

Test methods – The protective capability of anti-graffiti coatings on concrete

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Test methods – The protective capability of anti-graffiti coatings on concrete

1. Orientation

Anti-graffiti coatings are defined as surface treatments that prevent markings from sticking to a surface or which significantly facilitate the cleaning of the surface. An anti-graffiti coating can be of type sacrificial, which means that the coating is removed during the cleaning and must be reapplied. Permanent anti-graffiti coatings are supposed to withstand several colouring/cleaning cycles.

In section 3 of this document the procedures to determine the protective capability of sacrificial anti-graffiti coatings (SAG) is presented.

Section 4 of this document contains the procedures to determine the protective capability of permanent anti-graffiti coatings for which no chemical compounds are needed for the cleaning (PAG).

These procedures are intended to evaluate the durability and protective capability of anti-graffiti coatings on concrete.

The procedures in section 4 can not be used to evaluate PAG for which chemical compounds are needed to obtain sufficient cleaning.

The decisive criterion for the capability of the coatings as protection against anti-graffiti is for a SAG based on changes in colour value between the untreated concrete surface and the cleaned surface. For PAG, the decisive criterion for protection capability is based on changes in colour between the surface with the anti-graffiti coating exposed outdoors and the cleaned surface, where application of colour and cleaning has been repeated ten times.

However, the procedures also include determination of colour and gloss changes caused by the SAG or the PAG. The intention is that these values should be declared, to be used as a basis for the construction owner's choice of suitable anti-graffiti coatings.

If the SAG or PAG by itself causes substantial darkening of the concrete surface (change to a *L*-value below 50), the method will not give reliable results.

In informative annex A, guidance and recommendations on suitable limit values are given.

2. Principle

Three concrete slabs are coated with the anti-graffiti coating. The slabs are exposed outdoors during three months under summer conditions. Five different colours are then applied on the coated surface. Thereafter the coated surface is cleaned with a pressure washer. When used to assess the performance of a sacrificial type of anti-graffiti coating (SAG) the water temperature is 80°C and the cleaning is only carried out once. When used to assess the performance of a permanent type of anti-graffiti coating (PAG) the water temperature is 20°C and the application of colours and the cleaning is repeated ten times. The colour value is measured by a colour metre on the concrete surface before coating, after coating, after outdoor exposure and after cleaning. After cleaning, an assessment by visual inspection is carried out, where anti-graffiti coatings that unambiguously can be regarded as non-satisfactory are discarded. If the coating passes the visual assessment a colour value criteria also have to be fulfilled.

3. Equipment and materials

- Slabs of concrete according to EN 1766, type MC (0,45), with the deviation that a CEM I or CEM II/A-LL with a strength class 42,5 or higher shall be used (test slabs). The test slabs shall at least have the dimensions 100×500×50 mm. The test slabs shall be cast in moulds without form oil.
- A soft brush for cleaning of the test slabs.
- Exposure frame; a frame for the outdoor exposure giving the test slabs an inclination from a vertical axis of 45 degrees.
- Cleaning frame; a frame for placing the test slabs in vertical position for cleaning.
- Colour measuring device, for example Chroma Meter CR-410.
- Gloss measuring device, for example Multi Gloss 268.

- Application template: Template for application of the colours which give colour circles with a diameter of 8 cm (test circles).
- Colour measuring template; template for measuring colour. The measurement shall be carried out on the area that is provided by the test circles in the application template.
- Gloss measuring template; template for measuring gloss. The measurement shall be carried out on the area that is provided by the test circles in the application template.
- A drying cabinet holding 50 ± 5 °C.
- A climate room holding 21 ± 2 °C and $60 \pm 10\%$ RH.
- Specified set of colours:
 - a) Blue spray, alkyd based
 - b) Blue spray, acrylic
 - c) Red spray, alkyd based
 - d) Red spray, acrylic
 - e) Black spray, nitro-combination-resin
- Pressure washer to be used on sacrificial anti-graffiti coatings (SAG)
Settings:
 - Water flow: 20 ± 2 l/min
 - Pressure at the outlet: 120 ± 10 bar
 - Water temperature at the outlet: 85 ± 5 °C
 - Angle between the water jet and the surface of the test slab: around 45 degrees
 - Beam angle at the outlet: around 25 degrees.
- Pressure washer to be used on permanent anti-graffiti coatings (PAG)
Settings:
 - Water flow: 20 ± 2 l/min
 - Pressure at the outlet: 80 ± 10 bar
 - Water temperature at the outlet: 20 ± 2 °C
 - Angle between the water jet and the surface of the test slab: around 45 degrees
 - Beam angle at the outlet: around 25 degrees.

4. Procedures to be used on sacrificial anti-graffiti coatings (SAG)

4.1 Initial preparation of test slabs

When the water curing according to EN 1766 is terminated, the test slabs shall be lightly brushed on the form side of under running tap water and then stored for seven days in 21 ± 2 °C and $60 \pm 10\%$ RH.

Measurement I: Colour and gloss measuring is carried out according to section 6 on the concrete surface to be exposed (form side).

4.2 Application of the anti-graffiti coating

The SAG shall then be applied according to the instructions of the producer on the form side on horizontally placed test slabs. They shall then be stored for seven days in 21 ± 2 °C and $60 \pm 10\%$ RH.

Measurement II: Measurement of colour and gloss shall be carried out on the concrete surface with the SAG according to section 6 before starting the outdoor exposure.

4.3 Outdoor exposure

The three test slabs shall then be placed on the exposure frame with an inclination of 45 degrees from a vertical axis for a period of three months, freely exposed to the south. The three months shall be within a period during which the average monthly temperature is above 5 °C. After the outdoor exposure the exposed surface of the test slabs shall be cleaned with a soft brush and stored for seven days in 21 ± 2 °C and $60 \pm 10\%$ RH.

Measurement III: Measuring of colour and gloss shall be carried out on the concrete surface with the SAG according to section 6.

4.4 Application of colours and drying

The five specified colours according to section 2 shall be applied on each of the three test slabs with the help of the application template. Colour shall cover the entire test circles in the template. The test slabs shall then dry in 21 ± 2 °C and $60 \pm 10\%$ RH for 6 hours.

Thereafter the test slabs shall be dried in a drying cabinet at 50 °C for 16 hours.

The test slabs shall then be left to cool down in 21 ± 2 °C and 60 ± 10 % RH for 6 hours before cleaning.

4.5 Cleaning and drying

For the cleaning the test slabs shall be placed on the cleaning frame keeping the test slabs in vertical position.

Cleaning shall be carried out with the pressure washer with the settings for testing SAG given in section 2. The nozzle shall be lead back and forth over the test slab at a constant speed for two minutes. The distance between the nozzle and the test slab surface shall be around 10 cm. After the cleaning the test slabs shall be dried in a drying cabinet at 50 °C for 16 hours.

The test slabs shall then be left to cool down in 21 ± 2 °C and 60 ± 10 % RH for two hours before visual inspection is carried out.

4.6 Assessment by visual inspection

If the test slabs show

- unambiguously recognizable colour patterns, contours or shadows
- colour stains with a diameter larger than 5 mm.

the performance of the SAG is deemed to be non-satisfactory.

Photos of the test slabs shall be taken if the performance o the SAG is found non-satisfactory in the visual inspection.

4.7 Assessment by measuring

Measurement IV: If the performance of the SAG is not found non-satisfactory in the visual inspection, colour is measured on the cleaned test slabs according to section 6.

It is recommended to take photos of the test slabs when the testing is terminated.

5. Procedures to be used on permanent anti-graffiti coatings which do not need the use of chemical compounds (PAG)

5.1 Initial preparation of test slabs

When the water curing according to EN 1766 is terminated, the test slabs shall be lightly

brushed on the form side of under running tap water and then stored for seven days in 21 ± 2 °C and $60\pm 10\%$ RH.

Measurement I: Colour and gloss measuring is carried out according to section 6 on the concrete surface to be exposed (form side).

5.2 Application of the anti-graffiti coating

The PAG shall then be applied according to the instructions of the producer on the form side on horizontally placed test slabs. They shall then be stored for seven days in 21 ± 2 °C and $60\pm 10\%$ RH.

Measurement II: Measurement of colour and gloss shall be carried out on the concrete surface with the PAG according to section 6 before starting the outdoor exposure.

5.3 Outdoor exposure

The three test slabs shall then be placed on the exposure frame with an inclination of 45 degrees from a vertical axis for a period of three months, freely exposed to the south. The three months shall be within a period during which the average monthly temperature is above 5 °C. After the outdoor exposure the exposed surface of the test slabs shall be cleaned with a soft brush and stored for seven days in 21 ± 2 °C and 60 ± 10 % RH.

Measurement III: Measuring of colour and gloss shall be carried out on the concrete surface with the PAG according to section 6.

5.4 Application of colours and drying

The five specified colours according to section 2 shall applied on each of the three test slabs with the help of the application template. Colour shall cover the entire test circles in the template.

The test slabs shall then be left to dry in 21 ± 2 °C and 60 ± 10 % RH for 6 hours.

Thereafter the test slabs shall be dried in a drying cabinet at 50 ± 5 °C for 16 hours.

The test slabs shall then be left to cool down in 21 ± 2 °C and 60 ± 10 % RH for 6 hours before cleaning.

5.5 Cleaning and drying

For the cleaning the test slabs shall be placed on the cleaning frame keeping the test slabs in vertical position.

Cleaning shall be carried out with the pressure washer with the settings for testing PAG given in section 2. The nozzle shall be lead back and forth over the test slab at a constant speed for two minutes. The distance between the nozzle and the test slab surface shall be around 10 cm. After the cleaning, the test slabs shall be dried in a drying cabinet at 50 °C for 16 hours.

The test slabs shall then be left to cool down in 21±2 °C and 60±10 % RH for two hours before visual inspection is carried out.

5.6 Assessment by visual inspection

If the test slabs show

- unambiguously recognizable colour patterns, contours or shadows
- colour stains with a diameter larger than 5 mm.

the performance of the PAG is deemed to be non-satisfactory.

The test may be terminated.

Photos of the test slabs shall be taken.

5.7 Assessment by measuring

Measurement IV: If the performance of the PAG is not found non-satisfactory in the visual inspection, colour is measured on the cleaned test slabs according to section 6.

If the performance of the PAG is found to be non-satisfactory in the assessment by measuring the test may be terminated.

It is recommended to take photos of the test slabs if the performance of the PAG is found non-satisfactory in the assessment by measuring.

5.8 Repeated colouring/cleaning cycles

Unless the test is terminated due to the non-satisfactory results in the assessment by visual inspection (section 4.6) or in the assessment by measuring (section 4.7) sections 4.4, 4.5, 4.6 and 4.7 are repeated ten times.

If the performance of the PAG is found satisfactory after ten colouring/cleaning cycles it

is recommended to take photos of the test slabs after the last cycle.

6. Colour and gloss measuring

6.1 Colour measuring

The colour measuring template shall be placed over the test slab. Three measurements with the colour measuring device shall be carried out within each test circle. The brightness, L-value, of each measurement shall be noted. The average of the values from each test circle shall be calculated.

6.2 Gloss measuring

The gloss measuring template shall be placed over the test slab. Ten measurements with the gloss measuring device shall be carried out within each marked test circle. The gloss value, G-value, for each measurement shall be noted. The methodology according to EN ISO 2813 with an angle of 85 degrees shall be used. The average of the values from each test circle shall be calculated.

7. Calculations

7.1 Colour and gloss changes caused by the anti-graffiti coating (SAG or PAG)

The following colour changes shall be calculated for each test circle on each test slab expressed as difference in L-value.

- $L_I - L_{II}$, change due to application of the anti-graffiti coating
- $L_I - L_{III}$, change due to application of the anti-graffiti coating after outdoor exposure.

Where

L_I = brightness value of the concrete surface before application of the anti-graffiti coating

L_{II} = brightness value of the surface with the anti-graffiti coating before outdoor exposure

L_{III} = brightness value of the surface with the anti-graffiti coating after outdoor exposure

The following gloss changes shall be calculated for each test circle for each test slab as the difference in G-value

- $G_I - G_{II}$, change due to application of the anti-graffiti coating
- $G_I - G_{III}$, change due to application of the anti-graffiti coating after outdoor exposure.

Where

G_I = gloss value on the concrete surface before application of the anti-graffiti coating

G_{II} = gloss value of the surface with the anti-graffiti coating before outdoor exposure

G_{III} = gloss value of the surface with the anti-graffiti coating after outdoor exposure

Average of $G_I - G_{II}$, calculated on values from all test circles and test slabs

Average of $G_I - G_{III}$ calculated on values from all test circles and test slabs

7.2 Performance of sacrificial anti-graffiti coatings (SAG)

The following colour change shall be calculated for each test circle on each test slab expressed as difference in L-value.

- $L_I - L_{IV}$, change between cleaned surface and the non-treated concrete surface

Where

L_I = brightness value on the concrete surface before application of the anti-graffiti coating

L_{IV} = brightness value of the cleaned surface

Average of $L_I - L_{IV}$ for each colour A-E, calculated on values from all test slabs.

7.3 Performance of permanent anti-graffiti coatings (PAG)

The following colour change shall be calculated for each test circle on each test slab expressed as difference in L-value.

- $L_{III} - L_{IV}$, change between the cleaned surface and the exposed surface with PAG.

Where

L_I = brightness value of the surface with the anti-graffiti coating (PAG) after outdoor exposure

L_{IV} = brightness value of the cleaned surface

Average of $L_I - L_{IV}$ for each colour A-E, calculated on values from all test slabs.

8. Test report

8.1 For both sacrificial and permanent anti-graffiti coatings, SAG and PAG

The amount of the anti-graffiti coating/s used in the test shall be given.

The following values on the influence of the anti-graffiti coating on the colour and gloss of the concrete surface should be declared:

Influence of the non-exposed anti-graffiti coating:

- Average value for $L_I - L_{II}$
- Average value for $G_I - G_{II}$

Influence of the exposed anti-graffiti coating:

- Average value for $L_I - L_{III}$
- Average value for $G_I - G_{III}$.

8.2 For sacrificial anti-graffiti coatings (SAG)

The following values shall be declared as the capability of the SAG to protect a concrete surface against graffiti:

If the SAG does not fulfil the criteria for the visual inspection:

- Photos of the test slabs after cleaning which unambiguously show that the assessment criteria are not met.

If the SAG meets the criteria for the visual inspection:

- Statement that the criteria of the visual inspection was met.
- Average value $L_I - L_{IV}$ for each colour A – E; (5 values)
- The value $L_I - L_{IV}$ for each test circle (colour and test slab); in total 15 values
- If required by the client: Photos of the test slabs after cleaning

8.3 For permanent anti-graffiti coatings (PAG)

The following values shall be declared as the capability of the PAG to protect a concrete surface against graffiti:

If the PAG does not meet the criteria for the visual inspection after any colouring/cleaning cycle:

- After which colouring/cleaning cycle the test was interrupted
- Photos of the test slabs after cleaning which unambiguously show that the assessment criteria are not met.

If the anti-graffiti coating meets the criteria for the visual inspection after each colouring/cleaning cycle:

- Statement that the criteria of the visual inspection was fulfilled after each colouring/cleaning cycle.
- Average value $L_{III-LIV}$ after ten colouring/cleaning cycles for each colour A – E; (5 values)
- The value $L_{III-LIV}$ for each test circle (colour and test slab) after ten colouring/cleaning cycles (in total 15 values)
- If required by the client: Photos of the test slabs after the tenth cleaning

Annex A: Guidance on limit values for the anti-graffiti coatings

A.1 Recommended limit values for the capability of sacrificial anti-graffiti coatings (SAG) to protect concrete surfaces

The criterion reflects the difference between the colour of the original untreated concrete surface (L_I) and the cleaned surface (L_{IV}). The second condition is introduced to avoid a situation where the average value meets the requirement but there is a large scatter between individual test circles.

Condition 1:

The absolute value of the change in L -value $|L_I - L_{IV}|$, average value for each colour A – E shall be ≤ 10 .

Condition 2:

The absolute value of the change in L -value $|L_I - L_{IV}|$, average value for each colour A – E on each separate test slab (each test circle) shall be ≤ 11 .

A.2 Recommended limit values for the capability of permanent anti-graffiti coatings (PAG) to protect concrete surfaces

The criterion reflects the difference between the colour of the exposed concrete surface with the PAG (L_{III}) and the cleaned surface (L_{IV}) after ten colouring/cleaning cycles. The second condition is introduced to avoid a situation where the average value meets the requirement but there is a large scatter between individual test circles.

Condition 1:

The absolute value of the change in L -value $|L_{III} - L_{IV}|$, average value for each colour A – E shall be ≤ 10 .

Condition 2:

The absolute value of the change in L -value $|L_{III} - L_{IV}|$, average value for each colour A – E on each separate test slab (each test circle) shall be ≤ 11 .

A:3 Guidance on colour and gloss changes of the SAG or PAG

Colour changes, $|L_I - L_{II}|$ or $|L_I - L_{III}|$ (average values), caused by the SAG or PAG by itself which are larger than 10 will be perceived as a substantial change in colour. If the value indicates darkening of the surface so that a L -value under 50 is obtained before applying the colours, the values for capability to protect a concrete surface against graffiti may be misleading.

Gloss changes are generally very low, especially with SAG. Gloss changes, $|G_I - G_{II}|$ or $|G_I - G_{III}|$ (average values), under 5 will hardly be perceived.

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