# BRISBANE CITY COUNCIL

# REFERENCE SPECIFICATIONS FOR ENGINEERING WORK

# S310 SUPPLY OF DENSE GRADED ASPHALT

## AMENDMENT REGISTER

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| --- | --- | --- | --- |
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| 1.0 |  | Original issue | Oct 2001 |
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| 2.4 | Fatigue and rutting characteristics requirements updated. |
| 3.4 | Requirements for multigrade binder updated – Table 3.2 removed |
| 4.2 | Testing requirements for aggregate grading updated |
| 4.3 | Testing requirements for binder updated |
| 4.4 | First paragraph modified – test requirements removed |
| 4.0 | 1.1 | Use of Warm Mix Asphalt permitted for all projects | June 2018 |
| 1.3 | Deleted DTMR Test Methods removed |
| 2.2 | Reference to Austroads Test Methods added |
| 3.1 | Table 3.1 - Deleted DTMR Test Methods removed and guide notes added |
| 3.3 | Recycled fines from asphalt plant dust extraction filters included as part of the filler |
| 3.5 | Section reviewed |
| 3.6 | New Section – Granulated Glass Aggregate |
| 3.7 | New Section – Warm Mix Asphalt Additive |
| 4.1 | Table 4.1 – Nominal aggregate size for mix type 3 changed. Alternative DTMR mix changed to new DTMR classifications. |
| 4.2 | Table 4.2 – New grading requirements for mix type 3 |
| 4.3 | Table 4.3 – Requirement for mix Type 2 must have Class 170 binder if more than 15% RAP is included in the asphalt |
| 4.4 | Clarify that design mix with tolerances to meet Tables 4.2 & 4.3  Table 4.4 – add properties for mix Type 2 with M1000 bitumen.  Table 4.5 – permitted variation increased to reflect industry standards |
| 5.0 | Requirements for warm mix asphalt added |
| 5.0 | General | Document name changed from ‘Reference Specifications for Civil Engineering Work’ to ‘Reference Specifications for Engineering Work’ | Mar 2021 |
| 2.2 | Reference updated |

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## GENERAL

### Section Content

Manufacture of dense graded hot mix asphaltic concrete for road and related applications. Dense graded asphalt is a processed mixture of bituminous binder and mineral aggregate, with or without an added mineral filler.

Warm mix asphalt may be used on any project subject to meeting the properties specified for the asphalt mix that does not include warm mix asphalt additive.

### Standards

|  |  |  |
| --- | --- | --- |
| Australian Standard | AS 1141.15 | Methods for sampling and testing aggregates – Flakiness index |
| Australian/New Zealand Standard | AS/NZS 1141.17 | Methods for sampling and testing aggregates – Voids in dry compacted filler |
| Australian Standard | AS 1141.18 | Methods for sampling and testing aggregates – Crushed particles in coarse aggregate derived from gravel |
| Australian Standard | AS 1141.22 | Methods for sampling and testing aggregates – Wet/dry strength variation |
| Australian Standard | AS 1141.32 | Methods for sampling and testing aggregates – Weak particles (including clay lumps, soft and friable particles) in coarse aggregates |
| Australian Standard | AS 1141.42 | Methods for sampling and testing aggregates – Pendulum friction test |
| Australian Standard | AS 1141.5 | Methods for sampling and testing aggregates – Particle density and water absorption of fine aggregate |
| Australian Standard | AS 1141.66 | Methods for sampling and testing aggregates-Methylene blue adsorption value of fine aggregate and mineral fillers |
| Australian Standard | AS 1672.1 | Limes and limestones – Limes for building |
| Australian Standard | AS 2008 | Bitumen for pavements |
| Australian Standard | AS 2150 | Hot mix asphalt – A guide to good practice |
| Australian/New Zealand Standard | AS/NZS 2341.2 | Methods of testing bitumen and related roadmaking products – Determination of dynamic viscosity by vacuum capillary viscometer |
| Australian/New Zealand Standard | AS/NZS2341.10 | Methods of testing bitumen and related roadmaking products – Determination of the effect of heat and air on a moving film of bitumen (rolling thin film oven (RTFO) test) |
| Australian Standard | AS 2341.14 | Methods of testing bitumen and related roadmaking products – Determination of flashpoint of bitumen |
| Australian/New Zealand Standard | AS/NZS2341.20 | Methods of testing bitumen and related roadmarking products – Determination of sieve residue for bituminous materials |
| Australian Standard | AS 2341.7 | Methods of testing bitumen and related roadmaking products – Determination of density using a density bottle |
| Australian/New Zealand Standard | AS/NZS 2341.8 | Methods of testing bitumen and related roadmaking products – Determination of matter insoluble in toluene |
| Australian Standard | AS 2891.13.1 | Methods of sampling and testing asphalt – Determination of the resilient modulus of asphalt – Indirect tensile method |
| Australian/New Zealand Standard | AS/NZS2891.3.1 | Methods of sampling and testing asphalt - Binder content and aggregate grading – Reflux method |
| Australian Standard | AS 2891.5 | Methods of sampling and testing asphalt – Compaction of asphalt by Marshall method and determination of stability and flow – Marshall procedure |
| Australian/New Zealand Standard | AS/NZS2891.7.1 | Methods of sampling and testing asphalt – Determination of maximum density of asphalt – Water displacement method |
| Australian/New Zealand Standard | AS/NZS2891.8 | Methods of sampling and testing asphalt – Voids and volumetric properties of compacted asphalt mixes |
| Australian/New Zealand Standard | AS/NZS2891.9.1 | Methods of sampling and testing asphalt – Determination of bulk density of compacted asphalt – Waxing procedure |
| Australian/New Zealand Standard | AS/NZS2891.9.2 | Methods of sampling and testing asphalt – Determination of bulk density of compacted asphalt – Presaturation method |
| Australian/New Zealand Standard | AS/NZS3582.1 | Supplementary cementitious materials – Fly ash |
| Australian Standard | AS 3582.2 | Supplementary cementitious materials for use with portland and blended cement – Slag – Ground granulated iron blast-furnace |
| Australian Standard | AS 3972 | General purpose and blended cements |
| Australian/New Zealand Standard, International Standards Organization | AS/NZS ISO 9001 | Quality management systems – Requirements |

### References

|  |  |  |  |
| --- | --- | --- | --- |
| Austroads | Pavement Test Method | AGPT/T103 | Pre-treatment and loss on heating of bitumen multigrade and polymer binders (rolling thin film oven [RTFO] test) |
| Austroads | Pavement Test Method | AGPT/T231: | Deformation resistance of asphalt mixtures by the wheel tracking test |
| Austroads | Pavement Test Method | AGPT/T234 | Asphalt binder content (ignition oven method) |
| Austroads | Pavement Test Method | AGPT/T274 | Characterisation of Flexural Stiffness and Fatigue Performance of Bituminous Mixes |
| Queensland Department of Transport and Main Roads | Test Method | Q129 | Clay index of soils, crushed rock and filler |
| Queensland Department of Transport and Main Roads | Test Method | Q201 | Flakiness index of aggregate |
| Queensland Department of Transport and Main Roads | Test Method | Q203 | Polished aggregate friction value |
| Queensland Department of Transport and Main Roads | Test Method | Q214B | Particle density and water absorption of aggregate – coarse fraction |
| Queensland Department of Transport and Main Roads | Test Method | Q305 | Stability, flow and stiffness of asphalt – Marshall |
| Queensland Department of Transport and Main Roads | Test Method | Q308A | Binder content and aggregate grading of asphalt – Reflux method |
| Queensland Department of Transport and Main Roads | Test Method | Q308D | Binder content and aggregate grading of asphalt – Ignition oven |
| Queensland Department of Transport and Main Roads | Test Method | Q311 | Voids properties for compacted asphalt |
| Australian Asphalt Pavement Association | Guide Document |  | Reclaimed Asphalt Pavement (RAP) Management Plan |

Refer to the following other Reference Specifications for Engineering Work:

|  |  |
| --- | --- |
| S110 | General Requirements |
| S120 | Quality: Quality control testing |
| S150 | Roadworks |
| S320 | Laying of asphalt |

## QUALITY

### Quality System

The asphalt supplier must maintain a Quality Assurance System with third party accreditation to *AS/NZS ISO 9002*. The supplier must notify the Contractor or Superintendent within two days of becoming aware that process control tests relevant to the material supplied have fallen outside the specified limits.

### Tests

General

Methods: Use the specified Australian Standard, Austroads or Queensland Department of Transport and Main Roads test methods.

Testing authority: Use a testing facility registered by NATA for the test required.

Process control tests

Perform tests of the type and frequency necessary to adequately control the materials, and the combination of these materials in the final product. The minimum sampling and testing requirements for the asphalt production are specified in *Reference Specification* *S120 Quality – Clause 7.1*. *Refer annexure*.

Compliance assessment tests

Comply with conformance criteria specified in *Reference Specification* *S120 Quality – Clause 7.1*. The Contractor or Superintendent may carry out compliance assessment testing using a testing laboratory registered with NATA for the particular test.

### Samples

General

On request, submit samples of each proposed constituent material. *Refer annexure*.

* Each coarse and fine aggregate component: 50 kg.
* Reclaimed asphalt pavement (if used): 50 kg.
* Granulated glass aggregate (if used): 5 kg.
* Added filler: 5 kg.
* Binder: 8 litres.
* Additives: As appropriate.

Identification

Attach a tag to each sample showing relevant information including description, source, nominal size of material, date sampled, and by whom.

### Supplier's Submissions

Test program

On request, submit details of the supplier's inspection and test program covering all specified properties of the constituent materials. On request, submit details of recent test results demonstrating sustained compliance of the constituent materials with the required properties. *Refer annexure*.

Material details

Submit the following details for the proposed design mix (job mix) and the tolerance mixes before commencing production:

* Method of production (batch or continuous).
* Source quarry for the aggregates and geology of the rock.
* Combined aggregate particle size distribution.
* Binder content expressed as a percentage by mass of the total mix.
* The added filler content expressed as a percentage by mass of the combined aggregates (if applicable).
* The asphalt mix properties.
* The proposed mixing temperature.
* Resilient modulus value determined in accordance with *AS 2891.13.1* (if directed).
* Fatigue and rutting characteristics determined in accordance with *AGPT/T231* and *AGPT/T274* (if directed).
* Maximum RAP content expressed as a percentage by mass of the total mix (if applicable).
* Maximum granulated recycled glass aggregate content expressed as a percentage by mass of the total mix (if applicable). The type, source and manufacturer’s recommendations for granulated glass aggregate.
* The type and quantity of warm mix asphalt additive (if applicable).

## ASPHALT MATERIALS

### Coarse Aggregate

Material type: Crushed rock or crushed gravel particles that are retained on the 4.75 mm sieve. *Refer annexure*.

Material properties: Comply with Table 3.1. *Refer annexure*.

Table 3.1 – Coarse aggregate properties

| Property | Mix Types 3 and 4 | Mix Types 1 and 2 | Test procedure |
| --- | --- | --- | --- |
| Flakiness index | 30% maximum | 30% maximum | *AS 1141.15* or *DTMR Q201* |
| Weak particles | 1% maximum | 1% maximum | *AS 1141.32* |
| Water absorption | 2% maximum*(1)* | 2% maximum*(1)* | *AS 1141.5* or *DTMR Q214B* |
| Polished aggregate friction value (wearing course only) | 45% minimum | 40% minimum | *AS 1141.42* or *DTMR Q203* |
| Ten percent fines value (wet) | 150 kN minimum | 150 kN minimum | *AS 1141.22* |
| Wet/dry strength variation | 35% maximum*(2)* | 35% maximum*(2)* | *AS 1141.22* |
| Crushed faces | 80% minimum*(3)* | 80% minimum*(3)* | *AS 1141.18* |

1. For aggregate with water absorption between 2% and 2.5%, project specific approval may be granted, provided that a history of satisfactory performance has been demonstrated and suitable adjustments to the mix properties have been made.
2. For Greenstone aggregate only, the stated maximum wet/dry strength variation does not apply provided that the wet ten percent fines value is at least 210 kN.
3. Testing only required when aggregate is not obtained from a blasted face in a quarry.

### Fine Aggregate

Material type: Natural sand and/or crushed rock or crushed gravel particles passing the 4.75 mm sieve. *Refer annexure*.

Material properties: The fine aggregate must be clean, hard, durable and free from clay (plasticity index of not more than 3%) and aggregations of fine materials, soil, organic matter and any other deleterious material. The quantity of expansive clay minerals in the natural fines should be tested according to *DTMR Q129*, or alternatively *AS 1141.66*. The clay index value shall not exceed 2.2.  *Refer annexure*.

### Filler

Material type: Combinations of natural sand, crushed rock, crushed gravel particles, any added recycled fines from asphalt plant dust extraction filters and added filler, with particle size smaller than 0.075 mm.  *Refer annexure*.

Material properties: The filler mix must comply with the requirements of *AS 2150* as appropriate. Filler must be free from lumps, clay, organic matter and any other deleterious material. The combined filler, tested according to *AS 1141.17* must exhibit voids in the dry compacted filler of not less than 38%; the material passing the 0.075mm sieve should be used for this test. The quantity of expansive clay minerals in the natural fines should be tested monthly according to *DTMR Q129*, or alternatively *AS 1141.66*. The clay index value shall not exceed 2.2.  *Refer annexure*.

Added filler: Material not derived from the aggregate components. The use of added filler should be carefully considered in the mix design by assessing the stiffening effect of the different filler types.  *Refer annexure*.

* Hydrated lime to *AS 1672.1*. Moisture content 3% maximum.
* Fine grade fly ash to *AS 3582.1*. Moisture content 3% maximum, loss on ignition 4% maximum.
* Cement kiln dust comprising solid material extracted from flue gases in the manufacture of Portland cement. Moisture content 3% maximum, water soluble fraction maximum 20% by mass.
* Slag to *AS 3582.2*. Moisture content 3% maximum.
* Ground limestone consisting of rock dust derived from the grinding of sound limestone. Moisture content 3% maximum.
* Cement to *AS 3972*. Moisture content 3% maximum.

### Binder

Types: Class 170 residual bitumen or Class 320 residual bitumen or Class M1000 multigrade, as nominated in Table 4.3. *Refer annexure*.

Residual bitumen: Conform to the requirements of *AS 2008*.

Multigrade binder: Conform to the requirements of *AS 2008 Table 3.2*. Viscosity at 60°C (*AS/NZS 2341.2* or other agreed method) after RTFOT test (*AS/NZS 2341.10*) shall be between 3,500Pas and 6,500Pas.

Minimum testing frequencies should be determined as follows:

* annually: flash point, loss on heating
* each batch: penetration at 25°C
* 3-monthly: all other properties according to *Table 2.2 of AS 2008*.

### Reclaimed Asphalt Pavement (RAP)

General: Obtain RAP from milling and excavation of existing asphalt layers. RAP must be processsed before incorporation in the asphalt mix. It must be a well graded, free flowing, consistent product with maximum particle size appropriate to the required asphalt grading. Australian Asphalt Pavement Association’s *Reclaimed Asphalt Pavement (RAP) Management Plan* provides guidance on processing RAP.

Requirement: Reclaimed asphalt pavement (RAP) may be used as part of the materials for the asphalt manufacture, subject to meeting all the requirements of this clause. Do not incorporate RAP in asphalt mix unless the Superintendent gives approval in writing. A maximum of 20% (by weight) RAP may be used. The properties of the combined mix must conform to those specified for the asphalt mix that does not have RAP. *Refer annexure*.

Foreign material: RAP must be free from contamination by foreign materials such as uncoated base course stone, broken concrete, crumbed rubber or clay binder.

### Granulated Glass Aggregate

Requirement: Granulated glass aggregate means recycled glass cullet that has been processed and crushed to produce a ‘sand-like’ cubical glass material with a particle size diameter generally passing the 4.75 mm AS sieve, and that contains at least 98% recovered glass.

Glass cullet shall be primarily container glass and shall not include glass from ceramics, cathode ray tubes, fluorescent light fittings and laboratory glassware. It shall be cubical in shape, not sharp edged or elongated.

Foreign material: Granulated glass aggregate shall be generally free of contaminants such as paper, corks, metals, and other harmful materials (maximum limit of 2% by mass). It must be free of any putrid odour.

Limitation: Asphalt mix Types 1, 2 and 3 may contain a proportion of granulated glass aggregate not exceeding 2.5% of the total mix. Asphalt mix Type 4 may contain a proportion of granulated glass aggregate not exceeding 5% of the total mix.

### Warm Mix Asphalt Additive

General: Warm mix asphalt additive may be added to asphalt to reduce the asphalt manufacturing temperature and/or to improve workability during the paving and compaction operations.

Requirement: Provide details of the maximum proportion of additive in warm mix asphalt and how it is to be incorporated into the asphalt.

Where a warm mix asphalt additive is included and a lower temperature is used for the compaction of laboratory specimens than that specified in Q305, provide evidence to demonstrate the suitability of the temperature adopted.

## ASPHALT MIX DESIGN

### General

Mix design applications: In accordance with *Reference Specification S150 Roadworks Clause 4.0* for Brisbane City Council (BCC) mixes.

Mix substitution: Do not substitute Brisbane City Council mixes with the alternative Queensland Department of Transport and Main Roads (DTMR) dense graded asphalt mixes listed in Table 4.1, unless prior approval is obtained from Brisbane City Council. The same binder type as the BCC mixes are to used in substitute mixes.

Alternative DTMR asphalt mix: Where approval is granted by Brisbane City Council to substitute mix, comply with the requirements of the Queensland Department of Transport and Main Roads standard specification *MRTS30* *Dense Graded and Open Graded Asphalt* for limits of layer thickness, type and proportions of constituent materials, and mix properties. Do not use polymer modified binder in the alternative asphalt mix without written approval from the Superintendent.

Table 4.1 - Alternative asphalt mixes

| Brisbane City Council mix | | Alternative DTMR mix |
| --- | --- | --- |
| Classification | Nominal aggregate size*(1)* |
| Type 1 | 5 mm | AC7M |
| Type 2 | 10 mm | AC10M |
| Type 3 | 14 mm | AC14M |
| Type 4 | 35 mm | AC20M |

*(1)* Designation for a mix chosen to give an indication of the largest particle present; TMR mixes are defined differently.

### Grading

Test method: Testing for grading should be determined using solvent extraction (*AS 2891.3.1*) or ignition oven (*Austroads AGPT/T234*). *Refer annexure*. Test in accordance with *AS 2891.3.1* or *DTMR Q308A* and *DTMR Q308D*.

Requirement: Grading of the combined mineral aggregates and added filler must comply with limits specified in Table 4.2. The grading curve must be smooth and must not vary from the outer one-third of the range between the specified limits to the opposite one-third of the range between the specified limits for an adjacent sieve size.  *Refer annexure*.

Filler: Add filler as required to the combined mineral aggregates during the manufacture of the mix according to Section 3.3.

Table 4.2 – Grading limits for combined aggregate and filler

| AS. sieve size (mm) | % passing by weight | | | |
| --- | --- | --- | --- | --- |
| Mix Type 1 | Mix Type 2 | Mix Type 3 | Mix Type 4 |
| 37.5 |  |  |  | 100 |
| 26.5 |  |  |  | 80 - 100 |
| 19.0 |  |  | 100 | 60 - 90 |
| 13.2 |  | 100 | 80 - 100 |  |
| 9.5 | 100 | 90 - 100 | 65 - 90 | 40 - 71 |
| 4.75 | 70 - 100 | 60 - 80 | 40 - 65 | 30 - 56 |
| 2.36 | 55 - 75 | 38 - 55 | 25 - 45 | 22 - 42 |
| 0.600 | 26 - 50 | 22 - 32 | 10 - 30 | 9 - 23 |
| 0.300 | 15 - 32 | 15 - 23 | 6 - 20 | 6 - 17 |
| 0.150 | 8 - 20 | 7 - 14 | 4 - 14 | 4 - 12 |
| 0.075 | 4 - 12 | 3 - 8 | 2 - 8 | 2 - 8 |

### Binder Content

Test method: Testing for binder content should be determined using solvent extraction (*AS/NZS 2891.3.1*) or ignition oven (*Austroads AGPT/T234*). *Refer annexure*.

Requirement: Comply with the design requirements of Table 4.3.  *Refer annexure*.

Table 4.3 – Binder content of the design mix

| Mix | Binder content | Binder type |
| --- | --- | --- |
| Type 1 | 5.0% - 7.0% by mass | Class 170 or Class 320 |
| Type 2 | 4.5% - 6.5% by mass | Class 170 or Class 320*(1)* or Class M1000 multigrade |
| Type 3 | 4.5% - 6.0% by mass | Class 320 or Class M1000 multigrade |
| Type 4 | 3.0% - 5.0% by mass | Class 320 or Class M1000 multigrade |

*(1)* Restriction: Class 170 Binder shall be used if the mix contains more than 15% RAP.

### Mix Properties

Requirement: The mix design must satisfy the Marshall mechanical properties (using the 50 blow compactive effort) and air void contents specified in Table 4.4 for the design mix and for mixes prepared with the maximum permitted variations in grading and binder content specified in Table 4.5. With the tolerances in Table 4.5 applied to the mix design, the resulting job limits must be within the grading limits of Table 4.2 and bitumen content limits of Table 4.3. *Refer annexure*.

Table 4.4 – Marshall mechanical properties and air void content of the approved mix design

| Property | Mix Types 1 & 2 | Mix Types 3 & 4. Mix Type 2 with M1000 bitumen |
| --- | --- | --- |
| Stability of mix (*AS 2891.5* or *DTMR Q305*) | 4 kN minimum | 7.5 kN minimum |
| Flow of mix (*AS 2891.5* or *DTMR Q305*) | 2 - 4 mm | 2 - 4 mm |
| Air voids in compacted mix (*AS 2891.9.1* or *AS 2891.9.2*, *AS 2891.7.1*, *AS 2891.8* or *DTMR Q311*) | 2% - 5% | 3% - 7% |

Table 4.5 – Maximum permitted variations from the approved mix design during production

| Property | Maximum permitted variation |
| --- | --- |
| A.S. sieve size≥9.5 mm | ±7% by mass |
| A.S. sieve size 4.75 mm | ±7% by mass |
| A.S. sieve size 2.36 mm | ±5% by mass |
| A.S. sieve size 0.600 mm | ±4% by mass |
| A.S. sieve size 0.300 mm | ±4% by mass |
| A.S. sieve size 0.150 mm | ±2.5% by mass |
| A.S. sieve size 0.075 mm | ±1.5% by mass |
| Binder content (%) | ±0.3% by mass |

## ASPHALT MANUFACTURE

General: Undertake mixing in an approved batch or continuous drum type manufacturing plant, in accordance with the requirements of *AS 2150*.

Batch plant: The aggregates and bitumen are weighed separately and mixed together in predetermined batch sizes in a pugmill mixing chamber.

Drum mix plant: The aggregates and bitumen are mixed in the drier drum and combined in a continuous production of one type of mix.

Mixing temperatures: For standard classes of binder, do not heat beyond 170°C. For multigrade binder, store and heat in accordance with the manufacturer's written instructions. For asphalt incorporating warm mix asphalt additive, store, incorporate and heat in accordance with the manufacturer's written instructions.