9 RECYCLED MATERIALS FOR ROADWORKS

9.1 GENERAL

9.1.1 Scope

1 The conditions of this part cover the requirements of recycled aggregate obtained from demolition and excavation waste for use in roadworks.

2 The Engineer shall be sure and be responsible for use of any recycled materials that they are safe and adequate from an engineering point view and for the job site conditions.

3 Upon his responsibility, the Engineer could add and/ or modify any specification.

4 Related Parts are:

Part 1, ... General
Part 3, ... Earthworks
Part 4, ... Unbound Pavement Materials

9.1.2 References

1 The following standards are referred to in this Part:

ASTM C88.....Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate

ASTM C136.....Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C117.....Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C535.....Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C131.....Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM D1556.....Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method

ASTM D1557.....Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))

ASTM D1883.....Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils

ASTM D2216.....Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D2419.....Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

ASTM D4318.....Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4429.....Standard Test Method for CBR (California Bearing Ratio) of Soils in Place

ASTM D4791.....Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

ASTM D4944.....Standard Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester

ASTM D5821.....Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

ASTM D6913 .....Standard Test Methods for Particle Size Distribution (Gradation) of Soils Using Sieve Analysis

ASTM D6938.....Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

BS 1377 Part 3.....Methods of test for Soils for Civil Engineering Purposes: Chemical and electro-chemical tests

BS EN 933-11 .....Tests for geometrical properties of aggregates. Classification test for the constituents of coarse recycled aggregate

9.1.3 Definitions

1 Demolition Waste: Waste Material obtained from demolished concrete structures.

2 Excavation Waste: Waste obtained from excavated materials.

3 ESALs: Equivalent Single Axle Loads

4 Maximum dry density (MDD): The dry density of soil obtained using a specified compaction effort at the optimum moisture content when determined in accordance with the modified compaction test ASTM D1557. Unit weight and moisture content of materials containing more than 5% by mass of oversize fraction tested in accordance with ASTM D1557 should be corrected following ASTM D4718.

5 Optimum moisture content (OMC): the moisture content of soil at which a specific compaction effort will produce the maximum dry density when determined in accordance with the ASTM D1557.

6 Recycled Aggregate: Aggregate produced by the reprocessing of recycling waste materials. These include but are not limited to reclaimed asphalt, excavation waste, demolition waste, industrial waste such as aggregate produced by sand washing plants.

7 Reclaimed Asphalt Pavement (RAP): Milled or processed materials generated from the asphalt Wearing and Base Course layers of existing pavement.

8 General Fill: Fill materials of acceptable quality having specified characteristics to be used at more than 1m of structures.

9 Select Fill: Fill materials of acceptable quality having specified characteristics to be used within 1m of structures.

10 Subbase: It is the layer between the subgrade and the Road Base. It consists of compacted selected granular materials.

11 Road Base: It is the layer directly beneath the asphalt course layers and above the subbase or subgrade layer. It consists of compacted selected materials. It can be untreated or treated with suitable stabilizing admixtures.

9.1.4 Submittals

1 The Contractor shall submit recent test results for the proposed sources of materials for all quality requirements of the Contract. The Contractor shall submit a test certificate that proves that the raw materials that are purchased/used comply with specifications. The testing shall be performed by an approved private laboratory.

2 The contractor shall submit to the Engineer for approval method statements for the following:

(a) Source of materials facilities quality procedures.

(b) Materials production, handling, storage, identification, marking and traceability to source of production.

(c) Quality control testing plan.

(d) Equipment and its suitability to fulfill all construction activities to the required quality.

(e) Personnel capability.

(f) Safety and environment preservation measures.

9.2 RECYCLED AGGREGATE

9.2.1 Sources of Materials

1 Recycled aggregate can be obtained from a separate recycling plant or on-site recycling operation unit subject to approval by the Engineer. The on-site recycling process shall be implemented such that the techniques used do not adversely impact the environment in terms of dust, noise, emission to water and air emission.

2 Combined materials include recycled aggregates shall be mixed in suitable locations by suitable means to assure consistency of final mix.

3 Materials shall be clean, tough, hard, durable, non-organic, chemically stable and contains no harmful matter in quantities sufficient to adversely affect construction works. Materials shall be free from tree and plant stumps, perishable materials, materials subject to spontaneous combustion, material from sabkha and marshes.

4 Source of recycled aggregate shall not contain deleterious material, which may affect its reuse.

5 Sources of aggregate shall be thoroughly investigated to ensure the quality of material is satisfactory.

9.2.2 Storage and Handling of Materials

1 ebris pieces collected from demolition works shall be stock piled at suitable location where different types of materials can be separated.

2 Materials shall be stock piled separately according to materials type, required nominal sizes and proposed use.

3 If the construction waste consists of wood, paper, glass, plastic, metals and other non-mineral fractions, they should be adequately separated and disposed/recycled in a legal way.

4 Samples shall be taken of the recycled aggregate constituents for classification by hand-sorting the coarse aggregate particles in accordance with BS EN 933-11. The test shall be carried out by a suitably trained laboratory technician who has demonstrated competence in classifying the constituent classes in accordance with the test method.

9.2.3 Inspection Testing and Control

1 Loose materials for source acceptance and approval by the Engineer prior to use shall be sampled from stock piles not greater than 2000 m^3.

2 Loose materials for testing and acceptance shall be sampled from the un-compacted in-place layer.

3 For verification of plant weights and measures, character of materials used in the preparation of the mixes, testing and other quality control requirements, the Engineer shall at all times be provided access to all portions of the mixing plant, aggregate plant, storage yards, crushers and other facilities used for producing and processing the materials of construction.

4 The Engineer shall have authority to take samples and perform tests on any material supplied to the site from any source whatsoever in order to establish compliance and to accept or reject as he deems necessary. Samples shall be taken from completed work to determine compliance.

5 The Contractor shall provide suitable facilities at the quarry or plants to carry out all necessary tests on the raw materials and mixes.

6 The Contractor shall arrange for obtaining specimens of materials and samples taken from stockpiles, including the provision of any necessary equipment and plant. This work shall be performed in the presence of the Engineer if so directed by him.

7 Materials that are not in compliance shall be rejected and removed immediately from the site of the works unless otherwise instructed by the Engineer.

8 Where defects in the materials or the completed work have been corrected, the Contractor shall not proceed with subsequent work until approval has been given by the Engineer.

9.2.4 Applications

1 A maximum of 100% of recycled aggregate obtained from excavated material can be used in unbound layers and asphalt layers following the specifications provided in Parts 3, 4 and 5.

2 Deviations from permissible uses stated in Table 9.1 are subjected to the Engineer evaluation and approval.

3 Carefully selected recycled aggregate can be used in the applications shown below:

Table 9.1
Permissible use of recycled materials

No.	Material Classification	Permissible Use	
1	Aggregate Base layers	100% max.	Walk ways, cycle ways and light vehicle parking areas
2	General Fill	50% max.	
3	Select Fill	30% max.	
4	Subgrade Materials	100% max.	Roads with traffic levels up to 3 million ESALs
			Roads made to serve as temporary roads for less than 20 years
		50% max.	Roads with traffic levels of 3-30 million ESALs
5	Subbase Materials	50% max.	Roads with traffic levels up to 3 million ESALs
			Roads made to serve as temporary roads for less than 20 years
		30% max.	Roads with traffic levels of 3-30 million ESALs
6	Road Base Materials	30% max.	Roads with traffic levels up to 3 million ESALs
			Roads made to serve as temporary roads for less than 20 years
		20% max.	Roads with traffic levels of 3-30 million ESALs
7	Aggregate for ducts bedding	100% max.	
8	Aggregate for pipe bedding	100% max.	
9	Sand for cable bedding	100% max.	
10	Aggregate for concrete	Section 5 Part 2	
11	Asphalt base courses	15% RAP max.	• Roads with traffic levels up to 3 million ESALs • Roads made to serve as temporary roads for less than 20 years
		.	

4 Estimation of Foreign Materials percentage shall be carried out as follows:

a) The collected sample shall be reduced following ASTM C702 to minimum 3kg and dried at 50 – 60 °C to constant mass and left to cool down to ambient temperature.

b) Dry sample shall be split into two sizes, materials which are retained on the 4.75mm sieve, if any, and materials, which are passing the 4.75mm sieve and retained on the 2.36mm sieve, if any. Materials shall be sieved manually for not less than 2min following ASTM C136 procedure.

c) Each sample shall be sorted by hand and classified in accordance with Table 9.3. The amount of Foreign Materials shall be calculated for each size as percentage of the original total dry mass. The percentage of Foreign Materials for each class is the sum of percentages of these materials for all sizes of same class reported to the nearest 0.1%.

Table 9.3
Foreign Materials Classification

Class No.	Description	Materials
I	High density solid materials	Metal, glass, asphalt, stone, ceramics
II	Low density crushable materials	Plaster, clay lumps and other friable materials
III	Compressible materials	Rubber, plastics, bitumen, paper, cloth, paint, wood and vegetable matter

9.2.5 Subgrade, Select Fill and General Fill Layers

1 Recycled materials used in subgrade, select and general fill layers shall be within the specification limits of following table:

Table 9.2
Specifications of Recycled Aggregate for use in Earth Works Related to Roads[1]

Parameter	Standard	Specification Limits		Minimum Frequency
		Select Fill & Subgrade	General Fill	
Percent passing the 75mm sieve	ASTM C136	100%	100%	- Each Source - Visible change in material - 1 per 1000 m^3
Percent passing the 0.075mm sieve	ASTM C117	30% max.	35% max.	
Liquid limit	ASTM D4318 Method A	30% max.	40% max.	
Plasticity Index	ASTM D4318	10 % max.	12% max.	
California Bearing Ratio (CBR)	ASTM D1883 (Soaked)	15% min. at 95% MDD	15% min. at 95% MDD	
Swelling		2% max.	3% max.	
Field Density	ASTM D6938 ASTM D1556	Min. 95% of MDD	Min. 95% of MDD	- 1 per 200 m^2 per layer - 1 every 75m per lane per layer
In Place Moisture Content[2]	ASTM D6938 ASTM D4944	± 2% of OMC	± 2% of OMC	

Parameter	Standard	Specification Limits		Minimum Frequency
		Select Fill & Subgrade	General Fill	
In Place California Bearing Ratio (CBR)	ASTM D4429	15% min.	15% min.	1 per 2000 m^2
Acid soluble Chloride Content	BS 1377 Part 3	2% max.	-	1 per 2000 m^3
Acid soluble sulphate content	BS 1377 Part 3	3% max.	-	
Organic Matter	BS 1377 Part 3	2% max.	2% max.	
High density materials[3]	See Paragraph 2	20%	30%	1 per 1000 m^3
Low density/crushable materials[4]	See Paragraph 2	1%	2%	
Compressible materials[5]	See Paragraph 2	0.2%	0.3%	

[1]Loose materials for testing and acceptance shall be sampled from the un-compacted in- place layer.
[2]During compaction.
[3]Such as mortar, metal, glass, asphalt, ceramics
[4]Such as plastic, brick, plaster, clay lumps and other friable materials
[5]Such as rubber and wood

9.2.6 Subbase and Road Base Layers

1 Loose materials for testing and acceptance shall be sampled from the un-compacted in-place layer.

2 The required properties of fine aggregate for Road Base and Subbase layers are listed in Table 9.4.

Table 9.4
Specifications of fine aggregates for Road Base and Subbase layers

Parameter	Standard	Specification Limits		Minimum Frequency
		Road Base	Subbase	
Liquid Limit	ASTM D4318	25%max.	25% max.	- Each source - Visible change in material - 1 test every 1000m^3
Plasticity Index	ASTM D4318	6 % max.	6 % max.	
Sand equivalent	ASTM D2419	35 min.	25 min.	
Organic content	BS 1377 Part 3	1.0% max.	1.0% max.	

3 The required properties of coarse aggregate for Road Base and Subbase layers are listed in Table 9.5.

Table 9.5
Specifications of coarse aggregates for Road Base and Subbase layers

Parameter	Standard	Specification Limits		Minimum Frequency
		Road Base	Subbase	
Fractured Faces	ASTM D5821	50% min.	50% min.	- Each source - Visible change in material - 1 test every 2000m^3
Flat and Elongated Particles (5:1)	ASTM D4791	10% max.	15% max.	
Loss by Abrasion	ASTM C131 ASTM C535	30% max.	40% max.	
Soundness (5 cycles by $MgSO_4$)	ASTM C88	15% max.	20% max.	

4 The required properties of combined aggregate for Road Base and Subbase layers are listed in Table 9.6.

5 Unit weight and moisture content of materials containing more than 5% by mass of oversize fraction tested in accordance with ASTM D1557 should be corrected following ASTM D4718.

Table 9.6
Specifications of combined aggregates for Road Base and Subbase layers[1]

Parameter	Standard	Specification Limits		Minimum Frequency
		Road Base	Subbase	
Maximum Dry Density	ASTM D1557	2.15 Mg/m^3 min.	2.05 Mg/m^3 min.	- Each source. - Visible change in material - 1 test per 1000m^3
Gradation	ASTM C136	Table 4.4	Table 4.4	
California Bearing Ratio (CBR)	ASTM D1883 (Soaked)	80% min.	70% min.	
Swelling		0.5% max.	1.0% max.	
Field Density	ASTM D6938 ASTM D1556	100% of MDD	100% of MDD	- 1 per 200 m^2 per layer - 1 every 75m per lane per layer
In Place Moisture Content[2]	ASTM D6938 ASTM D4944	± 1.5% of OMC	± 2% of OMC	
In Place California Bearing Ratio (CBR)	ASTM D4429	80% min.	70% min.	1 per 2000 m^2
Acid soluble Chloride Content	BS 1377 Part 3	2% max.	2% max.	1 per 3000 m^3
Acid soluble sulphate content	BS 1377 Part 3	3% max.	3% max.	
High density materials[3]	Section 9.2.5	10%	15%	1 per 1000 m^3

Parameter	Standard	Specification Limits		Minimum Frequency
		Road Base	Subbase	
Low density/crushable materials[4]	Section 9.2.5	1%	2%	
Compressible materials[5]	Section 9.2.5	0.2%	0.3%	

[1]*Loose materials for testing and acceptance shall be sampled from the un-compacted in- place layer.*
[2]*During compaction.*
[3]*Such as mortar, metal, glass, asphalt, ceramics*
[4]*Such as plastic, brick, plaster, clay lumps and other friable materials*
[5]*Such as rubber and wood*

6 Gradation requirements of combined aggregate for Road Base and Subbase layers are listed in Table 9.7.

Table 9.7

Gradation limits for Road Base and Subbase layers

Sieve Size	Road Base	Subbase
50.0 mm	100	100
37.5 mm	95 – 100	90 – 100
19.0 mm	70 – 92	70 – 90
9.5 mm	50 – 70	45 - 75
4.75 mm	35 – 55	30 – 60
0.600 mm	12 – 25	10 – 30
0.075 mm	0 – 8	0 – 12

9.3 REUSE OF RECLAIMED ASPHALT

9.3.1 Field Recovery of RAP

1 The main properties of RAP are the age of binder, grading and properties of aggregate. RAP needs to be consistent and of known properties to optimise its level of use efficiently. Thus, processing the RAP to create a consistent raw material feed is a critical component of the total process and essential to the mix design.

2 The use of RAP shall be systematic and properly controlled starting by the milling process passing by adequate transportation, sieving and stockpiling. The asphalt mixture designs shall be optimised by using certain percentage of RAP which at the same time provides equivalent or better level of performance as the one obtained when asphalt mixtures are produced using virgin aggregates.

3 Milling is the best method of recovering RAP from existing asphalt pavement surfaces. RAP must not be contaminated with underneath layers (e.g. subbase or subgrade). Also, when milling a certain asphalt layer, a thin cushion of existing layer shall remain un-milled to prevent any potential contamination.

4 Milled materials shall be kept clean and segregated in separate stockpiles before further processing.

9.3.2 Processing of RAP

1 Processing must be carried out to recover original aggregate grading of recovered material while aggregates remain coated with bitumen; this is referred to as granulation. Crushing of RAP causes fractured faces and result in a lower acceptable RAP percentage in the final mix.

2 Generally, the best recyclable fractions are in the finer range. RAP is first screened to fine fractions since more bitumen is present in fine aggregates. Oversize, slabs and dig out materials are passed through a granulation process to form smaller particles without crushing to avoid generation of excessive fines. Granulated materials can be screened to the correct sizes.

3 RAP fractions shall be assessed by determining materials properties for both binder and aggregate. This is to obtain successful asphalt mixtures with optimum RAP content. Mix design optimization is essential and mixes with RAP shall be engineered for favourable outcomes.

9.3.3 Testing of Reclaimed Aggregate

1 Summary of tests for reclaimed aggregate are provided in Table 9.8:

Table 9.8
Aggregate Testing

Parameter	Standard	Minimum Frequency
Gradation	ASTM D5444 ASTM C136 ASTM C117	- Each source. - Visible change in material - 1 test per 500m^3
Specific Gravity and absorption	ASTM C127 ASTM C128	
Resistance to degradation by Micro-Deval apparatus	ASTM D6928	
Flat and Elongated Particles (5:1)	ASTM D4791	
Uncompacted Void Content of Fine Aggregate	ASTM C1252	

9.3.4 Testing of Binder

1 Binder shall be extracted from RAP using ASTM D2172 - Method A and rotary evaporator using toluene as a solvent. Binders shall be analyzed following AASHTO T315 and AASHTO T350 and graded to AASHTO M332 specifications. Summary of binder tests are provided in Table 9.9.

Table 9.9
Binders Testing

Parameter	Standard	Minimum Frequency
Binder extraction	ASTM D2172 Method A ASTM D5404	- Each source. - Visible change in

Parameter	Standard	Minimum Frequency
Rheology of base binder	AASHTO T315	material - 1 test per 500m^3 RAP
Rheology of RAP binder (MSCR)	AASHTO T350	
Rheology of RAP Binder (BBR)	AASHTO T313	
Rheology of RAP Binder (LAS)	AASHTO TP101	
Automated Heithaus Titrimetry	ASTM D6703	

2 Adjustment of blended grading with virgin binder shall be made with an approved rejuvenation agent to create a combined binder of no more than one PG grade higher than the required virgin grade. Take traffic, shear and actual temperature maximum into account.

3 RAP binder shall be extracted from the RAP where toluene is used for the chlorinated solvent for a complete extraction by rotary evaporator. After extraction, the recovered binder is tested for rheology and composition and compared to the database.

9.3.5 Design Guidelines

1 The following guidelines can be used based on amount of RAP included in the mix:

(a) 0-10% RAP

Use MS-2 Marshall design criteria. Rejuvenation and performance tests are not required.

(b) 10-15% RAP

Use MS-2 Marshall design criteria. Gyratory compactor shall be used instead of Marshall compactor.

(c) 15-30% RAP

Use MS-2 Marshall design criteria. Gyratory compactor shall be used instead of Marshall compactor.

2 Asphalt mix design guidelines shown in Table 9.10 are recommended for asphalt mixes include RAP.

Table 9.10
Mix Design Guidelines

Traffic Level (ESALs)	Mix Design Criteria
< 3 X 10^6	Marshall volumetric mix design
3 X 10^6 – 10 X 10^6	Marshall volumetric mix design + performance testing includes Resilient Modulus of Bituminous Mixtures by Indirect Tension (ASTM D7369), Effect of Moisture on Asphalt (ASTM D4867) and Refusal Density using Gyratory Compactor (ASTM 6925) at 250 cycles
10 X 10^6 -30 X 10^6	Marshall volumetric mix design + performance testing includes Resilient Modulus of Bituminous Mixtures by Indirect Tension (ASTM D7369), Effect of Moisture on Asphalt (ASTM D4867), Refusal Density using Gyratory Compactor (ASTM 6925) at 250 cycles and Wheel tracking (BS EN 12697-22)
>30 X 10^6	Marshall volumetric mix design + performance testing includes: Resilient Modulus of Bituminous Mixtures by Indirect Tension (ASTM D7369), Effect of Moisture on Asphalt (ASTM D4867), Refusal Density using Gyratory Compactor (ASTM 6925) at 250 cycles, Wheel tracking (BS EN 12697-22) and Fatigue Life of Asphalt (AASHTO T321)

9.3.6 Manufacturing of RAP Mixes

1 RAP shall not be heated with virgin aggregate. Addition of a preheater for RAP can assist in optimization of mix temperature. Rejuvenation agent can be sprayed onto the RAP feed or dosed with bitumen.

2 For batch plants and continuous plants, a cold fed system is essential with separate RAP bins. In batch plants, a conveyor system into the pugmill may be used. This limits RAP to about 25%.

9.4 USE OF BINDERS MODIFIED BY CRUMB RUBBER

1 Crumb Rubber is acceptable for use in roads with traffic levels up to 3 million ESALs. Performance grade crumb rubber (PG-CR) binders must provide improved rheological properties across the in-service temperature range when compared to conventional binders, in addition to the environmental benefits. PG-CR binders meet the provisions outlined in this section and are able to be graded to the appropriate PG Grade.

2 Asphalt binders modified using Crumb Rubber are referred to as Performance Grade Crumb Rubber (PG-CR) binders and shall be produced by blending the crumb rubber modifier before introducing to the mix.

3 Suppliers of PG-CR binders are required to be prequalified and comply with the quality requirements of QCS Section 2, following the frequency of testing, for modified binders, shown in Section 6 Part 5.

4 Crumb rubber must be produced from recycled car and truck tyres, which are processed to maximum 30 mesh size (600 microns). The modified PG-CR binder shall not include fibers or other discrete particles other than rubber with longest dimensions of more than 250µm when tested according to ASTM D5546 or AASHTO T44.

5 The residue from the solubility test shall be examined using ignition oven or furnace at 400°C for 1 hour to confirm that no mineral/metal particles exist by measuring the residue. The maximum measurable weight of the ignition oven or furnace residue shall not exceed 1% of the original modified binder weight from the solubility test.

6 The physical properties (i.e. gradation, metal contaminants, fiber contaminants, moisture content, and method of production) of the crumb rubber modifier must be reported. Percentages of crumb rubber by weight of PG-CR binder are encouraged to be minimum 10% but not more than 25%.

7 Crumb rubber shall contain less than 0.75% moisture by weight and shall be free flowing. The specific gravity of rubber shall be 1.15 ± 0.05. Crumb rubber shall not contain visible nonferrous metal particles and not more than 0.01% ferrous metal particles by weight. Fiber content shall not exceed 0.1% by weight of Crumb rubber. Other foreign contaminating materials such as glass, sand, wood, etc. shall be less than 0.25% by weight.

8 Moisture content shall be determined in accordance with ASTM D1864, except that the oven temperature shall be 105 ± 5C. Metal particles shall be detected and separated out by thoroughly stirring a magnet through a 50g sample and weighing the captured particles. Nonferrous metal content can be detected by visual inspection.

9 Sieve analysis shall be carried out according to ASTM D5644 and method of determining fiber content shall be specified by supplier and subject to user and Engineer approval.

10 AASHTO T 315 and AASHTO T 350 shall be performed at a 2mm gap height. Cup and Bob measurement of G* and phase angle are acceptable alternative methodologies.

11 For binders with viscosity values exceeding the specification limit, footnote (*c*) in Table 1 of AASHTO M332 shall be followed. In addition, the supplier needs to be consulted for any special handling procedures, including pumping capabilities.

12 The PG-CR binder must be stored in continuously agitated tanks at the modification terminal and the asphalt plant. The binder shall also be stored and used in accordance with storage and handling guidelines provided by the supplier.

13 PG-CR binders shall be graded in accordance with AASHTO M332. However, solubility requirements stated in Clause 5.4 shall be waived and J_{nrDiff} requirements shall be reported.

14 The supplier shall declare in the binder certificate that crumb rubber is used and not inorganic filler. The supplier must provide a certificate confirming conformance of the PG-CR binder with the specifications stated above and is required to submit quality management plan for the approval of the Engineer.

END OF PART