IPWEA/WALGA Specification for the supply of recycled road base

Version 1

May 2016

IPWEA/WALGA Specification for the supply of recycled road base

FOREWORD

These Specifications have been developed by the Institute of Public Works Engineering Australasia Western Australia Incorporated (IPWEA WA) in conjunction with the Western Australia Local Government Association (WALGA) for the purposes of outlining the specifications for the supply of recycled road base. To the extent permitted by law, WALGA and IPWEA WA exclude all warranties as to, and responsibility for, the accuracy, completeness or suitability of the information in the Specifications or for any error or omission in the information and will not be liable for any loss or damage suffered or incurred by any persons arising from the use or reliance on the information or data contained in the Specifications. To the extent permitted by law, IPWEA WA and WALGA disclaims all liability to the user for loss, injury or damage, arising out of, or related to, the use of the material outlined in the Specifications. Prior to using the material outlined in the Specification, approval should be sought from the relevant Local Government or appropriate Road Authority.

REVISION RECORD

VERSION No.	REVISION No.	DATE	DETAILS
1	0	May 2016	Original Version.

IPWEA/WALGA SPECIFICATION

Specification for the supply of recycled road base

1 Background

Recycled crushed demolition materials are widely used in other Australian states, notably Queensland, New South Wales, Victoria and South Australia, where these materials are included in State Road Authority Specifications. However Western Australia lags other states, and Main Roads WA does not include recycled materials for base courses in Specification 501.

Recycled pavement materials based largely on recycled crushed concrete have been well researched and have been shown in many studies to be superior in structural properties when compared to virgin crushed road base. Using recycled materials has significant environmental benefits including minimising landfill and use of finite resources.

Users of this specification are advised to consider the Guidance Note at the end of the specification.

2 General

The material shall consist of a uniformly blended mixture of coarse and fine aggregate resulting from the crushing of recycled concrete and other hard materials from construction and demolition material. It may contain other materials such as clay brick and tile, sand and glass according to the limits specified in Table 2.

3 Material classes

The material classes shall be determined according to the end use of the product which will be determined by the pavement design, traffic conditions and level in the pavement. The recommended material class required for a specific application is specified in Table 1

Table 1: Material class for given application

Level in pavement	Traffic (ESA/day)			
	> 500	< 500	50-100	< 50
Base < 50 mm asphalt or spray seal	Class 1	Class 1	Class 1	Class 1
Base ≥ 50 mm asphalt	Class 1	Class 1	Class 1	Class 2
Subbase	Class 2	Class 2	Class 2	Class 2

4 Limits on source material composition

Limits on the material composition are shown in Table 2. In order to achieve the improved structural strength in base materials, a high proportion of crushed concrete is required; however some upper limit (95%) of crushed concrete is recommended for application in base materials to limit the potential for shrinkage cracking. This is an ongoing research issue and some changes in these limits may apply in future revisions.

Table 2: Limits on constituent materials based on material class

Material	Class 1	Class 2
	Maximum % by weight	
Crushed Recycled Concrete (CCRB)	95	95 as base 100 as subbase
Recycled Asphalt Pavement (RAP)	10	15
High density clay brick & tile	10	15
High density aggregates from roads etc.	25	100
Low density materials (plastic, plaster, etc.)	1	1.5
Organic Matter (Wood, etc.)	0.5	0.5 as base 1.0 as subbase
Unacceptable high density materials (metals, glass, ceramics > 4 mm)	2	3
Asbestos	As per Department of Environment Regulation: Guidelines for Managing Asbestos at Construction and Demolition Waste Recycling Facilities (latest version)	

5 Particle size distribution (PSD)

PSD shall conform to the limits of Table 4. The PSD curve shall be classified by the descriptive classification as shown in Table 3. The PSD shall be determined in accordance with MRWA test method WA 115.1

Coarse aggregate (retained 4.75 mm sieve) shall consist of clean, hard, durable, angular fragments of recycled concrete or asphalt produced by crushing sound recycled materials originally made from sound unweathered rock and shall not include materials which break up when alternately wetted and dried.

Fine aggregate (passing 4.75 mm sieve) shall consist of crushed rock fragments or a mixture of crushed recycled concrete, asphalt or brick fragments produced by crushing sound recycled materials originally made from sound unweathered rock, clays or natural sand.

Table 3: Shape variability class for PSD

Shape variability descriptor	Shape attributes of PSD curve
Low	Where the grading curve fits smoothly within the envelope, and may gradually move from the high limits to the low limits or from the lower limits to the higher limits but does not wander between extremes
Medium	Where the grading curve changes from the higher limits to the lower limits or the lower limits to the higher limits in one sieve size that is above the 2.36 sieve
High	Where the grading curve fits outside the envelope for one or two sieve sizes above the 2.36 mm sieve, or where the grading envelope changes from the lower limits to the higher limits for any sieve size 2.36 mm or less, or where the grading curve changes from the higher limits to the lower limits or the lower limits to the higher limits on more than one instance
Unacceptable	Where the grading curve falls outside the envelope for any sieve size 2.36 mm or less or for more than two sieve sizes above 2.36 mm

Table 4: Limits for particle size distribution

Material Class	Class 1	Class 2
AS sieve size (mm)	% passing by mass minimum and maximum limits	
37.5		
26.5	100 - 100	100 - 100
19.0	95 - 100	95 - 100
9.50	60 - 80	59 - 82
4.75	40 - 60	41 - 65
2.36	30 - 45	29 - 52
1.18	20 - 35	20 - 41
0.600	13 - 27	13 - 29
0.425	11 - 23	10 - 23
0.300	8 - 20	8 - 20
0.150	5 - 14	5 - 14
0.075	3 - 11	3 - 11
Ratio of 0.475:0.075	0.35 – 0.60	0.35 – 0.60
Shape variability	Low	Base: Low or medium Subbase: Low, medium or high

6 Linear shrinkage (LS)

Linear shrinkage shall be determined on the portion of material passing the 425μm sieve in accordance with MRWA test method WA 123.1 Limits for LS are given in Table 5.

Table 5: Limits for linear shrinkage

Linear shrinkage (7 day)	Class 1 & 2
Base (%)	0.2 – 1.5
Subbase (%)	0.2 – 4.0

7 Unconfined Compressive Strength (UCS)

The UCS of the material when tested in accordance with MRWA test method WA 143.1 (7 days cured and 4 hours immersed) shall conform with the requirements of Table 6.

Table 6: Limits for unconfined compressive strength

Unconfined compressive strength	Class 1 & 2
Base (kPa)	200 – 1000
Sub-base (kPa)	200 – 2000

8 Los Angeles abrasion coarse aggregate

Limits for Los Angeles abrasion are given in Table 7. Testing shall be in accordance with Main Roads WA Test Method 220.1-2012 *Los Angeles Abrasion Value*

Table 7: Limits for Los Angeles abrasion test

Los Angeles abrasion	Class 1	Class 2
Los Angeles abrasion loss (%)	<40	<42

9 California Bearing Ratio (CBR)

The CBR shall be determined in accordance with MRWA test method WA 141.1. The sample shall be soaked for four days. The minimum requirements for CBR are detailed in Table 8. (Note no curing period shall be applied for this test, and the sample shall be soaked immediately after preparation).

Table 8: Limits for CBR

California Bearing Ratio	Class 1 (98% MDD, 100% OMC)	Class 2 (98% MDD, 100% OMC)
Californian Bearing Ratio (CBR) (%)	>100	>100

10 Minimum performance requirements

These tests shall not be required where the material manufactured meets all index tests, however when a material fails to meet the index tests specified, the RLTT may be used to prove the performance of the material produced by a manufacturer, at which case the material may be accepted by the superintendent.

Performance tests including the repeat load triaxial test (RLTT) test shall be used to determine the performance parameters of:

- resilient modulus at 400 kPa normal stress and 150 kPa confining stress both at 60% OMC
- resilient modulus at 400 kPa normal stress and 150 kPa confining stress both at 80% OMC
- maximum permanent strain at end of stress stage modulus cycle (%)

Table 9: Limits for modulus, permanent strain, friction angle and cohesion

Performance test limits	Class 1	Class 2
Resilient modulus @ 400 kPa normal stress and 150 kPa confining stress		
at 60% OMC	700 - 1000	650 - 1000
at 80% OMC	>600	>550
Maximum permanent strain at end of stress stage modulus cycle (%)	3%	3.5%

The RLTT shall be undertaken in accordance with Austroads Repeated Load Triaxial Test Method – *Determination of permanent deformation and resilient modulus characteristics of unbound granular materials under drained conditions* (Vuong and Brimble 2000), **modified as below**, and shall be used to report modulus and permanent strain values. The target values are given in Table 9.

The sample shall be prepared at Optimum Moisture Content, allowed to dry back to the desired moisture content at room temperature, wrapped to allow moisture to remain at the desired content, and cured for 7 days to allow even distribution of moisture through the sample.

11 Maximum dry density (MDD) and optimum moisture content (OMC)

The MDD and OMC of the material shall be determined in addition to all other tests at Frequency A. MDD and OMC shall be determined in accordance with MRWA test method WA 133.2 *Dry density/moisture content relationship: modified compaction coarse grained soils.*

12 Test frequency and sampling methods

12.1 Sampling methods

Sampling shall be undertaken using one of three options:

- one sample per time period
- one sample per number of tonnes produced
- certified stockpile.

Where a certified stockpile is used, the stockpile shall be manufactured, tested and certified, and no more material shall be deposited to the stockpile after certification.

Where a certified stockpile is used, the number of samples shall be related to the size of the stockpile. Samples shall be collected in accordance with MRWA test method WA 200.1 part 5 except that the limits on stockpile size shall not apply.

Each sample shall be collected and tested individually. The number of samples required shall be determined as follows:

- Stockpile <1,000 m^3, 3 samples
- Stockpile 1,000 – 2,000 m^3, 6 samples
- Stockpile >2,000 m^3, 6 samples + 1 sample per 1,000 m^3.

Where sampling is undertaken during continuous batching operations and forms part of a process control, sampling shall be undertaken in accordance with MRWA test method WA 200.1 part 2.

12.2 Sampling frequency

Where sampling is undertaken during continuous batching operations and forms part of a process control, sampling shall be undertaken on either a unit of time or unit of mass basis whichever is the most frequent. Testing shall be dependent on the importance of the test and shall be at Frequency A or Frequency B or Frequency C as follows:

Frequency A

- Particle size distribution (PSD)
- Linear shrinkage (modified)
- Percentage foreign materials (modified).

These shall be at a frequency of one sample per 1000 tonne or one sample per week or change in source material.

Frequency B

- Los Angeles Abrasion
- Californian Bearing Ratio (CBR)
- Unconfined Compressive Strength.

These shall be at a frequency of one sample per 5000 tonne or one sample per month or change in source material.

Frequency C

- Repeat Load Triaxial Test

Where a material does not meet the index requirements specified above, the repeat load triaxial test may be used to prove the product performance relative to the index properties of that material, and those index properties may then form the specification for that product.

12.3 Testing authority

All testing shall be undertaken by a NATA accredited laboratory.

13 Reporting

All test results shall be kept on file and shall be distributed to the client organisation within 4 weeks of the sample date.

GUIDANCE NOTE

Guidance note for the IPWEA/WALGA Specification for the supply of recycled road base

1 General

The working of roadbase sourced from demolition materials containing significant amounts of crushed concrete varies marginally from the methods required for conventional roadbase. However the material does have a tendency to bind due to the rehydration of the cement content in the roadbase, and becomes considerably stronger than conventional roadbase very early in the dryback process. The material is referred to as Reclaimed Concrete Roadbase (RCC).

2 Layer thickness and shrinkage

RCC has residual uncured cement and this will commence rehydration and strength gain immediately on completion of the pavement, and this strength gain will continue, initially at a rapid rate, but the rate of strength gain will reduce with time, but may continue gradually for many years.

RCC will, unless containing very large amounts of non pozzolanic material, become liable to fatigue if used in thin layers. Ideally RCC should be used for the full pavement profile. Experience has shown that in thick layers, when provided with good dryback and a primer seal, minor transverse cracking in the asphalt surface may occur; however due to its great inherent strength, asphalt fatigue life will be extended considerably.

However if used as a thin base layer, under heavy traffic, fatigue of the bound layer may occur, and block cracking may be evident.

For this reason, RCC when used in lightly trafficked roads will provide an excellent subbase, but may be covered with a 100mm granular roadbase to prevent shrinkage cracking in surfacing asphalt.

3 Moisture content and density

RCC has a lower density and higher optimum moisture content than Crushed Granite Roadbase (CRB). Due to the lower density, the additional water required for compaction of RCC is greater than that for CRB, but not as much as would be suggested by the laboratory OMC. However for dust control purposes, the supplier may have already added some of this moisture, and the water requirements on site may be minimal.

4 Delivery and compaction

There are several manufacturers of RCC; some of those manufacturers produce a high quality well graded and consistent material, others may just crush and use your road to dispose of the material in an attempt to avoid the landfill levy.

Materials should only be sourced from suppliers who have an Asbestos Management Plan and have been assessed by Department of Environmental Regulation as having systems in place to meet the Reduced Sampling Criteria as described in *Guidelines for managing asbestos at construction and demolition waste recycling facilities*

The IPWEA specification for Reclaimed Concrete Roadbase has strict requirements for sampling and testing for material conformance. Users of this material should ensure that the facility that supplies the material can demonstrate consistency, and like any other construction material, random audit testing should be undertaken to ensure compliance with the specification.

On delivery of the first loads, and randomly throughout the period of supply, the material delivered to site should be laid out and visually inspected to ensure any undesirable materials are limited.

The material should be laid out in layers according to the pavement design. For residential streets where the base may be less than 250mm, one layer may be sufficient with suitable roller size and number of passes.

Over 250mm thick pavement should be constructed in two layers, the subbase layer being thicker, and the base layer not being less than 100mm. This is consistent with any other pavement material. Generally a vibratory roller on high amplitude low frequency is used for initial compaction, followed by a rubber tyre roller for finish rolling. Where structures such as high pressure gas pipelines, sensitive water mains or in cases close to existing houses, a static roller may be required, with thinner layers compacted, or a greater number of passes.

5 Finishing

Due to the potential for rehydration of the cement component, it is important to finish to final levels before dryback, as it may become harder to cut. However the time available is still considerable, and operators should be aware that the time available is more than adequate, however where with CRB, sections may be left high to account for traffic damage, this should not be undertaken with RCC.

6 Ravelling under traffic

RCC is extremely resistant to ravelling from traffic once compacted and dryback has commenced. The RCC is considerably better than CRB where turning traffic is required to use a partially completed surface. Therefore the material should be completed to design levels and not left high to allow for damage from traffic.

7 Shrinkage during dryback

During the dryback process, rehydration of the cement does result in some minor shrinkage cracking, and allowance for this phenomena should be made. It is preferable to allow the material to dryback for at least 5 days, preferably longer, before sealing although research is still underway to determine the optimum period.

8 Primer seal

Good practice for any road pavement is a well constructed primer seal. In the case of emulsion based primer seals, a two coat application is essential. A 10/5 aggregate combination with a total <u>residual</u> bitumen rate of 1.5l/m^2 is required.

9 Asphalt surfacing

Asphalt surfacing may be carried out the next day after primer sealing as normal. Where RCC is used as a base in low volume roads, consideration should be given to a Stone Mastic Asphalt instead of a Dense Grade Asphalt.