

# ACT Government

## Engineering Advisory Note

EAN 22

### Specifications for the use of recycled materials in the construction of road pavements

#### Background

ACT NoWaste has released the *ACT Circular Economy Strategy and Action Plan 2023–2030*, which includes actions for government, business and industry to grow the circular economy in the ACT. One of the primary actions proposed by Transport Canberra and City Services (TCCS) in the Action Plan is to update the ACT Municipal Infrastructure Design Standards (MIS) and Municipal Infrastructure Technical Specifications (MITS) to encourage greater use of recycled materials in the design and construction of civil and open space assets, such as road pavements.

The use of recycled materials in pavements has been the subject of research for many years. Research is continuing to identify how new emerging recycled materials can be incorporated into pavements, and also how a greater proportion of traditional recycled materials can be incorporated into pavements, without compromising performance, durability and future maintenance impacts/costs. This emerging research in Australia is primarily being undertaken by Austroads.

Larger jurisdictions such as Transport for New South Wales (TfNSW), Department of Transport and Main Roads (TMR), Queensland and the Department of Transport and Planning (DTP), Victoria play a critical role in trialling new materials in the field, assessing the performance of new materials and setting acceptable criteria and requirements within their respective specifications. The requirements set by a jurisdiction account for lessons learned, provides sufficient mitigation against any risks that may impact performance, and are also specific to the region.

On this basis, TCCS is proposing to adopt primarily the TfNSW specification requirements for recycled materials in road pavements, but is also incorporating some of the latest guidance from Austroads publications.

## Specifications for recycled materials in asphalt

### **Crumb rubber**

Adopt the following requirements for crumb rubber asphalt:

- *TfNSW Specification R118* and *TfNSW Specification 3256* for the incorporation of crumb rubber using the 'dry method'.
- *TfNSW Specification 3252* and *TfNSW Specification 3256* for blended crumb rubber binders.

### **Recycled crushed glass**

Adopt requirements for recycled crushed glass in *TfNSW Specification R116*, *TfNSW Specification R117*, *TfNSW Specification R118* and *TfNSW Specification 3154*.

Note: In TfNSW Specifications, this is referred to as 'granulated glass aggregate'.

### **Reclaimed Asphalt Pavements (RAP)**

Adopt requirements for RAP in *TfNSW Specification R116*, *TfNSW Specification R117*, *TfNSW Specification 3153* and *TfNSW Technical Direction TD 00018:2021*.

### **Industrial slags**

The use of industrial slags (steel furnace slags) as replacement for aggregates in the asphalt mix is to be in accordance with *TfNSW Specification R116*, *TfNSW Specification R117*, *TfNSW Specification R118* and *TfNSW Specification 3152*.

### **Added fillers for asphalt**

The use of added fillers such as fly ash, cement works flue dust and ground limestone in the asphalt mix are to be adopted in accordance with *TfNSW Specification R116*, *TfNSW Specification R117*, *TfNSW Specification R118* and *TfNSW Specification 3211*.

### **Recycled plastics**

As of the date of effect of this Engineering Advisory Note, TfNSW Specifications are silent on the use of recycled plastics or ink toner in asphalt mixes, and such asphalt mixes are not approved for use by TfNSW. Until such time that specifications are developed by TfNSW or other state jurisdictions, Roads ACT will allow the use of asphalt mixes containing recycled plastics for lightly trafficked roads subject to the below standards and specification requirements. For heavily trafficked roads, the adoption of asphalt mixes containing recycled plastics will require formal approval by Roads ACT on a case-by-case basis – refer to **Annexure 2** for further details.

Further context on the adoption of recycled plastics in asphalt is provided in **Annexure 1**.

## Design criteria

The below specification applies to asphalt mixes containing recycled plastics to be adopted for roads where the design traffic load is less than  $1 \times 10^6$  ESA (equivalent standard axles) for a 20-year design life.

## Mix design and performance requirements

In addition to the mix design submission requirements of *TfNSW Specification R117* or *TfNSW Specification R116*<sup>1</sup>, *Clause 2*, the following additional mix design and performance requirements are to be adhered to.

Recycled plastics must be of granular form having a maximum size of 6.7 mm using the sieve size analysis test method in *AS/NZS 2891.3.1* or *AS 1141.11.1* (dry method only).

The particle size distribution of the recycled plastic-modified aggregate mix must be similar to the equivalent conventional aggregate mix according to the following criteria using the sieve size analysis test method in *AS 1141.11.1* (dry method only):

- Maximum 1.5% difference for each particular fraction.
- Maximum 4.0% difference in the total gradation.

The following performance tests are to be undertaken for the nominated recycled plastic-modified asphalt mix in order to compare against the results of the same tests undertaken for the equivalent conventional asphalt mix:

- Compactability tests in accordance with the test methods outlined in *AS/NZS 2891.2.2*<sup>2</sup> and *AS/NZS 2891.9.2*. Tests are to be undertaken to measure air voids after 250 gyrations. Acceptance criteria for air voids is between 2.0% and 5.5%.
- Moisture sensitivity test in accordance with Austroads *AGPT/T232*. Tests are to be undertaken to measure Tensile Strength Ratio (TSR). Acceptance criteria is minimum 80% TSR.
- Fatigue performance test in accordance with Austroads *AGPT/T274*. Tests are to be undertaken to measure micro strain level at  $10^6$  cycled to 50% of initial modulus. The strain value of the recycled plastic-modified asphalt mix is to be equivalent or greater than that of the conventional asphalt mix.
- One of the following:
  - a) Stability and flow test for Marshall compacted specimens in accordance with the test method in *AS/NZS 2891.5*<sup>2</sup>. Stability and flow results to be equivalent or improved upon than that of the conventional asphalt mix.
  - b) Resilient Modulus test in accordance with the test method in *AS/NZS 2891.13.1*. The Resilient Modulus is to be equivalent or greater than that of the conventional asphalt mix.

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<sup>1</sup> Regardless of whether the mix design submission and production testing requirements of *TfNSW Specification R117* or *TfNSW Specification R116* are adopted, the mix design, performance and production testing requirements outlined in *Engineering Advisory Note 22* for the use of asphalt mixes containing recycled plastics on lightly trafficked roads, are to be adhered to.

<sup>2</sup> Standard temperatures in the applicable test methods do not apply as they are intended for specified grades of bitumen or PMB intended for use in Conventional Asphalt. Recycled waste plastic modified binders or the addition of recycled waste plastic by the dry process will require laboratory compaction temperatures in excess of that used for C320 bitumen and likely in excess of the laboratory compaction temperature for some PMBs. Both *AS/NZS 2891.2.2* and *AS/NZS 2891.5* have an appendix to describe a process of how to determine an alternative compaction temperature.

### Production testing requirements

In addition to production tests outlined in *TfNSW Specification R117<sup>1</sup>, Table R117/L.2* or *TfNSW Specification R116, Table R116/L.2<sup>1</sup>*, the asphalt manufacturer is to undertake the following tests:

- One of the following performance-based production tests:
  - a) Stability and flow test for Marshall compacted specimens in accordance with the test method in *AS/NZS 2891.5<sup>2</sup>*. Acceptance criteria: stability and flow results to be equivalent to results achieved as part of mix design submission. Minimum test frequency is one test per 1,000 tonnes of the approved asphalt mix.
  - b) Resilient Modulus test in accordance with the test method in *AS/NZS 2891.13.1*. Acceptance criteria: Resilient Modulus is to be equivalent of greater than the results achieved as part of mix design submission. Minimum test frequency is one test per 1,000 tonnes of the approved asphalt mix.
- Moisture content test for asphalt in accordance with *AS/NZS 2891.10*. Acceptance criteria is maximum 0.5%. Minimum test frequency is one test per day of plant production of the approved asphalt mix.
- Moisture sensitivity test in accordance with *AGPT/T232*. Acceptance criteria is minimum 80% TSR. Minimum test frequency is one test per 5,000 tonnes of the approved asphalt mix.
- Uniform coating of binder test in accordance with *AS/NZS 2891.11*. Acceptance criteria is minimum 95%. Minimum test frequency is one test per 5,000 tonnes of the approved asphalt mix.

### Document management system

A manufacturer of an asphalt mix containing recycled plastic must maintain a documented management system which details how the asphalt manufacturer will manage processes for the manufacture, storage and transport of asphalt containing recycled waste plastic.

### Mix design submission and approval

The submission of the above mix design and mix performance tests are to be provided to Roads ACT in the format as shown in *Austrroads Research Report AP-R669-22, Table C 7* (Assessment framework for lightly trafficked pavements and local roads using recycled plastic). All test records are also to be attached to the submission.

Once approval of a mix design incorporating recycled plastics is granted by Roads ACT, it can be adopted on lightly trafficked roads where the design traffic load is less than  $1 \times 10^6$  ESA for a 20-year design life.

Roads ACT may forego one or more of the performance tests if the asphalt manufacturer can demonstrate, with documentary evidence and appropriate test records, that the asphalt mix can achieve the required performance and the asphalt mix is approved for use by another state or territory jurisdiction of Australia.

Refer to **Annexure 2** regarding the design submission and approval of an asphalt mix incorporating recycled plastics on moderately and heavily trafficked roads where the design traffic load is greater than  $1 \times 10^6$  ESA.

### Resource recovery exemption

The asphalt manufacturer is required to seek approval from ACT Environment Protection Authority for the use of recycled plastics in a proposed asphalt mix, or agreement from ACT Environment Protection Authority that a 'resource recovery exemption' granted by the NSW Environment Protection Authority can be applied in the ACT.

For recycled materials that are the subject of 'resource recovery exemptions' granted by the ACT Environment Protection Authority or the NSW Environment Protection Authority, comply with the conditions attached to any exemption as a 'consumer', 'processor' or a 'producer', as appropriate, and provide evidence demonstrating such compliance including all record keeping requirements.

### ***Other specification requirements***

Any asphalt that has been placed and is observed to have any recycled content that does not achieve particle grading requirements (e.g. recycled crushed glass with an aggregate diameter greater than 5 mm) will be deemed as non-conforming and will require to be replaced via hot-mix patch treatment as agreed by the Principal's Authorised Person. Minimum patch treatment dimension to be 1 m x 1 m and the longitudinal edge of the patch must not align with the wheel path.

## Specifications for recycled materials in unbound granular road base and subbase

On a project, either the MITS or the TfNSW Specifications are typically adopted. The specification requirements below are to be adopted regardless of which specification is adopted on a particular project.

### **Crumb rubber**

Crumb rubber is not to be adopted in unbound granular road base and subbase.

### **Recycled crushed glass**

Adopt maximum 10% recycled crushed glass as per *TfNSW Specification 3051, Table 3051.5* and as per [MITS 04 Flexible Pavements, Table 4-3](#).

Supply of recycled crushed glass is to be in accordance with *TfNSW Specification 3154*, regardless of whether *TfNSW Specification 3051* or [MITS 04 Flexible Pavements](#) is adopted for unbound granular road base and subbase.

Note: In TfNSW Specifications and MITS, this is referred to as 'granulated glass aggregate'.

### **Reclaimed Asphalt Pavements (RAP)**

Adopt maximum 40% RAP as per *TfNSW Specification 3051, Table 3051.5* and as per [MITS 04 Flexible Pavements, Table 4-3](#).

Supply of RAP is to be in accordance with *TfNSW Specification 3153*, regardless of whether *TfNSW Specification 3051* or [MITS 04 Flexible Pavements](#) is adopted for unbound granular road base and subbase.

### **Industrial slags**

Adopt maximum 100% slag as per *TfNSW Specification 3051, Table 3051.6*.

Supply of slag is to be in accordance with *TfNSW Specification 3051, Clause 10.5*.

Additional test: Unconfined Compressive Strength test to be undertaken for proposed road base materials (DGB20, RCCB20) containing slag as a constituent material, to *TfNSW test method T116* or *AS 5101.4*. Unconfined Compressive Strength to be maximum 1.0 MPa.

The above specification requirements are to be adopted on a project regardless of whether *TfNSW Specification 3051* or [MITS 04 Flexible Pavements](#) is adopted for unbound granular road base and subbase.

### ***Fly ash and furnace bottom ash***

Adopt maximum 10% fly ash and maximum 10% furnace bottom ash as per *TfNSW Specification 3051, Table 3051.6*.

Additional test: Unconfined Compressive Strength test to be undertaken for proposed road base materials (DGB20, RCCB20) containing fly ash or furnace bottom ash as a constituent material, to *TfNSW test method T116* or *AS 5101.4*. Unconfined Compressive Strength to be maximum 1.0 MPa.

### ***Recycled plastics***

Recycled plastics are not to be adopted in unbound granular road base and subbase.

### ***Recycled crushed concrete***

Adopt maximum 100% recycled crushed concrete as per *TfNSW Specification 3051, Table 3051.5* and as per [\*MITS 04 Flexible Pavements, Table 4-3\*](#).

Granular road base and subbase materials with more than 30% recycled crushed concrete must not be used within 100 mm of the underside of bituminous seals or asphalt with a total thickness of less than 150 mm, due to the potential for available cement which may rehydrate and result in shrinkage cracking.

For DGB20 material that is Traffic Category A or B, crushed concrete must be sourced from recycled structural concrete (Structural concrete is defined as concrete containing reinforcement or from rigid pavements). For DGB20 material that is Traffic Category C or D and for all subbase material, crushed concrete from structural and non-structural sources and concrete washouts is acceptable.

Additional test: Unconfined Compressive Strength test to be undertaken for proposed road base materials (DGB20, RCCB20) containing recycled crushed concrete as a constituent material, to *TfNSW test method T116* or *AS 5101.4*. Unconfined Compressive Strength to be maximum 1.0 MPa.

### ***Crushed brick***

Adopt maximum 20% crushed brick as per *TfNSW Specification 3051, Table 3051.5*.

Crushed bricks, excluding cement masonry bricks, are acceptable provided that they are uniform in quality and any adhering mortar or cement render does not produce any binding reaction in the base or subbase mix.

Additional test: Unconfined Compressive Strength test to be undertaken for proposed road base materials (DGB20, RCCB20) containing crushed brick as a constituent material, to *TfNSW test method T116* or *AS 5101.4*. Unconfined Compressive Strength to be maximum 1.0 MPa.

### **Total proportion of recycled materials**

The total proportion of recycled and manufactured constituent materials, other than slag or recycled crushed concrete, must not exceed 40% of the mix, unless otherwise approved by the Principal's Authorised Person.

### **Undesirable materials within constituent recycled materials**

Undesirable materials (also referred to as contaminants) and the maximum limits for undesirable materials within the constituent recycled materials is to be as per Table 3051.6 in *TfNSW Specification 3051*.

The maximum limits in Table 3051.6 in *TfNSW Specification 3051* apply regardless of whether a project has adopted MITS or TfNSW Specifications.

*TfNSW test method T276* to be adopted for testing for undesirable materials.

Test frequency to be as per *TfNSW Specification 3051, Annexure 3051/L, Table 3051/L.1* or as agreed with the Principal's Authorised Person.

### **Hold Points**

The following is to be a **HOLD POINT** as per *TfNSW Specification 3051, Clause 10.6*.

<b>HOLD POINT</b>	
Process Held:	Acceptance of recycled and/or manufactured constituent materials.
Submission Details:	<ul style="list-style-type: none"><li>(i) Evidence such as stockpile management plans and test results where applicable, to verify that the constituent material has been weathered, cured and managed to exclude any reactivity that may cause the material to expand after it has been placed in the pavement, and meets the requirements of <i>TfNSW Specification 3051, Table 3051.6</i>.</li><li>(ii) Test results demonstrating compliance with any applicable resource recovery exemption.</li></ul>
Release of Hold Point:	The Principal's Authorised Person will consider the submission prior to authorising the release of the Hold Point.

### **Other specification requirements and notes**

Refer to Section 10 of the Guide Notes in *TfNSW Specification 3051* for further guidance on the use of recycled materials in unbound granular road base and subbase.

Relationship between design traffic (over a 20-year design life) and 'Traffic Category' is outlined in *TfNSW Specification 3051, Annexure 3051/A, Table 3051/A.N1*.



## Specifications for recycled materials in sprayed bituminous surfacing

### Crumb rubber

Adopt the following requirements for the use of crumb rubber in sprayed bituminous surfacing:

- TfNSW Specification 3252 for crumb rubber modified binders.
- TfNSW Specification 3256 for the crumb rubber constituent material to be incorporated into a crumb rubber modified binder.

### Other specification requirements

#### Works as Executed submission requirements

For any project in which recycled materials are incorporated into pavement, including asphalt or granular materials, the following are to be provided as part of the Works as Executed submission:

- Denotation on the pavement plans or pavement details showing where materials have been adopted that contain recycled content.
- Materials mix design information for the materials that contain recycled content.

In due course, TCCS [Reference Document 11 – Drafting Requirements for Summary Drawings](#) and the associated [Ref 11 Toolkit](#) will be updated to include additional attributes to enable road pavements incorporating recycled materials to be captured in the TCCS Asset Information Management System.

### Administrative Arrangement

[MITS 04 Flexible Pavements](#) will be updated in the future to reflect the specification requirements outlined in this Engineering Advisory Note.

This Engineering Advisory Note will take effect from the latest date of endorsement by the Authorised Person/s.

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## Annexure 1 – Additional context on recycled plastics in asphalt

### Context

In September 2022, Austroads completed Austroads Project *APT6305* for the use of road-grade recycled plastics for sustainable asphalt pavements. This research was carried out by RMIT University and culminated in the completion of four research reports which can be downloaded from the [Austroads website](#).

Prior to this, Austroads published the *Interim Guidelines for the Use of Recycled Waste Plastic in Local Government Road Surfacing Applications (AP-G96-21)* in July 2021. This was intended to provide interim guidance to local government agencies on the adoption of asphalt mixes containing recycled plastics on municipal streets, in lieu of the existence of any specification.

The research conducted as part of Austroads Project *APT6305* is expected to enable state and territory jurisdictions to develop specifications for the use of recycled plastics in asphalt. However, as of the date of this Engineering Advisory Note (EAN), no state or territory jurisdiction of Australia has specifications in place for the use of recycled plastics in asphalt.

Until such time that a formal specification for use of recycled plastics in asphalt is developed, Roads ACT is taking a risk-based approach and its adoption will be permitted on lightly trafficked roads subject to the requirements of this EAN. For heavily trafficked roads, adoption of recycled plastics in asphalt will be reviewed on a case-by-case basis – refer to **Annexure 2** for details.

Roads ACT is monitoring the development of specifications for recycled plastics in asphalt by other major jurisdictions and will seek to incorporate such specifications into the MITS at the appropriate time.

This EAN refers to the different methods of incorporating recycled plastics into an asphalt mix which are:

- Wet method, where recycled plastics in the form of either flakes, pellets, or powder is added into bitumen as a polymer to produce polymer-modified bitumen.
- Dry method, where plastics are added into the asphalt mix as a replacement for quarry aggregates.
- Mixed method, where low-melting point plastics are included into hot aggregates before the addition of hot bitumen to improve the binding properties between aggregates and bitumen.

## **Annexure 2 – Adoption of recycled plastics in asphalt for heavily trafficked roads**

### ***Mix design submission and approval***

For the adoption of an asphalt mix containing recycled plastics on roads with design traffic loading greater than  $1 \times 10^6$  ESA for a 20-year design life, Roads ACT will assess each proposed asphalt mix on a case-by-case basis via the products approval process.

The granting of approval, or conditional approval, of an asphalt mix by Roads ACT will require that the asphalt manufacturer submit the results of more stringent material property tests and performance tests. Roads ACT will also require evidence of its approval for use on higher trafficked roads by another state or territory jurisdiction such as TfNSW or DTP. The additional material property tests and performance tests to be undertaken are to be agreed with Roads ACT. Appendix B and Appendix C of Austroads Research Report *AP-R669-22* outlines the tests recommended by Austroads to be undertaken.

### **Annexure 3 – Referenced documents**

#### ***Transport for NSW (TfNSW)***

TfNSW QA Specification 3051 Granular Pavement Base and Subbase Materials

TfNSW QA Specification 3152 Aggregates for Asphalt

TfNSW QA Specification 3153 Reclaimed Asphalt Pavement Material

TfNSW QA Specification 3154 Granulated Glass Aggregate

TfNSW QA Specification 3211 Cementitious Materials, Binders and Fillers

TfNSW QA Specification 3252 Polymer Modified Binder for Pavements

TfNSW QA Specification 3256 Crumb Rubber

TfNSW QA Specification R116 Heavy Duty Dense Graded Asphalt

TfNSW QA Specification R117 Light Duty Dense Graded Asphalt

TfNSW QA Specification R118 Crumb Rubber Asphalt

TFNSW Technical Direction TD 00018:2021 Dense graded asphalt containing high percentages of reclaimed asphalt pavement

#### ***Australian Standards***

AS 1141.11.1 Methods for sampling and testing aggregates: Particle size distribution – Sieving method

AS 5101.4 Methods for preparation and testing of stabilized materials

AS/NZS 2891.2.2 Methods of sampling and testing asphalt: Sample preparation – Compaction of asphalt test specimens using a gyratory compactor

AS/NZS 2891.3.1 Methods of sampling and testing asphalt: Binder content and aggregate grading - Reflux method

AS/NZS 2891.5 Methods of sampling and testing asphalt: Compaction of asphalt by Marshall method and determination of stability and flow – Marshall procedure

AS/NZS 2891.9.2 Methods of sampling and testing asphalt: Determination of bulk density of compacted asphalt – Presaturation method

AS/NZS 2891.10 Methods of sampling and testing asphalt: Moisture content of asphalt

AS/NZS 2891.11 Methods of sampling and testing asphalt: Degree of particle coating

AS/NZS 2891.13.1 Methods of sampling and testing asphalt: Determination of the resilient modulus of asphalt – Indirect tensile method

### ***Austroads***

AP-G96-21 Use of Recycled Waste Plastic in Local Government Road Surfacing Applications

AP-R669-22 Use of Road-grade Recycled Plastics for Sustainable Asphalt Pavements: Final Performance and Environmental Assessment Part A

### ***TCCS Technical Specification***

MITS 04 Flexible Pavements

### ***TCCS Reference Document***

Reference Document 11 Drafting Requirements for Summary Drawings

### ***TfNSW Test Methods***

TfNSW T116 Unconfined Compression Strength of Remoulded Road Construction Materials

TfNSW T276 Foreign Materials Content of Recycled Crushed Concrete

### ***Austroads Test Methods***

AGPT/T232 Stripping Potential of Asphalt – Tensile Strength Ratio

AGPT/T274 Characterisation of Flexural Stiffness and Fatigue Performance of Bituminous Mixes