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ZEHNTNER
TESTING INSTRUMENTS

TRANSLATION TEST REPORT

FEDERAL HIGHWAY RESEARCH INSTITUTE

(BASt)

re: the suitability of the measuring instrument ZRM 1013
Test no. 3201
(This test report includes 5 pages and an appendix of 4 pages)

Enclosures:
1. Original test report „Bundesamt für Strassenwesen“
2. Translation test report
3. Determination of night and day visibility (RL&Qd) of road markings

Bundesanstalt für Straßenwesen

Bundesanstalt für Straßenwesen • Postfach 100150 • D-51401 Bergisch Gladbach

7. Mai 2001

PRÜFBERICHT

über die Eignung des Messgerätes ZRM 1013
Prüf-Nr. 3201
(Dieser Prüfbericht umfasst 5 Seiten und eine Anlage von 4 Seiten)

1. Antrag

Antragsteller:	Zehntner GmbH Bärenmattenstr. 3 CH-4434 Hölstein
Antrag vom:	30. März 2001
Antragsache:	Feststellung der Eignung des Messgerätes ZRM 1013 Zehntner-Retroreflektometer R_L/Q_d zur Messung des Leuchtdichtekoeffizienten bei diffuser Beleuchtung Q_d und des Leuchtdichtekoeffizienten bei Retroreflexion R_L (Definition s. jeweils EN 1436) von Fahrbahnmarkierungen

2. Das Messgerät

Beschreibung (Angaben gemäß Unterlagen des Herstellers):	Das Messgerät ZRM 1013 ist als Kombinationsgerät sowohl zur Messung von Q_d als auch R_L ausgelegt. Es ist auch lieferbar nur für die Messung von Q_d oder R_L. Das ZRM 1013 ist ein tragbares, akkubetriebenes Messgerät. Die in dem Gerät verwendeten Messgeometrien entsprechen den Anforderungen der EN 1436. Für die Messung von Q_d und R_L werden zwei verschiedene Lichtquellen verwendet. Anstelle einer Kugel wird bei der Messung von Q_d die innere Fläche einer Kugelschicht, in deren Mitte der Kugelmittelpunkt liegt, zur Ausleuchtung der Messfläche verwendet. Die Messfläche beträgt 50 mm x 100 mm.

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Messprinzip:

Messgrößen sind

1. der Leuchtdichtekoeffizient bei diffuser Anleuchtung Q_d nach EN 1436: Anleuchtung der Markierungsoberfläche mit diffusem Licht, Messung des von der Markierungsoberfläche unter dem Beobachtungswinkel von 2,29° reflektierten Lichtes

2. der Leuchtdichtekoeffizient bei Retroreflexion R_L nach EN 1436: Anleuchtung der Markierungsoberfläche unter 1,24°, Messung des von der Markierungsoberfläche unter 2,29° retroreflektierten Lichtes.

3. Durchgeführte Messungen

Messproben:

Als Messproben wurden 18 Muster von verschiedenen Markierungen mit erhöhter Nachtsichtbarkeit bei Nässe verwendet. Die Art der Oberflächengestaltung ist in nachfolgenden Tabellen vermerkt. Die Proben befanden sich bei der Messung im Neuzustand.

Durchführung der Messungen:

Bei allen Proben wurde der Leuchtdichtekoeffizient bei diffuser Beleuchtung bzw. der Leuchtdichtekoeffizient bei Retroreflexion einmal mit dem zu untersuchenden Gerät und einmal mit den Messgeräten Reflektometer Qd 30 bzw. LTL 2000 der Fa. Delta Lys & Optics gemessen. Die Geräte wurden so auf die Probenoberfläche justiert, dass jeweils etwa die gleichen Teile der Markierungsoberfläche gemessen wurden. Da die Messfläche des Gerätes ZRM 1013 erheblich kleiner ist als die Messfläche des Delta-Gerätes, wurden mit dem Delta-Gerät ein Messwert und bei dem ZRM 1013 mindestens drei Messwerte je Messprobe aufgenommen. In die Tabellen wurde der Messwert des Delta-Gerätes und der Mittelwert aus allen Einzelmesswerten des ZRM 1013 eingetragen.

Die Messung erfolgte gemäß der jeweiligen Bedienungsanleitungen zu beiden Geräten.

4. Messergebnisse

4.1 Tabelle 1: Messwerte und Abweichungen für Q_d

Probe Nr.	Art der Oberfläche der Markierungsprobe	Q_d (mcd/m².lx)			prozentuale Abweichung ZRM 1013 von Ø
		Gerät LTL QD 30	Gerät ZRM 1013	gemeinsamer Mittelwert Ø	
A	Große Perlen (g. P.)	205	195	200	-2,5
B	g. P.	212	207	209,5	-1,2
C	g. P.	173	174	173,5	+0,3
D	g. P. und Strukturmarkierung	224	215	219,5	-2,1
E	g. P.	179	179	179	0
F	g. P.	217	213	215	-0,9
G	g. P.	255	247	251	-1,6
H	g. P.	242	245	243,5	+0,6
I	g. P. und Strukturmarkierung	196	207	201,5	+2,7
L	Strukturmarkierung	200	186	193	-3,6
N	Schrägprofil	176	172	174	-1,2
O	Agglomerate	198	202	200	+1,0
1	Grobe Nachstreumittel	259	269	264	+1,9
2	Typ 1-Oberfläche	261	269	265	+1,5
3	Strukturmarkierung	248	252	250	+0,8
4	Typ 1-Oberfläche	257	260	258,5	+0,6
5	Typ 1-Oberfläche	251	263	257	+2,3
6	Tetraeder-Profil	238	242	240	+0,8
	Alle Proben				0

4.2 Tabelle 2: Messwerte und Abweichungen für R_L

Probe Nr.	Art der Oberfläche der Markierungsprobe	R_L (mcd/m².lx)			Prozentuale Abweichung ZRM 1013 von Ø
		LTL 2000	ZRM 1013	gemeinsamer Mittelwert Ø	
A	Große Perlen (g. P.)	83	86	84,5	+1,8
B	g. P.	117	116	116,5	-0,4
C	g. P.	171	173	172	+0,6
D	g. P. und Strukturmarkierung	221	224	222,5	+0,7
E	g. P.	115	119	117	+1,7
F	g. P.	203	213	208	+2.4
G	g. P.	100	110	105	+4,8
H	g. P.	677	719	698	+3,0
I	g. P. und Strukturmarkierung	184	178	181	-1,7
L	Querprofil	302	271	286,5	-5,4
N	Strukturmarkierung	153	140	146,5	-4,4
O	Strukturmarkierung/Profil	194	217	205,5	+5,6
1	Grobe Nachstreumittel	323	327	325	+0,6
2	Typ 1-Oberfläche	320	312	316	-1,3
3	Strukturmarkierung	448	453	450,5	+0,6
4	Typ 1-Oberfläche	77	84	80,5	+4,4
5	Typ 1-Oberfläche	45	49	47	+4,3
6	Tetraeder-Profil	90	96	93	+3,2
	Alle Proben				+1,1

5. Bewertung der Messergebnisse

5.1 Leuchtdichtekoeffizient bei diffuser Reflexion Q_d

Tabelle 4.1 zeigt, dass die Messwerte des ZRM 1013 um höchstens +2,7 %/-3,6 % vom gemeinsamen Mittelwert beider Messgeräte abweichen. Die mittlere Abweichung beträgt 0 %.

5.2 Leuchtdichtekoeffizient bei Retroreflexion R_L

Tabelle 4.2 zeigt, dass die Messwerte des ZRM 1013 um höchstens +5,6 %/-4,4 % vom gemeinsamen Mittelwert beider Messgeräte abweichen. Die mittlere Abweichung beträgt + 1,1 %.

5.2 Gesamtbeurteilung

Die Abweichungen der Messwerte des Messgerätes ZRM 1013 vom gemeinsamen Mittelwert liegen sowohl für den Leuchtdichtekoeffizienten bei diffuser Reflexion Q_d als auch für den Leuchtdichtekoeffizienten bei Retroreflexion R_L im Rahmen der zulässigen Messgenauigkeit. Das Gerät ist damit für die Messung der beiden Messgrößen geeignet. Es wird empfohlen, zur Erhöhung der Sicherheit der Messwerte bei stärker strukturierten bzw. profilierten Messproben die Anzahl und Anordnung der Messwerte gemäß der diesem Prüfbericht beigefügten Anlage der Zehntner GmbH Testing Instruments: „Bestimmung der Nacht- und Tagessichtbarkeit (RL & Qd) von Strassenmarkierungen)" vorzunehmen.

(Dr. Meseberg)
Regierungsdirektor

Bundesanstalt für Straßenwesen
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ZEHNTNER GmbH TESTING INSTRUMENTS

Bestimmung der Nacht- und Tagessichtbarkeit (RL & Qd) von Strassenmarkierungen:

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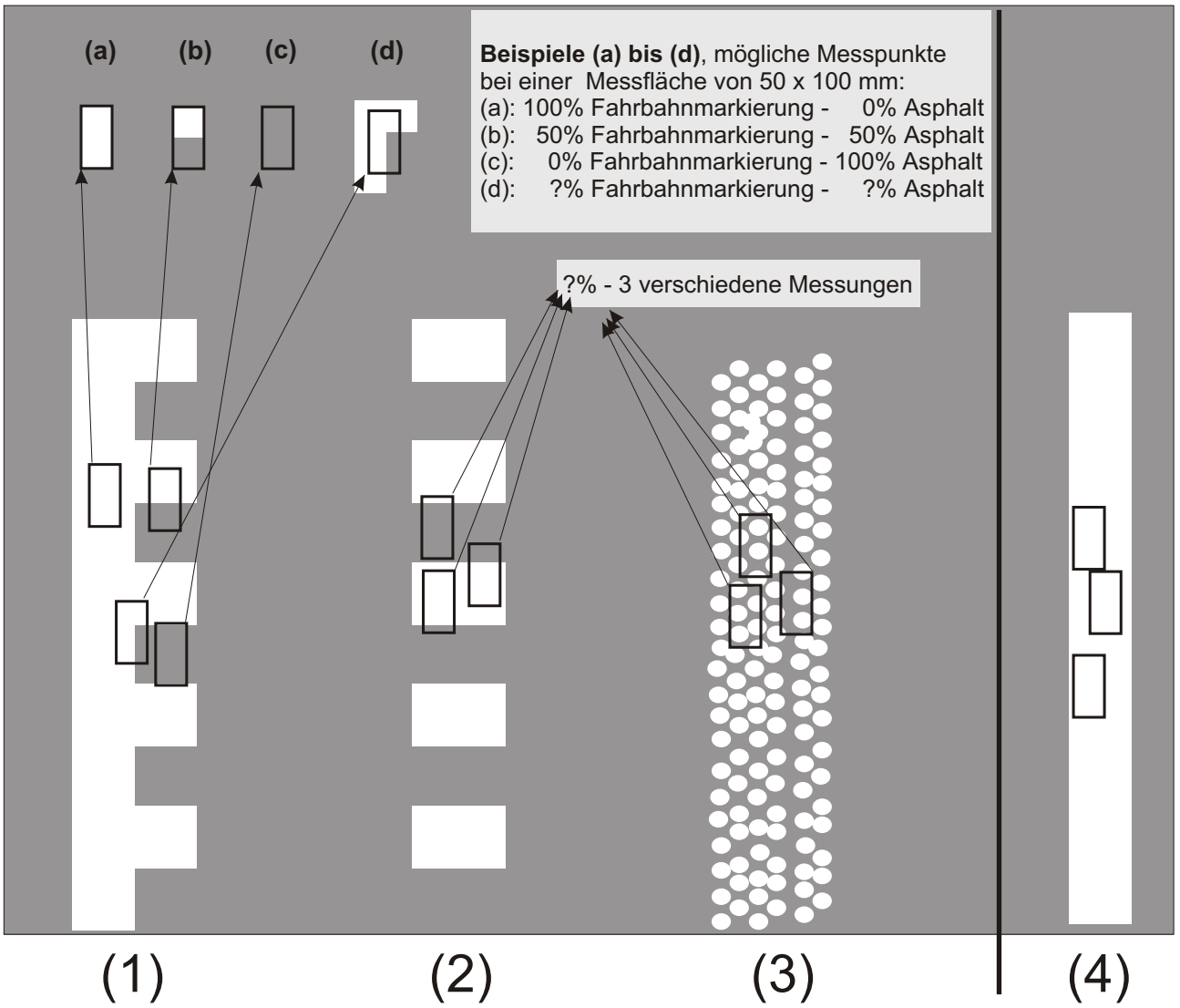
Mögliche Fehler bei der Bestimmung der Tages- und/ oder Nachtsichtbarkeit einer Fahrbahnmarkierung



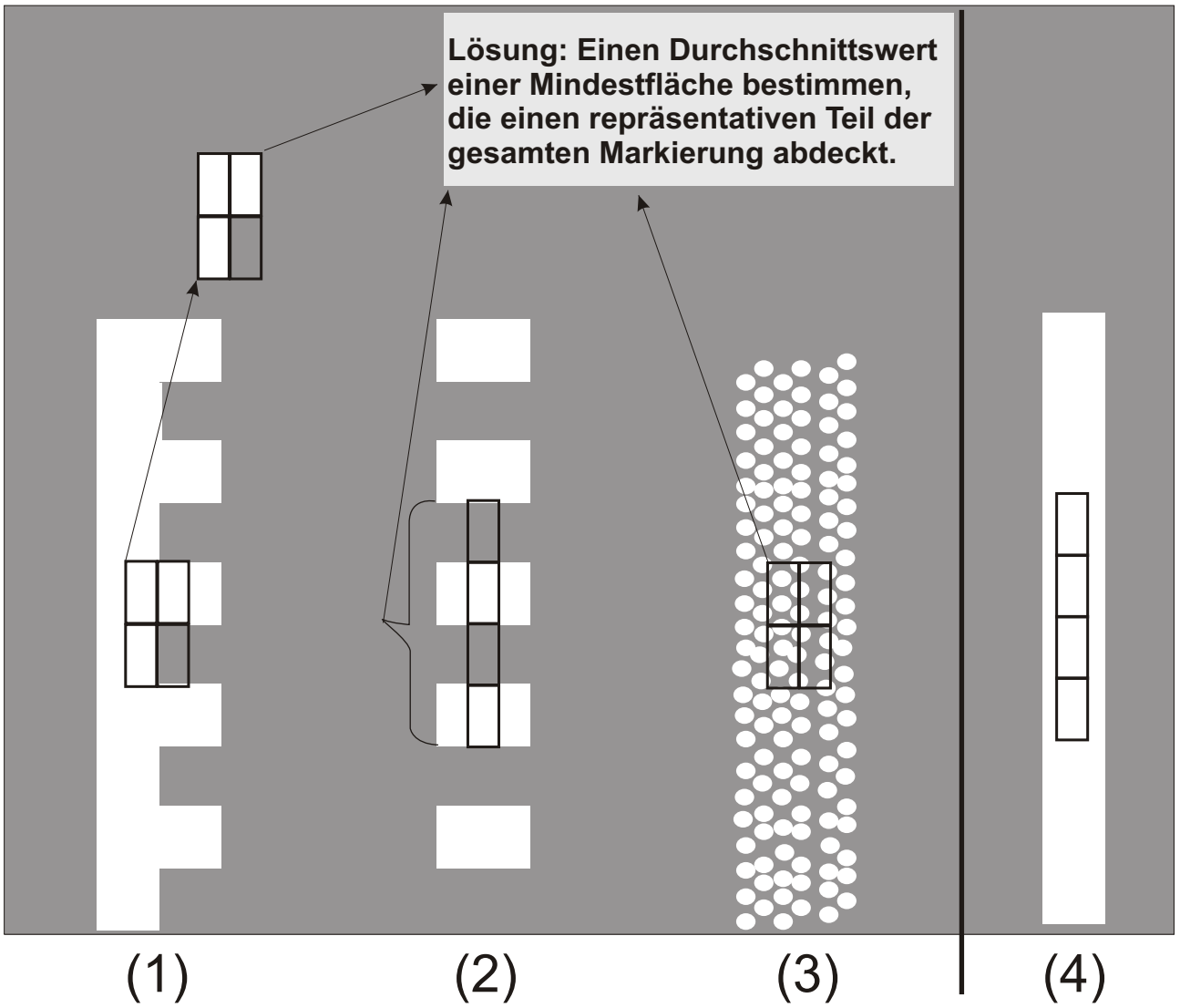
Kommentar:

Obenstehende Illustration zeigt, wie Sie auf keinen Fall messen sollten.

Alle 4 oben skizzierten Markierungen wurden in Hillerød, Dänemark, gemessen und sind auf den Fotografien im Report des Expert Panel von CEN/TC 226 WG2 zu sehen.

Es liegt auf der Hand, dass auf den Markierungen (1), (2), (3) jede Einzelmessung (markiert durch ein Rechteck) einen verschieden grossen Anteil an Weiss (Farbe, Thermoplastik) und Reflexmaterial aufweist. Daher muss ein Messgerät an den verschiedenen markierten Messpunkten der Markierungen (1), (2), (3) deutliche unterschiedliche Werte für RL wie für Qd messen!
Folglich ist es nicht möglich, Messergebnisse von zufällig positionierten Instrumenten zu vergleichen. Zudem ist es nicht legitim, aus den Beispielen (a) bis (d) Rückschlüsse hinsichtlich Abweichung und Wiederholbarkeit eines Gerätes zu ziehen.

Korrekte Bestimmung der Tages- und/oder Nachtsichtbarkeit einer Fahrbahnmarkierung



Kommentar:

Obenstehende Illustration zeigt, wie Sie Messungen vornehmen sollten.

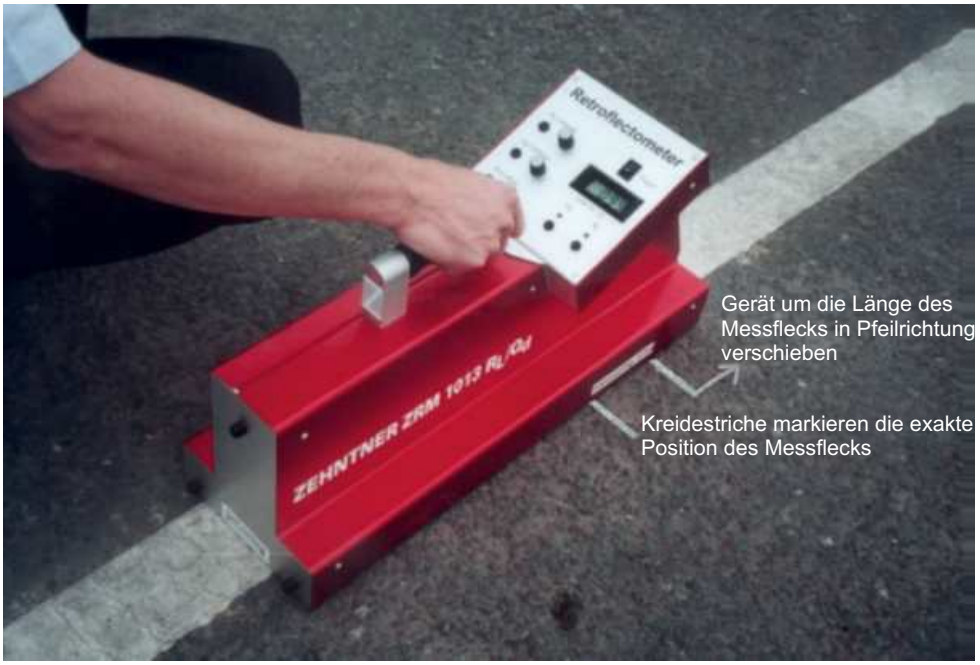
Alle 4 oben skizzierten Markierungen wurden in Hillerød, Dänemark, gemessen und sind auf den Fotografien im Report des Expert Panel von CEN/TC 226 WG2 zu sehen.

Eine Möglichkeit, die vorher beschriebenen Fehler zu vermeiden, ist folgendes Vorgehen:
- Bestimmen Sie eine Mindestfläche, die einen repräsentativen Teil der Markierung abdeckt.
- Machen Sie die notwendige Anzahl Messungen, um die vorher bestimmte Fläche zu messen.
- Bestimmen Sie den Mittelwert: **Dies ist der Wert für die Tages- resp. Nachtsichtbarkeit der Markierung!**

Sogar auf der Markierung (4) ist diese Lösung vorzuziehen, selbst wenn dort niemals dieselben grossen Unterschiede gemessen werden.

Es ist wichtig zu wissen, wo genau sich bei einem Messgerät der Messfleck befindet. In nebenstehender Abbildung ist illustriert, wo dieser beim ZRM 1013 ist.
Mit Hilfe der seitlichen Markierungen (”measuring area”) sowie vorne und hinten ("road marking”) kann das Gerät ganz exakt positioniert werden.
Um eine grössere, zusammenhängende Fläche zu messen, wie auf der vorhergehenden Seite gezeigt, gehen Sie z.B. vor wie auf untenstehender Fotografie gezeigt:

- Sie möchten 4 hintereinander liegende Messungen machen:
- Dazu stellen Sie das Gerät an einem Ende der zu messenden Strecke auf die Markierung;
- Wert messen und notieren;
- markieren Sie mittels Kreidestrich die Position der Gerätes und verschieben Sie das Gerät um genau die Länge des Messflecks nach vorne (vgl. Pfeil);
- erneut Wert messen und notieren, mit Kreide die Position des Messflecks markieren und das Gerät verschieben, bis die gesamte Fläche gemessen ist;
- berechnen Sie den Durchschnitt, indem Sie die Summe der Messwerte durch die Anzahl Messungen teilen



TEST REPORT

re: the suitability of the measuring instrument ZRM 1013
Text no. 3201
(This test report includes 5 pages and an appendix of 4 pages)

1. Application

Applicant: Zehntner GmbH
Baerenmattenstr. 3
CH-4434 Hoelstein

Dated: May 30, 2001

Subject: Determination of the suitability of the measuring instrument ZRM 1013 Zehntner-Retroreflectometer RL/Qd for measuring the luminance factor for diffused illumination Qd and the luminance factor for retroreflection RL (definition cf. EN1436) of road markings

2. The measuring instrument

Description (taken from the manufacturers data):

The measuring instrument ZRM 1013 is designed as a combined instrument for measuring Qd as well as RL It can also measure Rl only or Qd only. The ZRM 1013 is a portable, accumulator-powered measuring instrument. The measuring geometries used in the instrument conform to the requirements of EN 1436. For the measurement of Qd and RL, two different light sources are being used. For the Qd-measurement, instead of a sphere, the inner area of a spherical segment between two parallel circles is being used for the illumination of the measuring area.

The measuring area is 50 mm x 100 mm.

(page 2)

Measuring principle: measurable variables are

1. the luminance factor for diffused illumination Qd according to EN 1436: Illumination of the surface of the marking with diffused light, measurement of the reflected light in an observation angle of 2,29°
2. the luminance factor for retroreflection RL according to EN 1436: Illumination of the surface of the marking in an angle of 1,24°, measurement of the retro-reflected light in an observation angle of 2,29°.

3. Executed measurements

Test samples: 18 samples of different markings with enhanced night visibility in wet condition have been used as test samples. The kind of surface is noted in the following tables. All test samples were in a new state.

Execution of the measurements: For all samples, the luminance factor for diffused light and the luminance factor for retroreflection have been measured once with the instruments in test and once with the measuring instruments Reflectometer Qd 30 and LTL 2000 from the company Delta Lys & Optics. The instruments have been positioned in such a way, that approximately the same part of the surface of the marking has been measured. Since the measuring area of the ZRM 1013 is considerably smaller than the measuring area of the Delta-instrument, 1 reading was recorded with the Delta-instrument and at least 3 readings were recorded with the ZRM 1013. In the table, the reading of the Delta-instrument and the average value of all single measurements of the ZRM 1013 are noted.

The measurements have been carried out in accordance with the operating manuals of both instruments.

4. Measuring results

4.1 Table 1: Measuring values and deviation for Qd

Sample	Kind of surface of the marking	Qd (mcd/m^2·lx)			deviation in % ZRM 1013 to ø
no.		instrument LTL QD 30	instrument ZRM 1013	common average	
A	large glass beads (l.g.b.)	205	185	200	-2.5
B	l.g.b.	212	207	209.5	-1.2
C	l.g.b.	173	174	173.5	+0.3
D	l.g.b. and structured marking	224	215	219.5	-2.1
E	l.g.b.	179	179	179	0
F	l.g.b.	217	213	215	-0.9
G	l.g.b.	255	247	251	-1.6
H	l.g.b.	242	245	243.5	+0.6
I	l.g.b. and structured marking	196	207	201.5	+2.7
L	structured marking	200	186	193	-3.6
N	inclined profile	176	172	174	-1.2
O	agglomerates	198	202	200	+1.0
1	rough aggregates	259	269	264	+1.9
2	type-I-surface	261	269	265	+1.5
3	structured marking	248	252	250	+0.8
4	type-I-surface	257	260	258.5	+0.6
5	type-I-surface	251	263	257	+2.3
6	tetrahedral profile	238	242	240	+0.8
	all samples				0

4.2 Table 2: Measuring values and deviation for RL

Sample	Kind of surface of the marking	RL (mcd/m^2·lx)			deviation in % ZRM 1013 to ø
no.		instrument LTL 2000	instrument ZRM 1013	common average	
A	large glass beads (l.g.b.)	83	86	84.5	+1.8
B	l.g.b.	117	116	116.5	-0.4
C	l.g.b.	171	173	172	+0.6
D	l.g.b. and structured marking	221	224	222.5	+0.7
E	l.g.b.	115	119	117	+1.7
F	l.g.b.	203	213	208	+2.4
G	l.g.b.	100	110	105	+4.8
H	l.g.b.	677	719	698	+3.0
I	l.g.b. and structured marking	184	178	181	-1.7
L	structured marking	302	281	286.5	-5.4
N	inclined profile	153	140	146.5	-4.4
O	agglomerates	194	217	205.5	+5.6
1	rough aggregates	323	327	325	+0.6
2	type-I-surface	320	312	316	-1.3
3	structured marking	448	453	450.5	+0.6
4	type-I-surface	77	84	80.5	+4.4
5	type-I-surface	45	49	47	+4.3
6	tetrahedral profile	90	96	93	+3.2
	all samples				+1.1

5. Valuation of the measuring results

5.1 Luminance factor for diffused illumination Qd

Table 4.1 shows that the measured values of the ZRM 1013 differ by a maximum +2.7%/-3.6% from the common average of both measuring instruments. The mean deviation amounts to 0%.

5.2 Luminance factor for retroreflection RL

Table 4.2 shows that the measured values of the ZRM 1013 differ by a maximum +5.6%/-4.4% from the common average of both measuring instruments. The mean deviation amounts to +1.1%.

(page 5)

5.2 General performance evaluation

The deviations of the measured values of the instrument ZRM 1013 from the common average are within the tolerance range of accuracy for measuring the luminance factor for diffused reflection Qd as well as for the luminance factor for retroreflection RL. In order to grant an increased reliability of measuring values for more structured or for profiled markings, it is recommended to execute the measurements regarding number and placing as described in the attached appendix of Zehntner GmbH Testing Instruments: “Determination of night and day visibility (RL & Qd) of road markings”.

(Dr. Meseberg)

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ZEHNTNER
TESTING INSTRUMENTS

The correct determination of night and/or day visibility (R_L & Qd) of road markings

version 2.8, January 2006

Table of contents

Introduction

The night visibility R_L (value of retro reflection) and the day visibility Qd (luminance factor) of a road marking depend on various factors. Many road markings are not homogenous, that is they do not show equal values over the whole surface. This could be either due to a faulty application or to the nature of the marking itself (e.g. with structured markings). Since within one and the same road marking the measured values may show enormous variations, it is important in practice to apply the correct measuring proceeding. Only if certain conditions have been complied with is it possible to obtain objective measuring values for R_L and/or Qd.

Which are the most likely sources of error to avoid while measuring road markings? and how should the measurements be done correctly? – these are the questions that will be answered in the following.

Measuring principles

In order to make comprehension of the following explanations easier, we will begin with a short survey of the measuring principals on the basis of the measuring instruments used to determine R_L and/or Qd.

Night visibility (R_L)

When determining the value of retro reflection R_L, the instrument simulates the conditions under which the road markings are seen at night by a motorist driving with dipped headlights. The observation angle of 2,29° corresponds to the viewing distance of the motorist of 30m under normal conditions. The illumination angle is 1,24°.

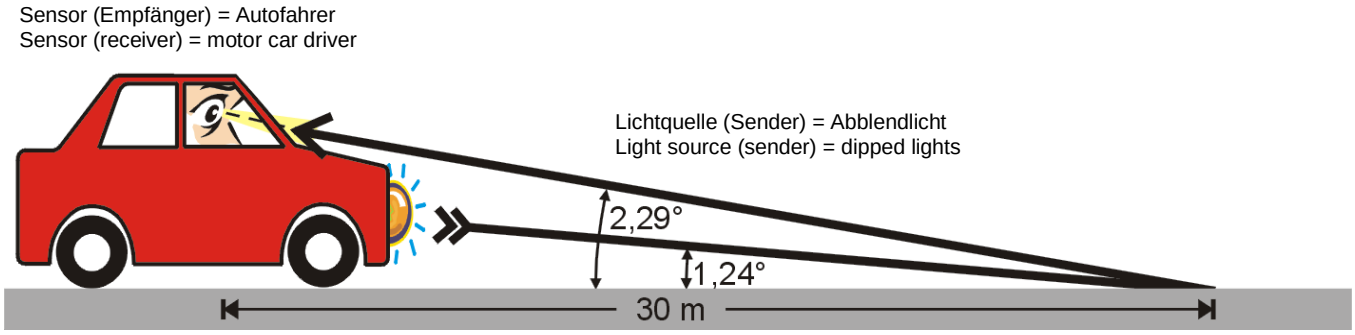


Figure 1: Measuring principle „night visibility" (R_L)

Day visibility (Qd)

When determining the luminance factor Qd, the instrument simulates the day visibility of road markings under normal conditions – that is under typical or average daylight or under street lighting. The observation angle of 2,29° corresponds to the viewing distance of a motorist of 30m under normal conditions. The illumination is diffuse.

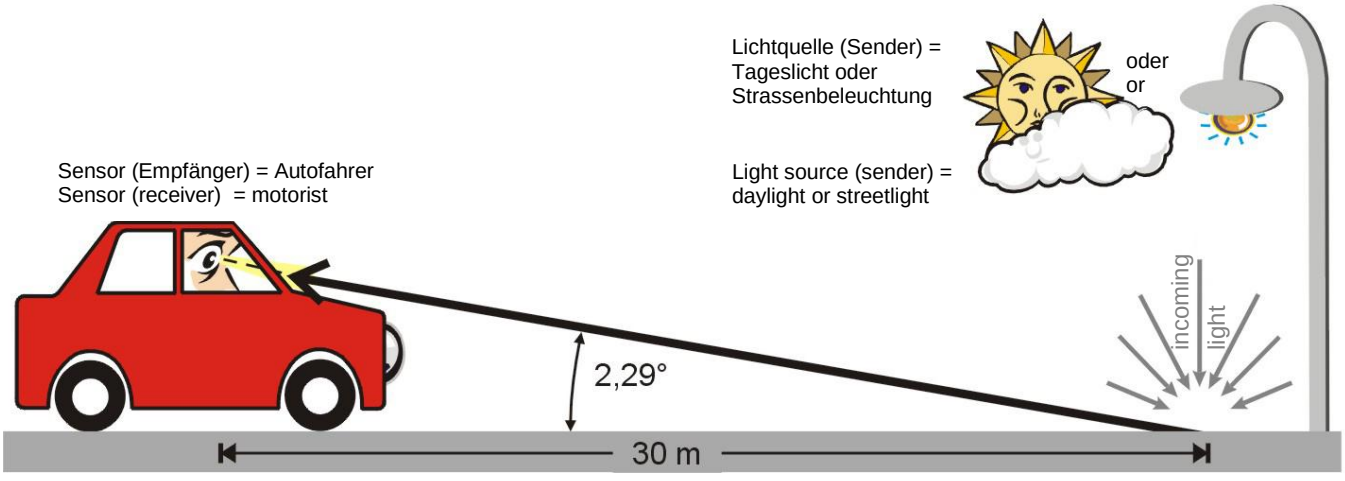


Figure 2: Measuring principle „night visibility" (Qd)

Random measurements yield unreliable results

The picture below shows four different road markings common in Europe. The black rectangles symbolize the measured areas. Each rectangle corresponds to the measuring area of the instrument and symbolizes one single measurement resp. the area measured with one single measurement.

In order to guarantee that the measuring result reflects the way a road marking is seen by a motorist at a distance of 30m, the marking has to be measured at the correct place as well as with the correct number of measurements. If the instrument is positioned at random as it was the case for the road markings showed in *Figure 3*, every measured area will show a random amount of road marking material. Therefore, the average value for R_L and/or Qd will be a random value as well; it will not correspond to reality.

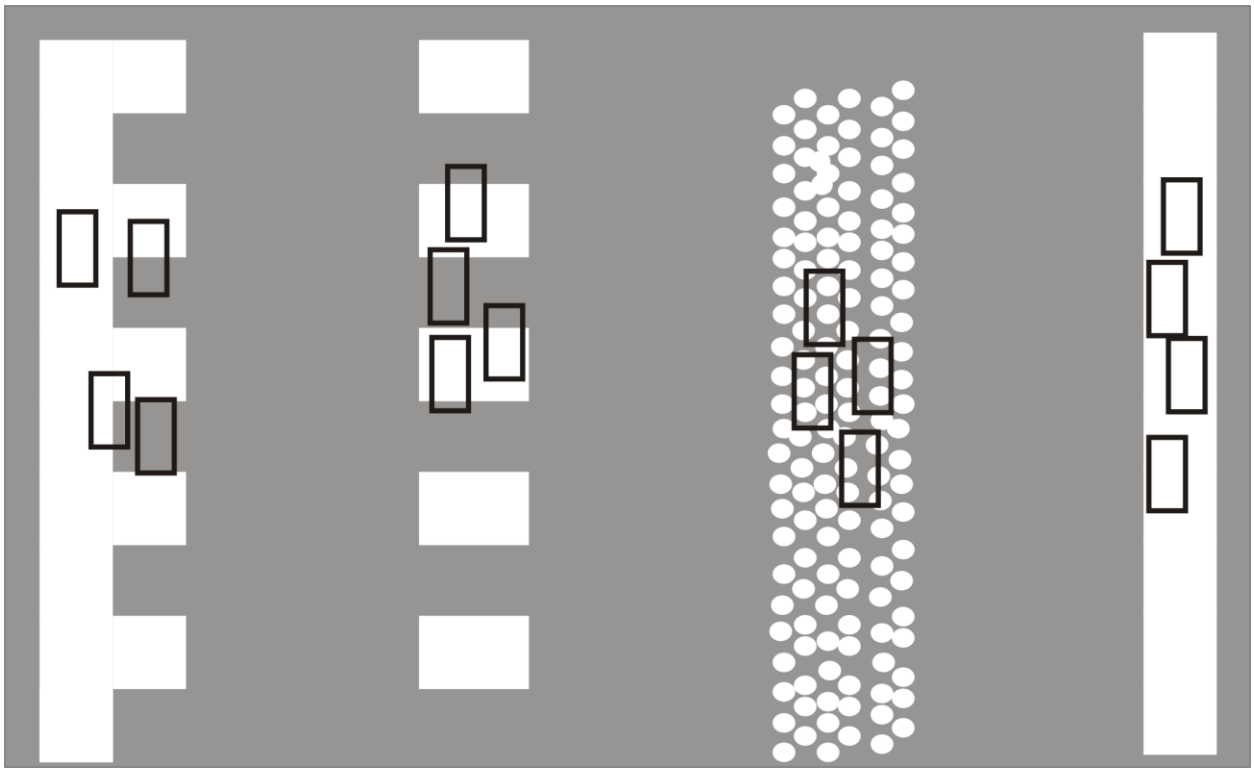


Figure 3: Different types of road markings common in Europe

The measuring proceeding must be well considered

A motorist who looks at the road marking – in driving direction and from a distance of 30m – will see a marking of the type shown in *Figure 4* as white, continuous line. How bright resp. white he sees this line depends on the marking's proportion between marking material and road surface (concrete, asphalt etc.). If the measuring instrument was positioned at random – for example only on the white part of the marking –, the average value of the total of measurements would be a random one. It would not reflect the impression of the motorist, for it does not base on the measured road marking's proportion between marking material and road surface.

In order to yield a reliable result, you have to be informed about the dimensions of the measuring area of the measuring instrument (see *Figure 5*). Furthermore, in order to be able to position the instrument precisely, you have to know the exact place of the measuring area of the instrument (see the corresponding description on page 12).

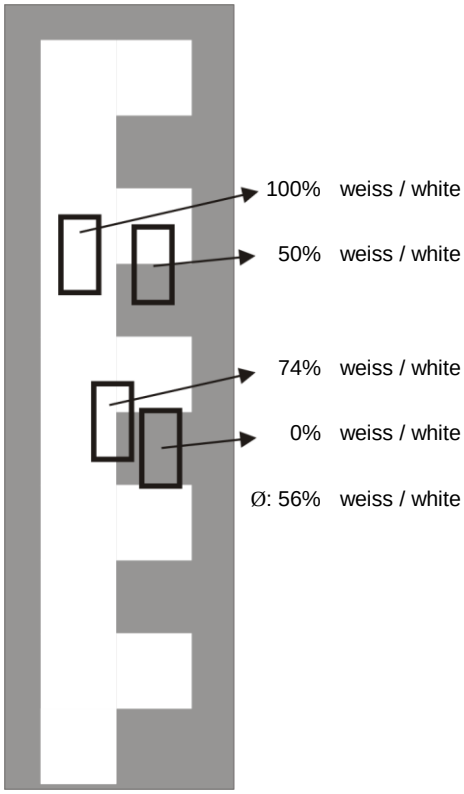


Figure 4: Rib-line marking

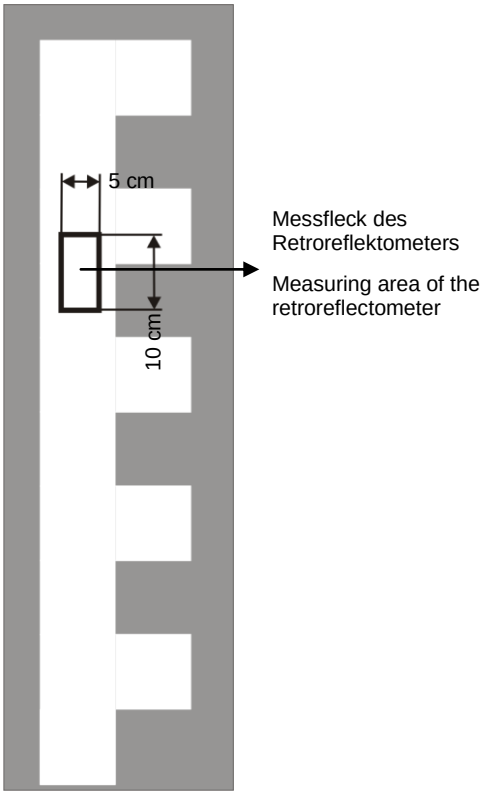


Figure 5: Measuring area of the retroreflectometer

Furthermore you have to analyse the road marking to be measured. To begin with, you must determine a minimal area that covers a representative part of the road marking. That is you have to know the dimensions of the road marking in question as well as the proportion between marking material and road surface (see *Figures 6* und *7*).

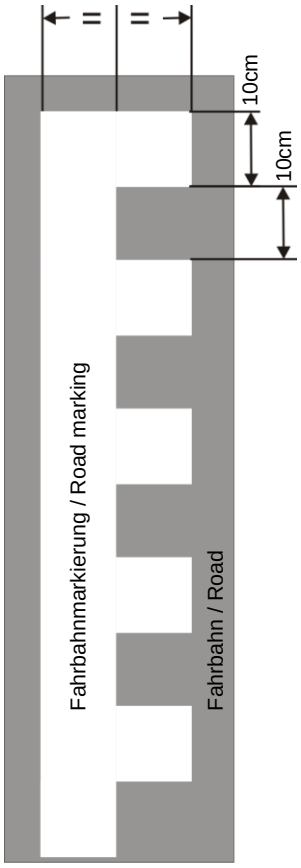


Figure 6: Dimensions of the road marking

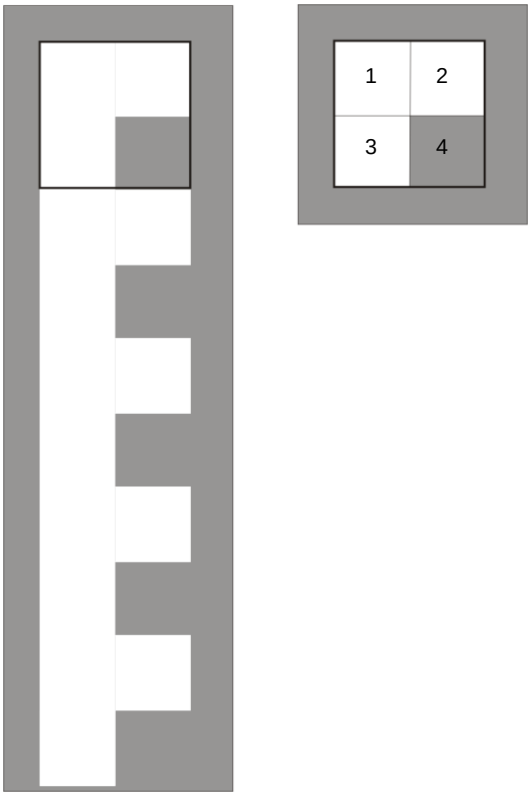


Figure 7: Representative part of the analysed road marking

The analysis of the road marking shown in *Figure 6* yields the following result: It is a symmetrical marking, consisting of ribs of equal length (10 cm) and equal width (20 cm). Ribs consisting of 100% marking material alternate with ribs consisting of 50% marking material and 50% road surface (concrete, asphalt etc.). Consequently, the representative minimal area of this marking consists of 4 squares of 10 cm x 10 cm: 3 squares are covered with marking material, 1 square shows the ‘original’ surface of the road. Hence the proportion between marking material and road surface is 3 : 1 resp. 75%: 25%.

Having analysed the marking to be measured, you have to fix the total number of measurements to be taken. Since in the present example the measuring area of the instrument happens to be 10 cm long (see Figure *5*), you need at least 4 single measurements to measure the representative minimal area of the marking (1 measurement per square). The average value of the 4 single measurements corresponds to the requested value for R_L and/or Qd.

In the present example, the single measuring positions must be chosen in such a way, that – according to our analysis – the proportion of marking material measured during one measuring series (= the total number of single measurements on the basis of witch the average value is calculated) is 75%. To do so, you can align the measuring instrument, when positioning it, either with the help of the absolute hair cross (see *Figure 8a*) or with the plumb line (see *Figure 8b*). If you positioned the instrument at random as shown in *Figure 8c* you would measure only an amount of 56% of road marking material. Therefore you would get a far to low value for R_L and/or Qd (see page 13 for some information about how to measure a connecting area).

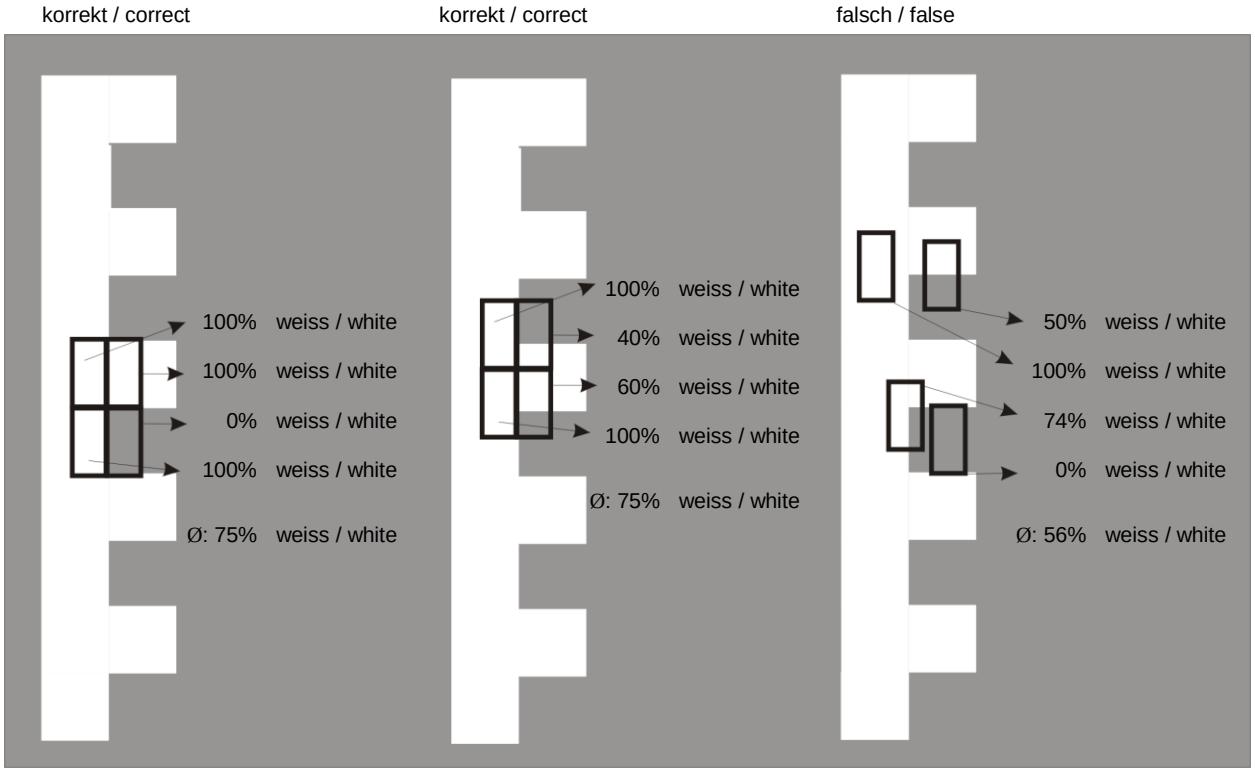


Figure 8a:
Measuring instrument aligned with the absolute hair cross

Figure 8b:
Measuring instrument aligned with the plumb line

Figure 8c:
Measuring instrument positioned at random

Increase of the measuring reliability

It is recommended to repeat the series of measurements at an other place of the road marking in order to get a comparative value and thus increase the measuring reliability.

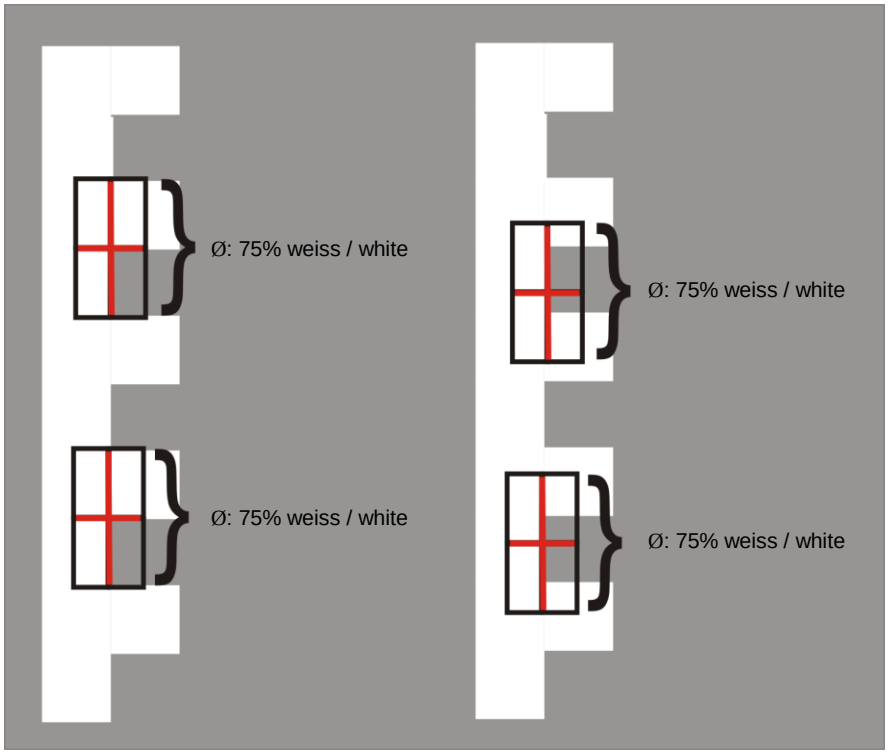


Figure 9: Example of a series of measurements, well considered and adapted to the road marking in question

Measuring area not congruent with parts of the road marking

The described proceeding works even then when the measuring area of the instrument is not congruent with parts of the road marking (see *Figure 10*).

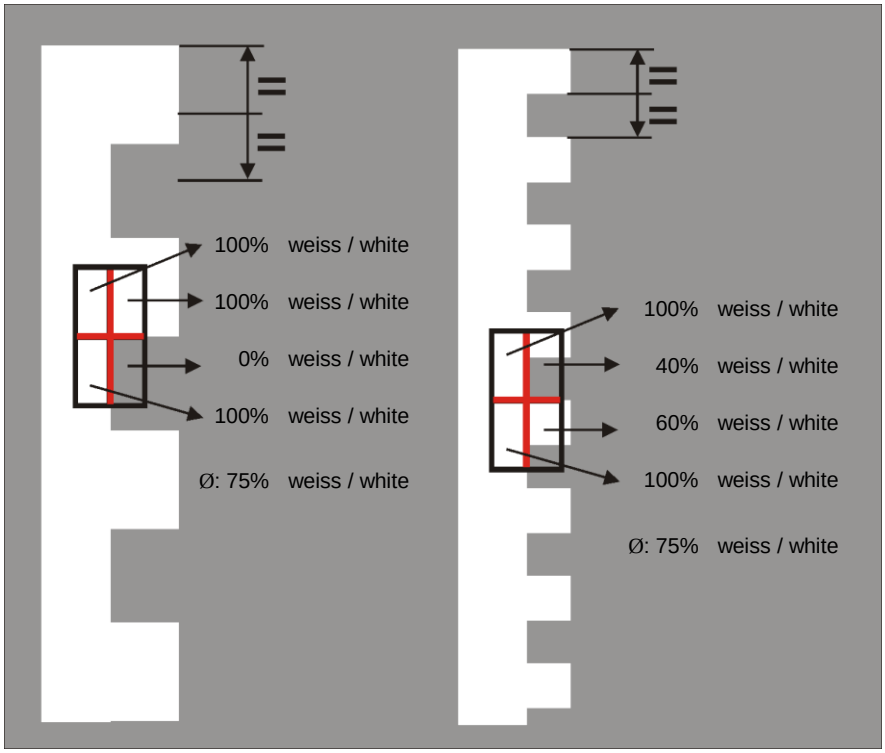


Figure 10: Measuring area shorter resp. longer than the rib of the road marking

As above it is recommended to repeat the series of measurements at an other place of the road marking in order to get a comparative value and thus increase the measuring reliability.

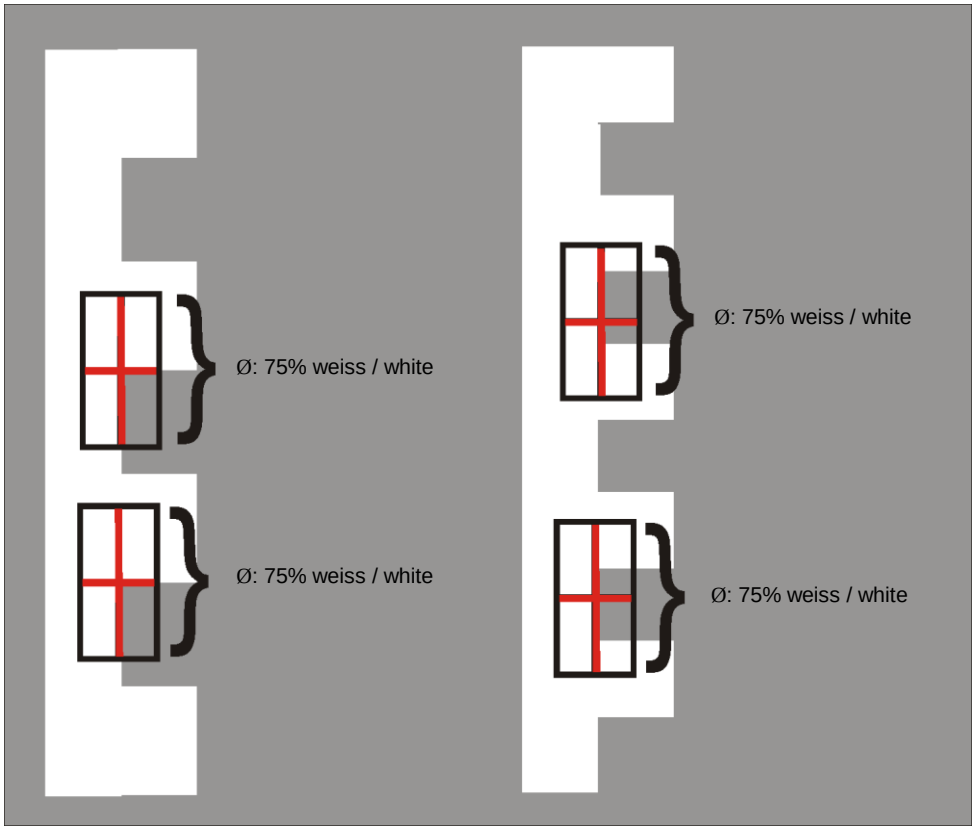


Figure 11: Example of a series of measurements, well considered and adapted to the road marking in question

Measurement of other types of road markings

The described proceeding works with other types of road markings as well.

The representative minimal area of the discontinuous road marking shown in *Figure 12* for example consists of 50% marking material and 50% road surface (concrete, asphalt etc.). The average value of the single measurements must reflect the same proportion. If you positioned the instrument at random as shown in *Figure 12b*, you would measure an amount of 60% of road marking material and therefore get a much too high value for R_L and/or Qd.

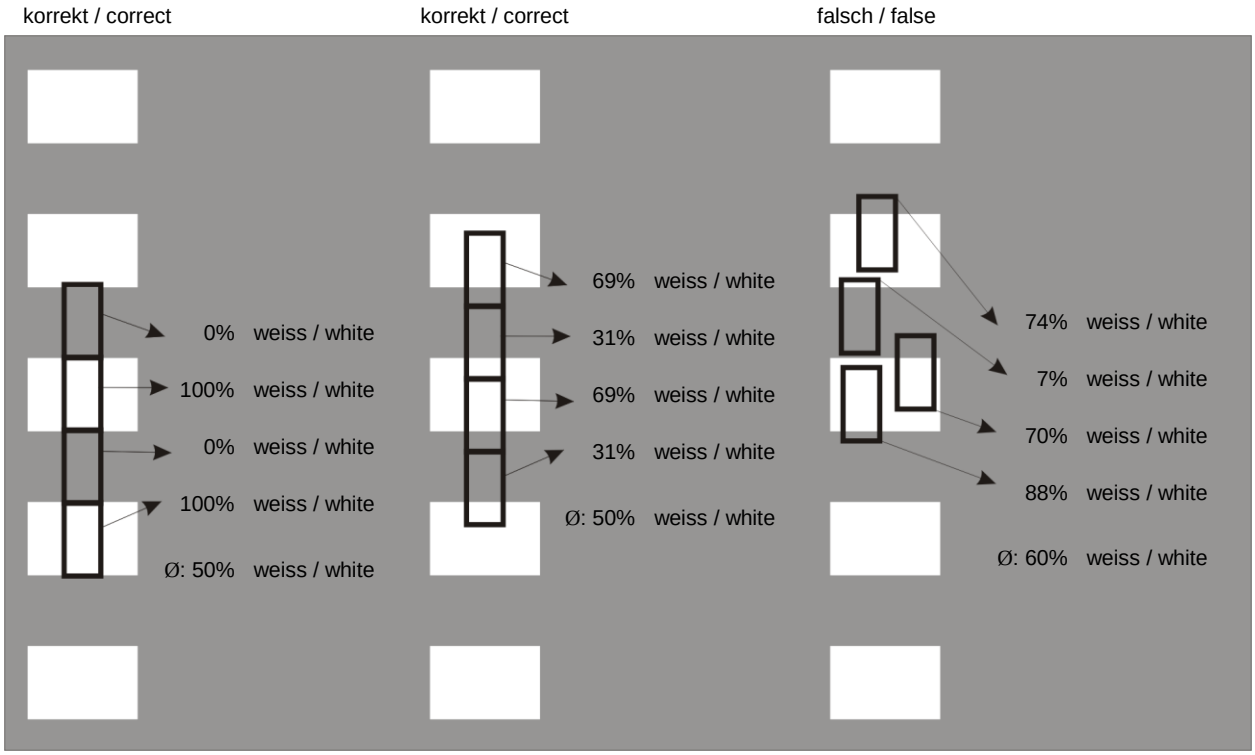


Figure 12a: Measuring series with well considered measuring positions

Figure 12b: Measuring series with measuring positions chosen at random

Even in connection with inhomogeneous road markings as shown in *Figure 13*, the average value of the single measurements is only significant when the measuring instrument has been positioned in a well considered way. Furthermore, it is recommended with this type of road marking to carry out one (better two) series of measurements of 6 single measurements each in order to increase the reliability of the measuring result (see *Figure 13a*).

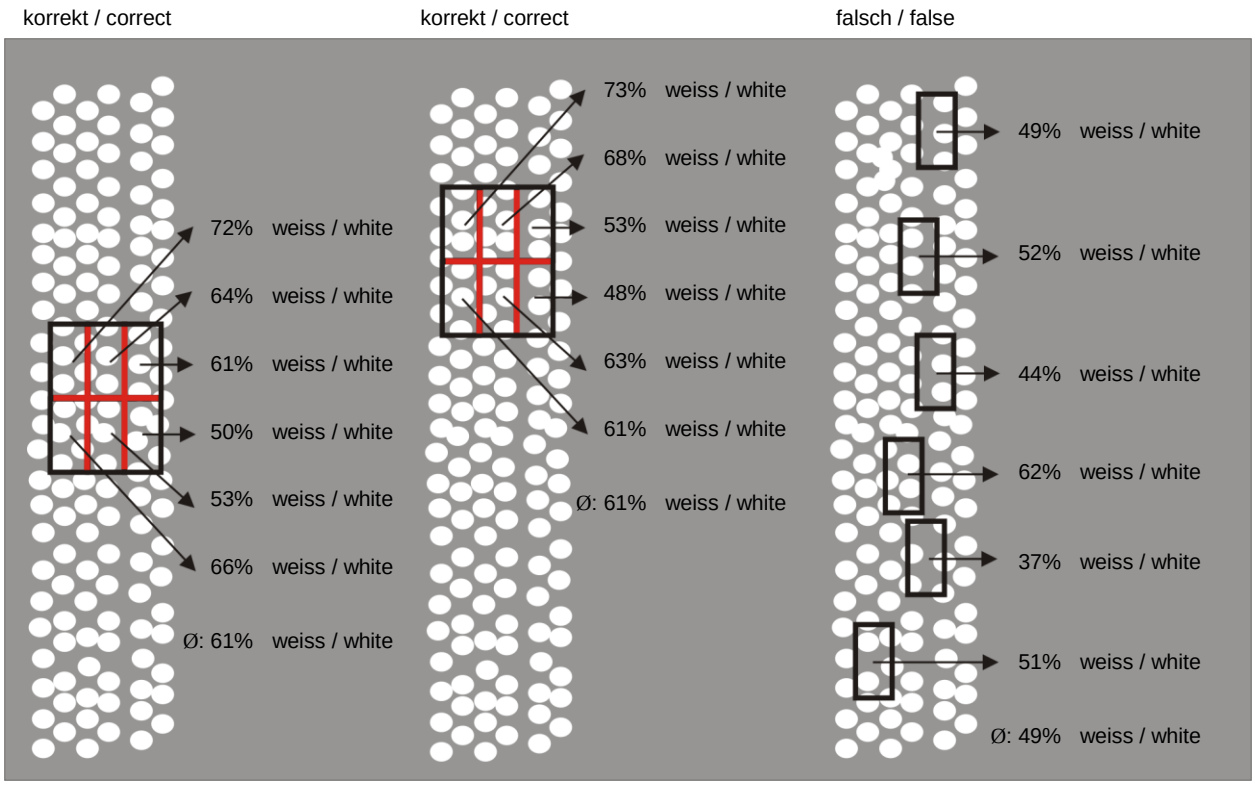
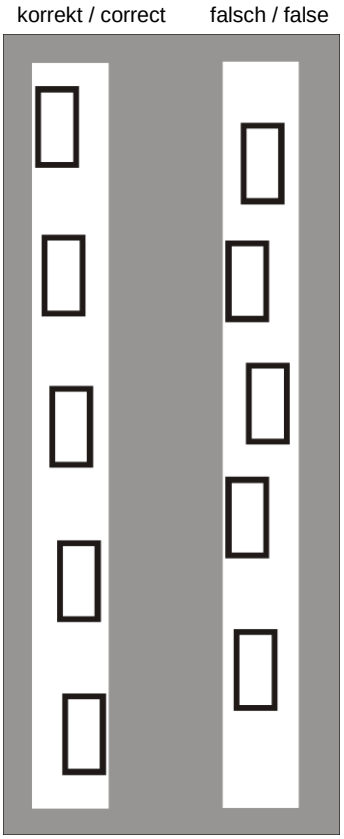


Figure 13a: Measuring series with well considered measuring positions

Figure 13b: Measuring series with measuring positions chosen at random

Even with discontinuous road markings as shown in *Figure 14*, a random positioning of the measuring instrument is not recommended – even though the expected differences wont be as important as with other types of road markings.

To get reliable results in such a case you should carry out one (or more) measuring series consisting of at least 5 single measurements each (as the ZTV M 02 *Zusätzliche Technische Vertragsbedingungen und Richtlinien für Markierungen auf Strassen* describes it for Germany). On the other hand you should move the measuring instrument slightly sideward (see *Figure 14a*) in order to measure over the whole width of the road marking. By doing so even unbalanced or not uniformly dispersed glass beads can be included.



Measuring series with well considered measuring positions — *Figure 14a*

Figure 14b — *Measuring series with measuring positions chosen at random*

Position of the measuring area of the instrument

The previous described proceeding for a reliable determination of night and/or day visibility can only be carried out when it is known, where the measuring area of the measuring instrument is. Only when the operator knows the exact position of the measuring are – for example due to markings on the housing of the instrument –, an exact positioning of the measuring instrument will be possible.

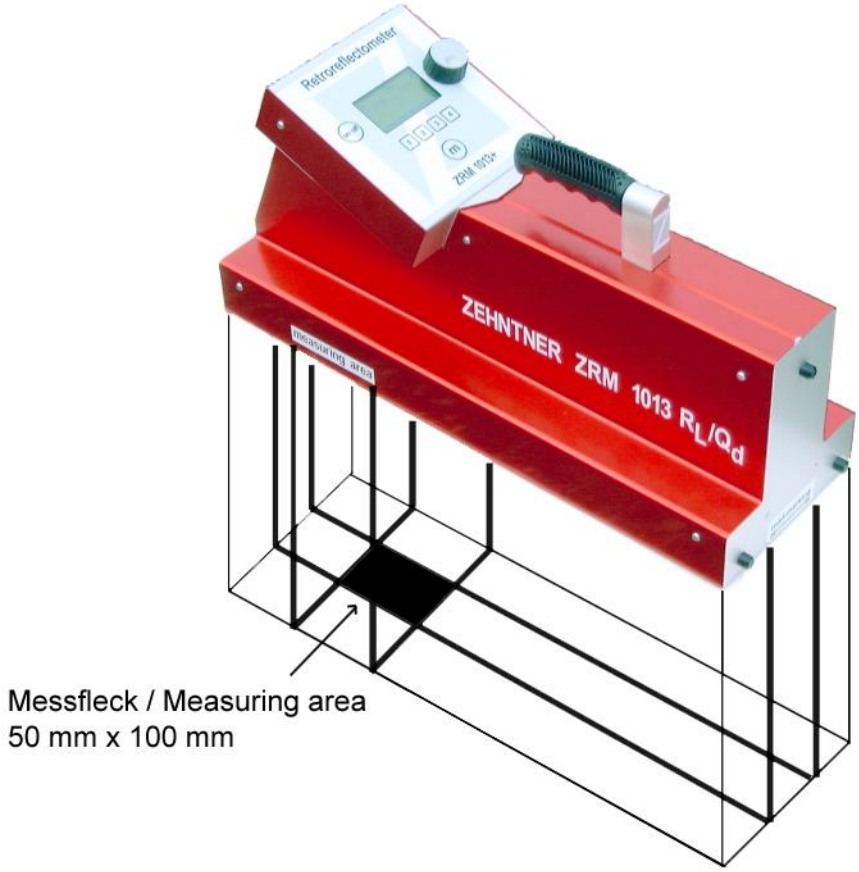


Figure 15: Position of the measuring area of the ZRM 1013+

Measuring a connecting area

Carry out 4 measurements as recommended for example in *Figure 8a* and *8b* on page 7:

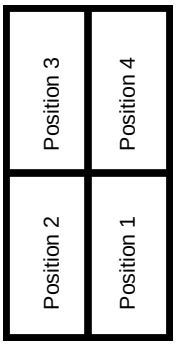


Figure 16: The four measuring positions for the desired measuring series

- Place the measuring instrument onto the road marking where the first measurement should be carried out (see *Figure 16*, Position 1).
- Due to two rulers and the markings on the housing of the instrument – „road marking“ and „measuring area“ – it is possible in our example to position the instrument exactly (see *Figure 17*).
- Carry out the first measurement and activate the function “average”.

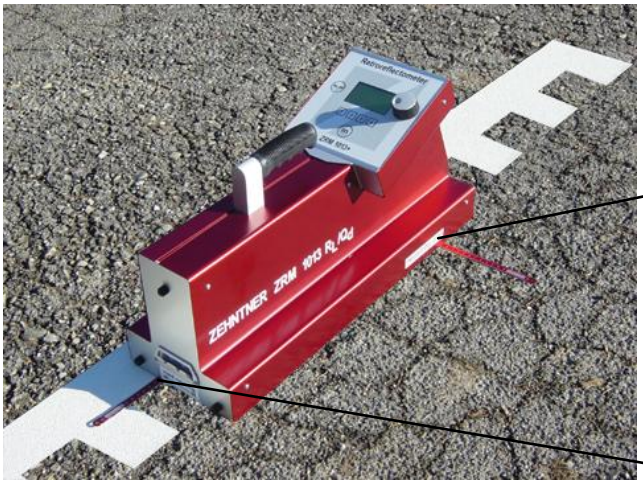


Figure 17 Position of the measuring instrument and the scales of the rulers before moving the instrument to the second measuring position

*The right side of the marking „measuring area“ is at „**5 cm**“*

*The left side of the marking „road marking“ is at „**10 cm**“*

- Move the instrument exactly by the width of the measuring area (5 cm) to the left to the position, where the second measurement should be carried out (see *Figure 16*, Position 2 and *Figure 18*).
- Carry out the second measurement.

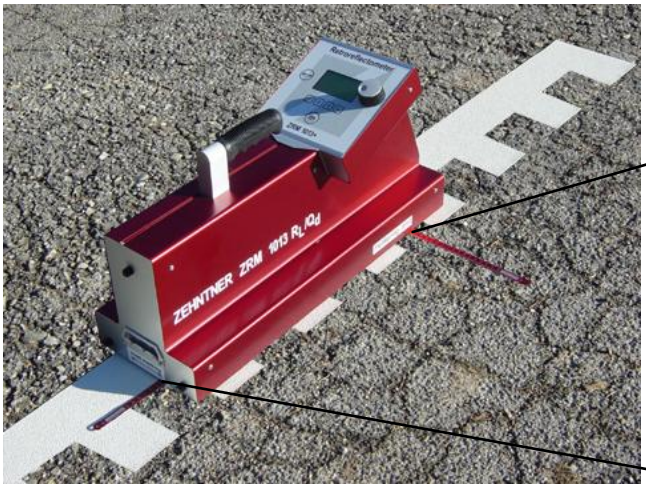


Figure 18 Position of the measuring instrument and the scales of the rulers before moving the instrument to the third measuring position

*The right side of the marking „measuring area“ is at „**0 cm**“*

*The right side of the marking „road marking“ is at „**10 cm**“*

- Move the instrument exactly by the length of the measuring area (10 cm) forwards to the position, where the third measurement should be carried out (see *Figure 16* Position 3 and *Figure 19*.
- Carry out the third measurement.

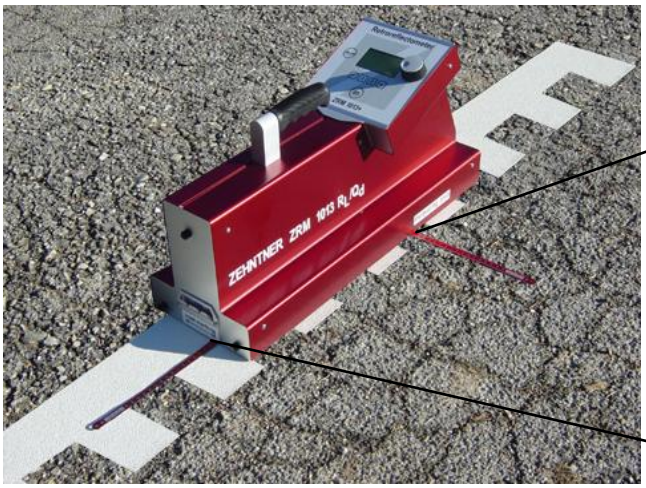


Figure 19 Position of the measuring instrument and the scales of the rulers before moving the instrument to the fourth measuring position

*The left side of the marking „measuring area“ is at „**0 cm**“*

*The left side of the marking „road marking“ is at „**0 cm**“*

- Move the instrument exactly by the width of the measuring area (5cm) to the right to the position, where the fourth measurement should be carried out (see *Figure 16*, Position 4 and *Figure 20*).
- Carry out the fourth and last measurement and read the avarage value of the four single measurements.

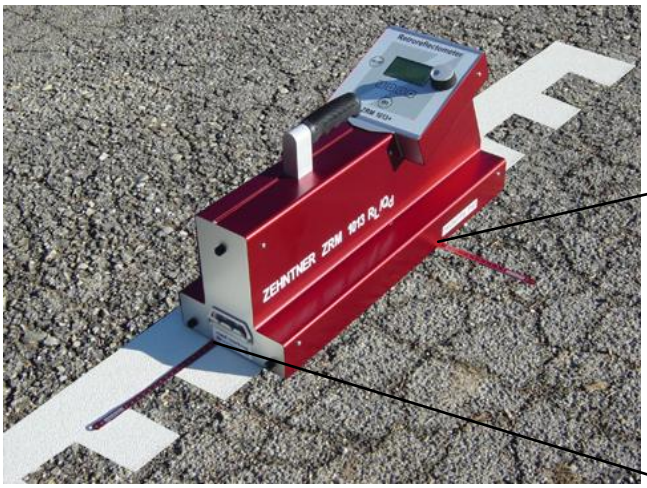


Figure 20 Position of the measuring instrument and the scales of the rulers after the fourth and last measurement

*The left side of the marking „measuring area“ is at „**5 cm**“*

*The left side of the marking „road marking“ is at „**0 cm**“*