
# Next-generation permeable concrete pavement

## Background and problem addressed

As societies become increasingly urbanised, there is a **vulnerability to flooding** because impermeable infrastructure are wholly incapable of absorbing rainfall. **Climate change is predicted to increase the likelihood of major storm events by 59%.** In 2019 the annual global costs of flooding was £60bn and it is forecasted to increase to £500bn by 2030.

**Permeable pavements** are Sustainable Urban Drainage Systems (SUDS). These are porous materials that **rapidly drain surface water**, enabling stormwater to pass through otherwise impermeable infrastructure. However, conventional permeable pavements have the following **drawbacks and limitations**:

1. They are **prone to premature clogging** degrading their performance and service life, needing frequent maintenance (increasing costs).
2. They have **poor freeze-thaw resistance**, leading to deterioration of the surface.
3. They have **low strength** and are limited to low bearing applications such as pedestrian footpaths and car parks.

## Technology overview

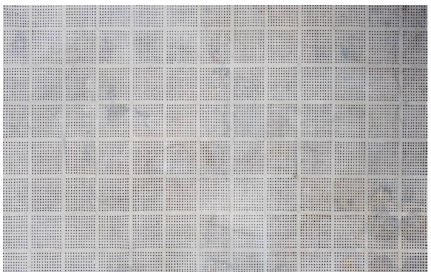
**A novel high-strength clogging resistant permeable pavement** (CRP) has been developed at Imperial College London. The key innovations of this pavement are:

(i) a **new engineered pore structure with low tortuosity**, which increases the permeability, reducing the probability of sediment clogging, improves freeze-thaw resistance and increases the strength.

(ii) it utilises a **higher strength self-compacting cementitious mix**, which also improves the freeze-thaw durability.

Rigorous lab testing confirmed the superior performance of this new material when compared with conventional permeable pavements. It has high strength (> 50 MPa) and high permeability (> 2 cm/s) yet does not clog despite extensive cyclic exposure to sand and clay. It is **at least twice as strong and ten times more permeable than conventional systems** of equal porosity, which completely clogged after just a few cycles of sediment exposure. Therefore, this new pavement can be used in a wider range of settings. It is more durable, requires less maintenance and its superior performance will deliver material and cost savings, making it commercially viable.

A **new interlocking tile system** has also been developed to deploy at scale as cast *in situ* slab or pre-cast pavers. The tiles are lightweight for ease of transportation and installation. These are placed on an aggregate sub-base and self-compacting cementitious material applied to the required thickness. The process is quick, simple and versatile, resulting in a controllable surface finish. This system has been used to **successfully delivered at scale in the trial site** at Imperial's White City Campus (pictures below).



This site is exposed to real world loading and weather conditions, and it is regularly monitored to assess its long-term durability and drainage performance with promising preliminary results.

## Benefits

- Flood mitigation-prospects properties.
- Sustainable urban drainage system-contributes to groundwater recharge.
- Prevents aquaplaning and stormwater run-off.
- Superior performance will deliver material and cost savings.
- Commercially viable.

## Advantages

Comparing to conventional permeable concrete:

- CRP is twice as strong and ten times more permeable.
- It is clogging resistant-requires less maintenance.
- More durable.
- Specialist contractors are not needed, and it can be installed easily.
- It can be deployed at scale as cast *in situ* slab or pre-cast pavers.

Dr Laura Cabo-Fernandez

Industry Partnerships and Commercialisation Officer

Faculty of Engineering

e: l.cabo-fernandez@imperial.ac.uk

t: +44 (0) 7590 250 597

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Imperial College London

## Intellectual property information

The International patent application is now published under the number WO2020/099868. The patent application is pending in Europe, the US, India, Singapore, Malaysia and Thailand.

## Link to published paper(s)

A. Kia, H.S. Wong, C.R. Cheeseman, 'High-Strength clogging resistant permeable pavement', *International Journal of Pavement Engineering*, ISSN:1029-8436.

A. Kia, H.S. Wong, C.R. Cheeseman, 'Defining clogging potential for permeable concrete' *Journal of Environmental Management*, 2018, **220**, 44-53.

A. Kia, H.S. Wong, C.R. Cheeseman, 'Clogging in permeable in permeable concrete: A review' *Journal of Environmental Management*, 2017, **193**, 221-233.

## Inventor information

This invention has been developed by Prof. Christopher Cheeseman and his team in the Department of Civil and Environmental Engineering at Imperial College.