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Using pervious concrete to manage stormwater

In modern cities where concrete rules supreme, could more porous surfaces be the answer to growing flood risks?

In January, Auckland received an entire summer's worth of rain in one day. It was the wettest month ever recorded, with more than half a metre falling in the central city in just a few hours.

The sheer volume of water overwhelmed Auckland's stormwater system. It simply couldn't drain the water away fast enough to prevent it accumulating. Some excess water was diverted to emergency storage like playing fields, parks and other ponding spaces where it could drain naturally. But in a modern city like Auckland, large areas of permeable land are increasingly hard to find.

Impervious cities

Like many cities, Auckland's growth has led to rapid increases in paved surfaces – roads, car parks, footpaths and residential properties all present a hard, impervious surface that water cannot penetrate. If it isn't adequately managed through a stormwater system or if rainfall is extreme enough to overwhelm that system, water will accumulate and either run off or flood.

Globally, it's a worsening problem as extreme weather events become more frequent, and city authorities are looking for ways to relieve the pressure on their stormwater infrastructure during such events. One option is to use pervious

Typical street in Auckland paved with pervious concrete.

concrete that allows water to pass through paved surfaces.

Like conventional concrete, pervious concrete – also known as porous concrete or permeable concrete – is made from a mixture of cement, coarse aggregates and water. However, it contains little or no sand, which results in a large proportion of void spaces.

While pervious concrete can be used for a range of applications, it doesn't look or behave like conventional concrete. It's highly porous and, typically, the finished surface isn't tight and uniform but open and irregular to allow for large quantities of stormwater to pass through.

Its low fines content and high porosity also mean it lacks the strength of conventional concrete mixtures – effectively ruling it out of structural and high-compression applications. Installing it on land sloping by more than 20˚C is problematic for similar reasons.

Nevertheless, pervious concrete has potential in applications such as footpaths and cycleways, parking zones, light traffic roading and commercial storage. In residential applications, it's suitable for driveways, courtyards, patios and balconies and other paved areas.

Manufacturers produce it in a variety of colours and textures, and Auckland Council has already used it to demarcate bus stops and pedestrian areas around the city.

Proponents also point to the safety benefits. Because water doesn't settle, it leads to less-treacherous walking, cycling and driving in wet or icy conditions.

Performance in local conditions

But could wholesale adoption of pervious concrete really help reduce stormwater loads, especially during extreme events? Remember, Auckland received over 500 mm of rain in less than a day.

According to Concrete NZ, a properly designed, installed and maintained pervious concrete system should expect an infiltration rate – the rate at which water passes through the surface – somewhere from 10,000 to 20,000 mm/hr, depending on the porosity and underlying soil conditions.

When installed on clay or other fine-grain soils that are slow to drain, a coarse gravel base course below the concrete can act as a temporary water store to give the soil time to absorb the water.

For instance, a typical residential driveway laid on Auckland's clay soils might use a combination of filter, subsurface drain, subgrade, base course and surface layers to achieve the required load, drainage and durability performance. It's also possible to trade off infiltration rate for increased strength by fine-tuning the ratio of fines in the mixture.

Manufacturers claim pervious concrete can reduce run-off by up to 25%, and with proper maintenance, the surface can expect a life of up to 20 years. Product and installation costs are roughly on par with conventional concrete too.

Why then do we not see pervious concrete used more often?

Challenges and limitations

The concept of hard, pervious surfaces is relatively novel in Aotearoa New Zealand. While they've been widely used overseas for decades, the first pilot wasn't installed here until 2000. Local manufacturers have also been slow to offer pervious concrete products, with some larger manufacturers not getting into the game until as recently as 2019.

But there may be another practical reason for its limited uptake – pervious concrete carries a significant maintenance burden.

The porous nature of the surface makes it highly susceptible to clogging with fine sediment, decayed organic material and other detritus. Without regular maintenance, material accumulates in the voids and must be cleared using special equipment, usually an industrial vacuum.

Manufacturers vary in their maintenance guidance, but a typical maintenance schedule for a pervious concreted residential driveway consists of routine sweeping or blowing of leaves and other organic material to prevent the build-up of sediment and yearly mechanised cleaning or waterblasting to remove built-up dirt, weeds and moss.

According to Auckland Council, if the correct surface is selected for a given site and it is correctly and routinely maintained, the surface should expect a service life like conventional concrete.

It's worth noting that some manufacturers also recommend resurfacing pervious concrete every few years, depending on the amount of traffic the surface carries, local weather conditions and, of course, how well the maintenance routine was followed. This may require specialist skills and equipment to remove and reinstall the surface layers, depending on the materials involved.

Overseas experience also suggests pervious concrete may be susceptible to cold environments, especially in locations that store water in the surface and base course and are exposed to regular freeze-thaw cycles.

None of these drawbacks are insurmountable, however. It's unlikely pervious concrete alone would have significantly changed the outcome of the Auckland floods, but it may form part of a wider solution to increase the resilience of our largest city.

FOR MORE Watch a video that shows Permeable Concrete New Zealand's pervious concrete product at www.youtube.com/watch?v=WlOwKEJ1xXQ