Highway Safety Group
By, Chad Dornsife
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Re: WSDOT Solar Powered Centerline Delineation Test

Oso, WA • SR 530 • 2.25 mile segment • MP 32.75 to 35.00

Post Installation Synopsis Looking Forward

Advantages and Observations:

1 Single string of internally illuminated raised, flush or subsurface markers can successfully convey unique bi directional advanced guidance as to passing and no passing exclusion zones as well as the nature of the changing terrain and curves ahead, illuminated studs only in Figure 1;

Figure 1: WSDOT - SR 530 – 900 plus feet of no passing zone with undulating terrain; Astucia flush studs milled-in subsurface on 40' centers

2 Improved and sustainable night and adverse weather guidance (fog, rain, ice, skiff of snow etc) even with traction materials are present because these studs rely on internal illumination rather than retroreflectivity; and

3 Guidance is maintained during winter months regardless of the condition of the painted markings and they're fully compatible with snow removal operations.

4 The goal for flush studs is to maintain consistent year-around enhanced guidance for the life cycle of the pavement (asphalt 7 years). We're also exploring methodologies to accommodate periodic chip seal operations.

5. Conspicuity and pattern densities. In the UK Astucia set their luminance to 1 candela to provide clear guidance without distraction taking into consideration their pattern densities and spacing. Except for spacing guidance pattern same as WSDOT.

Figure 2: Astucia - clear guidance without distraction.

Figure 3: Brand X - too much luminance and distracting patterns.

Centerline Intervals:

Exclusion Zones (double line)	*Passing Zones (broken line)*
UK 15’ (4.5m) (single marker)	20’(curves) to 30’ (6-9m) (single)
Caltrans 24’ (double markers)	48’ (single)
WSDOT 40’ (single marker)	80’ (single)

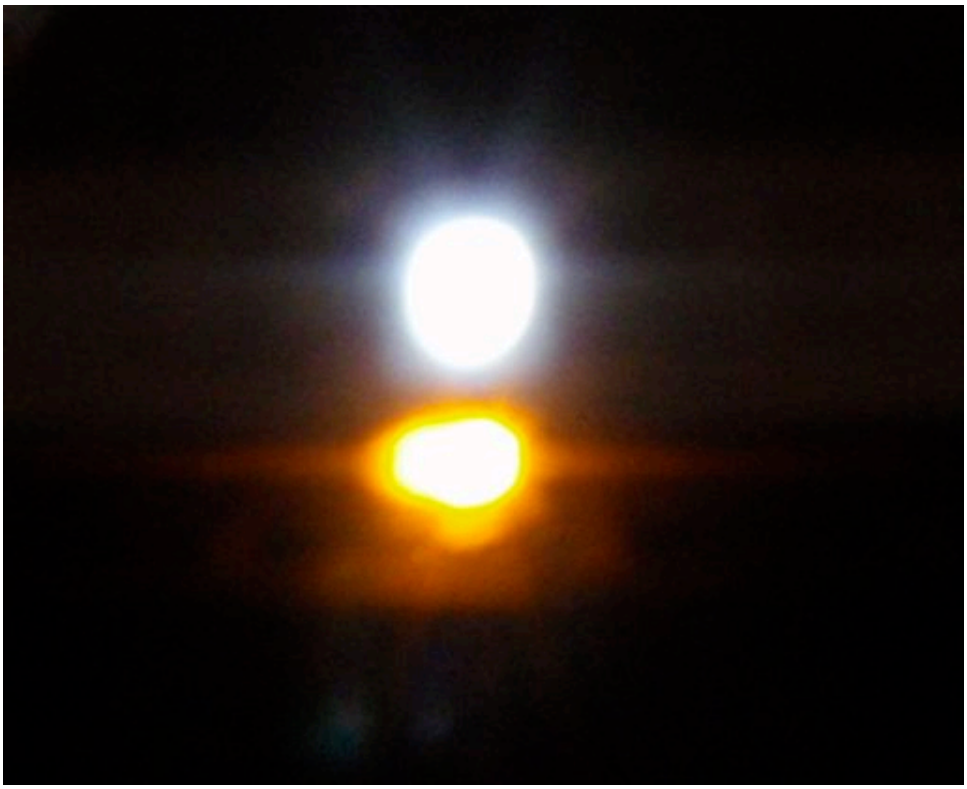

Figure 4;6: Astucia 1 candela white and amber stud conspicuity comparison

WSDOT spacing is MUTCD based but in adverse weather zones (fog etc) a closer spacing regime may be warranted, Additionally, because of our greater spacing and the conspicuity differences between white and amber light, suggest Astucia explore increasing their amber stud’s perceived conspicuity to be on par with their white counterparts for North American centerline applications. White studs are visible up to 900m.

Installation:

Astucia in the UK has employed a waterless milling process that cuts the stud hole to-depth (2”) in tarmac surfaces with no additional steps or handwork, which dramatically reduces secondary labor, support equipment and fixant requirements.

A purpose-equipped crew of 3 for temperate zones or 4 for snow zones (milling) would average 2 plus miles a day even with live traffic. Mother supply truck with trailer for 2 purpose modified golf carts* and the pavement miller for steel bit snowplow zones. Temperate and rubber bit snowplow zones do not need to be milled. *easy to maneuver and transport platforms

Traffic control additional as required.

Special installation considerations: Astucia flush studs were designed for temperate or snow zones with rubber bit snowplows. The stud optics are only 4mm (0.15”) above road surface (Figures 5;6), thereby maintaining site distance and conspicuity while making them impervious to dynamic forces.

In this instance SR 530 is in a snow zone where steel snowplow bits may be used during extreme storms. Therefore we subsurface mounted the studs with 6mm deep milled slots to maintain sight distances.

Figure 7: Milled-in Astucia flush stud

Figure 8: Astucia flush studs milled-in between double yellow lines

Regardless of the depth of the mill we set the top of the stud 1/8 inch below the road surface to maintain continuity in sight distance, we then filled in around the stud (not shown) to protect it and the edges of the holes. With the production configuration this QC would all be done in one pass/step.

YouTube: Installation, cross section, technology, and visibility demonstrations. http://www.youtube.com/user/SolarLites

WSDOT SR 530 Press Coverage:

WSDOT solar stud press coverage, installation and site photos

Figure 9: Link to Seattle King 5 News Coverage of installation

King 5 -Will new road markers make a safety difference?
http://www.king5.com/news/local/solar-road-reflectors-101200019.html
WSDOT - 2010 - Solar-powered road reflectors may light the way for future safety improvements
http://www.wsdot.wa.gov/News/2010/08/17_SR530SolarStuds.htm
Roads & Bridges: WSDOT to test solar-powered road reflectors
http://www.roadsbridges.com/index.cfm/fuseaction/showNewsItem/newsItemID/21340
HeraldNET - Highway 530 going solar
http://www.heraldnet.com/article/20100820/NEWS01/708209901/-1/rss02

Current Practice and Contiguous SR 530 Site Observations:

On east end of the SR 530 test site current recessed RPM not visible/apparent in the rain etc and their subsurface mounting causes sight distances to be erratic and foreshortened.

Figure 10: Typical milled-in pavement marker on SR 530 east of test.

The grooves readily fill with water or debris from sanding etc. In weather events headlights reflect off surface of water, thereby eliminating their conspicuity altogether, or they become hidden from view by debris.

Figure 11 is a debilitating debris example, the reflective surface of the stud is well below the road surface and it takes considerable time after a weather event to clear them - again ineffective when needed most.

Figure 11: Caltrans – Highway 89 - studs covered for extended periods

When clear of debris or water the reflective surfaces are short lived and despite their subsurface mounting they still require frequent replacement, in addition, the groove foreshortens site distances and they're viable only during good weather.

Figure 12: Caltrans – I5 Grapevine – effectiveness short lived

Adverse weather and conspicuity mitigation: Astucia's flush studs remain visible in rubber plow bit or a temperate zone because their internal light is located above the roadway surface and it has a 10 day power reserve.

When milled-in Astucia studs are still visible when covered with water and one tire pass clears water because of the shallow grove and raised light dome, and a few passes will clear debris enough to see the light source. In addition, their lenses are made of a material that is polished by tires.

Dynamic loading, high-speeds and lateral forces significantly foreshorten raised pavement marker service life on 2 lanes highways.

On the west end of the SR 530 test site, WSDOT striping crews recently restriped and marked the section and already the raised pavement markers are missing sometimes for significant distances or individually in ways that detract from their guidance except as a general centerline demarcation.

SR 530 has significant truck traffic the effects of dynamic loading cannot be overstated on these classifications of roadways, per the RPM in Figure 13 that is only a few months old.

Figure 12: WSDOT – SR 530 – Marker degradation/missing west of test

Dynamic loading and severe traffic mitigation - Regardless of dynamic loading, lateral forces on curves or wheel hop from the centerline rumple strips the Astucia stud's low profile design (.20 inch above; milled .125 below) is unaffected by these destructive forces.

Considerations:
On road with existing milled in raised pavement markers, replace a few segments with the Astucia solar surface mount studs thereby adding the advantages of the enhanced LED guidance. The improvement in conspicuity and advanced guidance would be readily apparent if a controlled installation-setting regime was also implemented.

Notwithstanding, Astucia's flush studs as used on the SR 530 provide optimum sight distances and consistency because the lens/light source is at or above the roadway, and not below the line of sight.

Project Team:

WSDOT

Nafisa Peshtaz
Safety Program Engineer
WSDOT - Northwest Region
15700 Dayton Avenue North, MS-120
PO Box 330310, Seattle, WA 98133
206-440-4346, fax 206.440.4804
Nafisa Peshtaz <PeshtaN@wsdot.wa.gov>

Public relations
Sandy Lam
Eastside Corridor Communications
Washington State Department of Transportation
425-456-8617 direct | 425-456-8500 main 600
108th Avenue NE Suite 405 | Bellevue, WA 98004
Sandy Lam <LamSa@wsdot.wa.gov>

Clearview Traffic LTD – Astucia Brand

Graham R Muspratt, Group Product Manager
Clearview Traffic Group Limited
Incorporating Astucia, Golden River and Count On Us
Switchboard: +44 (0) 1869 362809
www.clearviewtraffic.com
Graham R Muspratt <Graham.Muspratt@clearviewtraffic.com>

Highway Safety Group

Chad Dornsife, Founder
Highway Safety Group
775.332.0600 Nevada
775.721.2423 mobile
858.673.1926 San Diego
Skype cdornsife
www.highwaysafety.us
Chad Dornsife cdornsife@highwaysafety.us

Mike Morton
Serpak, Inc. – Brand: Marker Bond
604-B Industrial Ct.
Woodstock, GA 30189
770-516-0506
770-516-8334 fax
Mike Morton <mike@serpak.com>