CRUMB RUBBER

WHAT IS CRUMB RUBBER?

Crumb rubber is recycled rubber produced from end-of-life truck and car tyres. End-of-life tyres (ELT) comprise several materials, such as elastomer compounds, textile fibres, carbon black, steel cord and various other inorganic and organic components. Rubber from ELT can be processed into several different sizes, from crumb rubber to larger sizes such as rubber shreds.

WHAT ARE THE BENEFITS OF USING CRUMB RUBBER?

The benefits of using crumb rubber in road and rail infrastructure are as follows:

- **Environmental benefits**
  - Reduced traffic noise, energy consumption, greenhouse gas emissions and landfill.
- **Performance benefits when used in asphalt and sprayed seals**
  - Improved resistance to cracking, rutting, ageing and oxidation; lower maintenance costs; and improved aggregate retention on heavily trafficked roads (specifically for sprayed seals).
- **Performance benefits for railways**
  - In railway ballast, adding unbound crumb rubber decreases both ballast breakage and vertical stiffness and increases energy dissipation.
  - Pre-stressed concrete sleepers wrapped with crumb rubber powder and recycled plastics provide a reduction in maintenance costs through increased service life and reduced noise and vibration levels, compared to conventional designs

WHERE IS IT USED?

Crumb rubber can be used as a bitumen modifier for use in asphalt and sprayed seals via a wet process, as an additive for asphalt in a dry process, and in road speed humps, cycle paths and vibration-absorption systems for railway structures.

HOW MUCH CAN BE USED?

Typically, for bitumen and asphalt applications, ELT truck tyre rubber is used. In Australia, around 3,000–6,000 tonnes of crumb rubber could be absorbed each year, based on road construction rates. For sprayed seals and asphalt applications, crumb rubber is typically added in quantities of 5–18% by mass of the binder via the wet process and up to 2% by mass of asphalt mixture via the dry process.

Other road and transport applications can incorporate higher percentages of crumb rubber. For example, speed humps and cycle paths can be made with 100% recycled crumb rubber.

Crumb rubber can be combined with recycled plastics, a polymer-based additive and a magnesium hydroxide-based flame retardant, to manufacture the outer shell of railway sleepers. Approximately 67% by mass of that shell comprises recycled materials (rubber and plastics), whilst virgin materials comprise the remaining weight of the shell.

WHAT OPPORTUNITIES ARE THERE FOR IMPROVING ADOPTION?

To have a greater impact on the ELT waste stream, further transport infrastructure applications should be considered in parallel to bitumen and asphalt. Some, including cycle paths, footpaths and traffic management devices, such as speed humps, incorporate high percentages of crumb rubber. These applications, however, are relatively specialised and not widely adopted, and their volume usages are still likely to be much lower than those of asphalt and sprayed seals. Research suggests that yet further applications could include embankment fill, slope stabilisation, stabilisation of expansive soil, concrete, drainage backfill materials and riverbank/coastal stabilisation.

CRUMB RUBBER ASPHALT: EAST BENTLEIGH, VIC

In March 2020, a trial of crumb rubber asphalt (CRA) wearing course was successfully placed on East Boundary Road, East Bentleigh, in the eastern metropolitan suburbs of Melbourne. The site is an arterial road with moderate traffic (19,000 annual daily traffic and 6% commercial vehicles), comprising two trafficked lanes and one bicycle/parking lane. The first-of-its-kind trial consisted of two controls and four CRA mixes, including dense graded, stone mastic and gap graded asphalt. The 1.4-km trial site used an equivalent of 1,600 car tyres. Performance results from the two-year field monitoring are expected by mid-2022.

Department of Transport Victoria (DoT Vic) and Tyre Stewardship Australia (TSA) jointly funded the trial. ARRB coordinated the trial and delivered performance monitoring, laboratory analysis and reporting on outcomes. Boral, Downer and Fulton Hogan provided trial mixes based upon the Australian flexible Pavement Association's (AfPA) pilot specification for crumb rubber asphalt (CRA) designs. Additionally, Bitu-mill was engaged for the construction and placement of the materials.

Emissions testing during construction demonstrated no concern about exposure for crew members. All airborne particulates, compounds and fumes, were below or well below the limits set by SafeWork Australia.

With pavement performance monitoring still ongoing, the key benefits of the trial so far have been the successful implementation of a widely collaborative project and the promotion of CRA as a sustainable pavement option. This full-scale demonstration trial is a clear indicator that industry is ready and keen to explore and implement new and innovative materials, with the backing of industry bodies including AfPA, TSA and the asset owner, in this instance DoT Vic.

Technical Report TR 220 East Boundary Road Crumb Rubber Asphalt Trial Emissions Monitoring Report

National Specification for Crumb Rubber Binders in Asphalt and Seals

LOCATIONS

NATIONAL TRANSPORT RESEARCH CENTRE AND HEAD OFFICE:
80A TURNER STREET
PORT MELBOURNE, VIC 3207

OFFICES IN:
BRISBANE, SYDNEY, ADELAIDE, PERTH, CANBERRA

This case study is part of the project Best Practice Expert Advice on the Use of Recycled Materials in Road and Rail Infrastructure. This project has been funded by the Australian Government.

RECLAIMED ASPHALT PAVEMENT (RAP) WITH CRUMB RUBBER: WA

In 2019, the Western Australian Road Research and Innovation Program (WARRIP) investigated the potential recyclability of asphalt containing crumb rubber. WARRIP is a joint initiative between Main Roads Western Australia (MRWA) and the Australian Road Research Board (ARRB). This research addressed a key concern around using recycled materials in pavement: what happens when pavements containing recycled materials reach their end of life? A practicality study was undertaken to ensure the standard practices for collecting, processing and reusing RAP were not hindered by the presence of recycled crumb rubber. The project aimed to enable increased use of recycled materials in asphalt and increased use opportunities for RAP use.

Two trials were undertaken during the project, in partnership with Fulton Hogan and Downer. In these, crumb rubber asphalt was laid and then subsequently reclaimed using standard practices. The first trial, in 2019, used 10% crumb rubber modified RAP (CRM-RAP). No issues were encountered with reclaiming the CRM-RAP. The second trial, in 2020, used 25% rubber modified CRM-RAP. Issues encountered during reclamation, such as stickiness, indicated that high rubber content poses minor complications.

Overall, the findings were that the rubber did not affect standard practices for reclaiming and using RAP; that conventional equipment can be used without modification; and that reclamation may be slightly less efficient in highly modified pavements.

- The Use of Reclaimed Asphalt Pavement from Crumb Rubber Modified Asphalt
- Investigation of the use of Reclaimed Asphalt Pavement from Crumb Rubber Modified Asphalt
- Stage to: Investigation of the use of Reclaimed Asphalt Pavement from Crumb Rubber Modified Asphalt
- National Specification for Crumb Rubber Binders in Asphalt and Seals

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NATIONAL TRANSPORT RESEARCH
CENTRE AND HEAD OFFICE:
80A TURNER STREET
PORT MELBOURNE, VIC 3207

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RECYCLED TYRES: MITCHAM, SA

In 2020, the City of Mitcham, in South Australia, was funded by Tyre Stewardship Australia to trial a permeable pavement made with recycled tyres. The pavement is made of up to 50% recycled tyres, which is approximately three tyres per square metre.

The pavement, which was trialled in a carpark, allows water to flow through it and into the ground. It was designed by the University of Melbourne to reduce the risk of flash flooding and minimise water runoff. An added benefit is that the water reaches the trees dotted throughout the carpark. The design allows 60 m^3 of storm water to be absorbed into the ground.

Six sections, comprising 24 parking spaces, were paved using the mixture of tyre-derived aggregate, crushed rock and binder. Around 400 car tyres were used and it is estimated that many more tonnes of recycled material could be used if other councils adopt the same technology.

Furthermore, using recycled materials means reduced costs, as specialised materials for permeable pavements are often highly expensive.

TSA & University of Melbourne fund permeable pavement project in the City of Mitcham, SA

Permeable Pavement Carpark at St Marys Park

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