How to mix old tires and building rubble to make sustainable roads

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Researchers have shown how a blend of old tires and building rubble could be used as a sustainable road-making material, in a zero-waste solution to boost recycling and support the circular economy.

Construction, renovation and demolition account for about half the waste produced annually worldwide, while around 1 billion scrap tires are generated globally each year.

The new material, developed by researchers at RMIT University, is the first to combine recycled rubble and rubber in a mix that is precisely optimized to meet road engineering safety standards.

Designed to be used for base layers, the recycled blend is more flexible than standard materials, making roads less prone to cracking.

Lead researcher Dr. Mohammad Boroujeni said the rubble-rubber mix could deliver both environmental and engineering benefits.

"Traditional road bases are made of unsustainable virgin materials—quarried rock and natural sand," Boroujeni said.

"Our blended material is a 100% recycled alternative that offers a new way to reuse tire and building waste, while performing strongly on key criteria like flexibility, strength and permanent deformation. As we push towards a circular economy that can eliminate waste and support the continual use of resources, our recycled blend is the right choice for better roads and a better environment."

In Australia, only 16% of scrap tires are domestically recycled. About 3.15 million tons of processed building rubble—known as recycled concrete aggregate (RCA) – is added to stockpiles each year rather than being reused.

In 2019, federal and state governments agreed to ban the export of certain waste materials, with the aim of building Australia's capacity to generate high value recycled commodities and associated demand. As part of the agreement, whole used tires will be banned from export by December 2021.

On the road to a circular economy

Roads are made of four layers—a subgrade, base and sub-base, with asphalt on top.

All the layers must be strong enough to withstand the pressures of heavy vehicles, while being flexible enough to allow the right amount of movement so a road doesn't easily crack.

RCA can potentially be used on its own for road base layers, but adding recycled rubber can significantly enhance the finished product.

In previous research, the RMIT School of Engineering team has shown their rubble-rubber blend performs well when tested for stress, acid and water resistance, as well as strength, deformation and dynamic properties. Its low shrinkage and good flexibility reduce the risk of cracking.

The new study published in Construction and Building Materials looked at how the mix would withstand the pressures of being driven over by countless vehicles over its lifetime.

Researchers used special machinery to assess the blended material's performance under frictional force, or shear stress, and compared different types of crumb rubber (fine and coarse) mixed into the RCA at different ratios.

The team identified an optimal mixture—0.5% fine crumb rubber to 99.5% RCA—that delivered on shear strength while maintaining good cohesion between the two materials.

Chief investigator Professor Jie Li said while the recycling of construction waste and scrap tires was growing, both industries continued to produce significantly more waste than is currently reused.

"Solutions to our waste problems will come not only from reducing how much goes to landfill and increasing how much we recycle; developing new and innovative uses for our recycled materials is absolutely vital," Li said.

More information: Mohammad Saberian et al. An experimental study on the shear behavior of recycled concrete aggregate incorporating recycled tire waste, *Construction and Building Materials* (2020). DOI: 10.1016/j.conbuildmat.2020.120266

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