

Introduction

For regulated traffic signs, 3M recommends using only a single type of 3M retroreflective sheeting per sign. The rationale for this recommendation is primarily due to driver performance concerns, with secondary bases in application practices and cost concerns.

Controlling Luminance Contrast

When the same retroreflective sheeting series is used for sign background and copy, the contrast between the background sheeting and the copy is fixed. This is because the luminance of the background and the copy change in tandem with variables such as vehicle type, sign location, or viewing distance. As such, the luminance contrast on the sign is controlled as designed and intended by the sheeting manufacturer, regardless of any external variables. All drivers will observe the same contrast in most prevailing conditions according to standards and specifications.

This is one of the underlying reasons behind setting fixed percentages for colored versions of a given sheeting type with respect to its white counterpart in almost all standards and specifications, independent of the measurement angle (i.e. green is minimum 10% of white). When sheeting types are mixed, luminance contrasts are dictated by factors that cannot be controlled by the sheeting manufacturer, nor the agency. Different sheeting types—for example, 3M™ High Intensity Prismatic Reflective Sheeting Series 3930 which meets ASTM D4956 Type IV and 3M™ Diamond Grade™ DG³ Reflective Sheeting Series 4000 which meets ASTM D4956 Type XI—behave differently as entrance, observation, orientation and rotation angles change. These angles change with many independent factors including vehicle brand, driver location, distance to sign, sign location, lane position and sign placement (to name a few), and the resulting contrasts are at the mercy of these factors.

Continuous variation of contrast does not mean that a mixed-sheeting sign will fail under all conditions, but it does mean mixed-sheeting signs may underperform or fail to perform for a group of drivers, at certain viewing distances, or some combination of any of the factors mentioned above. As a result, the intended benefits of using a high-efficiency sheeting for the copy may be diluted by the use of a different sheeting for the background. Because of these performance concerns, 3M does not recommend mixing sheeting types or series on the same sign.

Balancing Luminance Contrast and Reducing Haloing

Although the human eye can adapt to varying levels of luminance and luminance contrasts, having either a very high positive contrast (brighter copy) or low contrast can both be detrimental to visibility. While the detrimental effect of low contrast is extensively documented in relevant scientific literature, having bright letters on dark backgrounds (leading to a relatively high contrast) can also lead to a reduction in legibility.

This is usually attributed to the scattering of light in the human eye, where the light coming from the body of the letter bleeds onto the critical detail of the letter, i.e. the unique component of the letter distinguishing it from other letters. As the eye ages, it becomes more vulnerable to light scattering, which is referred to as “disability glare” and many older drivers are susceptible to this type of glare. Disability glare generates the appearance of “haloing” in letters, as each letter becomes a light source on its own. Increasing the luminance of a sign background helps to balance the glare by providing an adaptation field.

Sivak and Olson (1985) recommended 12:1 as the optimal contrast for positive contrast signs, instead of decreasing the background luminance just to gain in nominal contrast. Similar literature recommends optimal contrast levels varying from around 6:1 to 12:1, depending on the overall sign luminance. A more recent study by Schnell, Yekhshatyan, and Daiker (2009) investigated whether legibility performance can be improved by reducing the background luminance without changing the luminance of the sign legend. Although reducing the background luminance increased contrast from 6:1 to 10:1, this type of an increase in contrast did not improve legibility. Researchers actually observed a slight decrease in the average legibility metric when contrasts were increased solely by reducing the background luminance.

Overall Sign Visibility

Reducing the sign background brightness reduces the visibility of the sign. When the overall brightness of a sign decreases, the sign’s visibility will be solely driven by the copy and the border (if any), which may not be sufficient, especially in urban environments with considerable visual clutter. Furthermore, increased overall brightness helps identify signs by providing longer distance conspicuity, which is sometimes referred to as “target value.” This was similarly identified in research by Gatscha et al. (2008) where eye movement characteristics were analyzed when reading different performance level traffic signs.

More recently work conducted by Schnell et al. (2022) found that brighter traffic signs reduced the time needed for drivers to acquire information, showing the efficiency of brighter sheeting in imparting their messaging. This is especially important as vehicle headlamps change. Work by Flannagan (2019) showed that newer LED lights provide lower levels of illumination for sign sheeting, on shoulder mounted signs, with the drop off being even more noticeable on overhead mounted signs, as the LED lights cut off more sharply compared to older incandescent headlamps. Brighter more efficient sheeting helps drivers see and understand the information signs are designed to provide by more effectively using the lower levels of light illuminating the signs.

Sheeting Warranty

A sheeting manufacturer's warranty will, by default, be determined by the weakest sheeting in terms of warranty. For example, if 3M™ Diamond Grade™ and 3M™ High Intensity Prismatic Sheeting are used in combination, the effective warranty will be that of high intensity prismatic sheeting.

Application Practices

If a specification calls for use of different types of sheeting, sign manufacturers will be forced to make signs by direct-applied-copy (DAC) method. This method increases the amount of sheeting needed to manufacture a sign, increasing sheeting waste, and precludes the use of common existing methods of sign making (i.e. by screen printing or imaging with colored transparent films) as well as emerging innovative imaging methods such as digital printing. Such alternative imaging methods can reduce overall sign costs as well as increase sign durability and performance.

Conclusion

For the reasons outlined above, 3M does not recommend using multiple retroreflective sheeting series on the same sign.

Bibliography

Sivak, Michel and Olson, Paul L.. Optimal and Minimal Luminance Characteristics for Retroreflective Highway Signs. Transportation Research Institute, the University of Michigan. 1985.

Michael Gatscha, Günther Schreder, Sandra Reichenauer. 2008. Analysis of eye movement characteristics at different laminated retroreflective traffic signs under realistic nighttime driving conditions. *87th Annual Meeting of the Transportation Research Board*. Transportation Research Board. 2008.

Schnell, T. et al. 2022. Traffic Signs and Real-World Driver Interaction. Manuscript Draft for Transportation Research Board Annual Meeting. 2023.

M. J. Flannagan, 2019. A Market-Weighted Description of Tungsten-Halogen and LED Low Beam Headlight Patterns in the US. University of Michigan Transportation Research Institute. Ann Arbor, Michigan, Report UMTRI 2019-5.

Health and Safety

Tools and Equipment Usage

When using any equipment, always follow the manufacturer's instructions for safe operation.

Chemicals

When handling any chemical products, read the manufacturers' container labels and the Safety Data Sheets (SDS) for important health, safety, and environmental information.

[Follow this link to obtain SDS sheets for 3M products.](#)

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