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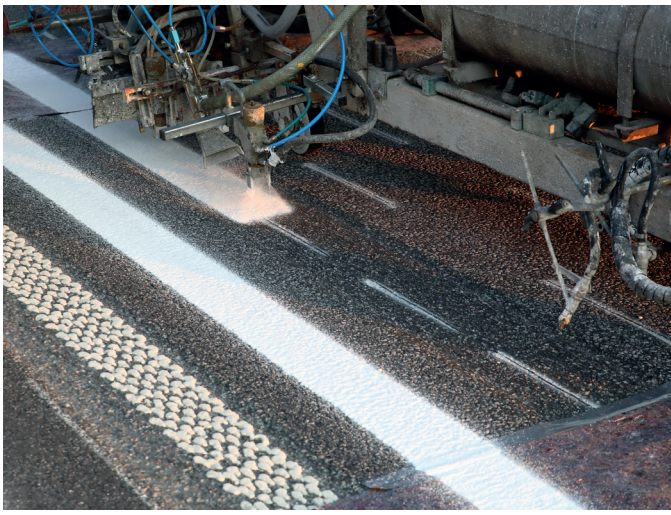

Nordic certification of road marking materials in Norway and Sweden 2016–2018

Trond Cato Johansen
Carina Fors

VTI rapport 995A | Nordic certification of road marking materials in Norway and Sweden 2016–2018

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Abstract

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

A Norwegian-Swedish test site was established in 2015, where between 43 and 81 materials have been applied yearly. The applied materials are followed up with performance measurements for two years. The materials are approved (certified) in relation to the number of wheel passages they will stand.

The certification system includes road marking materials for longitudinal road markings in categories with respect to colour (white, yellow), type (type I, type II, antiskid) and thickness (0.4, 0.6, 1.5, 3 and 4 mm).

The present report documents the follow-up performance measurements that were carried out at the Norwegian-Swedish test site in 2018, i.e. one-year follow-up measurements for materials applied in 2017 and two years follow-up measurements for materials applied in 2016. The performance parameters include the coefficient of retroreflected luminance (R_L) under dry and wet conditions, the luminance coefficient under diffuse illumination (Qd), the friction, the chromaticity in daylight, and the chromaticity of retroreflected light (yellow materials, only).

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Referat

En nordisk certifiering av vägmarkeringsmaterial introducerades 2015 och omfattar för närvarande Danmark, Norge och Sverige. I dessa länder krävs ett dokumenterat godkännande av vägmarkeringsmaterial som används på vägar som administreras av den statliga väghållaren. Detta godkännande baseras på funktionsmätningar på materialprover som har applicerats i provfält.

Ett norsk-svenskt provfält etablerades år 2015, där mellan 43 och 81 material har lagts ut för provning varje år. De utlagda materialproven följs upp med funktionsmätningar under två år. Materialen godkänns (certifieras) i relation till antalet hjulpassager de klarar.

Certifieringssystemet omfattar vägmarkeringsmaterial för längsgående vägmarkeringar i olika kategorier med avseende på färg (vit, gul), typ (typ I, typ II, friktion) och tjocklek (0,4; 0,6; 1,5; 3 och 4 mm).

Föreliggande rapport dokumenterar resultaten från de uppföljande funktionsmätningar som gjordes på det norsk-svensk provfältet 2018, det vill säga ettårsuppföljning av material som lades ut 2017 och tvåårsuppföljning av material som lades ut 2016. Funktionsmätningarna omfattar retroreflexion (R_L) i torrt och vått tillstånd, luminanskoefficient (Qd), friktion, färg i dagsljus och färg i fordonsbelysning (för gula material).

Titel:	Nordisk certifiering av vägmarkeringsmaterial i Norge och Sverige 2016–2018
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Preface

A Nordic certification system for road marking materials was introduced in 2015. Certification of products is based on documented performance measurements of material samples applied on test fields on public roads. This report compiles and presents the results of the performance measurements carried out in 2018 on road marking materials applied for certification at the Norwegian-Swedish test site in 2016–2017.

Performance measurements of retroreflection, luminance coefficient, friction and chromaticity coordinates were carried out by operators from Ramböll, supervised by staff from VTI.

The road trials are administered as a joint project between Ramböll AB and the Swedish National Road and Transport Research Institute (VTI). Trond Cato Johansen at Ramböll is the project manager and Carina Fors is the project leader at VTI. Kenneth Kjemtrup, the Danish Road Directorate, Bjørn Skaar, the Norwegian Public Roads Administration and Ulf Söderberg, the Swedish Transport Administration constitute a steering committee for the Nordic certification system.

Drøbak, November 2018

Trond Cato Johansen
Project Manager

Quality review

Internal peer review was performed 16 November 2018 by Magnus Larsson. Carina Fors has made alterations to the final manuscript of the report. Anna Anund examined and approved the report for publication on 27 November 2018. 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 16 november 2018 av Magnus Larsson. Carina Fors har genomfört justeringar av slutligt rapportmanus. Anna Anund har därefter granskat och godkänt publikationen för publicering 27 november 2018. De slutsatser och rekommendationer som uttrycks är författarnas egna och speglar inte nödvändigtvis myndigheten VTI:s uppfattning.

Contents

Summary

Nordic certification of road marking materials in Norway and Sweden 2016–2018

by Trond Cato Johansen (Ramböll) and Carina Fors (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 is required in order to use a road marking material on roads managed by the national road authorities. Product approval is based on monitored and documented performance measurements of material samples applied on test fields on public roads. Certification in Norway and Sweden is based on the results from a test site in Norway or in Sweden and certification in Denmark is based on the results from a test site in Denmark. The certification system includes road marking materials for longitudinal road markings in categories with respect to colour (white, yellow), type (type I, type II, antiskid) and thickness (0.4, 0.6, 1.5, 3 and 4 mm).

A Norwegian-Swedish test site was established in 2015, where 43 to 81 materials have been applied yearly. Approximately two weeks after application, the initial performance of the coefficient of retroreflected luminance R_L under dry and wet conditions, the luminance coefficient under diffuse illumination *Qd*, the friction, the chromaticity in daylight, and the chromaticity of retroreflected light (yellow materials, only) are determined.

Follow-up measurements of the performance parameters mentioned above are carried out one and two years after application. The present report documents the follow-up measurements that were carried out in 2018, i.e. one-year follow-up measurements for materials applied in 2017 and two years follow-up measurements for materials applied in 2016.

Materials are certified in relation to the number of wheel passages they will stand, with preserved functionality. Depending on the traffic flow, the position in the lane and the exposure time, different roll-over classes (P0–P6, corresponding to ≤50 000–2 000 000 wheel passages, defined by EN 1824) will be reached. For materials applied in 2017, roll-over classes P0, P2, P3 and P4 were reached in 2018 and for materials applied in 2016, roll-over class P5 was reached in 2018.

Out of the 66 materials applied in 2017, 57 (44 white, 13 yellow) were approved at the initial measurements and did thus qualify for follow-up measurements. Out of the 44 white materials, 9 fulfilled the requirement for roll-over class P4, 10 for class P3, 20 for class P2, and 24 for class P0. 20 white materials did not fulfil the requirements for any roll-over class. The corresponding figures for the 13 yellow materials show that no material fulfilled the requirement for roll-over classes P4. 1 material fulfilled the requirement for class P3, 3 for class P2 and 6 for class P0. 7 yellow materials did not fulfil the requirements for any roll-over class.

Seven materials applied in 2016 fulfilled the requirement for class P4 in 2017. The follow-up measurements carried out in 2018 showed that three of these materials fulfilled the requirement for class P5. Thus, the final result for the 72 materials applied in 2016 is as follows:

No P-class: 23 white, 17 yellow

P1: 25 white, 7 yellow

P2: 24 white, 4 yellow

P3: 11 white, 0 yellow

P4: 7 white, 0 yellow

P5: 3 white, 0 yellow

Sammanfattning

Nordisk certifiering av vägmarkeringsmaterial i Norge och Sverige 2016–2018

av Trond Cato Johansen (Ramböll) och Carina Fors (VTI)

En nordisk certifiering av vägmarkeringsmaterial introducerades 2015 och avser i ett första steg Danmark, Norge och Sverige. I dessa länder krävs 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 på allmän väg. Certifiering i Norge och Sverige baseras på resultat från provfält i Norge eller i Sverige, medan certifiering i Danmark baseras på resultat från provfält i Danmark. Certifieringssystemet omfattar för närvarande vägmarkeringsmaterial för längsgående vägmarkeringar i olika kategorier med avseende på färg (vit, gul), typ (typ I, typ II, friktion) och tjocklek (0,4; 0,6; 1,5; 3 och 4 mm).

Ett svensk-norskt provfält etablerades 2015, där mellan 43 och 81 material har lagts ut för provning varje år. Cirka två veckor efter utläggningen görs initiala mätningar av vägmarkeringarnas retroreflexion, R_L i torrt och vått tillstånd, luminanskoefficient, *Qd*, friktion, färg i dagsljus och färg i fordonsbelysning (för gula material).

Uppföljande mätningar av ovan nämnda funktionsparametrar görs ett respektive två år efter utläggning. Föreliggande rapport dokumenterar resultaten från de uppföljande mätningar som gjordes 2018, det vill säga ettårsuppföljning av material som lades ut 2017 och tvåårsuppföljning av material som lades ut 2016.

Materialen certifieras i relation till antalet hjulpassager de tål, med bibehållen funktion. Beroende på trafikflöde, position i körfältet och exponeringstid, uppnås olika hjulpassageklasser (P0–P6, motsvarande ≤50 000–2 000 000 hjulpassager) som definieras av europastandarden EN 1824. På provfältet som lades ut 2017 uppnåddes klasserna P0, P2, P3 och P4 under 2018 och på provfältet som lades ut 2016 uppnåddes klassen P5 under 2018.

Av de 66 material som lades ut för certifiering 2017 godkändes 57 (44 vita, 13 gula) vid de initiala mätningarna och de kvalificerade sig därmed för uppföljande mätningar. Av de 44 vita materialen uppfyllde 9 kraven för hjulpassageklass P4, 10 för klass P3, 20 för klass P2 och 24 för klass P0. 20 vita material uppfyllde inte kraven i någon hjulpassageklass. Motsvarande siffror för de 13 gula materialen visade att inga material uppfyllde kraven för klass P4. 1 material uppfyllde kraven för klass P3, 3 för klass P2 och 6 för klass P0. 7 gula material uppfyllde inte kraven i någon hjulpassageklass.

Sju material som lades ut 2016 uppfyllde kraven för klass P4 under 2017. De uppföljande mätningarna som gjordes 2018 visade att 3 av dessa material uppfyllde kraven för klass P5. De slutgiltiga resultaten för de 72 material som lades ut 2016 är således:

Ingen P-klass: 23 vita, 17 gula

P1: 25 vita, 7 gula

P2: 24 vita, 4 gula

P3: 11 vita, 0 gula

P4: 7 vita, 0 gula

P5: 3 vita, 0 gula

1. Introduction

A Nordic certification system for road marking materials, that applies to the countries of Denmark, Norway and Sweden, was introduced in 2015. In these countries, a documented product approval is required in order to use a road marking material on roads managed by the national road authorities. Product approval is based on monitored and documented performance measurements of material samples applied on test fields on public roads. Certification in Norway and Sweden is based on the results from a test site in Norway or in Sweden and certification in Denmark is based on the results from a test site in Denmark. The results from the Danish test site are presented in a separate report (Johansen and Fors, 2018).

The first round of material tests started in May 2015, when 81 materials were applied at the Norwegian-Swedish test site, which at that time was located to Sunne, Sweden. In 2016, another 72 materials were applied for certification at the test site in Sunne – 48 white and 24 yellow. In 2017, a new test site for certification in Norway and Sweden was established in Haslemoen in Norway, where 69 materials were applied. 66 materials – 48 white and 18 yellow – were applied for certification and 3 for manufacturer's internal test. In 2018, another 43 materials were applied at the test site in Haslemoen.

Follow-up measurements of the performance parameters coefficient of retroreflected luminance R_L under dry and wet conditions, luminance coefficient under diffuse illumination *Qd*, chromaticity in daylight, chromaticity of retroreflected light (yellow materials only) and friction are carried out one year and two years after application. Thus, in 2018, two-years follow-up measurements for materials applied in 2016 and one-year follow-up measurements for materials applied in 2017 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 roll-over classes (P-classes, defined by EN 1824) have been determined for each of the six or nine lines of road marking materials that were applied in the lane (see also Sections 2.1.2 and 2.2.2). For materials applied at the Norwegian-Swedish test site in 2016, the P-classes P1, P2, P3 and P4 were reached in 2017 and P-class P5 was reached in 2018. For materials applied at the Norwegian-Swedish test site in 2017, the P-classes P0, P2, P3 and P4 were reached in 2018.

The certification system is further described in the document *Nordic certification system for road marking materials – Version 5:2018* (Fors, Johansen, Lundkvist and Nygårdhs, 2018) which is a public report available at www.vti.se/en/publications. The document (and its previous versions) is referred to as *NCSRM-X:201x* in the present report.

1.1. Aim

The aim of this report is to compile and present the results of the follow-up performance measurements carried out in 2018 on the materials applied at the Norwegian-Swedish test sites in 2016 and in 2017, i.e. the report presents which materials have been certified for use in Norway and Sweden, for the P-classes mentioned above. Results for higher P-classes for materials applied in 2017 will be published after the two-years follow-up measurements in 2019.

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

2. Test sites

2.1. Test site Sunne (Sweden)

The test site in Sunne, Sweden, was established in 2015. Materials were applied in 2015 and in 2016.

2.1.1. 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 annual average daily traffic (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 in 2015.

Figure 1. The test site in Sweden at the time of application in 2015. Photo: Trond Cato Johansen.

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

The Köppen (climatic) 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, Grieser, Beck, Rudolf and Rubel, 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 percentage 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.*

2.1.2. Material application

Each marking material was applied as a row of seven longitudinal lines in the direction of the traffic, Figure 1. The length of the lines were 2.5 m and the width was 0.3 m. The distance between two adjacent rows of lines was at least 1 m. The lines are numbered from right to left in the driving direction, i.e. line 1 is the one on the shoulder and line 7 is the one next to the centre line.

2.1.3. Traffic volume and wheel passages

Measurements of wheel passages are carried out yearly, in order to determine roll-over classes (P-classes) for the lines, see also Section 4.2. The P-classes for 2017–2018 are based on wheel passage measurements carried out in September 2017. The number and type of vehicles and their lateral position were registered by a portable traffic analyser based on coaxial cable technique, developed at VTI. The measurement equipment was placed in an empty position (i.e. were no material was applied) in the middle of the test field. Wheel passages were registered for one week.

At the test field established in 2016, on average, 1 795 vehicles, corresponding to 4 119 wheel pairs, were registered per day (in one direction). 87.5 % were passenger cars, 12.1 % were heavy vehicles, and 0.4 % were other vehicles (two wheelers, working vehicles). The traffic flow was the highest on Friday (2 094 vehicles) and the lowest on Sunday (1 467 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 12.8 % 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 12.8 %).

The transversal distribution of wheel passages tends to move to the centre line in darkness compared to daylight. In darkness, passenger vehicles were positioned 8 cm more to the left and heavy vehicles were positioned 14 cm more to the left. 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.

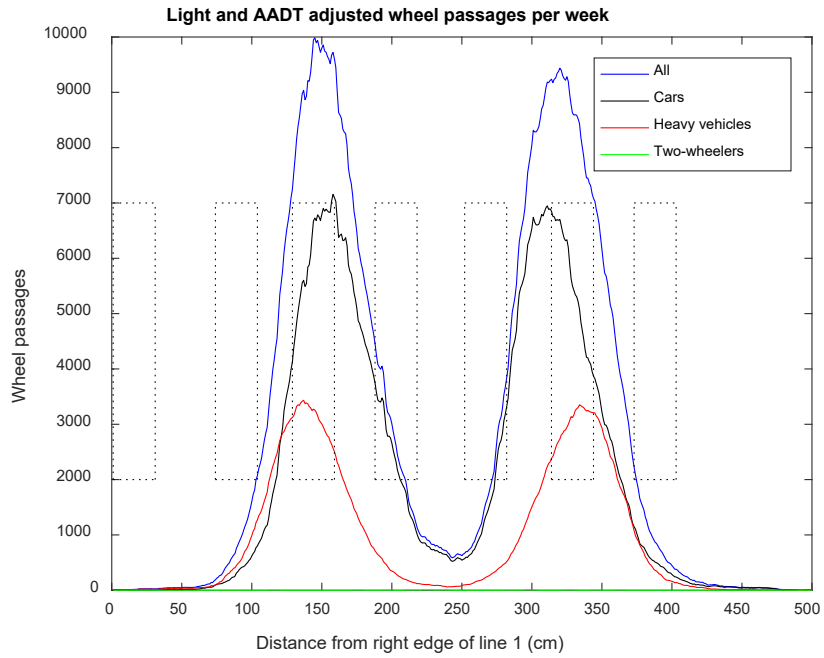

Figure 2. Wheel passages per week at the Swedish test field established in 2016, adjusted for AADT and light conditions (see Section 2.1.3). The dashed areas correspond to the seven lines (line 1 to the left, line 7 to the right). Please note that the shoulder is to the left in the figure. The number of two-wheelers are too few to be visible 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 5–Figure 7).

Table 1. Number of wheel passages per line and week, at the Swedish test field established in 2016. Line 2 is the one next to the edge line, see also Figure 5.

Line	Line 2	Line 3	Line 4	Line 5	Line 6	Line 7
Number of wheel passages per week	723	9 489	2 737	1 467	8 859	963

2.1.4. Weather conditions 2017–2018

The weather conditions from August 2017 to August 2018 are shown in Table 2.

Table 2. Weather conditions at the Swedish test site, from August 2017 to August 2018.

Weather parameter	Value
Annual average temperature	6.4 °C
Average summer temperature (Apr-Sep)	13.8 °C
Average winter temperature (Oct-Mar)	-1.0 °C
Annual precipitation	704 mm
Number of sun hours per month (Karlstad)	175 h
Number of weeks with snow	17
Number of times the snow plough has operated*	61
Number of times the road has been salted**	63

*) Includes salting
**) Salting only

Weather data was retrieved from *the Swedish Meteorological and Hydrological Institute* (SMHI) open data service[1]. Data on temperature, precipitation and snow are from weather stations located less than 15 km from the test site.

Information about snow plough operations and salting was obtained from the Swedish Transport Administration.

2.2. Test site Haslemoen (Norway)

The test site in Haslemoen, Norway, was established in 2017. Materials have been applied in 2017 and in 2018.

2.2.1. General

The road used for the test site is a two-lane rural road located in Hedmark, close to Haslemoen in eastern Norway, approximately 180 km northeast of Oslo, Figure 3. The road is straight and relatively flat and without any major junctions. The annual average daily traffic (AADT) is 3 200 vehicles/day (measured in 2016) and the posted speed limit is 90 km/h. The width of the road is 9 m and each lane is 3.15 m from the edge of milling track in the middle to the edge of milling at the edge line.

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

Figure 3. The road used for the Norwegian test site. (Photo: Trond Cato Johansen, Ramböll).

The road surface consists of a stone matrix asphalt (SKA) that was installed in 2016. The roughness class is RG2 i.e. the averaged measured texture depth is in the range of 0.60–0.90 mm.

The Köppen classification of the test site is Dfc, close to the boundary of the Dfb climate zone, based on data for the period 1951–2000 (Kottek, Grieser, Beck, Rudolf and Rubel, 2006). The climatic class according to EN 1824 is C3.

Studded tyres are permitted in Norway from 1 November to the first Sunday after Easter. The estimated amount of cars with studded tyres is 50–55%.

Further details can be found in *NCSRM-5:2018.*

2.2.2. Material application

Each marking material was applied as a row of ten longitudinal lines in the direction of the traffic. The length of the lines were 2.5 m and the width was 0.15 m. The distance between two adjacent rows of lines was 2 m. The lines are numbered from right to left in the driving direction, i.e. line 1 is the one on the shoulder and line 10 is the one next to the centre line.

2.2.3. Traffic volume and wheel passages

Measurements of wheel passages are carried out yearly, in order to determine roll-over classes (P-classes) for the lines, see also Section 4.2. The P-classes for 2017–2018 are based on wheel passage measurements carried out in September 2017. The number and type of vehicles and their lateral position were registered by a portable traffic analyser based on coaxial cable technique, developed at VTI. The measurement equipment was placed in an empty position (i.e. were no material was applied) in the middle of the test field. Wheel passages were registered for one week.

On average, 1 626 vehicles, corresponding to 3 791 wheel pairs, were registered per day (in one direction). 85.4 % were passenger cars, 14.1 % were heavy vehicles, and 0.5 % were other vehicles

(two wheelers, working vehicles). The traffic flow was the highest on Friday (1 915 vehicles) and the lowest on Sunday (1 146 vehicles).

The registered traffic flow was compared to AADT information provided by the Norwegian Public Roads Administration, and it was found that the difference was less than 0,5%. Thus, no adjustment of the measured data was needed.

The transversal distribution of wheel passages tends to move to the centre line in darkness compared to daylight. In darkness, passenger vehicles were positioned 9 cm more to the left and heavy vehicles were positioned 6 cm more to the left. 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 4 shows the distribution of wheel passages for the average week, adjusted for variations in distribution due to the light conditions.

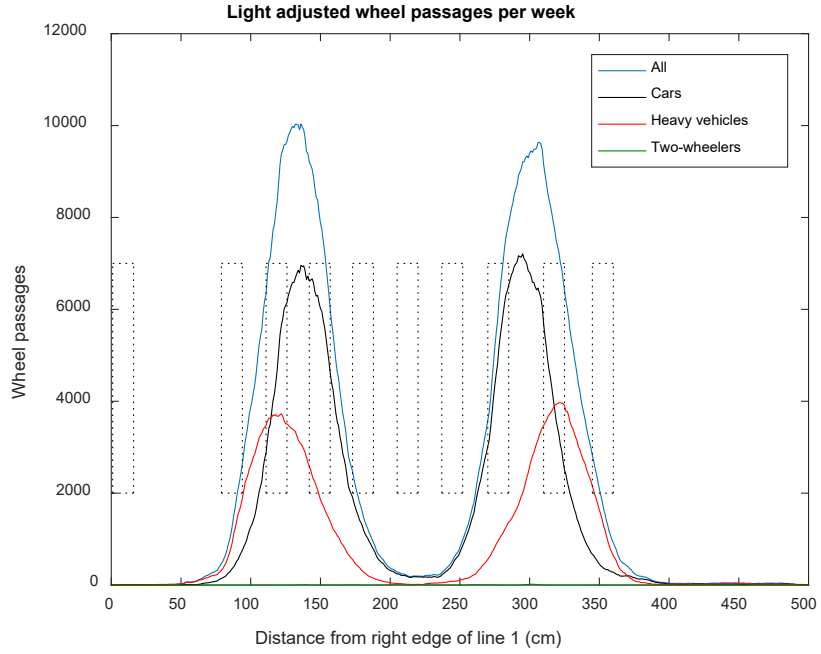

Figure 4. Wheel passages per week at the Norwegian test field established in 2017, adjusted for light conditions (see Section 2.2.3). The dashed areas correspond to the ten lines (line 1 to the left, line 10 to the right). Please note that the shoulder is to the left in the figure. The number of two-wheelers are too few to be visible in the figure.

Table 3 shows the number of wheel passages per line and week, as an average for the 15 cm wide lines (corresponding to the measurement area, see Figure 5–Figure 7).

Table 3. Number of wheel passages per line and week, at the Norwegian test field established in 2017. Line 2 is the one next to the edge line, see also Figure 5.

Line	Line 2	Line 3	Line 4	Line 5	Line 6	Line 7	Line 8	Line 9	Line 10
Number of wheel passages per week	1 187	8 160	8 106	1 585	208	506	5 806	7 889	1 817

2.2.4. Weather conditions 2017–2018

The weather conditions from August 2017 to August 2018 are shown in Table 4.

Table 4. Weather conditions at the Norwegian test site, from August 2017 to August 2018.

Weather parameter	Value
Annual average temperature	5.4 °C
Average summer temperature (Apr-Sep)	13.8 °C
Average winter temperature (Oct-Mar)	-3.0 °C
Annual precipitation	625 mm
Number of sun hours per month	*
Number of weeks with snow	21
Number of times the snow plough has operated	237
Number of times the road has been salted	39

*) No information available

Weather data was retrieved from Yr[2], which is a joint weather service from *the Norwegian Meteorological Institute* and *the Norwegian Broadcasting Corporation*, and from eKlima[3], which is a weather and climate database provided by *the Norwegian Meteorological Institute.* Data on temperature, precipitation and snow are from a weather station located approximately 10 km from the test site.

Information about snow plough operations and salting was obtained from the contractor for winter maintenance.

[2] https://www.yr.no/

[3] http://eklima.met.no/

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 procedures recommended by the respective manufacturer.

Performance measurements were carried out in August 2018.

3.2. Methods and measuring instruments

3.2.1. Coefficient of retroreflected luminance R_L 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). At the test site in Sunne where the lines were 0.30 m wide, measurements were taken at three points diagonally within the measurement area of 0.15 x 1.5 m, defined by EN 1824, Figure 5 (left panel). At the test site in Haslemoen where the lines were 0.15 cm wide, measurements were taken along the centre line, Figure 5 (right panel). The result of an individual line was calculated as the average of the three measurements.

The coefficient of retroreflected luminance, R_L, under wet conditions was measured on type II markings (i.e. road markings with special properties intended to enhance the retroreflection in wet or rainy conditions), with the same instrument and measurement points as described above. Approximately 3 litres of clean water was poured over the measurement area, and measurements were carried out 60 seconds afterwards.

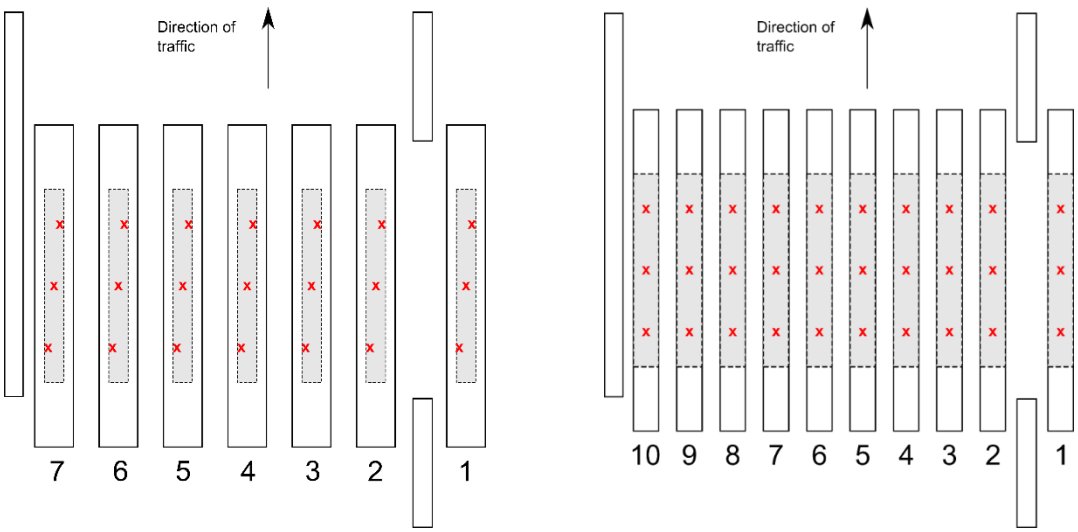

Figure 5. The measurement points (red crosses) for R_L and Qd were placed diagonally within the measurement area (grey) defined by EN 1824. Left panel: Test site Sunne. Right panel: Test site Haslemoen.

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.

Some marking lines were too worn to be measured. If the measurement area of the marking lines were worn in a way that made representative measurements impossible, these single lines were not

measured. However, other marking lines of the same product, that were not equally worn, were measured.

3.2.2. Chromaticity coordinates

Chromaticity (colour) coordinates were measured in one point on each line, located at the centre of the line, Figure 6. A *Spectrophotometer CM-2500c* and a *Spectrophotometer CM-25cG* (Konica Minolta, Japan) were 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).

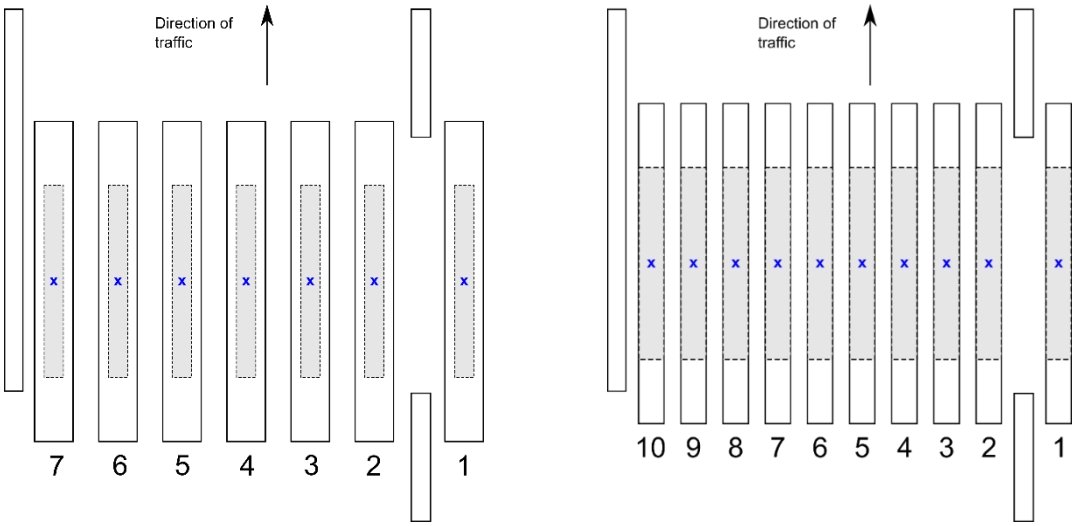

Figure 6. The measurement points (blue crosses) for chromaticity coordinates were placed in the centre of the lines. Left panel: Test site Sunne. Right panel: Test site Haslemoen.

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 version 4,* PFT (Coralba, Sweden), along the centre of each line, Figure 7. 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).

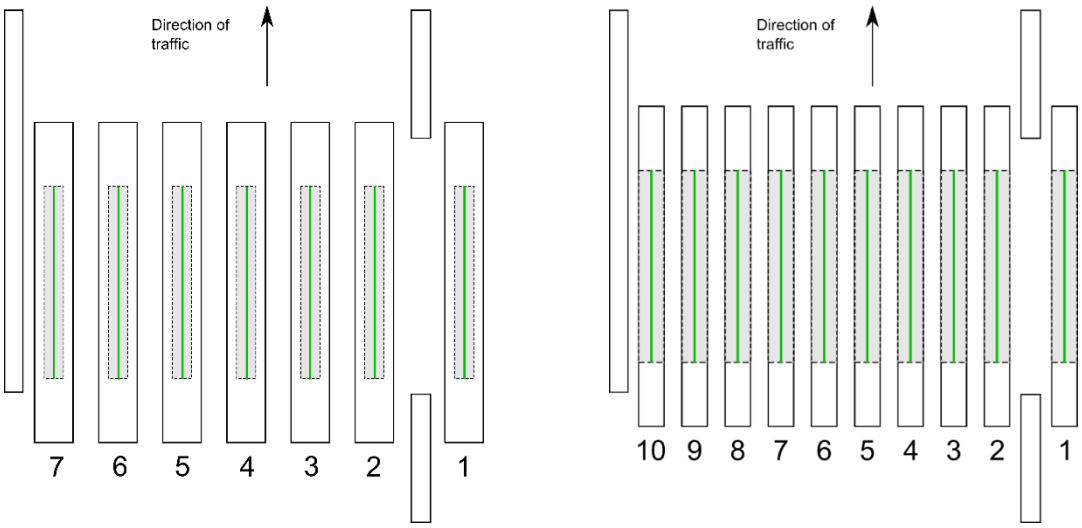

Figure 7. The measurement areas (green lines) for friction. Left panel: Test site Sunne. Right panel: Test site Haslemoen.

3.2.4. Measurement values that do not fulfil the performance requirements

In case a measured value was just below the performance requirement (see Section 4.1), extra measurements were taken to assure a correct result. If the new measurement values fulfilled the requirements, this was regarded as the final result and the material was thus approved with respect to that parameter. If the new measurements did not fulfil the requirements, the original measurement was regarded as the final result, i.e. the material was not approved.

3.3. Weather conditions

During the measurements at test site Sunne, the weather was shifting between sunshine and cloudy. The air temperature was approximately 14˚ C (morning) – 19˚ C (day). During the measurements at test site Haslemoen, it was cloudy and the air temperature was approximately 15˚ C (morning) – 19˚ C (day/evening). All performance measurements of $R_{L,dry}$, *Qd* and chromaticity coordinates were carried out on absolutely dry markings.

4. Performance requirements

4.1. Performance parameters

The performance requirements include four parameters for type I markings[4], five parameters for type II markings[5] and three parameters for antiskid materials, which are given in Table 5.

Table 5. Performance requirements.

Performance parameter	White markings	Yellow markings	Applies to marking type	Antiskid materials
Coefficient of retroreflected luminance, R_L dry [mcd/m^2/lx]	≥ 150	≥ 100	I, II	-
Coefficient of retroreflected luminance, R_L wet [mcd/m^2/lx]	≥ 35	≥ 35	II	-
Luminance coefficient under diffuse illumination, *Qd* [mcd/m^2/lx]	≥ 130	≥ 100	I, II	≥ 130
Friction, [PFT units]	≥ 0.52	≥ 0.52	I, II	≥ 0.71
Chromaticity coordinates, x, y	*	**	I, II	*

*) According to EN 1436:2018
**) Includes both daytime and night-time colour, according to EN 1436:2018

4.1.1. Special considerations regarding friction

A PFT value of 0.52 corresponds to a *Skid Resistance Tester* (SRT) value of 50. 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 fulfil 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 for type I and type II markings, and from 0.71 to 0.66 for antiskid materials.

4.2. Certification in relation to P-classes

Materials are certified in relation to the number of wheel passages they will stand. The six (2016) and nine (2017) 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 line in the lane, Table 6.

Materials are thus certified for a certain roll-over class (P-class). In order to be certified, all four (type I markings), five (type II markings) or three (antiskid materials) performance requirements must be fulfilled for that particular class.

[4] Type I refers to flat markings.

[5] Type II refers to markings with special properties intended to enhance the retroreflection in wet or rainy conditions.

Certification is given based on the follow-up measurements one and two years after application. No certification is given based on the initial measurements that are carried out a few weeks after application.

At the follow-up measurements, the performance parameters are defined as the registered value of the line which is the most representative of a certain P-class (see section 4.2.1).

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 one-year follow-up measurement), this certification is valid irrespective of the results of the measurements after two years. The two-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 6. 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 test site Sunne

For materials applied at the test site in Sunne in 2016, P-classes P1–P4 were reached in 2017, and P-class P5 was reached in 2018. All P-classes were represented by one line, Table 7.

Table 7. P-classes at the test site in Sunne, materials applied in 2016.

Roll-over class	Lines	Measured
P0	-	-
P1	Line 2	August 2017
P2	Line 7	August 2017
P3	Line 4	August 2017
P4	Line 3	August 2017
P5	Line 3	August 2018

4.2.2. P-classes at test site Haslemoen

For materials applied at the test site in Haslemoen in 2017, P-classes P0, P2, P3 and P4 were reached in 2018 and P-class P5 is expected to be reached in 2019. All P-classes were represented by one line, Table 7.

Table 8. P-classes at the test site in Haslemoen, materials applied in 2017.

Roll-over class	Lines	Measured
P0	Line 6	August 2018
P1	-	-
P2	Line 10	August 2018
P3	Line 8	August 2018
P4	Line 4	August 2018
P5	-	Summer 2019 (expected)

5. Certification of materials applied in 2016

Table 9–Table 15 show the certification of road marking materials in P-classes P1–P5 for materials applied at the test site in Sunne in 2016. **A** means approved and **NA** not approved material. Empty cells imply that the material was not approved in a lower P-class.

Only materials that were approved at the initial measurements and that participate as *certification materials* with two years follow-up are included in the tables below.

Measurement data per material and P-class can be found in Appendix 1.

5.1. White road markings

5.1.1. Type I

5.1.1.1. Material thickness 1.5 mm

Table 9. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P1–P5. White type I materials, 1.5 mm, applied in 2016.

Manufacturer *Material*	P1	P2	P3	P4	P5
Ennis Flint Spray W2016.10	NA				
Ennis Flint Spray W2016.11	NA				
Ennis Flint Spray W2016.9	NA				
Geveko Markings Viatherm 45 S30N	A	A	A	A	NA
Geveko Markings Viatherm 71 S	A	A	A	A	NA
Kelly Bros White Spray Briteline 150	A	A	NA		
Svevia X1653	A	A	A	NA	
Svevia X1654	A	A	A	NA	

5.1.1.2. Material thickness 3 mm

Table 10. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P1–P5. White type I materials, 3 mm, applied in 2016.

Manufacturer *Material*	P1	P2	P3	P4	P5
Ennis Flint Screed/extr. W2016.1	NA				
Geveko Markings PREMARK RETRO 161	A	A	NA		
Geveko Markings PREMARK RETRO 162	A	A	NA		
Geveko Markings Viatherm 31 E35NO	A	A	A	A	A
Geveko Markings Viatherm 35 E40	A	A	A	A	A
Geveko Markings Viatherm 71 E	A	A	A	A	A
Kelly Bros White Extr./Scr. Briteline 150	A	A	A	NA	
Kelly Bros White Extr./Scr. Briteline 150 S	A	A	A	A	NA
Kestrel Thermoplastics Eurolux SC White Extr. IGSO01	A	A	NA		
Kestrel Thermoplastics Eurolux SC White Extr. IGSO02	A	A	NA		
Kestrel Thermoplastics Eurolux SC White Extr. IGSO09	A	A	NA		
Swarco Vestglas Swarcotherm ERP 16 white	A	NA			
Svevia X1601	A	A	A	NA	
Svevia X1602	A	A	A	A	NA
Veluvine Thermolit Fabiola	A	A	NA		

5.1.2. Type II

5.1.2.1. Material thickness 0.6 mm

Table 11. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P1–P5. White type II materials, 0.6 mm, applied in 2016.

Manufacturer *Material*	P1	P2	P3	P4	P5
Swarco Limburger Lackf. Limboroute W13N	NA				

5.1.2.2. Material thickness 3 mm

Table 12. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P1–P5. White type II materials, 3 mm, applied in 2016.

Manufacturer *Material*	**P1**	**P2**	**P3**	**P4**	**P5**
Ennis Flint Screed/extr. W2016.4 *Profile/pattern:* Flat	NA				
Geveko Markings Viatherm 50 EP40 *Profile/pattern:* Drop, agglo	A	A	NA		
Promax Promax White prime profile 2016 *Profile/pattern:* Combi drop	NA				
Svevia X1622 *Profile/pattern:* Drop DoL	A	A	NA		
Svevia X1631 *Profile/pattern:* Combi drop	A	A	NA		
Svevia X1632 *Profile/pattern:* Combi drop	A	A	NA		

5.2. Yellow road markings

5.2.1. Type I

5.2.1.1. Material thickness 1.5 mm

Table 13. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P1–P5. Yellow type I materials, 1.5 mm, applied in 2016.

Manufacturer *Material*	**P1**	**P2**	**P3**	**P4**	**P5**
Ennis Flint Spray Y2016.12	NA				
Ennis Flint Spray Y2016.13	NA				
Ennis Flint Spray Y2016.14	NA				
Kelly Bros Yellow Spray Briteline 100	NA				

5.2.1.2. Material thickness 3 mm

Table 14. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P1–P5. Yellow type I materials, 3 mm, applied in 2016.

Manufacturer *Material*	**P1**	**P2**	**P3**	**P4**	**P5**
Ennis Flint Screed/extr. Y2016.5	NA				
Ennis Flint Screed/extr. Y2016.7	NA				
Geveko Markings Viatherm NTY 29E	A	NA			
Geveko Markings Viatherm NTY 71E	NA				
Kelly Bros Yellow Extr./Scr. Briteline 100	NA				
Kestrel Thermoplastics Eurolux SC Yellow IGSO 05	A	A	NA		
Kestrel Thermoplastics Eurolux SC Yellow IGSO 06	A	A	NA		
Kestrel Thermoplastics Eurolux SC Yellow IGSO 07	A	NA			
Promax Promax Yellow prime 2016	NA				
Swarco Vestglas Swarcotherm ERP 16 yellow	A	NA			
Svevia Y1605	A	A	NA		

5.2.2. Type II

5.2.2.1. Material thickness 3 mm

Table 15. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P1–P5. Yellow type II materials, 3 mm, applied in 2016.

Manufacturer *Material*	**P1**	**P2**	**P3**	**P4**	**P5**
Ennis Flint Screed/extr. Y2016.8 *Profile/pattern:* Flat	**NA**				
Svevia Y1615 *Profile/pattern:* Rullad	**NA**				

5.3. Summary of the results

Out of the 72 materials applied for certification at the Norwegian-Swedish test site in Sunne 2016, 32 have received certification in one or more P-classes. The final results, including materials with one and two years follow-up, per material category and P-class are shown in Table 16–Table 17.

Detailed results for P-classes P1–P4 can be found in the report *Nordic certification of road marking materials in Norway and Sweden 2015–2017* (Johansen, Fors, Kjellman, 2018).

Table 16. Summary of the final results for materials applied at the Norwegian-Swedish test site in 2016. Number of certified white materials per material category and P-class.

	White					
	Type I			Type II		
P-class	0.4 mm	1.5 mm	3 mm	0.6 mm	3 mm	*Total*
No P-class	4	3	8	3	5	*23*
P1	-	7	14	-	4	*25*
P2	-	7	13	-	4	*24*
P3	-	4	7	-	-	*11*
P4	-	2	5	-	-	*7*
P5	-	-	3	-	-	*3*

Table 17. Summary of the final results for materials applied at the Norwegian-Swedish test site in 2016. Number of certified yellow materials per material category and P-class.

	Yellow			
	Type I		Type II	
P-class	1.5 mm	3 mm	3 mm	*Total*
No P-class	6	9	2	*17*
P1	1	6	-	*7*
P2	1	3	-	*4*
P3	-	-	-	-
P4	-	-	-	-
P5	-	-	-	-

6. Certification of materials applied in 2017

Table 18–Table 29 show the certification of road marking materials in P-classes P0, P2, P3 and P4 for materials applied at the test site in Haslemoen in 2017. **A** means approved and **NA** not approved material. Empty cells imply that the material was not approved in a lower P-class.

Only materials that were approved at the initial measurements and that participate as *certification materials* with one or two years follow-up are included in the tables below.

Measurement data per material and P-class can be found in Appendix 1.

6.1. White road markings

6.1.1. Type I

6.1.1.1. Material thickness 0.4 mm

Table 18. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. White type I materials, 0.4 mm, applied in 2017.

Manufacturer *Material*	**P0**	**P2**	**P3**	**P4**
Geveko Markings EXP17N01 [0.4 mm]	**NA**			
Kelly Bros White Waterborne Paint	**NA**			
SAR WP 201	**NA**			
SAR WP 207	**NA**			
Swarco Limburger Lackf. Limboroute W13N	**NA**			
Teknos Teknoroad 3059 White	**NA**			
Visafo VIT VISA 30	**NA**			
Visafo VIT VISA 31	**NA**			
Visafo VIT VISA 32	**NA**			

6.1.1.2. Material thickness 0.6 mm

Table 19. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. White type I materials, 0.6 mm, applied in 2017.

Manufacturer *Material*	**P0**	**P2**	**P3**	**P4**
Geveko Markings EXP17N01 [0,6 mm]	**NA**			
Geveko Markings EXP17N02	**NA**			
Teknos Teknoroad 3059 White multilayer	**NA**			

6.1.1.3. Material thickness 1.5 mm

Table 20. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. White type I materials, 1.5 mm, applied in 2017.

Manufacturer *Material*	**P0**	**P2**	**P3**	**P4**
Ennis Flint Spray W2017.7	**A**	**NA**		
Geveko Markings ViaTherm EXP1771S W	**A**	**A**	**A**	**A**
Kestrel Thermoplastics Eurolux SC White 0012	**A**	**A**	**A**	**NA**
Svevia X1732	**A**	**A**	**NA**	

6.1.1.4. Material thickness 3 mm

Table 21. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. White type I materials, 3 mm, applied in 2017.

Manufacturer *Material*	P0	P2	P3	P4
Ennis Flint Screed/extr. W2017.1	NA			
Ennis Flint Screed/extr. W2017.2	NA			
Ennis Flint Screed/extr. W2017.3	NA			
Geveko Markings ViaTherm EXP1771EP W	A	A	A	A
Kelly Bros Cold White MMA	A	NA		
Kelly Bros White Extr./Scr. Briteline Plus	A	A	A	A
Kestrel Thermoplastics Eurolux SC White 0010	A	A	A	A
Kestrel Thermoplastics Eurolux SC White 0011	A	A	A	A
Promax Promax prime white 2017 TYP II	A	A	A	A
SAR TH 603	A	A	NA	
SAR TH 613	A	A	NA	
Stroypolimer LLC Markaplast T1W11b	NA			
Svevia X1710	A	A	A	A
Swarco Vestglas Swarcotherm ERP 17	A	A	NA	
Veluvine Thermolit Funen 17	A	A	NA	
Veluvine Thermolit Lolland 17	A	A	NA	

6.1.2. Type II

6.1.2.1. Material thickness 3 mm

Table 22. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. White type II materials, 3 mm, applied in 2017.

Manufacturer *Material*	**P0**	**P2**	**P3**	**P4**
Promax Promax prime white 2017 TYP I *Profile/pattern:* Flat	NA			

6.1.2.2. Material thickness 4 mm

Table 23. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. White type II materials, 4 mm, applied in 2017.

Manufacturer *Material*	**P0**	**P2**	**P3**	**P4**
Geveko Markings ViaTherm EXP1750EP W *Profile/pattern:* Chess/stairs	NA			
Geveko Markings ViaTherm EXP1771EP W *Profile/pattern:* Chess/stairs	A	NA		
Geveko Markings ViaTherm EXP1771EP W *Profile/pattern:* Drops	A	A	NA	
Kelly Bros Cold White MMA Agglomerate *Profile/pattern:* Structure stochastic	NA			
Kestrel Thermoplastics Eurodot SC White 0016 *Profile/pattern:* Borum DotnLine	NA			
Svevia X1711 *Profile/pattern:* Rullad trappflex	A	A	NA	
Svevia X1721 *Profile/pattern:* Rullad trappflex	A	A	NA	
Swarco Limburger Lackf. Limboplast D480 *Profile/pattern:* Structure stochastic	A	NA		
Swarco Limburger Lackf. Limboplast D492 *Profile/pattern:* Structure stochastic	A	A	NA	

6.1.3. Antiskid

6.1.3.1. Material thickness 4 mm

Table 24. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. White antiskid materials, 4 mm, applied in 2017.

Manufacturer *Material*	**P0**	**P2**	**P3**	**P4**
Geveko Markings ViaTherm EXP1731HF W	**A**	**A**	**A**	**A**
Svevia X1743	**A**	**A**	**A**	**A**

6.2. Yellow road markings

6.2.1. Type I

6.2.1.1. Material thickness 0.4 mm

Table 25. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. Yellow type I materials, 0.4 mm, applied in 2017.

Manufacturer *Material*	**P0**	**P2**	**P3**	**P4**
Teknos TEST SHI 07 NTY	**NA**			

6.2.1.2. Material thickness 0.6 mm

Table 26. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. Yellow type I materials, 0.6 mm, applied in 2017.

Manufacturer *Material*	**P0**	**P2**	**P3**	**P4**
Teknos TEST SHI 07 NTY multilayer	**NA**			

6.2.1.3. Material thickness 1.5 mm

Table 27. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. Yellow type I materials, 1.5 mm, applied in 2017.

Manufacturer *Material*	**P0**	**P2**	**P3**	**P4**
Ennis Flint Spray Y2017.8	**A**	**NA**		

6.2.1.4. Material thickness 3 mm

Table 28. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. Yellow type I materials, 3 mm, applied in 2017.

Manufacturer *Material*	P0	P2	P3	P4
Ennis Flint Screed/extr. Y2017.4	NA			
Ennis Flint Screed/extr. Y2017.5	NA			
Ennis Flint Screed/extr. Y2017.6	NA			
Geveko Markings ViaTherm EXP1773EP Y	A	NA		
Hot Mix Hotmix 3000 kombi Yellow A	A	A	NA	
Kestrel Thermoplastics Eurolux SC YELLOW 0013	A	A	A	NA
Svevia Y 1750	A	A	NA	
Swarco Vestglas Swarcotherm ERP 17 Yellow	NA			

6.2.2. Type II

6.2.2.1. Material thickness 4 mm

Table 29. Certification of road marking materials for use on Norwegian and Swedish roads, roll-over classes P0–P4. Yellow type II materials, 4 mm, applied in 2017.

Manufacturer *Material*	P0	P2	P3	P4
Geveko Markings ViaTherm EXP1773EP Y *Profile/pattern:* Drops	A	NA		
Kestrel Thermoplastics Eurodot SC YELLOW 0015 *Profile/pattern:* Borum DotnLine	NA			

6.3. Summary of the results

Out of the 66 materials – 48 white and 18 yellow – applied for certification at the Norwegian-Swedish test site in Haslemoen 2017, 29 have received certification in one or more P-classes after one year. Out of the 48 white materials, 9 fulfilled the requirement for roll-over class P4, 10 fulfilled the requirement for roll-over class P3, 20 fulfilled the requirement for roll-over class P2 and 24 fulfilled the requirement for roll-over class P0. 24 white materials did not fulfil the requirement for any roll-over class (4 did not fulfil the requirement at the initial measurements and 20 did not fulfil the requirement for class P0). Out of the 18 yellow materials, 1 fulfilled the requirement for roll-over class P3, 3 fulfilled the requirement for roll-over class P2 and 6 fulfilled the requirement for roll-over class P0. 12 yellow materials did not fulfil the requirement for any roll-over class (5 did not fulfil the requirement

at the initial measurements and 7 did not fulfil the requirement for class P0). The result per material category and P-class is shown in Table 30–Table 31.

The 9 materials that have fulfilled the requirement for roll-over class P4 have the opportunity to receive certification in roll-over class P5, which is expected to be reached in 2019.

Table 30. Summary of the results after one year for materials applied at the Norwegian-Swedish test site in 2017. Number of certified white materials per material category and P-class.

	White							
	Type I				Type II		Antiskid	
P-class	0.4 mm	0.6 mm	1.5 mm	3 mm	3 mm	4 mm	3 mm	*Total*
No P-class	9	3	-	7	1	4	-	*24*
P0	-	-	4	12	-	6	2	*24*
P2	-	-	3	11	-	4	2	*20*
P3	-	-	2	6	-	-	2	*10*
P4	-	-	1	6	-	-	2	*9*
P5	-	-	*	*	-	-	*	*

*) Result will be published in 2019.

Table 31. Summary of the results after one year for materials applied at the Norwegian-Swedish test site in 2017. Number of certified yellow materials per material category and P-class.

	Yellow						
	Type I				Type II		
P-class	0.4 mm	0.6 mm	1.5 mm	3 mm	3 mm	4 mm	*Total*
No P-class	1	1	-	8	1	1	*12*
P0	-	-	1	4	-	1	*6*
P2	-	-	-	3	-	-	*3*
P3	-	-	-	1	-	-	*1*
P4	-	-	-	-	-	-	-
P5	-	-	-	-	-	-	-

References

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Appendix 1 – Results of the performance measurements

Table 32–Table 33 show the results for roll-over class P5 for materials applied in 2016. Table 34–Table 41 show the results for roll-over classes P0, P2, P3 and P4 for materials applied in 2017.

Explanation of the denotations in the result tables	
Parameters	
$R_{L,dry}$	Mean value of the coefficient of retroreflected luminance for dry road marking, $R_{L,dry}$ [mcd/m^2/lx]
$R_{L,wet}$	Mean value of the coefficient of retroreflected luminance for wet road marking, $R_{L,wet}$ [mcd/m^2/lx]
Qd	Mean value of luminance coefficient under diffuse illumination, *Qd* [mcd/m^2/lx]
Frict.	Mean value of friction [PFT units]
Colour	"OK", when colour coordinates are inside the colour box (daylight colour)
NTY	"OK", when colour coordinates are inside the colour box (night-time colour)
Appr.	Approved (**A**) or Not Approved (**NA**) in the P-class referred to
Comments and annotations	
worn	No measurements could be carried out, because the material was too worn.
n.m.	Not measured (if there was a high degree of wear and the material did not fulfil the requirements for one or more of the other parameters).
d	Disqualified due to missing documentation.
-	The parameter does not apply to the material.

Values that do not fulfil the performance requirements are indicated in orange.

Rows marked in grey indicate that the material has not fulfilled the requirements in a lower P-class. It can thus not be approved in the present P-class.

Materials applied in 2016

Roll-over class P5

Table 32. The performance of materials applied at the Norwegian-Swedish test site in 2016 after two years. Roll-over class P5. White materials, per type and thickness. Alphabetical order by manufacturer.

Manufacturer *Material*	$R_{L,dry}$	$R_{L,wet}$	*Qd*	*Frict.*	*Colour*	*Appr.*
Type I, 1.5 mm						
Ennis Flint Spray W2016.10	worn	-	worn	worn	worn	NA
Ennis Flint Spray W2016.11	52	-	164	0.82	OK	NA
Ennis Flint Spray W2016.9	worn	-	worn	worn	worn	NA
Geveko Markings Viatherm 45 S30N	76	-	149	0.87	OK	NA
Geveko Markings Viatherm 71 S	worn	-	worn	worn	worn	NA
Kelly Bros White Spray Briteline 150	worn	-	worn	worn	worn	NA
Svevia X1653	worn	-	worn	worn	worn	NA
Svevia X1654	worn	-	worn	worn	worn	NA
Type I, 3 mm						
Ennis Flint Screed/extr. W2016.1	worn	-	worn	worn	worn	NA
Geveko Markings PREMARK RETRO 161	worn	-	worn	worn	worn	NA
Geveko Markings PREMARK RETRO 162	worn	-	worn	worn	worn	NA
Geveko Markings Viatherm 31 E35NO	173	-	198	0.79	OK	A
Geveko Markings Viatherm 35 E40	246	-	210	0.75	OK	A
Geveko Markings Viatherm 71 E	236	-	182	0.74	OK	A
Kelly Bros White Extr./Scr. Briteline 150	worn	-	worn	worn	worn	NA
Kelly Bros White Extr./Scr. Briteline 150 S	worn	-	worn	worn	worn	NA
Kestrel Thermoplastics Eurolux SC White Extr. IGSO01	worn	-	worn	worn	worn	NA
Kestrel Thermoplastics Eurolux SC White Extr. IGSO02	worn	-	worn	worn	worn	NA
Kestrel Thermoplastics Eurolux SC White Extr. IGSO09	worn	-	worn	worn	worn	NA

Swarco Vestglas Swarcotherm ERP 16 white	136	-	192	0.82	OK	**NA**
Svevia X1601	worn	-	worn	worn	worn	**NA**
Svevia X1602	worn	-	worn	worn	worn	**NA**
Veluvine Thermolit Fabiola	worn	-	worn	worn	worn	**NA**
Type II, 0.6 mm						
Swarco Limburger Lackf. Limboroute W13N	worn	worn	worn	worn	worn	**NA**
Type II, 3 mm						
Ennis Flint Screed/extr. W2016.4	74	n.m.	213	0.80	OK	**NA**
Geveko Markings Viatherm 50 EP40	worn	worn	worn	worn	worn	**NA**
Promax Promax White prime profile 2016	worn	worn	worn	worn	worn	**NA**
Svevia X1622	worn	worn	worn	worn	worn	**NA**
Svevia X1631	worn	worn	worn	worn	worn	**NA**
Svevia X1632	worn	worn	worn	worn	worn	**NA**

Table 33. The performance of materials applied at the Norwegian-Swedish test site in 2016 after two years. Roll-over class P5. Yellow materials, per type and thickness. Alphabetical order by manufacturer.

Manufacturer *Material*	$R_{L,dry}$	$R_{L,wet}$	*Qd*	*Frict.*	*Colour*	*NTY*	*Appr.*
Type I, 1.5 mm							
Ennis Flint Spray Y2016.12	worn	-	worn	worn	worn	worn	NA
Ennis Flint Spray Y2016.13	worn	-	worn	worn	worn	worn	NA
Ennis Flint Spray Y2016.14	worn	-	worn	worn	worn	worn	NA
Kelly Bros Yellow Spray Briteline 100	worn	-	worn	worn	worn	worn	NA
Type I, 3 mm							
Ennis Flint Screed/extr. Y2016.5	worn	-	worn	worn	worn	worn	NA
Ennis Flint Screed/extr. Y2016.7	worn	-	worn	worn	worn	worn	NA
Geveko Markings Viatherm NTY 29E	72	-	151	0.75	OK	outside	NA
Geveko Markings Viatherm NTY 71E	73	-	166	0.82	OK	outside	NA
Kelly Bros Yellow Extr./Scr. Briteline 100	57	-	142	0.88	OK	OK	NA
Kestrel Thermoplastics Eurolux SC Yellow IGSO 05	worn	-	worn	worn	worn	worn	NA
Kestrel Thermoplastics Eurolux SC Yellow IGSO 06	worn	-	worn	worn	worn	worn	NA
Kestrel Thermoplastics Eurolux SC Yellow IGSO 07	worn	-	worn	worn	worn	worn	NA
Promax Promax Yellow prime 2016	worn	-	worn	worn	worn	worn	NA
Swarco Vestglas Swarcotherm ERP 16 yellow	30	-	144	0.80	OK	OK	NA
Svevia Y1605	69	-	138	0.80	OK	OK	NA
Type II, 3 mm							
Ennis Flint Screed/extr. Y2016.8	37	n.m.	154	0.82	OK	OK	NA
Svevia Y1615	worn	worn	worn	worn	worn	worn	NA

Materials applied in 2017

Roll-over class P0

Table 34. The performance of materials applied at the Norwegian-Swedish test site in 2017 after one year. Roll-over class P0. White materials, per type and thickness. Alphabetical order by manufacturer.

Manufacturer *Material*	$R_{L,dry}$	$R_{L,wet}$	*Qd*	*Frict.*	*Colour*	*Appr.*
Type I, 0.4 mm						
Geveko Markings EXP17N01 [0.4 mm]	43	-	107	0.92	OK	NA
Kelly Bros White Waterborne Paint	74	-	103	0.89	OK	NA
SAR WP 201	46	-	80	0.91	OK	NA
SAR WP 207	81	-	101	0.89	OK	NA
Swarco Limburger Lackf. Limboroute W13N	49	-	98	0.91	OK	NA
Teknos Teknoroad 3059 White	48	-	92	0.93	OK	NA
Visafo VIT VISA 30	88	-	111	0.87	OK	NA
Visafo VIT VISA 31	120	-	121	0.82	OK	NA
Visafo VIT VISA 32	79	-	113	0.78	OK	NA
Type I, 0.6 mm						
Geveko Markings EXP17N01 [0,6 mm]	54	-	122	0.92	OK	NA
Geveko Markings EXP17N02	74	-	118	0.78	OK	NA
Teknos Teknoroad 3059 White multilayer	52	-	97	0.90	OK	NA
Type I, 1.5 mm						
Ennis Flint Spray W2017.7	187	-	198	0.65	OK	A
Geveko Markings ViaTherm EXP1771S W	569	-	196	0.53	OK	A
Kestrel Thermoplastics Eurolux SC White 0012	529	-	190	0.58	OK	A
Svevia X1732	237	-	196	0.68	OK	A
Type I, 3 mm						
Ennis Flint Screed/extr. W2017.1	97	-	204	0.74	OK	NA
Ennis Flint Screed/extr. W2017.2	113	-	198	0.72	OK	NA

Ennis Flint Screed/extr. W2017.3	109	-	209	0.69	OK	NA
Geveko Markings ViaTherm EXP1771EP W	578	-	191	0.50	OK	A
Kelly Bros Cold White MMA	208	-	189	0.60	OK	A
Kelly Bros White Extr./Scr. Briteline Plus	263	-	191	0.61	OK	A
Kestrel Thermoplastics Eurolux SC White 0010	341	-	193	0.53	OK	A
Kestrel Thermoplastics Eurolux SC White 0011	579	-	184	0.56	OK	A
Promax Promax prime white 2017 TYP II	276	-	194	0.77	OK	A
SAR TH 603	188	-	190	0.85	OK	A
SAR TH 613	217	-	193	0.95	OK	A
Stroypolimer LLC Markaplast T1W11b	101	-	180	0.82	OK	NA
Svevia X1710	290	-	184	0.71	OK	A
Swarco Vestglas Swarcotherm ERP 17	224	-	190	0.82	OK	A
Veluvine Thermolit Funen 17	237	-	195	0.81	OK	A
Veluvine Thermolit Lolland 17	161	-	184	0.80	OK	A
Type II, 3 mm						
Promax Promax prime white 2017 TYP I	260	25	204	0.74	OK	NA
Type II, 4 mm						
Geveko Markings ViaTherm EXP1750EP W [Ch./st.]	worn	worn	worn	worn	worn	NA
Geveko Markings ViaTherm EXP1771EP W [Ch./st.]	342	60	146	0.73	OK	A
Geveko Markings ViaTherm EXP1771EP W [Drops]	392	90	174	0.62	OK	A
Kelly Bros Cold White MMA Agglomerate	worn	worn	worn	worn	worn	NA
Kestrel Thermoplastics Eurodot SC White 0016	203	18	178	0.76	OK	NA
Svevia X1711	202	61	159	0.80	OK	A
Svevia X1721	222	57	160	0.81	OK	A
Swarco Limburger Lackf. Limboplast D480	264	47	151	0.95	OK	A

Swarco Limburger Lackf. Limboplast D492	284	58	153	0.83	OK	A
Antiskid, 4 mm						
Geveko Markings ViaTherm EXP1731HF W	(110)*	-	186	0.95	OK	A
Svevia X1743	(68)*	-	188	1.10	OK	A

*) No requirement

Table 35. The performance of materials applied at the Norwegian-Swedish test site in 2017 after one year. Roll-over class P0. Yellow materials, per type and thickness. Alphabetical order by manufacturer.

Manufacturer *Material*	$R_{L,dry}$	$R_{L,wet}$	*Qd*	*Frict.*	*Colour*	*NTY*	*Appr.*
Type I, 0.4 mm							
Teknos TEST SHI 07 NTY	32	-	86	0.97	OK	n.m.	NA
Type I, 0.6 mm							
Teknos TEST SHI 07 NTY multilayer	22	-	81	0.95	outside	n.m.	NA
Type I, 1.5 mm							
Ennis Flint Spray Y2017.8	115	-	136	0.62	OK	OK	A
Type I, 3 mm							
Ennis Flint Screed/extr. Y2017.4	69	-	137	0.63	OK	OK	NA
Ennis Flint Screed/extr. Y2017.5	84	-	134	0.56	OK	OK	NA
Ennis Flint Screed/extr. Y2017.6	84	-	136	0.56	OK	OK	NA
Geveko Markings ViaTherm EXP1773EP Y	200	-	138	0.66	OK	OK	A
Hot Mix Hotmix 3000 kombi Yellow A	160	-	135	0.68	OK	OK	A
Kestrel Thermoplastics Eurolux SC YELLOW 0013	214	-	142	0.59	OK	OK	A
Svevia Y 1750	156	-	135	0.64	OK	OK	A
Swarco Vestglas Swarcotherm ERP 17 Yellow	99	-	138	0.79	OK	OK	NA
Type II, 4 mm							
Geveko Markings ViaTherm EXP1773EP Y	161	35	115	0.81	OK	OK	A
Kestrel Thermoplastics Eurodot SC YELLOW 0015	worn	worn	worn	worn	worn	worn	NA

Roll-over class P2

Table 36. The performance of materials applied at the Norwegian-Swedish test site in 2017 after one year. Roll-over class P2. White materials, per type and thickness. Alphabetical order by manufacturer.

Manufacturer *Material*	$R_{L,dry}$	$R_{L,wet}$	*Qd*	*Frict.*	*Colour*	*Appr.*
Type I, 0.4 mm						
Geveko Markings EXP17N01 [0.4 mm]	21	-	93	0.88	OK	NA
Kelly Bros White Waterborne Paint	22	-	87	0.86	OK	NA
SAR WP 201	worn	-	worn	worn	worn	NA
SAR WP 207	40	-	94	0.85	OK	NA
Swarco Limburger Lackf. Limboroute W13N	33	-	96	0.84	OK	NA
Teknos Teknoroad 3059 White	27	-	93	0.86	OK	NA
Visafo VIT VISA 30	21	-	97	0.87	OK	NA
Visafo VIT VISA 31	24	-	96	0.83	OK	NA
Visafo VIT VISA 32	24	-	99	0.82	OK	NA
Type I, 0.6 mm						
Geveko Markings EXP17N01 [0,6 mm]	19	-	91	0.85	OK	NA
Geveko Markings EXP17N02	25	-	101	0.84	OK	NA
Teknos Teknoroad 3059 White multilayer	40	-	97	0.85	OK	NA
Type I, 1.5 mm						
Ennis Flint Spray W2017.7	123	-	218	0.79	OK	NA
Geveko Markings ViaTherm EXP1771S W	451	-	204	0.58	OK	A
Kestrel Thermoplastics Eurolux SC White 0012	463	-	195	0.64	OK	A
Svevia X1732	255	-	203	0.68	OK	A
Type I, 3 mm						
Ennis Flint Screed/extr. W2017.1	113	-	211	0.76	OK	NA
Ennis Flint Screed/extr. W2017.2	158	-	202	0.72	OK	NA
Ennis Flint Screed/extr. W2017.3	133	-	207	0.73	OK	NA

Geveko Markings ViaTherm EXP1771EP W	510	-	202	0.50	OK	A
Kelly Bros Cold White MMA	116	-	162	0.73	OK	NA
Kelly Bros White Extr./Scr. Briteline Plus	217	-	188	0.72	OK	A
Kestrel Thermoplastics Eurolux SC White 0010	543	-	200	0.61	OK	A
Kestrel Thermoplastics Eurolux SC White 0011	469	-	196	0.68	OK	A
Promax Promax prime white 2017 TYP II	260	-	195	0.63	OK	A
SAR TH 603	207	-	194	0.84	OK	A
SAR TH 613	187	-	201	1.01	OK	A
Stroypolimer LLC Markaplast T1W11b	106	-	186	0.82	OK	NA
Svevia X1710	251	-	187	0.68	OK	A
Swarco Vestglas Swarcotherm ERP 17	212	-	194	0.80	OK	A
Veluvine Thermolit Funen 17	268	-	198	0.76	OK	A
Veluvine Thermolit Lolland 17	156	-	190	0.86	OK	A
Type II, 3 mm						
Promax Promax prime white 2017 TYP I	285	21	217	0.77	OK	NA
Type II, 4 mm						
Geveko Markings ViaTherm EXP1750EP W [Ch./st.]	worn	worn	worn	worn	worn	NA
Geveko Markings ViaTherm EXP1771EP W [Ch./st.]	287	33	144	0.72	OK	NA
Geveko Markings ViaTherm EXP1771EP W [Drops]	377	71	173	0.63	OK	A
Kelly Bros Cold White MMA Agglomerate	worn	worn	worn	worn	worn	NA
Kestrel Thermoplastics Eurodot SC White 0016	199	14	185	0.73	OK	NA
Svevia X1711	201	46	147	0.77	OK	A
Svevia X1721	260	47	161	0.83	OK	A
Swarco Limburger Lackf. Limboplast D480	187	31	153	0.94	OK	NA
Swarco Limburger Lackf. Limboplast D492	180	35	135	0.90	OK	A

Antiskid, 4 mm						
Geveko Markings ViaTherm EXP1731HF W	(101)*	-	198	0.93	OK	A
Svevia X1743	(97)*	-	188	0.97	OK	A

*) No requirement

Table 37. The performance of materials applied at the Norwegian-Swedish test site in 2017 after one year. Roll-over class P2. Yellow materials, per type and thickness. Alphabetical order by manufacturer.

Manufacturer *Material*	***$R_{L,dry}$***	***$R_{L,wet}$***	***Qd***	***Frict.***	***Colour***	***NTY***	***Appr.***
Type I, 0.4 mm							
Teknos TEST SHI 07 NTY	19	-	83	0.87	outside	n.m.	NA
Type I, 0.6 mm							
Teknos TEST SHI 07 NTY multilayer	20	-	84	0.86	outside	n.m.	NA
Type I, 1.5 mm							
Ennis Flint Spray Y2017.8	68	-	143	0.80	OK	OK	NA
Type I, 3 mm							
Ennis Flint Screed/extr. Y2017.4	56	-	146	0.80	OK	OK	NA
Ennis Flint Screed/extr. Y2017.5	80	-	140	0.78	OK	OK	NA
Ennis Flint Screed/extr. Y2017.6	80	-	136	0.70	OK	OK	NA
Geveko Markings ViaTherm EXP1773EP Y	133	-	145	0.75	OK	outside	NA
Hot Mix Hotmix 3000 kombi Yellow A	163	-	140	0.62	OK	OK	A
Kestrel Thermoplastics Eurolux SC YELLOW 0013	215	-	143	0.58	OK	OK	A
Svevia Y 1750	153	-	140	0.65	OK	OK	A
Swarco Vestglas Swarcotherm ERP 17 Yellow	71	-	137	0.72	OK	OK	NA
Type II, 4 mm							
Geveko Markings ViaTherm EXP1773EP Y	87	11	113	0.80	OK	OK	NA
Kestrel Thermoplastics Eurodot SC YELLOW 0015	worn	worn	worn	worn	worn	worn	NA

Roll-over class P3

Table 38. The performance of materials applied at the Norwegian-Swedish test site in 2017 after one year. Roll-over class P3. White materials, per type and thickness. Alphabetical order by manufacturer.

Manufacturer *Material*	$R_{L,dry}$	$R_{L,wet}$	Qd	Frict.	Colour	Appr.
Type I, 0.4 mm						
Geveko Markings EXP17N01 [0.4 mm]	worn	-	worn	worn	worn	NA
Kelly Bros White Waterborne Paint	worn	-	worn	worn	worn	NA
SAR WP 201	worn	-	worn	worn	worn	NA
SAR WP 207	worn	-	worn	worn	worn	NA
Swarco Limburger Lackf. Limboroute W13N	worn	-	worn	worn	worn	NA
Teknos Teknoroad 3059 White	worn	-	worn	worn	worn	NA
Visafo VIT VISA 30	worn	-	worn	worn	worn	NA
Visafo VIT VISA 31	worn	-	worn	worn	worn	NA
Visafo VIT VISA 32	worn	-	worn	worn	worn	NA
Type I, 0.6 mm						
Geveko Markings EXP17N01 [0,6 mm]	worn	-	worn	worn	worn	NA
Geveko Markings EXP17N02	worn	-	worn	worn	worn	NA
Teknos Teknoroad 3059 White multilayer	worn	-	worn	worn	worn	NA
Type I, 1.5 mm						
Ennis Flint Spray W2017.7	54	-	236	0.76	OK	NA
Geveko Markings ViaTherm EXP1771S W	375	-	202	0.58	OK	A
Kestrel Thermoplastics Eurolux SC White 0012	295	-	198	0.71	OK	A
Svevia X1732	33	-	113	0.80	OK	NA
Type I, 3 mm						
Ennis Flint Screed/extr. W2017.1	57	-	233	0.77	OK	NA
Ennis Flint Screed/extr. W2017.2	97	-	215	0.73	OK	NA
Ennis Flint Screed/extr. W2017.3	89	-	217	0.71	OK	NA

Geveko Markings ViaTherm EXP1771EP W	438	-	202	0.53	OK	A
Kelly Bros Cold White MMA	35	-	189	0.84	OK	NA
Kelly Bros White Extr./Scr. Briteline Plus	175	-	199	0.73	OK	A
Kestrel Thermoplastics Eurolux SC White 0010	213	-	218	0.70	OK	A
Kestrel Thermoplastics Eurolux SC White 0011	348	-	199	0.65	OK	A
Promax Promax prime white 2017 TYP II	162	-	211	0.67	OK	A
SAR TH 603	worn	-	worn	worn	worn	NA
SAR TH 613	worn	-	worn	worn	worn	NA
Stroypolimer LLC Markaplast T1W11b	worn	-	worn	worn	worn	NA
Svevia X1710	169	-	186	0.71	OK	A
Swarco Vestglas Swarcotherm ERP 17	worn	-	worn	worn	worn	NA
Veluvine Thermolit Funen 17	worn	-	worn	worn	worn	NA
Veluvine Thermolit Lolland 17	worn	-	worn	worn	worn	NA
Type II, 3 mm						
Promax Promax prime white 2017 TYP I	145	24	235	0.78	OK	NA
Type II, 4 mm						
Geveko Markings ViaTherm EXP1750EP W [Ch./st.]	worn	worn	worn	worn	worn	NA
Geveko Markings ViaTherm EXP1771EP W [Ch./st.]	138	12	123	0.76	OK	NA
Geveko Markings ViaTherm EXP1771EP W [Drops]	242	32	145	0.64	OK	NA
Kelly Bros Cold White MMA Agglomerate	worn	worn	worn	worn	worn	NA
Kestrel Thermoplastics Eurodot SC White 0016	worn	worn	worn	worn	worn	NA
Svevia X1711	23	2	99	0.80	OK	NA
Svevia X1721	50	4	113	0.79	OK	NA
Swarco Limburger Lackf. Limboplast D480	worn	worn	worn	worn	worn	NA
Swarco Limburger Lackf. Limboplast D492	worn	worn	worn	worn	worn	NA

Antiskid, 4 mm						
Geveko Markings ViaTherm EXP1731HF W	(83)*	-	208	0.85	OK	A
Svevia X1743	(89)*	-	199	0.89	OK	A

*) No requirement

Table 39. The performance of materials applied at the Norwegian-Swedish test site in 2017 after one year. Roll-over class P3. Yellow materials, per type and thickness. Alphabetical order by manufacturer.

Manufacturer *Material*	***$R_{L,dry}$***	***$R_{L,wet}$***	***Qd***	***Frict.***	***Colour***	***NTY***	***Appr.***
Type I, 0.4 mm							
Teknos TEST SHI 07 NTY	worn	-	worn	worn	worn	worn	NA
Type I, 0.6 mm							
Teknos TEST SHI 07 NTY multilayer	worn	-	worn	worn	worn	worn	NA
Type I, 1.5 mm							
Ennis Flint Spray Y2017.8	33	-	161	0.82	OK	OK	NA
Type I, 3 mm							
Ennis Flint Screed/extr. Y2017.4	30	-	161	0.81	OK	OK	NA
Ennis Flint Screed/extr. Y2017.5	46	-	150	0.67	OK	OK	NA
Ennis Flint Screed/extr. Y2017.6	43	-	146	0.72	OK	OK	NA
Geveko Markings ViaTherm EXP1773EP Y	96	-	149	0.71	OK	outside	NA
Hot Mix Hotmix 3000 kombi Yellow A	97	-	148	0.68	OK	OK	NA
Kestrel Thermoplastics Eurolux SC YELLOW 0013	140	-	146	0.59	OK	OK	A
Svevia Y 1750	92	-	144	0.68	OK	OK	NA
Swarco Vestglas Swarcotherm ERP 17 Yellow	43	-	146	0.70	OK	OK	NA
Type II, 4 mm							
Geveko Markings ViaTherm EXP1773EP Y	41	2	107	0.78	OK	OK	NA
Kestrel Thermoplastics Eurodot SC YELLOW 0015	worn	worn	worn	worn	worn	worn	NA

Roll-over class P4

Table 40. The performance of materials applied at the Norwegian-Swedish test site in 2017 after one year. Roll-over class P4. White materials, per type and thickness. Alphabetical order by manufacturer.

Manufacturer *Material*	$R_{L,dry}$	$R_{L,wet}$	Qd	Frict.	Colour	Appr.
Type I, 0.4 mm						
Geveko Markings EXP17N01 [0.4 mm]	worn	-	worn	worn	worn	NA
Kelly Bros White Waterborne Paint	worn	-	worn	worn	worn	NA
SAR WP 201	worn	-	worn	worn	worn	NA
SAR WP 207	worn	-	worn	worn	worn	NA
Swarco Limburger Lackf. Limboroute W13N	worn	-	worn	worn	worn	NA
Teknos Teknoroad 3059 White	worn	-	worn	worn	worn	NA
Visafo VIT VISA 30	worn	-	worn	worn	worn	NA
Visafo VIT VISA 31	worn	-	worn	worn	worn	NA
Visafo VIT VISA 32	worn	-	worn	worn	worn	NA
Type I, 0.6 mm						
Geveko Markings EXP17N01 [0,6 mm]	worn	-	worn	worn	worn	NA
Geveko Markings EXP17N02	worn	-	worn	worn	worn	NA
Teknos Teknoroad 3059 White multilayer	worn	-	worn	worn	worn	NA
Type I, 1.5 mm						
Ennis Flint Spray W2017.7	51	-	236	0.80	OK	NA
Geveko Markings ViaTherm EXP1771S W	356	-	200	0.62	OK	A
Kestrel Thermoplastics Eurolux SC White 0012	83	-	130	0.76	OK	NA
Svevia X1732	49	-	134	0.79	OK	NA
Type I, 3 mm						
Ennis Flint Screed/extr. W2017.1	46	-	237	0.80	OK	NA
Ennis Flint Screed/extr. W2017.2	97	-	212	0.73	OK	NA
Ennis Flint Screed/extr. W2017.3	90	-	221	0.72	OK	NA

Geveko Markings ViaTherm EXP1771EP W	401	-	199	0.57	OK	A
Kelly Bros Cold White MMA	29	-	200	0.83	OK	NA
Kelly Bros White Extr./Scr. Briteline Plus	170	-	198	0.75	OK	A
Kestrel Thermoplastics Eurolux SC White 0010	199	-	219	0.75	OK	A
Kestrel Thermoplastics Eurolux SC White 0011	276	-	190	0.70	OK	A
Promax Promax prime white 2017 TYP II	172	-	206	0.70	OK	A
SAR TH 603	worn	-	worn	worn	worn	NA
SAR TH 613	worn	-	worn	worn	worn	NA
Stroypolimer LLC Markaplast T1W11b	worn	-	worn	worn	worn	NA
Svevia X1710	191	-	191	0.70	OK	A
Swarco Vestglas Swarcotherm ERP 17	worn	-	worn	worn	worn	NA
Veluvine Thermolit Funen 17	worn	-	worn	worn	worn	NA
Veluvine Thermolit Lolland 17	worn	-	worn	worn	worn	NA
Type II, 3 mm						
Promax Promax prime white 2017 TYP I	138	25	228	0.80	OK	NA
Type II, 4 mm						
Geveko Markings ViaTherm EXP1750EP W [Ch./st.]	worn	worn	worn	worn	worn	NA
Geveko Markings ViaTherm EXP1771EP W [Ch./st.]	38	3	101	0.78	OK	NA
Geveko Markings ViaTherm EXP1771EP W [Drops]	133	3	131	0.71	OK	NA
Kelly Bros Cold White MMA Agglomerate	worn	worn	worn	worn	worn	NA
Kestrel Thermoplastics Eurodot SC White 0016	worn	worn	worn	worn	worn	NA
Svevia X1711	42	8	103	0.78	OK	NA
Svevia X1721	79	8	126	0.78	OK	NA
Swarco Limburger Lackf. Limboplast D480	worn	worn	worn	worn	worn	NA
Swarco Limburger Lackf. Limboplast D492	worn	worn	worn	worn	worn	NA

Antiskid, 4 mm						
Geveko Markings ViaTherm EXP1731HF W	(83)*	-	209	0.90	OK	A
Svevia X1743	(89)*	-	192	0.90	OK	A

*) No requirement

Table 41. The performance of materials applied at the Norwegian-Swedish test site in 2017 after one year. Roll-over class P4. Yellow materials, per type and thickness. Alphabetical order by manufacturer.

Manufacturer *Material*	***$R_{L,dry}$***	***$R_{L,wet}$***	***Qd***	***Frict.***	***Colour***	***NTY***	***Appr.***
Type I, 0.4 mm							
Teknos TEST SHI 07 NTY	worn	-	worn	worn	worn	worn	NA
Type I, 0.6 mm							
Teknos TEST SHI 07 NTY multilayer	worn	-	worn	worn	worn	worn	NA
Type I, 1.5 mm							
Ennis Flint Spray Y2017.8	28	-	158	0.84	OK	OK	NA
Type I, 3 mm							
Ennis Flint Screed/extr. Y2017.4	24	-	158	0.84	OK	OK	NA
Ennis Flint Screed/extr. Y2017.5	44	-	149	0.78	OK	OK	NA
Ennis Flint Screed/extr. Y2017.6	43	-	149	0.76	OK	OK	NA
Geveko Markings ViaTherm EXP1773EP Y	95	-	144	0.75	OK	OK	NA
Hot Mix Hotmix 3000 kombi Yellow A	101	-	144	0.70	OK	OK	NA
Kestrel Thermoplastics Eurolux SC YELLOW 0013	86	-	126	0.69	OK	OK	NA
Svevia Y 1750	89	-	140	0.72	OK	OK	NA
Swarco Vestglas Swarcotherm ERP 17 Yellow	worn	-	worn	worn	worn	worn	NA
Type II, 4 mm							
Geveko Markings ViaTherm EXP1773EP Y	worn	worn	worn	worn	worn	worn	NA
Kestrel Thermoplastics Eurodot SC YELLOW 0015	worn	worn	worn	worn	worn	worn	NA

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