GLASS BEAD SPECIFICATIONS

The ability to see a pavement marking at night is based on the retro-reflective characteristics of the marking. *Retro-reflectivity* is the technical term used to define how much light is reflected from a light source back to a specific measurement or vantage point. The retro-reflective characteristics of a marking are associated with the glass beads applied to the marking material, the manner in which the beads are applied, and the characteristics of the marking binder.

Glass beads are round spheres of either recycled or virgin glass that provide retro-reflective properties when embedded into pavement markings. *Embedment* is the partial submersion of the glass bead in the marking material (binder). As the binder is applied to the pavement, the glass beads (about the size of a grain of sand) are dropped onto the binder. Ideally, they submerge part way into the binder, becoming suspended as the binder dries and cures around them. If the beads are over-embedded or under-embedded, the marking becomes less retro-reflective. But when the beads are applied and embedded properly, the marking provides visual guidance during darkness or low visibility conditions (due to its retro-reflectivity), thus making the pavement marking functional 24 hours a day.

Glass bead specifications for use on airfields fall under the Federal Specification TT-P-1325, Types I, III or IV. It is worth noting that there are also Types I, II, and III beads used in highway applications. The classification of bead types is different for highway and airport applications. Users should ensure that the beads used on airport markings meet the TT-B-1325 type classifications and are not glass beads for highway applications.

Each type of bead described in figure 1 has different coverage rates, based on their size and/or specific gravity. Whereas Type I and Type III glass beads are suited to any material, Type IV is best suited for thicker material application due to the size of the bead and the need for proper embedment in the wet binder. Retroreflectivity ranges *at installation* are provided in the figure as a guide for performance criteria.

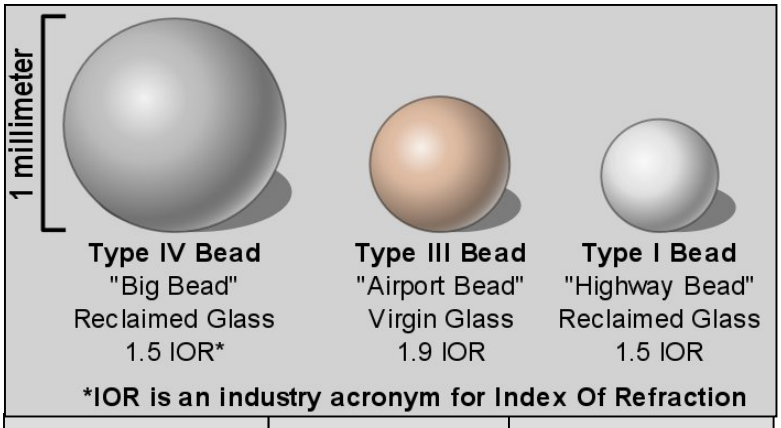


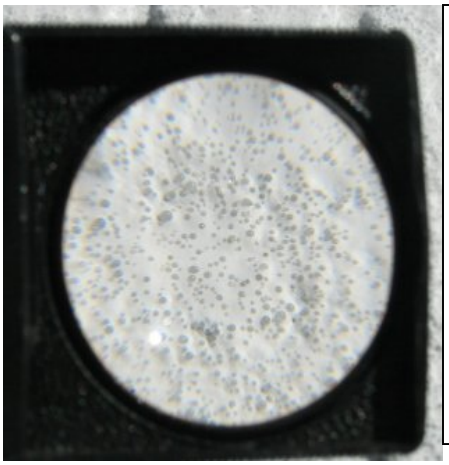
Figure 1: Size comparison of three types of glass beads approved for airport use.

Type I Low Index (1.5 IOR)

The **TT-B-1325D, Type I** low index beads have been used on highways for decades, and were adopted by the FAA and USAF in the mid 90s for use on airports. Made from recycled glass, compared to the other approved bead types, Type I have the smallest diameter.

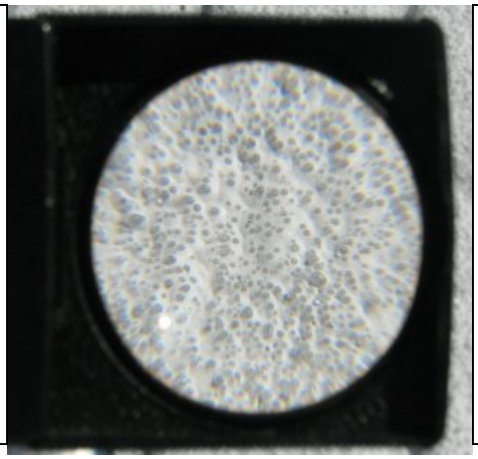
Type I glass beads are the least dense and have a coverage rate of seven pounds per gallon of waterborne or solvent paint. At *installation*, Type I, applied properly in a white binder, should yield reflectivity readings ranging from 300-450 mcd/m²/lux. Figure 2 is an example of *poor* Type I bead distribution, figure 3 demonstrates *good* Type I distribution. *Excellent* bead distribution should yield up to 450 mcd/m²/lux at *installation.*

Figure 2: poor bead distribution



At left is an example of poor Type I glass bead coverage, with readings only averaging 135 mcd/m²/lux.

Figure 3: good bead distribution

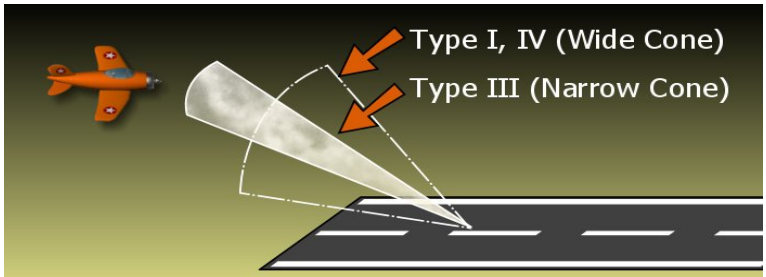


At left is an example of good Type I glass bead population, readings averaged 300 mcd/m²/lux.

Federal Specification TTB-1325, Type II – is obsolete

Federal Specification TTB-1325, Type III (1.9 IOR)

Type III glass beads are made from virgin materials, not recycled glass and have an index of refraction (IOR) of 1.9 or higher, resulting in a concentrated beam of returned light, depicted in figure 4. By comparison, Type I and Type IV beads return a diffused light beam.



Type III (Airport Beads) direct more light into the pilot's field of vision. Therefore, markings are brighter and visible from greater distances.

Figure 4

When installed in white paint, Type III beads should yield reflectivity values between 600-1300 mcd/m²/lux at *installation*, and represent the highest potential reflective values of any of the specified glass beads. **Type III is recommended for use where increased durability and long term performance are desired.**

Type III beads are the densest of the glass beads, and require distribution of ten pounds per gallon due to their high specific gravity. Although more expensive than either Type I or Type IV, Type III beads are expected to provide 1) better *initial* reflectivity and 2) if applied properly, better *long-term* performance. For example, if markings have initial readings of 800-900 mcd/m²/lux, it will take longer for the markings to lose their effectiveness, resulting in less maintenance. Conversely, if the low index beads are installed properly with initial readings of 300-500 mcd/m²/lux, reflectivity will drop below acceptable levels more quickly, requiring more frequent maintenance, more paint build up, etc.

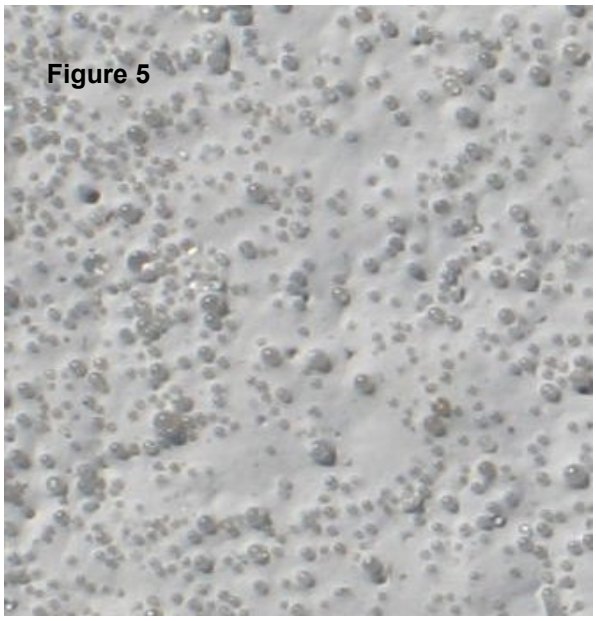


Figure 5 is an example of <u>poor</u> Type III glass bead population, yielding reflective readings of only 325 mcd/m²/lux.

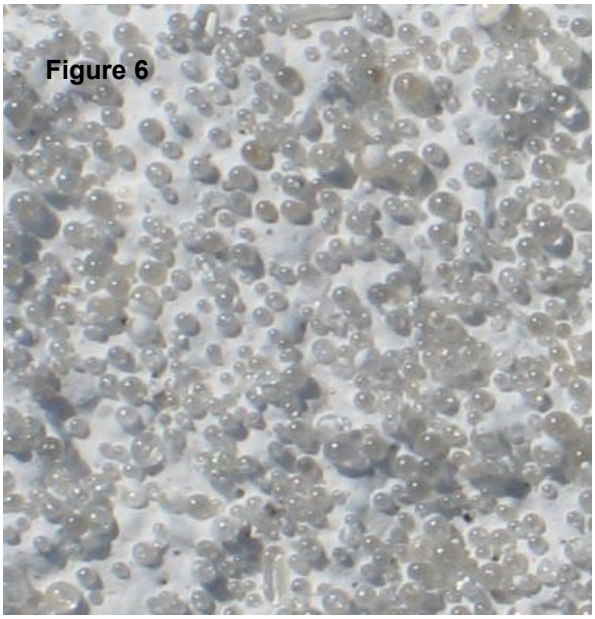


Figure 6 is an example of <u>excellent</u> Type III glass bead population, with readings of over 1100 mcd/m²/lux.

At *installation,* Type III reflectivity values should yield between 600-1300 mcd/m²/lux. Figure 5 shows poor distribution, figure 6 *excellent* distribution.

<u>Type IV Low Index (1.5 IOR), Type A and B</u>

<u>TT-B-1325C, Type IV "big beads"</u> were approved for use by the airport industry in 2005. Also made from recycled glass or "direct hot melt", they are larger than any of the specified glass beads. When applied in standard white waterborne paint, the reflectivity readings should range between 350-500 mcd/m²/lux at *installation*. However, given the size of the glass bead (0.84 mm to 1.68 mm for Type A, and 0.59 mm to 1.19 mm for Type B), they are best suited for use in the high build acrylic binder with a specified wet film thickness of at least 25-30 mils (TT-P-1952E, Type III). When Type IV glass beads are applied to standard water-borne traffic paint at 15 mils wet film thickness, results are poor. Type IV glass beads are applied using eight pounds per gallon of water-borne or solvent-borne paint.

TT-P-1952, Type I or II should only be applied between 12 and 16 mils to avoid cracking of the dry film and premature failure, and therefore should not be used in conjunction with Type IV glass beads.

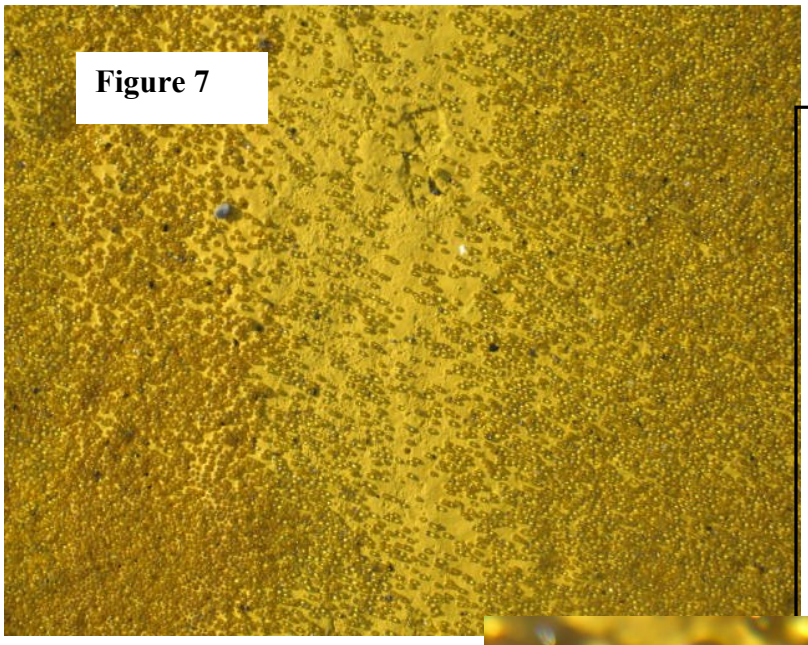


Figure 7

Figure 7 demonstrates excellent Type IV bead population on both edges, but poor population in the middle, missed by the glass bead dispensers that couldn't cover the entire marking..

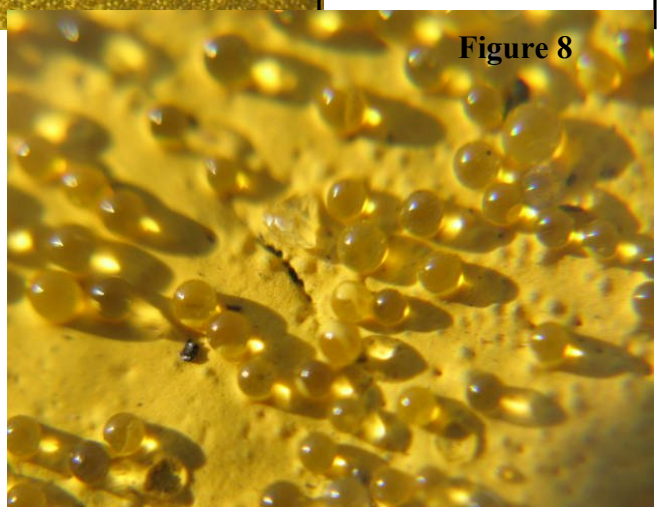


Figure 8

Figure 8 shows poor bead *embedment* of the same area shown in figure 7. The beads are barely anchored in the coating, and will dislodge with very little traffic. Although population was excellent, reflectivity readings were only 125 mcd/m²/lux on the yellow marking. With better embedment, the readings would increase to a range of 200-350 mcd/m²/lux for yellow markings.

A considerably thicker wet film thickness (wft) (TT-P-1952, Type III at 25+ mil wft) or other material must be applied to achieve proper bead embedment and anchoring of the Type IV glass beads.