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Improving Stormwater Infrastructure with Low-Carbon SuDS: A Comparison of Porous Asphalt versus Interlocking Permeable Pavements

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Abstract: *Climate change resulting in frequent flooding events have caused catastrophic effects to Small Island Developing States (SIDS) in recent times. Rainfall events have become less predictable in recent years. This paper presented the findings of a project that evaluated permeable pavement systems (PPS) using low-carbon materials, recycled aggregates, and carbon-negative aggregates within its structure as a sustainable drainage system (SuDS). It replicates typical drainage systems, reducing the surface runoff volumetric rates and retaining stormwater pollutants from downstream runoff. Low carbon permeable pavements and Carbon Negative pavement systems are novel structural pavements implementing materials which can withstand the same axial loading as the conventional pavements and can enhance stormwater quality by water treatment through filtration and infiltration between sub-base layers. Carbon-negative aggregates utilise patented technology that converts secondary waste products into high-quality aggregates based on a process that absorbs CO_2 into the pavement materials. This paper evaluates two pilot-scaled Low-Carbon-Porous Asphalt Pavement (LC-PAP) systems versus two carbon-negative interlocking concrete block permeable pavement systems (CN-ICB-PPS) on the overall environmental and structural performance. It was found that the pavement systems achieved similar permeability for stormwater remediation results using a combination of virgin aggregates, recycled aggregates, and carbon-negative aggregates for the CN-ICB-PPS and LC-PAP. The pavement systems utilising greater content of carbon-negative aggregates displayed a higher water infiltration rate when compared to the CN-ICB-PPS because of the sub-base design implemented. The LC-PAP systems could achieve the necessary strength at a lower cost, implementing low-carbon recycled materials and carbon-negative aggregates forming 70 % of sub-base layer of the pavements. For the LC-PAP system, ammonium, nitrates, colour, BOD and COD from the stormwater influent decreased significantly when compared to outflow water samples from the CN-ICB-PPS. Due to the variations in the top layers of the pavements with very small pore-spaces, this ensured a greater pollutant retention rate improving the overall stormwater quality being discharged from the pavement. The CN-ICB-PPS displaced a slight decrease in ammonium, nitrates, and colour over the period of study. Moreover, the LC-PAP contained higher content of low-carbon materials and recycled aggregates, placed above the saturation zone of the pavement, allowing some stormwater pollutants to filtrate easily through the pavement structure.*

Keywords: *Porous Asphalt; Environmental Monitoring; Resilience; Sustainable Drainage Systems (SuDS); Flood Management*