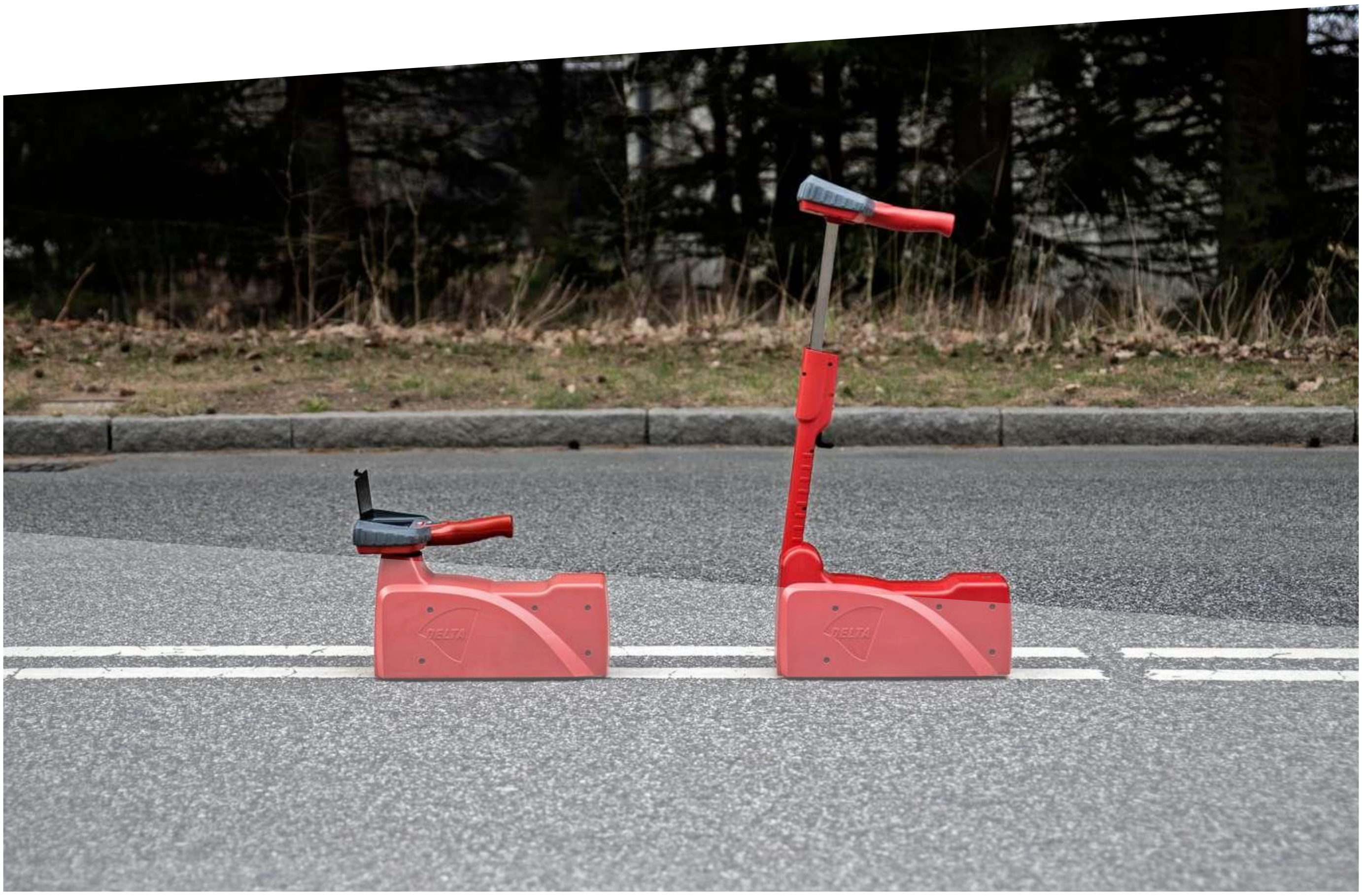
Guidance for the measurement of R_L and Qd of road markings with DELTA handheld instruments



1 Introduction

DELTA handheld retroreflectometers are used for the measurement of R_L and Qd values of plane and profiled road markings. Refer to annex A for an introduction to these concepts.

NOTE: The DELTA vehicle mounted retroreflectometer LTL-M measures the R_L values of longitudinal road markings while driving at speed. This instrument copes with any road marking without precautions and is, therefore, not considered in the following.

2 General aspects

For handheld instruments, there are some general aspects to consider:

a. the instrument should point in the driving direction,
b. at a site, the instrument should be placed at a few locations, and the average of the R_L and Qd values should represent the site,
c. on a broken line, measurements should be taken on the lines only, not in the gaps.

Re. a.: The patterns of some profiled road markings introduce a directionality of the R_L and Qd values. However, it is reasonable to measure in the driving direction only. See figure 1.

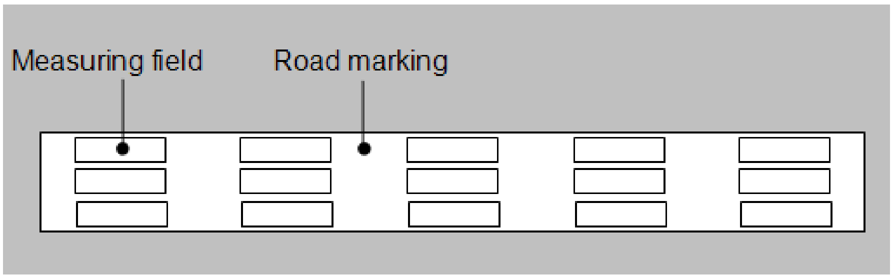
Figure 1: A profiled road marking with directionality of the R_L and Qd values.

Re. b.: When at a site, it is easy to move the instrument to a few locations in the longitudinal direction. If the road marking is wide, for instance 20 cm or more, the instrument should also be moved to a few transverse locations. The instrument itself can provide the average value.

COST 331:1999 "*Requirements for horizontal road markings*" demonstrates that the visibility of road markings depends on average values – not on details of variation.

Figure 2 illustrates locations of the measuring field of on a wide road marking.

Figure 2: *Locations of the measuring field on a wide road marking.*



Re. c. COST 331 informs that a broken line is less visible than a continuous line of the same width and provides a correct method for the evaluation of broken lines.

NOTE: An excel file, “Visibility excel”, interprets COST 331. It is available on nmfv.dk. This is a link: Visibility Excel

3 Aspects for profiled road markings

Profiled road markings introduce some further considerations:

d. whether or not the instrument can measure profiled road markings correctly,
e. if yes, then how to do the measurements.

Re. d.: This is a matter of reserve in the fields of measurement and illumination, which can be tested by lifting the instrument in steps above a road marking sample until the value starts to decrease. The result is the final lift height H.

These heights can be expected to be different for R_L and Qd.

EN 1436:2017 “*Road marking materials – Road marking performance for road users and test methods*” states that: “When an instrument is able to perform at a height position H, it is able to measure structured road markings when the structure height is at most H or the gaps between structures is at most 25 × H”. This applies for both R_L and Qd – refer to clauses B.4.2.4 and A.4 of EN 1436.

Re. e.: DELTA instruments have ample properties for measuring profiled road markings. As examples, the LTL 3000 and LTL 3500 have a lift height of 7 mm for both R_L and Qd, while the LTL-XL has even higher lift heights.

The measured values may vary along a profiled road marking, but the average values, when following a particular procedure, are correct.

4 How to measure profiled road markings

The general aspects of clause 2 apply.

A profiled road marking may be described by its module, i.e., the length in which the pattern repeats itself.

For profiled road markings whose R_L and Qd values vary little with the location of the instrument, there is no special concern. This applies for profiled road markings with modules of up to 10 cm. An example is shown in figure 3.

Figure 3: Two profiled road markings with short modules.

For other profiled road markings, the measured values will vary with the location in the longitudinal direction.

An example is shown is figure 4.

This example applies for a marking with a sequence of 7 cm line and 7 cm gap, and accordingly a module of 14 cm. It is an often-used profiled road marking with the trade name of “Longflex”. The values of figure 4 are obtained by moving the instrument in steps that are a bit longer than the module as illustrated in figure 5.

Figure 4: Variation of the measured values when moving the instrument in steps.

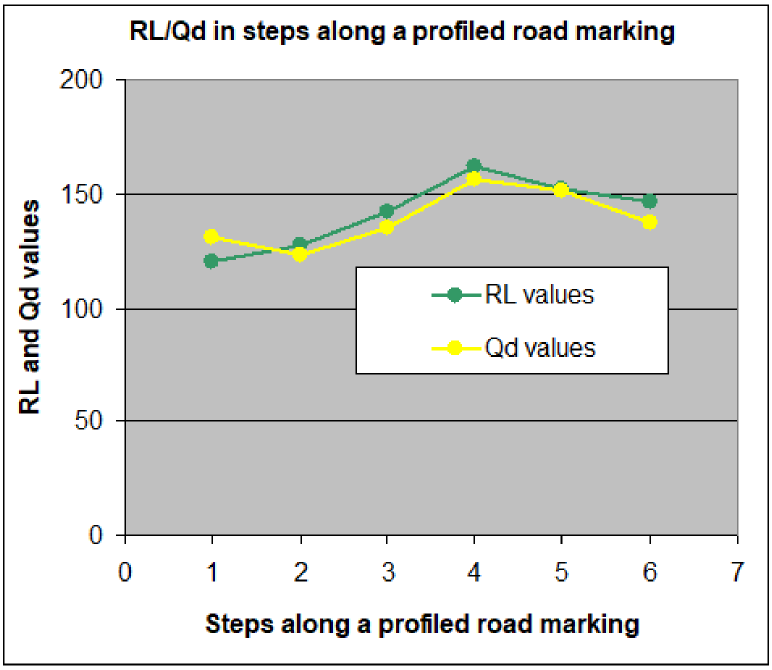
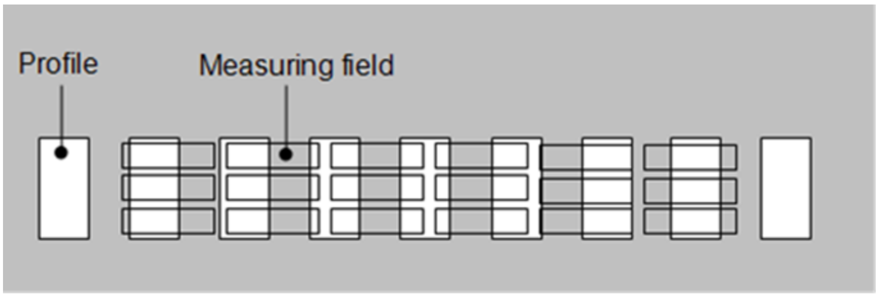


Figure 5: Movement of the instrument in steps that are a bit longer than the module.



The steps are arranged in such a way that one more step would bring the measured field in the same position relative to the profiles as in the first position.

This sounds a bit difficult to figure out when standing at a road, but it needs not be very accurate and the strategy can be to place the instrument at a location where the back of the instrument matches the back side of a profile and to move it a fixed length forward relative to the profiles in each step – for instance by 2 cm.

When done reasonably correct, the average values are the correct representations of the road marking.

NOTE: Figure 5 is just an illustration as the measured field of DELTA instruments is longer than the module of this profiled road marking.

Some profiled road markings have profiles that are not at a right angle. In this case, the instrument should be placed in the same transverse position in all the steps.

Annex A: R_L and Qd

The ability of a road marking to provide luminance and contrast in headlamp illumination at night is measured by the coefficient of retroreflected luminance R_L.

See the illustrations in figures A.1 and A.2 for respectively the dry and a wet condition. For wet conditions, only road markings with special properties maintain some retroreflection. These are mostly profiled road markings.

R_L applies for a field on a road marking or road surface and is the ratio between the luminance of the field created by headlamp illumination and the illuminance at the field on a plane perpendicular to the illumination direction.

As luminance has the unit of candela per square meter ($cd \cdot m^{-2}$) and illuminance the unit of lux (lx), R_L has the unit of $cd \cdot m^{-2} \cdot lx^{-1}$. However, the 1000 times smaller unit of $mcd \cdot m^{-2} \cdot lx^{-1}$ is used in practice.

R_L is measured in the 30 m geometry defined in EN 1436 and ASTM E1710-18.

The ability to provide luminance and contrast is daylight is measured by the luminance coefficient in diffuse illumination Qd. See the illustration in figure A.3.

Qd_L applies for a field on a road marking or road surface and is the ratio between the luminance of the field created in diffuse illumination and the illuminance on the field.

As luminance has the unit of candela per square meter ($cd \cdot m^{-2}$) and illuminance the unit of lux (lx), Qd has the unit of $cd \cdot m^{-2} \cdot lx^{-1}$. However, the 1000 times smaller unit of $mcd \cdot m^{-2} \cdot lx^{-1}$ is used in practice.

Qd is measured in the 30 m geometry defined in EN 1436 and ASTM E2302-03a.

Figure A.1: Headlamp illumination of road markings – dry conditions.

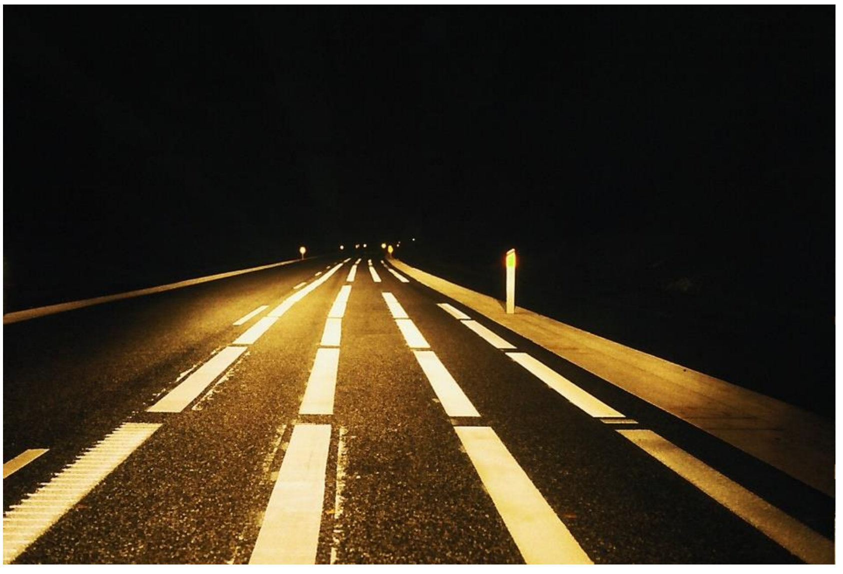


Figure A.2: Headlamp illumination of road markings – wet conditions.

Figure A.3: Road markings in daylight.