Are Our Monuments Melting Away ?

Exploring the Impact of Climate Change on Stone Surface Finishes of Belgian Heritage Buildings

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Bridging two disciplines, our research highlights the effects of weathering on **architectural details** and the **surface behavior** of geological materials.

Introduction

The surface weathering of ashlar threatens the perception and conservation of monuments, affecting their material integrity due to climate change and to the influence of environmental, climatic, biological, and anthropogenic factors, such as **acid rain**.

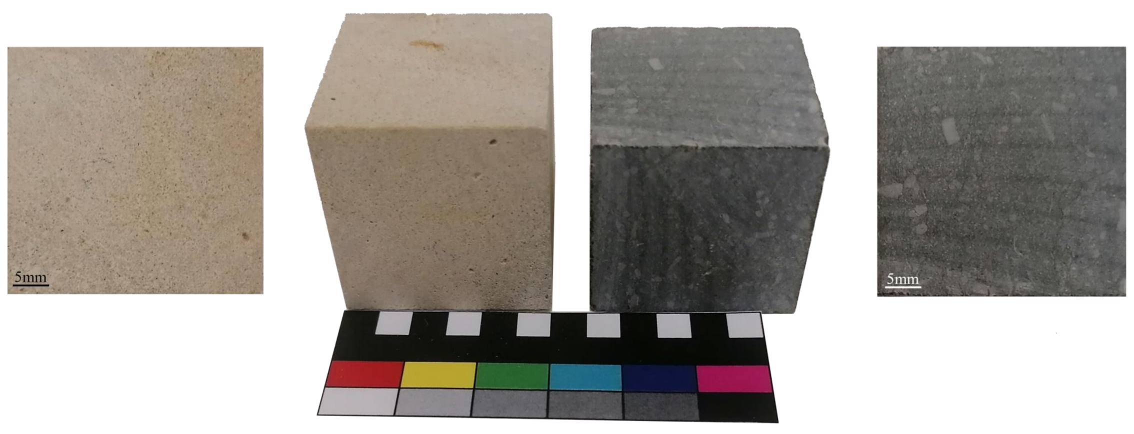
This preliminary study analyzes the impact of **acidic solutions**, simulating **synthetic acid rain** and **household degradation**, on **limestone** used in European monuments.[1, 4]

Methods

Two ornamental limestones

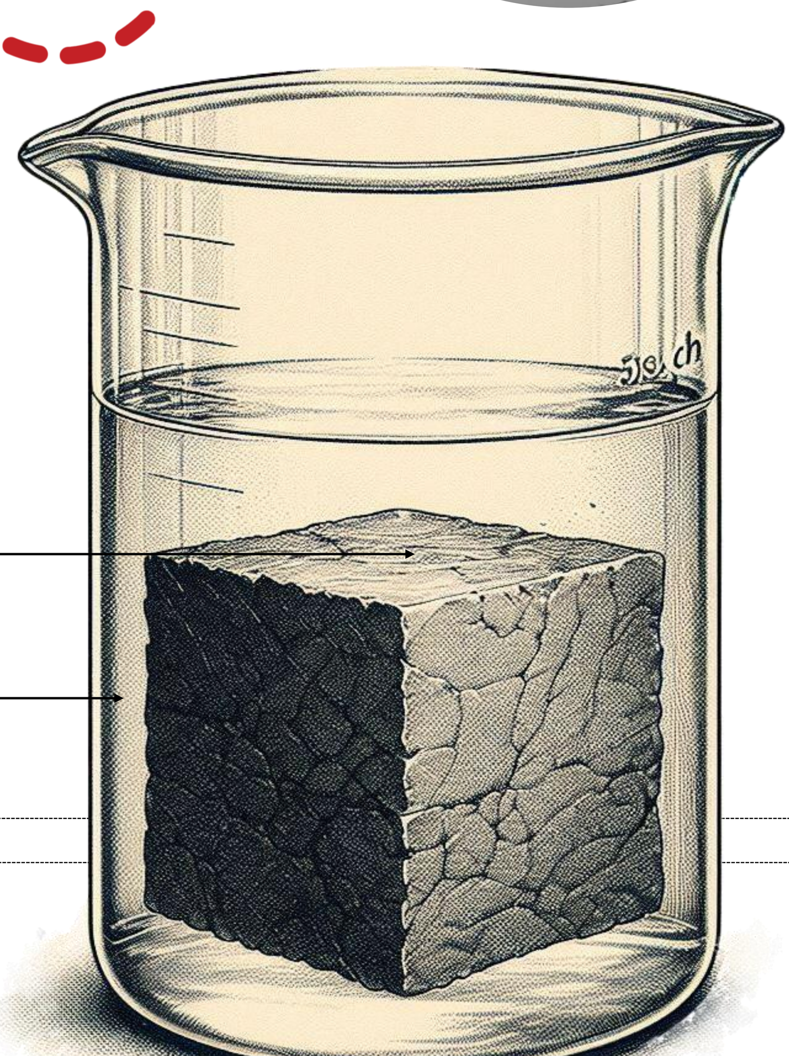
Gobertange Stone – **GS/361** (Lutetian)

Belgian Blue Stone – **BBS/341** (Carboniferous)



24h Passive Immersion

24h Drying

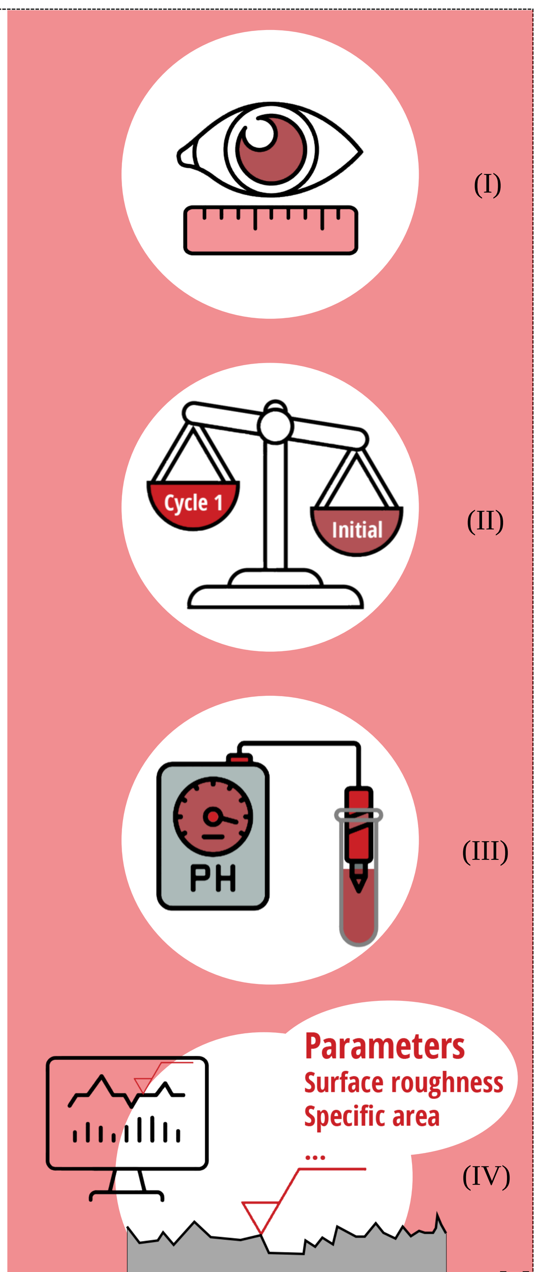


2 Acid Solutions ~130ml/each test

CH_3COOH – 7% → pH 2,44

HNO_3 – 10-5mol/l (600ml) + H_2SO_4 – 5.10-6mol/l (400ml) → pH 5 [2, 3]

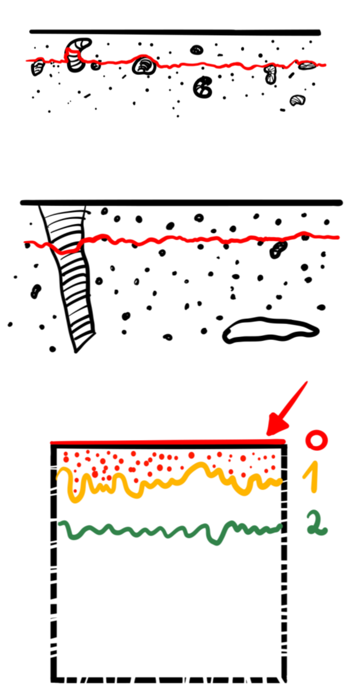
ANALYSIS



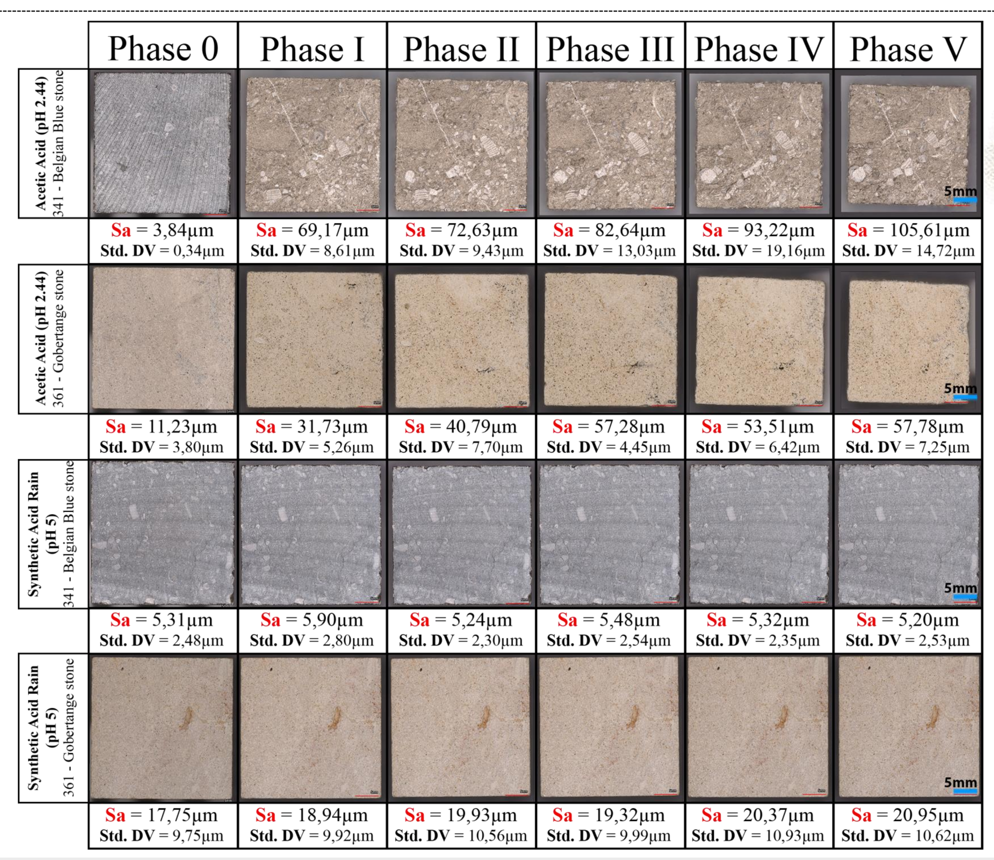
3D optical profilometry[5]

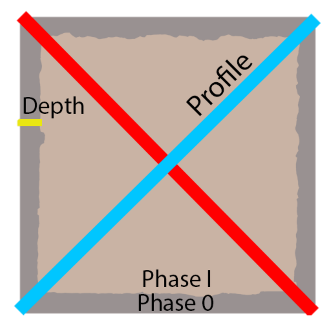
Results and Discussion

- **Increased** surface roughness (Sa)
- Acetic Acid
  - **Color change**: bluish-grey to brownish-grey (BBS) - more orangish (GS)
  - **Loss of mass** (BBS : 7 to 8% /cycle & GS : 8 to 9 % /cycle)
  - **Increased** surface area for the 1st cycle
- pH **rise** (>2)
- **Correlation** loss of mass and C.S. area

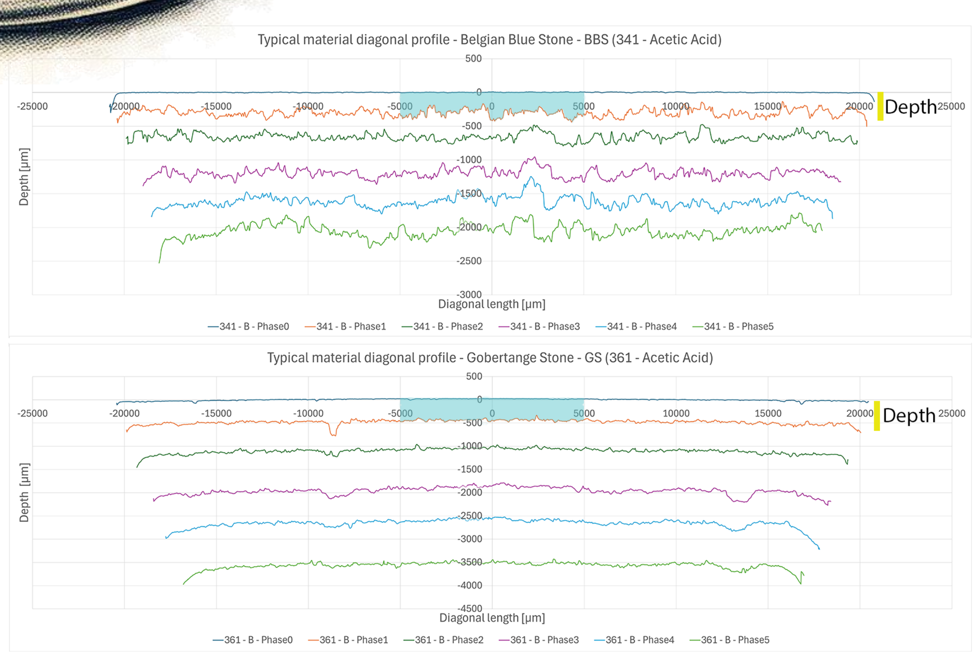


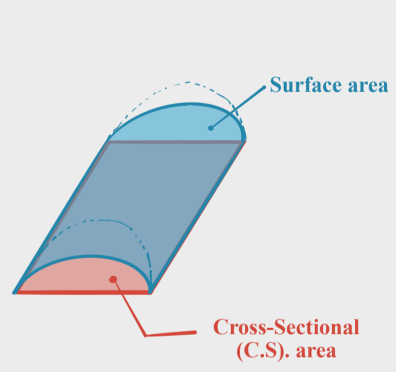
(I – IV)





(IV)





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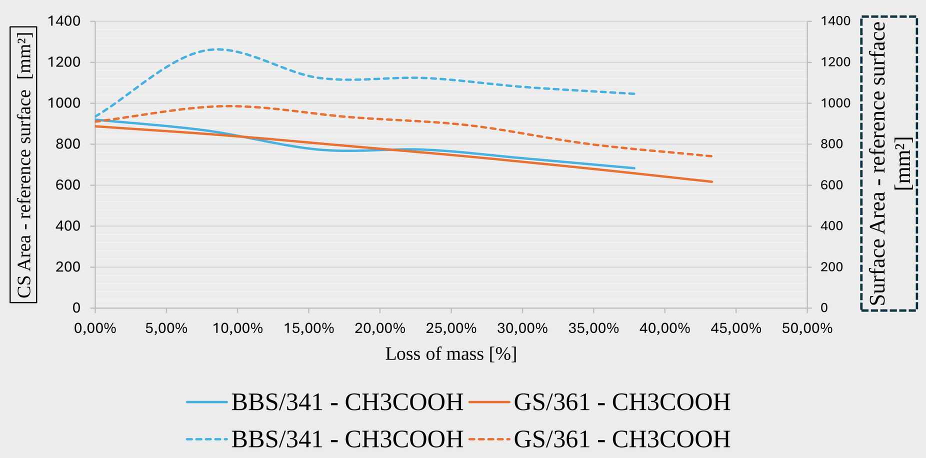
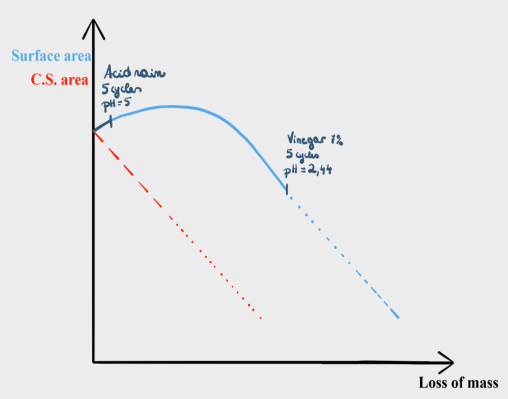
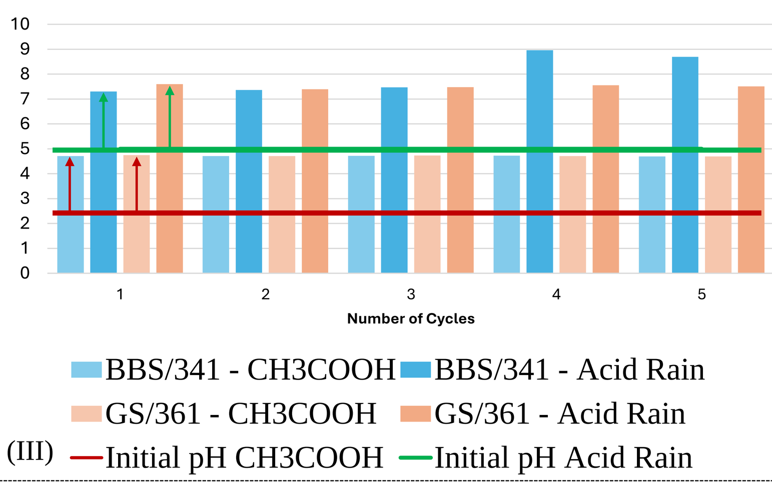
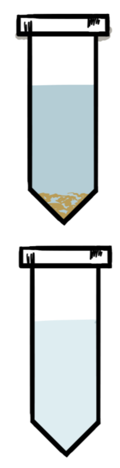




Same trend but lower



(III)



Conclusions

Acetic acid (pH 2.44) has a greater impact on limestone surfaces after five immersion/drying cycles compared to **synthetic acid rain** (pH 5), due to the stronger acidity and type of acid.

Reaction kinetics: Limestone dissolution and surface property changes occur faster in acetic acid compared to synthetic acid rain, although similar trends are observed on a reduced scale with the latter.

Limitations: The test campaign was limited in scope; more tests are needed with more cycles and additional pH levels (pH 3 and 4).

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References

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