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Glass beads and particles for pavement-marking materials



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Glass beads and particles for pavement-marking materials

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Preface

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee CH-003, Paints and Related Materials, to supersede AS/NZS 2009:2006, *Glass beads for pavement-marking materials*.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this document as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this document is to specify the material, physical characteristics, retroreflectivity performance and heavy metal requirements for glass beads; and the material, physical characteristics, and heavy metal requirements for glass particles which are intended for use in pavement-marking applications. It applies to glass beads intended to improve the visibility of pavement-marking materials by reflecting the incident light from vehicle headlamps back to the driver under night-time conditions. It applies to glass particles with multiple uses which include, but are not limited to, a substitute material in place of aggregates to aid in slip and skid resistance.

The major changes in this edition are as follows:

- (a) Incorporation of B-HR, C-HR and “other” bead types that have $> 450 \text{ mcd/lux/m}^2$, such as beads used in airport markings, ceramic beads with prisms etc.
- (b) Review of the sampling techniques used.
- (c) Review of all appendices to accommodate current practices.
- (d) Inclusion of beads that are applicable to all types of line-marking and pavement-marking, i.e. standard beads for use in carparks, HR beads for use in line marking etc.

The terms “normative” and “informative” are used in Standards to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance.

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Australian Standard®

Glass beads and particles for pavement-marking materials

1 Scope

This document specifies the material, physical characteristics, retroreflectivity performance and heavy metal requirements for glass beads; and the material, physical characteristics, and heavy metal requirements for glass particles which are intended for use in pavement-marking applications. It applies to glass beads intended to improve the visibility of pavement-marking materials by reflecting the incident light from vehicle headlamps back to the driver under night-time conditions. It applies to glass particles with multiples uses which include, but are not limited to, a substitute material in place of aggregates to aid in a slip and skid resistance.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1141.2, *Methods for sampling and testing aggregates, Method 2: Basic testing equipment*

AS 2700S-2011(G55), *Colour Standards for general purposes, Part G55: Lichen*

AS 4049.3, *Paints and related materials—Pavement marking materials, Part 3: Waterborne paint—For use with surface applied glass beads*

AS ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO 385, *Laboratory glassware — Burettes*

ISO 3310, *Test sieves — Technical requirements and testing*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

beads

glass beads having retroreflective properties, which are intended for incorporation into and onto pavement-marking materials

3.2

competent person

person who has acquired, through education, training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the task required

3.3

heavy metals

metallic chemical element that has a relatively high density, including arsenic, antimony, lead, mercury, cadmium and chromium

3.4

high retroreflectivity

HR

beads which, when tested in accordance with [Appendix L](#), report higher retroreflective performance by comparison with standard grades with a minimum performance of 450 mcd/lux/m²

3.5**lot**

all packages of glass beads or particles manufactured in a single manufacturing facility and labelled with a unique identifier

3.6**particles**

glass particles that have multiples uses which include, but is not limited to, a substitute material in place of aggregates, having anti-slip and anti-skid properties, which are intended for incorporation into and onto pavement-marking materials

3.7**Type A**

glass beads of the size specified in [Table 3](#), for use in pavement-marking applications which may include surface application or incorporation to a pavement-marking material

3.8**Type B****Type B-HR**

glass beads of the size specified in [Table 3](#), intended for use in surface application or incorporation to a pavement-marking material that have standard retroreflectivity (Type B) or high retroreflectivity (Type B-HR)

3.9**Type C****Type C-HR**

glass beads of the size specified in [Table 3](#), intended for use in surface application or incorporation to a pavement-marking material, that have standard retroreflectivity (Type C) or high retroreflectivity (Type C-HR)

3.10**Type D****Type D-HR**

glass beads of the size specified in [Table 3](#), intended for use in surface application or incorporation to a pavement-marking material, that have standard retroreflectivity (Type D) or high retroreflectivity (Type D-HR)

3.11**Type E**

<specialty beads> glass beads intended for incorporation into materials used for pavement-marking purposes, or intended for use with pavement-marking applications which may include surface application or incorporation to a pavement-marking material available in a range of sizes but within the nominal 75 µm to 1700 µm range

Note 1 to entry: Refer to the manufacturer or specification for further information.

4 Materials of manufacture

Beads are water insoluble, transparent and spherical, containing no less than 62 % amorphous silica and are nominally referred to as glass beads. Sources of glass may be recycled or manufactured to meet the specific requirements set out in [Clause 5](#).

Particles are water insoluble, irregularly shaped small pieces or fragments of glass. They may be of similar composition to beads, including from recycled glass sources, and are nominally referred to as glass particles.

NOTE Glass particles can also be referred to as crushed glass, silica, silicon dioxide, fused quartz, sodium carbonate, pot ash or similar.

5 Properties

5.1 General

Beads shall be spherical.

When stored under cover in their original, unopened container, beads shall remain free flowing for at least 12 months from the date of their manufacture. All beads shall conform to the requirements of [Clauses 5.2](#) to [5.12](#).

NOTE Glass particles are not assessed for flow properties, due to their irregular shape.

5.2 Foreign matter

The nominated mass of beads shall be evenly spread over the base of a clear, colourless glass Petri dish of nominal diameter 95 mm, placed over a white sheet of paper and inspected under magnification. The beads shall conform to the requirements of [Table 1](#).

Table 1 — Foreign particles

Type of bead	Test mass (g)	Maximum number of foreign particles
A	0.5	100
B/B-HR	1	50
C/C-HR	1	50
D/D-HR	3	25
E	1	50
Particle	1	50

5.3 Optical quality

When a minimum of 200 beads is examined using a microscope fitted with facilities for transmitted light, capable of being used at the magnification specified in [Table 2](#), the beads shall conform to the following:

NOTE 1 Avoid the use reflected or incident illumination which may result in reflection and reduce the quality of the observed field of view. Transmitted or fibre-optic illuminator may be used for better observation.

- (a) Beads shall be clear and not show opacity greater than 2 % by count.

NOTE 2 Some adhesion coated beads may be semi-transparent and this shall be considered when assessing opacity.

- (b) Beads with greater than 25 % of the visible area affected by gas inclusions (bubbles) shall not make up more than 2 % of the beads, by count.

- (c) Bead surfaces shall be smooth. No more than 2 % by count shall exhibit surface crazing.

NOTE 3 [Appendix J](#) provides pictorial examples of beads with defects and without defects.

To facilitate the counting of the beads, they may be spread in a single layer over the base of a clear, colourless watch glass or recessed microscope slide, and placed over a sheet of 1 mm graph paper to allow segmenting of the beads into manageable groups. Petroleum jelly, or similar, may be used to prevent the beads from moving around during examination.

Table 2 — Optical quality

Type of bead	Magnification
A	At least 40 x
B/B-HR	At least 20 x
C/C-HR	At least 20 x
D/D-HR	10 x
E	At least 20 x

NOTE 5 Glass particles, due to their use as an anti-slip and anti-skid material, are not assessed for optical quality.

5.4 Size

Table 3 — Size distribution for glass beads

Sieve size, µm	Glass bead type				
	A	B/B-HR	C/C-HR	D/D-HR	E
	Percent RETAINED by mass	Percent RETAINED by mass	Percent RETAINED by mass	Percent RETAINED by mass	Percent RETAINED by mass
1700				0	0
1400			0	0-5	
1180			0-3	0-25	
1000				45-85	
850		0	5-20	5-40	
710				0-5	
600	0	0-10			
425	10-30	15-65	65-95		
300	40-60	0-60			
212	20-40				
150		10-35			
75		0-5			99-100
Pan	0-10	0-1	0-10	0-2	

Bead sizes shall conform to the size distribution requirements of [Table 3](#) when tested in accordance with [Appendix B](#).

NOTE Glass particle sizes may conform to the size distribution of [Table 3](#), depending on the particle size span of the product, when tested in accordance with [Appendix B](#). For example, if the particle size span is between 425-1000µm, size requirement relates to product type B/B-HR or C/CHR; if the size is 1000µm+, size requirement relates to product type D/D-HR.

5.5 Shape

5.5.1 General

Beads shall be tested for roundness in accordance with [Clause 5.5.2](#) or [Clause 5.5.3](#), as appropriate.

NOTE Glass particles are not assessed for shape, due to their irregular non-spherical shape.

5.5.2 Type A beads

When Type A beads are optically examined for roundness in accordance with [Appendix D](#), the “rounds” shall be at least 80 % by count.

5.5.3 Type B/B-HR, C/C-HR and D/D-HR beads

When Type B/B-HR, C/C-HR, or D/ D-HR beads are tested for roundness in accordance with [Appendix C](#), the “rounds” shall be at least 70 % by mass.

Containers that avoid the build-up of electrostatic charges and allow free flow shall be used.

5.6 Colour

When a sample of beads is tested in accordance with [Appendix E](#), the colour shall be lighter than required by AS 2700S-2011 (G55).

NOTE 1 This procedure is aimed at detecting coloured glass, which if present, may interfere with the retroreflective properties of the beads.

NOTE 2 Glass particles are not assessed for colour.

5.7 Water resistance

Glass beads and particles are inherently insoluble. Water resistance testing in accordance with [Appendix F](#) is only required in the following circumstances:

- (a) In the event that there is a request from a customer.
- (b) To provide evidence of resistance, i.e. of excessive wear of beads or particles, or of deterioration of retroreflective performance, in the event of a dispute relating to performance.

5.8 Moisture-proof coating

Glass beads and particles claiming the presence of a moisture-proof coating shall be tested in accordance with [Appendix G](#) and flow freely, showing no evidence of caking. Where no claim is made, the test certificate shall report “Not tested”.

5.9 Adhesion coating

Glass beads and particles claiming the presence of adhesion coatings shall be tested in accordance with [Appendix K](#) and show fluorescence, indicating the presence of a coating.

NOTE Glass particles are not assessed for the presence of an adhesion coating.

5.10 Refractive index

When tested in accordance with [Appendix H](#), beads shall exhibit a refractive index of at least 1.50 or a higher value, as specified.

Where a higher refractive index is required, testing shall be conducted and reported in accordance with [Appendix H](#). The index shall not vary by more than 0.05.

Two methods are provided in [Appendix H](#). The Rainbow method shall be used for referee purposes.

NOTE 1 Glass beads with a refractive index greater than 1.5 can provide a higher level of retroreflectivity.

NOTE 2 Glass particles are not assessed for refractive index.

5.11 Retroreflectivity

Only beads claiming high retroreflectivity (Type HR) status shall be tested in accordance with [Appendix L](#) and meet the requirements of [Table 4](#).

Table 4 — Retroreflectivity performance

	Type B-HR	Type C-HR	Type D-HR
Retroreflectivity mcd/ lux/m ²	≥ 450	≥ 450	≥ 600

NOTE Glass particles are not assessed for retroreflectivity.

5.12 Heavy metals

Information regarding heavy metals in glass beads and particles is provided in [Appendix M](#).

6 Packaging

6.1 General

Packages shall be robust and moisture resistant. Packages shall be able to withstand normal transport and handling without damage.

6.2 Labelling

Each package shall be clearly and permanently labelled with the following information:

- (a) Bead or particle type, e.g. Type A, B/B-HR, C/C-HR, D/D-HR, E or glass particle.
- (b) Name or identifying mark of the manufacturer.
- (c) Identification number of consignment or lot, which will allow the manufacturer to determine the month and year of manufacture.
- (d) Mass of the contents of the package, in kilograms.

Appendix A (normative)

Sampling and preparation of glass beads and particles for testing

A.1 Scope

This appendix specifies how representative subsamples are obtained.

A.2 Sampling

Representative samples shall be taken in each lot in accordance with [Clauses A.4](#) or [A.5](#), as applicable, at a minimum frequency of every 10 tonnes of product.

A.3 General

When the sampling plan is prepared, one of the two methods specified in this appendix shall be employed as appropriate for the individual packaging size of the beads or particles. Two methods are described for sampling consignments of beads and particles to obtain representative primary samples. A method of preparing test samples from these primary samples is also described.

A.4 Sampling method 1 — Sample divider

A.4.1 Principle

A random selection of at least one package (approx. 25 kg) of beads or particles is made from each lot of a consignment. Each package is reduced using a sample divider to obtain a representative test sample of at least 500 g.

A.4.2 Apparatus

The following equipment is required:

- (a) *Sample divider* — Conforming to AS 1141.2. The sample divider shall be equipped with two receivers each capable of holding at least 50 % of the total mass of the package to be processed, with a maximum slot dimension of 50 mm.
- (b) *Sample reducer (optional)* — 16 to 1 chute and divider type sample reducer suited for glass beads or particles up to 3 mm diameter with capacity to contain the full quantity of the nominated package size. An image of a typical 16-to-1 sample reducer is shown in BS 6088:1981, Figure 2.
- (c) *Sample containers* — Either tinplate-friction-closure cans or high density polyethylene (HDPE) containers, with sufficient capacity to facilitate retesting of all parameters for the specific bead or particle type as stated in [Appendix I](#).

A.4.3 Procedure

The sampling procedure shall be as follows:

- (a) Unless otherwise specified, randomly select at least one package of beads or particles from each lot making up the consignment.

- (b) Set up the sample divider if using one and, in an even, full-width stream, pour the contents of the first package into the sample divider.

NOTE Prior to using the sample divider, the contents of the package may be reduced using the sample reducer.
- (c) Discard the contents of one receiver and place two clean empty receivers under the sample divider.
- (d) Pour, in an even, full-width stream, the contents of the remaining receiver through the sample divider.
- (e) Repeat Steps (c) and (d) until approximately 500 g of the sample remains in each receiver.
- (f) Discard the contents of one receiver and transfer the contents of the remaining receiver to the sample container and seal.
- (g) Label the container with the source, type, consignment number and lot number of the beads or particles, and the date of preparation of the primary sample.
- (h) Repeat Steps (b) to (g) for any additional packages selected in Step (a) so that one primary sample of approximately 500 g is obtained for each of the selected packages.
- (i) If a representative sample of the consignment is to be prepared for the purposes of testing, proceed with [Clause A.6](#).

A.5 Sampling method 2 — Probe (sample thief)

A.5.1 Principle

This method describes sampling of glass beads or particles packaged in a nominal, one tonne, intermediate-bulk container using a probe (sample thief).

A.5.2 Apparatus

The following equipment is required:

- (a) Sample thief of suitable length to ensure a sample can be taken from the full height of the package (see [Figure A.1](#)).
- (b) Rubber or plastic hose of at least 100 mm in length, longer than the sample thief length so as to fit inside the sample thief (see [Figure A.1](#)).
- (c) Receptacle of suitable size and construction to contain five full probe samples of glass beads or particles.

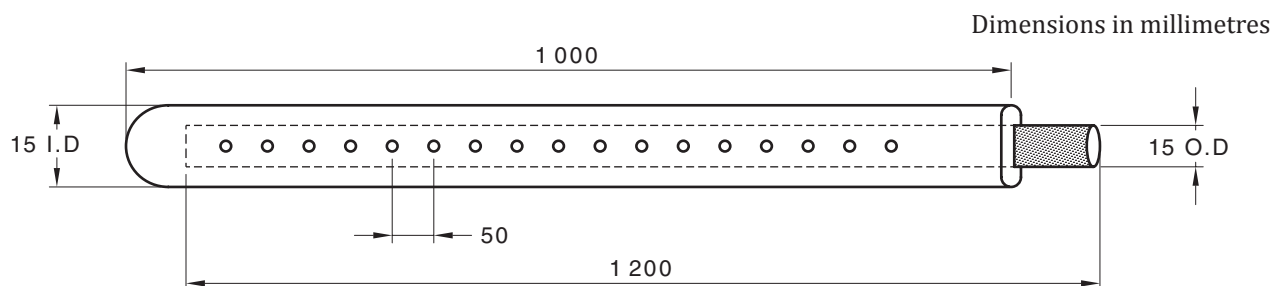
A.5.3 Procedure

The sampling procedure shall be as follows:

- (a) Ensure that the sampling equipment is clean and free of contamination. Withdraw the hose from the sample thief. Inspect both the hose and the sample thief and clean if required.
- (b) Replace the hose in the sample thief. Hold the probe by the open end and vertically above the container intended for sampling.
- (c) Push the probe slowly (with the hose inserted fully into the probe) into the first sampling area (see [Figure A.2](#)), all the way down until it touches the bottom of the container. Remove the hose slowly so the material enters the probe through the 17 holes (see [Figure A.1](#)). Shake the probe to encourage beads or particles to fill the sample thief.

- (d) Remove the probe containing the glass bead or particle sample slowly and pour the sample into the collection bag.
- (e) Repeat Steps (a) to (d) in the remaining sample test areas of the container, as identified in [Figure A.2](#). Empty each probe sample into the same sample collection bag.
- (f) Label the sample in accordance with Clause A.4.3(g).

NOTE The sample thief needs to be used in the vertical plane. Using it horizontally will not compensate for segregation and may provide erroneous results.



NOTE Stainless steel tube wall thickness of at least 3 mm with 17 holes, each 8 mm in diameter.

Figure A.1 — Sample thief

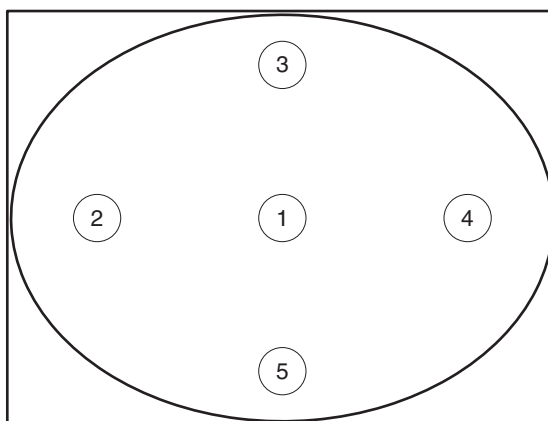


Figure A.2 — Probe sampling sequence

A.6 Preparation of test samples

A.6.1 Principle

Consignment samples obtained in accordance with [Clause A.4](#) or [Clause A.5](#), are passed through a sample divider and subdivided until a sample of the required size is obtained.

A.6.2 Apparatus

The following equipment is required:

- (a) *Sample divider* — conforming to the requirements of AS 1141.2. The sample divider shall contain slots of 3 mm to 6 mm width. It shall be equipped with three receivers, each capable of holding at least 50 % of the total primary sample to be processed (see [Clause A.4.2](#)).

- (b) *Sample containers* — Either tinsplate friction-closure cans or high density polyethylene (HDPE) containers, with sufficient capacity to facilitate retesting of all parameters for the specific bead or particle type stated in [Appendix I](#).

A.6.3 Procedure

The procedure shall be as follows:

- (a) Collect all containers of primary samples prepared in accordance with the appropriate method specified in [Clause A.4](#) or [Clause A.5](#) and determine the total mass of sample to be processed.
- (b) Set up the sample divider [see [Clause A.4.2\(a\)](#)] and pour the contents of each primary sample into the sample divider in an even, full-width stream, one following the other.
- (c) When all primary samples have been processed, retain the contents of one receiver and place two clean, empty receivers under the sample divider. Retained beads or particles shall be retained in sealed, labelled containers for future use.
- (d) Using the proper pouring procedure, pass the contents of the remaining receiver through the sample divider.
- (e) Repeat Steps (c) and (d) until the required size of test sample is obtained.
- (f) Transfer the final sample to a suitable container conforming to [Clause A.4.2\(c\)](#) and seal, labelling the container with information including the source, type, lot number and unambiguous date of preparation (viz., day, month, year).

Appendix B (normative)

Determination of size distribution

B.1 Scope

This appendix describes two methods for determining the size distribution of glass beads or particles used with pavement-marking materials.

B.2 Principle

Glass beads or particles are dry-sieved through a nest of sieves of predetermined mesh size. The percentage mass of beads or particles retained on each sieve is determined.

B.3 Apparatus

The following equipment is required:

- (a) *Collection pan* — of similar diameter to the sieves and having a snug fit on the bottom sieve in the nest.
- (b) *Drying apparatus* — capable of maintaining a temperature of at least 100°C.
- (c) *Sieves* — conforming to the requirements of ISO 3310 for Grade B sieves, and 200 mm in diameter with apertures corresponding to those specified for the appropriate bead or particle type in [Table 3](#).
- (d) *Weighing balance* — capable of weighing the total mass of the test sample to an accuracy of ± 0.01 g.
- (e) *Brush* — to dislodge beads or particles from the test sieves and transfer residual beads to a weighing container.

A mechanical sieve shaker may be used as an alternative to the “hand tap” method. If used, the mechanical sieve shaker shall be capable of agitating the nest of sieves and its charge for 20 min $\pm$ 2 min when shaking them on both the horizontal and vertical planes at a rate of approximately 100 strokes per minute.

B.4 Procedure

B.4.1 Mechanical sieve shaker method

The procedure shall be as follows:

- (a) Ensure 50 g of beads or particles are dried to a constant mass.
- (b) Weigh and record the mass to the nearest 0.01 g.
- (c) Assemble the nest of sieves so that the sieve of coarsest mesh is at the top of the nest and the one with the finest mesh is at the bottom. Place the collection pan underneath the last sieve.