Use of Recycled Plastic Materials in Roads and their Potential for Microplastics Release

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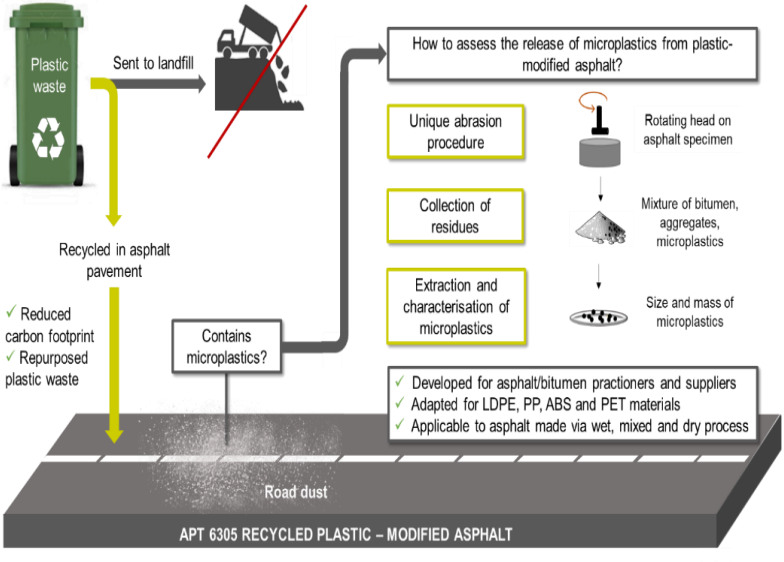
Graphical Abstract



Abstract

A total of 3.5 million tonnes of plastics were consumed in Australia for the 2018-19 financial year. 11.5% of the consumed plastics were recycled (locally and exported) while the rest were sent to land fill. With the national ban on plastic exports, alternative methods to deal with waste plastics must be implemented for a sustainable future. In this context the Transport and Infrastructure Council of Australia,

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which bring together Australian and New Zealand transport ministers, has funded a large research project on recycled plastics in asphalt roads (Austroads Project APT6305). The project is investigating the benefits, methodologies, testing frameworks, and performance-based specifications for incorporating recycled plastics into asphalt.

All around the world, road authorities are trying to incorporate recycled materials in roads; but more stringent environmental requirements are coming into place that ask scientists to also evaluate new aspects of these technologies. In fact, although fostering recycling in roads can be seen as an effective measure to reduce the infrastructure's carbon footprint, there are many aspects that have never been studied before. In the case of recycled plastics, for instance, there are concerns around the possible generation of microplastic particles due to weathering and trafficking. The analysis of the composition of road dust has just started to be evaluated by some research studies and no standards or universal testing frameworks are available yet.

In particular, the release of microplastics from plastic-modified asphalt has not been investigated although constituting a potential threat for the environment due to the known toxicity of microplastics. A unique abrasion procedure has therefore been developed for practitioners and suppliers to benchmark the release of microplastics from different types of plastic-modified bituminous materials. The abrasion conditions of an asphalt sample submerged in water were optimised based on the test duration, system temperature and water pH to yield a measurable amount of microplastics and ensure the accuracy and reproducibility of the test. Optimum conditions were obtained for a test duration of 20 min, a temperature of 5 °C and a water pH of 7. The suitability of the hose material generating abrasion by rotating on the asphalt sample was also assessed and a stainless-

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steel hose was selected at the expense of a rubber hose, which was quickly damaged during the test. The extraction of microplastics from the mixture of bitumen, aggregates and plastics generated by the abrasion test was performed by dissolving the bitumen in toluene and separating the microplastics from the aggregates via density separation in dichloromethane. The collected microplastics were then fractionated through four filters into 0.45 – 3 µm, 3 – 38 µm, 38 – 368 µm and > 368 µm size range. Up to 4.5 g of residues were collected after the abrasion of 800 g LDPE-modified asphalt sample, among which 12 mg was made of microplastic, most of which falling within the 3 – 38 µm and > 368 µm size range. The extracted microplastics were finally analysed via staining and fluorescence microscopy, which confirmed the efficiency of the extraction procedure to separate microplastics from bitumen and aggregates.

Keywords: asphalt roads; bitumen; recycled plastics; microplastics

Biography

Associate Professor ***Filippo Giustozzi*** is an expert in road and airport pavement materials. He completed his second Ph.D. at Virginia Tech University (USA) and is now the Chair of the Technical Committee on Sustainable and Resilient Pavements at the Transportation Research Board of the National Academies of Sciences and Engineering in the USA. He has participated in several major road and airport construction projects since 2008. Dr. Giustozzi is the Lead Investigator of the national Austroads project APT6305 on Road-grade recycled plastics for sustainable asphalt pavements, approved by the Transport and Infrastructure Council that brings together Commonwealth, State, Territory and New Zealand Ministers. He also collaborates with several industry associations and contractors on a variety of research and field projects, mainly on polymer-modified bitumen and recycled materials

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for road applications. At RMIT University, he is leading the Intelligent Materials for Road and Airport Pavements research group and has developed the only university-based fully equipped asphalt and bitumen laboratory in Australia, which currently employs more than 20 researchers.

Dr Marie Enfrin has been a Postdoctoral Research Fellow at RMIT from January 2021. She completed her PhD in chemistry and chemical engineering at the University of Surrey, UK, and Deakin University, Australia. Her research interests lie in the field of microplastic pollution, from their generation to their release and impact on aquatic and terrestrial ecosystems. She is currently a member of A/Prof. Filippo Giustozzi's research group where she is investigating the environmental impact of using recycled plastic waste in sustainable asphalt pavements.

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