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Nordic certification of road marking materials in Sweden 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 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.

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 Sweden. The first round of material application took place in 2015, while follow-up measurements were carried out around one year later, in 2016. At this point in time, the wheel passage classes P0, P1, P2, P3 and P4 were reached at the Swedish test site. In other words, the report presents which materials were certified for the mentioned P-classes in 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 i framtiden att krävas 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 Sverige. Initiala mätningar gjordes 2015 och uppföljande mätningar efter cirka 1 år, 2016. Vid denna tidpunkt hade hjulpassageklasserna P0, P1, P2, P3 och P4 uppnåtts. Således visar denna rapport vilka vägmarkeringsmaterial som godkändes för ovan nämnda P-klasser 2016.

Titel:	Nordisk certifiering av vägmarkeringsmaterial i Sverige 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, November 2016

Trond Cato Johansen
Project Manager

Quality review

Internal peer review was performed on 11 November 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 11 november 2016 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.

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Summary

Nordic certification of road marking materials in Sweden 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 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.

The first round of material tests in Sweden started in May 2015, when 81 materials, 78 for certification and 3 for manufacturer's internal test, were applied at the Swedish test site in Sunne. 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, the chromaticity in daylight, the chromaticity of retroreflected light (yellow materials, only) and friction were determined.

In 2016, about one year after application, follow-up measurements of the performance parameters mentioned above were carried out.

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, P3 and P4 were reached.

The initial measurements showed that out of the total 78 materials, six had frictions below requirement and another two materials were outside the yellow colour box. One year later, in 2016, there were less problems with friction, instead most rejections were due to low retroreflectivity, and regarding the yellow materials, night-time colour.

Of the 49 white materials tested for certification, 3 fulfilled the requirement for roll-over class P4, 12 for class P3, 21 for class P2 and 27 for both class P1 and P0. Consequently, 22 of the road markings tested for certification did not fulfil the requirements for any roll-over class.

The corresponding figures for the 29 yellow materials show that no material fulfilled the requirement for roll-over class P4, 3 for P3, 5 for P2 and 6 for both P1 and P0. This means that 23 materials did not fulfil the requirements for any roll-over class.

Sammanfattning

Nordisk certifiering av vägmarkeringsmaterial i Sverige 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 krävas ett 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 Sverige påbörjades i oktober 2015, då 81 material, 78 för certifiering och tre för tillverkarnas interna test, applicerades på det svenska provfältet norr om Sunne. Cirka två veckor efter utläggningen gjordes fysikaliska mätningar av vägmarkeringarnas retroreflexion, R_L, luminanskoefficient, *Qd*, friktion, färg i dagsljus och färg i fordonsbelysning (för gula material). Ett år senare, 2016, gjordes uppföljande mätningar av ovan nämnda funktionsparametrar.

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, P3 och P4.

De initiala mätningarna 2015, visade att sex av totalt 78 material hade alltför låg friktion och två material hade felaktig gul färg. Ett år senare fanns inte problem med friktionen och de flesta underkännandena berodde då på alltför låg retroreflexion.

Av de 49 vita material som testades för certifiering uppfyllde 3 kraven för hjulpassageklass P4, 12 för klass P3 samt 21 för klass P2 och 27 för både klass P1 och P0. Således uppfyllde 22 material inte kraven för någon hjulpassageklass.

Motsvarande resultat för gula material visade att inget av de 29 materialen uppfyllde kraven för hjulpassageklass P4, 3 för klass P3, 5 för klass P2 och 6 för både klass P1 och P0. Detta betyder att 23 material inte uppfyllde kraven för någon klass.

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 Sweden and Norway will be based on the results from a test site in Sweden and certification in Denmark will be based on the results from a test site in Denmark. The results from the Danish test site are presented in a separate report (Johansen et al., 2016).

The first round of material tests in Sweden started in May 2015, when 81 materials were applied at the Swedish test site in Sunne. 78 materials – 49 white and 29 yellow – were applied as certification materials. Consequently, 3 manufacturer's internal test materials, not included in this report, were applied.

In the summer 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 Swedish test site, the P-classes P0, P1, P2, P3 and P4 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 *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 3:2016* (Fors, Johansen and Lundkvist, 2016) which is freely available at www.vti.se/en/publications. The document is referred to as *NCSRM-3:2016* 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 European road E45, approximately 10 km north of Sunne, Sweden, 130 km east of Oslo, Norway. The road is relatively straight and flat and without any major junctions and has an AADT of around 3 900 vehicles/day in two directions, with a posted speed limit of 90 km/h. The width of the road is 9.0 m and each lane is 3.75 m wide. Figure 1 shows the test site at the time of application.

Figure 1 The test site in Sweden at the time of application in 2015.

The road surface consists of a thin asphalt overlay which was laid in 2012. The roughness class is RG3, i.e. the averaged measured texture depth is in the range 0.90 – 1.20 mm.

The Köppen classification of the test site is Dfb, close to the boundary of the Dfc climate zone, based on data for the period 1951–2000 (Kottek et al. 2006). The climatic class of the Swedish test site according to EN 1824 is C3. The extent of winter maintenance may vary a lot between years.

Studded tyres are permitted in Sweden from 1 October to 15 April. In 2014, the amount of cars using studded tyres in Karlstad, 70 km south of the test site, was 80 % (Trafikverket 2014).

Further details can be found in *NCSRM-3:2016.*

2.2. Traffic volume and wheel passages

Measurements of wheel passages were carried out the first week in October, 2015. The measurement equipment, which is based on coaxial cable technique, was placed in an empty position in the middle of the test field. Wheel passages were registered for one week.

On average, 1690 vehicles were registered per day (in one direction), 87.7 % passenger cars and 12.2 % heavy vehicles. The traffic flow was the highest on Friday (2007 vehicles) and the lowest on Saturday (1257 vehicles).

The registered traffic flow was compared to AADT information provided by the Swedish Transport Administration (STA), and it was found that the latter was 15.7 % higher. STA has a measurement point 1 km south of the test site, and for this point there is a theoretical model of traffic flow variations over the year available. This model confirms that our measurements were carried out when the traffic flow is relatively low (traffic flow peaks during the winter and summer holidays) and thus, our data was adjusted according to the STA data (i.e. increased by 15.7 %).

The transversal distribution of wheel passages tend to move to the centre line in darkness compared to daylight. At the test site, passenger vehicles were positioned 9 cm more to the left and heavy vehicles were positioned 23 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 STA's AADT data and for variations in distribution due to the light conditions.

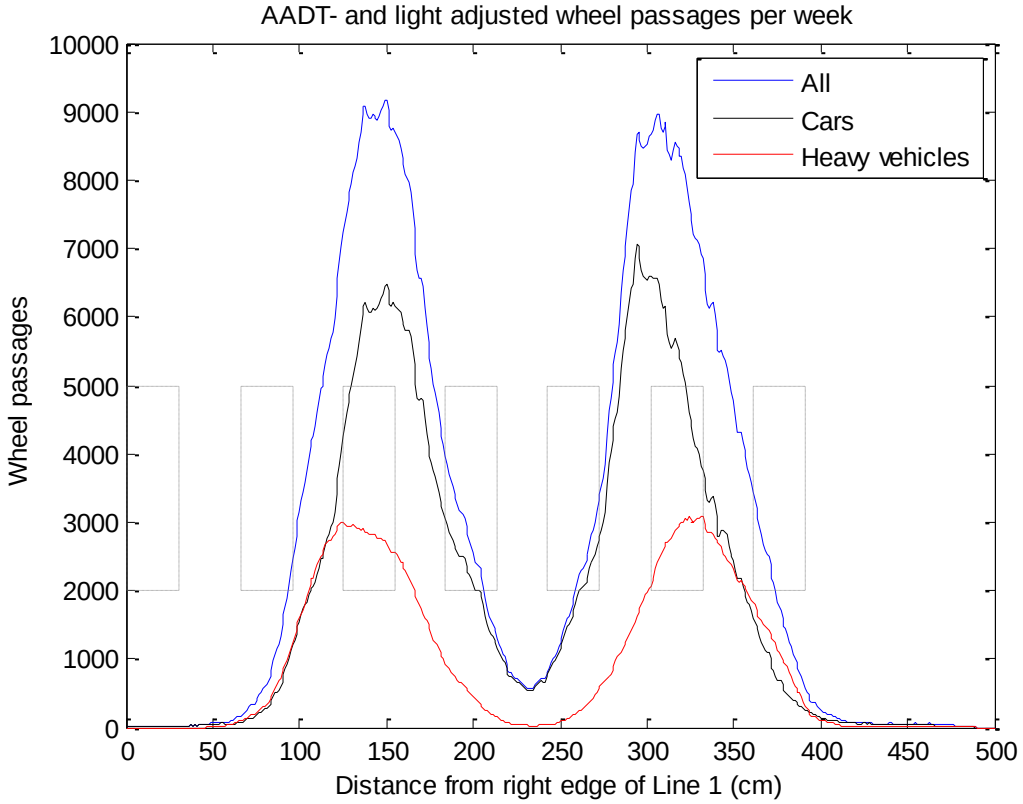

Figure 2. Wheel passages at the Swedish test site per week, adjusted for AADT and light conditions. The dashed areas correspond to the seven lines (line 1 to the left, line 7 to the right). Please note that the shoulder is to the left in the figure.

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 - 5).

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

Line	Line 2	Line 3	Line 4	Line 5	Line 6	Line 7
Number of wheel passages per week	663	8787	2738	1830	8394	1918

2.3. Weather conditions

The weather conditions from May 2015, when the materials were applied, to May 2016, when the first follow-up measurements were carried out are shown in Table 2.

Table 2. Weather conditions at the Swedish test site, from May 2015 to May 2016. Refers to Gustavsfors, about 50 km northeast of Sunne.

Weather parameter	Value
Annual average temperature	5,9° C
Average summer temperature (Apr-Sep)	11,5° C
Average winter temperature (Oct-Mar)	0,4° C
Annual precipitation	767 mm
Number of sun hours (Karlstad)	159 h
Number of weeks with snow	11
Number of times the snow plough has operated	39
Number of times the road has been salted	61

Weather data was retrieved from *the Swedish Meteorological and Hydrological Institute* (SMHI) open data service[1]. Information about snow plough operations and salting was obtained from the Swedish Road Administration.

[1] http://opendata-download-metobs.smhi.se/explore/

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 were calibrated according to recommended procedures.

At the Swedish test site, the performance measurements for all P-classes were carried out in August 2016 (week 39).

3.2. Methods and measuring instruments

3.2.1. Coefficient of retroreflected luminance RL and luminance coefficient under diffuse illumination 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, 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. This applies for all materials to line 5 in class P2 at the Swedish test site.

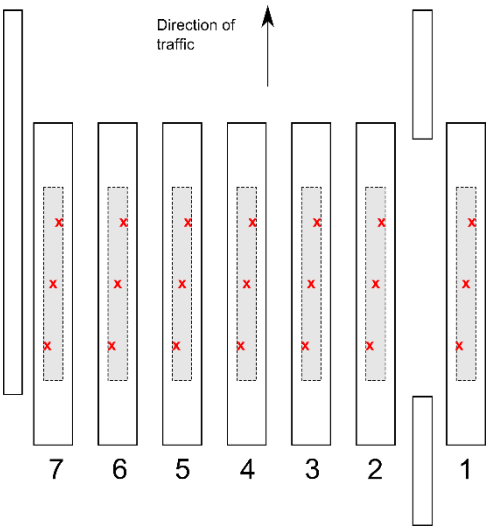

Figure 3. The measurement points (red crosses) for R_L and Qd were placed diagonally within the measurement area (grey) defined by EN 1824.

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, Figure 4. A *Konica Minolta Spectrophotometer CM-2500c* was used to measure the colour

coordinates. The chromaticity coordinates of yellow materials in retroreflected light (night-time colour) were measured by an *LTL 2000Y* (Delta, Denmark).

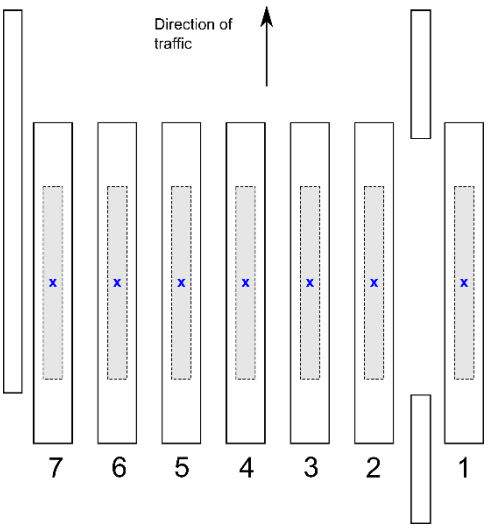

Figure 4. The measurement points (blue crosses) for chromaticity coordinates were placed in the centre of the lines.

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 4.

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).

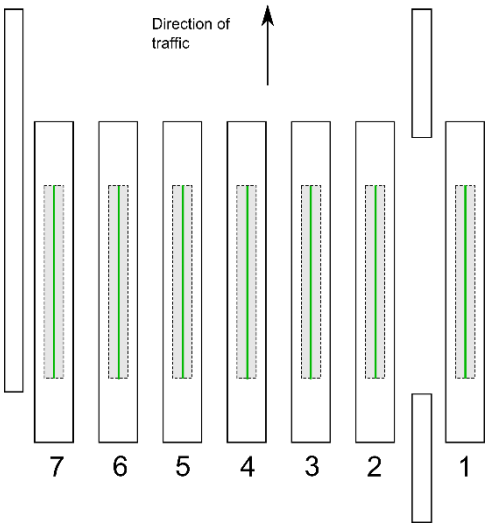

Figure 5. The measurement areas (green lines) for friction.

3.3. Weather conditions

During the measurements in week 22, it was mostly sunny. The air temperature was 18–26 °C, the temperature of the road marking surface was 23–30 °C and the relative humidity was 45–70 %. The road surface was completely dry.

Also in week 39 the weather was dry and relatively warm for the season. The relative humidity was 50–70 %. 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 markings	Yellow markings
Coefficient of retroreflected luminance, R_L dry [mcd/m^2/lx]	≥ 150	≥ 100
Luminance coefficient under diffuse illumination, *Qd* [mcd/m^2/lx]	≥ 130	≥ 100
Friction, [PFT units]	≥ 0.52[1]	≥ 0.52[1]
Chromaticity coordinates, x, y	*	**

1) The requirement of PFT units is equivalent to 50 SRT units.
*) According to EN 1436
**) Includes both daytime and night-time colour. Daytime colour: according to class Y1 in EN 1436. Night-time colour: according to ASTM D6628.

4.1.1. 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.

4.2. Certification in relation to P-classes

Materials are certified in relation to the number of wheel passages they will stand. The six lines within the driving lane 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, 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 %

4.2.1. P-classes at the Swedish test site

At the Swedish test site, P-classes P0–P4 were reached in 2016, and P-class P5 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 Swedish test site.

Roll-over class	Lines	Measured
P0	Line 2	August 2016
P1	Line 2	August 2016
P2	Line 7	August 2016
P3	Line 4	August 2016
P4	Line 6	August 2016
P5	-	Summer 2017

5. Certification of materials

Materials that have received certification from the Swedish test site are approved for use in Norway and Sweden. The certification is valid forever or until the requirements are changed.

Tables 6 – 30 show the results for roll-over classes P0, P1, P2, P3 and P4, for white and yellow materials, 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.

If there is no value in a cell, “worn” means that the road marking was wrenched. “Missing” means that the road marking was never applied.

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

5.1. White materials

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

Manufacturer *Material*	R_L	Qd	Friction	Colour	Appr.
Cleanosol AB AQ 6010	27	82	0.92	OK	NA
Cleanosol AB CLAQ 6007	23	73	0.91	OK	NA
Cleanosol AB, A/S 31 E35 NO	174	185	0.68	OK	A
Cleanosol AB, A/S 50 EP40 Agglo	174	182	0.74	OK	A
Cleanosol AB, A/S 31 E35	156	181	0.68	OK	A
Cleanosol AB, A/S, LKF A/S CL 35E1 R3	197	188	0.68	OK	A
Cleanosol AB, A/S, LKF A/S CL 35E2 R3	185	181	0.69	OK	A
Cleanosol AB, A/S, LKF A/S CL 71E1 R3	162	189	0.77	OK	A
Cleanosol AB, A/S, LKF A/S 45 S30 N	118	187	0.77	OK	NA
Ennis Flint Crystalex W2015.5	103	168	0.79	OK	NA
Ennis Flint Crystalex W2015.6	121	177	0.79	OK	NA
Ennis Flint Sprayplastic W2015.2	123	177	0.77	OK	NA
Ennis Flint Sprayplastic W2015.1	99	171	0.75	OK	NA
Hermseal A/S MeltMark ESP	112	164	0.73	OK	NA
Hitex HiBrite WR EXTR	133	165	0.72	OK	NA
Hot Mix Oy Hot Mix 3000M (white)	198	172	0.66	OK	NA
Hot Mix Oy Hot Mix 1A white	198	193	0.66	OK	A
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW1)	180	187	0.74	OK	A
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW)	193	191	0.70	OK	A
Kelly Bros (Erinline) Ltd Spray Briteline 150 (SW)	202	181	0.70	OK	A

Table 7. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P0. Manufacturers L-S.***

Manufacturer *Material*	R_L	Qd	Friction	Colour	Appr.
LKF Materials A/S Viatherm SK20	166	176	0.66	OK	A
LKF Materials A/S Viatherm Viking	232	173	0.58	OK	A
LKF Materials A/S Viatherm SK60	168	185	0.71	OK	A
LKF Materials A/S Viatherm SK25	150	179	0.76	OK	A
LKF Materials A/S Premark SK151	235	173	0.78	OK	A
LKF Materials A/S Premark SK152	213	174	0.70	OK	A
LKF Materials A/S Premark SK153	164	164	0.87	OK	A
Plastiroute GmBH AquaRoute BST-NO	48	104	0.89	OK	NA
Plastiroute GmBH AquaRoute HD BST	44	99	0.91	OK	NA
Promax Industries ApS Promax white prime	351	168	0.68	OK	A
Swarco Vestglas GmBH Swarcoterm SRP15 white	109	169	0.65	OK	NA
Swarco Vestglas GmBH Swarcoterm ERP15 white	157	175	0.66	OK	A
Swarco Limburger Lackf. GmBH Limboroute W 13	22	73	0.87	OK	NA
Swarco Vestglas GmBH Limboroute W15	23	79	0.88	OK	NA
Swarco Limburger Lackf. GmBH Limboroute W16	23	75	0.87	OK	NA
Svevia X204	348	151	0.61	OK	A
Svevia X205	162	150	0.70	OK	A
Svevia X206	121	125	0.78	OK	NA
Svevia X201	313	162	0.70	OK	A
Svevia X202	145	158	0.71	OK	NA

Table 8. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P0. Manufacturers T-V.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***Appr.***
Teknos Oy TEKNOROAD 3059 (white)	59	91	0.85	OK	NA
Tielinja Oy Hotmark VH35N	218	182	0.68	OK	A
Tielinja Oy Hotmark VH spray 35N	166	165	0.76	OK	A
Trafikmarkering TTP 30	195	186	0.59	OK	A
Veluvine Thermolit Nausta	194	190	0.85	OK	A
Veluvine Thermolit Gaula	152	190	0.90	OK	A
Vernicol Hidrocryl WBM F500	30	84	0.89	OK	NA
Visafo VIT VISA 15	25	81	0.87	OK	NA
Visafo VIT VISA 12	23	77	0.86	OK	NA

Table 9. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P1. Manufacturers C-K.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***Appr.***
Cleanosol AB AQ 6010	27	82	0.92	OK	NA
Cleanosol AB CLAQ 6007	23	73	0.91	OK	NA
Cleanosol AB, A/S 31 E35 NO	174	185	0.68	OK	A
Cleanosol AB, A/S 50 EP40 Agglo	174	182	0.74	OK	A
Cleanosol AB, A/S 31 E35	156	181	0.68	OK	A
Cleanosol AB, A/S, LKF A/S CL 35E1 R3	197	188	0.68	OK	A
Cleanosol AB, A/S, LKF A/S CL 35E2 R3	185	181	0.69	OK	A
Cleanosol AB, A/S, LKF A/S CL 71E1 R3	162	189	0.77	OK	A
Cleanosol AB, A/S, LKF A/S 45 S30 N	118	187	0.77	OK	NA
Ennis Flint Crystalex W2015.5	103	168	0.79	OK	NA
Ennis Flint Crystalex W2015.6	121	177	0.79	OK	NA
Ennis Flint Sprayplastic W2015.2	123	177	0.77	OK	NA
Ennis Flint Sprayplastic W2015.1	99	171	0.75	OK	NA
Hermseal A/S MeltMark ESP	112	164	0.73	OK	NA
Hitex HiBrite WR EXTR	133	165	0.72	OK	NA
Hot Mix Oy Hot Mix 3000M (white)	198	172	0.66	OK	NA
Hot Mix Oy Hot Mix 1A white	198	193	0.66	OK	A
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW1)	180	187	0.74	OK	A
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW)	193	191	0.70	OK	A
Kelly Bros (Erinline) Ltd Spray Briteline 150 (SW)	202	181	0.70	OK	A

Table 10. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P1. Manufacturers L-S.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***Appr.***
LKF Materials A/S Viatherm SK20	166	176	0.66	OK	A
LKF Materials A/S Viatherm Viking	232	173	0.58	OK	A
LKF Materials A/S Viatherm SK60	168	185	0.71	OK	A
LKF Materials A/S Viatherm SK25	150	179	0.76	OK	A
LKF Materials A/S Premark SK151	235	173	0.78	OK	A
LKF Materials A/S Premark SK152	213	174	0.70	OK	A
LKF Materials A/S Premark SK153	164	164	0.87	OK	A
Plastiroute GmBH AquaRoute BST-NO	48	104	0.89	OK	NA
Plastiroute GmBH AquaRoute HD BST	44	99	0.91	OK	NA
Promax Industries ApS Promax white prime	351	168	0.68	OK	A
Swarco Vestglas GmBH Swarcoterm SRP15 white	109	169	0.65	OK	NA
Swarco Vestglas GmBH Swarcoterm ERP15 white	157	175	0.66	OK	A
Swarco Limburger Lackf. GmBH Limboroute W 13	22	73	0.87	OK	NA
Swarco Vestglas GmBH Limboroute W15	23	79	0.88	OK	NA
Swarco Limburger Lackf. GmBH Limboroute W16	23	75	0.87	OK	NA
Svevia X204	348	151	0.61	OK	A
Svevia X205	162	150	0.70	OK	A
Svevia X206	121	125	0.78	OK	NA
Svevia X201	313	162	0.70	OK	A
Svevia X202	145	158	0.71	OK	NA

Table 11. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P1. Manufacturers T-V.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***Appr.***
Teknos Oy TEKNOROAD 3059 (white)	59	91	0.85	OK	NA
Tielinja Oy Hotmark VH35N	218	182	0.68	OK	A
Tielinja Oy Hotmark VH spray 35N	166	165	0.76	OK	A
Trafikmarkering TTP 30	195	186	0.59	OK	A
Veluvine Thermolit Nausta	194	190	0.85	OK	A
Veluvine Thermolit Gaula	152	190	0.90	OK	A
Vernicol Hidrocryl WBM F500	30	84	0.89	OK	NA
Visafo VIT VISA 15	25	81	0.87	OK	NA
Visafo VIT VISA 12	23	77	0.86	OK	NA

Table 12. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P2. Manufacturers C-K.***

Manufacturer *Material*	R_L	Qd	Friction	Colour	Appr.
Cleanosol AB AQ 6010	worn	worn			NA
Cleanosol AB CLAQ 6007	worn	worn			NA
Cleanosol AB, A/S 31 E35 NO	178	192	0.76	OK	A
Cleanosol AB, A/S 50 EP40 Agglo	180	187	0.79	OK	A
Cleanosol AB, A/S 31 E35	170	183	0.77	OK	A
Cleanosol AB, A/S, LKF A/S CL 35E1 R3	222	190	0.76	OK	A
Cleanosol AB, A/S, LKF A/S CL 35E2 R3	218	183	0.72	OK	A
Cleanosol AB, A/S, LKF A/S CL 71E1 R3	144	164	0.79	OK	NA
Cleanosol AB, A/S, LKF A/S 45 S30 N	112	187	0.78	OK	NA
Ennis Flint Crystalex W2015.5	127	181	0.80	OK	NA
Ennis Flint Crystalex W2015.6	156	193	0.81	OK	NA[1]
Ennis Flint Sprayplastic W2015.2	145	201	0.84	OK	NA
Ennis Flint Sprayplastic W2015.1	127	192	0.87	OK	NA
Hermseal A/S MeltMark ESP	127	194	0.83	OK	NA
Hitex HiBrite WR EXTR	152	171	0.81	OK	NA[1]
Hot Mix Oy Hot Mix 3000M (white)	193	202	0.82	OK	NA
Hot Mix Oy Hot Mix 1A white	179	203	0.83	OK	A
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW1)	160	188	0.81	OK	A
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW)	179	190	0.80	OK	A
Kelly Bros (Erinline) Ltd Spray Briteline 150 (SW)	180	186	0.81	OK	A

[1] The reason for NA is that the road marking was not approved for roll-over class P0.

Table 13. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P2. Manufacturers L-S.***

Manufacturer *Material*	R_L	Qd	Friction	Colour	Appr.
LKF Materials A/S Viatherm SK20	171	183	0.79	OK	A
LKF Materials A/S Viatherm Viking	240	180	0.71	OK	A
LKF Materials A/S Viatherm SK60	175	200	0.82	OK	A
LKF Materials A/S Viatherm SK25	173	196	0.78	OK	A
LKF Materials A/S Premark SK151	229	187	0.75	OK	A
LKF Materials A/S Premark SK152	179	193	0.87	OK	A
LKF Materials A/S Premark SK153	161	177	0.91	OK	A
Plastiroute GmBH AquaRoute BST-NO	worn	worn			NA
Plastiroute GmBH AquaRoute HD BST	worn	worn			NA
Promax Industries ApS Promax white prime	339	192	0.72	OK	A
Swarco Vestglas GmBH Swarcoterm SRP15 white	99	183	0.80	OK	NA
Swarco Vestglas GmBH Swarcoterm ERP15 white	176	181	0.87	OK	A
Swarco Limburger Lackf. GmBH Limboroute W 13	worn	worn			NA
Swarco Vestglas GmBH Limboroute W15	worn	worn			NA
Swarco Limburger Lackf. GmBH Limboroute W16	worn	worn			NA
Svevia X204	missing	missing			NA
Svevia X205	28	78	0.81	OK	NA
Svevia X206	151	151	0.82	OK	NA[1]
Svevia X201	missing	missing			NA
Svevia X202	154	176	0.78	OK	NA[1]

[1] The reason for NA is that the road marking was not approved for roll-over class P0.

Table 14. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P2. Manufacturers T-V.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***Appr.***
Teknos Oy TEKNOROAD 3059 (white)	worn	worn			NA
Tielinja Oy Hotmark VH35N	213	188	0.80	OK	NA
Tielinja Oy Hotmark VH spray 35N	150	170	0.84	OK	A
Trafikmarkering TTP 30	189	194	0.64	OK	A
Veluvine Thermolit Nausta	167	175	0.92	OK	A
Veluvine Thermolit Gaula	143	211	0.96	OK	NA
Vernicol Hidrocryl WBM F500	worn	worn			NA
Visafo VIT VISA 15	worn	worn			NA
Visafo VIT VISA 12	worn	worn			NA

Table 15. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P3. Manufacturers C-K.***

Manufacturer *Material*	R_L	Qd	Friction	Colour	Appr.
Cleanosol AB AQ 6010	worn	worn			NA
Cleanosol AB CLAQ 6007	worn	worn			NA
Cleanosol AB, A/S 31 E35 NO	138	187	0.72	OK	NA
Cleanosol AB, A/S 50 EP40 Agglo	160	181	0.73	OK	A
Cleanosol AB, A/S 31 E35	138	178	0.70	OK	NA
Cleanosol AB, A/S, LKF A/S CL 35E1 R3	181	182	0.69	OK	A
Cleanosol AB, A/S, LKF A/S CL 35E2 R3	163	173	0.73	OK	A
Cleanosol AB, A/S, LKF A/S CL 71E1 R3	150	155	0.77	OK	NA[2]
Cleanosol AB, A/S, LKF A/S 45 S30 N	116	176	0.77	OK	NA
Ennis Flint Crystalex W2015.5	121	180	0.74	OK	NA
Ennis Flint Crystalex W2015.6	133	186	0.76	OK	NA
Ennis Flint Sprayplastic W2015.2	123	191	0.80	OK	NA
Ennis Flint Sprayplastic W2015.1	89	184	0.82	OK	NA
Hermseal A/S MeltMark ESP	96	185	0.79	OK	NA
Hitex HiBrite WR EXTR	153	170	0.73	OK	NA[1]
Hot Mix Oy Hot Mix 3000M (white)	153	175	0.73	OK	NA
Hot Mix Oy Hot Mix 1A white	141	198	0.75	OK	NA
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW1)	worn	worn			NA
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW)	95	131	0.78	OK	NA
Kelly Bros (Erinline) Ltd Spray Briteline 150 (SW)	93	131	0.73	OK	NA

[1] The reason for NA is that the road marking was not approved for roll-over class P0.

[2] The reason for NA is that the road marking was not approved for roll-over class P2.

Table 16. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P3. Manufacturers L-S.***

Manufacturer *Material*	R_L	Qd	Friction	Colour	Appr.
LKF Materials A/S Viatherm SK20	158	183	0.70	OK	A
LKF Materials A/S Viatherm Viking	189	178	0.67	OK	A
LKF Materials A/S Viatherm SK60	158	192	0.74	OK	A
LKF Materials A/S Viatherm SK25	154	189	0.75	OK	A
LKF Materials A/S Premark SK151	241	178	0.77	OK	A
LKF Materials A/S Premark SK152	158	197	0.69	OK	A
LKF Materials A/S Premark SK153	127	172	0.84	OK	NA
Plastiroute GmBH AquaRoute BST-NO	worn	worn			NA
Plastiroute GmBH AquaRoute HD BST	worn	worn			NA
Promax Industries ApS Promax white prime	247	180	0.72	OK	A
Swarco Vestglas GmBH Swarcoterm SRP15 white	93	172	0.71	OK	NA
Swarco Vestglas GmBH Swarcoterm ERP15 white	154	180	0.69	OK	A
Swarco Limburger Lackf. GmBH Limboroute W 13	worn	worn			NA
Swarco Vestglas GmBH Limboroute W15	worn	worn			NA
Swarco Limburger Lackf. GmBH Limboroute W16	worn	worn			NA
Svevia X204	171	142	0.79	OK	NA[1]
Svevia X205	42	93	0.83	OK	NA
Svevia X206	60	109	0.79	OK	NA
Svevia X201	194	169	0.71	OK	NA[1]
Svevia X202	120	155	0.73	OK	NA

[1] The reason for NA is that the road marking was not approved for roll-over class P2.

Table 17. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P3. Manufacturers T-V.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***Appr.***
Teknos Oy TEKNOROAD 3059 (white)	worn	worn			NA
Tielinja Oy Hotmark VH35N	188	177	0.70	OK	NA
Tielinja Oy Hotmark VH spray 35N	58	113	0.79	OK	NA
Trafikmarkering TTP 30	161	186	0.58	OK	A
Veluvine Thermolit Nausta	worn	worn			NA
Veluvine Thermolit Gaula	worn	worn			NA
Vernicol Hidrocryl WBM F500	worn	worn			NA
Visafo VIT VISA 15	worn	worn			NA
Visafo VIT VISA 12	worn	worn			NA

Table 18. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P4. Manufacturers C-K.***

Manufacturer *Material*	R_L	Qd	Friction	Colour	Appr.
Cleanosol AB AQ 6010	worn	worn			NA
Cleanosol AB CLAQ 6007	worn	worn			NA
Cleanosol AB, A/S 31 E35 NO	113	189	0.81	OK	NA
Cleanosol AB, A/S 50 EP40 Agglo	136	190	0.81	OK	NA
Cleanosol AB, A/S 31 E35	110	186	0.82	OK	NA
Cleanosol AB, A/S, LKF A/S CL 35E1 R3	148	192	0.80	OK	NA
Cleanosol AB, A/S, LKF A/S CL 35E2 R3	134	187	0.80	OK	NA
Cleanosol AB, A/S, LKF A/S CL 71E1 R3	126	192	0.82	OK	NA
Cleanosol AB, A/S, LKF A/S 45 S30 N	93	189	0.77	OK	NA
Ennis Flint Crystalex W2015.5	worn	worn			NA
Ennis Flint Crystalex W2015.6	109	181	0.83	OK	NA
Ennis Flint Sprayplastic W2015.2	46	122	0.84	OK	NA
Ennis Flint Sprayplastic W2015.1	worn	worn			NA
Hermseal A/S MeltMark ESP	91	180	0.87	OK	NA
Hitex HiBrite WR EXTR	worn	worn			NA
Hot Mix Oy Hot Mix 3000M (white)	125	198	0.83	OK	NA
Hot Mix Oy Hot Mix 1A white	119	200	0.81	OK	NA
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW1)	worn	worn			NA
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW)	worn	worn			NA
Kelly Bros (Erinline) Ltd Spray Briteline 150 (SW)	worn	worn			NA

Table 19. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P4. Manufacturers L-S.***

Manufacturer *Material*	R_L	Qd	Friction	Colour	Appr.
LKF Materials A/S Viatherm SK20	91	152	0.84	OK	NA
LKF Materials A/S Viatherm Viking	152	173	0.83	OK	A
LKF Materials A/S Viatherm SK60	worn	worn			NA
LKF Materials A/S Viatherm SK25	115	184	0.80	OK	NA
LKF Materials A/S Premark SK151	worn	worn			NA
LKF Materials A/S Premark SK152	152	170	0.82	OK	A
LKF Materials A/S Premark SK153	worn	worn			NA
Plastiroute GmBH AquaRoute BST-NO	worn	worn			NA
Plastiroute GmBH AquaRoute HD BST	worn	worn			NA
Promax Industries ApS Promax white prime	244	176	0.75	OK	A
Swarco Vestglas GmBH Swarcoterm SRP15 white	76	183	0.82	OK	NA
Swarco Vestglas GmBH Swarcoterm ERP15 white	134	189	0.87	OK	NA
Swarco Limburger Lackf. GmBH Limboroute W 13	worn	worn			NA
Swarco Vestglas GmBH Limboroute W15	worn	worn			NA
Swarco Limburger Lackf. GmBH Limboroute W16	worn	worn			NA
Svevia X204	worn	worn			NA
Svevia X205	worn	worn			NA
Svevia X206	39	105	0.75	OK	NA
Svevia X201	218	170	0.76	OK	NA[1]
Svevia X202	133	155	0.74	OK	NA

[1] The reason for NA is that the road marking was not approved for roll-over class P2.

Table 20. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P4. Manufacturers T-V.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***Appr.***
Teknos Oy TEKNOROAD 3059 (white)	worn	worn			NA
Tielinja Oy Hotmark VH35N	165	182	0.83	OK	NA
Tielinja Oy Hotmark VH spray 35N	worn	worn			NA
Trafikmarkering TTP 30	141	183	0.66	OK	NA
Veluvine Thermolit Nausta	worn	worn			NA
Veluvine Thermolit Gaula	worn	worn			NA
Vernicol Hidrocryl WBM F500	worn	worn			NA
Visafo VIT VISA 15	worn	worn			NA
Visafo VIT VISA 12	worn	worn			NA

5.2. Yellow materials

Table 21. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P0. Manufacturers C-H.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***NTY***	***Appr.***
Cleanosol AB, A/S NTY 29E Yellow	83	137	0.77	OK	outside	NA
Cleanosol AB, A/S NTY 27 Agglo Yellow	80	131	0.78	OK	OK	NA
Cleanosol AB, A/S CL 29E2 R2 Yellow	75	133	0.74	OK	outside	NA
Cleanosol AB, A/S CL 27EP2 R2 Yellow	83	130	0.70	OK	outside	NA
Cleanosol AB, A/S CL 71E1 R2	98	133	0.81	OK	OK	NA
Cleanosol AB, A/S, LKF A/S NTY 29S Yellow	95	139	0.76	OK	outside	NA
Cleanosol AB, A/S, LKF A/S CL 7151 R2	100	139	0.81	OK	OK	A
Cleanosol AB, A/S, LKF A/S CL 2952 R2	79	134	0.75	OK	outside	NA
Ennis Flint Crystalex Y2015.8	71	128	0.81	OK	outside	NA
Ennis Flint Crystalex Y2015.7	84	128	0.70	OK	outside	NA
Ennis Flint Sprayplastic Y2015.3	65	127	0.77	OK	outside	NA
Ennis Flint Sprayplastic Y2015.4	52	122	0.77	OK	OK	NA
Hitex HiBrite Yellow EXTR1	94	140	0.75	outside	outside	NA
Hitex HiBrite Yellow EXTR2	81	130	0.75	OK	outside	NA
Hot Mix Oy Hot Mix 3000M (yellow)	103	133	0.79	OK	OK	A
Hot Mix Oy Hot Mix 1A yellow	100	136	0.69	OK	OK	A

Table 22. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P0. Manufacturers K-T.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***NTY***	***Appr.***
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 100 (SW)	140	132	0.70	outside	outside	NA
Kelly Bros (Erinline) Ltd Spray Briteline 100 (SW)	125	137	0.71	outside	outside	NA
LKF Materials A/S Viatherm SK55 yellow	124	137	0.76	OK	OK	A
LKF Materials A/S Viatherm SK50 yellow	134	131	0.69	OK	OK	A
Plastiroute GmBH AquaRoute HD BST Yellow	37	92	0.91	OK	outside	NA
Promax Industries ApS Promax yellow prime	135	113	0.62	OK	OK	NA
Swarco Vestglas GmBH Swarcotherm ERP 15	101	122	0.74	OK	outside	NA
Swarco Vestglas GmBH Swarcotherm SRP 15	70	133	0.79	OK	outside	NA
Svevia Y313	missing	missing				NA
Svevia Y314	missing	missing				NA
Svevia Y311	81	113	0.70	OK	OK	NA
Teknos Oy TEKNOROAD 3059 (yellow)	31	76	0.91	OK	outside	NA
Tielinja Oy Hotmark KH40N	121	128	0.71	OK	OK	A

Table 23. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P1. Manufacturers C-H.***

Manufacturer *Material*	R_L	Qd	Friction	Colour	NTY	Appr.
Cleanosol AB, A/S NTY 29E Yellow	83	137	0.77	OK	outside	NA
Cleanosol AB, A/S NTY 27 Agglo Yellow	89	131	0.78	OK	OK	NA
Cleanosol AB, A/S CL 29E2 R2 Yellow	75	133	0.74	OK	outside	NA
Cleanosol AB, A/S CL 27EP2 R2 Yellow	83	130	0.70	OK	outside	NA
Cleanosol AB, A/S CL 71E1 R2	98	133	0.81	OK	OK	NA
Cleanosol AB, A/S, LKF A/S NTY 29S Yellow	95	139	0.76	OK	outside	NA
Cleanosol AB, A/S, LKF A/S CL 7151 R2	100	139	0.81	OK	OK	A
Cleanosol AB, A/S, LKF A/S CL 2952 R2	79	134	0.75	OK	outside	NA
Ennis Flint Crystalex Y2015.8	71	128	0.81	OK	outside	NA
Ennis Flint Crystalex Y2015.7	84	128	0.70	OK	outside	NA
Ennis Flint Sprayplastic Y2015.3	65	127	0.77	OK	outside	NA
Ennis Flint Sprayplastic Y2015.4	52	122	0.77	OK	OK	NA
Hitex HiBrite Yellow EXTR1	94	140	0.75	outside	outside	NA
Hitex HiBrite Yellow EXTR2	81	130	0.75	OK	outside	NA
Hot Mix Oy Hot Mix 3000M (yellow)	103	133	0.79	OK	OK	A
Hot Mix Oy Hot Mix 1A yellow	100	136	0.69	OK	OK	A

Table 24. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P1. Manufacturers K-T.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***NTY***	***Appr.***
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 100 (SW)	140	132	0.70	outside	outside	NA
Kelly Bros (Erinline) Ltd Spray Briteline 100 (SW)	125	137	0.71	outside	outside	NA
LKF Materials A/S Viatherm SK55 yellow	124	137	0.76	OK	OK	A
LKF Materials A/S Viatherm SK50 yellow	134	131	0.69	OK	OK	A
Plastiroute GmBH AquaRoute HD BST Yellow	37	92	0.91	OK	outside	NA
Promax Industries ApS Promax yellow prime	135	113	0.62	OK	OK	NA
Swarco Vestglas GmBH Swarcotherm ERP 15	101	122	0.74	OK	outside	NA
Swarco Vestglas GmBH Swarcotherm SRP 15	70	133	0.79	OK	outside	NA
Svevia Y313	missing	missing				NA
Svevia Y314	missing	missing				NA
Svevia Y311	81	113	0.70	OK	OK	NA
Teknos Oy TEKNOROAD 3059 (yellow)	31	76	0.91	OK	outside	NA
Tielinja Oy Hotmark KH40N	121	128	0.71	OK	OK	A

Table 25. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P2. Manufacturers C-H.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***NTY***	***Appr.***
Cleanosol AB, A/S NTY 29E Yellow	71	135	0.75	OK	OK	NA
Cleanosol AB, A/S NTY 27 Agglo Yellow	86	133	0.74	OK	outside	NA
Cleanosol AB, A/S CL 29E2 R2 Yellow	90	138	0.75	OK	outside	NA
Cleanosol AB, A/S CL 27EP2 R2 Yellow	94	134	0.75	OK	outside	NA
Cleanosol AB, A/S CL 71E1 R2	87	140	0.78	OK	OK	NA
Cleanosol AB, A/S, LKF A/S NTY 29S Yellow	92	140	0.74	OK	OK	NA
Cleanosol AB, A/S, LKF A/S CL 7151 R2	100	137	0.80	OK	OK	A
Cleanosol AB, A/S, LKF A/S CL 2952 R2	84	136	0.72	OK	outside	NA
Ennis Flint Crystalex Y2015.8	92	136	0.80	OK	outside	NA
Ennis Flint Crystalex Y2015.7	103	140	0.79	OK	outside	NA
Ennis Flint Sprayplastic Y2015.3	78	140	0.87	OK	outside	NA
Ennis Flint Sprayplastic Y2015.4	69	137	0.86	OK	outside	NA
Hitex HiBrite Yellow EXTR1	104	144	0.76	outside	outside	NA
Hitex HiBrite Yellow EXTR2	90	136	0.77	outside	outside	NA
Hot Mix Oy Hot Mix 3000M (yellow)	104	141	0.81	OK	OK	A
Hot Mix Oy Hot Mix 1A yellow	103	141	0.79	OK	outside	NA

Table 26. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P2. Manufacturers K-T.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***NTY***	***Appr.***
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 100 (SW)	131	134	0.79	outside	outside	NA
Kelly Bros (Erinline) Ltd Spray Briteline 100 (SW)	128	146	0.81	OK	outside	NA
LKF Materials A/S Viatherm SK55 yellow	132	145	0.76	OK	OK	A
LKF Materials A/S Viatherm SK50 yellow	148	140	0.79	OK	OK	A
Plastiroute GmBH AquaRoute HD BST Yellow	worn	worn				NA
Promax Industries ApS Promax yellow prime	158	125	0.76	OK	outside	NA
Swarco Vestglas GmBH Swarcotherm ERP 15	116	127	0.78	OK	outside	NA
Swarco Vestglas GmBH Swarcotherm SRP 15	85	134	0.80	OK	outside	NA
Svevia Y313	126	79	0,85	OK	OK	NA
Svevia Y314	94	125	0,79	OK	OK	NA
Svevia Y311	91	125	0.78	OK	OK	NA
Teknos Oy TEKNOROAD 3059 (yellow)	worn	worn				NA
Tielinja Oy Hotmark KH40N	108	133	0.80	OK	OK	A

Table 27. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P3. Manufacturers C-H.***

Manufacturer *Material*	R_L	Qd	Friction	Colour	NTY	Appr.
Cleanosol AB, A/S NTY 29E Yellow	69	135	0.78	OK	outside	NA
Cleanosol AB, A/S NTY 27 Agglo Yellow	74	130	0.72	OK	outside	NA
Cleanosol AB, A/S CL 29E2 R2 Yellow	80	138	0.75	OK	outside	NA
Cleanosol AB, A/S CL 27EP2 R2 Yellow	76	132	0.71	OK	outside	NA
Cleanosol AB, A/S CL 71E1 R2	85	135	0.78	OK	OK	NA
Cleanosol AB, A/S, LKF A/S NTY 29S Yellow	93	140	0.78	OK	outside	NA
Cleanosol AB, A/S, LKF A/S CL 7151 R2	102	138	0.78	OK	OK	A
Cleanosol AB, A/S, LKF A/S CL 2952 R2	85	136	0.77	OK	outside	NA
Ennis Flint Crystalex Y2015.8	74	135	0.73	OK	outside	NA
Ennis Flint Crystalex Y2015.7	82	135	0.74	OK	outside	NA
Ennis Flint Sprayplastic Y2015.3	67	130	0.84	OK	outside	NA
Ennis Flint Sprayplastic Y2015.4	45	113	0.82	OK	outside	NA
Hitex HiBrite Yellow EXTR1	105	144	0.69	OK	outside	NA
Hitex HiBrite Yellow EXTR2	92	136	0.71	outside	outside	NA
Hot Mix Oy Hot Mix 3000M (yellow)	80	140	0.71	OK	outside	NA
Hot Mix Oy Hot Mix 1A yellow	78	140	0.72	OK	OK	NA

Table 28. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P3. Manufacturers K-T.***

Manufacturer *Material*	***R_L***	***Qd***	***Friction***	***Colour***	***NTY***	***Appr.***
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 100 (SW)	60	101	0.77	outside	outside	NA
Kelly Bros (Erinline) Ltd Spray Briteline 100 (SW)	worn	worn				NA
LKF Materials A/S Viatherm SK55 yellow	108	128	0.75	OK	OK	A
LKF Materials A/S Viatherm SK50 yellow	132	138	0.67	OK	OK	A
Plastiroute GmBH AquaRoute HD BST Yellow	worn	worn				NA
Promax Industries ApS Promax yellow prime	95	117	0.71	OK	outside	NA
Swarco Vestglas GmBH Swarcotherm ERP 15	89	132	0.66	OK	outside	NA
Swarco Vestglas GmBH Swarcotherm SRP 15	66	139	0.66	OK	outside	NA
Svevia Y313	missing	missing				NA
Svevia Y314	78	119	0.77	OK	OK	NA
Svevia Y311	59	107	0.81	OK	OK	NA
Teknos Oy TEKNOROAD 3059 (yellow)	worn	worn				NA
Tielinja Oy Hotmark KH40N	90	133	0.69	OK	OK	NA

Table 29. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P4. Manufacturers C-H.***

Manufacturer *Material*	R_L	Qd	Friction	Colour	NTY	Appr.
Cleanosol AB, A/S NTY 29E Yellow	72	141	0.80	OK	outside	NA
Cleanosol AB, A/S NTY 27 Agglo Yellow	66	136	0.79	OK	outside	NA
Cleanosol AB, A/S CL 29E2 R2 Yellow	69	140	0.78	OK	outside	NA
Cleanosol AB, A/S CL 27EP2 R2 Yellow	68	138	0.79	OK	outside	NA
Cleanosol AB, A/S CL 71E1 R2	84	141	0.82	OK	OK	NA
Cleanosol AB, A/S, LKF A/S NTY 29S Yellow	85	145	0.77	OK	OK	NA
Cleanosol AB, A/S, LKF A/S CL 7151 R2	85	144	0.81	OK	OK	NA
Cleanosol AB, A/S, LKF A/S CL 2952 R2	73	140	0.76	OK	outside	NA
Ennis Flint Crystalex Y2015.8	worn	worn				NA
Ennis Flint Crystalex Y2015.7	worn	worn				NA
Ennis Flint Sprayplastic Y2015.3	worn	worn				NA
Ennis Flint Sprayplastic Y2015.4	worn	worn				NA
Hitex HiBrite Yellow EXTR1	97	147	0.77	OK	outside	NA
Hitex HiBrite Yellow EXTR2	77	134	0.78	outside	outside	NA
Hot Mix Oy Hot Mix 3000M (yellow)	65	141	0.84	OK	OK	NA
Hot Mix Oy Hot Mix 1A yellow	64	145	0.83	OK	OK	NA

Table 30. The performance of the participating certification road markings at the Swedish test field in 2016. ***Roll-over class P4. Manufacturers K-T.***

Manufacturer *Material*	R_L	Qd	Friction	Colour	NTY	Appr.
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 100 (SW)	worn	worn				NA
Kelly Bros (Erinline) Ltd Spray Briteline 100 (SW)	worn	worn				NA
LKF Materials A/S Viatherm SK55 yellow	worn	worn				NA
LKF Materials A/S Viatherm SK50 yellow	worn	worn				NA
Plastiroute GmBH AquaRoute HD BST Yellow	worn	worn				NA
Promax Industries ApS Promax yellow prime	52	96	0.79	OK	outside	NA
Swarco Vestglas GmBH Swarcotherm ERP 15	61	135	0.85	OK	outside	NA
Swarco Vestglas GmBH Swarcotherm SRP 15	57	148	0.80	OK	outside	NA
Svevia Y313	missing	missing				NA
Svevia Y314	70	120	0.80	OK	outside	NA
Svevia Y311	worn	worn				NA
Teknos Oy TEKNOROAD 3059 (yellow)	worn	worn				NA
Tielinja Oy Hotmark KH40N	worn	worn				NA

6. Summary of the results of the certification

6.1. White materials

Tables 31-33 show the result of this first Nordic certification, carried out 2015 – 2016, white road marking materials valid for use in Norway and Sweden. **A** means approved and **NA** not approved material.

*Table 31. Certified white road marking materials for use on Norwegian and Swedish state roads, **A**. Materials which did not pass the test are indicated **NA**. Manufacturers C – K.*

Manufacturer *Material*	***initial***	***P0***	***P1***	***P2***	***P3***	***P4***
Cleanosol AB AQ 6010	A	NA				
Cleanosol AB CLAQ 6007	A	NA				
Cleanosol AB, A/S 31 E35 NO	A	A	A	A	NA	
Cleanosol AB, A/S 50 EP40 Agglo	A	A	A	A	A	NA
Cleanosol AB, A/S 31 E35	A	A	A	A	NA	
Cleanosol AB, A/S, LKF A/S CL 35E1 R3	A	A	A	A	A	NA
Cleanosol AB, A/S, LKF A/S CL 35E2 R3	A	A	A	A	A	NA
Cleanosol AB, A/S, LKF A/S CL 71E1 R3	A	A	A	NA	NA	NA
Cleanosol AB, A/S, LKF A/S 45 S30 N	A	NA				
Ennis Flint Crystalex W2015.5	A	NA				
Ennis Flint Crystalex W2015.6	A	NA				
Ennis Flint W2015.2	NA					
Ennis Flint Sprayplastic W2015.1	A	NA				
Hermseal A/S MeltMark ESP	A	NA				
Hitex HiBrite WR EXTR	A	NA				
Hot Mix Oy Hot Mix 3000M (white)	NA					
Hot Mix Oy Hot Mix 1A white	A	A	A	A	NA	
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW1)	A	A	A	A	NA	
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 150 (SW)	A	A	A	A	NA	
Kelly Bros (Erinline) Ltd Spray Briteline 150 (SW)	A	A	A	A	NA	

*Table 32. Certified white road marking materials for use on Norwegian and Swedish state roads, **A**. Materials which did not pass the test are indicated **NA**. Manufacturers L – S.*

Manufacturer *Material*	***initial***	***P0***	***P1***	***P2***	***P3***	***P4***
LKF Materials A/S Viatherm SK20	A	A	A	A	A	NA
LKF Materials A/S Viatherm Viking	A	A	A	A	A	A
LKF Materials A/S Viatherm SK60	A	A	A	A	A	NA
LKF Materials A/S Viatherm SK25	A	A	A	A	A	NA
LKF Materials A/S Premark SK151	A	A	A	A	A	NA
LKF Materials A/S Premark SK152	A	A	A	A	A	A
LKF Materials A/S Premark SK153	A	A	A	A	NA	
Plastiroute GmBH AquaRoute BST-NO	A	NA				
Plastiroute GmBH AquaRoute HD BST	A	NA				
Promax Industries ApS Promax white prime	A	A	A	A	A	A
Swarco Vestglas GmBH Swarcoterm SRP15 white	A	NA				
Swarco Vestglas GmBH Swarcoterm ERP15 white	A	A	A	A	A	NA
Swarco Limburger Lackf. GmBH Limboroute W 13	A	NA				
Swarco Vestglas GmBH Limboroute W15	A	NA				
Swarco Limburger Lackf. GmBH Limboroute W16	A	NA				
Svevia X204	A	A	A	NA		
Svevia X205	A	A	A	NA		
Svevia X206	A	NA				
Svevia X201	A	A	A	NA		
Svevia X202	A	NA				

*Table 33. Certified white road marking materials for use on Norwegian and Swedish state roads, **A**. Materials which did not pass the test are indicated **NA**. Manufacturers T – V.*

Manufacturer *Material*	***initial***	***P0***	***P1***	***P2***	***P3***	***P4***
Teknos Oy TEKNOROAD 3059 (white)	A	NA				
Tielinja Oy Hotmark VH35N	A	A	A	NA		
Tielinja Oy Hotmark VH spray 35N	A	A	A	A	NA	
Trafikmarkering TTP 30	A	A	A	A	A	NA
Veluvine Thermolit Nausta	A	A	A	A	NA	
Veluvine Thermolit Gaula	A	A	A	NA		
Vernicol Hidrocryl WBM F500	A	NA				
Visafo VIT VISA 15	A	NA				
Visafo VIT VISA 12	A	NA				

6.2. Yellow materials

Tables 34-35 show the result of this first Nordic certification, carried out 2015 – 2016, yellow road marking materials valid for use in Norway. **A** means approved and **NA** not approved material.

*Table 34. Certified yellow road marking materials for use on Norwegian state roads, **A**. Materials which did not pass the test are indicated **NA**. Manufacturers C – H.*

Manufacturer *Material*	***initial***	***P0***	***P1***	***P2***	***P3***	***P4***
Cleanosol AB, A/S NTY 29E Yellow	A	NA				
Cleanosol AB, A/S NTY 27 Agglo Yellow	A	NA				
Cleanosol AB, A/S CL 29E2 R2 Yellow	A	NA				
Cleanosol AB, A/S CL 27EP2 R2 Yellow	A	NA				
Cleanosol AB, A/S CL 71E1 R2	A	NA				
Cleanosol AB, A/S, LKF A/S NTY 29S Yellow	A	NA				
Cleanosol AB, A/S, LKF A/S CL 7151 R2	A	A	A	A	A	NA
Cleanosol AB, A/S, LKF A/S CL 2952 R2	A	NA				
Ennis Flint Crystalex Y2015.8	NA					
Ennis Flint Crystalex Y2015.7	NA					
Ennis Flint Sprayplastic Y2015.3	A	NA				
Ennis Flint Sprayplastic Y2015.4	A	NA				
Hitex HiBrite Yellow EXTR1	A	NA				
Hitex HiBrite Yellow EXTR2	NA					
Hot Mix Oy Hot Mix 3000M (yellow)	A	A	A	A	NA	
Hot Mix Oy Hot Mix 1A yellow	A	A	A	NA		

*Table 35. Certified yellow road marking materials for use on Norwegian state roads, **A**. Materials which did not pass the test are indicated **NA**. Manufacturers K – T.*

Manufacturer *Material*	***initial***	***P0***	***P1***	***P2***	***P3***	***P4***
Kelly Bros (Erinline) Ltd Extr./Screed Briteline 100 (SW)	A	NA				
Kelly Bros (Erinline) Ltd Spray Briteline 100 (SW)	A	NA				
LKF Materials A/S Viatherm SK55 yellow	A	A	A	A	A	NA
LKF Materials A/S Viatherm SK50 yellow	A	A	A	A	A	NA
Plastiroute GmBH AquaRoute HD BST Yellow	A	NA				
Promax Industries ApS Promax yellow prime	NA					
Swarco Vestglas GmBH Swarcotherm ERP 15	NA					
Swarco Vestglas GmBH Swarcotherm SRP 15	NA					
Svevia Y313	A	NA				
Svevia Y314	A	NA				
Svevia Y311	A	NA				
Teknos Oy TEKNOROAD 3059 (yellow)	A	NA				
Tielinja Oy Hotmark KH40N	A	A	A	A	NA	

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

Of the 49 white materials tested for certification, 3 fulfilled the requirement for roll-over class P4, 12 for class P3, 21 for class P2 and 27 for both class P1 and P0. Consequently, 22 of the road markings tested for certification did not fulfil the requirements for any roll-over class.

The corresponding figures for yellow materials show that no material fulfilled the requirement for roll-over class P4, 3 for P3, 5 for P2 and 6 for both P1 and P0. This means that 23 materials did not fulfil the requirements for any roll-over class.

References

Fors, C., Johansen, T-C. and Lundkvist, S-O. (2016). *Nordic certification system for road marking materials – Version 3:2016.* VTI notat 17A-2016. Swedish National Road and Transport Research Institute, Linköping, Sweden.

Johansen, T.C., Fors C., Nygårdhs, S., Lundkvist, S-O. (2016). *Nordic certification of road marking materials in Denmark 2015 – 2016.* VTI rapport 911A. Swedish National Road and Transport Research Institute, Linköping, Sweden.

Kottek, M., Grieser, J., Beck, C., Rudolf, B. and Rubel, F. (2006). *World Map of Köppen-Geiger Climate Classification updated*. Meteorol. Z. **15**(3):259–263. Web: http://koeppen-geiger.vu-wien.ac.at/present.htm

Trafikverket (2014). *Undersökning av däcktyp i Sverige – vintern 2014 (januari-mars).* Trafikverket publikation 2014:100. Web: http://www.dackinfo.se/wp-content/uploads/2012/04/Dackundersokning_PV_vinter_2014.pdf

Wälivaara, B. (2007). *Validering av VTI-PFT version 4. Mätningar på plana och profilerade vägmarkeringar.* VTI notat 16-2007. Swedish National Road and Transport Research Institute, Linköping, Sweden.

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