Supporting scientific literature

1. Retroreflectivity of road markings should not on any road drop below:
   - 150 mcd/m²/lx under dry conditions
   - 50 mcd/m²/lx under wet conditions
   - 35 mcd/m²/lx under rainy conditions

Analysis based on preview distances, concluding: “This study recommends a minimum retroreflectivity of 150 mcd/m²/lx for white and yellow pavement markings in both dry and wet night time conditions.”

Closed-circuit field testing in the United States, concluding: “The results suggested that the threshold value of an acceptable versus unacceptable level of retroreflectivity appeared to be between 80 and 130 mcd/m²/lux for (…) drivers younger than 55 and between 120 and 165 mcd/m²/lux for drivers older than 55.”

Driving simulator testing of horizontal road markings with high and low retroreflectivity, concluding: “The study found consistently superior results for the enhanced markings in comparison to the standard markings for both the objective driving performance and the workload/subjective data.”

Closed-circuit field testing in Austria, with enhanced road marking having retroreflectivity under dry conditions 407–572 mcd/m²/lx and under wet conditions 43–112 mcd/m²/lx, concluding: “the presence of enhanced road markings did significantly increase driver comfort, especially for older drivers.”

Questionnaires assessment after test application of enhanced road marking, concluding: “58-75% of respondents reported noticing markings with retroreflectivity higher than the standard (…). Over 80% of respondents felt that road safety during nighttime driving would increase if horizontal markings had higher retroreflectivity.”

Evaluation of vision-based lane-departure warning systems (LDWS), concluding: “improving the retroreflectivity (...) improves the performance of LDWS (...) performance improves significantly with the use of enhanced types of pavement markings that have high visibility during rain.”

2. **The width of horizontal road markings should not be less than 15 cm**


Statistical analysis of accidents in the United States, concluding: “This study provides detailed evidence to suggest that wider edge lines are effective in reducing crashes on rural, two lane highways, especially with regard to relevant target crashes such as single vehicle crashes (...). The safety effects of wider edge lines were consistently positive and statistically significant using data from three states.”


3. **The unification of markings across various countries is needed to improve the reliability of machine vision and universality of automated vehicles, but also to improve mobility and safety amongst human drivers**


Comprehension of road signs varies widely between cultures and countries. The study concluded: “signs that conform to good ergonomic design principles are more likely to be fully comprehended than signs that violate these requirements. **Signage should be standardized across countries as much as possible, so that the number of signs unique to a country will be kept to a minimum.**”


4. **Maintenance of a sufficiently high contrast ratio between the marking and pavement is needed to mitigate possible false readings caused by glare.** While a contrast ratio of 3:1 appears sufficient, better results can be achieved with a 4:1 ratio


Even though the glare studies concentrated on glare caused by a light source and detection of pedestrians, the same principles do apply to visibility of road markings: “The results show that the relatively low glare source caused a significant drop in detecting simulated pedestrians along the roadside and made participants drive significantly slower on dark and winding roads.”


Analysis of accidents frequency in Japan, concluding: “when the sun is in a position that tends to blind drivers, traffic accidents tend to be more frequent”.


Analysis of accidents frequency in the United States, concluding: “odds of glare crash occurrence are higher in east and west bound compared to north and south bound directions.”


Glare might cause effects similar to driving in fog, where due to a “perceptual quirk: it appears that drivers think they are driving far more slowly than they actually are in foggy conditions, and therefore increase their speed.”


A laboratory evaluation of capability to detect an object under constant luminance in the presence and absence of glare, concluding: “Glare increased the contrast needed for detection of the foveal target (…). For peripheral targets, contrast threshold was also reduced by the presence of extraneous light at a non-target location and this effect was increased in the presence of glare.”


Pavement marking tapes with high values of Y and black contrast exhibit plateau behaviour over a wide range of illuminations conditions that result in Weber contracts above a threshold level (~ 4 for the camera specifications used in this study), and a linear dependence on Weber contrast for Weber contrast below that threshold.