UNIVERSITÀ
DEGLI STUDI
DI BRESCIA

DEPARTMENT OF CIVIL, ENVIRONMENTAL, ARCHITECTURAL ENGINEERING AND MATHEMATICS

Master’s Degree Course in Civil and Environmental Engineering

Architectural Restoration and conservation

TECHNICAL REPORT

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1. Irma

1.1. Introduction

The technical visit carried out in the municipality of Irma, Province of Brescia, was part of the Architectural Restoration and Conservation course within the Civil and Environmental Engineering program.
The main goal of the visit was to study architectural survey techniques and observe conservation interventions applied to historic buildings.
At the same time, the experience allowed us to reflect on a broader issue: how the preservation of historic buildings may contribute to the revitalization of small mountain villages affected by demographic decline. Irma currently has a very small population and an aging community, conditions that are typical of many inner rural areas in Italy.
In this context, conservation is not only about protecting old structures, but also about giving them new value and potential uses. Revitalizing existing buildings can help strengthen local identity and support small-scale regeneration processes.
During the visit, we analyzed two main buildings: the first through a detailed digital survey using GPS, laser scanning, and mobile mapping tools; the second by observing ongoing restoration works and consolidation techniques.

1.2. Territorial Context

Irma is a small mountain municipality located in the upper Trompia Valley, in the Province of Brescia.

Figure 1 Irma viewed from Vaghezza village

The municipal area covers 5.12 km^2 and has a population of 129 inhabitants[1], making it the second smallest municipality in the Province of Brescia in terms of population density [1]
Irma is classified within Seismic Zone 3 and belongs to Climate Zone F (figure 2), the coldest climatic classification in Italy. This category is characterized by long and harsh winters, significant temperature variations, and extended heating periods. These environmental conditions significantly influence building typologies, construction materials, and maintenance strategies: in fact, severe climatic conditions accelerate material decay processes, especially freeze–thaw cycles that affect masonry, mortar, and roofing elements. As a result, maintenance strategies and conservation interventions must

[1] (2024, ISTAT)

carefully address thermal performance, moisture control, and structural reinforcement, particularly in historic buildings.

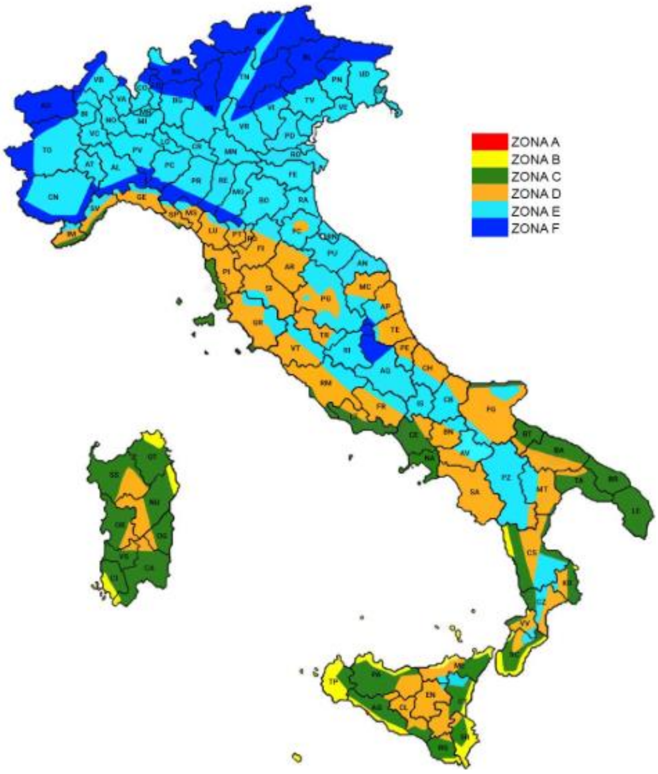


Figure 2 Climate zones by municipality: A (warmest), B, C, D, E, F (coldest). Table DPR 412/93

Demographic Trends

Historical demographic data show a long-term population decline (figure 3). The village reached its demographic peak in the 17th century, with approximately 470 inhabitants, followed by a gradual decrease over time. Although the total number of residents has remained relatively stable in recent years, the main issue today is population aging.

The majority of current residents are elderly, while the number of young adults is limited and children are extremely few.

Like most small mountain settlements, this area sees little immigration and high daily out-migration. Residents travel to larger centers where transport, jobs, and essential services are more accessible.

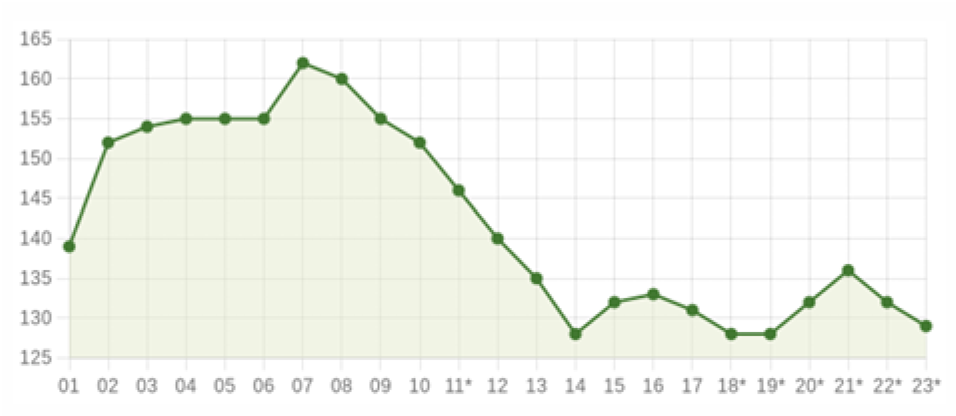


Figure 3 Demographic trend of the population resident in Irma municipality from 2001 to 2023 (ISTAT)

This demographic imbalance highlights the need for strategies aimed at revitalizing the village. One of the key objectives of the case study conducted by PhD researcher Anastasia Psoma was to explore strategies aimed at making Irma more attractive not only for potential new residents, but also for tourists, through the conservation and adaptive reuse of its historic heritage.
As part of the research, a questionnaire was administered directly to local residents in order to identify their main needs, priorities, and suggestions for improving the village's accessibility and overall livability. The collected responses may help define possible strategies to enhance services, support local development, and promote sustainable tourism.

1.3. Casa Renica Building, Survey Activity

The first building analyzed during the field trip was **Casa Renica** (figure 4), a historic structure located in Vicolo Tre Archi in Irma. The site was constructed with traditional mountain building methods and likely dates back to the 17th or 18th century, the different materials used for balconies (wood and reinforced concrete) show that the building has undergone various transformations over the years. [2]
Today, the building shows severe signs of decay and neglect. The wooden balconies are in such poor condition that they are losing pieces, while the reinforced concrete balconies added during the 20th century are thin and deteriorating. Furthermore, the roof structure is significantly aged and already exhibits a partially collapsed section. Because of these significant structural concerns, the entire complex needs to be restudied and redesigned to ensure its future safety and stability

Figure 4 Facade and Back of Casa Renica

The survey was conducted under the supervision of Professor Vassena and his team, whose academic field specifically focuses on surveying and advanced geomatics methodologies.
The initial phase of the survey involved the combined use of GPS instrumentation and a drone. Several ground control targets were placed on the ground and measured using GPS in order to obtain precise reference coordinates. These targets were clearly visible in the drone images and allowed the aerial data to be accurately georeferenced (figure 5).. This integrated approach ensured a reliable spatial framework for all subsequent survey operations. Aerial images and photogrammetric data can be also particularly useful for assessing damage, such as collapsed roof portions or deteriorated structural elements.

Figure 5 on the left, targets used for GPS positioning, on the right, drone

Subsequently, Laika laser scanner was used to acquire detailed geometric information. This technology allows the generation of highly accurate three-dimensional point clouds by measuring distances between the instrument and the building surfaces. The result is a precise digital model of the structure, useful for documenting its current condition and identifying structural deformations or irregularities.

Figure 6 Laika laser scanner

Mobile mapping systems were also employed. This method integrates sensors and cameras to capture spatial data while moving around the building, allowing faster data acquisition and providing a comprehensive representation of the surrounding environment.

The collected data will support the restoration and regeneration project developed by **SEVAT - Servizi Valle Trompia**, which is currently working on the documentation and rehabilitation of Casa Renica. The survey provides an accurate knowledge base necessary for structural assessment, design proposals, and future conservation interventions.

The ground floor was originally a stable for cows, and its layout still reflects this use. The floor shows a raised platform where the cows stood, with a drainage channel in front for waste. Along the wall, the original feeding area is still visible. The room also shows signs of a later intervention, with an added wooden beam providing extra structural support.

Behind the façade we can see a metal element sticking out from the floor, embedded in the concrete structure. It consists of two rods: one smooth and one rusted, with the latter partially wrapped around the former, as if to create an anchoring or reinforcing point. The assembly clearly indicates a subsequent intervention compared to the original construction. The presence of oxidation and the arrangement of the rods suggest that they were intended to reinforce the structure.

Figure 8 steel bars in the back

Figure 9 Arch Casa Renica

The image shows a stone archway made of local quarry stone. The warm, orange-toned stones forming the arch are a clear example of traditional local craftsmanship. An interesting observation is that the archway is partially obscured by the staircase. This suggests that the stairs were a later addition to the original structure, as they obstruct the full view of the arch.

1.4. Casa Corsini Building, Conservation Intervention

During the visit to the second building, we observed ongoing restoration works. The interventions focused mainly on structural consolidation rather than replacement.

The construction site was already active at the time of our visit, with scaffolding installed around the structure and workers carrying out different phases of the intervention. This allowed us to directly examine the building while the restoration process was in progress.

The visit started from the upper part of the building. We first accessed the roof area, where structural interventions were being implemented.

The original curved clay roof tiles were maintained instead of being fully replaced, following a conservation-oriented approach aimed at preserving as much existing material as possible while improving structural stability. An additional protective layer was installed beneath the tiles to enhance waterproofing performance, and they were secured using S-shaped copper hooks to ensure proper fixation and durability while maintaining the traditional roofing system.

Figure 10 Copper hooks holding tiles

After examining the roof, we gradually moved downward to observe the internal structural elements. Here, we could clearly see the integration between original beams and newly added wooden supports, designed to enhance load-bearing capacity while respecting the original construction system.

Figure 11 old and new wooden beams

Continuing the visit, we reached the lower floors, where we observed restored wooden doors that had been repainted and treated. These elements showed how surface interventions can contribute to both protection and aesthetic improvement.

Figure 12 treated door

Then, we exited the building to examine the external façade. The plaster had been repaired and repainted in a light pink/peach tone, refreshing the appearance of the building while maintaining its traditional character within the village context.

At the end of the visit, we examined a room located at street level, accessible directly from the road. Due to its position on the shaded side of the building and its contact with the ground, the space presents persistent moisture problems. One of the perimeter walls appeared constantly damp, showing clear signs of rising humidity and water infiltration. Although completely eliminating the problem may be difficult due to the building's orientation and ground conditions, mitigation strategies were discussed. In particular, it was suggested to remove the portion of the concrete screed directly in contact with the damp wall and replace it with a layer of stone(figure 13).

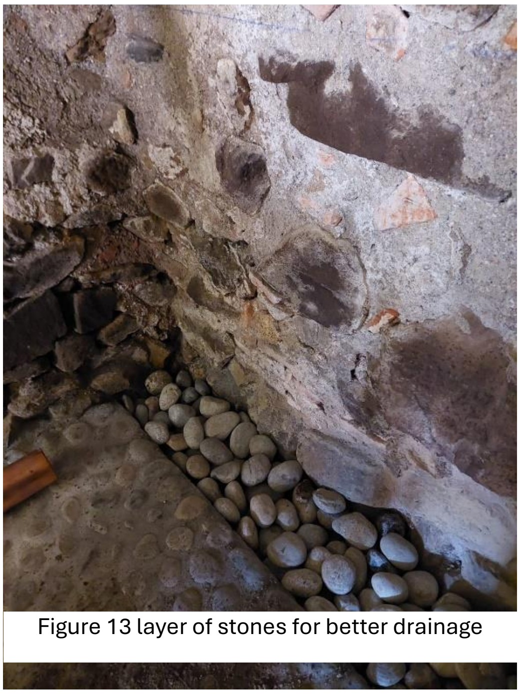


Figure 13 layer of stones for better drainage

This solution would allow water to drain more effectively beneath the floor, improving ventilation and reducing capillary moisture accumulation. The intervention could be integrated with the existing ventilated subfloor system (igloo), helping to limit long-term damage to the masonry. This example highlighted how even small technical adjustments can significantly improve the durability and conservation of historic buildings affected by environmental factors.

1.5. Final considerations

The visit to Irma highlighted how architectural conservation is closely connected to both technical and social aspects. On one hand, the survey activity demonstrated the importance of accurate digital documentation as a basis for safe and informed design decisions. On the other hand, the restoration works showed how consolidation and material compatibility can preserve historic value while improving structural performance.

The experience also emphasized that interventions on historic buildings in small mountain villages are not only technical operations, but part of a broader strategy of regeneration. In contexts affected by demographic aging and economic fragility, conservation and adaptive reuse can support local identity and contribute to making the village more attractive and sustainable.

Overall, the field activity provided a valuable opportunity to connect theoretical knowledge with practical observation, strengthening our understanding of restoration processes within real territorial conditions

2. Heritage Detective – Medina of Fez (Morocco)

The historic site I chose is the Medina of Fez in Morocco, which is also my city of birth. Even though I have always lived in Italy, I feel connected to this place because it represents an important part of my cultural identity and family background.

The Medina of Fez is one of the oldest historic cities in Morocco and one of the largest and best-preserved medieval urban areas in the Arab-Islamic world. Because of its historical and cultural importance, it was added to the UNESCO World Heritage List in 1981 [3]. The site was recognised not only for the beauty of its monuments but also because it preserves an entire historic urban environment that still functions today.

What interests me most about Fez is that it represents an idea of restoration that goes beyond simply protecting old buildings. The Medina is not preserved as a museum separated from modern life: it is still inhabited and continues to be a place of everyday activity, work, culture and social life.

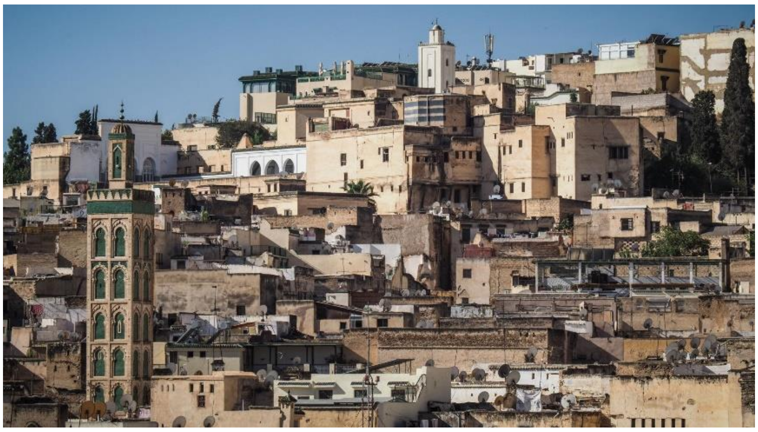
Figure 14 Bab Bujloud

One example that represents this continuity is Bab Ftouh, one of the historic gates of the old medina. The name Bab (al-) Ftouh literally means "Gate of the Opening," but historically it has been interpreted as "Gate of Conquest" or "Gate of Victory."

Originally established in the 11th century and rebuilt in its current form around 1212 during the Almohad period, the gate has preserved its historic character despite many restorations over the centuries. Interestingly, while most old gates in Fez have curved entrances to block enemies, Bab Ftouh is unique because it provides a straight and direct passage into the city. To protect this entrance, it was built with two massive rectangular towers on the sides. Standing about 15 meters high, it is one of the largest gates in Fez. Visually, its main entrance features a classic Moroccan horseshoe arch set inside a simple decorative frame, flanked by smaller arched doors on both sides.

Today, Bab Ftouh still remains connected to daily life and movement in the city and continues to serve as an entrance to areas linked to local activities and markets. This shows how historic spaces in Fez preserve their importance not only through protection but also through continued use. [4]

Another important element is the old medina itself, known as **Fez el-Bali** (the oldest walled part of the city). Founded as the Idrisid capital between 789 and 808, it is famous for housing the University of al-Qarawiyyin, recognized as the oldest continuously operating university in the world. Because of this rich historical and cultural fabric, the entire urban area, including its walls and surroundings, was designated a UNESCO World Heritage Site in 1981. Today, with a population of around 156,000, Fez el-Bali is believed to be the largest car-free urban area in the world.
Fez el-Bali is made of narrow streets, small passages and interconnected alleys that create a dense urban fabric. These streets are not only an architectural feature: they reflect centuries of social organisation and traditional urban life. Walking through them gives the feeling that history is still active rather than frozen in the past. [5]



The madrasas, historic schools inside the medina, are another important example. Their internal courtyards, geometric decoration, carved wood, mosaics and detailed craftsmanship show the high level of traditional construction knowledge developed over centuries. Preserving these buildings means preserving not only structures but also artistic techniques and cultural knowledge.
A prime example of this heritage is the **Bou Inania Madrasa** [6], widely considered the most important and magnificent historic school in Fez. Built in the 14th century, it is a masterpiece of Marinid architecture, showcasing the highest level of traditional craftsmanship with its stunning central courtyard, intricate stucco carvings, complex geometric tilework (*zellij*), and cedarwood ceilings. What makes Bou Inania particularly relevant to the concept of continuity is that it was unique in functioning not only as an elite educational institution but also as a congregational mosque. Today, it stands as a living monument where history, community memory, and spiritual life still intersect.

What I find especially meaningful is that, in many parts of the Arab world, historic preservation is often understood as continuity as much as conservation. The importance of heritage does not come only from maintaining buildings exactly as they were, but also from allowing them to continue serving cultural and social functions in the present. Heritage remains alive because communities continue to use it.

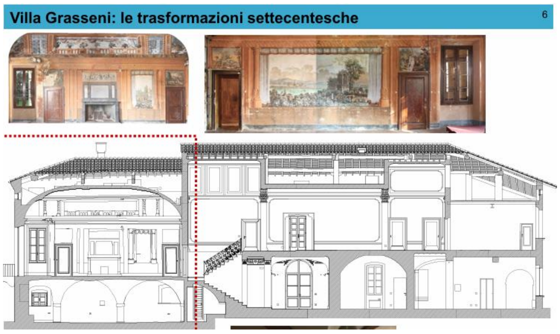
This idea contributes directly to the discipline of historic preservation because it suggests that restoration is not only about protecting physical materials but also about protecting identity, memory and traditional knowledge.
The common values identified are:

- respect for cultural heritage;
- preservation of historical identity;
- continuity between past and present;
- transmission of traditional craftsmanship;
- protection of community memory.

From the buildings in Fez, we can infer several traditional construction techniques such as the use of local materials, internal courtyards adapted to climate conditions, handcrafted decoration, carved wood, mosaics and building methods transmitted across generations.
For me, the Medina of Fez represents an example of how restoration can protect history while allowing a place to remain part of contemporary life. Although I have always lived in Italy, knowing that this is my city of origin makes this idea of continuity feel especially meaningful and personal.

3. Villa Grasseni (Flero, Italy)

Villa Grasseni, located in Flero near Brescia, is a historic villa set within a context that today is a mix of residential areas, public services and local landmarks such as the parish church. Although the surrounding environment has changed significantly over time, the villa still stands as a recognizable element of the historical landscape and reflects the layered development of the territory.



From a historical point of view, the building has undergone several phases of transformation, which are still partly readable in its current configuration. Archival maps and documents helped to reconstruct its evolution, showing how the villa adapted over time to different uses and social contexts. However, what emerged most clearly during the visit is that the building should not be read as a single "fixed" object, but as a structure made of overlapping historical layers.

A particularly interesting aspect is the presence of the oldest nucleus of the villa, partially identifiable through traces discovered in the attic and in relation with decorated surfaces on the lower floors. The presence of fresco fragments suggests that some parts of the original decorative system are still preserved, although fragmented and incorporated into later modifications. This aspect highlights how much of the building's history is still physically embedded in its walls.
The intervention of restoration in 1980 appears to have been guided by both conservation needs and a desire to recover the architectural readability of the complex. One of the main outcomes is the balance between consolidation of the structure and respect for the historical identity of the villa.

The current restoration works observed during the visit are focused on the conservation of both wall surfaces and decorative elements, with particular attention to materials that are most vulnerable, such as plaster and frescoes.

One of the main principles explained on site is that original plaster is considered an essential historical layer and, whenever possible, it is preserved rather than removed or replaced. Even when detached or damaged, it is treated as part of the building's memory.
A key technique shown during the visit was the consolidation of plaster through injections. In cases where the plaster is no longer well attached to the masonry, a fluid mixture is inserted using syringes in order to re-establish adhesion between the support and the surface layer. This method allows intervention in a minimally invasive way, avoiding the loss of original material. It also demonstrates how restoration today relies on precise technical operations rather than complete replacement.

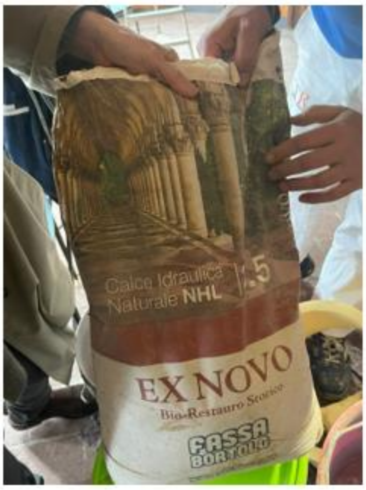
A recurring problem observed in several areas of the building was the presence of humidity in the walls. Moisture infiltration is one of the main causes of deterioration, leading to detachment, cracking and surface loss in plaster layers. For this reason, much of the restoration work is not only focused on aesthetic recovery but primarily on stabilization and structural consolidation of the existing materials.

The visit also provided the opportunity to observe the frescoed surfaces more closely. The villa contains highly decorated rooms, where wall and ceiling paintings play a central role in defining the architectural space. In some areas, different pictorial layers appear to overlap, suggesting the presence of earlier decorative phases beneath the visible surface. This stratification adds further complexity to the building and confirms its long and layered history.

A particularly important aspect of fresco restoration that was explained during the visit concerns the treatment of losses. When large portions of decoration are missing, they are not reconstructed or repainted, in order to avoid creating a false historical image. Instead, the gaps are left neutral and clearly readable.
When losses are smaller, a limited chromatic integration is used, aiming to visually harmonize the surface without reproducing figures or original designs. This approach maintains a clear distinction between original and restored parts.

One of the most striking spaces observed was a large hall with a very high ceiling and rich decorative system. The proportions of the room, with a height well above five meters, enhance the visual impact of the frescoes and contribute to the perception of the space as both architectural and symbolic. At the four corners of the ceiling, representations of the Four Seasons are visible, forming a coherent decorative cycle that frames the room.
During the visit, restoration materials and tools were also presented, including brushes and mixtures used for consolidation works. These

materials helped illustrate how restoration is not only theoretical but also highly practical, requiring manual precision and a deep understanding of material behaviour.
Overall, the experience at Villa Grasseni highlighted how restoration is a process based on balance: between preservation and intervention, between readability and authenticity, and between technical solutions and respect for historical material.

Personally, what impressed me the most during the visit was seeing how restoration is often not about making things look “new”, but about carefully keeping what already exists. I found it very interesting that even damaged plaster is not removed, and that special techniques like injections are used to make it stick again to the wall.
I was also impressed by the frescoed hall, especially the ceiling with the Four Seasons. Even after all the technical explanations, the room still looked very powerful and beautiful. It made me realize that restoration is not only a technical job, but also something that allows people to continue experiencing and appreciating these spaces today.

4. Braun Lecture

The lectures focused on how to analyse and work with historical buildings before starting any restoration or intervention project. The main idea was that good planning starts from a deep understanding of the existing building and its history.

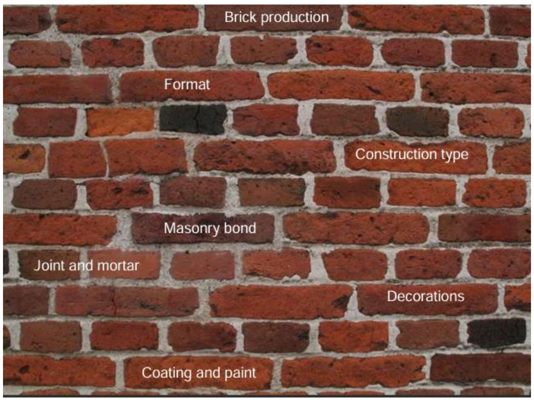
The first important point was the knowledge of what we are analysing. Before planning, it is necessary to understand the plot, the building structure, and all the existing conditions. Knowing property boundaries is essential and cadastral maps are very useful to understand the area and building density. In Northern Germany many cadastral maps come from historical periods and can provide important information.
Existing drawings can help but they should never be accepted without checking because they may contain errors. For this reason, new measurements are often necessary. During the survey phase it is important to represent real dimensions and real angles. Historic buildings are rarely perfectly regular, so angles should not automatically be drawn as ninety degrees.

Another important aspect is understanding the territorial context. Every project should start from a general reading of the area and the relationship between the building and its surroundings. Documentation should be organised and systematic in order not to lose important information.
A concept introduced during the lecture was the Raumbuch. In Italian it can be translated as libro degli ambienti. It is a systematic documentation of all rooms and surfaces inside a building and includes information about dimensions, materials, conditions, and historical elements. This method helps organise data and supports restoration planning.

The lectures also explained the importance of investigating building history. Instead of asking how old a building is, the correct question is understanding how old the different parts of the building are. Historic buildings usually change over time and every phase becomes part of their identity.

One example presented was the Renaissance castle in Gadebusch. Through surveys and photogrammetric analysis it was possible to identify older architectural elements and reconstruct the historical development of the facade. Another interesting structural solution shown was the hanging truss, used to create large spaces without internal columns.
A further topic was status detection, which means documenting the actual condition of the building. This work should be done directly on site and often involves architects, engineers, surveyors, and restorers. Attention should be given to cracks, deformations, humidity, material loss, and other signs that can explain the building condition.

The second part of the lectures focused on traditional building materials in Northern Germany. Before industrialisation construction was done by hand and depended on local resources. Because natural stone was limited, brick became the main material. Brick production methods influenced colours, dimensions, and construction quality.



Traditional mortars were also discussed. Lime was commonly used and in some areas high fired gypsum was an important historical technique. This method was later forgotten and rediscovered in modern times.

Overall, the lectures showed that working with historical buildings requires careful observation, accurate documentation, and respect for the existing structure. Understanding the building before intervening is essential to make sustainable and appropriate design decisions.

5. Degradation of materials

For the understanding of different types of materials degradation, we went with the professor in the historic center of Brescia: the professor showed us many examples of degradation on historic buildings. Historic buildings are made of natural and artificial materials such as stone, brick, mortar and plaster. Every building is different, so there is no standard restoration method. For this reason, conservation prefers regular maintenance and the preservation of the original materials instead of replacing them.


We started the visit at Piazza Vittoria, where there are different buildings from Fascist period and the square had a different appearance.

In this figure, we can observe stone slabs that were used to protect the original stone. On one slab we can see red stains caused by the oxidation of iron. These stains can be removed with cleaning, however it must be done carefully, because cleaning always could remove small parts of the stone.

During the visit we also talked about cleaning methods. There are different types of cleaning and conservators must always choose the least aggressive one. The objective is not to make the building look new, but to preserve as much original material as possible.


Other types of degradation are lacuna and detachment, that we could observe on several buildings. Detachment happens when part of the surface separates from the support. If that detached part falls away completely, it leaves a lacuna. These degradations are common on plaster and stone surfaces.



The professor also showed us crusts on stone surfaces. Black crust is usually caused by pollution and chemical reactions. In some areas the crust was also connected to dog urine because salts can contribute to the formation of effluorescence (left image). If black crust penetrates inside the stone, it can cause the loss of the original surface (central image). Dust deposits may also become crusts after many years if they are not removed (right image).

Another common degradation was biological growth. We saw biological crusts, moss and vegetation growing on walls. Plants retain moisture and can damage the stone or create cracks. Vegetation is not only an aesthetic problem because its roots can accelerate deterioration.

We observed chromatic alteration in different places. It is a change in the original colour of the material caused by sunlight, pollution, chemical reactions or unsuitable restoration materials. In the picture, it is presented the case where the colour of the columns changed over time because of light exposure.

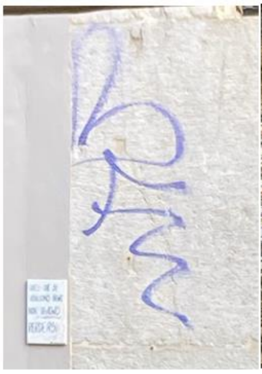
we saw also different types of staining: on the left image, we saw green stains produced by copper elements and on the right image there’s the example of surface staining due to rainwater. Water can also create visible streaks on façades when it flows over the surface.

Another important degradation was efflorescence. We noticed white salt deposits on some walls. Efflorescence appears when water moves through porous materials, carries dissolved salts to the surface and then evaporates, leaving white crystals behind. Although it often looks like only an aesthetic problem, salts can also crystallize inside the stone and produce more serious damage.


In several buildings we identified scaling and alveolization. Scaling is the detachment of thin layers from the stone surface. Alveolization, also called honeycomb decay, creates small cavities that give the stone a honeycomb appearance.



Patina was another important topic during the visit. Patina is a natural surface modification that develops over time due to ageing and environmental exposure. It acts as a protective layer, though it can take many different forms depending on the stone, the environment, and biological activity.
Patina is generally considered part of the history of the monument and should not be removed. For example, bleach can remove the patina and damage the historical value of the stone (left image, they used to clean with bleach but then they saw it caused damage).
It could be caused even by people touching statues continuously (central image).




In the historic centre we also found graffiti and erosion of pavements.
Graffiti are a form of anthropic degradation because they are caused by human actions.
Some pavements showed erosion due to continuous foot traffic.
Other pictures show loss due to damage caused by bombs during the war or also loss of parts of statues, such as a missing nose.

The professor pointed out some previous restoration works carried out with incompatible materials, such as concrete used to fill gaps in historic columns. Modern materials are sometimes chemically or physically incompatible with the original stone and may create new degradation instead of solving the problem. This is why restoration today always tries to use compatible materials and preserve the original structure whenever possible.

At the end of the visit it was clear that recognizing degradation is one of the most important steps in conservation. Every monument has its own history and its own problems. Before any intervention, it is necessary to understand the causes of deterioration and choose the most suitable conservation strategy, always respecting the original materials

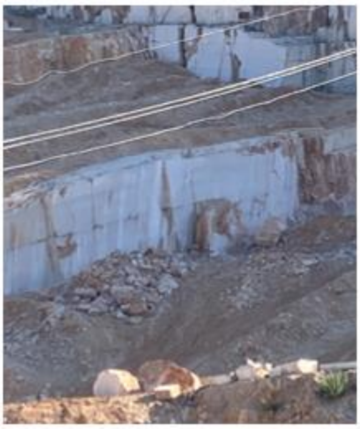
6. Cave

As part of the course, we visited the Botticino quarries, near Brescia, to understand how Botticino stone is extracted and processed. Botticino marble is actually a compact limestone, famous for its strength, durability and light beige colour. It has been used for many important buildings in Italy and abroad because it can be polished and has good mechanical properties.

At the beginning of the visit we stopped at a panoramic point called Destrarino, where we could observe the quarry from above. The professor explained that the excavation area has different levels and that there is also a shelter below for workers. Some parts of the quarry have a slope of about 25%, so rocks can naturally fall from the upper areas. For this reason, safety is very important.

We then observed the Botticino Classico basin, where several companies work next to each other. Every company owns a different part of the quarry and extracts stone from its own area. One of the companies we saw was Fassa, where a large amount of waste material was stored.





The professor explained that quarrying produces a lot of waste. Only about 25% of the extracted rock becomes commercial blocks, while the remaining 75% is waste material because it contains fractures, impurities or has the wrong dimensions. Part of this waste is not completely discarded because it can be reused to produce lime, fillers and other construction materials.


We also saw the large bedding planes of the stone. The orientation of these natural layers is very important because the blocks must be cut following the bedding planes. If the stone is cut in the wrong direction, it becomes weaker and can break more easily over time.

The extraction process starts by isolating the block from the rock mass. Today this is done mainly with a diamond wire saw. The steel wire, covered with industrial diamonds, cuts the limestone very precisely and allows large blocks to be detached with limited vibrations compared to older extraction methods.

After the extraction, the blocks are transported to the production area. Here we visited the factory where the stone is processed. The large blocks are first cut into slabs using a large frame saw (the yellow machine in the picture).

This yellow machine produces slabs with a uniform thickness that can later be used for floors, walls and cladding.


Before the slabs are finished, a resin is applied to the stone. The resin fills small pores and natural imperfections and also strengthens the slab, reducing the risk of breaking during the following processing stages.

Finally, the slabs pass through polishing machines. First they are ground to obtain a flat surface, and then they are polished until they become smooth and shiny. According to the final use, the slabs can also receive additional cuts or different surface finishes.

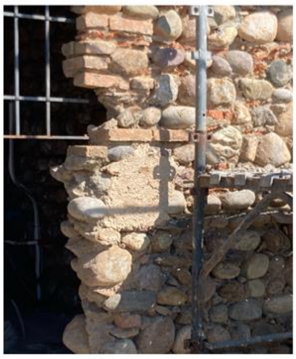
The visit helped us understand that the production of Botticino stone is a long process, from extraction in the quarry to the finished polished slab. We also learned that careful extraction, correct cutting direction and proper processing are essential to obtain a durable and high-quality material while reducing waste as much as possible.

7. Construction site in Brescia

During another field trip, we went to a restoration construction site. The building had been abandoned for about 50 years and had never been used during that time. Originally it was a farm building, with a barn and a stable, but during the restoration its function was changed into a residential house.
The main objective of the project was to preserve as much of the original building as possible.

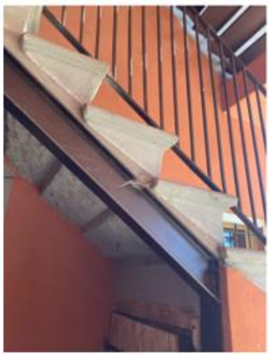
The old floor structures were replaced with new solid timber floors and they chose solid wood instead of laminated wood to keep a more traditional appearance. The intervention also avoided the use of reinforced concrete whenever possible, using steel beams to improve the structure while respecting the historic building.

Outside, we observed that the lower part of the walls was the original masonry, while the upper part had been raised using bricks to increase the height of the building (right image). At the end of the works the exterior will be covered with natural hydraulic lime plaster, a material that is more compatible with historic masonry because it allows the walls to breathe and reduces moisture problems (left image).



The upper part of the building was originally the hayloft, recognizable by its large rectangular openings used in the past for ventilation. We also observed the roof details, including the traditional coppi tiles, the wooden eaves and the chimney used to release smoke from the stove. The building will also have photovoltaic panels, making it a low-impact and energy-efficient house while preserving its historical appearance.

Looking at the lant of the building, we noticed that there was a side of the building directly attached to another property, so the masonry wall was insulated from the inside. In this situation it was not possible to intervene from the outside.

We also observed a reinforced brick-and-concrete lintel above one of the openings and a staircase built with Pietra di Sarnico, a local stone widely used in Lombardy because of its strength and durability.

This visit showed how a historic rural building can be adapted to modern needs while preserving its original character. The restoration followed the main conservation principles discussed during the course: maintaining the original masonry whenever possible, using compatible materials such as hydraulic lime, limiting unnecessary interventions and combining traditional construction techniques with modern solutions only where they were really needed.

8. Aosta

During the field trip to Aosta, we visited several important Roman monuments and studied how conservation works in real archaeological contexts. Aosta was founded as Augusta Praetoria in 25 B.C. and still preserves many structures from the Roman period. The visit helped us understand how ancient buildings are studied, restored, and protected today, a multidisciplinary process where the administrative framework in Italy assigns the legal role of project supervisor to the architect, following the historical Professional System established by Law number 1395 of June 24, 1923.

In the morning, we started by exploring the Roman city walls. These walls show a typical Roman construction system with a double structure: an external layer originally made of large, regular blocks of travertine or natural conglomerate (left image), and an internal core made of *opus caementicium*, a type of Roman concrete mixed with river stones and aggregates. Locally in Aosta, this internal core material is traditionally called *sacco* (central image, picture taken from above).
On the top section of the wall we could see that the internal structural buttresses are directed toward the inside of the city, while the flat stone face looks outside.



Over time, many external stones were removed and recycled in other buildings, showing that in the past, ancient populations accepted the reuse of materials for pragmatic reasons rather than being obsessed with physical conservation in place.

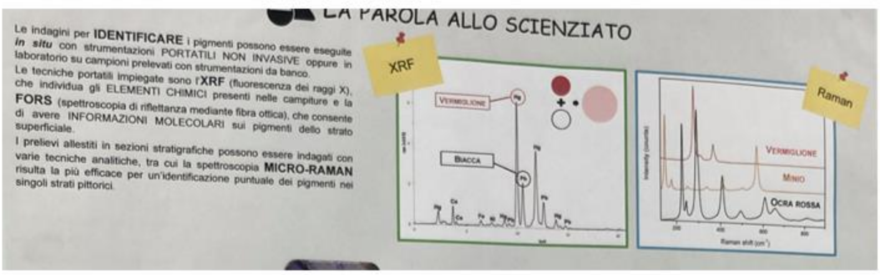
We also observed how different historical periods are visible on the same structure. For example, some parts were modified or integrated in the medieval period, while other interventions were added in the 19th and 20th centuries.
During this visit we could understand better also modern protection methods. These included surface monitoring using small resin disks to fix target mirrors for structural topographic control, the application of a specific biocide liquid to eliminate vegetation roots without damaging masonry, and a dry micro-abrasive surface cleaning system using specialized pink sand.
These methods included:

- Monitoring the walls by using small resin disks to hold mirrors for structural control (left image)
- Putting a special liquid (biocide) on the walls to kill plant roots without hurting the stones.
- Cleaning the surface without water by using a dry system with special pink sand (right image)

No water washing was allowed, as water can cause dangerous phenomena due to frost-thaw or wet-dry cycles, where freezing water expands inside the open pores of the stone and causes a loss of cohesion, leading to cracking and detachment.

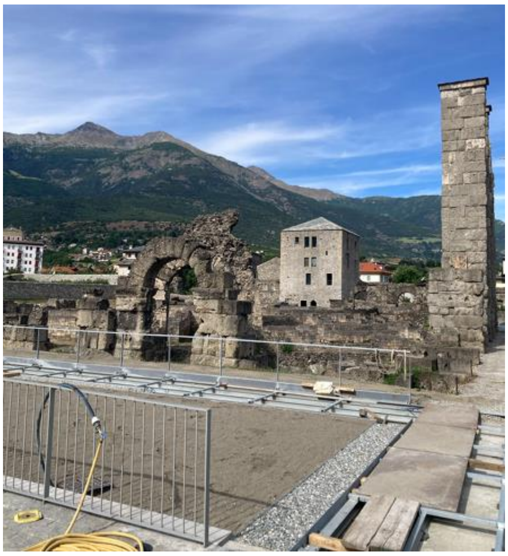
Another example of restoration work is the one made by Alfredo d'Andrade on the *Tour Fromage*, who completed some missing parts using bricks and new stone materials to stabilize the structure and make its original shape readable, without hiding the difference between old and new. This approach is important in modern conservation because it avoids creating a false historical reconstruction.

In the afternoon, we visited a specialized chemical laboratory directed for decades by Lorenzo Appolonia, a key international figure in chemistry applied to cultural heritage protection. As a leading expert in diagnostics and restoration, he managed this laboratory to study material characterization, analyze degradation processes, and develop non-invasive methods for preventive and planned conservation. Although he is now retired, he remains a highly respected chemist who still monitors operations and supports the laboratory. In Italy, cultural heritage is usually protected by state institutions, but in autonomous regions with a special statute like Valle d'Aosta, the management is done directly by a regional body, the *Soprintendenza per i beni e le attività culturali*, which operates with independent regional powers rather than answering to the local municipality, though it works in close coordination with the *Comune* for practical executive projects.
During his career, Lorenzo Appolonia held an important national and international role, serving as President of the Italian Group of the International Institute for Conservation (IIC) and coordinating UNI and CEN groups to define European standards for heritage protection [7].
He represented one of the very few scientific figures in Italy dedicated specifically to the scientific defense of national patrimony within state heritage departments.
He explained to us how conservation today is strongly scientific and is always a compromise between theory and reality, because material behavior depends heavily on three main parameters: the environmental microclimate, the specific geometry of edges and corners which conditions water flow, and human physical contact.



In the laboratory, we learned that scientific analysis is essential before any restoration to design a non-invasive intervention. Technicians use microscopic observation to look at stone layers and perform

chemical tests to understand the material composition. They also use molecular spectroscopy with portable tools like XRF and Micro-Raman to quickly identify the chemical elements and specific pigments used in the past without damaging the ancient surfaces.
These studies help conservators decide the most suitable intervention, avoiding damage to the original material.



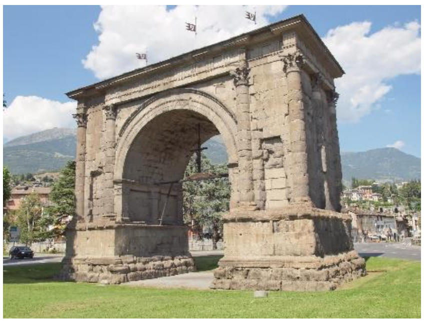
Later, we visited the Roman Theater of Aosta. In Roman urban planning, theaters were usually built outside the city walls, but the theater of Aosta is a special exception because it was built directly inside the fortified perimeter. The city walls themselves were heavily fortified and connected to numerous defensive towers located at regular distances. The theater is still partially preserved, and its most impressive feature is a large, 22-meter-high façade wall with regular openings.
The building suffers from typical degradation problems, and water represents the main threat to the structure because of the low temperatures during winter. The frost-thaw cycles cause the water inside the stone pores to freeze and expand, which accelerates the damage to the masonry.
The stratification of the wall shows different historical phases, including past restoration interventions where protective, sacrificial layers of mortar and stone were applied to absorb weather damage and protect the original Roman materials underneath. Today, the site includes new work like the surrounding pavement and modern railings; however, these additions are often criticized because the design of the railings is visually invasive and alters the aesthetic value of the ancient monument.

The next site was the Criptoportico, an underground horse-shoe-shaped double gallery originally connected to the Roman forum, which formed the structural basement surrounding the sacred temple area and was later used as a secret meeting place during early Christian times.
The structure features a very fine finishing layer of original Roman plaster (central image); one of the most interesting aspects was the presence of ancient repair works for example in the right image, it is possible to see that in origin there was an arch but since a main stone pillar had moved, shifting the weight of the arch above, old restorers solved this by adding a supporting integration wall.

These differences are intentionally visible, perfectly matching the principles later written in the Venice Charter of 1964, since the original wall uses large stone blocks while the restoration uses smaller stones with a different surface texture to avoid creating a historical fake.

We also visited important monuments in the city center, such as the Porta Praetoria and the Arch of Augustus.

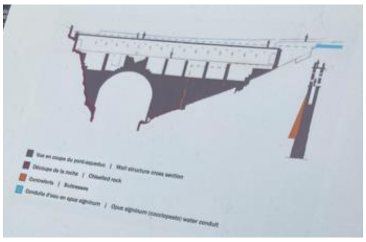
The Porta Praetoria was built in 25 B.C. as the main eastern entrance to the city. It has two parallel walls made of large stone blocks (*opus quadratum*) between two defensive towers, creating a central courtyard with a walkway on top. The gate has three archways for chariots and people walking. The main structure was made of large blocks of local natural stone, but during the 1st century A.D., it was decorated with beautiful local and imported marbles (Marmo Bardiglio, right image). Recent archaeological excavations uncovered the base of the pillars and the original Roman stone road. This allows us to see the real, original height of the monument. It also shows how the gate changed over time, especially during the Middle Ages when the top walkway was transformed. In fact, the excavations found that after the Roman era, people used the spaces inside the gate for houses and workshops, which stopped the structure from being used as a regular passage.



Nearby stands the Arch of Augustus, a single-vault celebratory monument that has an important restoration history. Originally, the arch had a very high upper part called an attic, which held a dedication inscription in bronze letters. During the Middle Ages, this attic collapsed, and in the 12th century, a protective slate roof was added to prevent rain and winter water from entering the structure, freezing, and cracking the stones.

In the 19th century, the monument was restored following the principles of the Roman school of Stern and Valadier. Instead of rebuilding the missing parts with decorative fakes, the restorers decided to stabilize the existing structural shoulders and preserve the authentic patina of the stone, keeping the medieval roof as part of the monument's history.

More recently, modern restoration interventions were carried out to fix damages caused by air pollution and weathering. Restorers carefully cleaned the surface to remove dark crusts caused by traffic pollution without damaging the ancient stone. They also performed micro-injections of special lime-based mortars into the cracks to consolidate the large blocks of local conglomerate stone that were starting to split apart.



In the afternoon, we visited the Pont-d'Ael, a Roman aqueduct bridge built in 3 B.C. over a deep valley. It is an amazing example of Roman engineering with two levels: an upper channel to carry water and a lower covered tunnel for people walking. On the upper part, archaeologists found the impression of a nailed boot left in the ancient mortar by a Roman worker. Outside the bridge, excavations also uncovered a piece of the original Roman road cut directly into the mountain rock.

To build the bridge, Roman engineers cut and shaped the bare rock of the mountain to create a strong foundation. The entrances to the lower tunnel have rounded stone arches with small square holes in the floor, showing where wooden doors were originally attached.

Inside the tunnel, archaeologists removed a lot of dirt and discovered 7 internal walls. These walls create a series of hollow rooms inside the bridge. Architects and engineers explained that this clever system made the bridge much lighter and more flexible against earthquakes without losing its strength. They also found an original piece of a wooden beam inside a wall, and a Carbon-14 test proved it was part of the original Roman scaffolding.

Originally, the pedestrian floor was made of wooden boards supported by a small side stone recess, but since it was completely lost, the modern restoration project installed a contemporary glass walkway. This allows visitors to look down into the internal hollow chambers without damaging them, creating transparency and a clear dialogue between ancient construction and modern structural comprehension.

At the end of the visit, it was clear that Aosta is a place where different historical layers coexist. Roman construction techniques, medieval modifications, and modern restoration projects are all visible at the same time. Conservation in this context does not mean rebuilding the past, but understanding it, protecting it, and making it readable for the future. The visit showed how important it is to combine historical knowledge, scientific analysis, and respect for material authenticity in every restoration project.

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