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Enhanced stormwater treatment performance by design modifications to the permeable pavement structure

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ABSTRACT

Managing urban stormwater runoff is a challenge since quality of urban runoff can be degraded, and its quantity is increased as result of increased impervious surfaces. The aim of this doctoral study is to improve the pollutant removal capability of permeable pavement systems (PPS) through design modifications. There are four key aspects of this doctoral study, which are critical literature review, laboratory investigation, data analysis and design recommendations as illustrated in Figure 1.

The findings show that the typical PPS structure is inefficient in attenuating nitrates, nitrites, heavy metals (such as Cr, Cu, Mo, Sr), and phosphates. It also reveals that under high rainfall intensities and for longer duration rainfall events, PPS's attenuation efficacy of these pollutants diminishes further. When a saturated zone is maintained and an organic carbon source is introduced to the PPS subbase, denitrification in the PPS improves (Figure 2). PPS was able to enhance heavy metal attenuation by maintaining a saturated zone, thin sand layer, and providing a carbon source in its subbase (Figure 3). It has also been demonstrated that inserting thin sand layers inside the PPS framework improves overall phosphorous and phosphate attenuation (Figure 4). Two journal papers and one scholarly book chapter have been published as a result of this research, and two more journal articles are now being reviewed.

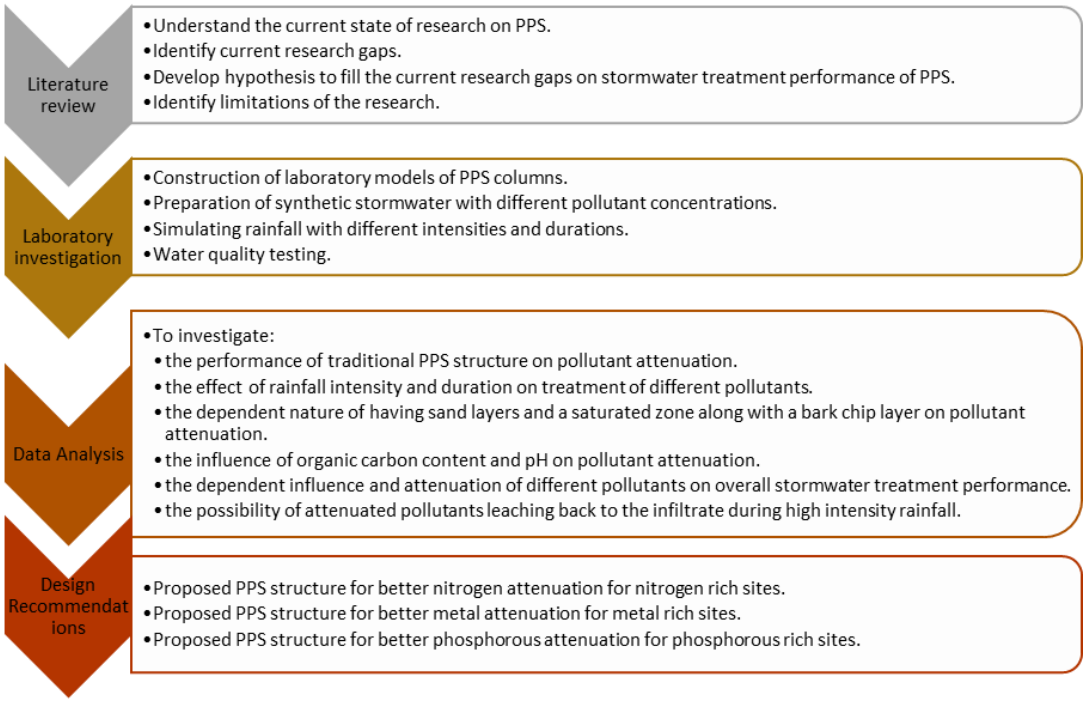


Figure 1: Graphical abstract of the PhD research by Upeka Kuruppu

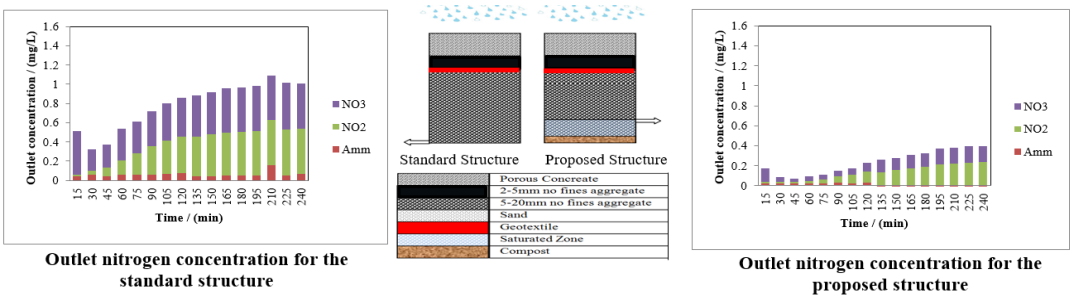


Figure 2: Nitrogen attenuation performance of standard PPS structure vs. proposed structure

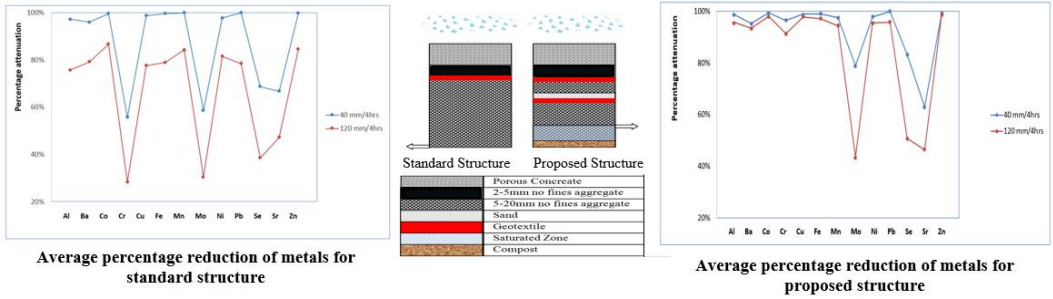
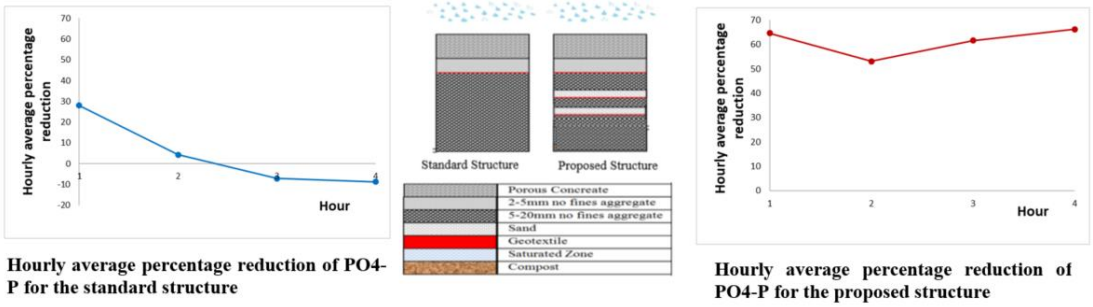


Figure 3: Metal attenuation performance of standard PPS structure vs. the proposed one



Hourly average percentage reduction of PO4-P for the standard structure

Hourly average percentage reduction of PO4-P for the proposed structure

Figure 4: Phosphate attenuation performance of standard PPS structure vs. proposed structure