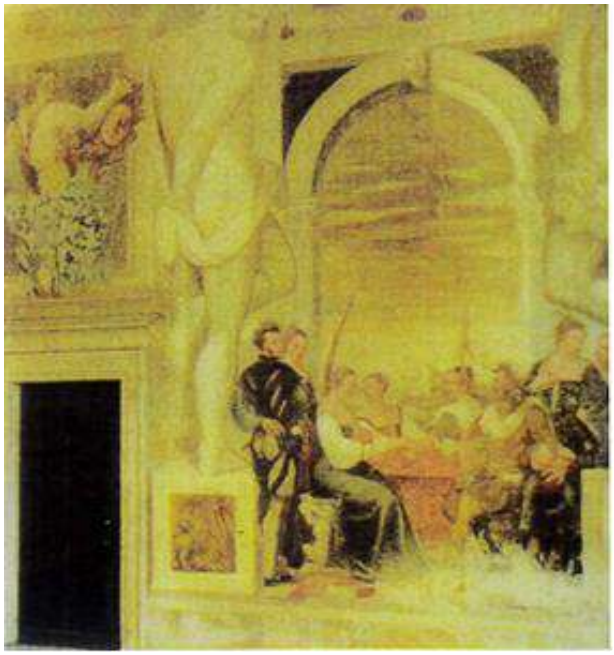
CONSOLIDATION WITH CARBON FIBERS SHEET

OF A VAULTED ROOM

## INTERVENTION CRITERIA SELECTION

Villa Caldogno – Nordera restoration is part of a particularly complex construction site both for the general deterioration of the building and for the delicacy of the intervention choices.
The new intended use of the villa vaulted rooms (concert hall) resulted in an increase in the accidental load, for which a verification of the adequacy of the load-bearing structure was required. From the first tests carried out to identify the thickness of the vaults and the nature of the materials used to fill the sides, it was ascertained that the room located on the east side of the villa was not able to guarantee a sufficient level of static safety for its public use.
After demolishing the existing floor of no value, the elevation of the dimensions indicated that the thresholds of the room were at the same height as the keys of the vaults. It was therefore necessary to find a solution that would allow the vaults to be adequately reinforced without increasing their thickness: the choice was to utilised carbon fiber sheet, able to easily follow the complex pattern of the vault extrados with a final thickness increase of 1 mm.



## DESIGN CRITERIA

The analysis of the tensional state of the juxtaposed arches constituting the vaulted room indicated the onset of a state of pressure bending caused by the release of the pressure line from the central core of inertia, with consequent tensile stresses on most of the extradossal surface.
It was therefore decided to create on the extrados an exoskeleton with carbon fibers sheet, extremely light and with exceptional tensile strength in the range of 4.900 Mpa, able of performing a dual function:
1) take on the tensile forces not bearable by masonry;
2) create a widespread binding of the elements constituting the vaults, designed to give homogeneity of structural comfort.
Since the carbon fiber reinforcement has created a new resistant section, the tensional state of compression on the intrados, increased by the combined compressive and bending stress, has been carefully evaluated, verifying that it was resulting less than the allowable amound after compensation intervention on the present cracks with the mortar suitable to restore the correct compression behaviour of the arches. In this regard, it is emphasized that the reinforcement exerts a positive effect of upward displacement of the neutral axis, with a consequent increase in the compressed area and the corresponding decrease in the intrados tension for the same load.
Since the vaults consisted of succession of brick arches juxtaposed 26 cm wide. the desire to create a shell-effect by intercepting all the elements has automatically led to choosing the 26 cm pitch for the carbon fiber sheet.

(The frescoes that decorate the Villa are the work of Zelotti, a pupil of Veronese)

## DESCRIPTION OF THE INTERVENTION

The intervention was carried out as part the following procedure:
· mending of cracks with epoxy resin mortar;
· regularization of the support with similar mortar;
· manual cleaning of the substrate and subsequent dust removal;
· impregnation of the support with very low viscosity epoxy resins, so as to facilitate penetration and improve adhesion of the support by forming the so-called "epoxy needles";
· bonding of carbon fiber sheet tapes with epoxy paste along the main directions of the room;
· final saturation of the carbon fiber sheet with solvent-free epoxy resin.

## LABORATORY TESTS

Before starting the consolidation work on the vaults, a cycle of destructive tests on various samples of brick suitably plated with carbon fiber sheet and epoxy paste, to evaluate the suitability of this reinforcement system, was realized at the Laboratory of the Department of Construction Science of the Engineering Faculty of the University of Padova.

(Application of the carbon fiber sheet )

(Some application phases of the carbon reinforcement)

(Vault surface after reinforcement with carbon fibers sheet applied with epoxy pade)

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