USE OF DEMOLITION WASTE AND BIOCHAR IN A HYBRID CONSTRUCTED WETLAND-EXTENSIVE GREEN ROOF

Marek Petreje[1,2], Michal Sněhota[1,2], Tomáš Chorazy[3], Michal Novotný[3], Barbora Rybová[2], Petra Hečková[1,2]
[1] Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, Praha 6, 166 29, Czech republic
[2] University Centre for Energy Efficient Building, Czech Technical University in Prague, Třinecká 1024, 273 43 Buštěhrad, Czech Republic
[3] Advanced Materials, Structures and Technologies, Brno University of Technology, Purkyňova 139, 612 00 Brno, Czech Republic

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ABSTRACT AND OBJECTIVES

The first objective of the project was to design, build and experimentally verify the functionality of a new concept of a combination of a constructed wetland and a green roof using greywater for irrigation. The second objective was to design and test a growing media for an extensive green roof with an addition of recycled materials based on construction recyclate and pyrolysed sewage sludge in the form of biochar, in accordance with the principles of circular economy. The hydrophysical characteristics of the proposed substrate mixtures were determined and two were selected for use on wetland-extensive green roof areas. Water balance, water chemistry and vegetation condition were monitored in relation to the addition of biochar.

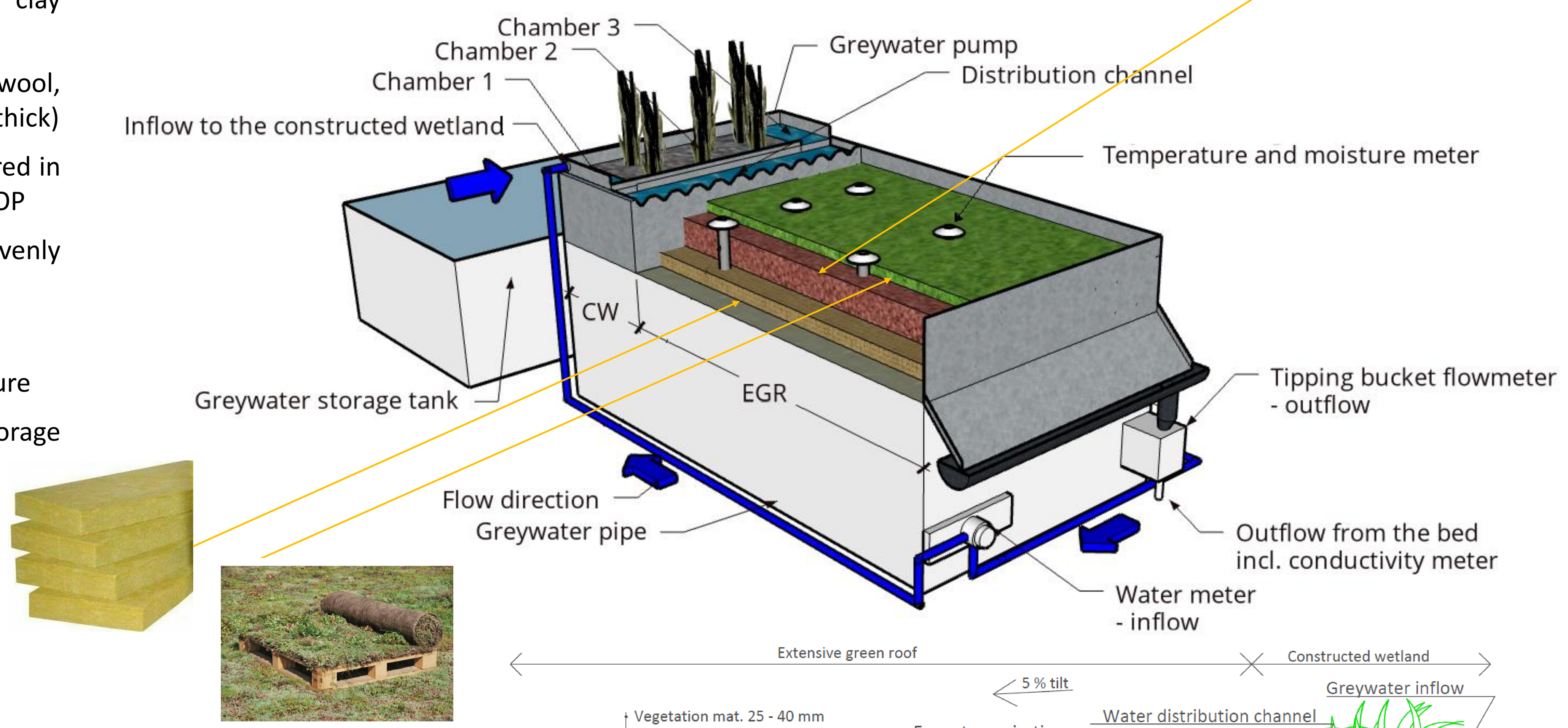
MATERIALS AND METHODS

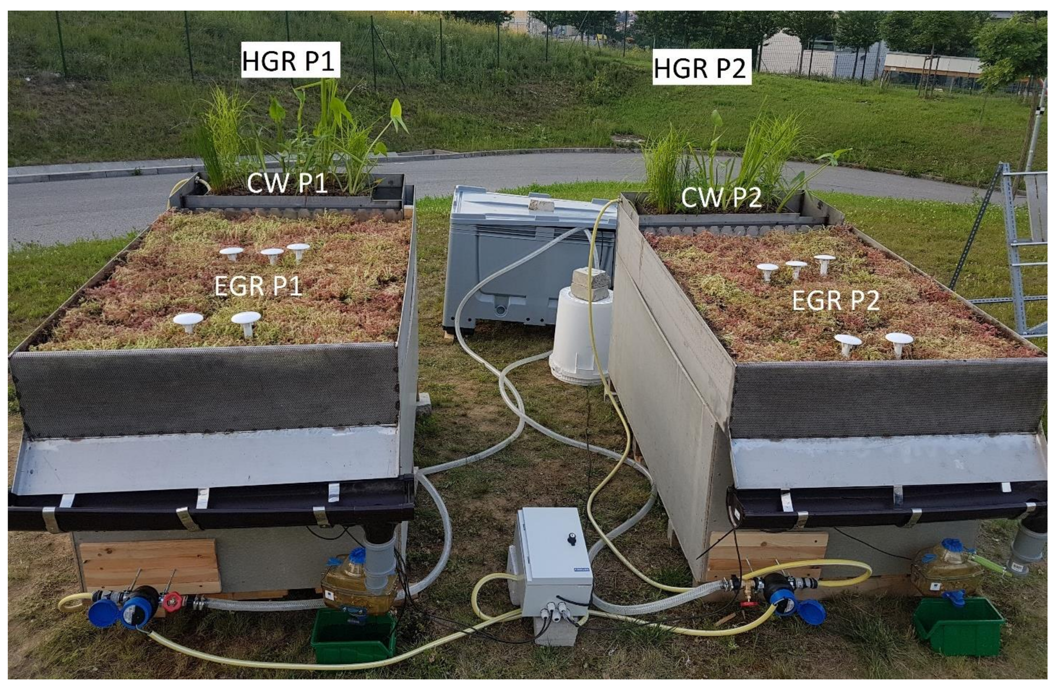
- Two growing media selected for testing on experimental plots of wetland-extensive green roofs
- Biochar produced by pyrolysis of sewage sludge. Construction recyclate with a predominant proportion of brick rubble
- Two experimental plots differing only in growing media composition (P1: with biochar and P2: without biochar
- Each experimental plot has two main parts: a constructed wetland and an extensive green roof
- **Constructed wetland:** flooded area of horizontal-flow filter filled with 50 l of expanded clay fraction 8-16 mm and planted with wetland vegetation
- **Green roof:** stainless steel bathtub at a 5 % slope covered with geotextile, 5 cm of mineral wool, 10 cm thick layer of growing media and a stonecrop vegetation mat (5-8 species, 2.5 – 4.0 cm thick)
- The plots irrigated with pre-treated greywater (GW) originating from basins and showers stored in a storage tank after pre-treatment with membrane and aeration technology by ASIO AQUALOOP
- **Irrigation** once a day by pumping 10 l (5.4 mm) into the constructed wetland, then evenly distributed on the green roof via the overflow
- Hydrophilic mineral wool with water storage and distribution function on the green roof
- Water **measurement** of wetland inflow , green roof runoff, humidity and green roof temperature
- Conducted a **water quality sampling survey** at various points of the experimental plots (storage tank, constructed wetland, green roof runoff)

Recycled Brick | Peat | Expanded clay | Biochar | Crushed marl | Growing media after mixing

37.5 % 9.5 %

No biochar With biochar





Experimental plots as installed 17.6.2020
(plot P1 with biochar on the left, P2 without biochar on the right)

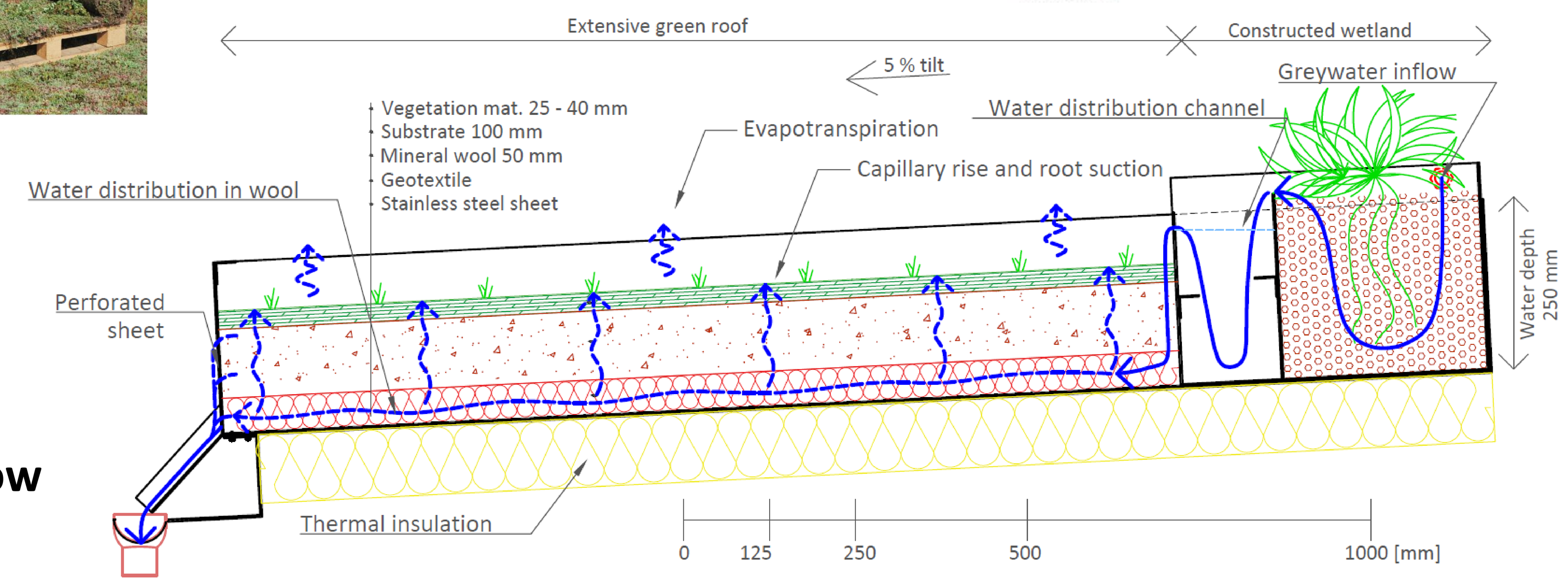


Diagram of water flow in the cross-section

RESULTS AND DISCUSSION

- Newly designed substrates in terms of hydrophysical characteristics comparable to commercially available variants
- The most pronounced moisture changes in response to irrigation observed in mineral wool, limited response in the growing media. Vegetation mats without response. Response to rainfall is inverse
- Maximum temperatures in the lower part of the experimental green roof layer reached around midnight -> shifted by about 12 hours compared to air temperature. Minimum temperatures in the mineral wool generally reached around 8 to 10 am

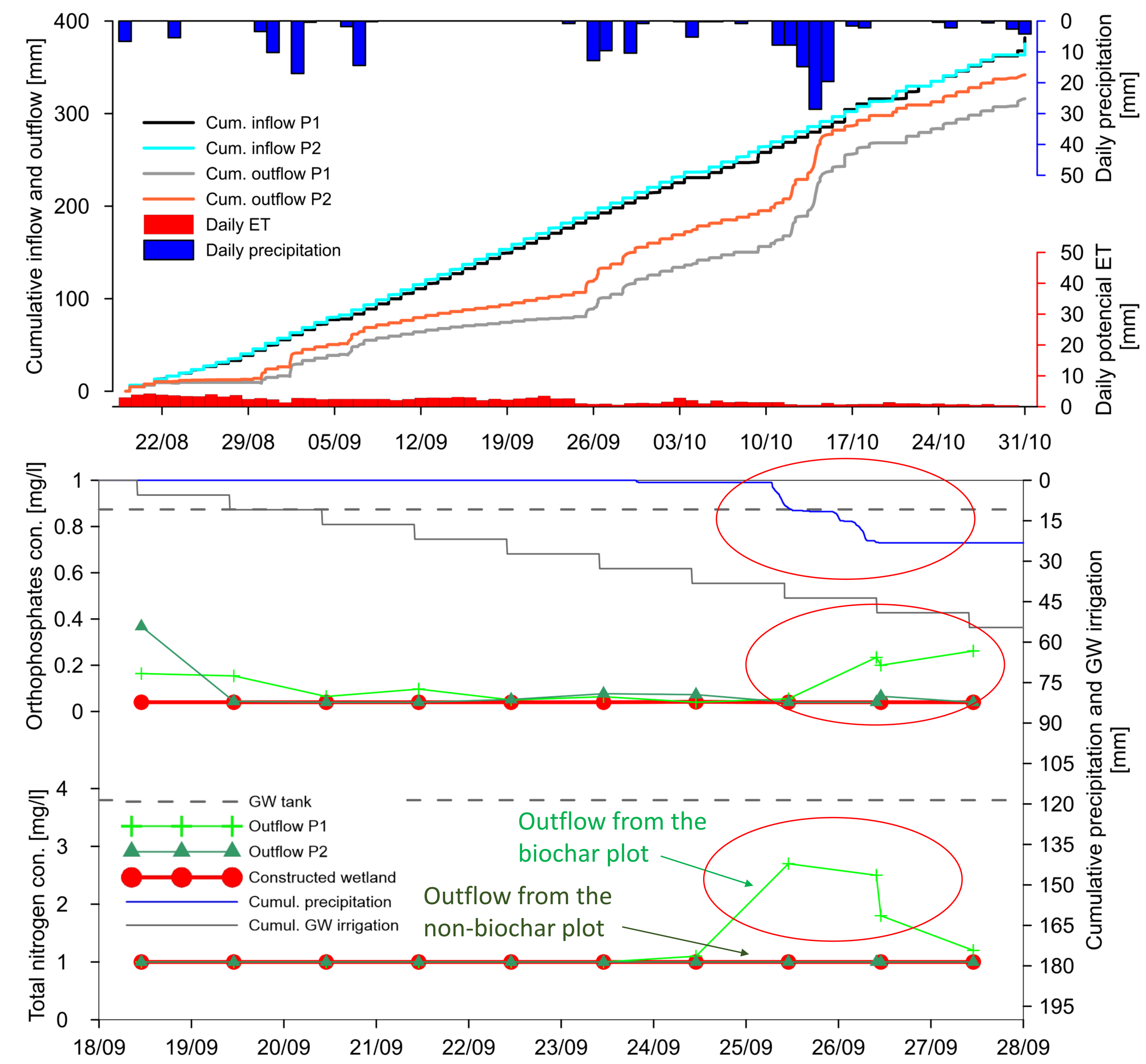
	P1 gro. media	ACRE light*	ACRE heavy*	Optigreen E light**	Optigreen E heavy**
WHC [%]	41,6	35-55	40-50	min 35	min 35
Bulk density dry [kg/m³]	822	480–900	900–1100	min 750	min 1000
Bulk density at max WHC [kg/m³]	1238	900–1400	1400–1600	max 1450	max 1800
pH	6,5-7,0	6,5-8,5	6,5-8,5	6,0-8,0	6,0-8,0

Water balance

- Different runoff response to the same irrigation regime
- From P1 biochar plot flows less water than from P2
- The likely cause is higher evapotranspiration (ET) due to greater vegetation development on the biochar plot
- Biochar rich in nitrogen and phosphorus nutrients supports vegetation development
- Evapotranspiration corresponds to an irrigation rate of 3.2 mm/day

Water quality

- The irrigation method, where water is distributed by mineral wool after overflowing onto the green roof, does not cause nutrients to leach out of the biochar
- In response to rainfall, the concentration of the nutrients nitrogen and phosphorus in the runoff from the biochar plot P1 increases significantly. In the plot P2 without biochar, there is no increase
- Constructed wetland is effective in nutrient removal
- Compared to the greywater storage tank, the nutrient content is reduced at the outflow from the green roof
- Nutrient concentrations are low compared to the literature (Kuoppamäki and Lehvävirta, 2016), but due to irrigation there is a larger total runoff volume



Vegetation development over time

16.7.2020

28.8.2020

30.10.2020, (P1 left, P2 right)

CONCLUSION

Vegetation in both plots of the hybrid wetland-extensive green roof is thriving well and greywater irrigation has not had a negative impact. Due to the higher nutrient supply, the biochar plot has more vegetation development and therefore higher evapotranspiration and lower runoff. However, higher concentrations of nutrients are released from the biochar area in response to rainfall.

CONTACT
Faculty of Civil Engineering CTU in Prague and the University Centre for Energy Efficient Buildings of the CTU in Prague
marek.petreje@fsv.cvut.cz

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