Surface Treatment and Reflected Brightness of Concrete Curbing

A comparison of coating effects on brightness (visibility) of concrete curbing.

Tom Schwerdt
Texas Department of Transportation
Construction Division, Materials & Pavements Section
Traffic Materials Branch
512-506-5883
Tschwer@dot.state.tx.us

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Issues with night-time visibility of curbing on traffic islands was brought to the attention of the laboratory by Mark Bloschock, BRG Design section with an initial focus on developing a beaded (retroreflective) clearcoat. A brief procedure was published on May 15, 2007.

Following the project, differing opinions were found on the relative effectiveness of the beaded clearcoat when compared to beaded or unbeaded white traffic paint.

A moderate amount of testing and evaluation was performed to measure relative brightness (visibility) of the various surface treatments on concrete representing curb material with the objective of determining the treatment which provides maximum curb visibility.

Materials:

Clear acrylic waterborne coating, Sherwin Williams Sher-Clear.
White acrylic waterborne traffic paint, per DMS 8200.
Type II retroreflective glass traffic beads
2" brush
3" x 7.5" light grey cement panels representing curb material.

Sample Preparation:

Five panels were prepared as follows:

Panel 1: Bare Concrete
(Control)

Panel 2: White Traffic Paint
(Concrete coated with white traffic paint, unbeaded)

Panel 3: Beaded Clear Paint
(Concrete coated with clear acrylic and 10-11 pounds / 100 sq foot Type II glass traffic beads)

Panel 4: Beaded White Paint 1
(Concrete coated with white traffic paint and 8-9 lb/100 sq foot Type II glass traffic beads)

Panel 5: Beaded White Paint 2
(Concrete coated with white traffic paint and 10-11 lb/100 sq foot Type II glass traffic beads)

Each panel was wire brushed under running water to remove loose material, then allowed to dry for a minimum of 48 hours.

White traffic paint was brush applied to Panel 2.

Sher-Clear was brush applied to Panel 3. Type II glass beads were immediately hand-scattered into the wet coating at 10-11 lbs per 100 square feet.

White traffic paint was brush applied to Panel 4. Type II glass beads were immediately hand-scattered into the wet coating at 8-9 lbs per 100 square feet.

White traffic paint was brush applied to Panel 5. Type II glass beads were immediately hand-scattered into the wet coating at 10-11 lbs per 100 square feet.

All panels were allowed to cure in the laboratory for one week at 78 ± 2º F and 30 ± 15% Relative Humidity.

Procedure:

The relative brightness of the samples was evaluated in our dark tunnel in a manner similar to that for evaluating retroreflective sign sheeting. The samples were evaluated at an incident angle of 0.2° and viewing angles from 0° to 65° in 5° increments utilizing a D65 illuminant and computer video capture. Video capture of a particular angle was performed simultaneously on all five samples. Relative brightness of the samples was compared utilizing an average pixel value across the surface of the sample, with approximately the outer quarter inch ignored so as to avoid any edge effects.

Results and discussion:

While the exact brightness ratios varied across the different viewing angles, the samples remained in the same brightness ranking for all angles. This ranking followed the panel numbers with Panel 1 the least bright and Panel 5 the brightest.

Panel 1 (Bare Concrete) was the least bright of all of the samples.

Panel 2 (White Traffic Paint) was approximately 40-50% brighter than the bare concrete.

Panel 3 (Beaded Clear Paint) was approximately 80-200% brighter than bare concrete.

Panel 4 (Beaded White Paint 1) was approximately 130%-350% brighter than bare concrete

Panel 5 (Beaded White Paint 2) was approximately 190-475% brighter than bare concrete.

Two graphs of the results are attached. The first graph shows all results normalized to the 0° (face-on) viewing-angle brightness of the bare concrete control panel. The second graph shows all results normalized to the brightness of the bare concrete control panel at the same (current) viewing angle where the measurement was taken.

Visual evaluation of the panels matched the computer results in ranking the brightness of the samples.

As the viewing angle became shallower, the absolute brightness of the two unbeaded samples fell off more rapidly than any of the beaded samples. This is expected, as light reflects in a scattered manner from unbeaded samples, while it will instead retroreflect from the beaded samples. Panel 3 shows a unique increase in brightness around 45-50º and this is likely due to the interaction of the bead retroreflection and the materials underneath.

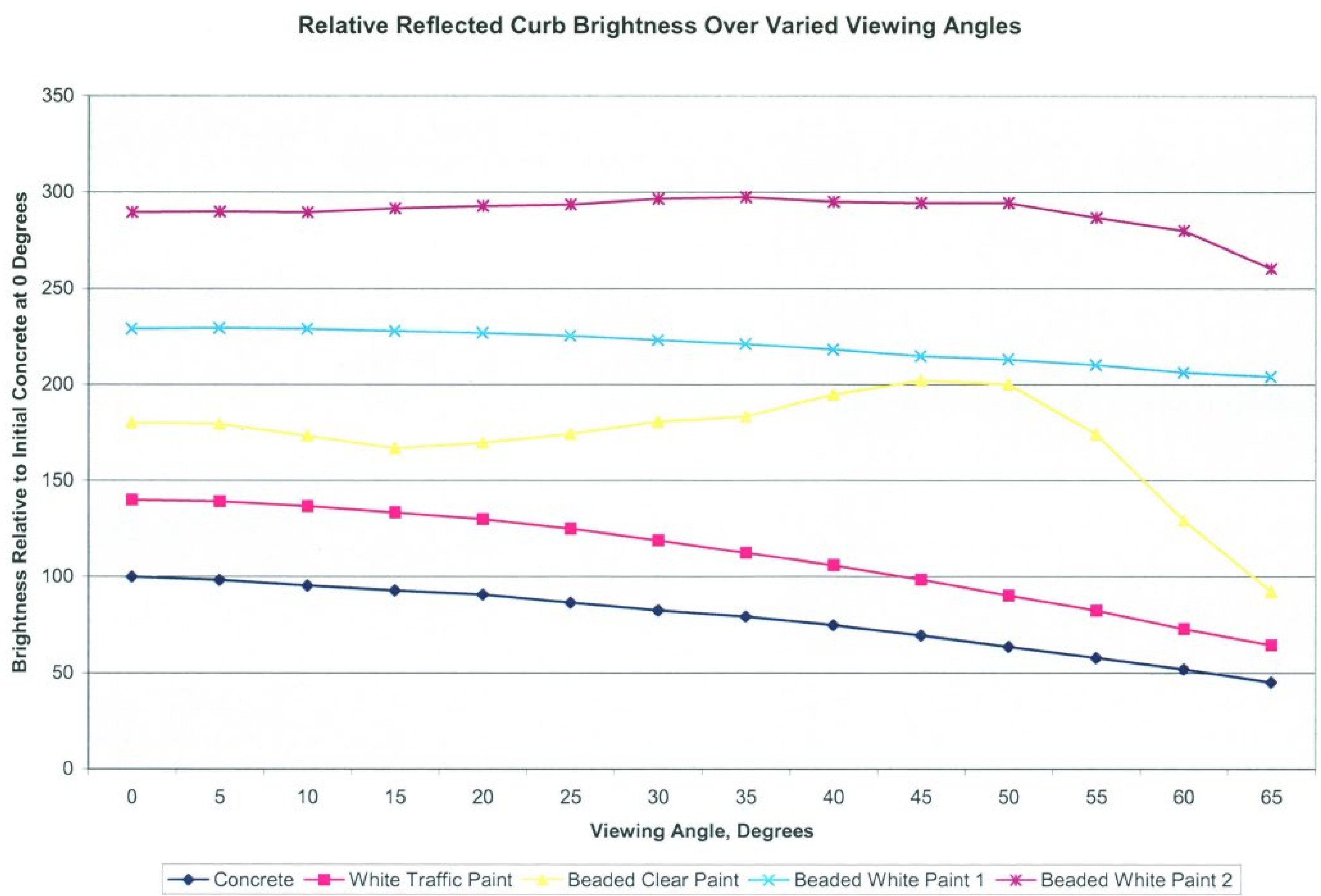
Retroreflection is a phenomenon of both the round shape of the bead and the material directly in contact with the far (reflecting) surface of the bead. Retroreflection of light is increased when the reflecting side of the bead is in contact with a white material, such as the titanium dioxide in our traffic paint. Retroreflection is also increased when the difference in refractive index between the reflecting face and the material in contact is higher. My current theory is that because the clear material is a thinner film than the traffic paint, the peak in retroreflection is due to an increased refractive index where the reflecting side of the bead is against air at shallow angles instead of against the clear paint. Samples 3 and 5 both drop off more rapidly than the other samples from 55-65º and this is likely due to interference or "shadowing" between beads, as these samples have a higher bead loading.

Conclusions:

All systems tested showed an improvement in visibility when compared to bare concrete, across all viewing angles.

Retroreflective glass traffic beads significantly improve visibility of the concrete material, whether clear or white paint is used to hold them in place.

White traffic paint with a relatively heavy loading of beads performs the best of all combinations tested.


Relative Reflected Curb Brightness Over Varied Viewing Angles
Brightness Relative to Initial Concrete at 0 Degrees
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Viewing Angle, Degrees
Concrete
White Traffic Paint
Beaded Clear Paint
Beaded White Paint 1
Beaded White Paint 2