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Nordic certification of road marking materials in Denmark 2015–2016

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Abstract

A Nordic certification system for road marking materials was introduced in 2015. In the first stage, the certification system applies to Denmark, Norway and Sweden. In these countries, a documented product approval will be required in order to use a road marking material on roads managed by the national road authorities. Product approval will be based on monitored and documented performance measurements of material samples applied on test fields on public roads.

Today, the certification system includes two test sites: one in Sweden and one in Denmark. However, the present report only deals with the certification in Denmark; the results from the Swedish test site will be presented in another report. The first round of material application took place in 2015, while follow-measurements were carried out around one year later, in 2016. At this point in time, the wheel passage classes P0, P1, P2 and P3 were reached at the Danish test site. In other words, the report presents which materials were certified for the mentioned P classes in 2016.

Title:	Nordic certification of road marking materials in Denmark 2015–2016
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Referat

Ett nordiskt system för certifiering av vägmarkeringsmaterial introducerades 2015. I ett första steg omfattar certifieringen Danmark, Norge och Sverige. I dessa länder kommer det i framtiden att krävas ett materialgodkännande för att få använda materialet på vägar som administreras av den statliga väghållaren. Materialgodkännandet baseras på fysikaliska mätningar på material som har applicerats i provfält på allmänna vägar.

I dagsläget omfattar certifieringen två provfält, ett i Danmark och ett i Sverige, men föreliggande rapport behandlar endast resultaten från Danmark – resultaten från det svenska provfältet redovisas i en annan rapport. Initiala mätningar gjordes 2015 och uppföljande mätningar efter cirka 1 år, 2016. Vid denna tidpunkt hade hjulpassageklasserna P0, P1, P2 och P3 uppnåtts. Således visar denna rapport vilka vägmarkeringsmaterial som godkändes för ovan nämnda P-klasser 2016.

Titel:	Nordisk certifiering av vägmarkeringsmaterial i Danmark 2015–2016
Författare:	Trond Cato Johansen (Ramböll RST) Carina Fors (VTI) Sara Nygårdhs (VTI) Sven-Olof Lundkvist (VTI)
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Preface

This study on certification was initiated by the road authorities in Denmark, Norway and Sweden. The authorities have formed a steering group consisting of Kenneth Kjemtrup, the Danish Road Directorate, Bjørn Skaar, the Norwegian Roads Public Administration and Lars Petersson, the Swedish Transport Administration.

The study is carried out as a joint project between Ramböll RST AB and the Swedish National Road and Transport Institute (VTI). The project manager is Trond Cato Johansen, Ramböll and beside him is a working group consisting of Carina Fors, VTI and Sara Nygårdhs, VTI. Moreover, the physical measurements have been carried out by staff from Ramböll and supervision of the measurements with staff from VTI. Finally, Sven-Olof Lundkvist, VTI, has been the handyman of the study.

Drøbak, October 2016

Trond Cato Johansen
Project Manager

Quality review

Internal peer review was performed on 7 October 2016 by Anna Vadeby. Trond Cato Johansen and Sara Nygårdhs have made alterations to the final manuscript of the report. The research director, Anna Anund, examined and approved the report for publication on 14 November 2016. The conclusions and recommendations expressed are the authors' and do not necessarily reflect VTI's opinion as an authority.

Kvalitetsgranskning

Intern peer review har genomförts 7 oktober av Anna Vadeby. Trond Cato Johansen och Sara Nygårdhs har genomfört justeringar av slutligt rapportmanus. Forskningschef Anna Anund har därefter granskat och godkänt publikationen för publicering 14 november 2016. De slutsatser och rekommendationer som uttrycks är författarnas egna och speglar inte nödvändigtvis myndigheten VTI:s uppfattning.

Table of content

Summary

Nordic certification of road marking materials in Denmark 2015–2016.

by Trond Cato Johansen (Ramböll RST), Carina Fors (VTI), Sara Nygårdhs (VTI) and Sven-Olof Lundkvist (VTI)

A Nordic certification system for road marking materials was introduced in 2015. In the first stage, the certification system applies to Denmark, Norway and Sweden. In these countries, a documented product approval will be required in order to use a road marking material on roads managed by the national road authorities. Product approval will be based on monitored and documented performance measurements of material samples applied on test fields on public roads.

The first round of material tests in Denmark started in October 2015, when 32 materials, 24 for certification and 8 for manufacturer's internal test, were applied at the Danish test site in Hornbæk. Approximately two weeks after application, the initial performance of the coefficient of retroreflected luminance R_L, the luminance coefficient under diffuse illumination *Qd*, the friction and the chromaticity in daylight were determined.

In 2016, around one year after application, follow-up measurements of the performance parameters mentioned above were carried out. In this follow-up, only 23 of the 24 materials which were applied for certification will be part of this report, as payment was not received for one of the materials.

The aim of the certification was to determine to which of the roll-over P-classes P0–P5 the road marking materials belong. However, after only one year of wear on a road with relatively low traffic volume, only P-classes P0, P1, P2 and P3 were reached.

The initial measurements showed that five out of 23 materials had poor friction. One year later there was less problems with friction, instead most rejections were due to low retroreflectivity.

Of the 23 materials tested for certification, five materials fulfilled the requirement for roll-over class P3, twelve for class P2, fifteen for class P1 and sixteen for class P0. Consequently, seven of the road marking materials tested for certification did not fulfil the requirements for any roll-over class.

Sammanfattning

Nordisk certifiering av vägmarkeringsmaterial i Danmark 2015–2016.

av Trond Cato Johansen (Ramböll RST), Carina Fors (VTI), Sara Nygårdhs (VTI) och Sven-Olof Lundkvist (VTI)

En nordisk certifiering av vägmarkeringsmaterial introducerades 2015 och avser i ett första steg Danmark, Norge och Sverige. I dessa länder kommer det att krävas dokumenterat godkännande av vägmarkeringsmaterial som används på vägar som administreras av den statliga väghållaren. Detta godkännande baseras på funktionsmätningar på vägmarkeringar som har applicerats i provfält.

En första testomgång i Danmark påbörjades i oktober 2015, då 32 material, 24 för certifiering och 8 för tillverkarnas interna test, applicerades på det danska provfältet i Hornbæk. Cirka två veckor efter utläggningen gjordes fysikaliska mätningar av vägmarkeringarnas retroreflexion, R_L, luminanskoefficient, *Qd*, friktion och färg.

Ett år senare, 2016, gjordes uppföljande mätningar av ovan nämnda funktionsparametrar. Denna gång mättes endast 23 av de 24 materialen som deltog för certifiering eftersom en tillverkare inte fullföljde sina ekonomiska åtaganden. Föreliggande rapport avser således 23 vägmarkeringsmaterial.

Syftet med certifieringen är att fastställa till vilken av hjulpassageklasserna P0–P5 vägmarkeringsmaterialet tillhör. Efter endast ett år i ett provfält med relativt liten trafikvolym uppnåddes endast klasserna P0, P1, P2 och P3.

De initiala mätningarna 2015, visade att fem av 23 material hade alltför låg friktion. Ett år senare var problemen med friktion mindre och de flesta underkännandena berodde då på alltför låg retroreflexion.

Av de 23 material som testades för certifiering uppfyllde fem kraven för hjulpassageklass P3, tolv för klass P2, femton för klass P1 och sexton för klass P0. Således uppfyllde sju material inte kraven för någon hjulpassageklass.

1. Introduction

A Nordic certification system for road marking materials was introduced in 2015. In the first stage, the certification system applies to the countries of Denmark, Norway and Sweden. In these countries, a documented product approval will be required in order to use a road marking material on roads managed by the national road authorities. Product approval will be based on monitored and documented performance measurements of material samples applied on test fields on public roads. Certification in Denmark will be based on the results from a test site in Denmark and certification in Norway and Sweden on the results from a test site in Sweden. The results from the Swedish test site are presented in a separate report (Johansen et al., 2016).

The first round of material tests in Denmark started in October 2015, when 24 materials were applied at the Danish test site in Hornbæk.

In 2016, follow-up measurements of the performance parameters coefficient of retroreflected luminance R_L, luminance coefficient under diffuse illumination *Qd*, chromaticity in daylight, chromaticity of retroreflected light (yellow materials only) and friction were carried out.

Materials are certified in relation to the number of wheel passages they will stand. Measurements of the transversal distribution of wheel passages have been carried out at the test sites, and wheel passage classes (P classes) have been determined for each of the six lines. At the Danish test site, the P classes P0, P1, P2 and P3 were reached.

The present report documents the results of the one-year follow-up measurements, i.e. the report presents which materials were certified for the P classes mentioned above. Results for higher P classes will be published in 2017.

The report includes results of materials registered as *certification materials*. Results of materials registered as *manufacturer's internal test materials* will be available only to the specific participant.

The certification system is further described in the document *Nordic certification system for road marking materials – Version 2:2015* (Fors, Johansen and Lundkvist, 2015) which is freely available at www.vti.se/en/publications The document is referred to as *NCSRM-2:2015* in the present report.

2. Test site

2.1. General

The road used for the test site is a two-lane rural road located at the island of Sjælland on route 237, 50 km north of Copenhagen. The road is relatively straight and flat and without any major junctions and has an AADT of around 2 700 vehicles/day. The posted speed limit is 80 km/h. The width of the road is 7.5 m and each lane is 3.45 m wide. The road surface consists of flexfalt type 6 that was placed in 2008. The roughness class is RG1, i.e. the averaged measured texture depth is < 0.60 mm. Figure 1 shows the test field at the time of application.

Figure 1. The test field in Denmark at the time of application.

The annual average temperature during the years 2011–2014 was 9˚ C. The highest and lowest temperatures registered were 30˚ C and -11˚ C, respectively. On average, the temperature was below 0˚ C 58 days per year. The annual average precipitation was 628 mm. (*Weather data: www.dmi.dk*)

The Köppen (climatic) classification of the test site is Cfb, based on data for the period 1951–2000 (Kottek et al. 2006). The climatic class of the Danish test site according to EN 1824 is C3, i.e. Cfb with winter maintenance. The extent of winter maintenance may vary a lot between years.

Studded tyres are permitted in Denmark from 1 November to 15 April. However, the amount of cars with studded tyres is low (estimation: about 5 %). Further details can be found in *NCSRM-2:2015.*

2.2. Traffic volume and wheel passages

Measurements of wheel passages were carried out during one week in the middle of April 2016. The measurement equipment was placed in an empty position in the western part of the test field.

On average, 1,825 vehicles were registered per day. 95.2 % were passenger cars, 3.9 % were heavy vehicles and 0.8 % were two-wheelers. The traffic flow was the highest on Friday (2145 vehicles) and the lowest on Monday (1,616 vehicles). The registered traffic flow was compared to AADT information from 2013 provided by the local road authority in Helsingør, and it was found that the latter was 10.7 % lower. According to the local road authority, the traffic flow has increased over the

past few years and our registration is thus assumed to be representative for the traffic flow in 2015–2016.

The transversal distribution of wheel passages tends to move to the centre line in darkness compared to daylight. At the test site, passenger vehicles were positioned 13 cm more to the left and heavy vehicles were positioned 7 cm more to the left in darkness. This was adjusted for by calculating normalized wheel passage curves for daylight and darkness, and multiplying them by the amount of traffic that passes in daylight and darkness, for each week during the year. Daylight was defined to start when morning civil twilight begins, and to end when evening civil twilight ends. Darkness was defined to start when daylight ended and to end when daylight began.

Figure 2 shows the distribution of wheel passages for the average week, adjusted for variations due to the light conditions.

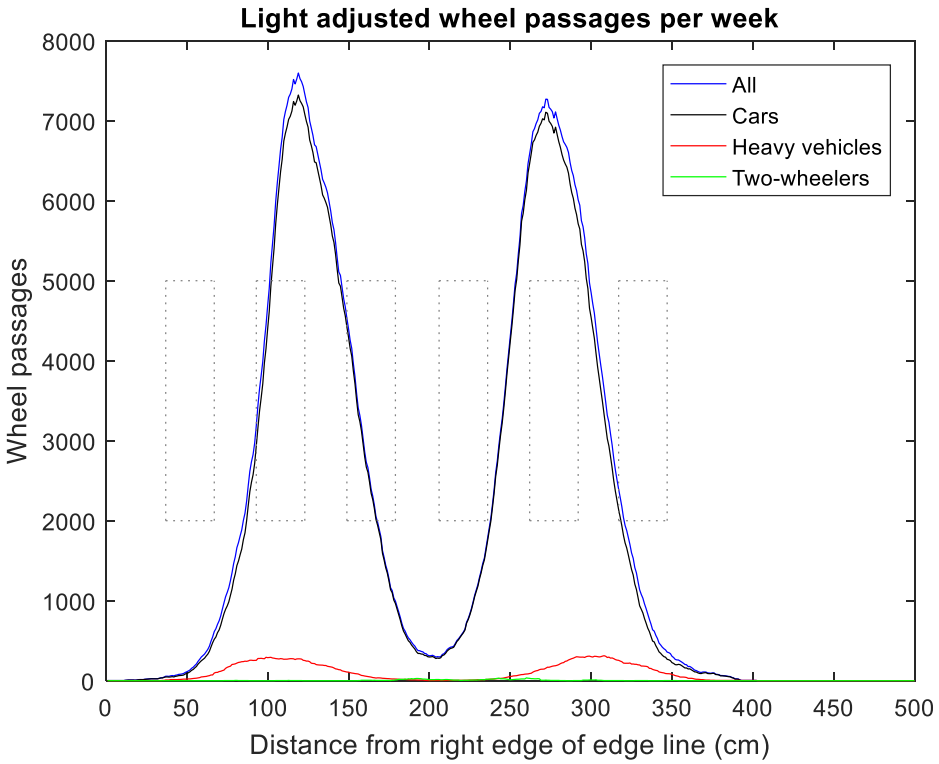

Figure 2. Wheel passages at the Danish test site per week, adjusted for light conditions. The dashed areas correspond to the six lines (line 1 to the left, line 6 to the right). Please note that the shoulder is to the left in the figure.

Table 1 shows the number of wheel passages per line and week, as an average for the 15 cm wide area in the centre of the line (corresponding to the measurement area, see Figure 3–Figure 5).

Table 1. Number of wheel passages per line and week.

Line	Line 1	Line 2	Line 3	Line 4	Line 5	Line 6
Number of wheel passages per week	146	6225	2564	638	7044	1135

2.3. Weather conditions

The weather conditions from October 2015, when the materials were applied, to June 2016, are shown in Table 2.

Table 2. Weather conditions at the Danish test site, from October 2015 to June 2016.

Weather parameter	Value
Annual average temperature	6
Average summer temperature (Apr-Sep)	16
Average winter temperature (Oct-Mar)	3
Annual precipitation	55
Number of sun hours per month	105
Number of weeks with snow or frost	7
Number of times the snow plough has operated	5
Number of times the road has been salted	57

Weather data was retrieved from *the Danish Meteorological Institute* (DMI), at the following places: Nakkehoved Fyr approximately 10 km north-west of the test site (temperature), Nordkystens renseanlaeg in Hornbaek close to the test site (precipitation) and Sjaelsmark approximately 24 km south of the test site (sun hours). Information about snow plough operations and salting was obtained from the local road authority in Helsingør.

3. Performance measurements

3.1. General

Measurements of all performance parameters were carried out by operators from Ramböll, supervised by an observer from VTI. All measurement equipment was calibrated according to recommended procedures. The measurements for roll-over classes P0, P1, P2 and P3 were performed in summer 2016, while measurements for class P4 will take place in 2017.

3.2. Methods and measuring instruments

3.2.1. Retroreflectivity R_L and luminance coefficient, *Qd*

The coefficient of retroreflected luminance, R_L, and the luminance coefficient under diffuse illumination, *Qd*, were measured using an *LTL-XL* (Delta, Denmark). Measurements were taken at three points diagonally within the measurement area of 0.15 x 1.5 m, defined by EN 1824, see Figure 3. The result of an individual line was calculated as the average of the three measurements.

In case there was a substantial difference in wheel passages across a line – observed both from the calculations of wheel passages and at the test site – the measurement points were moved towards the side with less wheel passages, in order to reduce measurement uncertainty.

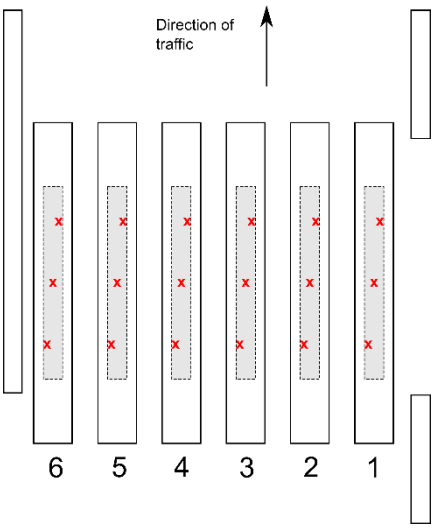

Figure 3. The measurement points (red crosses) for R_L and Qd were placed diagonally within the measurement area (grey) defined by EN 1824.

The markings were not cleaned before the measurements, but in case a substantial part of the measurement area was abnormally dirty (e.g. oil stain), the instrument was moved in the longitudinal direction to the closest area not affected by abnormal dirt.

3.2.2. Chromaticity coordinates

Chromaticity coordinates were measured in one point on each line, located at the centre of the line, see Figure 4. A *Konica Minolta Spectrophotometer CM-2500c* was used to measure the colour coordinates.

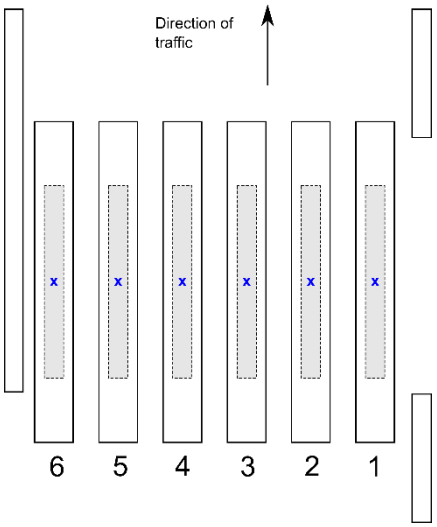

Figure 4. The measurement points (blue crosses) for chromaticity coordinates were placed in the centre of the lines.

For materials with a high degree of wear, the measurement was taken at an area where the material was intact, if possible. For materials that had a very non-homogenous surface (due to unevenly distributed drop-on), an area that appeared to represent the average surface of the material was selected as measurement point. In some cases, several measurement points were selected, to ensure correct chromaticity coordinates. These points had to be located within the grey area in Figure .

The markings were not cleaned before the measurements, but in case a substantial part of the measurement area was abnormally dirty (e.g. oil stain), the instrument was moved to the closest area not affected by abnormal dirt.

3.2.3. Friction

Friction measurements were carried out using a *Portable Friction Tester*, PFT (Coralba, Sweden), along the centre of each line, Figure 5. The PFT takes a sample approximately every 1.9 cm and thus, about 70 samples are taken on each line. The result of an individual line is calculated as the average of all samples from that line.

In case there were any notches, joints or other abnormalities on the marking surface, the measurement area/line was either reduced or moved somewhat, so that no samples were taken from the abnormality.

Friction was measured on wetted markings. The friction measurements were always carried out after the measurements of the coefficient of retroreflected luminance, R_L, the luminance coefficient under diffuse illumination, *Qd*, and chromaticity coordinates. The PFT instrument is further described in (Wälivaara 2007).

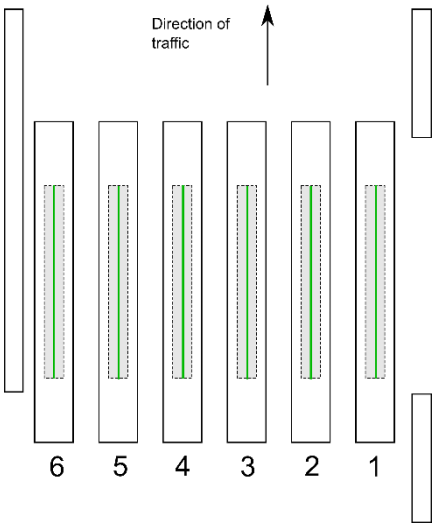

Figure 5. The measurement areas (green lines) for friction.

3.2.4. Weather conditions at the Danish test site

During the measurements in week 23, it was sunny and the air temperature was around 22° C. In week 35 the weather was cloudy with an air temperature of around 20° C. At both occasions the road surface was completely dry.

4. Performance requirements

4.1. Performance parameters

The performance requirements include four parameters, which are given in Table 3.

Table 3. Performance requirements.

Performance parameter	White permanent road markings
Coefficient of retroreflected luminance, R_L dry [mcd/m^2/lx]	≥ 150
Luminance coefficient under diffuse illumination, *Qd* [mcd/m^2/lx]	≥ 130
Friction, [PFT units]	≥ 0.52[1]
Chromaticity coordinates, x, y	*

[1] The requirement of PFT units 0.52 is equivalent with SRT units 50.

[*] According to EN 1436

4.2. Special considerations regarding friction

The translation from PFT units into SRT units and vice versa results in an uncertainty of approximately 10 % (Wälivaara, 2007). Consequently, there is a risk that a reading of a value just below 0.52 PFT units, in fact has 50 SRT units and therefore should fulfill the requirement.

In order to minimize the risk that materials are rejected because of the uncertainty when translating PFT units into SRT units, the required limit for approval was lowered by approximately 10 % or 0.05 PFT units, from 0.52 to 0.47.

4.3. Certification in relation to P-classes

Materials are certified in relation to the number of wheel passages they will stand. The six lines on the test field are exposed to different numbers of wheel passages, which means that different roll-over classes are reached on different lines at different times.

Roll-over classes according to EN 1824 are determined from the measurements of wheel passages for each of the six lines, see Table 4.

Materials are thus certified for a certain roll-over class (P-class). In order to be certified, all four performance requirements must be fulfilled for that particular class. At the initial measurements only P0 can be evaluated and the performance is the average of all six lines.

At the follow-up measurements, the performance parameters are defined as the registered value of the line which is closest to the centre of a certain P-class (see 4.2).

The materials have to fulfil the requirements for all classes lower than that it is certified for, provided that the lower classes exist on the test field. Example: In order for a material to be certified as a P3 material, the performance requirements have to be fulfilled also for classes P0, P1 and P2.

If a material has been certified for a certain P class after one year (i.e. at the 1 year follow-up measurement), this certification is valid irrespective of the results of the measurements after two years. The 2 year follow-up measurements are merely used to evaluate whether the material fulfils the requirement for a higher P class than what it is already certified for.

Table 4. Roll-over classes, EN 1824.

Roll-over class	Number of wheel passages
P0	≤ 50 000
P1	Between 50 000 and 60 000
P2	100 000 ± 20 %
P3	200 000 ± 20 %
P4	500 000 ± 20 %
P5	1 000 000 ± 20 %
P5.5	1 500 000 ± 20 %
P6	2 000 000 ± 20 %

4.1.1. P-classes at the Danish test site

At the Danish test site, P-classes P0–P3 were reached in 2016, and P-class P4 is expected to be reached in 2017. The dates for the follow-up measurement were selected so that all P-classes were represented by one line, Table 5.

Table 5. P-classes at the Danish test site.

Roll-over class	Lines	Measured
P0	Line 4	Summer 2016
P1	Line 6	Summer 2016
P2	Line 3	Summer 2016
P3	Line 2	Summer 2016
P4	Line 2 or 5	Summer 2017
P5	-	-

5. Certification of materials

Materials that have received certification from the Danish test site are approved for use in Denmark. The certification is valid forever or until the requirements are changed.

Tables 6–9 show the results for roll-over classes P0, P1, P2 and P3, respectively. In these tables a performance value lower than the requirement has orange background. Furthermore, **A** means that the road marking material was approved and **NA** not approved.

Materials not approved in the initial measurements 2015 are marked with red background.

Table 6. The performance of the participating certification road markings at the Danish test field in 2016. ***Roll-over class P0.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***Appr.***
Ennis Flint Lifeline LL150.2	355	144	0.35	OK	NA
Ennis Flint EF Ser. Pref. Thermopl.Mat. 1	133	143	0.57	OK	NA
Ennis Flint Lifeline LL150.1	283	150	0.44	OK	NA
Ennis Flint EF Ser. Pref. Thermopl.Mat. 2	280	125	0.52	OK	NA
Ennis Flint Crystalex 70	214	150	0.39	OK	NA
Hitex Traffic Safety Ltd HiBrite WR Extr DK #1	322	161	0.49	OK	NA
Hitex Traffic Safety Ltd HiBrite WR Extr DK #2	242	151	0.48	OK	NA
Kelly Bros (Erinline) Ltd Extr./Sc. Briteline 150(DK) – WE150 Type 1(DK)	254	154	0.47	OK	A
Kelly Bros (Erinline) Ltd Extr./Sc. Briteline 150(DK) – WE150 Type 2(DK)	267	158	0.48	OK	A
Kelly Bros (Erinline) Ltd W Spray Briteline 150(DK) – WE150 Type 2(DK)	253	171	0.50	OK	A
Kelly Bros (Erinline) Ltd W Spray Briteline 150(DK) – WE150 Type 1(DK)	191	177	0.53	OK	A
LKF Materials a/s PREMARK	150	146	0.62	OK	A
LKF Materials a/s Viathem Viking	172	156	0.52	OK	A
LKF Materials a/s Viathem DK40	244	172	0.56	OK	A*
LKF Materials a/s Viathem DK30	199	174	0.61	OK	A
LKF Materials a/s Viathem DK10	213	172	0.59	OK	A
Promax Industries ApS Promax white basic DK	324	147	0.56	OK	A
Swarco Vestglas GmbH Eurotherm HPX5	260	199	0.69	OK	A
Swarco Vestglas GmbH Swarcotherm ERP 15 white DK	446	137	0.60	OK	A
Svevia AB E400	327	171	0.63	OK	A
Svevia AB E350	256	172	0.59	OK	A
Veluvine BV Thermolit Lolland	172	180	0.82	OK	A
Veluvine BV Thermolit Funen	183	165	0.76	OK	A

* Based only on lines 1, 4, 5 and 6.

Table 7. The performance of the participating certification road markings at the Danish test field in 2016. ***Roll-over class P1.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***Appr.***
Ennis Flint Lifeline LL150.2	163	158	0.58	OK	NA
Ennis Flint EF Ser. Pref. Thermopl.Mat. 1	97	148	0.54	OK	NA
Ennis Flint Lifeline LL150.1	170	161	0.54	OK	NA
Ennis Flint EF Ser. Pref. Thermopl.Mat. 2	135	142	0.54	OK	NA
Ennis Flint Crystalex 70	87	160	0.66	OK	NA
Hitex Traffic Safety Ltd HiBrite WR Extr DK #1	137	163	0.70	OK	NA
Hitex Traffic Safety Ltd HiBrite WR Extr DK #2	165	156	0.56	OK	NA
Kelly Bros (Erinline) Ltd Extr./Sc. Briteline 150(DK) – WE150 Type 1(DK)	240	163	0.50	OK	A
Kelly Bros (Erinline) Ltd Extr./Sc. Briteline 150(DK) – WE150 Type 2(DK)	239	169	0.56	OK	A
Kelly Bros (Erinline) Ltd W Spray Briteline 150(DK) – WE150 Type 2(DK)	223	176	0.56	OK	A
Kelly Bros (Erinline) Ltd W Spray Briteline 150(DK) – WE150 Type 1(DK)	238	172	0.55	OK	A
LKF Materials a/s PREMARK	131	147	0.69	OK	NA
LKF Materials a/s Viathem Viking	221	148	0.53	OK	A
LKF Materials a/s Viathem DK40	243	160	0.57	OK	A
LKF Materials a/s Viathem DK30	224	166	0.59	OK	A
LKF Materials a/s Viathem DK10	241	160	0.60	OK	A
Promax Industries ApS Promax white basic DK	200	154	0.62	OK	A
Swarco Vestglas GmbH Eurotherm HPX5	202	188	0.68	OK	A
Swarco Vestglas GmbH Swarcotherm ERP 15 white DK	280	142	0.56	OK	A
Svevia AB E400	201	161	0.62	OK	A
Svevia AB E350	234	151	0.61	OK	A
Veluvine BV Thermolit Lolland	187	171	0.83	OK	A
Veluvine BV Thermolit Funen	197	161	0.76	OK	A

Table 8. The performance of the participating certification road markings at the Danish test field in 2016. ***Roll-over class P2.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***Appr.***
Ennis Flint Lifeline LL150.2	113	155	0.64	OK	NA
Ennis Flint EF Ser. Pref. Thermopl.Mat. 1	88	139	0.55	OK	NA
Ennis Flint Lifeline LL150.1	117	153	0.61	OK	NA
Ennis Flint EF Ser. Pref. Thermopl.Mat. 2	145	120	0.52	OK	NA
Ennis Flint Crystalex 70	67	150	0.67	OK	NA
Hitex Traffic Safety Ltd HiBrite WR Extr DK #1	129	157	0.67	OK	NA
Hitex Traffic Safety Ltd HiBrite WR Extr DK #2	112	146	0.60	OK	NA
Kelly Bros (Erinline) Ltd Extr./Sc. Briteline 150(DK) – WE150 Type 1(DK)	183	160	0.57	OK	A
Kelly Bros (Erinline) Ltd Extr./Sc. Briteline 150(DK) – WE150 Type 2(DK)	189	158	0.55	OK	A
Kelly Bros (Erinline) Ltd W Spray Briteline 150(DK) – WE150 Type 2(DK)	177	167	0.58	OK	A
Kelly Bros (Erinline) Ltd W Spray Briteline 150(DK) – WE150 Type 1(DK)	183	166	0.57	OK	A
LKF Materials a/s PREMARK	142	132	0.68	OK	NA
LKF Materials a/s Viathem Viking	166	135	0.53	OK	A
LKF Materials a/s Viathem DK40	230	155	0.55	OK	A
LKF Materials a/s Viathem DK30	206	161	0.61	OK	A
LKF Materials a/s Viathem DK10	209	157	0.59	OK	A
Promax Industries ApS Promax white basic DK	164	128	0.63	OK	NA
Swarco Vestglas GmbH Eurotherm HPX5	34	208	0.60	OK	NA
Swarco Vestglas GmbH Swarcotherm ERP 15 white DK	211	128	0.61	OK	NA
Svevia AB E400	190	135	0.63	OK	A
Svevia AB E350	172	142	0.63	OK	A
Veluvine BV Thermolit Lolland	157	164	0.84	OK	A
Veluvine BV Thermolit Funen	177	158	0.75	OK	A

Table 9. The performance of the participating certification road markings at the Danish test field in 2016. ***Roll-over class P3.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***Appr.***
Ennis Flint Lifeline LL150.2	108	157	0.67	OK	NA
Ennis Flint EF Ser. Pref. Thermopl.Mat. 1	75	149	0.56	OK	NA
Ennis Flint Lifeline LL150.1	108	154	0.63	OK	NA
Ennis Flint EF Ser. Pref. Thermopl.Mat. 2	154	116	0.56	OK	NA
Ennis Flint Crystalex 70	67	147	0.68	OK	NA
Hitex Traffic Safety Ltd HiBrite WR Extr DK #1	110	156	0.74	OK	NA
Hitex Traffic Safety Ltd HiBrite WR Extr DK #2	90	157	0.64	OK	NA
Kelly Bros (Erinline) Ltd Extr./Sc. Briteline 150(DK) – WE150 Type 1(DK)	137	161	0.60	OK	NA
Kelly Bros (Erinline) Ltd Extr./Sc. Briteline 150(DK) – WE150 Type 2(DK)	135	167	0.61	OK	NA
Kelly Bros (Erinline) Ltd W Spray Briteline 150(DK) – WE150 Type 2(DK)	118	178	0.65	OK	NA
Kelly Bros (Erinline) Ltd W Spray Briteline 150(DK) – WE150 Type 1(DK)	144	165	0.59	OK	NA
LKF Materials a/s PREMARK	139	129	0.69	OK	NA
LKF Materials a/s Viathem Viking	136	137	0.62	OK	NA
LKF Materials a/s Viathem DK40	163	145	0.63	OK	A
LKF Materials a/s Viathem DK30	169	152	0.61	OK	A
LKF Materials a/s Viathem DK10	174	163	0.62	OK	A
Promax Industries ApS Promax white basic DK	159	124	0.62	OK	NA
Swarco Vestglas GmbH Eurotherm HPX5	25	199	0.53	OK	NA
Swarco Vestglas GmbH Swarcotherm ERP 15 white DK	164	125	0.59	OK	NA
Svevia AB E400	167	146	0.62	OK	A
Svevia AB E350	153	143	0.62	OK	A
Veluvine BV Thermolit Lolland	130	170	0.88	OK	NA
Veluvine BV Thermolit Funen	145	156	0.79	OK	NA

The results of the follow-up measurements one year after application can be summarized as follows:

Of the 23 materials tested for certification, five materials fulfilled the requirement for roll-over class P3, twelve for class P2, fifteen for class P1 and sixteen for class P0. Consequently, seven of the road marking materials tested for certification did not fulfil the requirements for any roll-over class.

6. Summary of the results of the certification

Table 10 shows the result of this first Nordic certification, carried out 2015–2016. **A** means approved and **NA** not approved material. Materials not approved in the initial measurements 2015 are marked with grey background.

*Table 10. Certified road marking materials for use on Danish state roads, **A**. Materials which did not pass the test are indicated **NA**.*

Manufacturer *Material*	***initial***	***P0***	***P1***	***P2***	***P3***
Ennis Flint Lifeline LL150.2	NA				
Ennis Flint EF Ser. Pref. Thermopl.Mat. 1	NA				
Ennis Flint Lifeline LL150.1	NA				
Ennis Flint EF Ser. Pref. Thermopl.Mat. 2	A	NA			
Ennis Flint Crystalex 70	NA				
Hitex Traffic Safety Ltd HiBrite WR Extr DK #1	NA				
Hitex Traffic Safety Ltd HiBrite WR Extr DK #2	NA				
Kelly Bros (Erinline) Ltd Extr./Sc. Briteline 150(DK) – WE150 Type 1(DK)	A	A	A	A	NA
Kelly Bros (Erinline) Ltd Extr./Sc. Briteline 150(DK) – WE150 Type 2(DK)	A	A	A	A	NA
Kelly Bros (Erinline) Ltd W Spray Briteline 150(DK) – WE150 Type 2(DK)	A	A	A	A	NA
Kelly Bros (Erinline) Ltd W Spray Briteline 150(DK) – WE150 Type 1(DK)	A	A	A	A	NA
LKF Materials a/s PREMARK	A	A	NA		
LKF Materials a/s Viathem Viking	A	A	A	A	NA
LKF Materials a/s Viathem DK40	A	A	A	A	A
LKF Materials a/s Viathem DK30	A	A	A	A	A
LKF Materials a/s Viathem DK10	A	A	A	A	A
Promax Industries ApS Promax white basic DK	A	A	A	NA	
Swarco Vestglas GmbH Eurotherm HPX5	A	A	A	NA	
Swarco Vestglas GmbH Swarcotherm ERP 15 white DK	A	A	A	NA	
Svevia AB E400	A	A	A	A	A
Svevia AB E350	A	A	A	A	A
Veluvine BV Thermolit Lolland	A	A	A	A	NA
Veluvine BV Thermolit Funen	A	A	A	A	NA

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