# Plastic waste in road construction

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Part of the Tranzinfo Hot Topics series, this issue offers a selection of recent material on the use of plastic waste in road construction. Roads constructed using recycled plastic waste are often known as 'plastic roads'.

## Contents:



## Case studies and research

Recycled waste plastic for extending and modifying asphalt binders
White, G & Reid, G, Symposium on Pavement Surface Characteristics (SURF), 8th, 2018, Brisbane, Queensland, Australia.
Plastic drink bottles, single-use plastic bags and other waste plastics have a significant impact on the environment. This paper assesses the use of three commercially available recycled plastic products for bituminous binder extension and modification in asphalt mixtures.

Performance of recycled plastic waste modified asphalt binder in Saudi Arabia
Dalhat, M & Al-Abdul Wahhab, H, International Journal of Pavement Engineering, vol. 18, no. 4, pp. 349-357, 2017.
The amount of solid plastic waste generated from material packages like plastic bottles and similar utilities within the kingdom of Saudi Arabia has skyrocketed. The associated cost of managing these solid wastes has also increased. The effect of polypropylene, high- and low-density polyethylene (PP, HDPE and LDPE)-recycled plastic wastes (RPW) on the viscoelastic

performance of the local asphalt binder has been investigated. The recycled plastics were obtained by shredding and grounding the RPW to a desirable size for easier blending with the asphalt binder.

Use of waste plastic materials for road construction in Ghana
Appiah, Johnson Kwabena, Berko-Boateng, Victor Nana & Tagbor, Trinity Ama, Case Studies in Construction Materials, Volume 6, 2017, pp. 1-7.
This paper forms part of research to solve two main problems in Ghana: firstly, the management of municipal solid waste (MSW), particularly with regards to used plastics which have overwhelmed major cities and towns; secondly, the formation of potholes on roads due to excessive traffic and axle weight. This study examines the effect of blending waste thermoplastic polymers, namely high-density polyethylene (HDPE) and polypropylene (PP) in conventional AC-20 graded bitumen, at various plastic compositions. The use of waste commodity plastics in binder modification carries the advantage of a cheap and effective means of enhancing conventional bitumen binder performance characteristics and is an alternative way to utilise plastic waste.

Effect of waste plastic and waste tires ash on mechanical behavior of bitumen
Karmakar, Sandip & Roy, Tapas Kumar, Journal of Materials in Civil Engineering, Volume 28, Issue 6, 2016.
This paper deals with the utilization of waste plastic and waste tire rubber with bitumen for construction of low-budget roads instead of conventional polymer modified bitumen (PMB) due to its high price value.

Eco-friendly materials for a new concept of asphalt pavement
Kowalski, Karol J et al., Transportation Research Procedia, Volume 14, 2016, pp. 3582-359.
It is estimated that more than 90% of the 5.2 million kilometres of European paved roads and highways are surfaced with asphalt. The construction of a new road has a number of implications for the environment, consuming large amount of materials and energy. Also, the price of crude oil, which is the major source of bituminous binder, has significantly increased in recent years (the most noticeably in 2001–2008). This has led to an increase in the total price of asphalt mixtures. In order to promote sustainable practices and to combat price increase, measures with sound sustainability credentials need to be widely implemented. Developing novel materials and technologies to integrate greener material, waste and recycled materials into the production cycle of asphalt mixtures is a solution that improves both sustainability and cost-efficiency of the asphalt pavement industry.

Repair of deteriorating pavement using recycle concrete materials
Krishnamoorthy, Renga Rao et al., Procedia Engineering, Volume 142, 2016, pp. 371-382.
The incessant demand for new high strength and recycled material is ever increasing. Concrete material consists of portland cement, clean river sand, water and coarse aggregate. In this research, the road structure is made up of flexible pavement. The research was carried out to upgrade the standard

concrete material with the recycle concrete material that can be applied to the study area. The recycle concrete materials come from industrial waste. Shredded tyre rubber and ground plastic bottles (polypropylene, PP) have been reused as coarse aggregate replacement and clean river sand in concrete mixture, respectively. Both coarse aggregate and clean river sand were replaced by 10%, 20%, 30%, 40% and 50% of shredded tyre rubber and ground plastic bottles (polypropylene, PP), respectively. It was found that the optimum percentage of recycle concrete material that can be used to get good value of indirect tensile strength is in the range 10% to 30% of shredded tyre rubber and ground plastic bottles (polypropylene, PP).

Utilisation of waste plastic in bituminous mix for improved performance of roads

Jafar, Jalal J, KSCE Journal of Civil Engineering, Volume 20, Issue 1, 2016, pp. 243-249.

The use of waste plastic as a partial aggregate replacement in bituminous mix products often suffers from weak bonding between the plastic surface and the bitumen. This work reports on the use of plastic waste and chemical additives in order to improve the performance of the volumetric and mechanical properties of bituminous mixtures.

Comparison of Stone Matrix Asphalt mixtures with polymer-modified bitumen and shredded waste plastics

Sarang, Goutham et al., Road Materials and Pavement Design, Volume 17, Issue 4, 2016, pp. 933-945.

Stone Matrix Asphalt (SMA) is a gap-graded bituminous mixture characterised with its improved rut resistance and durability. It has comparatively higher proportion of coarse aggregates and binder mastic with bituminous binder and mineral filler. Drain down of mastic content at various stages of construction is a common issue with SMA, and generally, some fibre additives are used to stabilise the mixture or a modified bitumen is used as the binder material. In this study, shredded waste plastics (SWP) are used instead of other stabilising additives, to prepare SMA mixtures with conventional viscosity graded (VG) 30 bitumen.

Impact performance of recycled plastic-based concrete

Liu, Feng et al., Journal of Materials in Civil Engineering, Volume 27, Issue 2, 2015.

This paper reports an experimental study on recycled plastic concrete (RPC) which uses recycled Acrylonitrile-butadiene-styrene/Polycarbonate copolymer (ABS/PC) plastic particles to replace 5%, 10%, 15% and 20% (in volume) of fine aggregate sand. The plastic particles used in this research were recycled from waste plastic.

An approach to the usage of polyethylene terephthalate (PET) waste as roadway pavement material

Guru, M at al., Journal of Hazardous Materials, no. 279, 2014, pp. 302-310.

This study investigates an application area for Polyethylene Terephthalate (PET) bottle waste which has become an environmental problem in recent

decades as being a considerable part of the total plastic waste bulk. Two novel additive materials, namely Thin Liquid Polyol PET (TLPP) and Viscous Polyol PET (VPP), were chemically derived from waste PET bottles and used to modify the base asphalt separately for this aim.

Utilization of fly ash and waste recycled product reinforced with plastic wastes as construction materials in flexible pavement
Choudhary, AK et al., Geo-Congress 2014, American Society of Civil Engineers, 2014, pp. 3890-3902.
An experimental study was carried out to demonstrate the potential of using two industrial wastes, namely fly ash and waste recycled product (WRP) generated after recycling of blast furnace slag from steel plant, reinforced separately with high-density polyethylene (HDPE) plastic waste strips. The study reveals that the addition of waste plastic strips to fly ash and WRP results in appreciable increase in CBR and secant modulus. The proposed materials can be used in flexible pavement construction leading to safe and economical disposal of these materials that otherwise would be disposed of as wastes.

Effective use of waste plastic as bitumen strength modifier
Ayoub, M et al., Civil Engineering and Architecture, vol. 2, no. 9, 2014, pp. 313-6.
This paper covers a new method to utilize waste plastic bags in modification of bitumen not only to effectively utilize waste plastics but also to improve strength properties of bitumen concrete mix of flexible pavement.

Incorporation of waste plastic in asphalt binders to improve their performance in the pavement
Costa, Liliana MB et al., International Journal of Pavement Research and Technology, vol. 6, no. 4, 2013
Although the modification of bitumen with virgin polymers can improve the properties of asphalt mixtures, the use of recycled plastic may also show a similar result with additional environmental advantages. This work aims to evaluate the possible advantages of modifying the bitumen with different plastic wastes, namely polyethylene (high density HDPE and low density LDPE), ethylene-vinyl acetate (EVA), acrylonitrile-butadiene-styrene (ABS) and crumb rubber, in order to improve the properties of the resulting binders for use in high performance asphalt mixtures.

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# In the news

This Australian-first road will be built from plastic bags and glass
Institute of Public Works Engineering Australasia, Wednesday 30 May 2018.
Recycled plastic bags and glass bottles and toner from used printer cartridges have been used to create asphalt for the construction of a road in the Melbourne suburb of Craigieburn.

Drive home on bread bags
Transport & Logistics News, 20 November 2018
Recycling company Close the Loop has unveiled an upgraded manufacturing facility that could divert two-thirds of Australia's 300,000 tonnes of waste soft plastics sent to local landfill annually.
The new manufacturing line in Melbourne will produce TonerPlas, an asphalt additive that contains the equivalent of 530,000 recycled plastic bags, toner from more than 12,000 recycled cartridges and 168,000 glass bottles in every kilometre of two-lane road. In conjunction with Downer, roads featuring TonerPlas have already been laid in Melbourne and Sydney this year.

Plastic and glass road that could help solve Australia's waste crisis
The Age, Thursday 2 August 2018.
Sutherland Shire is the first NSW council to trial a 'Plastiphalt' road following a similar pilot in Hume City Council in Melbourne's outer north-west in May this year.

On the road to tackling Australia's waste crisis
The Age, 3 August 2018.
To the naked eye Rayfield Avenue looks like any other residential street in Craigieburn, a suburb in Melbourne's north. Few visitors would realise they are driving along a road that is quite literally rubbish.

A road full of bottlenecks: Dutch cycle path is made of plastic waste
The Guardian, 13 September 2018
The world's first plastic bicycle path made of recycled bottles, cups and packaging has opened in the Netherlands, as part of a pilot project.

First road in U.S. made with recycled plastic paved on campus
U-Wire, 4 November 2018
UC San Diego is taking the initiative to head toward a greener society by installing the United States' first asphalt road made with a recycled plastic binder.

Road makers turn to recycled plastic for tougher surface
Economist, 13 September 2018
On September 11th in Zwolle, a town in the Netherlands, a 30-metre bicycle track made from 70% recycled plastic and the rest from polypropylene was opened. It will be used to test a product called PlasticRoad, which is being developed by two Dutch firms—KWS, a road builder, and Wavin, a firm that makes plastic piping—in partnership with Total, a French oil-and-gas firm.

Crazy paving: Rotterdam to consider trialling plastic roads
The Guardian, 11 July 2015
Rotterdam City Council in The Netherlands is considering a trial of roads made of recycled plastic bottles.

The streets of Vancouver are paved with.... Recycled plastic
New Atlas, 1 December 2012.
The city is trialling a new warm mix paving process that makes use of the kind of waste plastic placed in blue household recycling boxes by conscientious citizens, reducing greenhouse gases and improving air quality along the way.

**INDIA**

The man who paves India's roads with old plastic
The Guardian, 19 July 2018
Dr. R. Vasudevan, known as India's plastic man, claimed to be first to introduce the idea of using plastic in roads.
Plastic Man web page: http://www.indianplasticman.com/

Plastic roads: India's radical plan to bury its garbage beneath the streets
The Guardian, 30 June 2016
In India, roads made from shredded plastic are proving a popular solution to tackling waste and extreme weather

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## Industry players

MacRebur – Plastic Road Company, UK
Products are made from 100% waste materials and are used to replace part of the bitumen in any asphalt mix.

PlasticRoad - Netherlands
PlasticRoad consortium consists of the following three partners: KWS (part of VolkerWessels), Wavin (part of the Mexichem group) and Total.

Downer – Australia
Downer and Hume City Council have partnered with resource recovery and recycling companies Close the Loop and RED Group to recycle soft plastics and glass and toner from more than 4,500 used printer cartridges to use in asphalt.
Downer recently constructed a new plant to recycle plastic waste for road construction.

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