Thermal resistance, water permeability and water retention capacity of green roof layers with recycled and artificial aggregates

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1. ABSTRACT

The shape and type of materials used in green roof drainage and substrate layers significantly impact thermal resistance, water retention and detention capacity of green roofs. The effect of recycled and artificial materials on green roof layers' performances is relatively unexplored. This study let us measure the water permeability, the water retention capacity, and the thermal resistance of substrate and drainage layers of green roof systems in which coarse recycled and artificial materials were used.

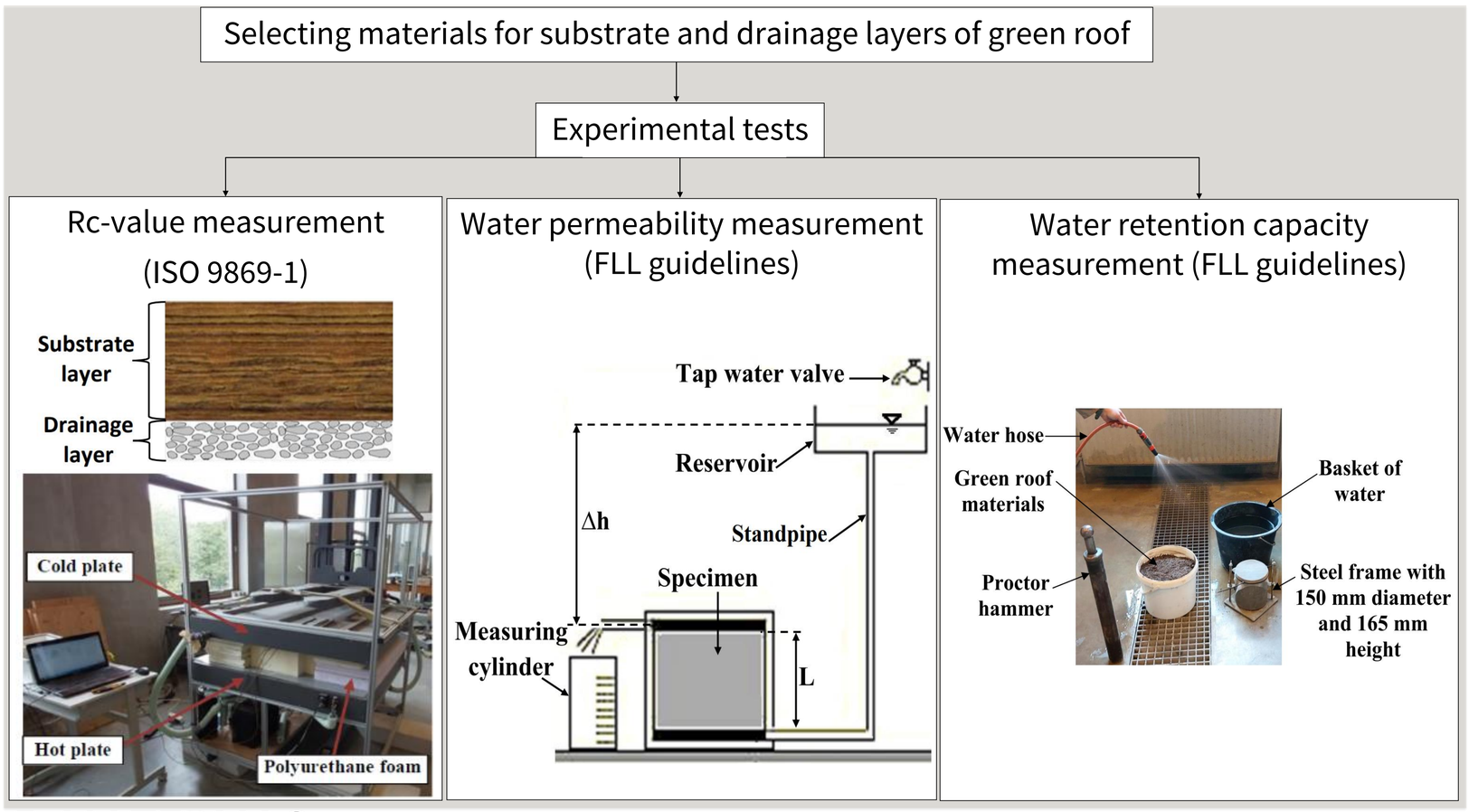
2. OBJECTIVES

- Proposing recycled and artificial materials for drainage and substrate layers of green roof systems.
- Verifying that thermal resistance, water permeability and water retention capacity of green roof layers including recycled and artificial materials are complying with rules.

3. RESEARCH QUESTION

To what extent can the use of recycled and artificial materials provide better thermal resistance, water passing ability, and water retention capacity for substrate and drainage layers compared to conventional green roof materials?

4. METHODOLODY



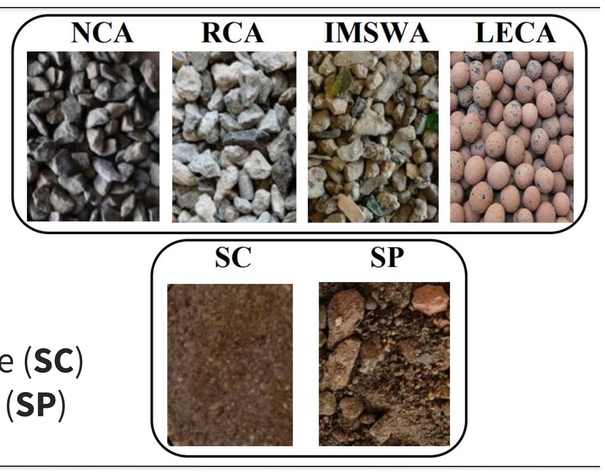
5. MATERIALS

Drainage materials:

- Natural Coarse Aggregate (**NCA**)
- Recycled Coarse Aggregate (**RCA**)
- Incinerated Municipal Solid Waste Aggregate (**IMSWA**)
- Lightweight Expanded Clay Aggregate (**LECA**)

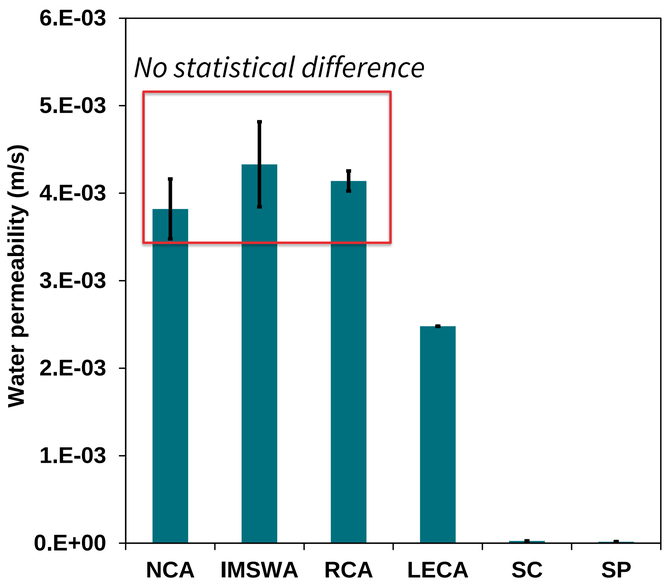
Substrate materials:

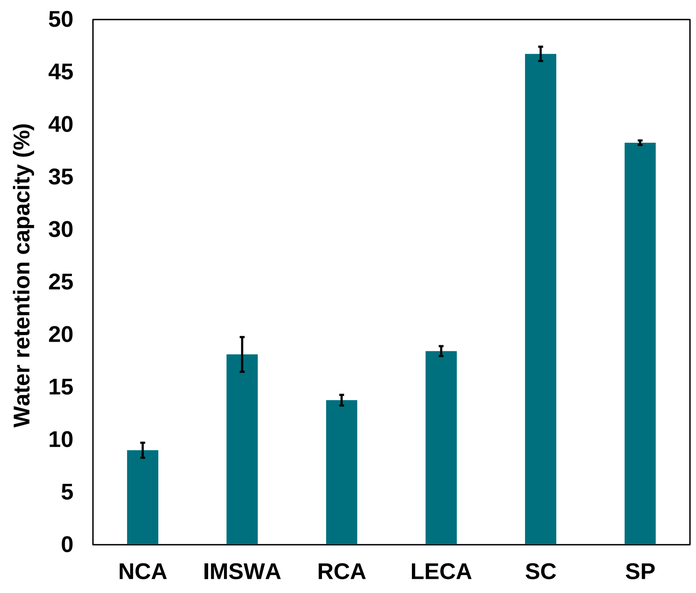
- Substrate *without* coarse recycled materials, Control Substrate (**SC**)
- Substrate *with* coarse recycled materials, Proposed Substrate (**SP**)



6. RESULTS

Specimens ID	Test duration (h)	Convergence duration (h)	Thermal conductivity (W/m·K)	Rc-value (m^2 K/W)
NCA5	101	76	0.114	0.44
RCA5	101	76	0.110	0.45
IMSWA5	101	76	0.115	0.43
LECA5	101	76	0.067	0.73
SC15_Wet	122	73	0.310	0.48
SC15_Dry	140	116	0.150	1
SP15_Wet	122	73	0.320	0.46
SP15_Dry	165	75	0.160	0.94
NCA5-SC15_Wet	166	118	0.270	0.75
NCA5-SC15_Dry	165	120	0.142	1.38
RCA5-SP15_Wet	166	118	0.280	0.72
RCA5-SP15_ Dry	166	120	0.151	1.31
IMSWA5-SP15 _Wet	168	120	0.270	0.74
IMSWA5-SP15 _Dry	168	120	0.160	1.26
LECA5-SP15 _Wet	168	120	0.192	1.04
LECA5-SP15 _Dry	168	120	0.147	1.36





7. CONCLUSIONS

✓ **Thermal resistance:**

- For drainage layer: LECA obtained the highest Rc-value. The results of NCA, IMSWA, and RCA were nearly the same.
- For substrate layer: Rc-value of SC was marginally more than SP. The results of dry substrate were about twice of wet substrate.

✓ **Water permeability:**

- For drainage layer: The result of NCA was 1.5 times more than LECA. The results of NCA, IMSWA, and RCA were nearly the same.
- For substrate layer: The result of SC was 1.5 times more than SP. Both were within the range of FLL guidelines (10^{-5} - 1.17×10^{-3} m/s).

✓ **Water retention capacity**:

- For drainage layer: The results of IMSWA, RCA, and LECA were more than NCA.
- For substrate layer: The result of SC was 1.2 times more than SP. Both were within the range of FLL guidelines (35% - 65%).

REFERENCE

Kazemi, M., Courard, L., Attia, S., Water permeability, water retention capacity, and thermal resistance of green roof layers made with recycled and artificial aggregates, Building and Environment, 227 (2023), 109776, https://doi.org/10.1016/j. buildenv.2022.109776.

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