SECTION 505

USE OF RECLAIMED ASPHALT PAVEMENT IN ASPHALT PAVEMENT CONSTRUCTION

505.01 Preliminary and General

The work covered by this section covers the use of Reclaimed Asphalt Pavement (RAP) material in hot mix asphalt construction. This specification allows for the use of both Classified and Unclassified RAP.

The contractor's development and processing of RAP into an end paving product must meet SS 502 Asphalt Pavement Construction (EPS) for Highway Construction.

The maximum allowable percentage of RAP allowed in asphalt pavement will be based on the classification of the roadway and the location of the mix in the pavement structure or as identified in the Special Provisions.

505.02 Roadway Categories

Roadways are divided into the following 2 categories:

- Category A – All numbered Highways.
- Category B - Other Roads.

The roadway Category shall be identified in the Special Provisions.

505.03 Definitions

Reclaimed Asphalt Pavement (RAP) – Removed and/or reprocessed pavement materials containing asphalt and aggregates. These materials are generated when asphalt pavements are removed for reconstruction and/or resurfacing. When properly screened and crushed, it consists of high quality aggregate coated by asphalt cement.

Classified RAP – RAP obtained from Ministry roadways will be termed as Classified RAP.

Unclassified RAP – RAP obtained from non-Ministry sources or mixed with RAP from other sources.

Rheology - is the study of deformation and flow of matter. For asphalt binder rheology, it refers to the flow characteristics of the asphalt binder in the asphalt mix. Deformation and flow of the asphalt binder in asphalt mix is important in determining asphalt pavement performance.

505.04 Allowable RAP Addition Rates

The maximum RAP allowed in the asphalt mix shall be determined by the contribution of the RAP Asphalt Cement (AC) towards the total AC content in the mix by weight as per the percentages specified in Table 505-A. The Contractor shall notify the Ministry Representative, 14 days in advance of Paving if RAP will be used in the project, and shall fill all fields as applicable and sign this Appendix II – RAP RECORD SHEET and submit it to the Ministry Representative 10 days in advance unless the project Special Provisions state differently.

Table 505-A: Maximum Percent RAP AC Replacement allowed in Asphalt Mix

Road Classification	Top Lift	Lower Lifts
Category A	15	30
Category B	30	30

The amount of total AC replaced by AC in the RAP will be calculated as follows:

$$\% \text{ AC Replacement} = \frac{\mathbf{a} \times \mathbf{b}}{\mathbf{c}}$$

Where;

a = AC content of RAP
b = RAP percent in mixture by total weight of mix
c = Total Percent AC content in mixture

Inclusion of RAP into the hot mix asphalt will be as per the maximum allowable percentage of AC replacement unless otherwise noted in the Special Provisions.

505.05 Materials

505.05.01 RAP

The Contractor shall fulfill or exceed the requirements of SS 505 Appendix 1 – RAP Management Best Practices for the management of RAP materials from the time of collection through processing, mix design and quality control practices during the production of asphalt mixtures containing RAP and the Contractor

shall provide documentation to the Ministry Representative that best practices have been followed in the handling, classification, and storage of RAP material, prior to being allowed to use the RAP.

505.05.02 Asphalt Cement

When the Percent RAP AC Replacement amount is greater than 15%, the blended AC must meet the penetration and viscosity requirements of the specified asphalt cement specified in the Special Provisions (when penetration graded asphalt cement is specified) or the temperature requirements of the specified Performance Graded Asphalt Cement (PGAC) when a PGAC is specified or substituted for penetration graded asphalt cement.

505.05.03 Use of Rejuvenators

Usage of Softening agents, rejuvenators or recycling agents will not be permitted.

505.05.03 Use of Recycled Asphalt Shingles

Usage of Recycled asphalt shingles will not be permitted.

505.06 RAP Sampling

Sampling of the RAP shall be as per SS 505 Appendix 1 – RAP Management Best Practices.

505.07 Quality Control

The quality control testing requirements for RAP shall be based on the percent of AC replacement in the asphalt mix as per the requirements listed in Table 505 –B and the Minimum test frequency guidelines for Quality Control listed in (Table 505-C in Appendix I)

505.07.01 RAP Aggregate Testing

a) Basic Tests

The following basic properties shall be determined for the proposed RAP:

- Moisture Content;
- Asphalt Content;
- Gradation;
- Percent Fracture; and
- Specific Gravity of coarse and fine fractions (for mix design purposes).

Individual representative RAP samples shall be tested to determine moisture content, gradation, percent fracture and asphalt content.

Tests to determine the specific gravity of the coarse and fine fractions of RAP shall be completed on the combined aggregates (obtained by combining the individual reclaimed aggregates retained after the extraction of the asphalt cement).

b) **Consensus Tests**

The tests for the consensus properties shall be completed on the combined aggregates (virgin aggregates and reclaimed aggregates) mixed in the proportions proposed for the mix design.

The following aggregate consensus properties shall be determined for the combined aggregate samples:

- Maximum Micro Deval Abrasion loss factor (%);
- Standard Test Methods for un-compacted void content of fine aggregate (as influenced by particle shape, surface texture and grading) (ASTM C1252) ; and
- Percentage of flat and elongated particles (for Superpave mixes only).

505.07.02 AC Rheology Testing

When AC rheology testing and design is required, the blended AC must meet the penetration and viscosity requirements of the specified AC type. For penetration graded asphalt, rheology is measured in terms of penetration at 25^{o}C and viscosity at 60^{o}C. For performance grade asphalt cements (PGAC), rheology is tested as per the procedures outlined in AASHTO MP1 and reported in terms of high and low temperature service ratings, i.e. PG 58-34.

Since the rheological properties of asphalt binder vary with temperature, rheological characterization involves two key considerations:

- To compare different asphalt binders, their rheological properties must be measured at some common reference temperature.
- To fully characterize an asphalt binder, its rheological properties must be examined over the range of temperatures that it may encounter during its life.

For mixes specified to use PGAC, the blended AC must meet the temperature requirements of the specified PGAC. For asphalt mixtures containing RAP and specified to use Performance Graded (PG) asphalts, the RAP rheology and the grade of virgin asphalt to be used shall be determined according to Appendix X1 of AASHTO MP2.

505.07.03 Quality Control Testing

Table 505-B: Quality Control Testing Requirements

Classified RAP	% AC Replacement	Required Tests
	≤ 15%	• Basic Tests
	> 15%	• Basic Tests • Consensus Tests • AC Rheology Testing
Unclassified RAP	≤ 15%	• Basic Tests • Consensus Tests
	> 15%	• Basic Tests • Consensus Tests • AC Rheology Testing

505.08 Asphalt Mix Design

RAP shall be included at the proposed addition rates during the mix design. The Contractor shall submit a mix design to the Ministry Representative for review at least 5 business days prior to the start of asphalt mix production.

In addition to the information required in SS502.08.04 - Asphalt Mix Design Submittals, the following information shall be provided in the mix design submittal for the asphalt mixes containing RAP:

- All RAP aggregate gradations for each RAP product;
- Asphalt Content for RAP;
- Results for Consensus properties of combined aggregates as specified in Section 505.07.01 (when applicable);
- Design RAP Rheology test results; and
- Blending Charts for the virgin and reclaimed AC. (when applicable)

Should a change in the source or addition rate of RAP be made after the mix design has been approved, a new mix design and/or job mix formula shall be submitted to the MoT for review.

505.09 Payment Adjustments

SS 502 PART F – PAYMENT ADJUSTMENTS shall

apply to all work utilizing reclaimed asphalt pavement in the asphalt mix unless otherwise specified in the Special Provisions.

SS 505 APPENDIX 1

RAP MANAGEMENT BEST PRACTICES

A **best practice** in the context of this Standard Specification is a method or technique that has consistently shown results superior to those achieved with other means, and that is used as a benchmark. A "best" practice may evolve to become better as improvements are discovered. Best practice is considered to describe the process of developing and following a standard way of doing things that are commonly achieved in the industry.

RAP Sources - RAP may be obtained from several sources. The common sources of RAP are:

Cold Milling – This is the most common source of RAP. The milling process should be closely examined to make sure that the milled material is not contaminated with soil, base materials, paving geotextiles or other foreign material (sulphur, asbestos, rubber etc.). The milled material that becomes contaminated should be stockpiled separately from RAP to be used in asphalt mix.

A special milling operation may also be beneficial when it is desirable to mill the surface layer in one pass and the underlying layers in a second pass because the surface course millings may contain aggregates with higher fractured aggregates that could be incorporated in the new surface layers.

Full Depth Pavement Removal – RAP can also be obtained from the removal of the existing pavement using a bulldozer or a backhoe. This process typically results in large chunks of pavement that may be contaminated with underlying soils. This contaminated material should be stored in a separate stockpile and not to be used in the hot mix asphalt.

Asphalt Plant Waste – This includes the waste generated during plant start-up, transition between mixes, plant clean out, mix rejected from projects and excess mix produced that could not be placed.

This material usually has fewer fines than the typical RAP since it wasn't milled or broken up during pavement removal and the AC is less aged than RAP since it hasn't been subjected to environmental aging.

This material should be stockpiled and tested separately from the other RAP.

RAP Contamination – Best practice for RAP stockpiles is to keep them free from contaminants. RAP stockpiles should be treated as a valuable material. Truck drivers bringing the material on the site should ensure that unwanted debris or contaminated material does not end up in the RAP stockpile.

The plant QC personnel and the loader operators should continuously monitor processed and unprocessed RAP stockpiles to make sure that they do not contain deleterious materials. If any contaminants are found, they should be removed immediately so that they are not covered up with other RAP brought on to the yard.

RAP Categories – RAP obtained from MoT sources is referred to as **Classified RAP.** RAP obtained from non MoT sources or mixed with RAP from other projects is referred to as **Unclassified RAP**.

RAP Processing – Best practice for RAP processing involves one or more steps to create consistent materials. Screening is used to separate sizes. In some cases, it may be desirable to screen or fractionate RAP to coarse and fine fractions. RAP separation based on sizes increases quality and reduces variability in the RAP properties.

For stockpiles of RAP from multiple sources, particularly stockpiles containing oversize fragments of RAP or pavement slabs, the material should be processed to produce RAP with a maximum size of 37.5 mm for use in hot mix asphalt.

Further processing of RAP may include both screening and crushing to produce a uniform gradation, AC content and other properties. Since crushing RAP will create more aggregate fines, it is best to set up the crushing operation so that the RAP is screened before it enters the crusher.

RAP processing shall occur as early as possible in the construction planning process.

RAP Stockpiling – The best practice to minimize the accumulation of moisture in stockpiles is to cover the stockpile with a shelter, tarp or building to prevent precipitation from getting to the RAP.

APPENDIX 1 - RAP MANAGEMENT BEST PRACTICES

RAP stockpiles should be placed on a base with adequate drainage and constructed with minimal segregation. Arc-shaped, conical, uniform stockpiles are preferred for storing processed or unprocessed RAP. No contamination of the RAP from the stockpile base materials should occur.

Use of heavy equipment on top of the RAP stockpile should be minimized to avoid compaction of the RAP. It is also recommended that the RAP stockpiles be limited to 4 m in height to reduce the potential for self-consolidation of the stockpile.

RAP Sampling - Best practice is for representative RAP samples to be collected from the stockpile prepared for the project. At least one sample per 750 tonnes of RAP in the stockpile or a minimum of ten samples per stockpile should be taken and retained for testing.

If the asphalt mix from an existing pavement is to be used as RAP, 150 mm diameter cores should be extracted at a frequency of at least one core every 1.5 kilometer in each lane prior to the start of the project. The asphalt mix from the pavement lift to be recycled should be tested to determine the properties of the aggregates and the asphalt cement in the pavement.

Sampling Method – Best practice for sampling aggregates applies to the sampling of RAP as well. RAP stockpiles should be sampled as they are being built at the location where they will be fed into the asphalt plant. Sampling at the time the stockpile is built is the best practice and will be easier and more representative of the stockpile compared to samples taken later after the formation of the crust on the face of the RAP stockpile.

Proper sampling procedures normally used for virgin aggregates should also be used to sample RAP aggregates as included in *"AASHTO T2: Sampling of Aggregates", Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 30th Edition*.

Minimum Test Frequencies – The quality control tests on the RAP and the extracted aggregates should be completed at the minimum frequencies specified in Table 505-C: Guidelines for Minimum Quality Control Test Frequencies.

All RAP aggregates retained after extraction should be combined together into one sample. The combined sample should then be sieved and split into coarse and fine fractions and used to determine the specific gravity of the recycled aggregates.

Stockpile Management – When a stockpile reaches the desired quantity and has been sampled and characterized, no additional RAP material should be added to it. Subsequent RAP material should be stockpiled in a separate stockpile and characterized in the same manner. This process should continue such that characterized stockpiles are not compromised by new RAP materials.

Samples from the RAP stockpile should be taken and the testing completed as per the minimum test frequencies specified in Table 505-C.

Table 505-C: Guidelines for Minimum Quality Control Test Frequencies

Test	Minimum Frequency
Asphalt Content	One per 750 tonnes
Gradation	One per 750 tonnes
Percent Fracture (%)	One per 750 tonnes
Specific Gravity of coarse fraction of RAP	Minimum of One per 3000 tonnes or three per stockpile
Specific Gravity of fine fraction of RAP	Minimum of One per 3000 tonnes or three per stockpile
Maximum Micro Deval Abrasion loss factor (%)	Minimum of One per 3000 tonnes or three per stockpile
Fine aggregate angularity	Minimum of One per 3000 tonnes or three per stockpile
Flat and elongated particles (For Superpave Only)	Minimum of One per 3000 tonnes or three per stockpile
AC Rheology	Minimum of One per 3000 tonnes of RAP or a minimum of three tests per project.

SS 505 APPENDIX II
RAP RECORD SHEET

This Appendix is part of the Standard Specification SS 505. The Contractor shall notify the Ministry Representative unless the project Special Provisions state differently, 14 days in advance of Paving if RAP will be used in the project, and shall fill all fields as applicable and sign this Appendix II – RAP RECORD SHEET and submit it to the Ministry Representative 10 days in advance unless the project Special Provisions state differently.

Contractor:

Ministry Representative:

Project Name per Signed Contract:

Project Number:

Numbered Highway Name: (if Applicable)

Road Name: (If Applicable)

Segment No.	Tonnage	RAP percentage	Classified RAP	Unclassified RAP	Top Lift %	Bottom Lift %	Left/Right LKI	Start LKI	Finish LKI

Filled by (Name and Date):

Address and Contacts

Submitted by:

Name:

Signature and Date: