Safeguarding and conservation of Gelati Monastery World Heritage Property, Georgia

PHASE 2 - Analysis and development of the acquired documentation

Deliverable 2

Findings of the analysis: keynotes based on the results of the studies conducted by RS and GET

Remote Meeting
September 28th, 2022

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STRUCTURE AND RESTORATION

ACKNOWLEDGEMENTS

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1.1 - Results of the diagnostic process

A) Defective materials

B) Incorrect installation technique

C) Un-functional design solution

1.1 - Results of the diagnostic process

A) Defective materials

Glazed tiles (both white and red type)

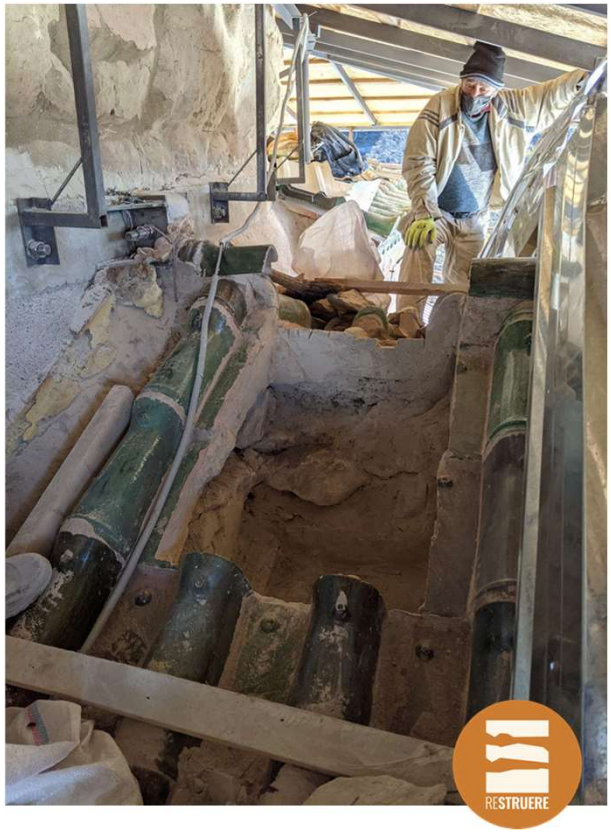
The tests carried out at CNR-ISPC showed how the used tiles could not guarantee effective protection from water infiltration because of their composition and inadequate cooking.

1.1 - Results of the diagnostic process

B) Incorrect installation technique

B1. Thick layer of porous lime mortar, capable of absorbing a lot of water.

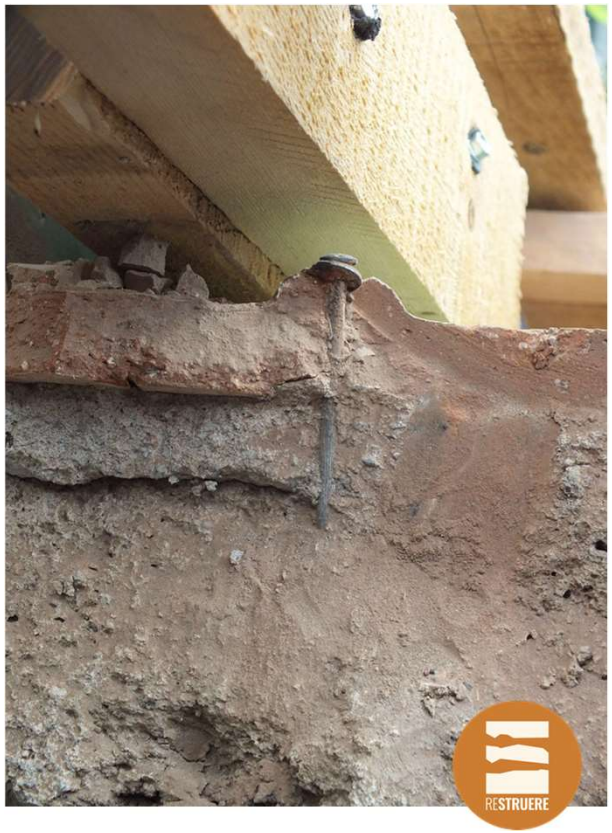
Unable to allow the necessary small relative movements useful under thermic exposition.
The ridges follow such a technique.



1.1 - Results of the diagnostic process

B) Incorrect installation technique

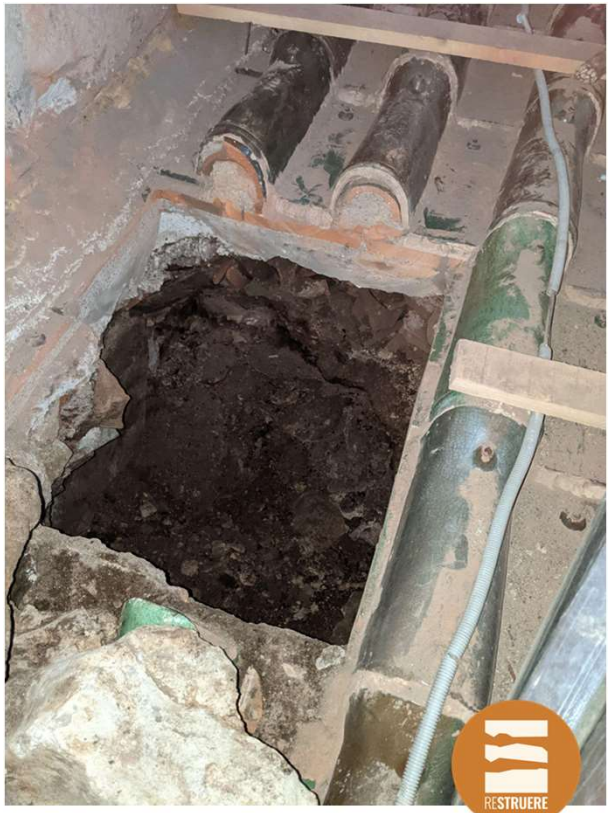
B2. In some pitches no insulation layer is installed. Even where some kind of insulation is present, both the material (quantity and thickness) and the installation are defective



1.1 - Results of the diagnostic process

B) Incorrect installation technique

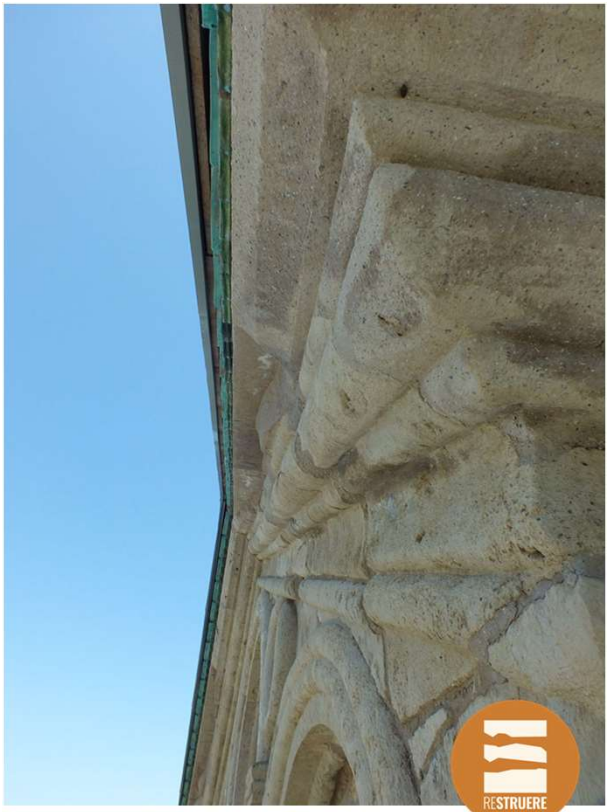
B3. The large quantity of the filling material of the under roofs, absorbing the water transferred from the tiles layer, constituted a reservoir of humidity.



1.1 - Results of the diagnostic process

C) Un-functional design solution

C1. The roofing of the pitches does not have sufficient overhangs to guarantee the protection of the cornices and other parts of the stonewall



1.1 - Results of the diagnostic process

C) Un-functional design solution

C2. There are no specific protection devices (such as flashings) on the intersection surfaces between the pitches and the vertical walls or in coincidence with the impluvium where the risk of infiltration is greater.

1.1 - Results of the diagnostic process

C) Un-functional design solution

C3. Absence of devices useful for the collection and channelling of rainwater (gutter and downpipes)

This item includes the broader one of the transmission system of the rain from the roof to the ground and the subsequent removal from the foot of the building. Consequences of this deficiency concern the phenomenon of rising water by capillarity at the floor level too.

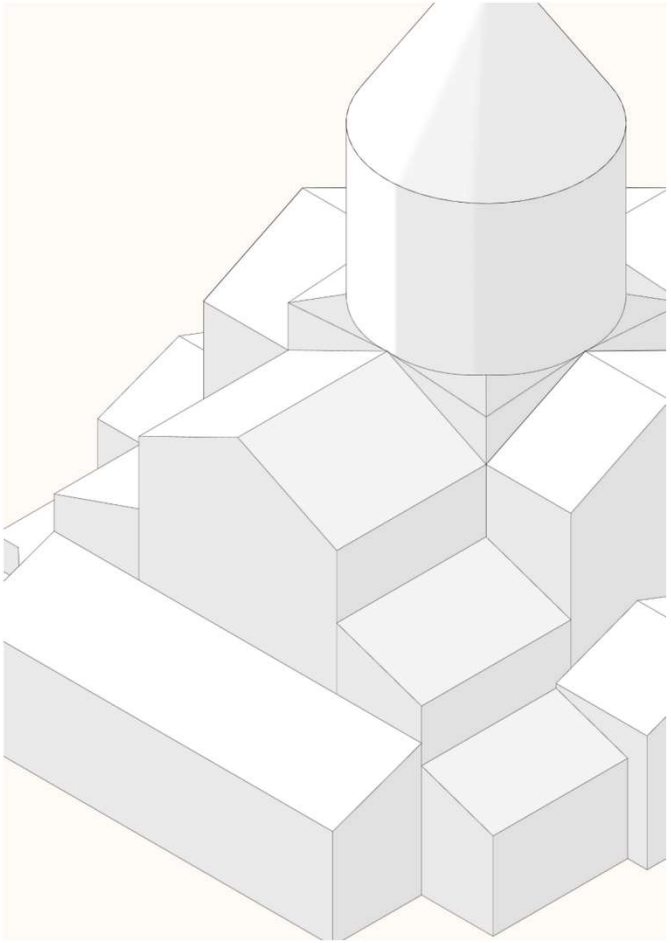
1.2 - Key principles to be respected in the intervention strategy

1. **Historical-aesthetic compatibility**
2. Control of the humidity in the vaults extrados and under-roofing by means of **ventilation**.
3. **Safety and security** needs.
4. Control of
   - **water impermeability**
   - **interstitial condensation**
   - **thermal changes.**
5. Control of the **rainwater**
6. **Cornices protection**.
7. Protection of all the **tricky and weak points** of the roof geometry.
8. **Maintenance.**
9. **Physical**, **mechanical** and **chemical compatibility**

2 - Identification and study of the qualifying elements of the drainage and waterproofing project

From the key principles, we can identify the design steps needed to secure the Monastery

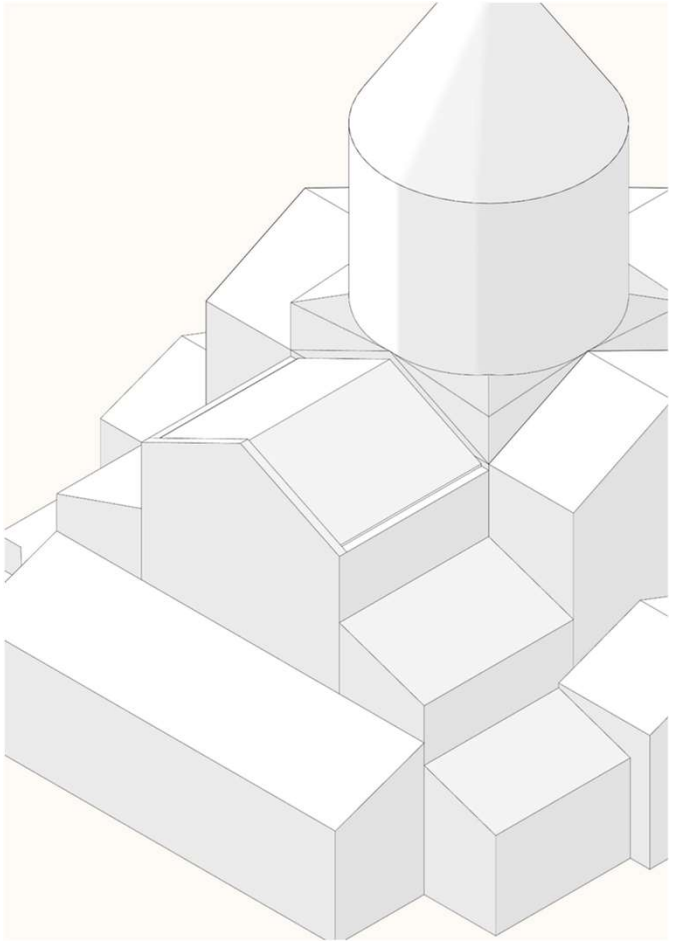
The scheme that shows the steps to be followed in the renovation of the roof is purely indicative. It only shows the West Arm as we currently have a good documentation relating to this Arm.
We have to expect different situations in the pitches, preparing ourselves to carry out targeted interventions.



Existing situation

Removal of ineffective current components

Removal of the current covering in all the pitches.

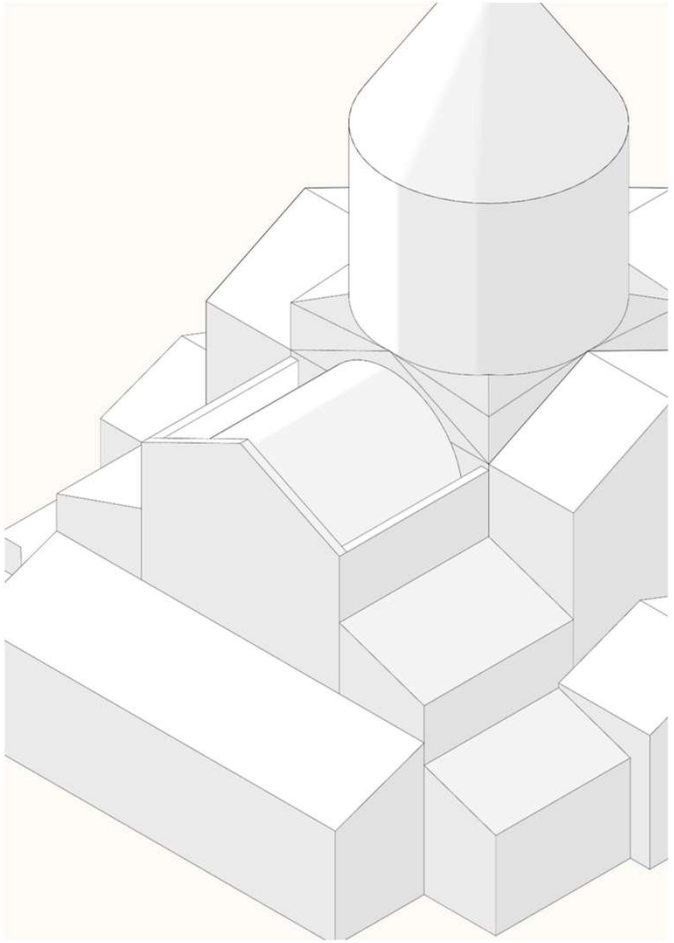


2 - Identification and study of the qualifying elements of the drainage and waterproofing project

Removal of ineffective current components

Removal of the current covering in all the pitches.

Removal of the incoherent materials present as filling in the under roofs and cleaning of the extrados of the vaulted system



2 - Identification and study of the qualifying elements of the drainage and waterproofing project

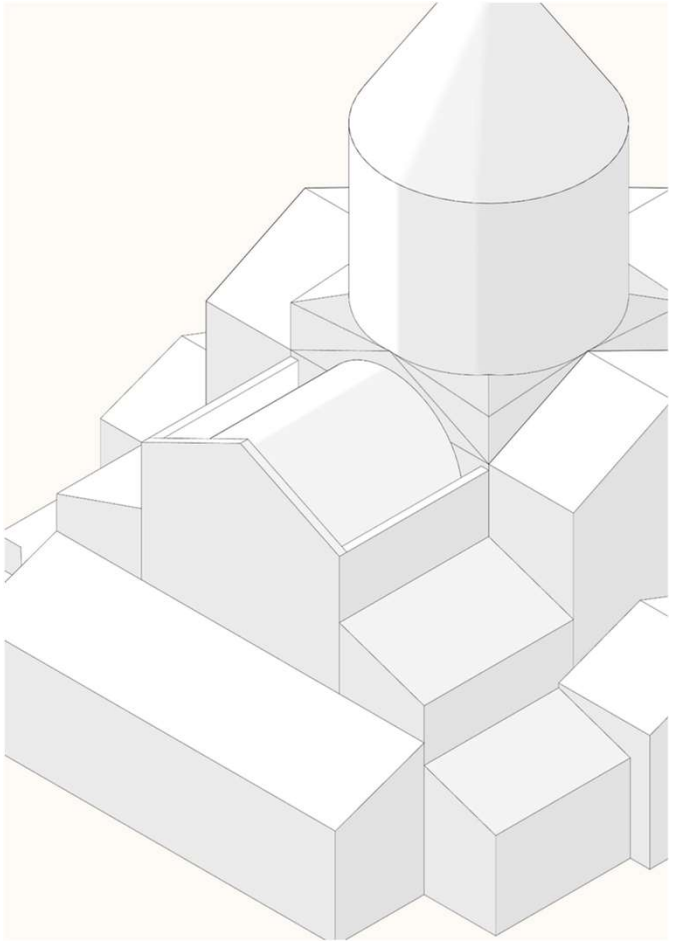
Removal of ineffective current components

Removal of the current covering in all the pitches.

Removal of the incoherent materials present as filling in the under roofs and cleaning of the extrados of the vaulted system

and

Creation of space in the under-roof useful for ventilation



2 - Identification and study of the qualifying elements of the drainage and waterproofing project

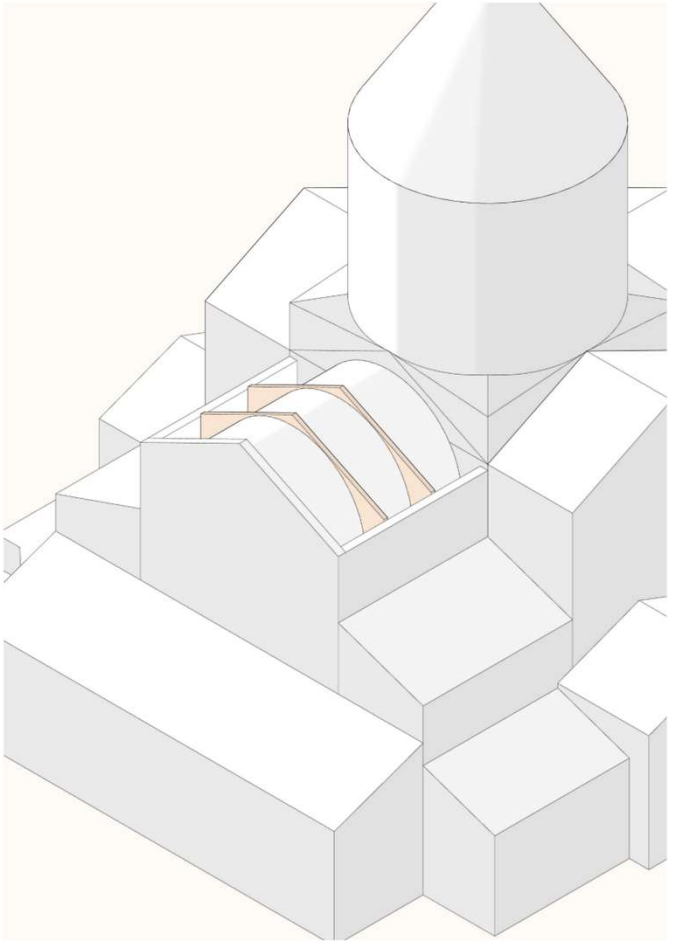
Qualifying components of the safeguard design

Creation of the new structure for the roof used in old times:

Sort of spurs or buttresses (in Italian “frenelli”)

Alternative: a system of small, self-supporting beams capable of controlling the thrusts on the walls

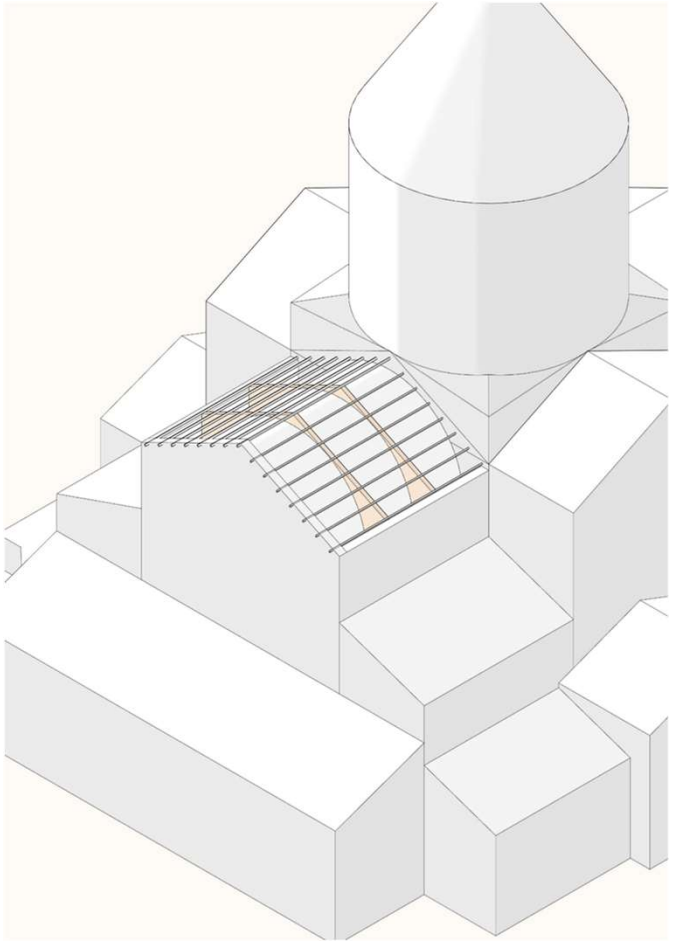
The picture shows the proposal with only two “frenelli”



Qualifying components of the safeguard design

Creation of the new structure for the roof:

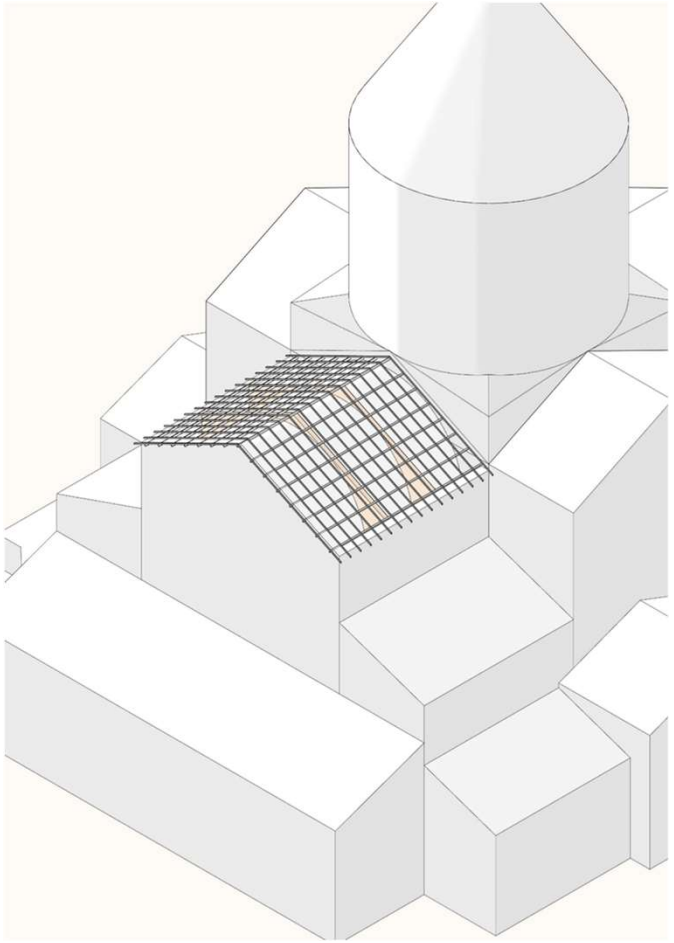
Purlins



2 - Identification and study of the qualifying elements of the drainage and waterproofing project

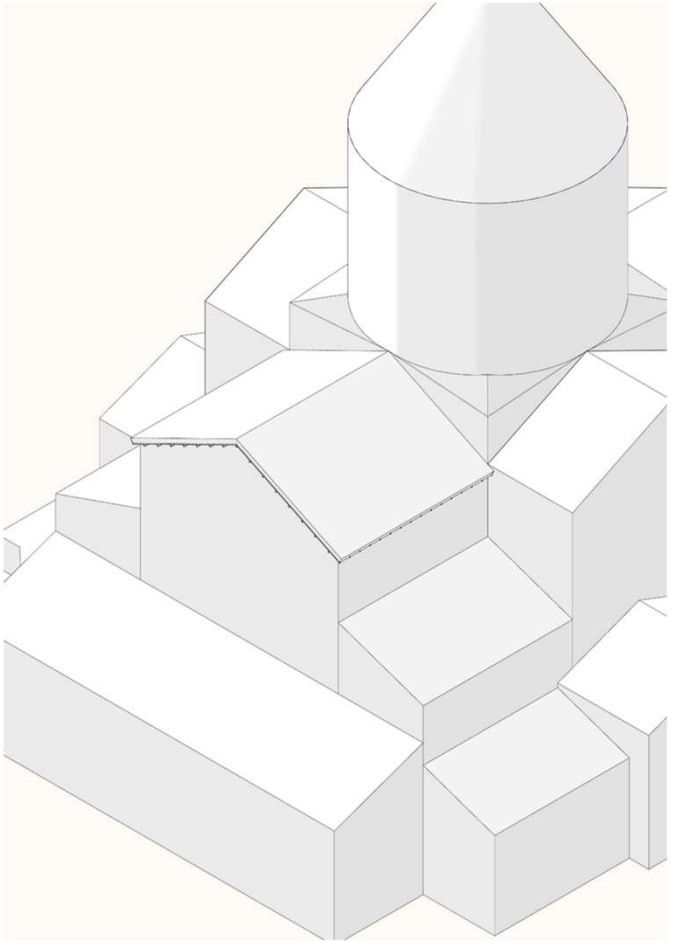
Qualifying components of the safeguard design

Creation of the structure supporting the coverage package



Qualifying components of the safeguard design

Creation of the new covering package



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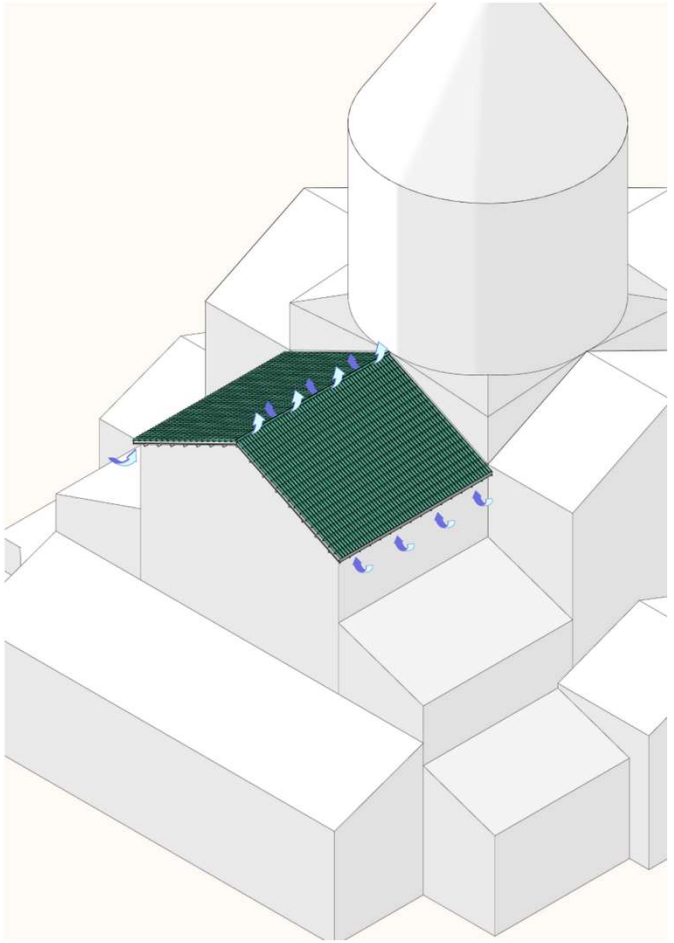
Qualifying components of the safeguard design

Creation of the new covering package



Functioning of the new ventilation system

2 - Identification and study of the qualifying elements of the drainage and waterproofing project

Choice of roof covering material

A) Revival of glazed tiles

B) Shaped pre-oxidized copper

C) Shaped lead

The images are purely indicative

2 - Identification and study of the qualifying elements of the drainage and waterproofing project

Choice of roof covering material

Glazed tiles

- ✓ Similar to the recent solution and adopted in other sites
- ✗ Difficulties of local production
- ✗ Very long production and verification times
- ✗ Considerable thicknesses and weights

Pre-oxidized copper

- ✓ Solution present in the story
- ✓ Light
- ✓ Good aesthetical impact
- ✗ Difficulties of local production
- ✗ Very accurate anchoring techniques

Lead

- ✓ Common solution in cultural heritage
- ✓ Weight facilitates the anchoring (wind, …)
- ✗ Difficulties of local production
- ✗ The weight increase the support structure size

3 - Investigation on the ancient water drainage system present on the site and evaluation of the possibility to put it back into operation

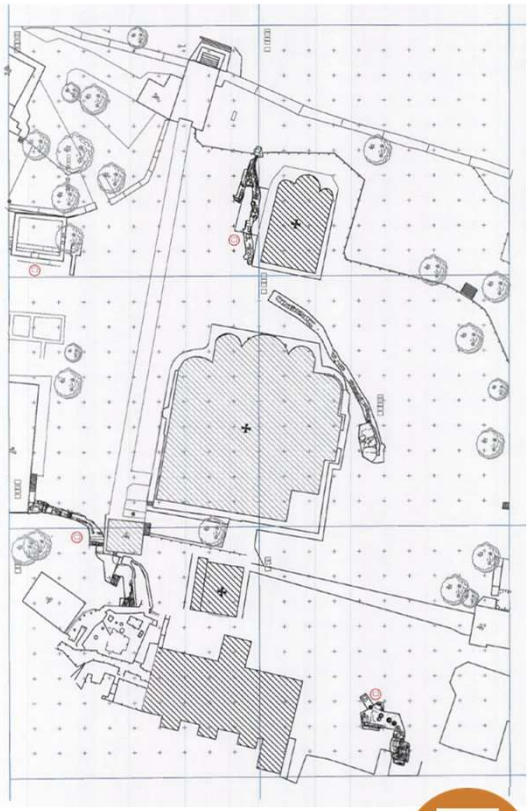
At present, the drainage system corresponds to the morphology of the land.

The choice to use only the grass covering as a drainage system dates back to the last interventions that interested the Monastery (2008-2019).

3 - Investigation on the ancient water drainage system present on the site and evaluation of the possibility to put it back into operation

During archaeological excavations, ancient drainage channels have been found around the Churches of the Monastery.

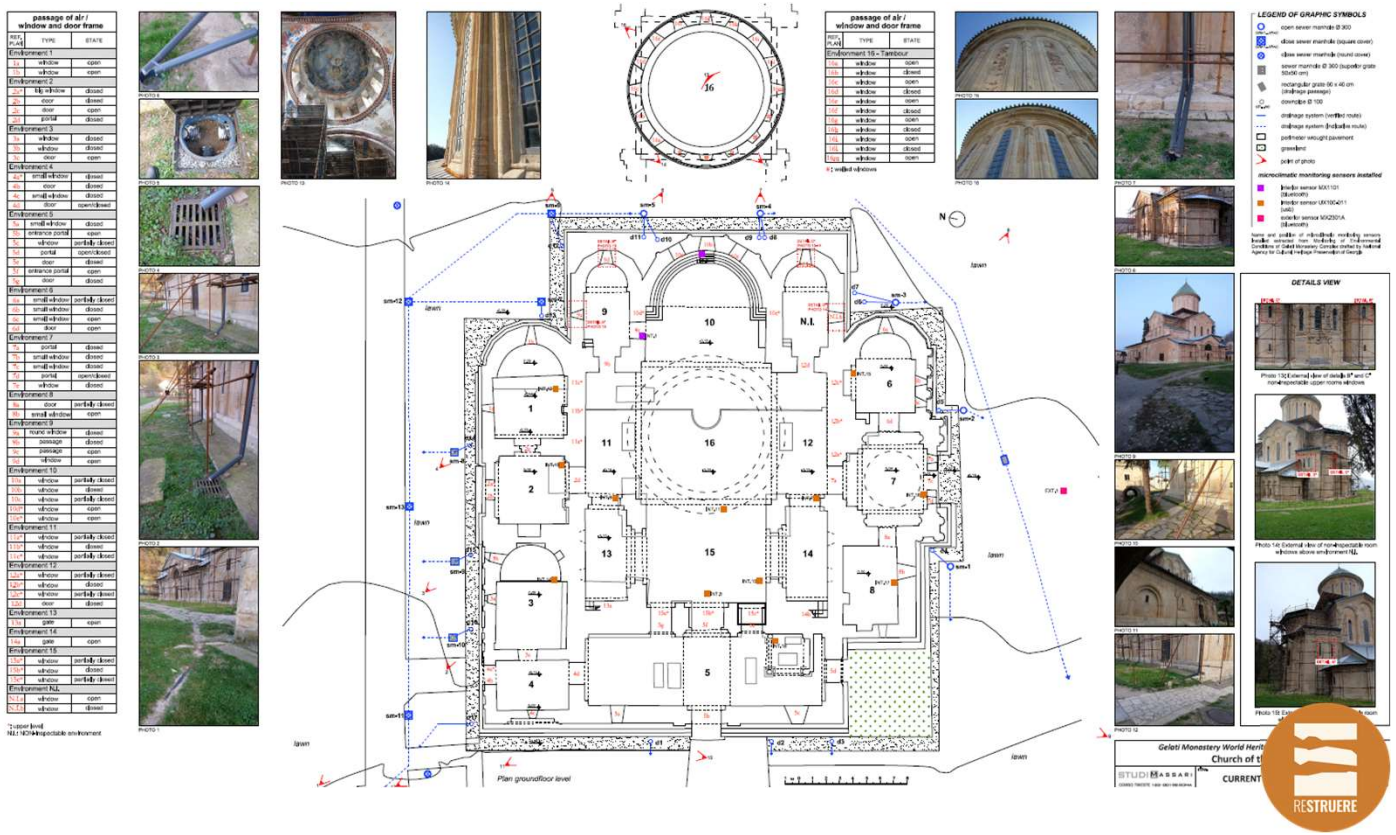
The ancient water drainage system is out of order for a long time and, moreover, it is not visible as it is covered by the ground.



Photos from Photo Report on *Drainage Collector restoration-rehabilitation (2018-2019)* shared by GET

3 - Investigation on the ancient water drainage system present on the site and evaluation of the possibility to put it back into operation

For the collection and passage of water, there is a more recent system (2019-2020) consisting of downpipes, sewer manholes and a sewage network outwards pertaining to the Virgin Church.



3 - Investigation on the ancient water drainage system present on the site and evaluation of the possibility to put it back into operation

In St. George there is not a sewage network outwards with sewer manholes and the water floods the pavements.

The serious situation on outside affects the internal conditions, where the walls exhibit moisture from the ground up to 1.5–2m with consequent damage to the paintings.

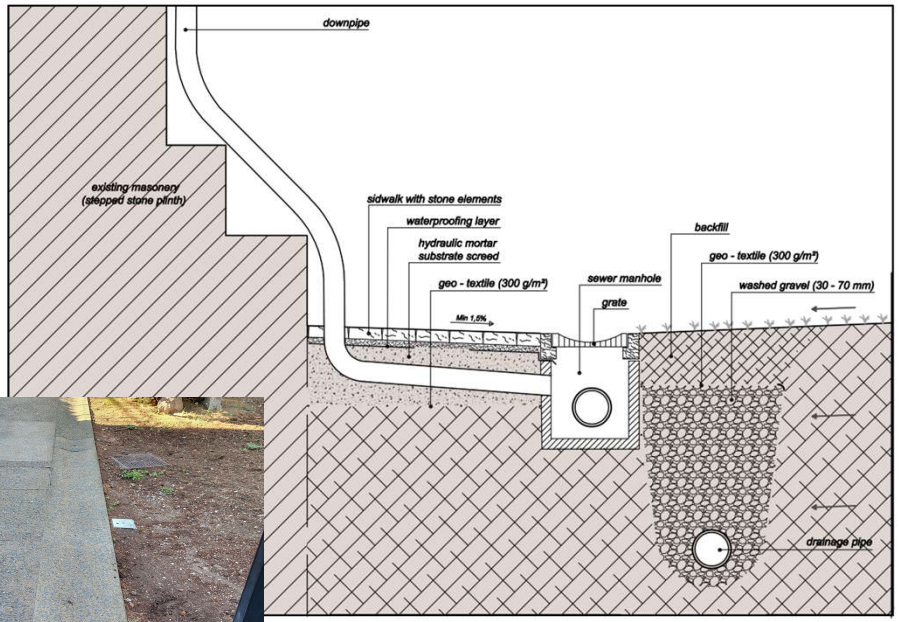
Church of St George - Preliminary investigations on the structural hygrometric - Missions Arch. Alessandro Massari of 06 – 12/11/2021 and 28/06 – 01/07/2022 – with Technical Sheets

3 - Investigation on the ancient water drainage system present on the site and evaluation of the possibility to put it back into operation

Assessment-for-design Actions

Works for the protection of the foundation walls are desirable and necessary but, to be sure about the feasibility of a foundation drainage system (such as drainage ditches), it is necessary to better understand the relationship between the Churches with the ground:

- **dimensioned survey of the ground** outside the Churches and position and conformation of the rocky surface
- **ground borings** to study the foundations
- specify the water runoff system for the permanent roofs



The detail is purely indicative

3 - Investigation on the ancient water drainage system present on the site and evaluation of the possibility to put it back into operation

Short-term Actions in St. George and Recommendations

- **shaping of the ground slopes** so as to divert the dispersed surface water away from the building

- **restoration of the exterior sidewalk** or resurfacing of the same.

- it is necessary to **install a water drainage system** similar to that that was created for the Virgin Church consisting of sewer manholes and a sewage network outward

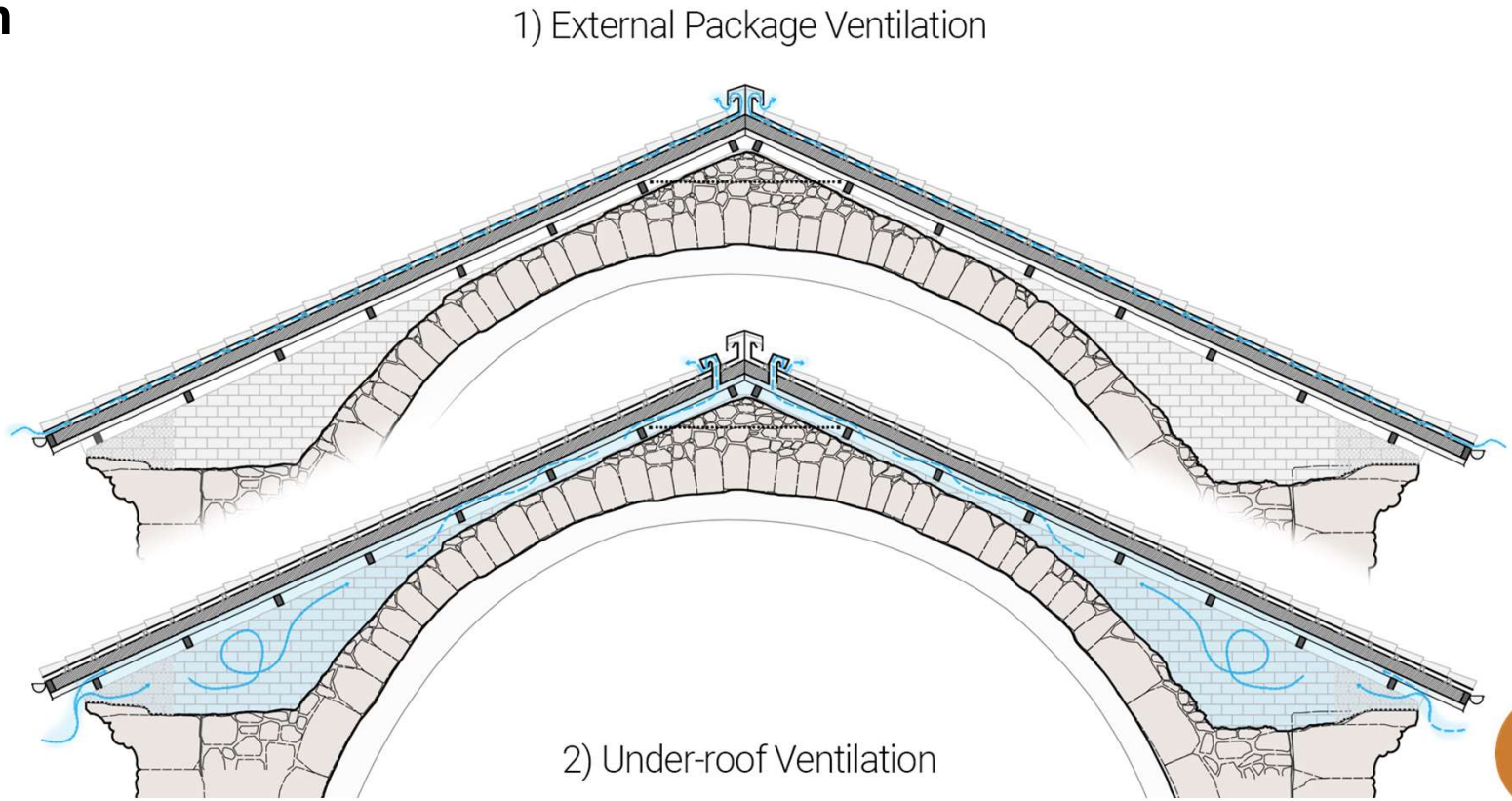
- it would be preferable to **separate**, in the area near the building, **the disposal of water coming from the roofs from that relating to the ground**. These two systems can be reunited at a certain distance from the monument

- constant **maintenance** of the buildings

Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

1 - **Ventilation**

It is advisable to create **two separate circuits** for the airflow to obtain an optimal roof ventilation system



Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

1 - **Ventilation**

The technical solutions to obtain such double ventilation are various.

The important thing is to make sure that the airflows belonging to the two circuits **must remain separated**.

Therefore, it will be necessary to pay attention to the definition of suitable technological details for the inlet and outlet of the air for the two circuits.

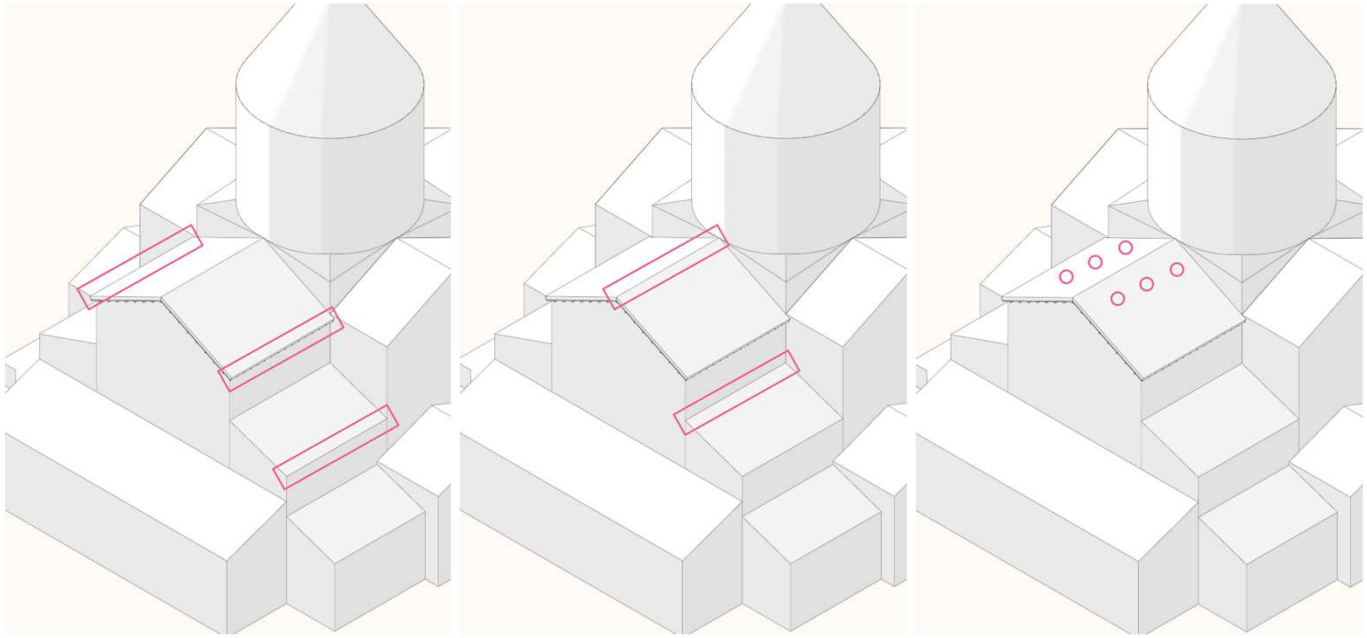
Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

1 - **Ventilation**

· **Air inlet node**, at the level of the gutters

· **Air outlet node, at the ridge** for the main arm's pitches and at the intersection with the vertical masonry for the minor arm's pitches

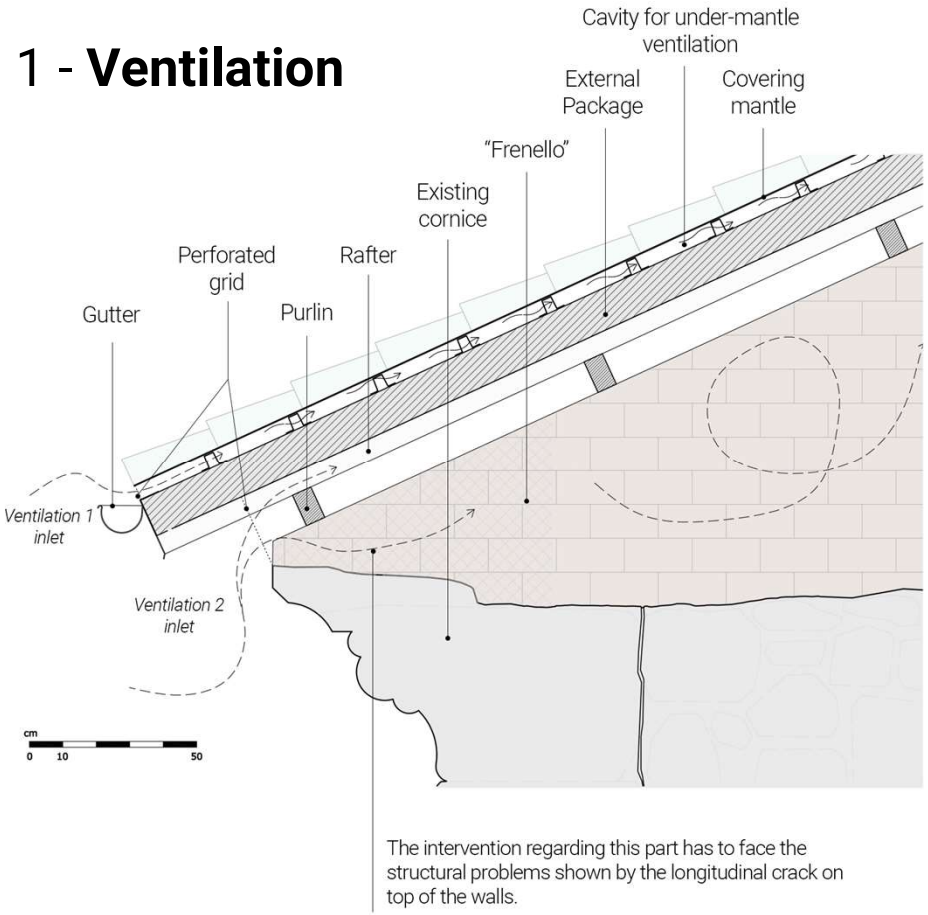
· **Air outlet node of ventilation system 2**, which, having to intersect system 1, must remain separate.



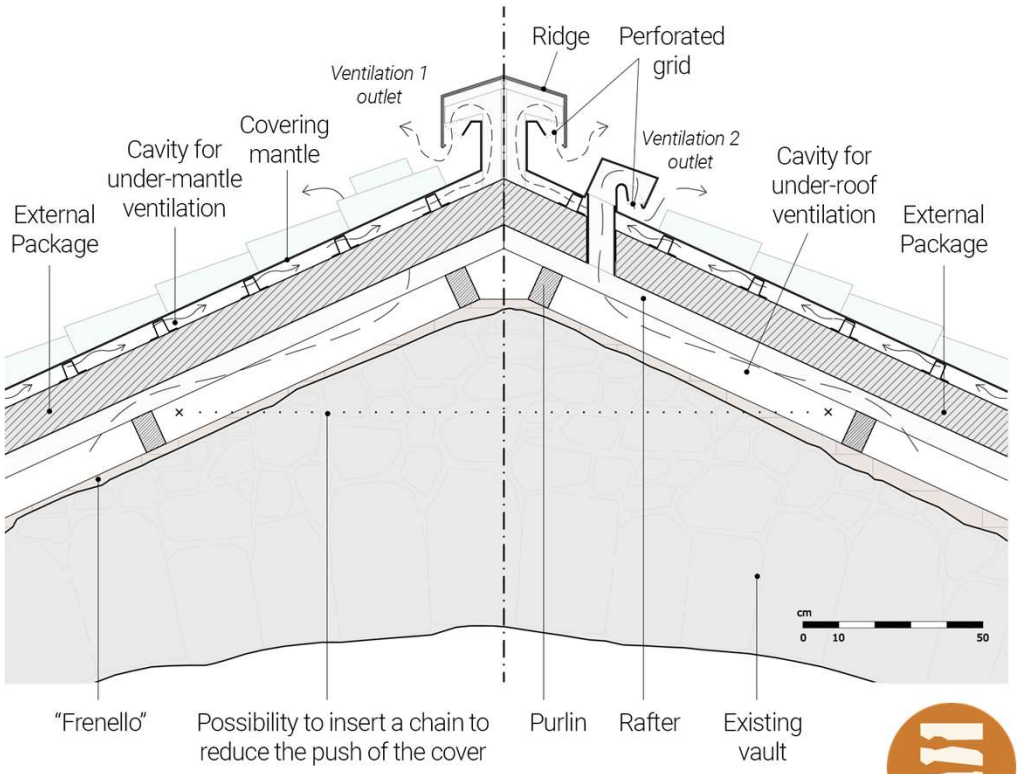
4 - Comparison of possible technical solutions to be adopted for the roof

Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

1 - **Ventilation**



The intervention regarding this part has to face the structural problems shown by the longitudinal crack on top of the walls.

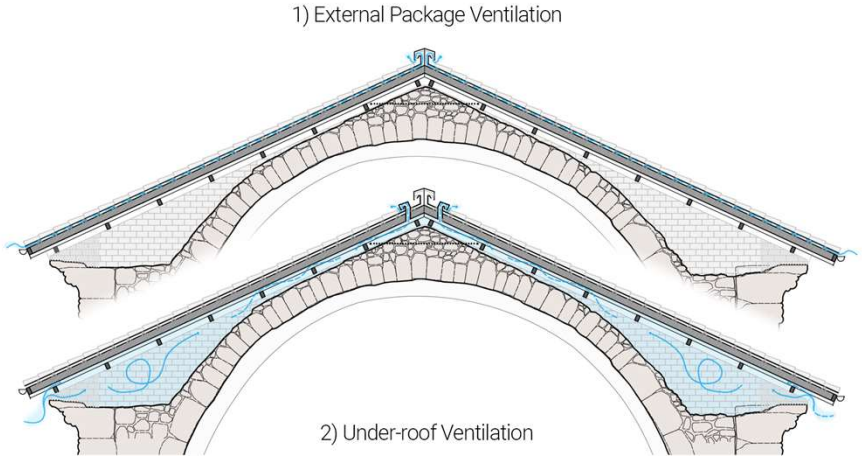


Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

1 - **Ventilation**

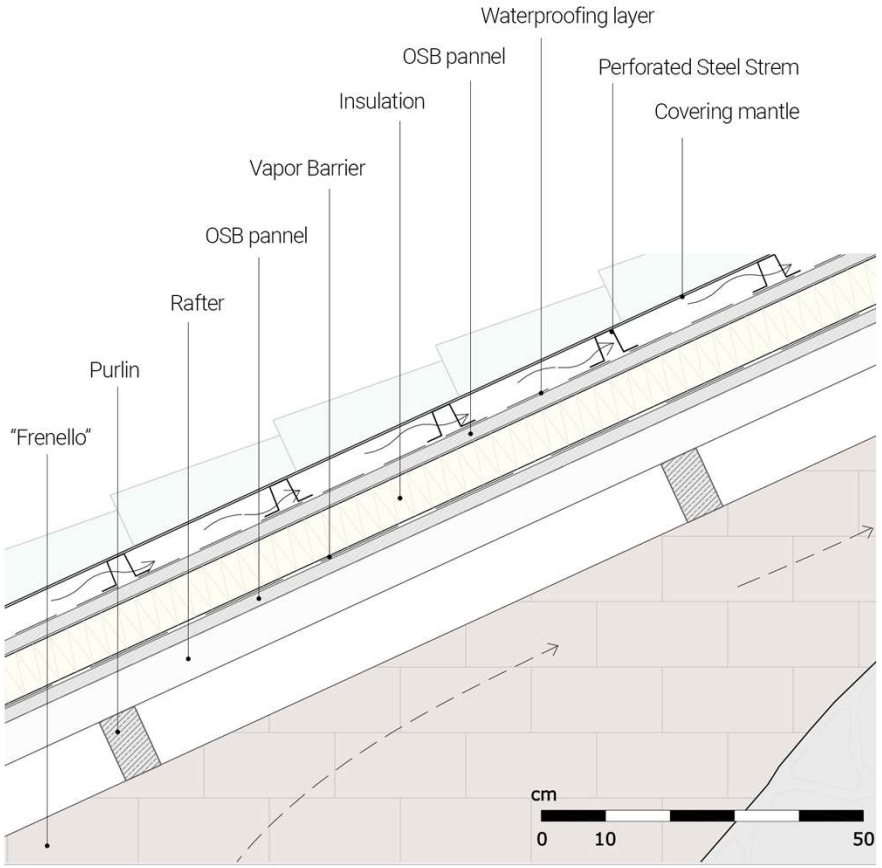
Choices to make:

- The surface of the air inlet and outlet section of the two ventilation systems is based on the amount of air needed for ventilation
- Design of air inlet and outlet systems



Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

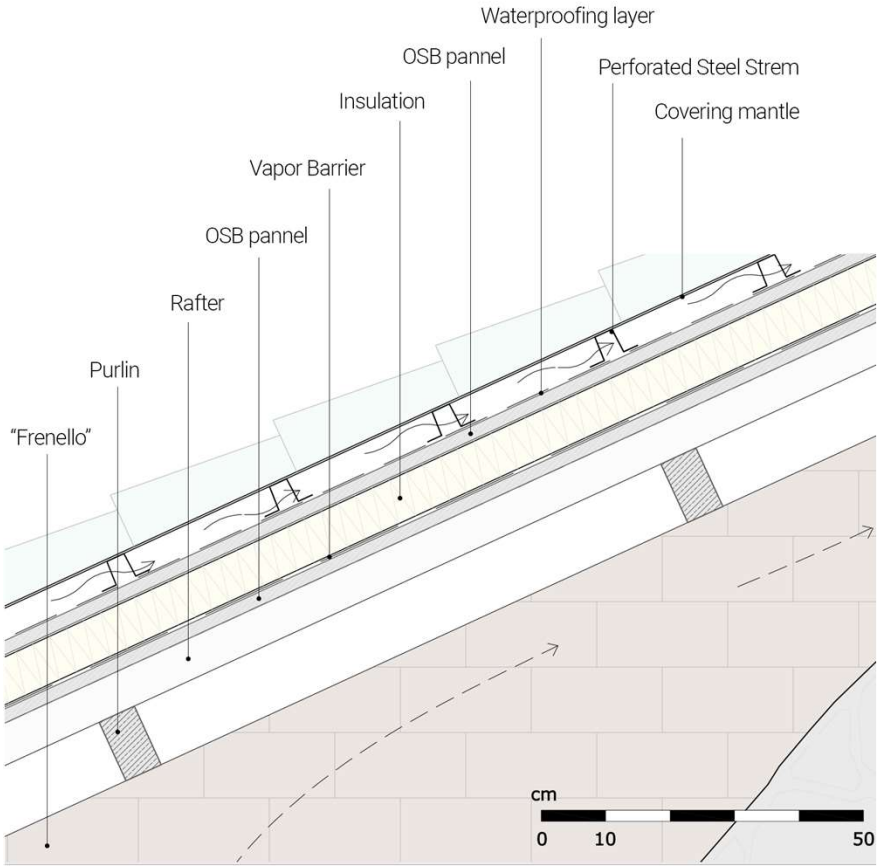
2 - New roofing and external package



Example for the ventilation system 1.
In this case, the covering mantle is made of tiles (from a technical publication).

Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

2 - **New roofing and external package**



Choices to make:

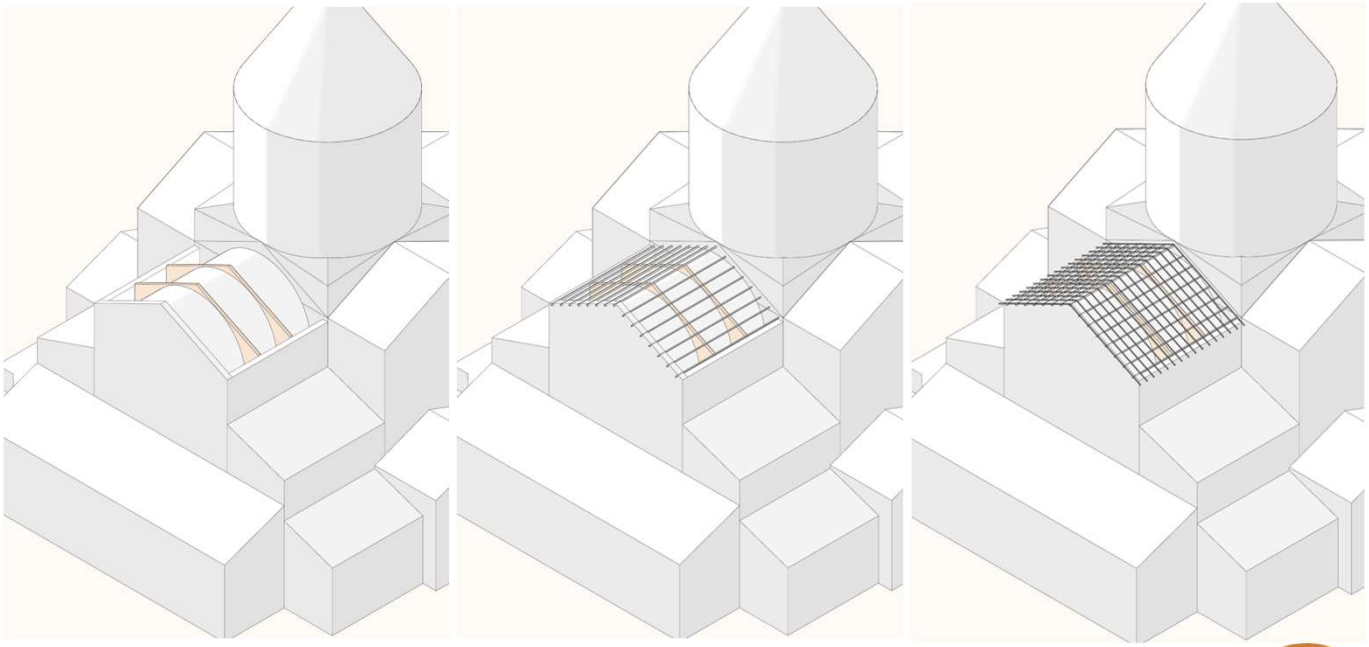
- Material for the covering mantle (tiles, copper or lead)
- Materials for waterproofing layer
- Material and thickness for a thermal insulation layer. This choice is reflected in the presence and the type of vapour barrier

Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

3 - **A light simple structure able to support the external package**

The new roof should rely on a support structure which should be:

- autonomous
- light
- not-thrusting
- sustainable



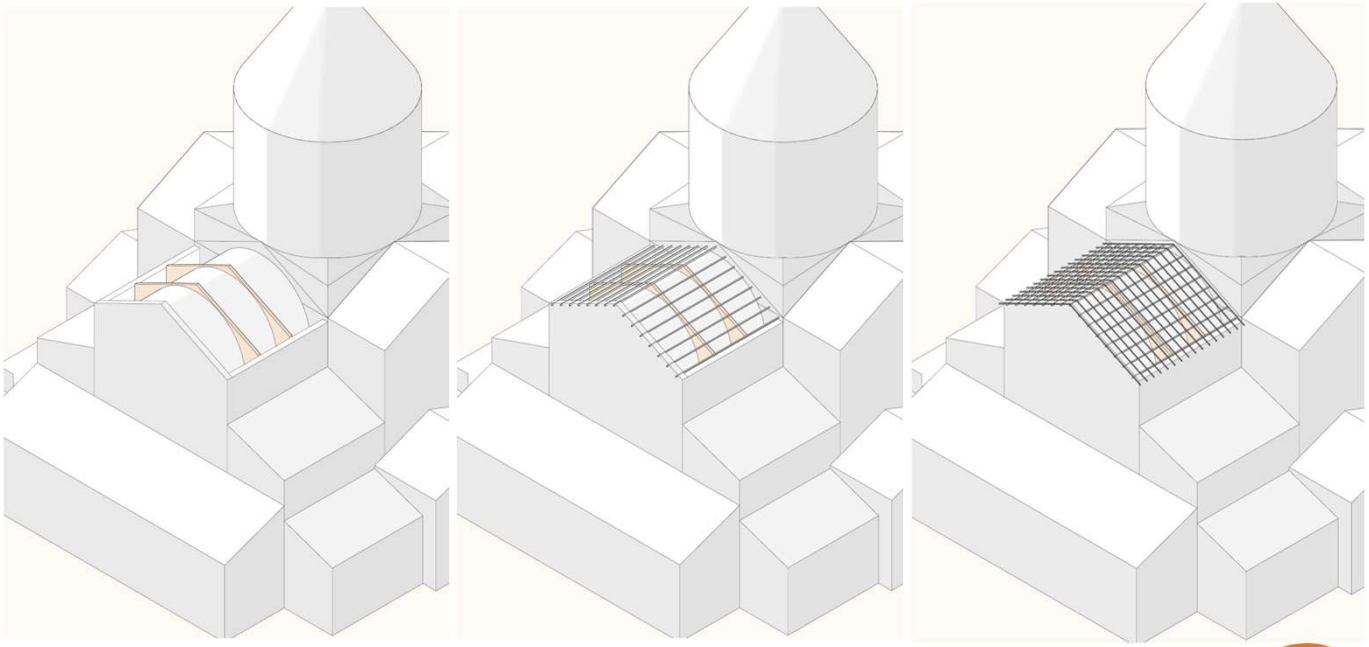
Alternative to “frenelli” can be a system of small, self-supporting beams capable of controlling the thrusts on the walls

Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

3 - **A light simple structure able to support the external package**

Choices to make or to investigate:

- Concept of the structure
- Material of the new structure (wood or steel)
- Sizing of the new structure



Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

In order to create a ventilated and insulated under-roof space we need to rely on a detailed survey after the cleaning of the extrados of the vault.

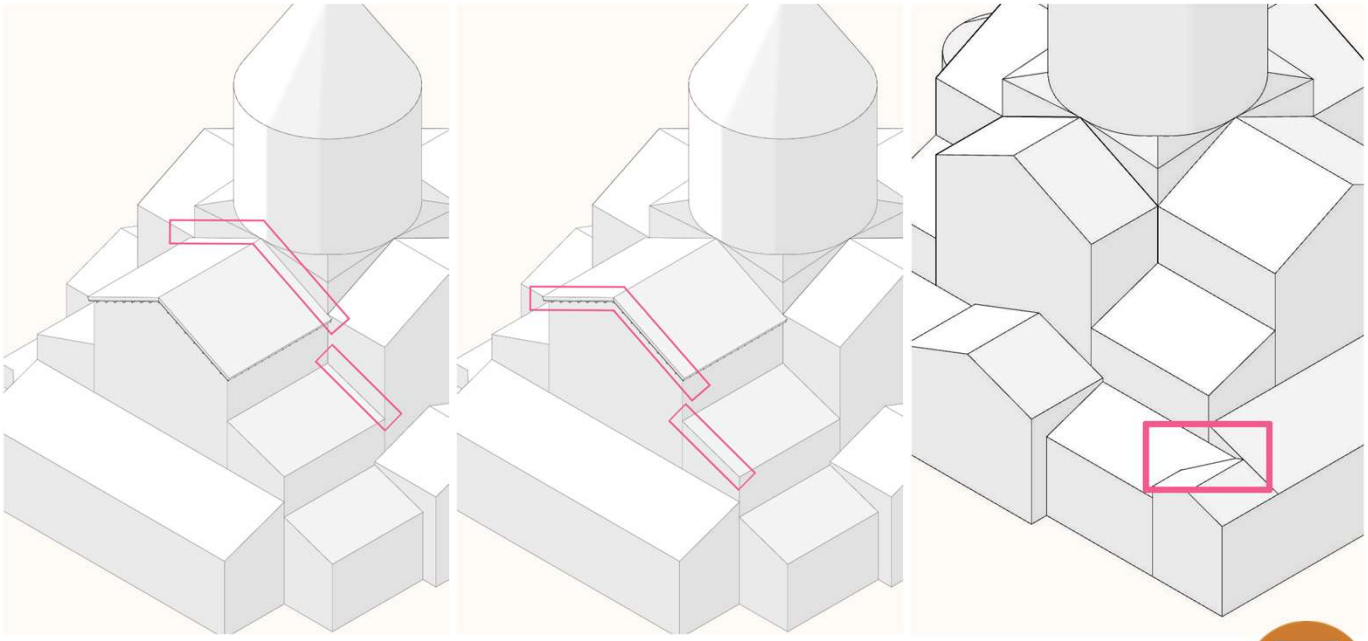
In function of this, it could be clear how to allow ventilation from the lower and the upper parts of the space.

If in some points the empty space will be too scarce, it will be possible to create some small channels, operating through the conglomerate, able to guarantee the transversal ventilation.

Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

5 - Water runoff system and new design of the relationship between pitches and stone walls

The runoff system has to be designed carefully, paying particular attention to **points of discontinuity**, and it will be integrated with the water drainage system to be designed at the ground level.

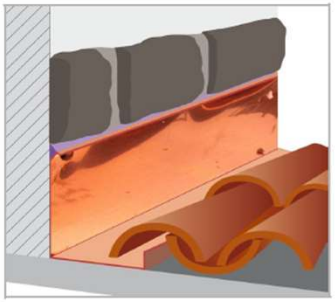


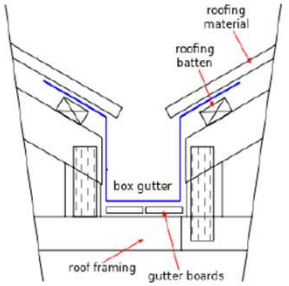
Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

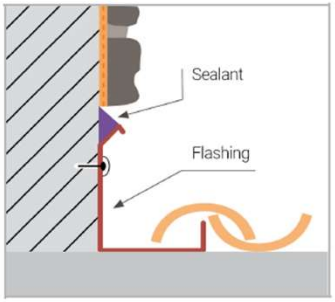
5 - Water runoff system and new design of the relationship between pitches and stone walls

Choices to make:

- Position of downspouts
- Downspouts and gutter materials
- Gutter shape to better integrate them with the cornice of the walls
- Possibility to design hidden or on-sight gutters







Design criteria determining the guidelines scenario. Identification of the most reliable solutions for Monastery safeguarding

6 - **Maintenance**

Utmost care in designing a system that allows localised (and safe) maintenance interventions with the possibility of inspections.

CONCLUSION

All the design areas examined above interact with each other. In particular, the **structure**, the **ventilation**, and the **water runoff system** highlight how the design of the detail concerning the lower part of the pitches is both extremely important and delicate. In fact, this part must

- ensure sufficient overhang of the roof,
- allow air to enter the two ventilation circuits,
- accommodate the gutter necessary for the removal of rainwater from the roofs,
- appear aesthetically consistent with the Monument to not negatively impact its appearance.

Finally, last but not least, nothing that we are now analysing in detail, and evaluating in terms of efficiency and compatibility, will prove useful if the **implementation phase** will not be taken care of to the maximum degree. In these types of works, a careful execution is the decisive part of the design. It is important to involve **skilled workers and masons**, accompanied by the constant presence of expert technicians on site (every day).

Thank you for the attention

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