Core CONSERVATION

Dampness Report

Clock Tower – Arts Centre

23 February 2025

To whom it may concern,

Please see below the results of the recent dampness survey performed on your building.

The following information is covered:

Feel free to contact me with any questions you might have.

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Reason for Inspection

We have been asked to investigate the dampness problem in the clock tower of the Arts Centre affected by **increasing water ingress** during the past few months.

Key Findings – Short Summary

After performing a detailed technical inspection (detailed in the next section), here is a short summary of the key findings:

- Three areas have been inspected: the Storage Room, the Clock Room and the Cupola.
- The south wall and concrete ceiling of the Storage Room is subject to significant condensation that results in liquid water dripping. Other, mostly external wall are subject to some rainwater penetration, that over time slowly have ruined the plastering.
- The Clock Room walls are subject to rainwater penetration due to the exposed nature of the walls. This results in high internal humidity, which is also affecting the clock mechanism. There is also significant condensation on the steel and concrete surfaces, creating water drips to the floor (and potentially to the Storage Room), resulting in consistent but slow damages to the timber floor of the Clock Room.
- The Cupola is exposed to wind driven rain. Two round window panes are missing, causing significant water ingress on the North and East Walls.

FINDINGS

Thank you for your time earlier, for showing me around your property. Here is a quick summary of findings and some of the points we have discussed.

The Clock Tower comprises of three rooms:

1. **The Storage Room** used as a storage. This room also houses parts of the tower clock winding mechanism.
2. **The Clock Room** housing the 1911 main tower clock mechanism.
3. **The Cupola** with the clock faces.

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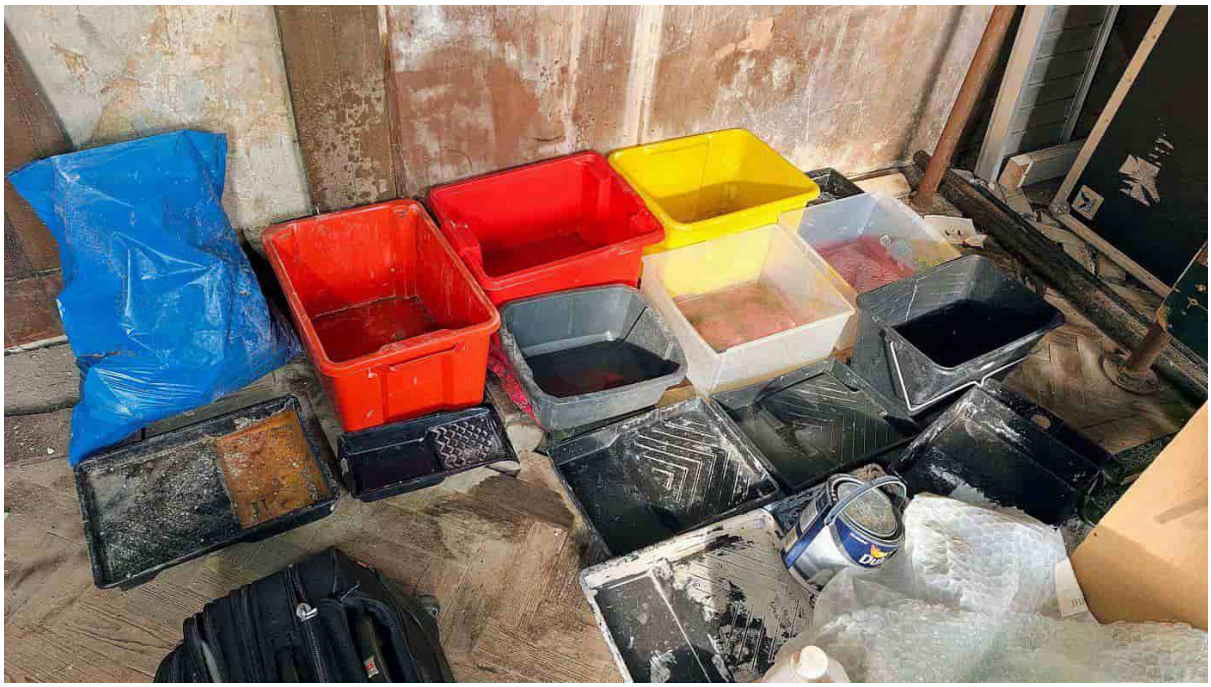
Clock Tower – Storage Room

Increasing water ingress has been reported from the storage room, which significantly worsened from November 2024 with the onset of the cold and rainy season. Water catching trays and buckets had to be put in place to deal with the ongoing dripping water into the storage area.



The worst affected area is the South facing wall with a concrete flat roof section above the dripping area.

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Due to the cold environment and lack of any thermal insulation in this area, condensation causes ongoing liquid water formation on the cold concrete and embedded metal beam surfaces. The condensation is so intense, that it causes similar manifestation to liquid water ingress, resulting in ongoing water dripping.

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As this problem has been ongoing for years, it already caused some significant damages to the timber ceiling and joists, which are also the floor of the clock room situated above.

If not addressed, the water from the ongoing condensation could permanently damage the historic timber ceiling structure.

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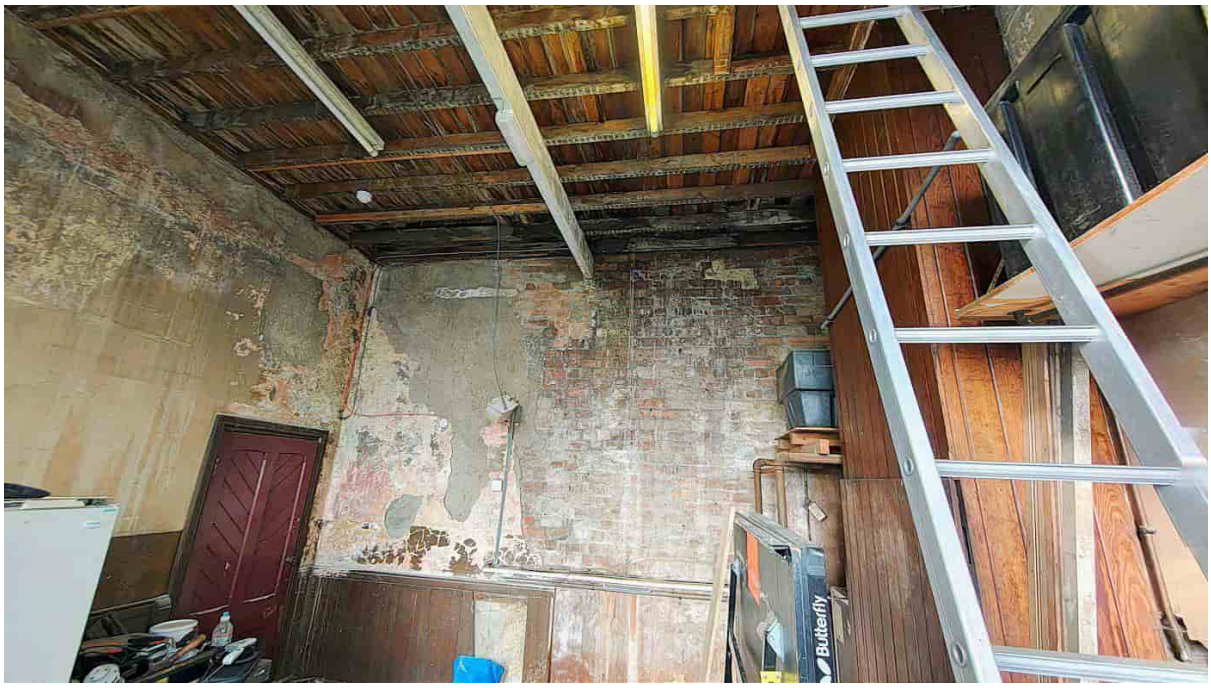
The plastering in the room is in generally poor condition. The lime plaster on the South facing wall, mostly affected by the dripping condensation, has almost completely decayed.



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Due to the decayed lime plaster, the wall surface get even colder, as shown by the infrared (IR) camera photos.

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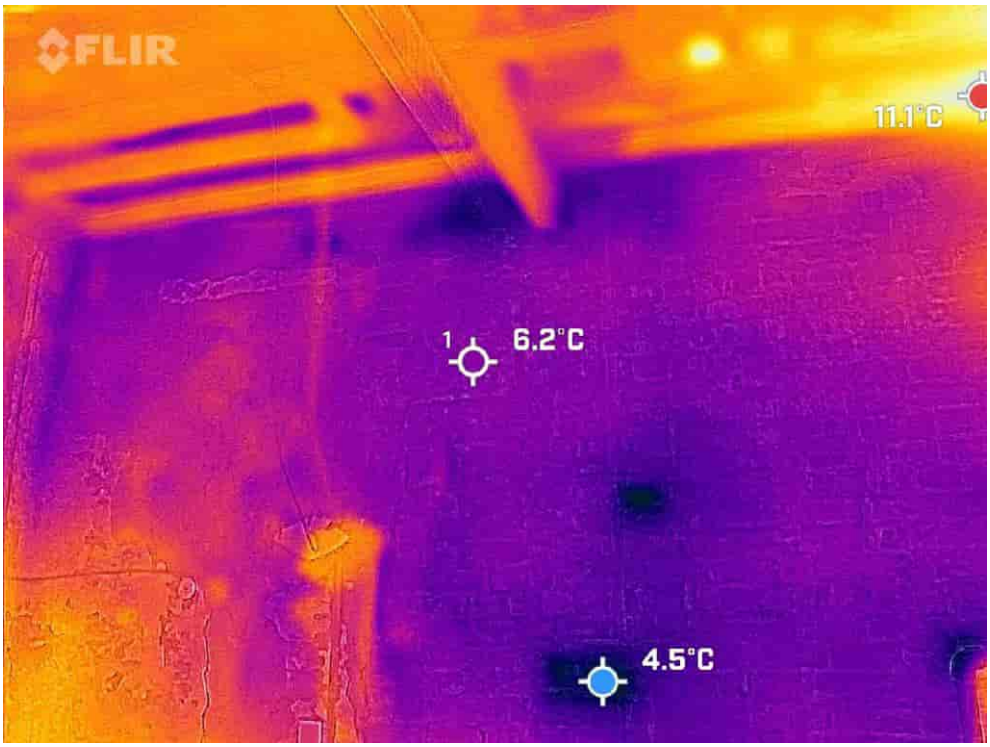
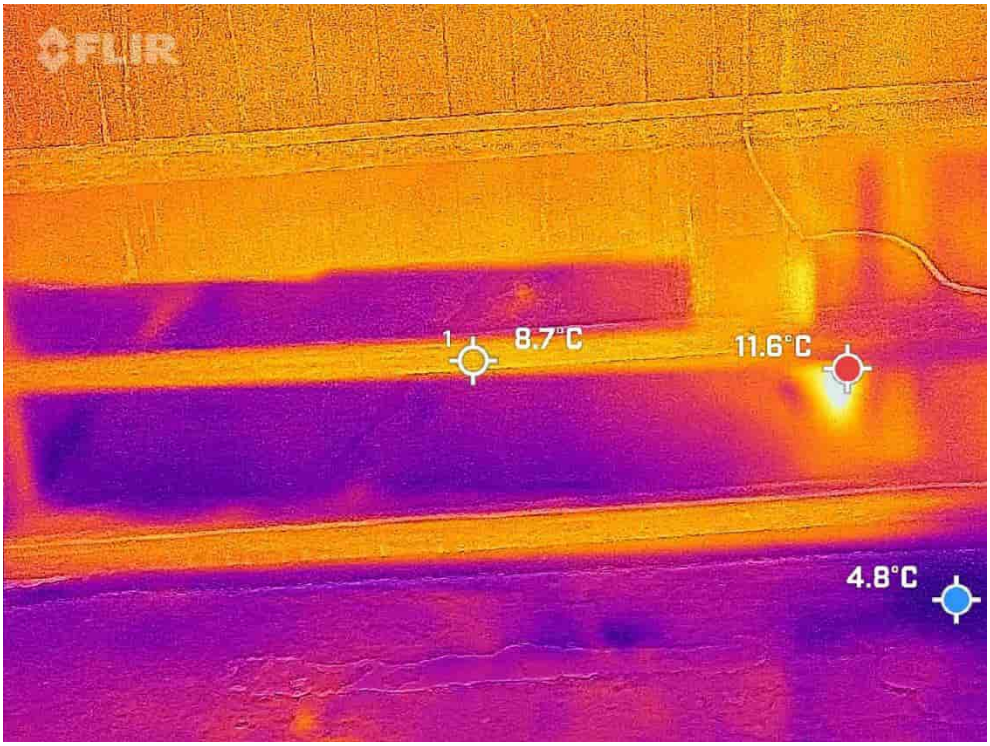
Soth Wall, the most affected by condensation. Fully external wall, very cold.



Here is the cement ceiling, which in comparison to the surrounding timber elements, is about 4-6 degrees colder.



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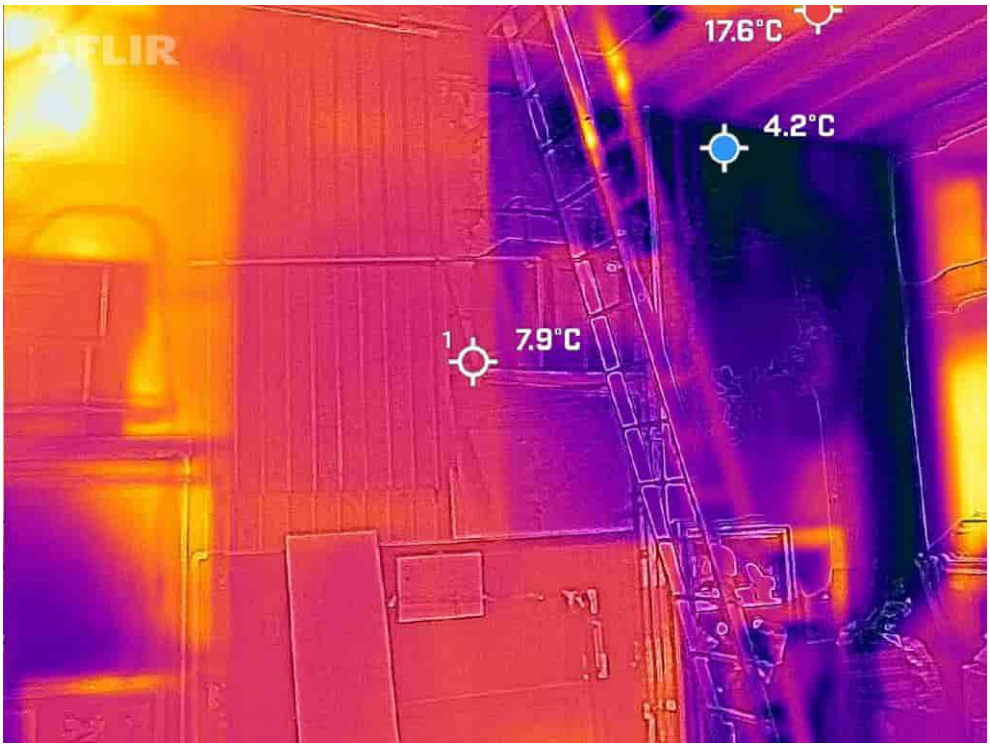
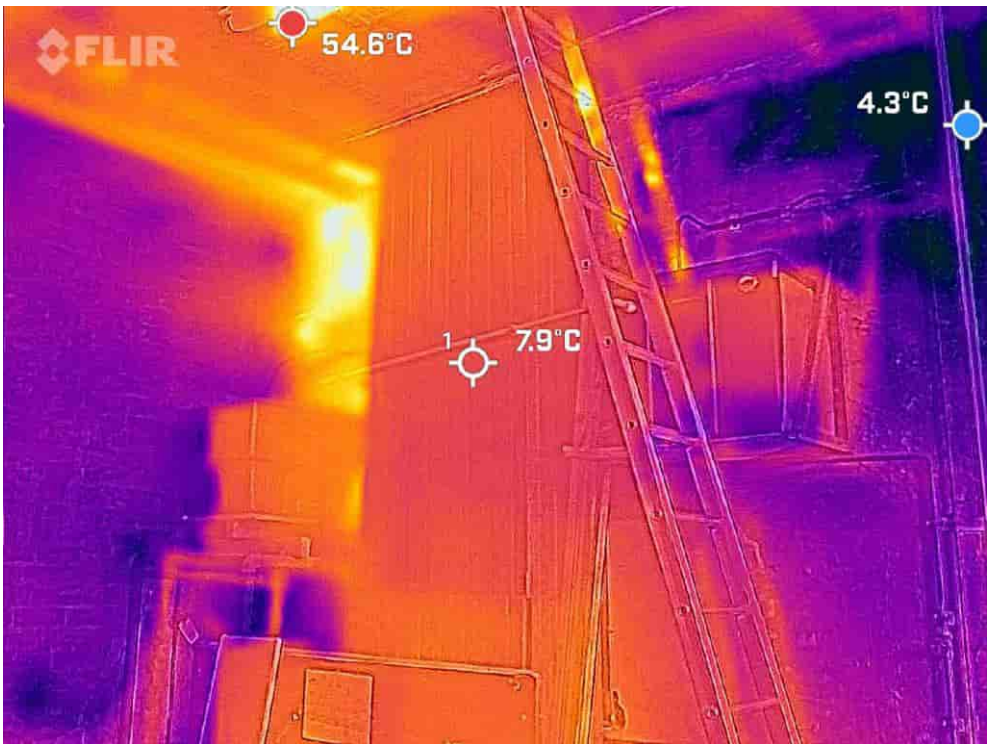
West Wall, with the ladder. Mostly external wall.





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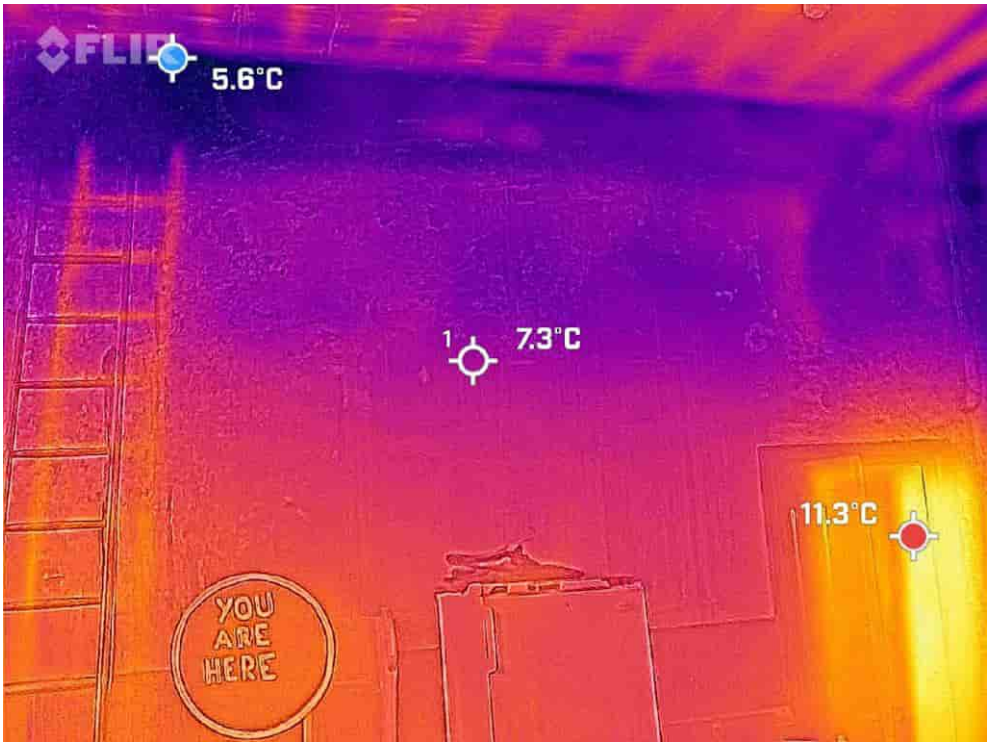
North Wall, external, with the two windows. Cold but relatively dry, so overall warmer than the other damper walls.

East Wall, mostly internal, except the upper third which is external.



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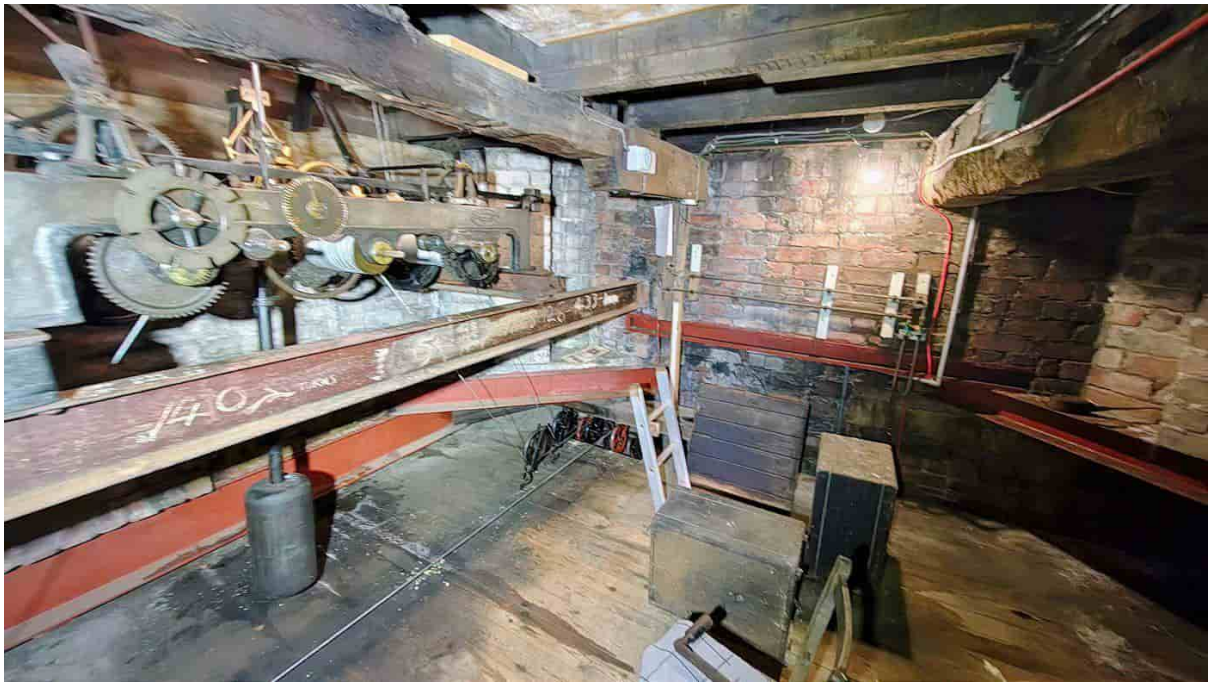
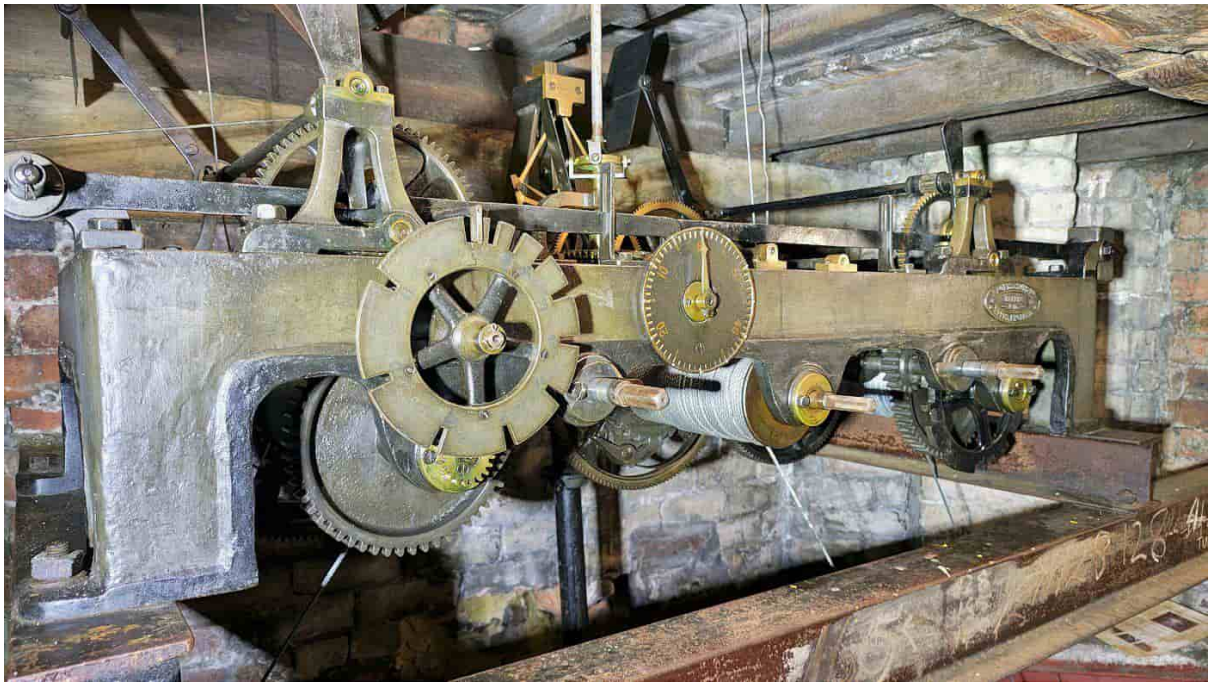
Clock Tower – Clock Room

The Clock Room, also housing the clock mechanism, is situated above the Storage Room.





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This room has been most probably the subject of some major structural work in the past. Some parts of the tower have been reinforced with steel beams, adding brick reinforcement piers to better support the weight of the cupola.

The reinforcement steel beams have also been encased in modern Portland cement, indicating that this most likely has been a later modification.

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There is **heavy salt crystallization** through the mortar bed of the reinforcement piers. This, on the surface, looks like a small cosmetic issue, however long-term it can cause or contribute to structural problems.

In the presence of humidity changes salts get damp then crystallize, expanding 5-10 times in volume, leading to the spalling and cracking of bricks, as well as historic masonry decay.

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Salt-induced cracks are already visible on some bricks, leading to permanent fabric loss and structural weakening over time.

The cement blocks reinforcing the steel beams contain salts. In the presence of moisture this leads to significant salt crystallization on the surface of cement.

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In the presence of humidity, **salts bond chemically the humidity of the air** – known as **hygroscopic effect**. This results in sustained high humidity in the Clock Room, causing ongoing condensation, leading to an **accelerated rusting of steel beams** and a **premature decay of the historic timber** beams supporting the floor of the Cupola, situated above the Clock Room.

Condensation and rust on the steel and cement surfaces.

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Condensation on timber elements and subsequent rot of beams and joists:

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The high humidity and resulting condensation in the Clock Room results in **ongoing liquid water drips** from the underside of the piers and metal beams onto the floor of the Clock Room, causing slow but sustained damages to the floor.

The dripping condensation water from the ceiling (which is also the underside of the cupola floor) cause the clock mechanism to stop. This has been partially mitigated by placing modern foam above the clock mechanism. This stops the dripping but leaves the timber in contact with the non-breathable foam subject to rot.

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There are also **signs of historic water ingress** in the Clock Room.

Water ingress might still be present though the solid walls, although there are no signs of significant water penetration through the stone and bricks. However, a wet fabric evaporates moisture into the clock room, resulting in increased indoor humidity. A wet wall fabric is also colder, contributing to increased condensation.

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Clock Tower – Cupola

The Cupola is the very top of the Clock Tower, housing the clock bells dating back from 1852.

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The Cupola has a timber floor being made **waterproof with fibreglass** acting as a flat roof and complete moisture barrier.

Any potential moisture ingress from the cupola is channelled into the gutters, designed to keep the underlying Clock Tower and Storage Room dry.

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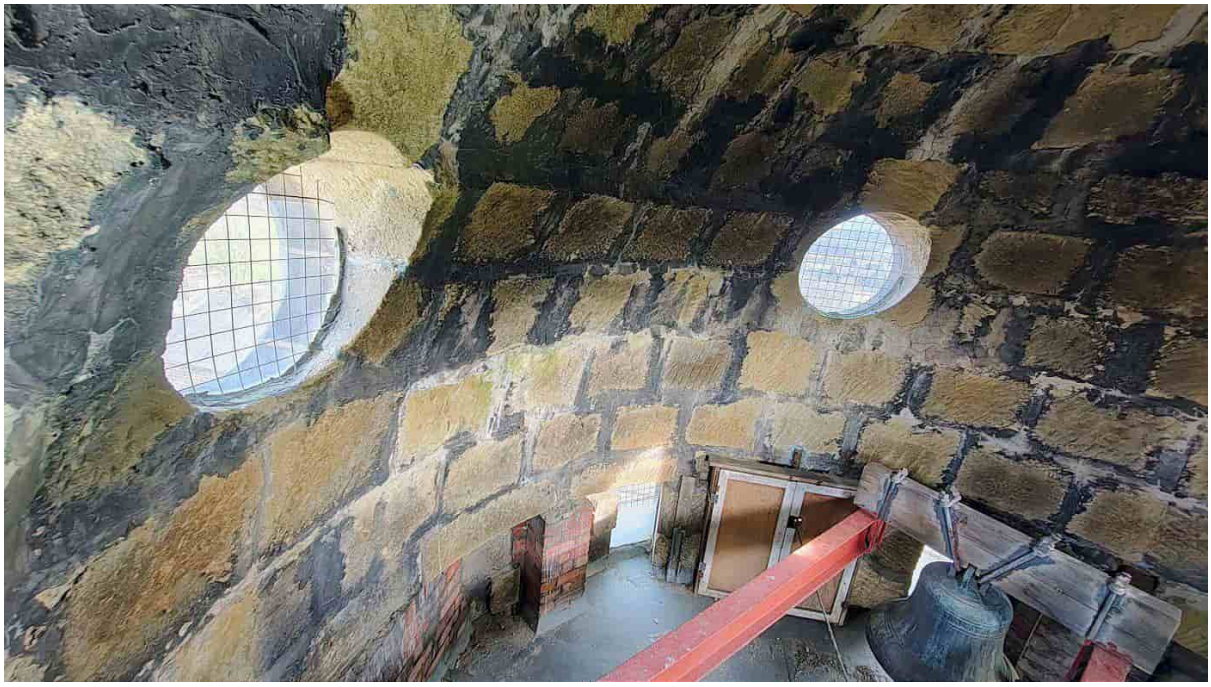
The cupola has 4 round openings. To reduce moisture ingress and to keep the inside of the cupola dry, the four openings are covered by a sheet of glass. Two of these **protective round glasses are missing**, resulting in water ingress on the North and East walls. The walls with water ingress have a distinct green colour as a result of moss growth.



Water ingress and moss growth along two walls (North and East).

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Glass pane in place along the South Wall – no water ingress, no moss growth.

Missing glass along the North Wall – water ingress, green moss growth.

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The condition of the stone is in fairly weathered condition. Acid rain, as a result of air pollution, reacts with the sand stone, resulting in the known black crust, leading to the gradual decomposition of the stone.

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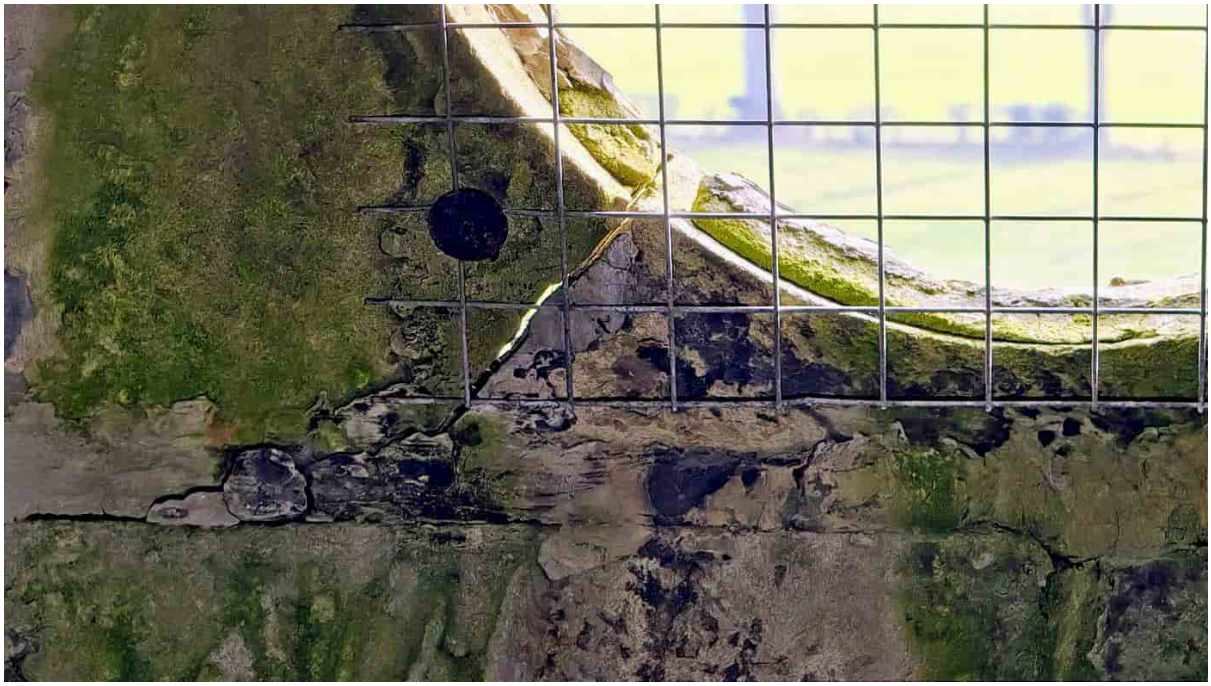
Some of the repointing of the cupola in the past has been done with cement, which in certain areas is cracking badly – partially also due to the traffic and vibration induced by the bells – letting rainwater in.



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There is also a small chimney at along South Wall, which has been repointed not too long ago – this looks fine.

There is an approx. 1 metre **flat roof section** alongside the base of the South Wall.

The roof has also been inspected for leaks and none has been found. This lead covered flat roof with a cement base – reinforcing a wall holding the clock mechanism – is responsible for a significant aspect of condensation of the underlying Storage Room. Both the lead and the cement base are dense cold materials, easily cooled down during the cold season. This creates significant thermal bridging in the internal environment, resulting in heavy condensation.

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Professional Dampness Measurements

The moisture content of the walls has been analysed using a **Trotec T3000 state-of-the-art moisture meter / digital wall scanner**, made in Germany. This instrument can be interfaced with a range of professional moisture sensors and is capable of detecting moisture up to **300 mm deep** using microwave (ground penetrating radar) technology.

The results of the moisture analysis are presented below.

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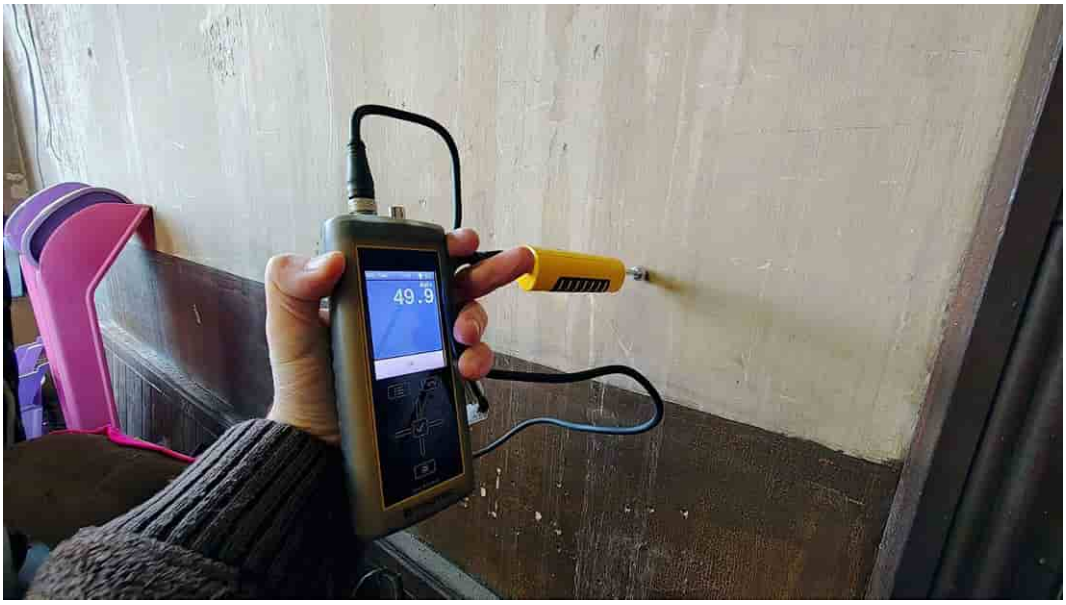
Depth Readings from the Walls

Dampness meter readings confirm this. **Readings over 70 are higher than normal**. There is a significant difference between the upper and lower parts of the walls.

Storage Room Readings

East Wall – internal wall section, low normal reading for reference: 49



South Wall – plaster, high reading: 160

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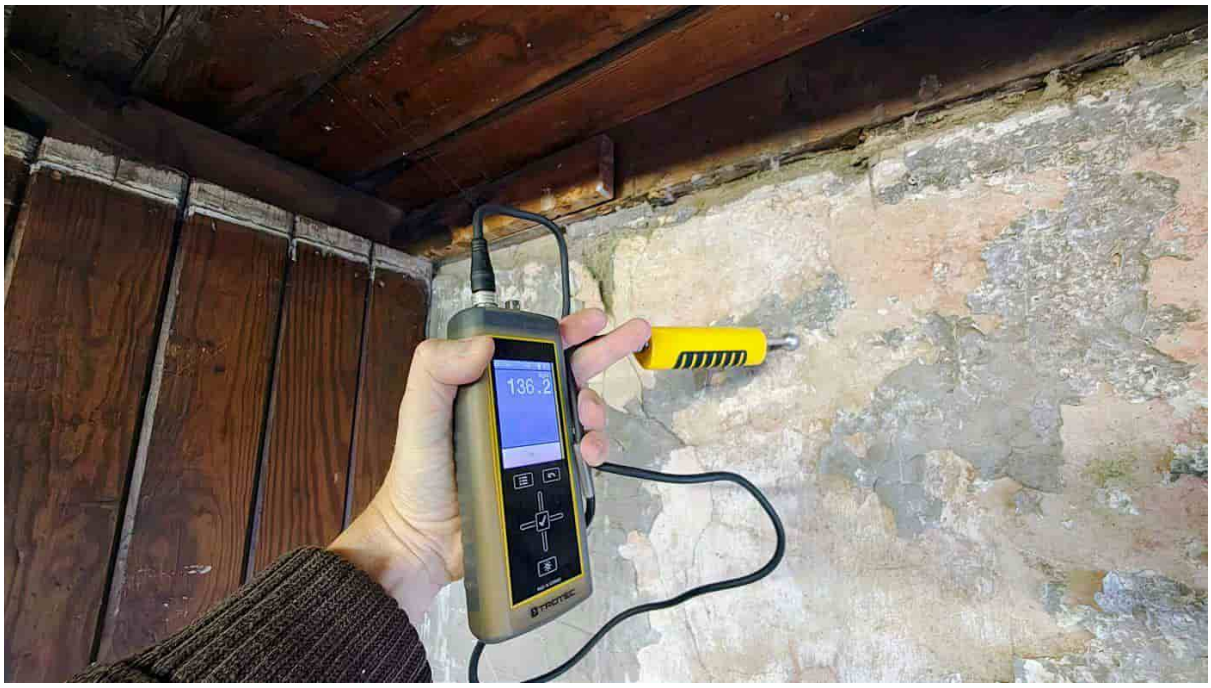
West Wall – plaster high elevation, high reading: 136



North Wall – plaster, high reading: 133

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Clock Room Readings

East Wall – external wall, very high reading: 171

South Wall – external wall, very high reading: 175

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West Wall – external, high reading: 147

North Wall – external, high reading: 143

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Air Humidity Readings

Moisture readings have also been taken from the storage and clock rooms to see **the real moisture content** of the air (**absolute moisture content**), expressed in grams/m^3.

The Storage Room humidity was a = 5.74 g/m^3.

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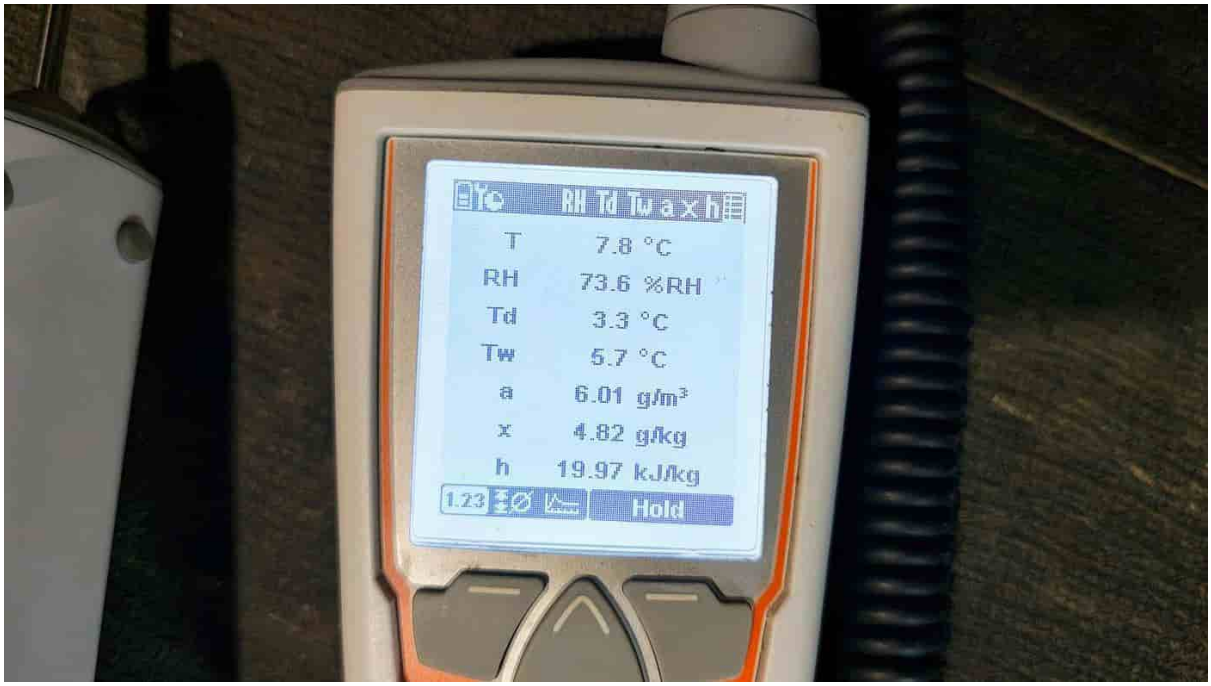
The Clock Room humidity was higher (a = 6.01 g/m^3) as a result of the **evaporative effect** of the damper walls higher up in the Clock Room.



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Salts – Professional Salts Analysis

In addition to dampness, salts and salt crystallization is a major threat to the integrity of the wall fabric and plastered finishes. Transported by water, salts crystallize, breaking down the bricks and mortar.

A professional salt analysis has also been performed, and the concentration of **chlorides, nitrates and sulphates** – the most common salt types known to damage the masonry – has been determined using lab grade chemical strips.

The origin of various salts is detailed below:

1. **Chlorides**: the main source of chlorides are sea salts. They can also originate from the ground which contains chlorides, from road salts used for de-icing or as a result of flooding.

2. **Nitrates**: nitrates originate from ground from the decomposition of organic materials, organic waste or fertilizers (including animal excrements such as urine etc.). They are prevalent in farming areas, around drains, sewers, churches and cemeteries. Nitrates are carried up into the building fabric primarily by rising damp, and their presence is a strong indication of rising damp.

3. **Sulphates**: the most damaging salt type due to their unique needle-shaped crystallization structure. Sulphates primarily originate from modern building materials (cement, gypsum etc.) or from the combustion of wood and other fossil fuels as a by-product of burning. They can be found in/around old chimney breasts, or in large cities in the air due to high air pollution or in the ground.

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The following salts have been found in Clock Room walls:

- **Sulphates** (pink to orange): very high concentration, originating from the cement, where gypsum powder (calcium-sulphate) is added to slow down the setting of cement.
- **Nitrates** (white to purple): medium concentration, most likely from washed down bird guano.
- **Chlorides** (brown to white): none.

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SOLUTIONS & RECOMMENDATIONS

1. Replastering, Renovation, Thermal Insulation

Choice of Renovation Materials

Because older buildings have been built of older, more porous bricks and a very porous lime mortar (as opposed to a modern dense sand-and-cement mortar), there is a considerable moisture movement inside the fabric of old buildings, the old fabric constantly evaporating out some of its moisture. The ongoing evaporation, also known as "breathing", is how old buildings regulate their humidity and stay dry long-term.

Most modern plasters, however, are non-breathable. In addition to liquid moisture they supposed to block they also block all vapour movement, essential for old properties to stay dry. This results in unwanted **moisture accumulation** behind the plaster, leading to serious dampness problems long-term.

Breathability

Thus, the application of modern cement plasters is not recommended in older buildings as **they lead to moisture accumulation and dampness problems long-term**. One such problem can be the appearance of rising damp in higher areas of the wall as the non-breathable tanking materials "push" the moisture upwards inside the walls.

The recommended solution would be a "breathable" plaster that is allowing the underlying building fabric to breathe, thus preventing excess moisture accumulation inside the wall fabric long-term.

Salt-Resistance

A significant majority of plaster damages (flaking, crumbling, peeling etc.) are **not the result of humidity, but salts**. These most often originate from the ground from rising or penetrating damp, but salts can also originate from the air (sea spray, air pollution etc.). Due to the ongoing evaporation, most salts are drawn to the outer 10-15 mm area of the wall where they **crystallize**, increasing in volume by 500% – 1,000%. The crystallization pressure can exceed 800 atmospheres which breaks down the plaster, the wall fabric, even concrete – the strongest concrete rarely can withstand 550 atmospheres.

Additionally, salts **can chemically bond humidity from the air** (hygroscopy). Crystallizing salts near the surface can make the plastering look damp even when the wall fabric in depth is much drier.

Crystallizing salts breaking down the plaster

To prevent the crumbling of the plastering a **salt-resistant protective lime base coat must be used under the main lime coat**. This protects the plastering by preventing the migration of salts into the fresh plaster, making it last much-much longer, typically decades even in high dampness conditions.

Such breathable and salt-resistant materials exist. These plasters have been "invented" by the Romans, who discovered that mixing lime with carefully selected **volcanic ashes and sands**, in the right proportions, results in special lime plasters that are salt-resistant. Moreover, they are also waterproof that can stop liquid water while letting water vapours though.

A selection of volcanic sands and ashes

These plasters were very well known from the antiquity for their waterproofing abilities, being used by Roman architects in the construction of ports, canals or other hydraulic works where waterproofing was necessary.

The outstanding properties of these materials can be attributed to the volcanic ingredients. When the lava cools down, it results in a light, porous, breathable material. The chemical reactions between the lime and the volcanic ingredients will **make the mix waterproof** which can also withstand salt crystallization.

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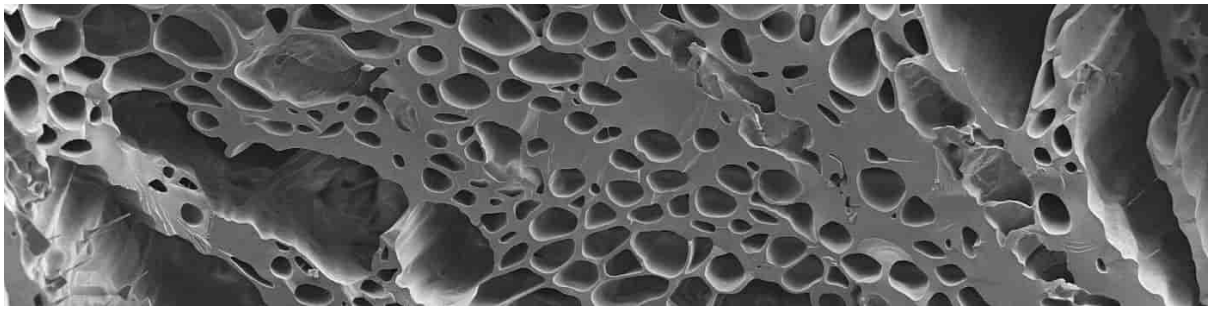

The pore structure of natural volcanic pozzolans facilitates breathabilty

The lifespan of these volcanic tanking mixes is also outstanding, **it can last for decades** in very harsh environments (e.g. submerged in sea water), **significantly longer than modern cement**.

Applying one coat of Rinzaffo MGN Roman waterproofing mortar – described next – onto the walls can make them waterproof and salt-resistant while preserving the wall fabric's breathability.

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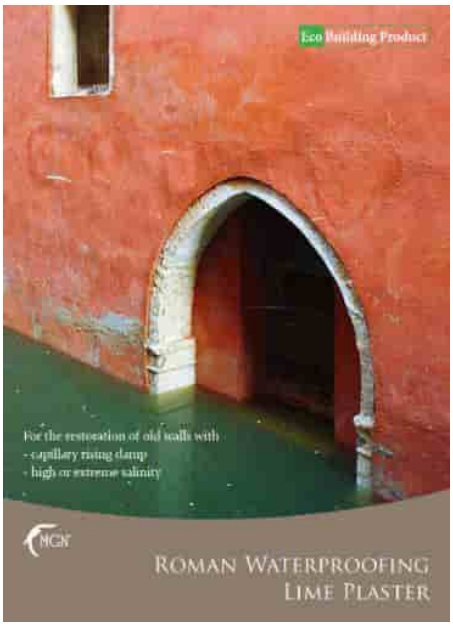
Rinzaffo MGN – Roman Salt Resistant Lime Mortar



The Rinzaffo MGN Roman salt-resistant lime base coat has been developed in Venice to the problem of rising damp, penetrating damp, wind driven rain and salts. The plaster is based on a 2,000-year-old Roman recipe. The Romans have figured out that by mixing the lime with **volcanic ashes and sands** (also known as volcanic pozzolans) results in salt-resistant, waterproof yet fully breathable lime mixes. Using this traditional technology throughout the Roman Empire, the Romans have built their famous viaducts, baths and wells, some of them still standing today.

Rinzaffo MGN's unique pore structure acts as a natural salt filter. It regulates the evaporation of humidity; preventing the crystallization of salts inside its pore structure and the premature damage of plastering by salt crystallization. As a result, the life expectancy of plastering increases multifold, the plaster stays dry and aesthetically pleasing much longer.

Because Rinzaffo MGN is **both waterproof and breathable**, it is suitable for many demanding applications such as:

- A base coat in any building subject to **rising or penetrating damp**
- A plaster against the damp patches, discoloration or the crystallization of salts (sulphates) around old **fireplaces and chimney stacks**, a frequent problem in old buildings
- A lime-based breathable tanking slurry for making **basements or cellars waterproof**
- A render against **driving rain**
- A mortar for **pointing chimney stacks and roof areas**
- A waterproof (but breathable) floor screed **to prevent flooding** in high water-table or pressure water situation

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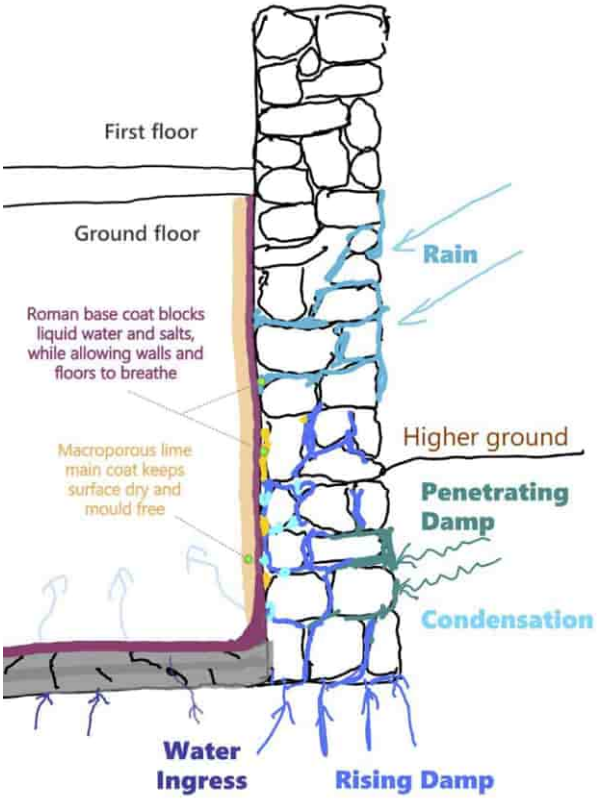
How to Replaster and/or (Optionally) Thermally Insulate Old Walls?

Damaged walls can be replastered wither with a breathable lime plastering system or, optionally for external walls, with a breathable thermal lime plaster. To make the renovations long-lasting, the following actions are recommended:



For internal walls with no need for thermal insulation the following plastering is recommended:

- Salt resistant, waterproof lime base coat (**Rinzaffo MGN**): @10 mm thickness
- High quality main lime coat, fully breathable (**Calcina Bianca MGN**) @12 mm
- High quality lime finishing coat (**Rasacol MGN**) @4 mm

For external walls in need for thermal insulation the main lime coat can (optionally) be replaced by a special lime thermal insulation coat, as per below:

- Salt resistant, waterproof lime base coat (**Rinzaffo MGN**): @10 mm thickness
- Lime thermal insulation coat: depending on the application, a combination of 1 or 2 types of thermal plasters (**Termointonaco 2020 MGN** and/or **Termorasante Aerogel MGN** lime-aerogel superinsulation with extremely good thermal value.
- High quality lime protective finish (**Rasante B40 MGN**) @4 mm

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2. Cupola – Rainwater Protection

To minimize the ongoing rainwater ingress and keep the inside of the Cupola drier, it is recommended to **refit the two missing glass panes** of the North and East Walls.

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3. Cupola – Repointing

In case any repointing work is needed on the Cupola, the pointing should only be done with a traditional lime mortar. Cement mortars should be entirely avoided as they trap humidity, leading to future dampness problems.

Because the Cupola is subject to wind driven rain, vibrations and the mortar also has a structural reinforcement role, the Rinzaffo MGN Roman mortar should be used for repointing. This breathable mortar:

- Keeps liquid water away
- Blocks all salts
- Reinforces the stones, giving additional mechanical resistance to the cupola, while keeping everything flexible

SPECIFICATIONS

Replastering

Here are the surface areas for the various walls:

1. Storage Area (75 m^2)

- North wall (with 2 windows): 12 m^2
- East wall (partially internal): 18 m^2
- South wall (worst): 20 m^2
- West wall: 15 m^2
- Ceiling cement beams: 10 m^2

Total: 75 m^2

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Here is the recommended plastering schedule for the storage area:

Walls

- **Rinzaffo MGN** salt resistant, waterproof lime base coat: @10 mm thickness (15 mm included to allow for the repair and levelling of uneven surfaces).
- **Calce Fondo 2020 MGN** high quality lime coat, breathable @20 mm. This material has high moisture tolerance while being very breathable.
- **Rasacol MGN** high quality lime protective finish @4 mm

Ceiling cement beams

- **Fondo Pozzolanico MGN**: because the ceiling contains metal beams that can't be plastered on, it needs the application of a special waterproof lime coat, on the cement and metal beams to allow subsequent plaster coats to bond to it. So this coat is a lime-based bonding coat, that allows the application of any lime plaster onto the metal and cement.
- **Rinzaffo MGN** salt resistant, waterproof lime base coat: @10 mm thickness (15 mm included to allow for the repair and levelling of uneven surfaces).
- **Coccioterm 2020 MGN** high quality lime-cocciopesto thermal insulating coat, breathable @60 mm. This material has high moisture tolerance and condensation regulating properties, while being very breathable, capable of dealing with the heavy condensation under the flat roof.
- **Rasacol MGN** high quality lime protective finish @4 mm

2. Clock Room (35 m^2)

- Walls: 4 x 8 m2 = 32 m^2
- Condensing cement surfaces: 3 m^2

Total: 35 m^2

To prevent water ingress and condensation in the clock tower, protecting the clock mechanism, the following plastering schedule is recommended:

Walls

- **Rinzaffo MGN** salt resistant, waterproof lime base coat: @10 mm thickness (15 mm included to allow for the repair and levelling of uneven surfaces).
- **Calce Fondo 2020 MGN** high quality lime coat, breathable @20 mm. This material has high moisture tolerance while being very breathable.

Being a non-inhabited area with no foot traffic, the protective-decorative line finish can be omitted.

Furthermore, to minimize condensation on the underside of the cement blocks, protecting the timber floors from dripping condensation water, the following plastering schedule is recommended:

Cement blocks under the reinforcement piers

- **Rinzaffo MGN** salt resistant, waterproof lime base coat: @15 mm thickness (20 mm included to allow for the levelling of uneven surfaces).
- **Coccioterm 2020 MGN** high quality lime-cocciopesto thermal insulating coat, breathable @20 mm. This material has high moisture tolerance and condensation regulating properties, while being very breathable.

About Core Conservation Ltd

Core Conservation has been operating since 2013. We are an Award Winning company providing damp investigation and remedy solutions for any old or listed building.

We have won several industry awards including the **Homebuilding and Renovating Awards** as well as the prestigious **Build-It Awards**.

Our activity covers 4 main areas of expertise:

- **Research**: in our in-house labs we research moisture movement in porous building materials and connected electronic phenomena associated with wetting, movement of moisture and dehydration of materials.
- **Professional dampness surveys**: using cutting-edge diagnostic equipment we assess all types of damp. Very old buildings, especially the ones older than 200 years present their own specific challenges that are very different from newer buildings. We specialize in solving difficult or complex dampness cases, our surveyors are amongst the best in the business.
- **Solving dampness problems**: using a patented magnetic dehydration system we permanently resolve the problem of rising damp non-invasively. As a result the building dries out permanently, the crumbling of the wall fabric slows down or stops altogether, the building becomes warmer and often the musty smell vanishes too. For peace of mind, we also monitor the dehydration of every building for 1-2 years or until it becomes dry.
- **Sympatethetic renovations**: dampness problems and associated ground salts often create a lot of decorative or structural damage; in most cases some restoration work is necessary. We advocate and use specialist traditional building materials which not only allow the building to breathe, but which are suitable for the long-term restoration of very old, salty buildings.

We have worked on many listed buildings, cottages, manor houses and commercial properties.

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Hope you find the above helpful. If you have any question, please feel free to get in touch.

Kind regards,

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Val Juhasz is an Electronic Engineer with a Master's Degree from the Manchester Business School (MBS). He is the co-founder of Core Conservation Ltd, pioneering the most modern, non-invasive dampness remedy solutions which can be safely applied even to very old, listed or heritage buildings throughout the UK. He regularly attends conservation seminars and workshops throughout Europe, including Venice where dampness remedy technologies are at their best. He has held numerous talks to private architectural and surveying practices throughout the UK, as well as the CIOB and RICS.