Resistance of Clay Brick Masonry Façades to Wind-Driven Rain

Repointing of Eroded Mortar Joints

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The risk of WDR penetration might be overestimated in masonry

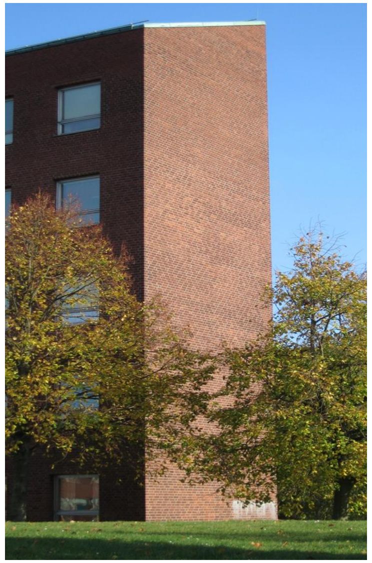
Penetration may occur when masonry is saturated

Part 1: Background

Part 2: Experimental studies

Part 3: Numerical studies

Overview



Resistance of Clay Brick Masonry Façades to Wind-Driven Rain:

Repointing of Eroded Mortar Joints

Clay Brick Masonry Façades

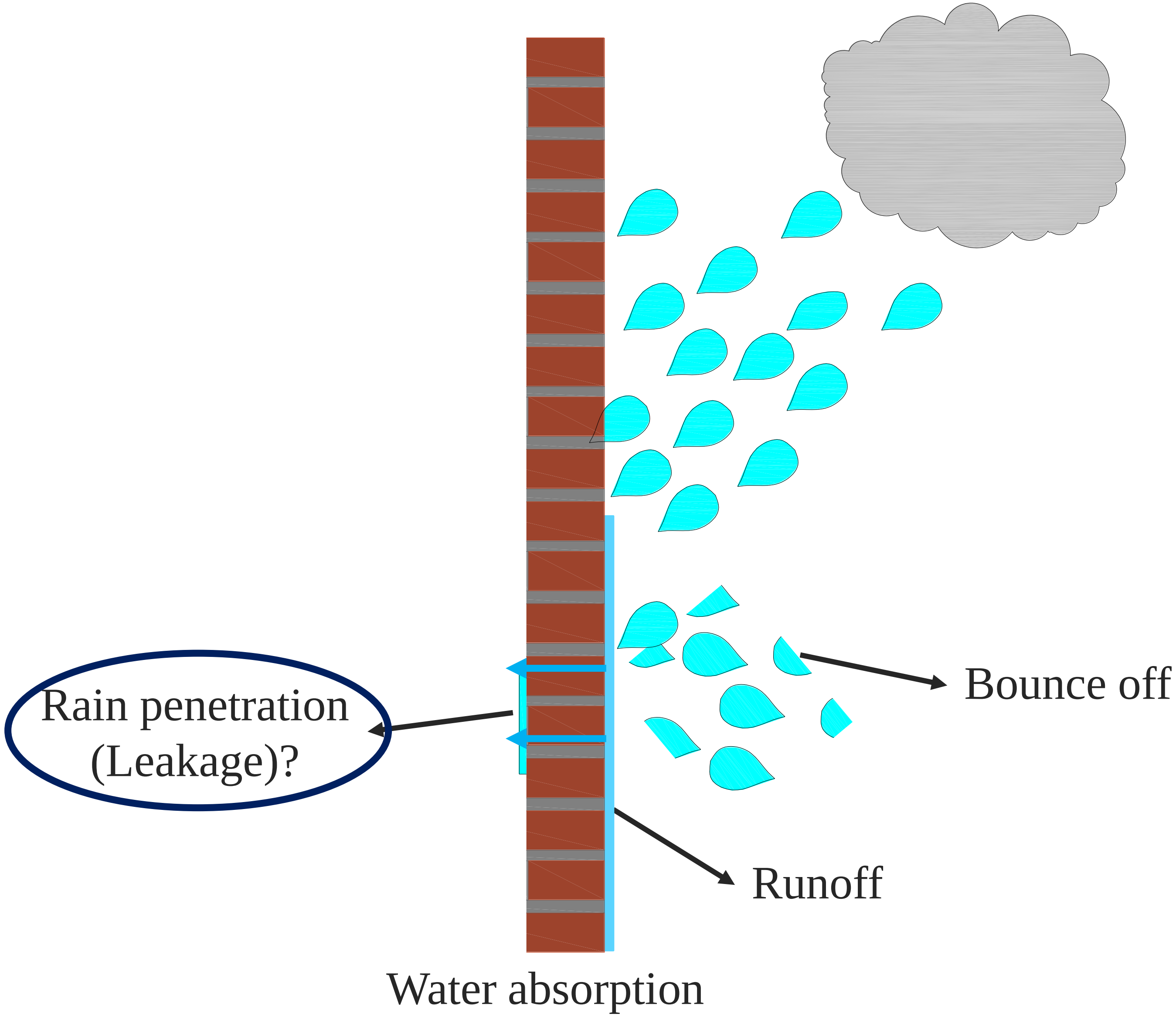
- Durability
- Long-term performance
- 300 million square meters façades in Sweden

Wind-Driven Rain (WDR)

Co-occurrence of wind and rain

Oblique driving rain vector

Response of masonry façades to WDR



Impacts of WDR on masonry façades

- Increase in moisture content and water penetration
  - Damage in timber-based walls
  - higher risk of freeze-thaw cycles
  - microbiological growth
  - corrosion of reinforcement

- Mortar joint erosion

Regular Maintenance is necessary

Maintenance of masonry façades

Repointing

Repointing of eroded mortar joints

Replacing the outer part of the mortar joints, approximately 25 mm, with new mortar:

a. eroded joints are raked out

b. new mortar is applied

- Carried out after 40-100 years from erection of façades
- When eroded mortar joints are observed

60-year-old façade

before *during* *after repointing*

Repointing
Pros & Cons

- ✓ Mitigate moisture-related issues due to eroded-cracked mortar joints **!**
- ✓ Improve aesthetics **?!**

- ✘ Costly
- ✘ Labor intensive

Part 1: Background

Part 2: Experimental studies

Develop a test setup to study:

Clay brick masonry response to WDR

- Frequent and realistic WDR events

Resistance of masonry to WDR with different

- Brick absorption properties
- Mortar joint profiles

Part 3: Numerical studies

Specimens

Triplet masonry specimens

250 mm × 215 mm × 120 mm

Three different kinds of bricks

a. Medium suction [I]

b. Medium suction [II]

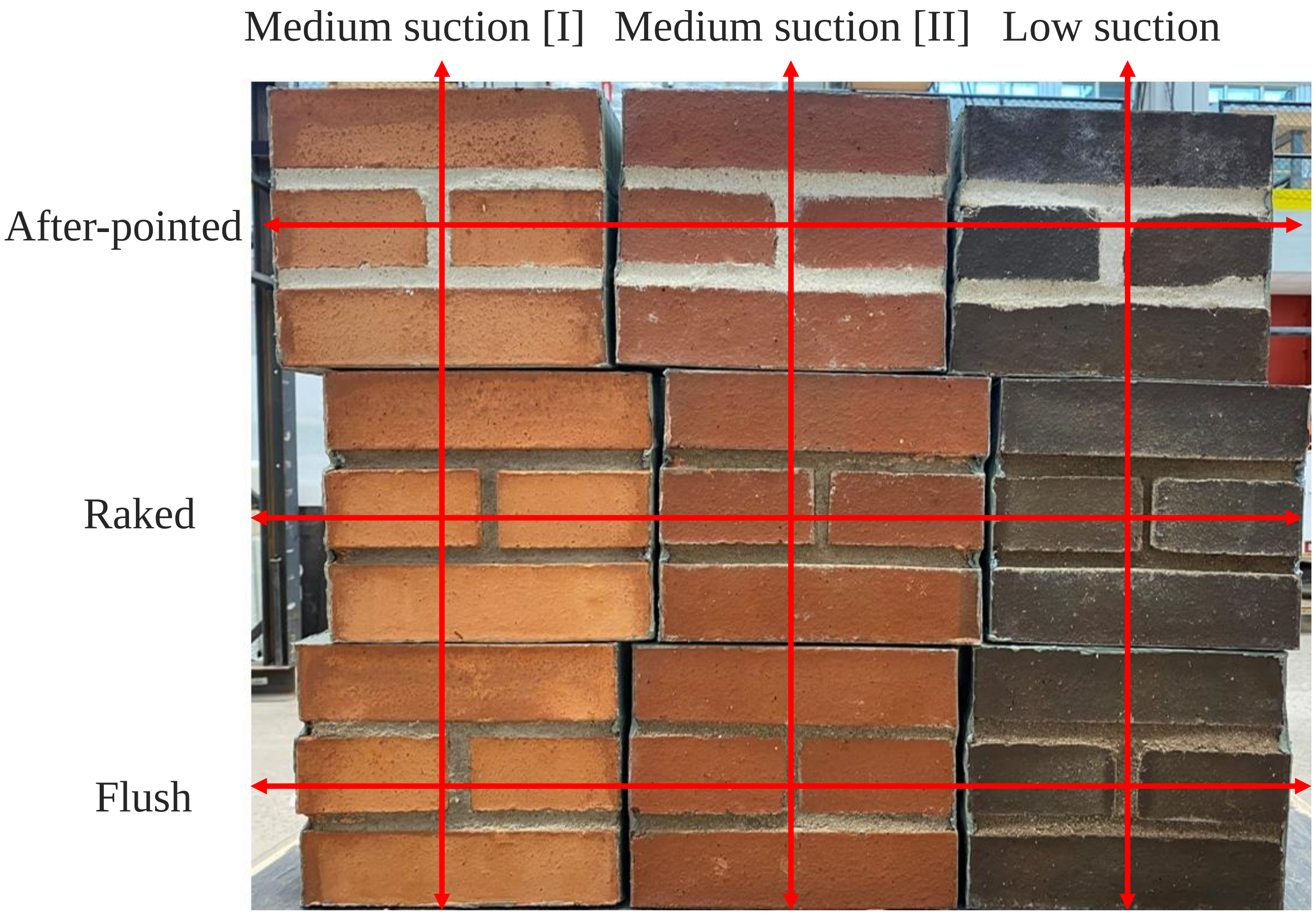
c. Low suction

Three kinds of mortar joint profile finishes

a. Flush

b. Raked

c. After-pointed



Specimens – Mortar Joint Profiles

Mortar M 2.5, cement-based mortar

Mortar joint profile

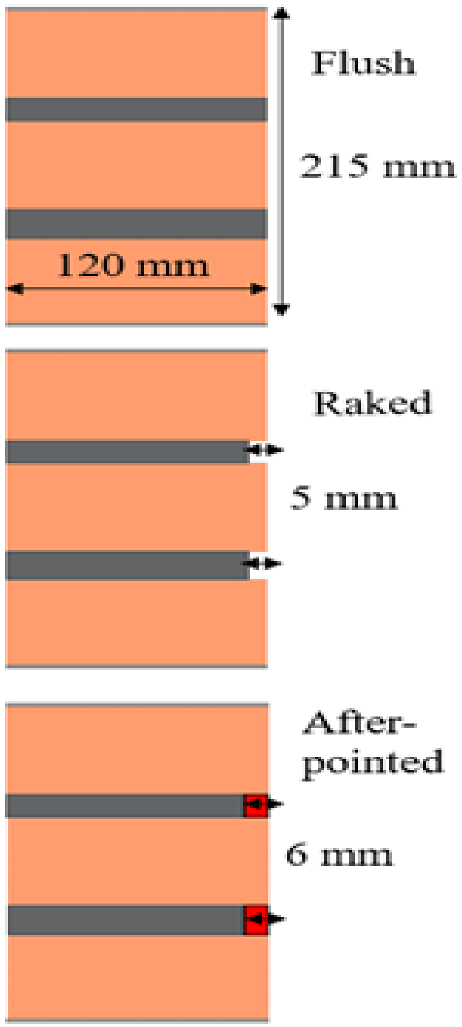
Flush

Raked (~ 5 mm):

- Representative of eroded mortar joints

After-pointed (~ 6 mm):

- Outer part natural hydraulic lime (NHL) mortar



Test setup

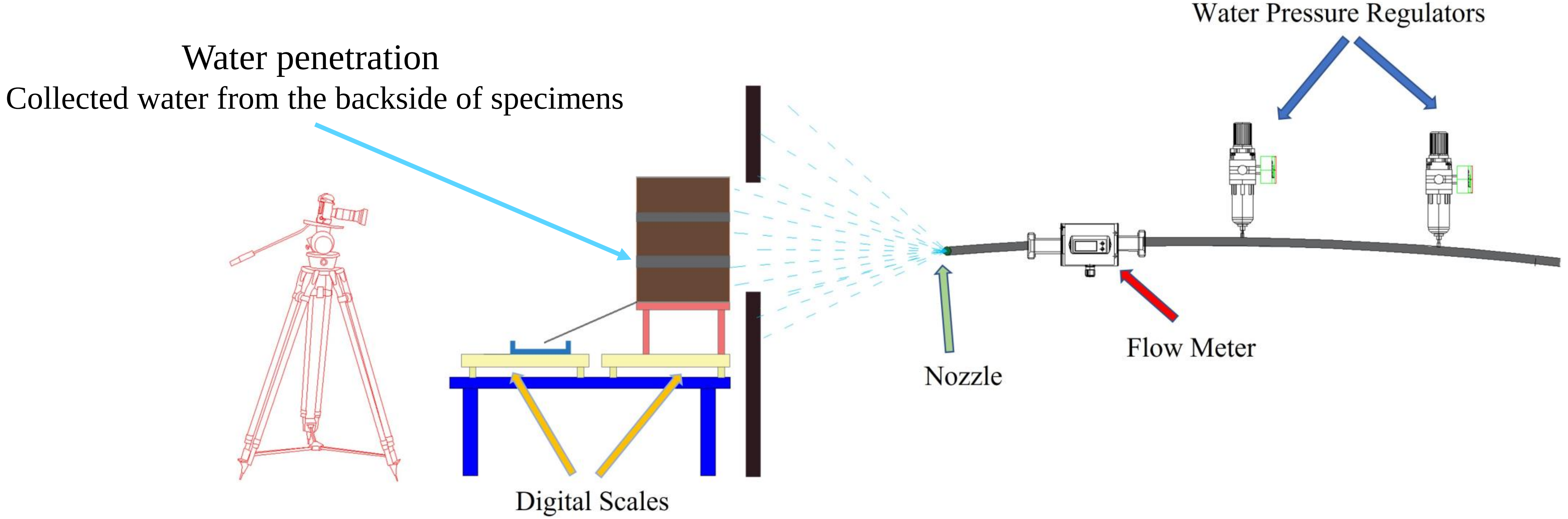
23 hours of testing

- six consecutive cycles
- each cycle 210 min of water spraying and 20 min of drying

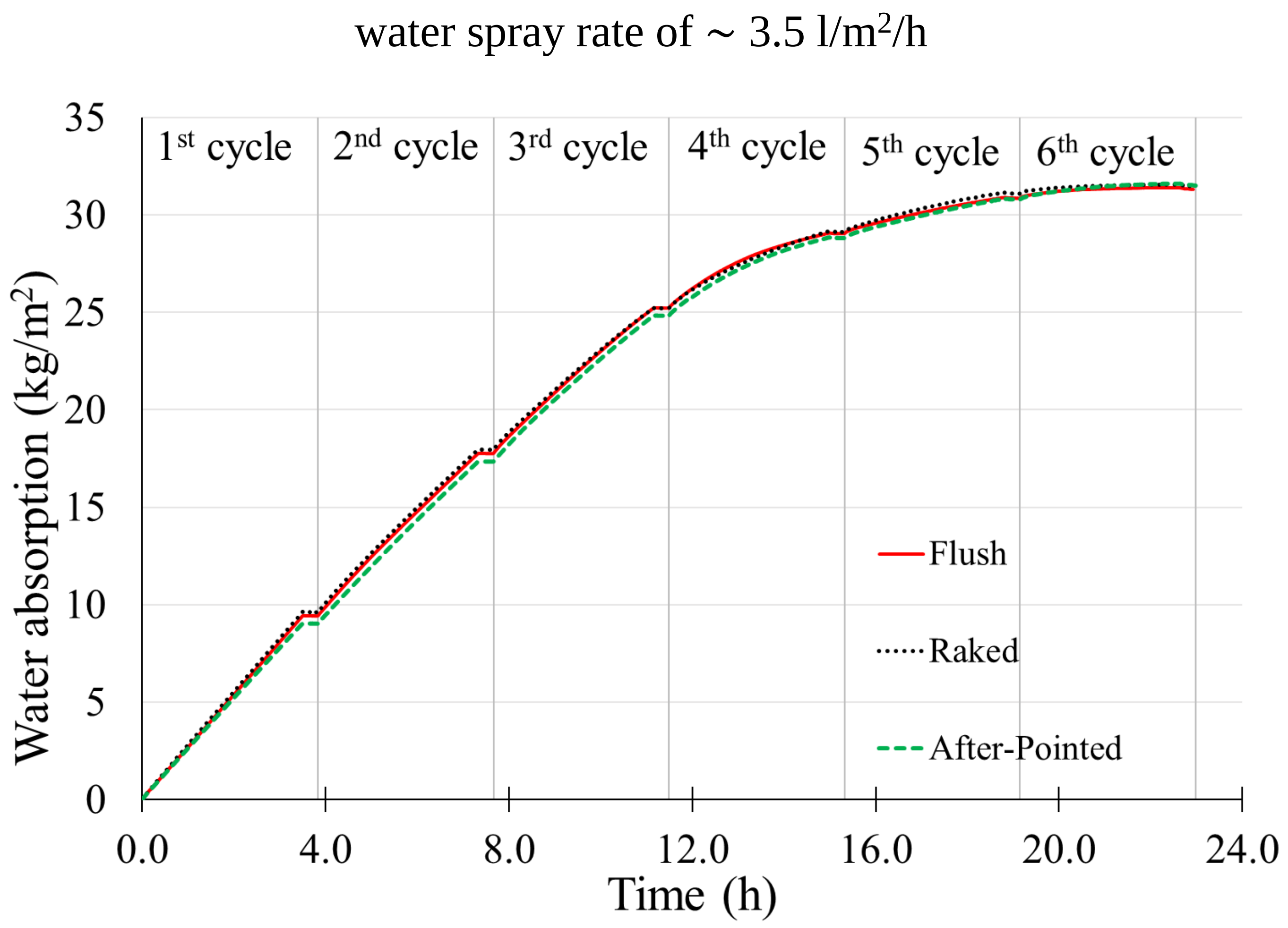
water spray rates varying between 1.7 and 3.8 l/m^2/h (Campaign [I])

water spray rate of ~ 6.3 l/m^2/h (Campaign [II])

Continuous water absorption and penetration measurement



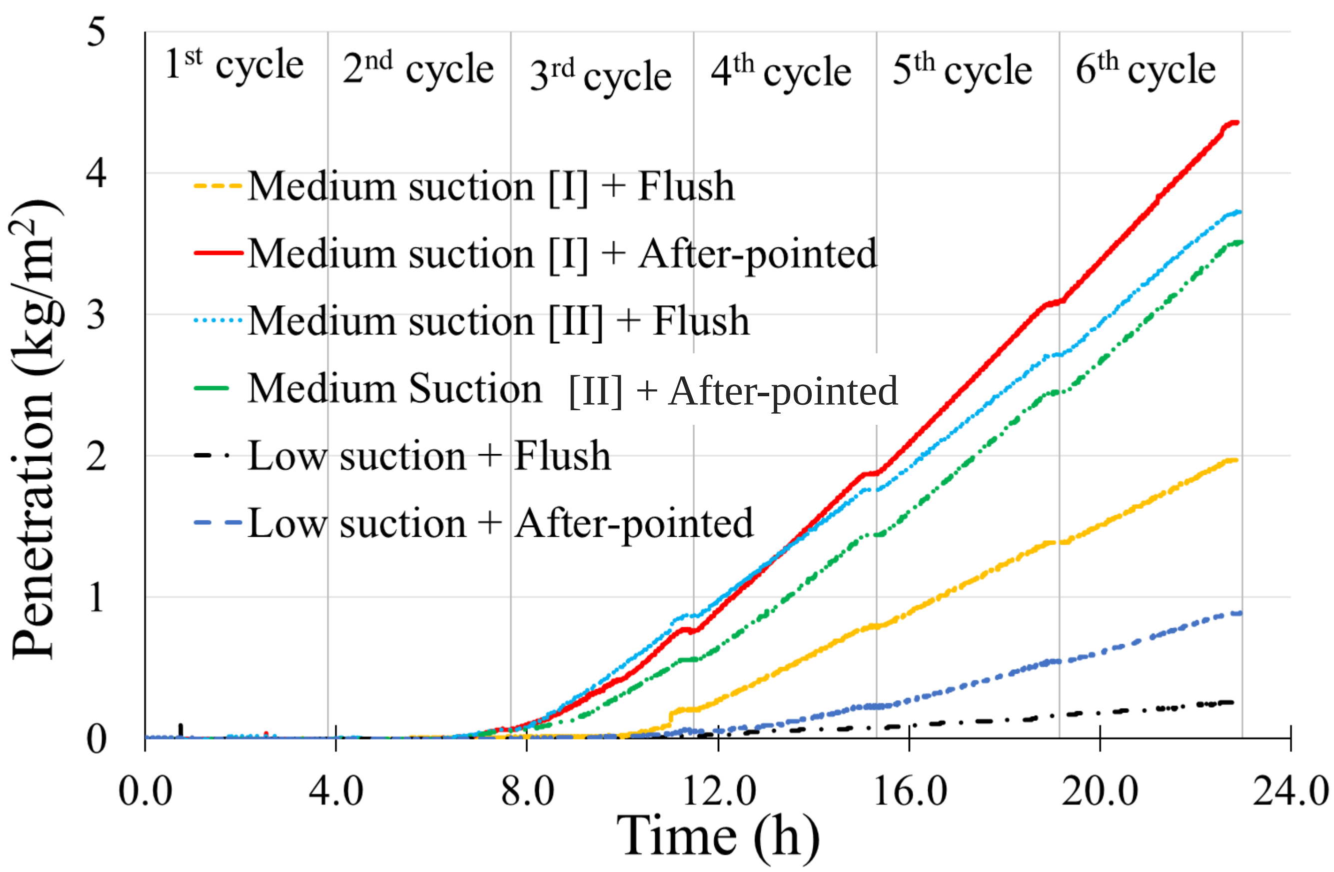
Water absorption [ii] – Specimens built with medium suction bricks [I]



No significant effect of the mortar joint profile on water absorption

Average water penetration curve for different specimens type

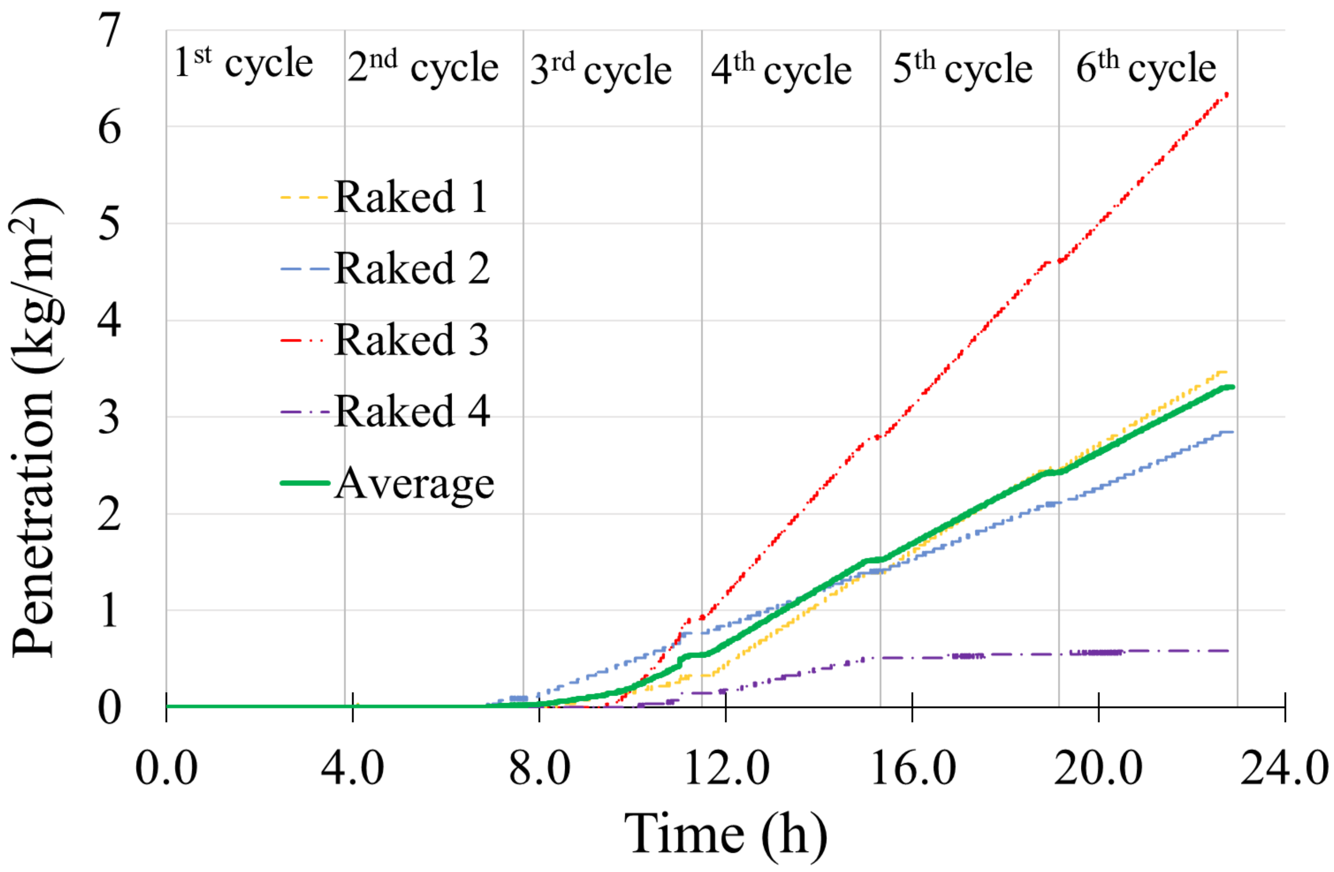
water spray rate of ~ 6.3 l/m²/h



Water penetration may occur once moisture content exceeds 90 % of saturation capacity

Water penetration – Individual specimens

Specimens built with medium suction bricks [I] and raked joint profiles



- Water penetration occured when moisture content exceeded 90%

- Penetration might depend on:
    - Workmanship
    - Voids in the bricks

Part 1: Background

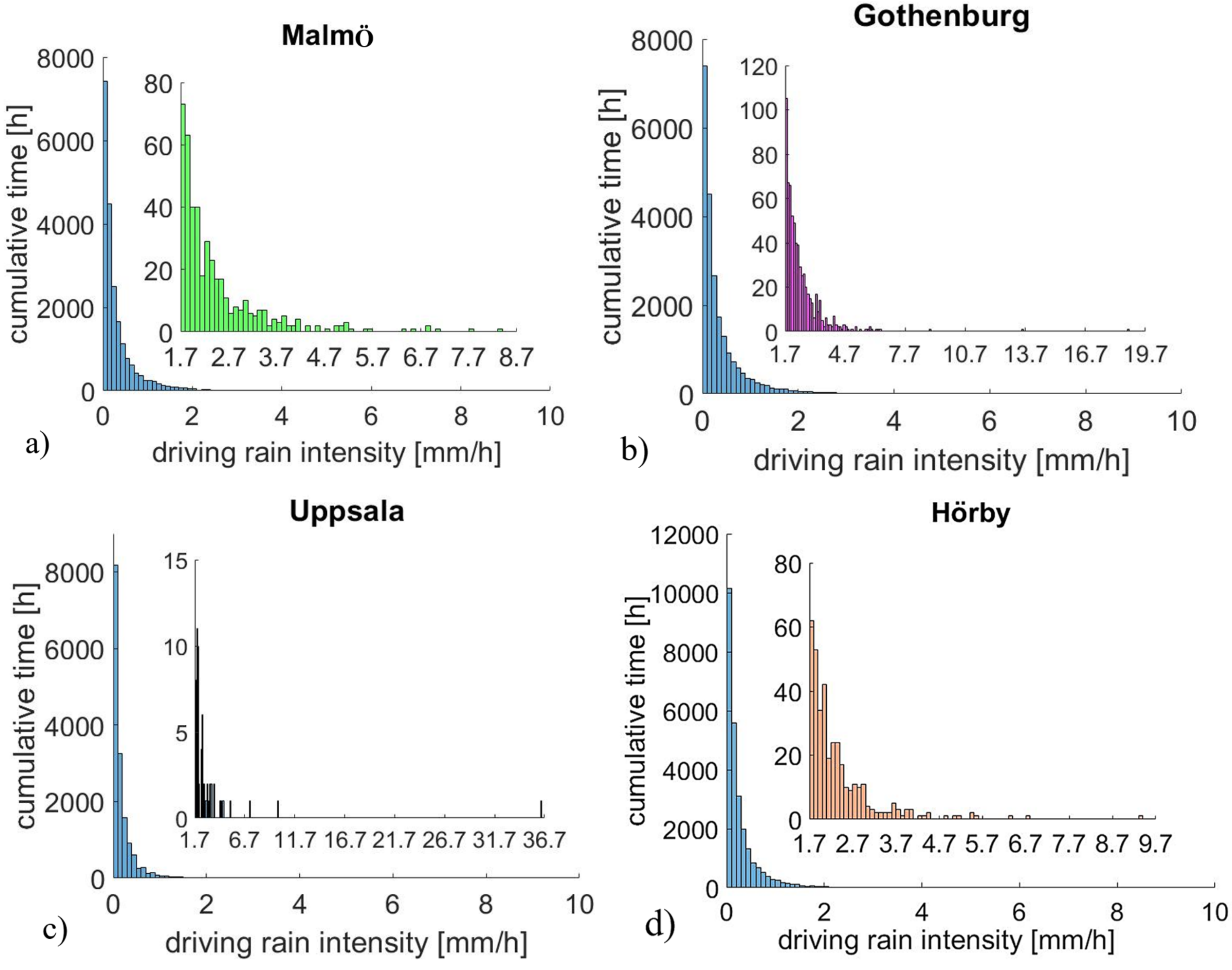
Part 2: Experimental studies

Part 3: Numerical studies

- WDR intensity in Sweden
- Moisture content of masonry walls in Sweden

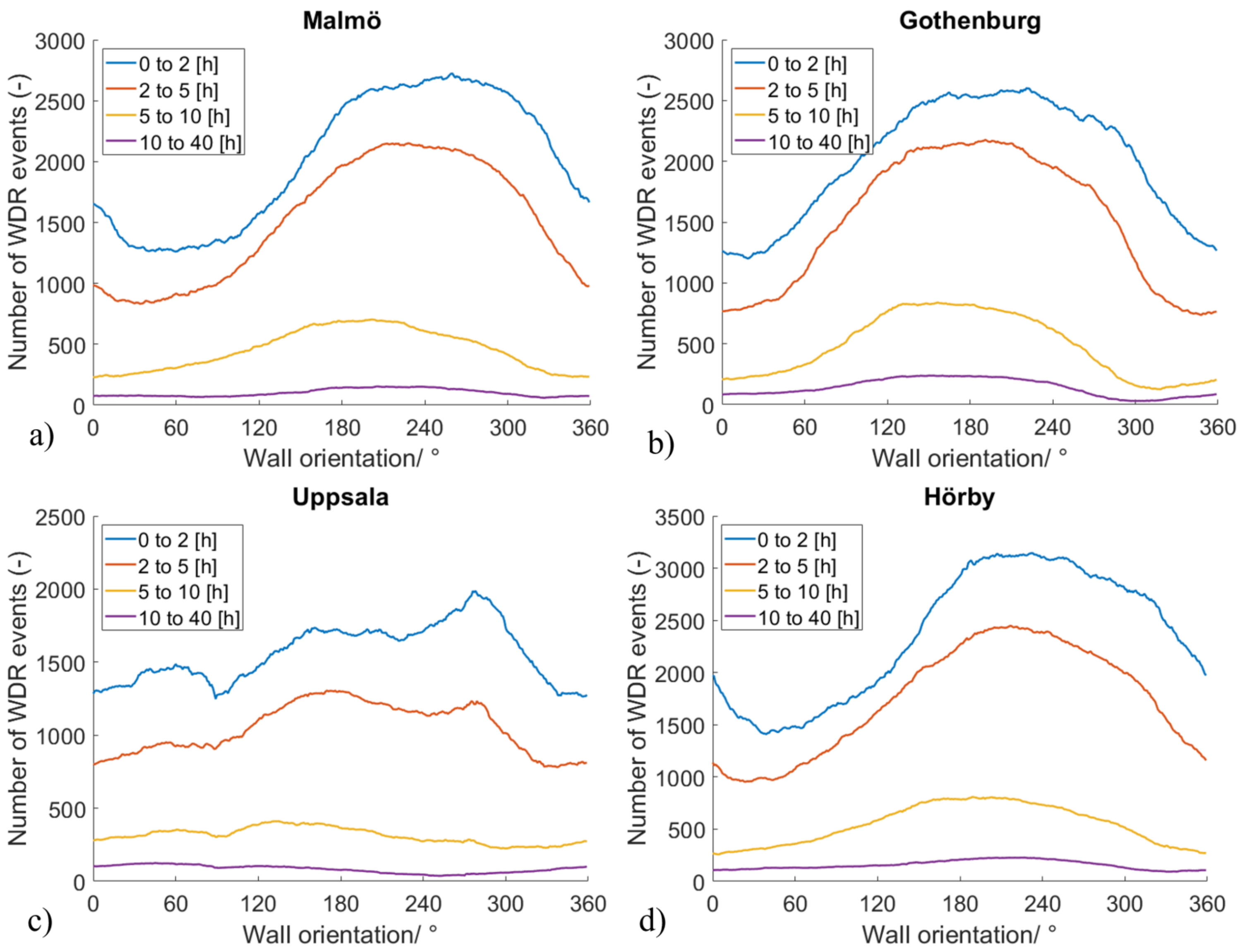
WDR in Sweden

WDR intensity (1995 – 2020)



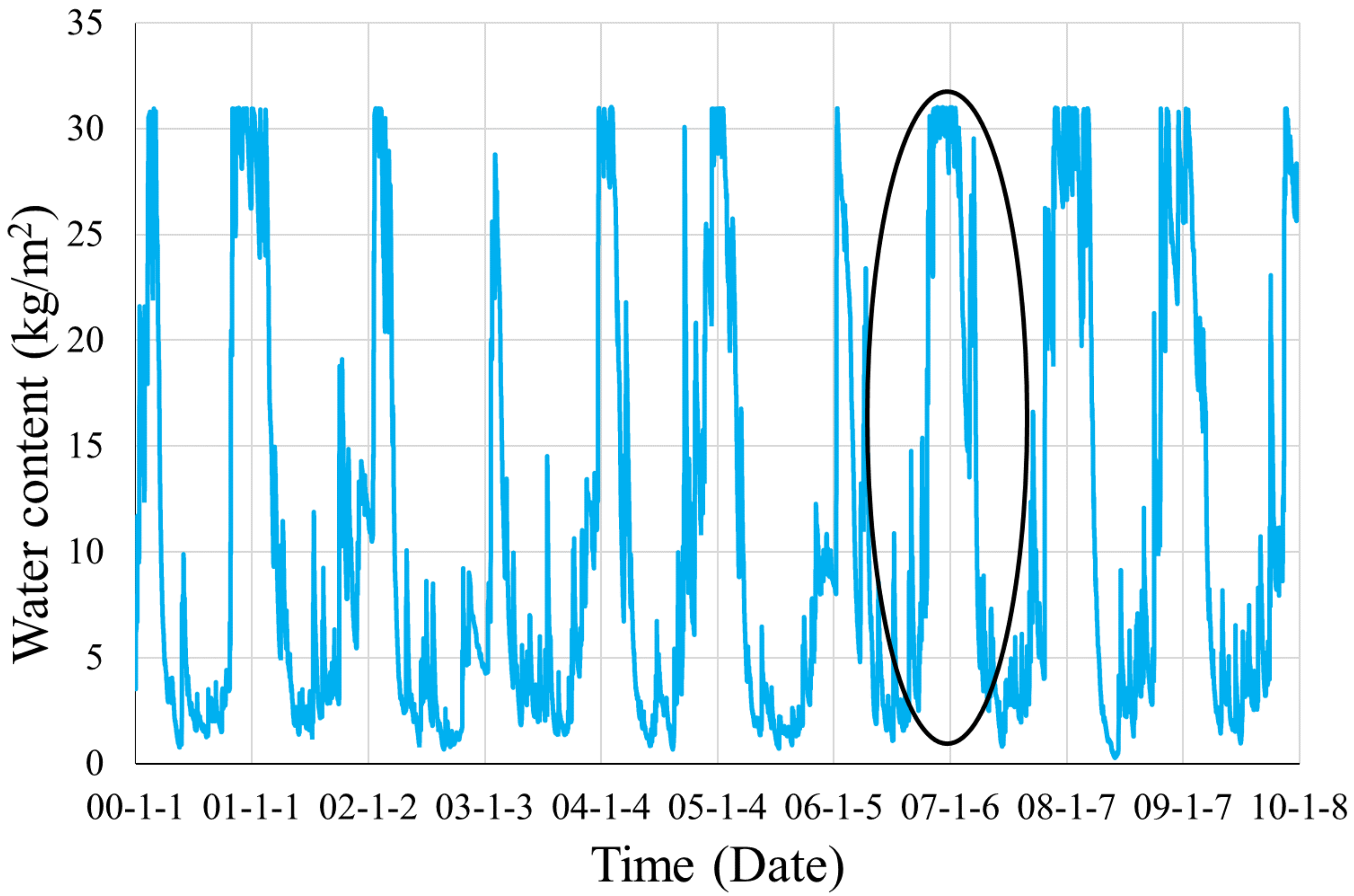
WDR in Sweden

Duration of WDR events (1995 – 2020)



Façade orientation is south

Gothenburg (2000 – 2010)



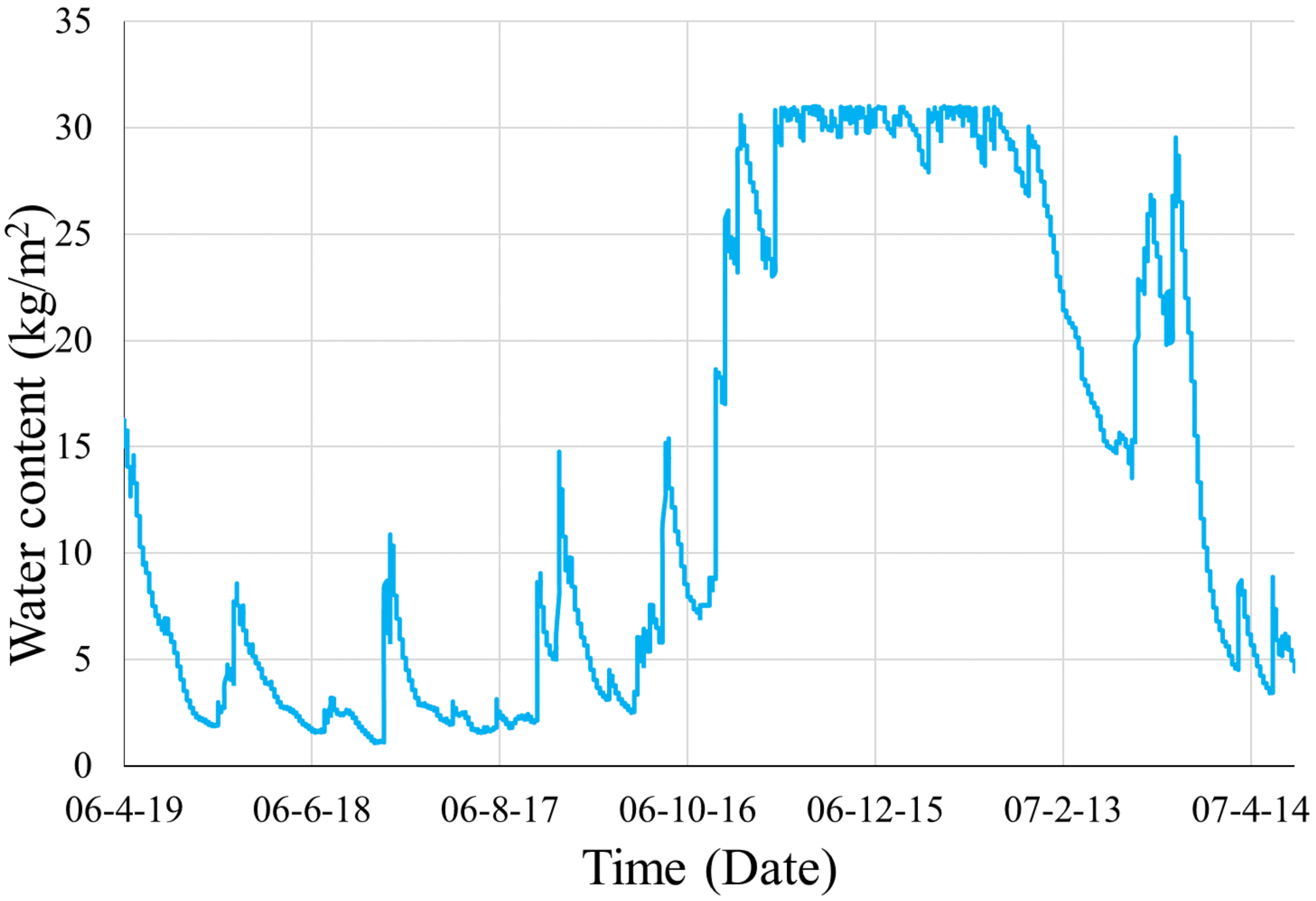
Façade orientation is south

Gothenburg (2006/04 – 2007/04)

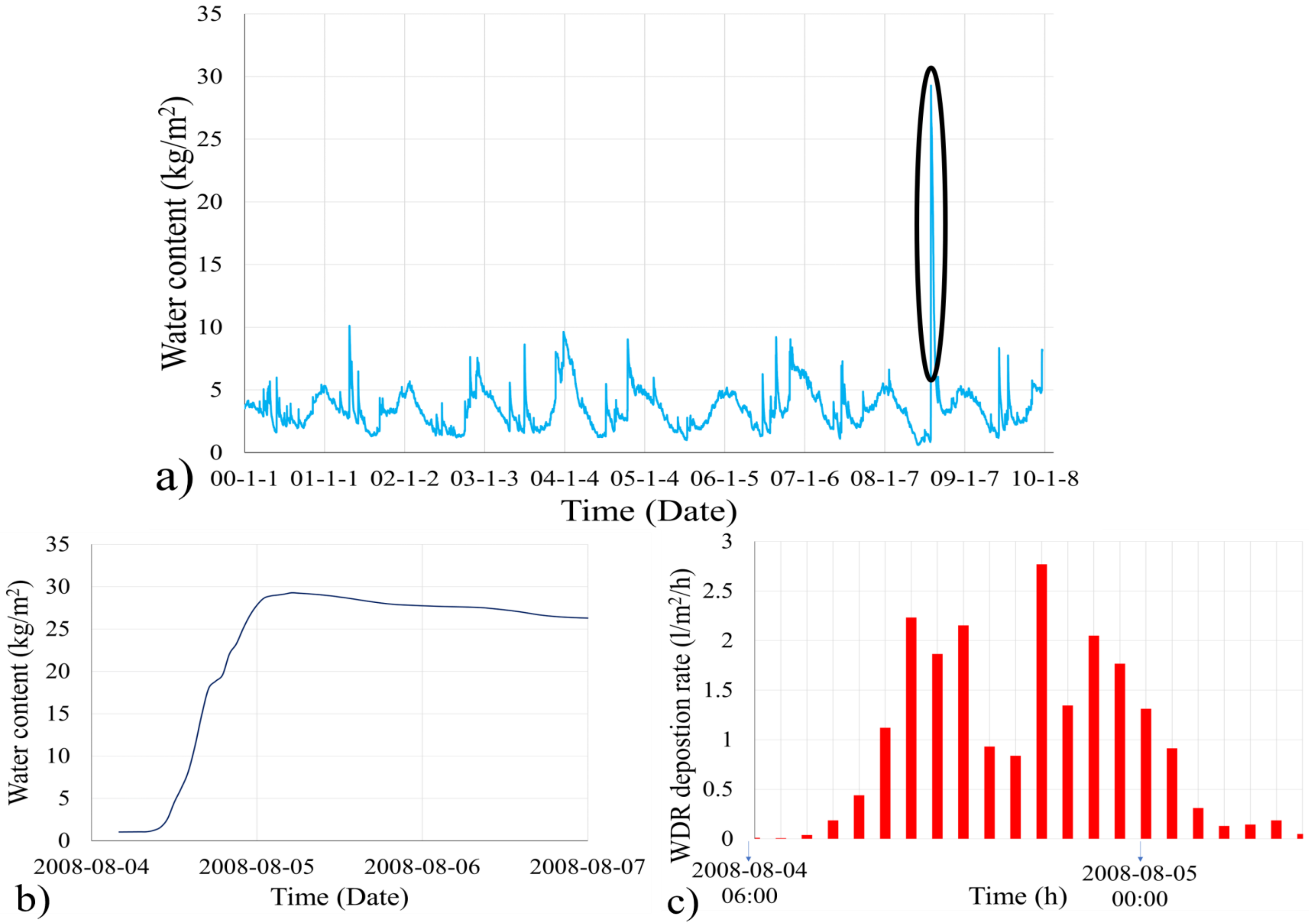
The accumulative WDR deposed on the masonry wall = 289 l/m²

209 l/m² (72 % of WDR exposure) was deposed when the moisture content of the masonry wall was below 90 %.

Probably no leakage when moisture content is less than 90% of saturation



Façade orientation is north
Gothenburg (2000 – 2010)



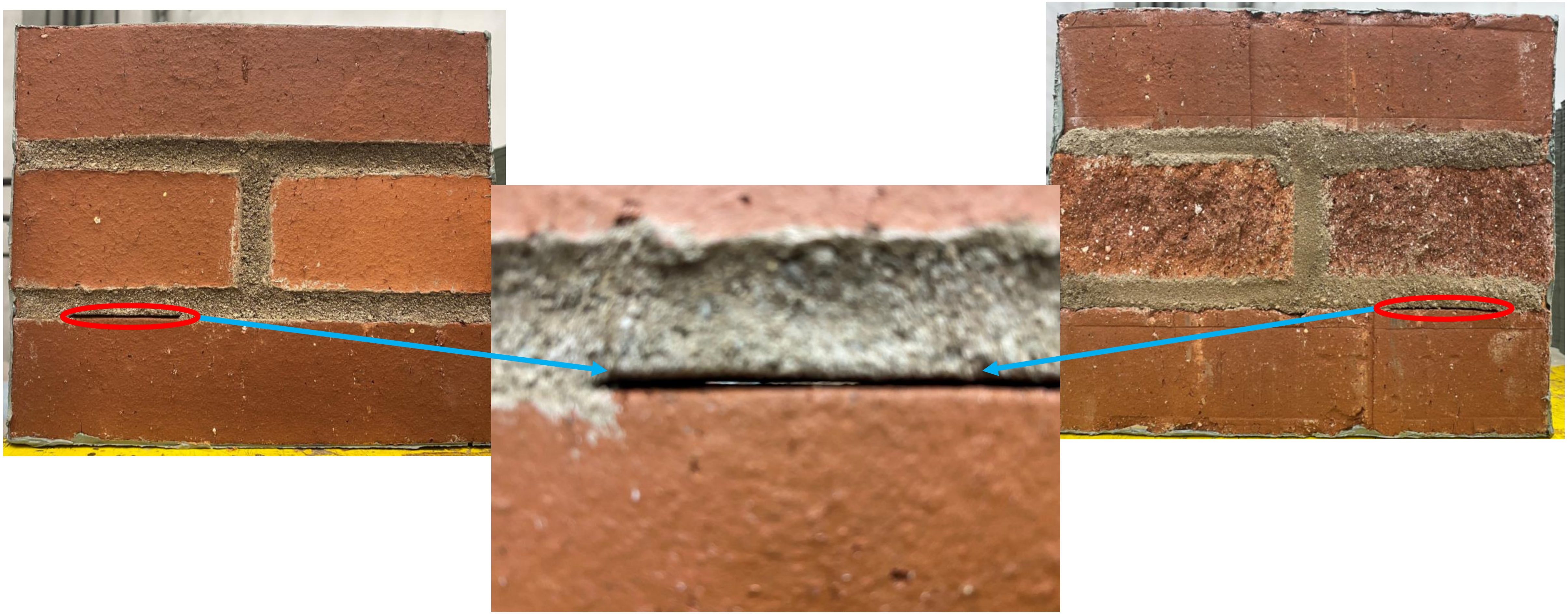
Conclusions

- Moisture absorption response of the masonry specimens → Mainly dependent on the water absorption properties of the bricks.
- Effect of mortar joint profile on water absorption and penetration → Not significant
- Water penetration starts → When the masonry specimens are close to saturation
- Leakage in masonry due to WDR might be overestimated

Future Study

Cracked Specimens

- Cracked with different width between 0.3 mm and 1 mm



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