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GLASS BEADS & RETROREFLECTIVITY

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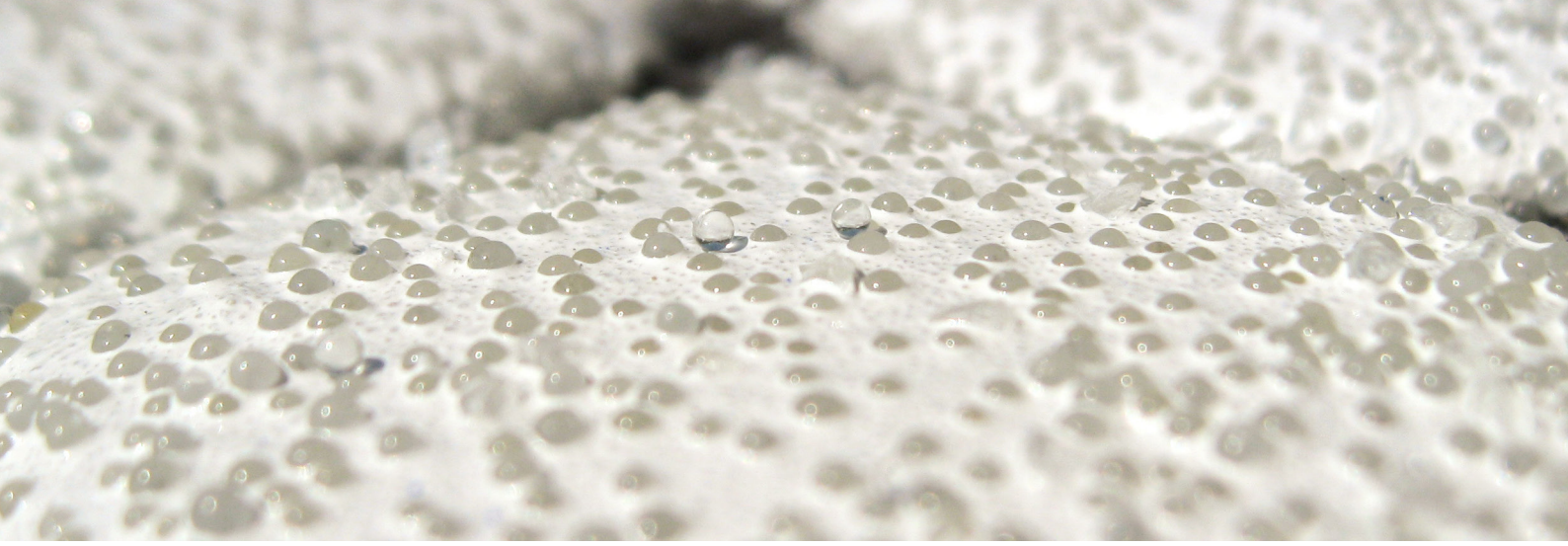
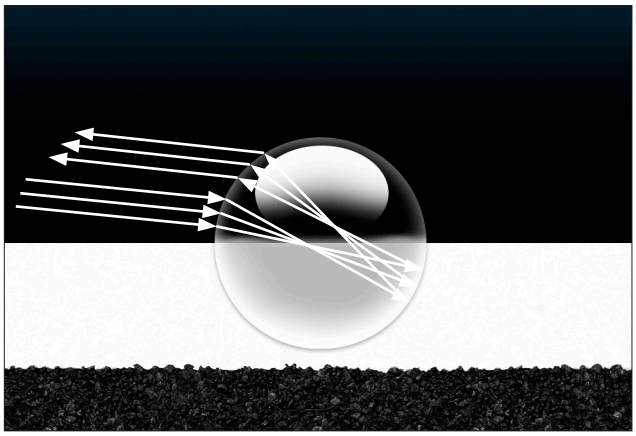


Glass Beads

Glass beads are an essential part of traffic safety systems. The beads increase a driver's ability to be able to see road markings at night and in bad weather conditions due to the retro-reflective properties of a glass bead. The light is refracted in the beads, allowing it to be reflected by the road marking back towards the driver.



Glass beads are used both as drop-on beads on top of road markings and as premix beads in some types of road marking. European regulations regarding performance criteria, test criteria, quality requirement etc. can be found in the standards EN1423 and EN 1424.

Retroreflection

Retroreflection refers to the light reflected back to the driver from the vehicle headlights. The level/intensity of the light reflected back to the driver is a key measure of how effective a road marking is. Retroreflection is measured with an equipment known as a retroreflectometer, which measures and calculates the level of retro-reflected light at a specified geometry. This geometry refers to the distance from the observer to the illuminated point of interest, which is 30 meters away. It measures the retroreflected light from the road marking. This is measured in millicandelas per square meter per lux (mcd/m2/lux).

Retroreflection – What has an influence?

Typically, these factors affect retro-reflectivity:

- Bead size distribution
- Ratio between glass beads and friction material
- Roundness of the beads
- Defects/Clarity/Colour of the beads
- Refractive index of the glass
- Quality and composition of the road marking
- Bead coverage
- Bead embedment
- Miscellaneous, e.g. dirt, weather, wear, condition of the road surface etc.

Beads size distribution refers to the mix of various sizes of glass beads used. This is relevant for both premix beads and drop-on beads. The size will typically vary between 800 to 150 microns. Big bead gradations typically vary between 1600 to

600 microns.

The optimal size distribution (gradation of glass beads) depends e.g. on the type of road marking system, application thickness and the kind of application equipment being used.

In some applications, smaller beads may become heavily embedded allowing only the larger beads to protrude above the surface. If the gradation of the beads is too large, wear from the traffic may push the beads out of the binder system (particularly in case of thin road markings).

Typically drop-on glass beads will be used in combination with friction material. The higher ratio and size of the friction material, the lower the retroreflection will become and vice versa.

Defect non-round beads do not reflect light uniformly, which overall results in reduced retroreflectivity. Many specifications require at least 70% or 80% rounds for traditional beads. Larger beads typically require between 80% to 90% rounds. The higher the percentage of round beads, the more light is reflected back.

The glass bead's clarity and colour also impact reflectivity. The greater transparency of the glass bead and the lower the air inclusions and defects, then the greater the return of reflected light.

Road marking quality and colour also impact levels of retroreflectivity. In general, brighter markings reflect better than darker markings, thus white markings have the highest level of retroreflection. Materials with higher loads of pigmentation enhance reflectivity where bead properties are identical. Formulation, thickness, composition of material and other factors contribute to the road marking's reflectivity.

Good bead coverage and a balanced dispersion of glass beads influence the level of retroreflection.

Embedment relates to the depth of the drop-on glass beads within the road marking material. To optimize performance, a range of 50% to 60% of the bead diameter is regarded as good embedment.

If the embedment sinks too low (more than 60%), most of the bead will be unseen, making it ineffective, as little or no light will be returned to the driver. If embedment isn't very deep (less than 50%), the beads are liable to come out of the binder material prematurely and light can pass through the bead without being reflected back.

Good embedment of the glass beads involves several factors, such as glass bead size, coating, binder viscosity, ambient temperature and equipment design.

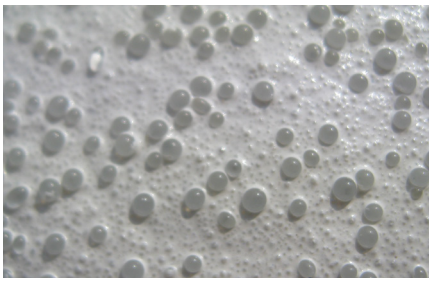
Coatings might be added to the surface of the glass beads to enhance adhesion and embedment

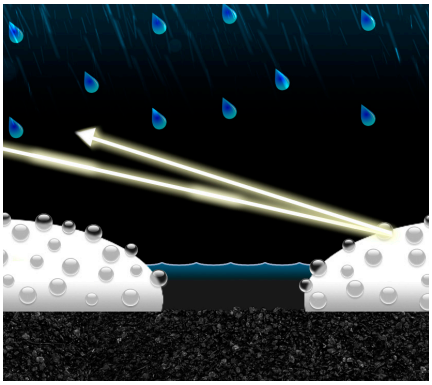
Every kind of road marking material has its own handling aspects and optimal application temperatures, so it's vital that you adhere to the recommendations of the manufacturer's instructions to achieve correct embedment of the beads.

Wet / Night Visibility

In dry weather, traditional glass beads can provide excellent retroreflective visibility. During wet conditions, however, it can be beneficial to use beads and/or markings with special properties. This is to avoid a thin film of water on top of the road marking, which will deflect light from the vehicle headlights in various directions instead of reflecting it back. To enhance retroreflection during wet conditions, profiled markings and/or larger glass beads can be utilized to ensure the top of the beads are above the water film.

Beads with higher refractive index can also be used to direct the light more efficiently. A glass bead's refractive Index defines the angle at which light is refrac-





Established in 2005, AllGlass has now become the market leader in the manufacture and supply of glass beads in the UK. Now producing 17,000mt with plans for future expansion and growth

ted within a bead, this bends the light towards the embedded part of the bead, which acts as a mirror and causes the light to be reflected back to the driver.

The specific refractive index is determined by the glass chemistry. Standard glass beads from reprocessed glass nominally have a 1.5 refractive index value which meets the European standard requirement EN 1423 and EN 1424. Higher refractive index beads are available and these can be used to improve the performance during wet conditions.

Bead coatings

Coatings can be applied to the surface of glass beads. They are used to enhance the glass bead's properties. This include performance in regard to adhesion, flotation and moisture proofing properties. The optimal coating of the beads depends on the road marking system.

Recommended storing and handling of glass beads

Preferably store the beads inside under dry conditions. If this is not possible, ensure that the beads are covered completely and securely with a waterproof material. Beads packages should be closed after opening them. It is good practice to open packaging just prior to use to avoid moisture issues.

When glass beads become contaminated with moisture, application and equipment errors can occur due to lumping and decreased flow.

Application of drop-on

Operators should be mindful of the following during application:

Aim for 50% to 60% embedment for optimal results.

Uniformity and distribution of glass beads on the whole line surface are essential. Always ensure that the amount of beads being applied corresponds to the recommendations of road marking material manufacturer.

Parameters like application speed, material temperature, pressures, bead gun settings etc. should be checked continuously.

Inspect application and measure the retroreflection levels at regular intervals.

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