

How To Get Concrete Surfaces Look Like You Want

***Experiences and
Practical Tips
From Tests and
Workmanship***

The Colour and Structure of Concrete Surfaces

The colour and structure of concrete surfaces are significant factors in how a concrete construction appears. This catalogue gives tips on what you can do in the production stage so that the concrete surface has the appearance you desire.

The findings have come about after five years of research into concrete surfaces, mainly done on two large field projects; one being a project that Cementa and the Swedish National Rail Administration started in 1995, the other being an SBUF project that Cementa and NCC started in 1998.

The facts have been compiled by Arne Retelius from Cementa and Bengt Ström from NCC.

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Are Concrete Surfaces Always Grey?

The colour of concrete varies. As long as the colour is smooth and even, not many people notice it. However, when a new concrete construction is blotchy, white-speckled, or has large, dark spots here and there, then one wonders what causes it.

You may think that concrete is always grey, but if you take a closer look at different concrete constructions, you can see that concrete surfaces appear different. There are....

... surfaces with lime efflorescence

... light surfaces

... dark surfaces

... blotchy surfaces

... dirty surfaces.

Besides these, each surface has different shades of colour.

A Study of Concrete Surfaces...

The colour and structure of concrete surfaces have been studied in both building projects and in prepared test pieces.

What has been of interest is to see what a large effect a seemingly small procedure has on the colour, character and appearance of concrete surfaces.

There are no patented solutions on what you can do to get a concrete surface to look the way you would like it to look. However, studies point to a line of procedures one can take to avoid the most common problems.

When concrete is hardening, it is dehydrating. The form's function is to ensure that no moisture escapes from the concrete. The results depend on how airtight or absorbent the form is, the surrounding temperature, the humidity in the air, and the concrete recipe.



If the concrete surface looks like this, it would be due to the fact the form's boards have been heavily oiled. This oil has been absorbed a few millimetres into the concrete and has reacted with it, which has resulted in less tensile strength in the concrete's outer layer...



...parts of the concrete's outer layers fasten on the form's boards, which can look like this at a closer angle.



If the concrete surface looks like this it could be because the underneath concrete layer has been left too long before the next concrete layer has been placed on top and vibrated together with it. We can say that the concrete has "curtains".

The Colour and Structure of Concrete Surfaces

When the concrete is cast in a form face, its surface becomes a direct impression of the form's surface. The fresh concrete and the characteristics of the form's face are what give the final result.

However, the casting method, the finishing, the temperature, chemical reactions, as well as the timing of the form stripping and weather conditions will also have an effect on the end result.

A Very Thin Layer is Formed between the Concrete and the Form Face...

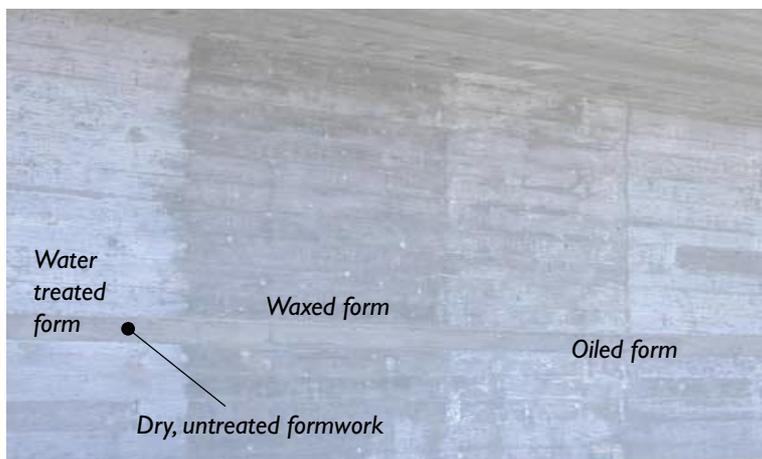
This thin layer can be composed of water, cement and other fine material. The durability of this thin layer while the concrete is being cured, affects to a large extent what colour the concrete layer is given. The tone of the concrete's outer layer is affected by different factors, which in turn will have an effect on the colour of the concrete's surface. These factors are:

- **The concrete recipe**
- **The casting method**
- **Vibrations**
- **The characteristics of the form face**
- **Chemical reactions between the fresh concrete and the form face**
- **The effect of the form tapering solution**
- **Dirt on the form face**
- **The weather conditions during and after concreting**

The Form Face is One of Many Factors...

The same concreting time, the same concrete, but different types of form faces can result in completely different looks.

The picture below shows a concrete surface where the form has been treated in different ways. The concrete surface varies from light to dark, and from smooth to porous.



The appearance of the concrete surface is determined, to a large extent, when the pouring is done...

The colour which can be seen on all untreated concrete surfaces exists only in a very thin layer of approx. 0.1-0.2 mm.

The best opportunity to affect the colour and appearance of the concrete is on site...

Finishing on hardened concrete surfaces will give a more even colour...

Cause and Effect

Lime efflorescence, except on a section where you have a "clean" surface by not oiling the form...

The pillar is covered immediately after form stripping. The cover is blown apart, which produces lime efflorescence where the concrete surface lacks covering...

The bridge "wing" with lime efflorescence on the part of the concrete surface that was exposed to rainfall...

Why Coloured Variations?

Here are examples of some interesting observations. What appeared at first to be "unexplainable" variations in colour of the concrete surfaces, proved to have quite logical causes.

Everything Has an Explanation...





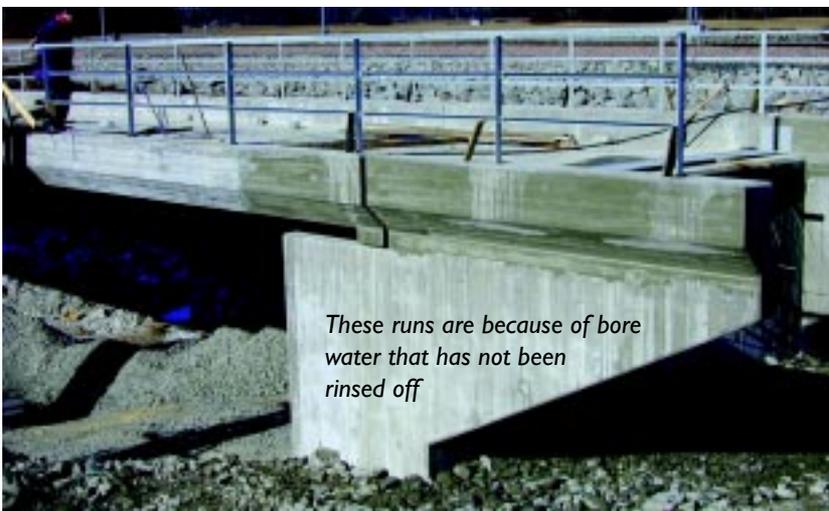
This bridge was cast in three stages:

- Cast stage 1, the lighter section on the right, oiled form.
- Cast stage 2, the middle section, untreated form.
- Cast stage 3, the lighter section on the left, oiled form.

The middle section of the bridge was cast with a form that was untreated...



Bridge girder with a blotchy surface, so-called "curtains". The concrete layers have been lying too long before they were re-vibrated together with the upper layers.



These runs are because of bore water that has not been rinsed off

The lime efflorescence on the farthest section of the bridgeslab. However, not on the nearest section, where the form was stripped 14 days later...

From these observations, as well as experience from building projects and laboratory tests, we shall provide, on the following pages, tips and advice on how to get a concrete surface looking the way you want it to look.



An oiled form board gives a porous and "dusty" surface. Without oil, the surface becomes hard and compact.

Lime Efflorescence

Lime efflorescence can be caused by...
...early form stripping
...low surface temperature
...form tapering solution

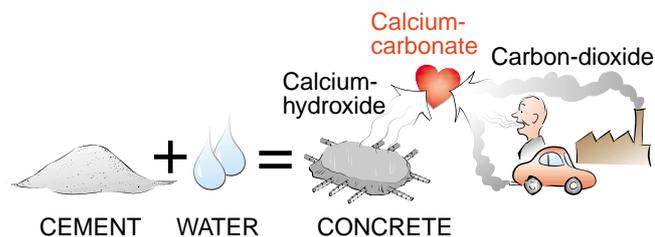


Lime efflorescence sometimes appear as heavy white coatings on a concrete surface. Lime efflorescence consist of calcium-carbonate which comes about from a chemical reaction between the concrete's calcium-hydroxide and the air's carbon-dioxide. The reaction occurs on the premise that moisture is present.

Lime efflorescence usually occur in connection with form stripping. The concrete's outer layer is then temporarily weakened, which facilitates movement of the water in the surface of the concrete. The water is either capillarity water from the concrete, or rain and frost that trickles through the outer layer. When the water evaporates, the concrete surface is enriched with calcium-hydroxide.

If the form remains a longer time than normal, then the moisture balance is neutralised. By using a timber form with a high density, one can reduce lime efflorescence. Dens timber forms come about when, for example, the timber form is used a second time. Timber forms can also be impregnated with wax. In both instances, one can avoid the timber's characteristics from affecting the concrete's outer layer.

Tests have also been conducted with dry timber form casting. It consistently gave a light concrete surface without lime efflorescence.



Tips!

How to Avoid Lime Efflorescence on Concrete Surfaces...

- Use timber with a high density
- Delay form stripping
- Avoid low surface temperatures
- Avoid form tapering solution that delays the concrete surface from hardening
- Do not use form boards that are wet-through

Light Surfaces



Light surfaces are due to the fact that the form has been tight and is not absorbent...

The term light surface should not be confused with lime efflorescence. Light surfaces refers to surfaces of light colour that are created from forms such as plywood-, sheet-metal- or matrix-forms. The light surface exists already at the time of the form stripping. A premise that the colour will be consistent is that the fresh concrete is vibrated evenly and that the concrete formula is such that the outer layer can easily form.

The concrete needs to be vibrated easily. This means that it should be fresh and not have a tendency to harden too quickly in the form. An important premise is good planning, before and during concreting.

Requirements on the Quality of Fresh Concrete

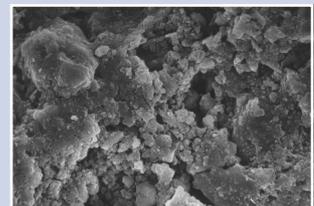
- Easy to vibrate
- Easy to re-vibrate after 1-2 hours
- Hardens slowly

Requirements for the Form's Surface

- Tight = non-absorbent
- It should not react together with the concrete

Requirements for Casting the Concrete

- Good planning
- Maximum of 1 hour between pouring the concreting layers
- Neat and even concrete layers
- No old concrete remaining anywhere
- No late vibrating in the underlying concrete layers



A light surface enlarged 2000x.

Tips!

How to Get a Light Concrete Surface

- Use a compact, non absorbent form
- Use concrete that hardens slowly
- Cast continually with equally high layers
- Vibrate the fresh concrete and the underlying layer systematically

Dark Surfaces

Dark surfaces are due to the form absorbing the concrete's surface water...



By grinding or blasting a light concrete surface it will often become dark. One can get a dark concrete surface when concreting against a new board form, that is quite absorptive. The formwork then absorbs the concrete's outermost light coloured layer, which results in a dark surface. The concrete surface can transform into a blotchy surface that can vary between light and dark.

It is very common with variations in colour between different concreting stages on the same construction. This is often due to the fact that one has mixed new and used board forms, or the form face has been wet and dry in different places, due to rain, for instance.

The concrete surface often becomes darker when one does not use oil on the form face.



*Dark surface enlarged
2000x*

Tips!

To Get a Darker Surface

- Allow the form to remain twice as long as usual
- Avoid using oil on the form faces
- Grind or blast the concrete surface after formstripping

Blotchy Surfaces



Blotchy surfaces consist of a variety of light and dark sections.

A blotchy surface can have several causes:

- Local absorbent form face
- Vibration at a late stage
(creates what are sometimes called "curtains")
- Bad or uneven vibration
- High, uneven concrete layers
- Quick hardening of already existing concrete layers
- The concrete has "hung itself" in the form and the concrete reinforcement and it has been difficult to vibrate it evenly
- Leakage due to holes and crevices in the form. This shows up as dark spots and stripes on the concrete surface.
- Large variations in the concrete's consistency between different concreting layers.

Blotchy surfaces are a result of, besides other things, the concrete being treated differently during the concreting period, or because it has hardened quickly in the form...



Test piece with "curtains". The underneath concrete layer has been standing for three hours before it was re-vibrated in connection with the top layer being added.

Tips!

To Avoid Blotchy Concrete Surfaces...

- Careful planning and execution of concreting and vibrating
- Use the same material in the whole form
- Do not allow the concrete layers to become too old before re-vibrating
- Ensure that the form is tight, without holes or crevices

Dirty Surfaces

Dirty concrete surfaces can be due to, for example, rust from the reinforcement sticking to the form face.



Dirty concrete surfaces can be due to the fact that the form face was dirty prior to concreting and then the dirt has stuck to the concrete surface. A quite common reason for this is that rust from the reinforcement has stuck to the form and thus the concrete surface becomes "rusty". Concrete surfaces can also be dirtied after form stripping, due to, besides other things, surrounding construction work.

"Traffic" dirt is another common reason for dirty concrete surfaces.



Cover the protruding reinforcement so that rusty water does not run out onto the concrete surface.



Tips!

To Avoid Dirty Concrete Surfaces...

- Cover the form and reinforcement while waiting to concrete
- Keep the form faces clean
- Protect the concrete surface after form stripping

What to Think About Before, During and After Concreting

To bring about desired results before, during and after concreting, good planning is required.

The planning involves the construction supervisors, architects and especially building contractors who are going to carry out the work. The colour and structure of the concrete surface is determined by the concrete formula, the concreting method, the form face and form stripping. The result is thus, to a large extent, dependent on the type of working method one chooses.

It is important to pay attention to all factors that affect the concrete surface's colour and to adapt the choice of material and working methods accordingly, in order to get the concrete surface you want. *It is also important after the form stripping to assess and evaluate the concreting results.*

Besides the concrete formula itself, there are several factors that affect the colour and evenness, for example, characteristics of the form face, the amount of vibration and how one casts the concrete.

If, despite all efforts, one still gets an unwanted colour or structure on the concrete surface, it is important to draw the right conclusions and to adjust the working methods for the next concreting.

Plan
Prepare
Carry out
Follow-up
Feed-back
Improve

The following six factors greatly affect the colour and structure of concrete surfaces:

The concrete formula

The form face

Casting concrete

Concrete hardening

Form stripping

Attention given to hardened concrete

All of these factors are important for the end result.

For each of these areas the following pages describe in detail important things to think about for the best possible results.



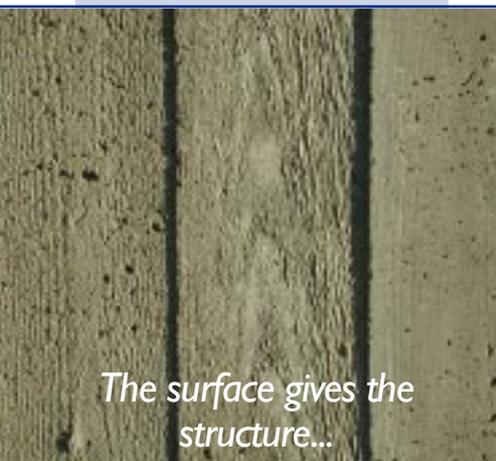
Concrete Recipe



To Think About:

- **The concrete one chooses lays the foundation.**
 - Construction cement gives lighter surface than building cement
 - Lime sediments and blotchy surfaces can arise independently of the type of cement used
 - Hardening of the fresh concrete should take its course
 - The concrete should be easy to re-vibrate after 1-2 hours
 - Check the concrete's tendency to produce blotchy surfaces

Form Face



To Think About

- **The form's surface affects the outer layer that forms on the concreted construction.**
 - Tight form materials, like steel-, plywood-, and matrix-forms, as well as used form boards, produce light concrete surfaces
 - The concrete's outer layer can react negatively together with the form material
 - Form oil can give the fresh concrete a porous surface
 - Very wet and swollen form boards can release substances that delay the concrete's surface hardening
 - Uninsulated forms during winter give slow resistance growth, or at worse, freezes the outer layer
 - The wind's cooling effect

Concreting



To Think About:

- **Concreting should be "well-attended" to, in combination with a good concrete formula.**
 - Good planning when filling the form
 - Concrete layers that are even and not too high
 - Constant rising rate
 - Even and continuous vibration
 - Watch over the "hangings" in forms and reinforcements
 - Good on site lighting
 - Pay attention to the top layer; bleeding must not occur

Concrete Hardening

To Think About

- **Hardening of the concrete surface can be interrupted by, for example, low surface temperatures and chemical reactions between the form face and the fresh concrete.**
- The concrete's strength is determined by the temperature; avoid low surface temperatures by using insulated forms
- The outer layer should have the same strength growth as the rest of the concrete in the form
- Absorbent form face and form oil can delay the concrete's surface hardening
- Wet form boards can release substances that delay the hardening process of the concrete's outer layer



Form Stripping

To Think About

- **The concrete surface can be weak at the form face. Water of capillarity can then quickly run off the concrete's outer layer, which can also be affected by outer moisture.**
- Premature form stripping can result in lime sediments on the concrete surface
- Cover the concrete surface immediately after form stripping



Measures Taken on Hardened Concrete

To Think About:

- **The colour one sees on the concrete surface is only a very thin outer layer.**
- Dry-blasting is a good way of improving a concrete surface
- High pressure cleaning or wet-blasting is also useful
- Mechanical, dry methods are preferable, as one can quickly see the result





Moisture-saturated timber forms release various substances onto the concrete, which can inhibit the concrete from hardening.

Tips!

...for presentable concrete surfaces

- Use fresh concrete that does not have a tendency to separate and that can easily be re-vibrated
- Plan for effective control of the concreting
 - Even concrete layers
 - Systematic vibration
 - Re-vibration on time
- Use form materials with an even suction ability
- Use form work with high density
- Seal any holes or cracks in the form
- Use form wax instead of form oil
- Delay form stripping if the form is oiled or wet
- Cover the concrete surface when the form stripping is premature
- Do a test concreting under real conditions with the concrete one intends to use

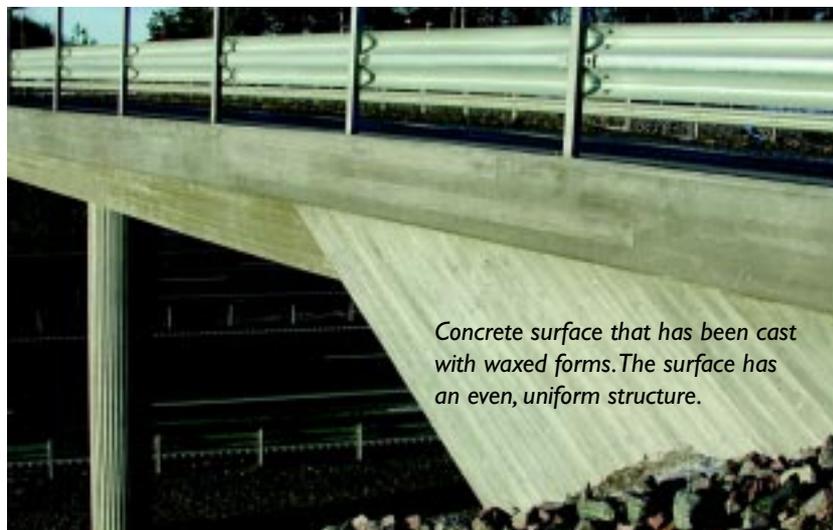
Tips!

...when using form- oil or wax

- Apply a thin layer on the entire form face
- Apply using an injection
- Excess oil or wax must be removed carefully

NB!

Do not use form oil on forms that will not be used for a long time prior to concreting.



Concrete surface that has been cast with waxed forms. The surface has an even, uniform structure.

CEMENTA

NCC

 **Vägverket**

FÄRDIG BETONG 

SBUF 

How To Get Concrete Surfaces Look Like You Want

The reason why concrete surfaces are light, dark, blotchy or striped is due, besides other things, to how you cast concrete, what type of form has been used, when the form was stripped, the season and weather conditions.

This booklet is about the colour of the concrete surfaces.

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