



Road markings: Choose the right type of retroreflector

It's well known that the visibility of road markings is important for the traffic flow and road safety. The reflection properties giving the visibility of the road marking are measured using a retroreflector. Road marking management programs, securing minimum values for visibility, can help reduce accidents, save money and provide valuable information for asset utilisation. Likewise service performance and economy can be improved when maintenance decisions are based on monitoring and not on fixed replacement intervals.

The type of retroreflector needed for measuring the visibility of road markings is depending on the visibility parameters and the type of road marking you need to measure.

This paper describes the different visibility parameters and types of road markings and explains how this is related to the types and parameters of the retroreflector needed for the measurement. Furthermore, easy-to-use and safety aspects as measurement time and ergonomics, additional monitoring of weather conditions and GPS position and validity of the calibration standard are features to be considered.

For interfacing with road markings management and GIS systems, reporting and data communications are becoming important features.

Road marking visibility parameters

The basic parameters used to characterise visibility of road markings are the retroreflection for night time

visibility and the reflection in daylight or under road lighting.

The characteristic used for retroreflectivity is the coefficient of retroreflected luminance, R_L . To characterise the visibility in daylight the luminance coefficient in diffuse illuminations Q_d is used. Both parameters are defined in ASTM E1710, and in EN1436. Both standards are based on a measurement geometry simulating that a driver is observing a marking 30 m ahead of the vehicle. Retroreflectometers used for measurements on road markings must comply with the formal requirements of the standards relating to the 30 m geometry, spectral correction, and linearity and have a profile height capacity sufficient for the type of profiles to be measured. Further to this, instruments should have sufficient capability in view of practical field performance, adequate calibration standards, and they should provide additional features securing correct measurements under different field conditions.*

The night time visibility, the retroreflectivity R_L , measured in $\text{mcd/m}^2\text{lx}$, is basically measured in dry condition. Further to this, the R_{ill} can be measured in wet condition, or during rain.

For measuring R_{ill} in wet condition both EN and ASTM specify that the test conditions shall be created using clean water from a bucket at a height of about 0.3 m above the surface. The R_L in condition of wetness shall be measured after 60 seconds. Wet timers giving an acoustic signal after this period are integrated in the software of some instruments. On wetted road marking the R_L value is often small



while the surface reflection is strong. Retroreflectometers should be constructed in a way that surface reflections do not provoke an offset. A possible offset can be tested using a black acrylic plate whose R_L is zero. The measured value on such a plate should not exceed $2 \text{ m cd/m}^2 \cdot \text{lx}$.

Testing R_L in rain conditions requires a test condition where an artificial rain fall is created without mist or fog at an average intensity of 20 mm/hour. The measurement of rain is done after 5 min. of continuous rain or when stability of the measurement is achieved. Retroreflectometers for testing continuous rain must have an open beam construction having the measurement field in front of the instrument.

The visibility in daylight and street lighting conditions based on the use of the 30 m geometry is characterised by the Q_d also measured in $\text{mcd/m}^2 \cdot \text{lx}$. The Q_d is only specified for dry surfaces. Instruments capable of measuring Q_d must have a diffuse illumination system with properties specified in the standards.

From the above it is clear that it is not possible at the same time to measure R_L in rain condition and Q_d . The diffuse illumination above the road marking prevents the open beam construction.

Measuring of nighttime color

In order to measure the nighttime color of the pavement markings optional features includes measuring of chromaticity coordinates. This has major importance in many countries in securing that the yellow road markings are yellow and not white when

observed by night at realistic driver conditions. To measure the color, a retroreflectometer with three optical filters representing the human eye color sensitivities is used.

Road markings types – profile height capacity

The material type of a road marking like paint based or thermoplastic etc. do not affect the measuring of retroreflection. The important parameter is the instrument's ability to measure structured road markings or non planar markings having texture, curvature humps or particles on the surface.

When measuring structured pavement markings the instrument is left on the top of the structure, while measurement is done at the sides and bottom of the structure. In most retroreflectometers the measurement field contains the illumination field. The measured area of the road marking is in these systems the illumination field. Both the ASTM and the CEN standards specify that the minimum size of this shall be minimum 50 cm^2 , but as road markings can be very inhomogeneous, a larger field is highly preferable in order to average the measurements, and fewer readings need to be taken.

The structured road marking results in a movement of the two fields determined by the profiled height or the gap between the profiles. The height capacity of a retroreflectometer is depending on the ratio between the length of the illumination field and the length of the measurement field. Further information on this matter can be located in Technical Note 104.*



Three classes of road markings are recommended with the criterion that the reading measurements must not deviate more than 10%.

Class 1: Non-structured markings: 2 mm (specified as the minimum in the CEN and ASTM standards).

Class 2: Moderately structured road markings 2-5 mm

Class 3: Heavily structured road markings: More than 5 mm in profile height.

To measure a heavily structured profile as a rumble stripe with a profile depth of 12 mm, you will need a Class 3 retroreflectometer with at least 12 mm in profile height capacity. It is not possible to measure a structured marking with an instrument having a lower profile height capacity than the profile depth.

In figure 1 two types of retroreflectometers are shown: The LTL-X Class 3 retroreflectometer for measuring profiles up to 15 mm in depth and both R_L in dry, wet and continuous rain conditions, and the new LTL-XL Class 2 retroreflectometer for profiles up to 5 mm for R_L in dry and wet conditions and including daytime visibility Qd measurement. The LTL-XL is based on state of the art LED technology resulting in extreme reliable operation and long lifetime. The measuring should not be affected by stray light. Some instruments use different means to prevent daylight from entering into the instrument resulting in an offset. These means are seldom effective when the instruments are used on structured markings. It is recommended that the retroreflectometer has an automatic electronic stray light compensation.

	LTL-X Retroreflectometer	LTL-XL Retroreflectometer
Measurement time:	Less than 0.01 sec	R_L : 1 sec. / R_L and Qd : 3 sec.
Parameter:	R_L : dry, wet and rain condition	R_L : dry, wet and Qd
Profile height capacity:	Class 3 : 15 mm	Class 2 : 5 mm
Measurement area:	200x50 mm	185x50 mm
Weight:	9 kg	6.8 kg
Dimensions:	570x22x540 mm	570x22x540 mm
Data storage:	More than 1000 measurements	More than 200.000 measurements
Additional features:	<ul style="list-style-type: none"> Extended ID functions Single handed operation Adjustable handle Wheels GPS Printer 	<ul style="list-style-type: none"> Extended ID functions Air temperature and humidity measurement Single handed operation Adjustable handle Wheels GPS Printer

Figure 1.

Additional parameters measured

In order to monitor the geographical position for the measurement, GPS is integrated in the retroreflectometer. Important features are the updating time which should not be more than a few seconds as well as the precision. Rapid and precise retagging using GPS is done with 50 channel precision GPS receivers in DELTA's retroreflectometers.

For monitoring the ambient weather conditions during the measuring time, both air temperature and air humidity are monitored. The R_L and Qd data with GPS, temperature and humidity measurements can be stored in the retroreflectometer. The LTL-XL has a storage capacity of more than 200,000 measurements. All instrument settings including calibration are also stored.





Easy and safe to use – measuring time

An important feature is that the instrument is easy to use and the operation results in reliable measurement. It is preferable that the operation is single handed and that the measurement is done with a single touch. The measurement time is an important parameter and should be as short as possible. A measurement time shorter than one second for a measurement is preferable.

The display should be easy to read in full daylight. Further, the instrument should have features for ID of the measurements: Road marking type, user name, day and time, road name and for averaging functions. In figure 2 the instrument display is shown for the LTL-XL retro-reflectometer.



Figure 2.



Figure 3.

For improved handling the retro-reflectometer can be fitted with wheels and adjustable handle as shown in figure 3.

Calibration standards and traceability

A very important aspect in all metrology is traceability of the measurement. The traceability can be directly

to national primary laboratories or more frequently to reference laboratories. In these laboratories regular audits of the approved calibration procedures and traceability to the international primary laboratories ensure the highest level of accuracy. All standards supplied with DELTA retroreflectometers are calibrated in DELTA's accredited laboratory which is direct traceable to PTB and NIST.

Reporting and data communication

Built-in printers can be used for instant printing of the measurement results. The instrument should be delivered with software enabling the results to be downloaded for report generation. Geotagging using GPS mapping software allows to you to link your data to geographical maps and GIS systems as shown in figure 4. USB, Bluetooth and Ethernet connectivity allow easy connection to any PC equipment, PDAs and Smartphones.



Figure 4.

* See www.roadsensors.com/technical information – Technical Notes RS100-104

