ReBuMat
German-Vietnamese Collaborative Project on Resource-efficient Construction using Sustainable Building Materials

German-Vietnamese cooperative project on resource-efficient building using sustainable building materials

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Bio-based materials tested in climatic conditions of Ho Chi Minh City: several results from REBUMAT project

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Workshop of REBUMAT project, Germany, 06 September 2024

SUMMARY

1/ Introduction

2/ In-situ test-stand at TDTU campus

- Materials investigated

3/ Results after 2 years in-situ

4/ Conclusion and perspectives

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INTRODUCTION

Conventional materials:

- **Concrete:**
  - **Cement:** CO_2 emission and high energy consumption
  - **Aggregates: sand, gravels**

i. December 7, 1995

ii. December 24, 2013

- **Clay burn bricks:**
  - **CO_2 emission**
  - **Agricultural soil**

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Strategies adopted:

- **Bio-based** materials: Renewable, negative carbon footprint

- **Soil-based** materials

2/ In-situ test-stand at TDTU campus

Exposed face: North

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2.1/ Materials investigated

Wall section	1	2	3	4	5	6	7	8
main material	hollow **clay brick**	**foam concrete** brick	**ACC** brick	**foam glass** concrete brick	rammed **earth**	**typha** board wall	**cement board**	**coconut coir** bricks
width [m]	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Composition	▪ Internal paint ▪ Internal cement plaster ▪ 4 hollow **clay bricks +** cement mortar ▪ External cement plaster ▪ External Paint	▪ Internal paint ▪ Internal cement plaster ▪ **foam concrete** brick **+** cement mortar ▪ External cement plaster ▪ External Paint	▪ Internal paint ▪ Internal cement plaster ▪ **ACC** brick **+** glue ▪ External cement plaster ▪ External Paint	▪ Internal paint ▪ Internal cement plaster ▪ **foam glass concrete** brick ▪ External cement plaster ▪ External Paint	▪ Internal paint ▪ Internal cement plaster ▪ **rammed earth** ▪ External cement plaster ▪ External Paint	▪ Internal paint ▪ Internal cement plaster ▪ **Internal cement board** ▪ **typha board** wall ▪ **External cement board** ▪ External cement plaster ▪ External Paint	▪ Internal paint ▪ **Internal cement board** ▪ **External cement board** ▪ External Paint	▪ Internal paint ▪ Internal cement plaster ▪ **coconut coir** bricks ▪ External cement plaster ▪ External Paint

2.1/ Materials investigated

2.1/ Materials investigated

coconut coir bricks

coconut coir bricks with cem-board

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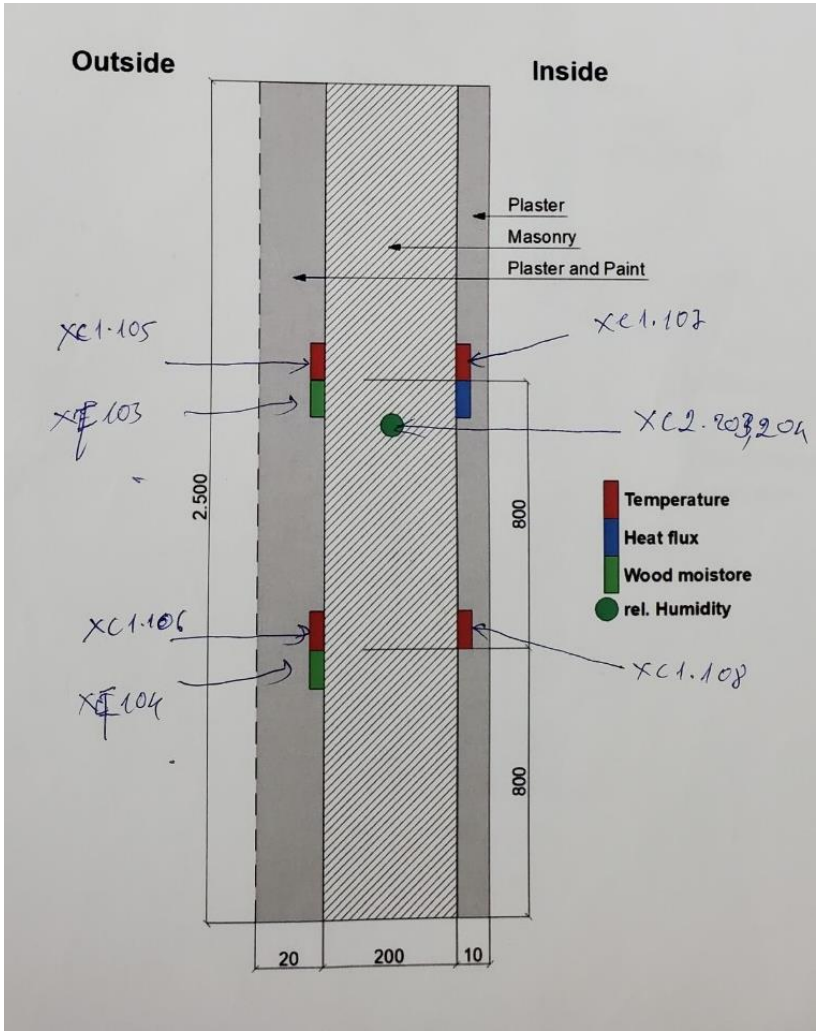
2.2/ Installation of equipment

On the **exterior face** of the wall



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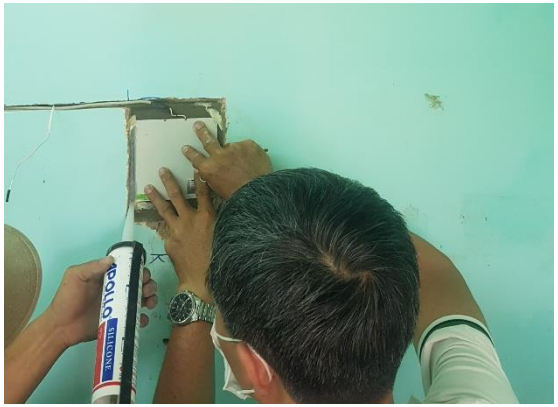
2.2/ Installation of equipment



Mid-thickness and interior face of the wall

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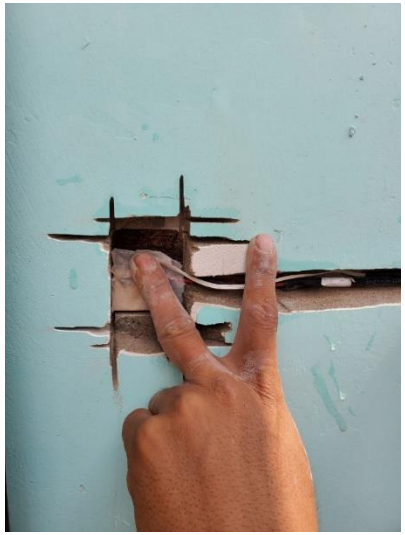
2.2/ Installation of equipment



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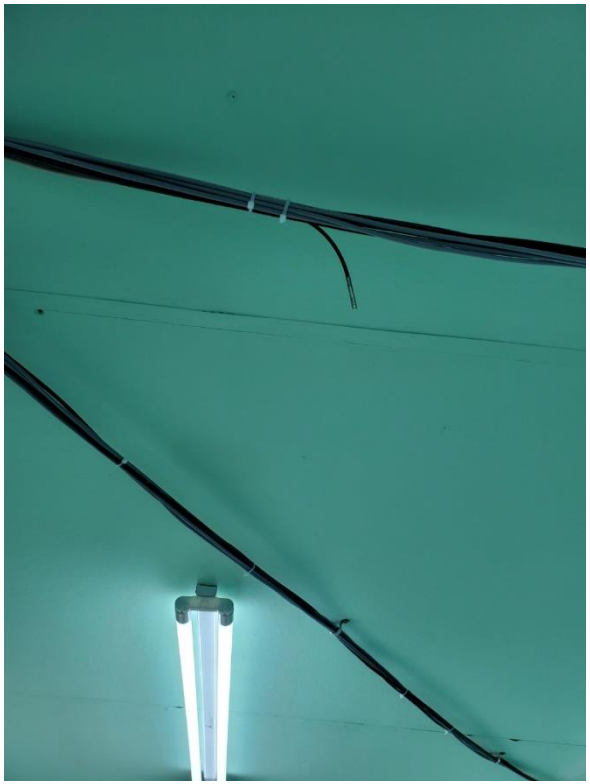
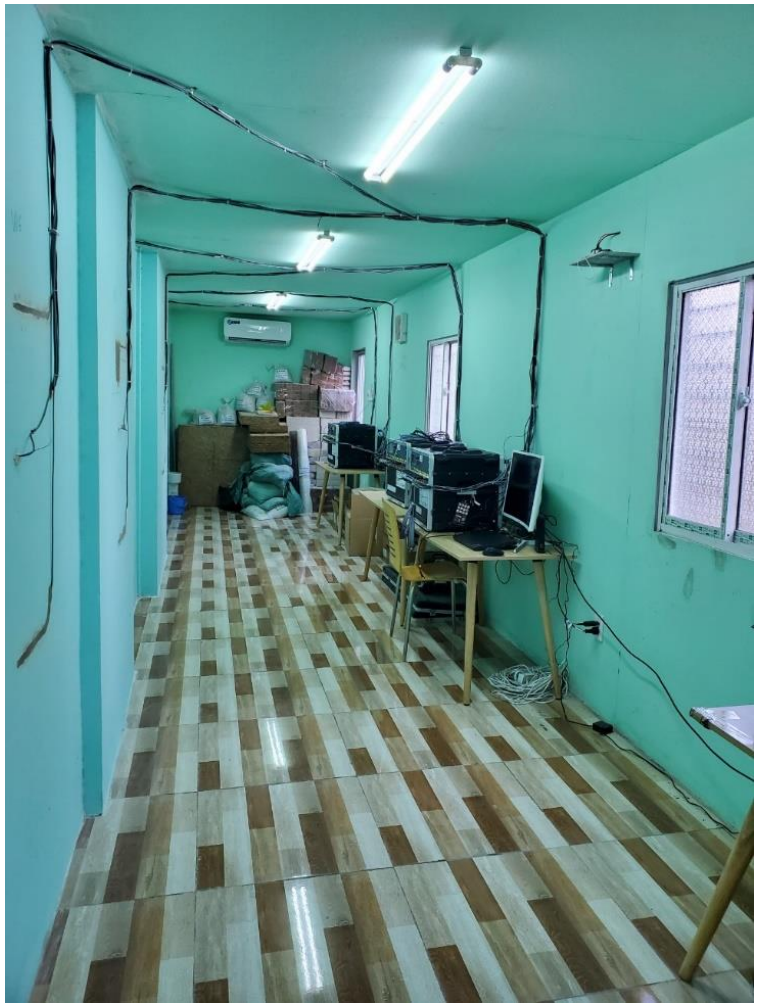
2.2/ Installation of equipment





For indoor ambient

2.2/ Installation of equipment

For outdoor ambient

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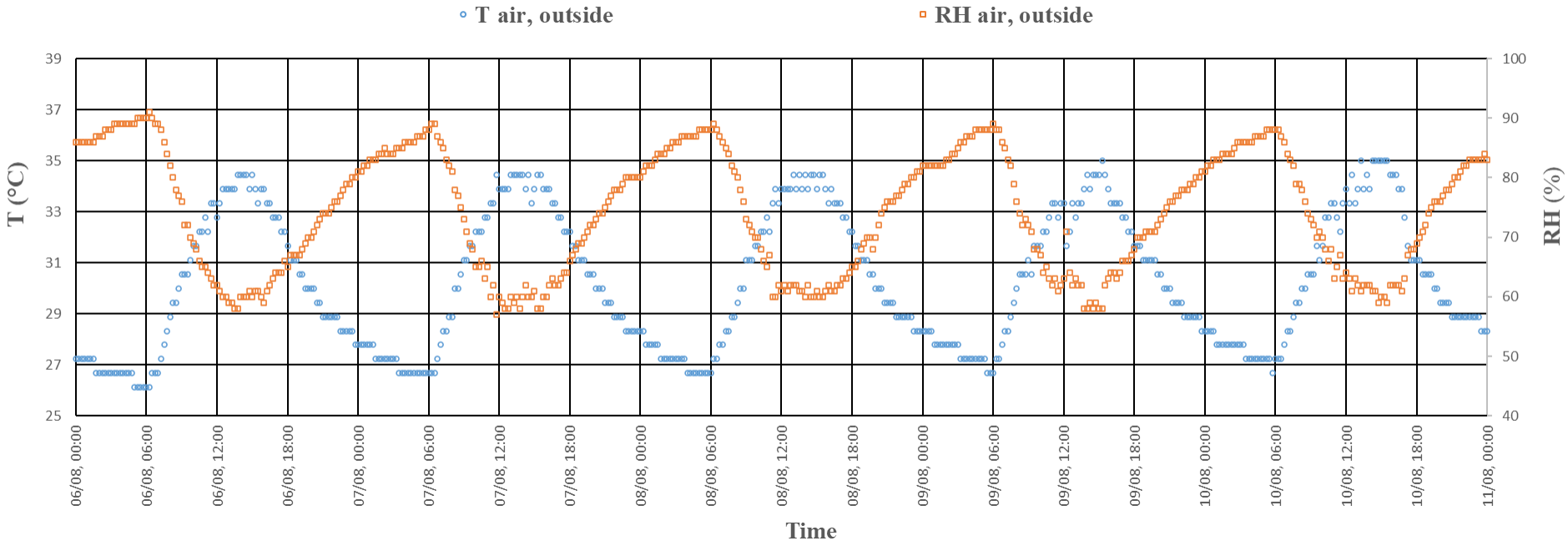
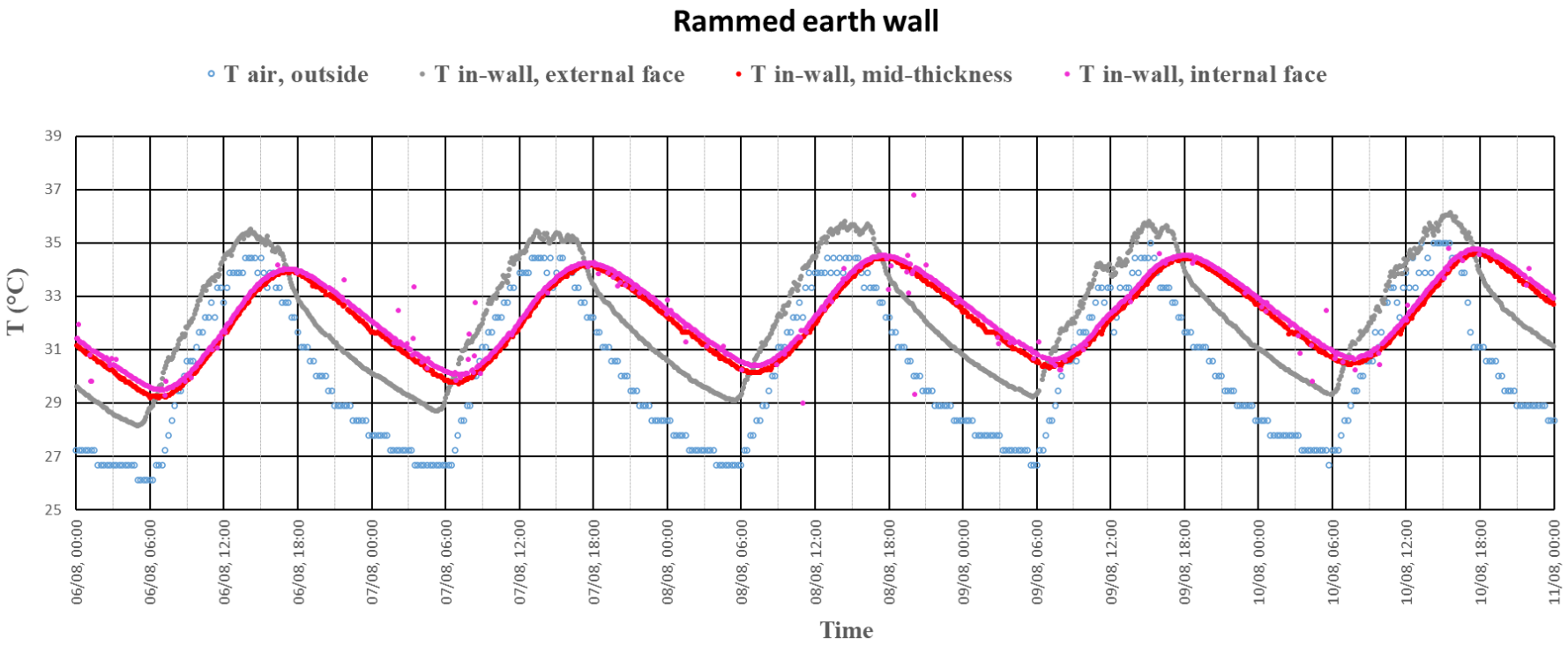
3/ Results after 2 years in-situ

Only some results presented here



Example: August 2023:

- Temperature: **27-35 °C**
- RH: **60-90%**



- $T_{wall,\ external\ face}$ (until **36 °C**) **>** T_{air} => effects of the Sun radiation on the wall
- $T_{in\text{-}wall,\ mid\text{-}thickness}$ **~** $T_{in\text{-}wall,\ internal\ face}$ (**29.5 - 34.5 °C**)
- Temperature **dephasing** between **outside** and **inside** (about **4.5 h**) => Inertia effect

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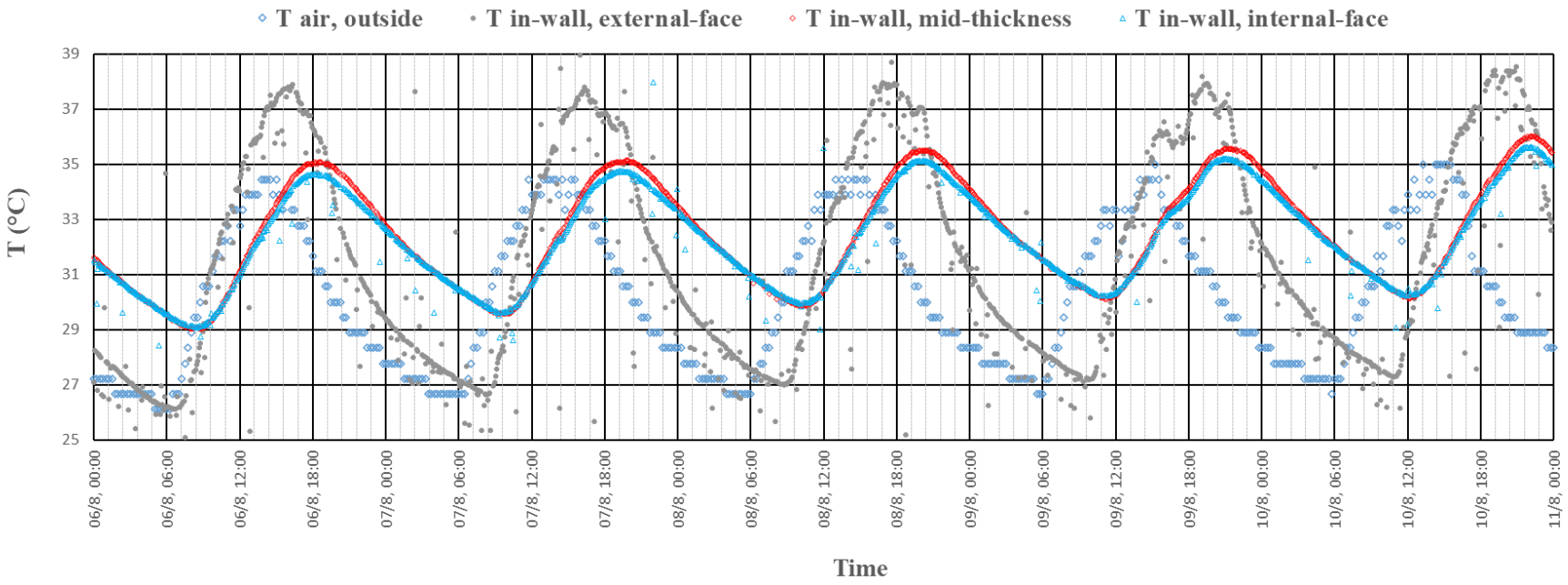
Typha wall



- $T_{wall,\ external\ face}$ (until **38.5 °C**) **>** $T_{air,\ outside}$ => effects of the Sun radiation on the wall
- $T_{in\text{-}wall,\ mid\text{-}thickness}$ **~** $T_{in\text{-}wall,\ internal\ face}$ (**29 - 36 °C**), BUT: difference at the “peaks” (about **0.5 °C**) => effect of **thermal insulation**.
- $T_{wall,\ external\ face}$ **>>** $T_{wall,\ internal\ face}$ (**about 2 °C**) => effect of **thermal insulation**.
- Temperature **dephasing** between **outside** and **inside** (about **6 h**) => Inertia effect

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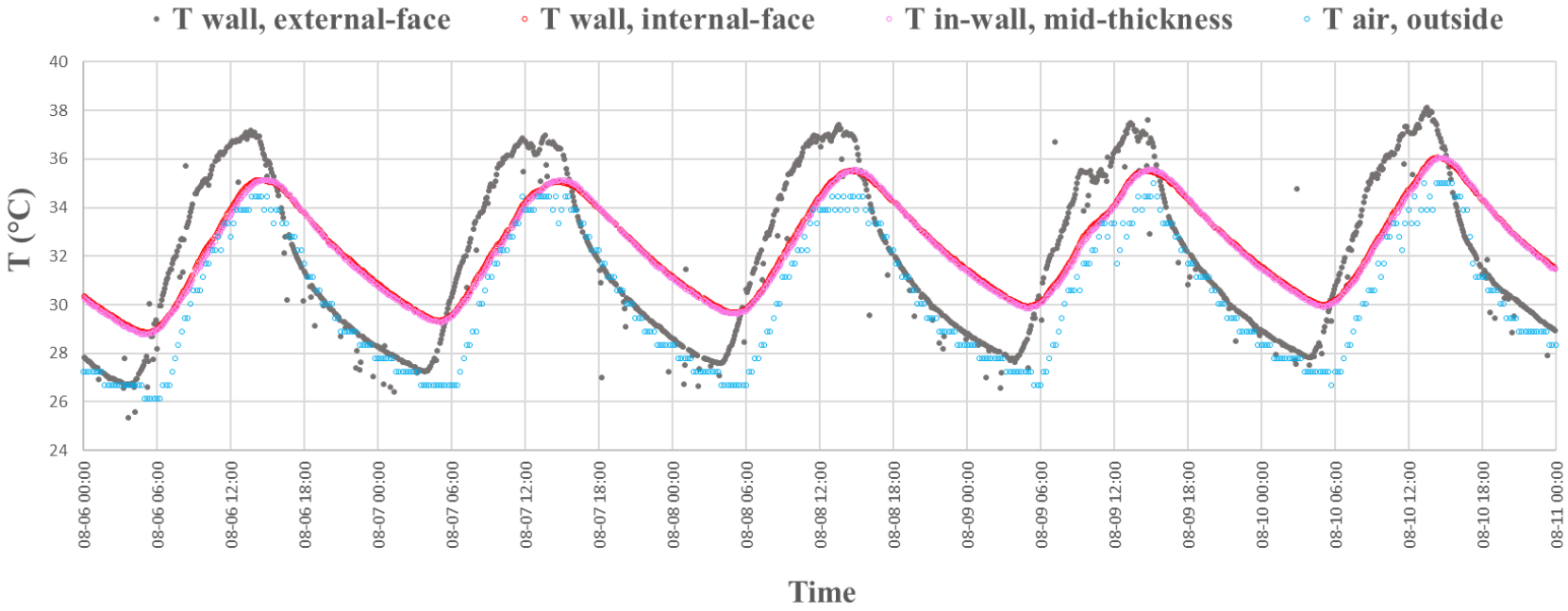
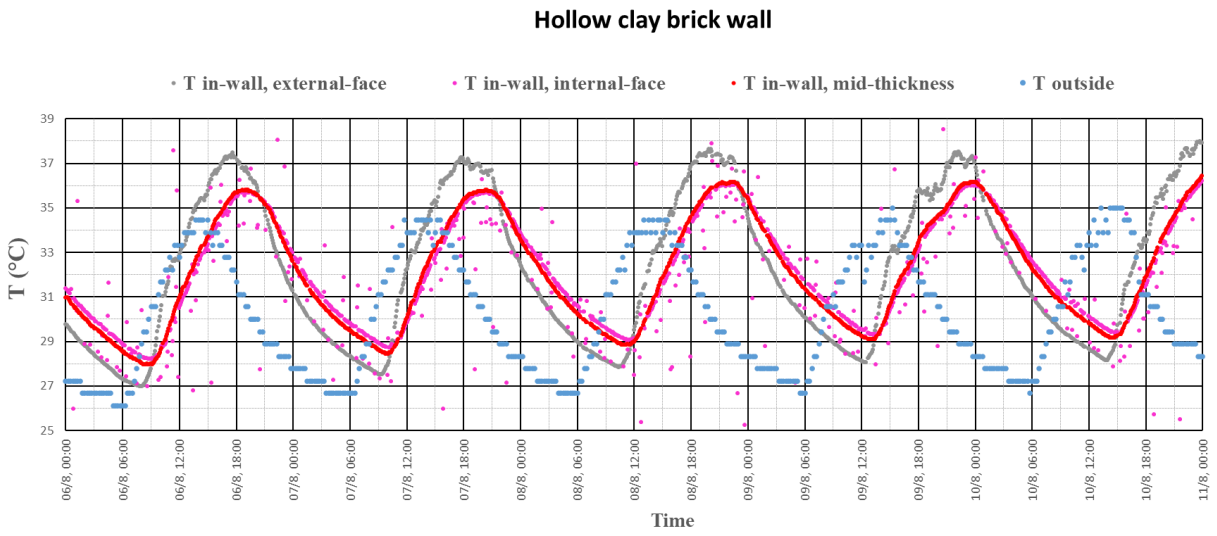
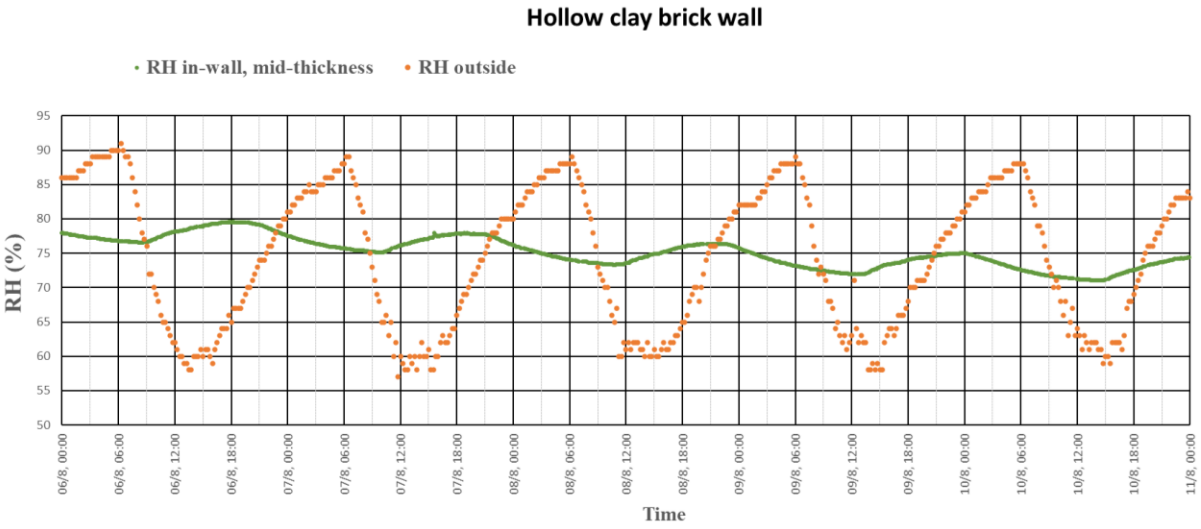
Coconut coir bricks



- $T_{wall,\ external\ face}$ (until **36 °C**) **>** $T_{air,\ outside}$ => effects of the Sun radiation on the wall
- $T_{in\text{-}wall,\ mid\text{-}thickness}$ **~** $T_{in\text{-}wall,\ internal\ face}$ => no effect of **thermal inertia**.
- Temperature **dephasing** between **outside** and **inside** (about **1 h**) => **low inertia** effect

- higher temperature on the external plaster of the Hollow clay brick wall (until **38 °C**)
- $T_{\text{in-wall, mid-thickness}}$ ~ $T_{\text{in-wall, internal face}}$(**28-36.5 °C**).
- Temperature **dephasing** between **outside** and **inside** (about **5.5 h**) => Inertia effect
- **RH in-wall: 71-80%**





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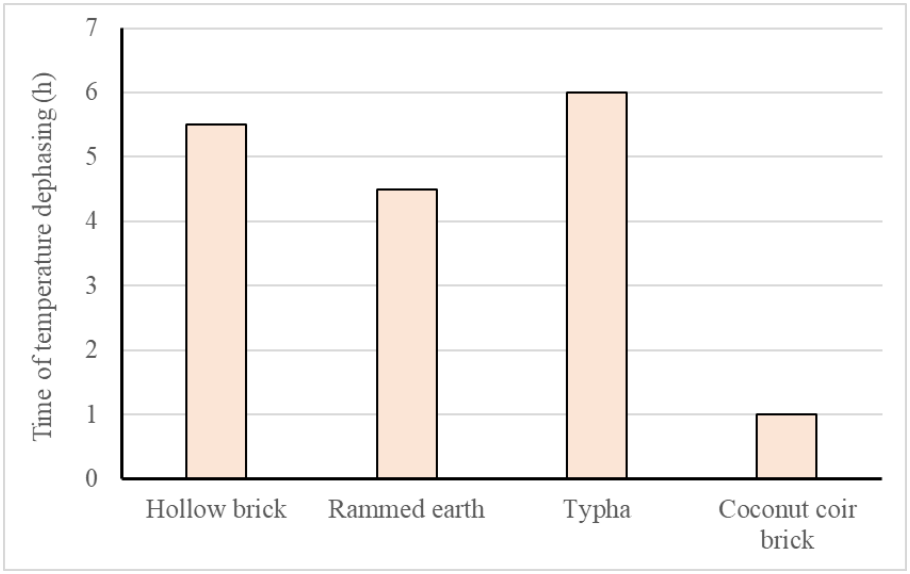
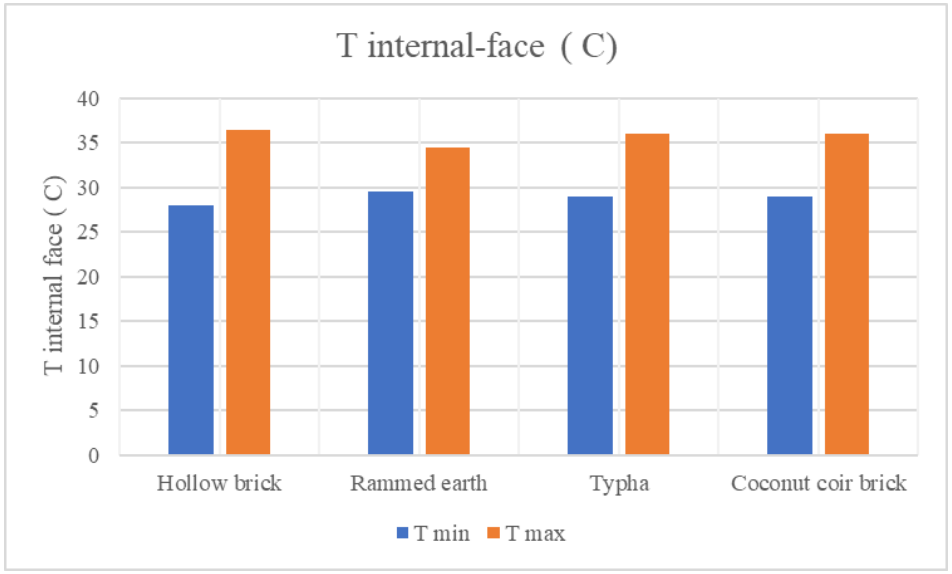
Temperature dephasing and variation in the internal face





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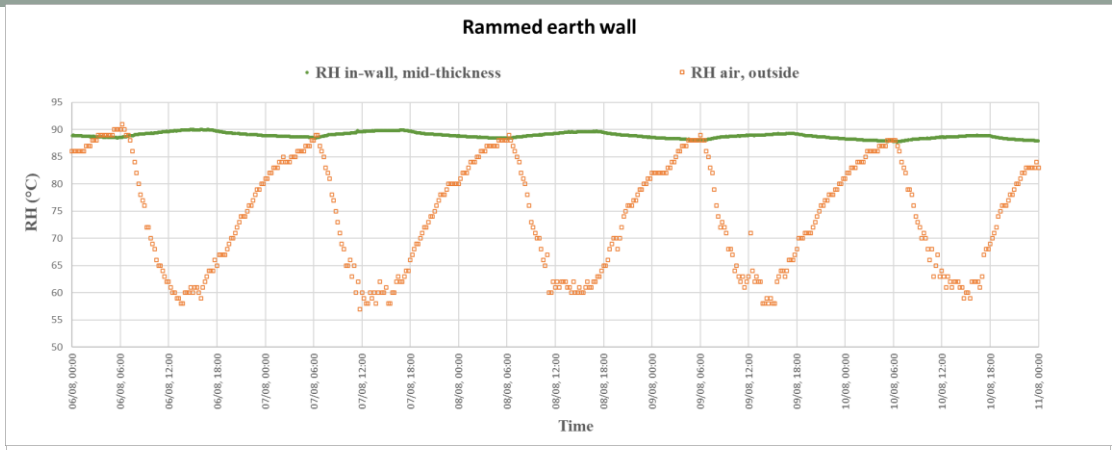
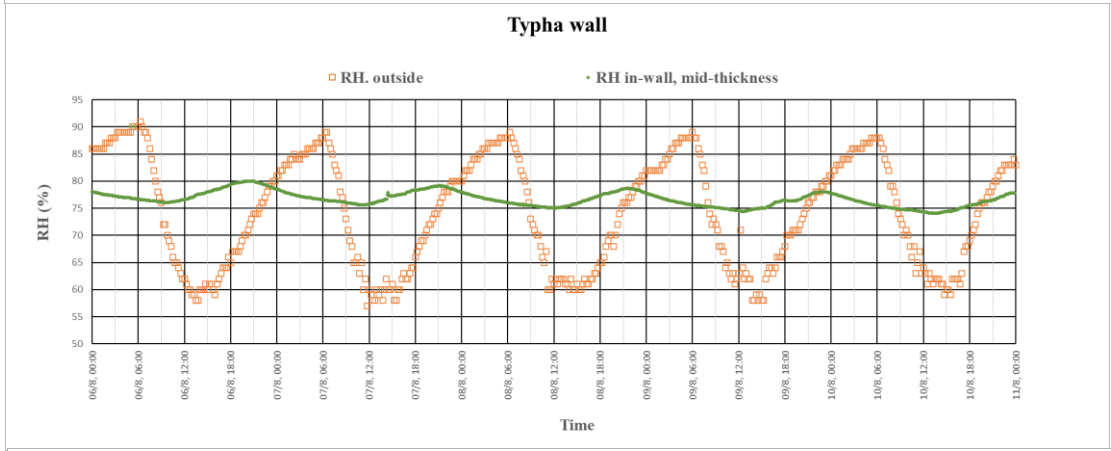
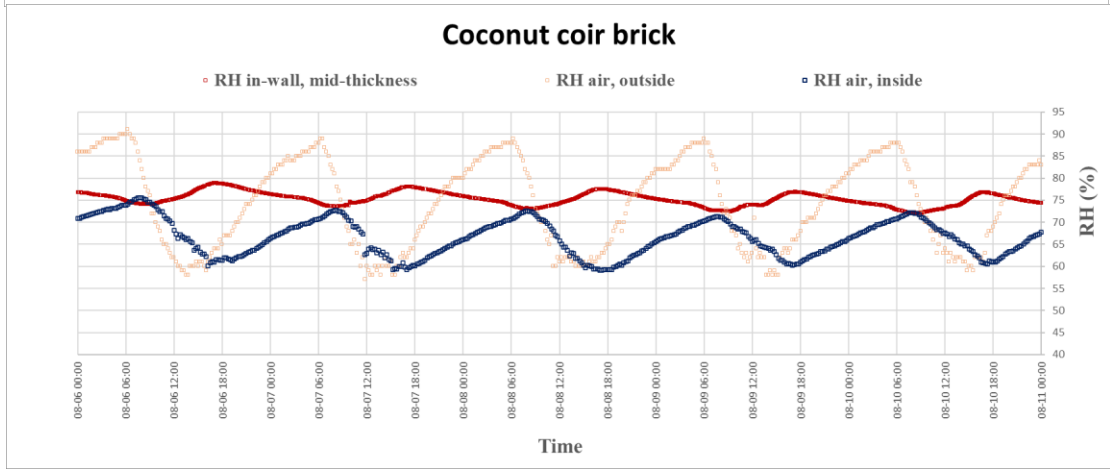
RH in-wall:

- Rammed earth: 88-90% (very low variation)
- Typha: **75-80%** (relatively high variation)
- Coconut coir brick: 72-79% (high variation)

⇒ absorption/desorption capacity of **bio-based** materials
⇒ "regulator" of indoor humidity







4. Conclusion and perspective

- Preliminary results obtained after 2 year in-situ,
- Typha: highest thermal inertia;
- Rammed earth: lowest temperature variation
- $T_{in\text{-}wall,\ internal\ face,\ max}$: Rammed earth (**34.5 °C**) < Typha~ Coconut coir (**36 °C**) < hollow clay brick wall **(36.5 °C**)
- Other scenarios (with air conditioning during the office hours, air conditioning all day) are being analysed,
- Numerical simulation for the hygro-thermal behaviour of the walls
- Comparison between different climatic conditions

THANK YOU FOR YOUR ATTENTION

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