An initiative for more **color in architecture**.

**COLORED CONCRETE WORKS®**

An initiative of LANXESS
The color of the Bodega Antón, designed by the world-renowned architect Jesús Marino PASCUAL in the Spanish wine-growing region of La Rioja, supports the overall architectural concept.
More publicity for colored concrete

Colored Concrete Works® is an initiative by LANXESS to showcase the versatile, aesthetic and technical characteristics of concrete colored with Bayferrox® pigments. Colored Concrete Works® has been conceived as a set of case studies, which document the use of colored concrete in international construction projects, for example.

Focus of attention: the reference projects

Although the outstanding practical characteristics of concrete are recognized everywhere, this universal construction material still frequently suffers from a negative image. Therefore, a focus of the initiative is case studies outlining in particular reference projects where building owners and architects tell about their experiences working with colored concrete.

Creating added value and structural improvement

Colored concrete offers added value for anyone who works with it because it adds permanent beauty to a standard construction material. This not only makes structures more desirable, it also distinguishes them from others. More and more architects, building owners and manufacturers are discovering this potential – a trend that Colored Concrete Works® supports on a permanent basis.

Creating sustainability

In order for color to become interesting and relevant as a marketing instrument for architects, building owners and manufacturers, the Colored Concrete Works® initiative operates in several fields simultaneously. Not only case studies and building specifications, but also symposiums and workshops contribute to the lasting enhancement of interest in colored concrete.
To ensure that the Colored Concrete Works® initiative from LANXESS achieves the widest possible publicity, an interested specialist audience is not the only group able to gain detailed information on the broad topic spectrum offered by Colored Concrete Works®. Anyone who would like to know more about the architectural possibilities of colored concrete can use various communication channels to gain more information. For instance, on the key medium, the Internet, at www.colored-concrete-works.com, numerous sources of information are available: from current trade show dates and press articles on colored concrete through precise product information to downloads of Colored Concrete Works® case studies and Bayferrox® product data sheets. Colored Concrete Works® case studies, for example, which are also sent as mailings to architects, primarily enable building owners and architects to voice their opinions and report on their experiences working with colored concrete. Further information includes fair posters, advertisements and informational brochures – which all address the topic of colored architectural concrete.

Example: the Colored Concrete Works® case studies. They document the use of colored concrete in international building projects, showing successful examples of how the unique technical attributes of this universal construction material can be optimally combined with aesthetic requirements.
Selecting the color

To initiate the planning of colored exposed concrete, a clear vision of the desired color is necessary. The Bayferrox® and Chrome Oxide Green pigments suitably cover the color range that is particularly sought after.

<table>
<thead>
<tr>
<th>Pigment</th>
<th>Color Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayferrox® red</td>
<td>Yellow-red to blue-red</td>
</tr>
<tr>
<td>Bayferrox® yellow</td>
<td>Greenish to reddish shade of yellow</td>
</tr>
<tr>
<td>Bayferrox® brown</td>
<td>Light brown to dark brown/red brown</td>
</tr>
<tr>
<td>Bayferrox® black</td>
<td>Dark gray to anthracite</td>
</tr>
<tr>
<td>Chrome Oxide Green</td>
<td></td>
</tr>
</tbody>
</table>

With the titanium dioxide and cobalt blue pigments available on the market, white and blue shades are also possible.

Delivery forms for pigments

The color pigments are available in powder form, but also as pigment preparations. In addition to powder as the original delivery form for these pigments, various forms of pigment preparations exist, such as granulates, compacted powders or slurries which can be manually added to the concrete. Due to their lack of dust and excellent flow characteristics, the pigment preparations specified mainly offer application advantages. This is particularly of interest if the pigment processor uses bigger amounts of pigment or utilizes an automatic metering system.

Product range

A broad range of pigments and delivery forms are available. Along with pigments in powder form and granulated or compacted pigments, the products can also be supplied through our network of partner companies, for example, in liquid form, in water-soluble bags, in small packets, etc.

- Bayferrox®
- COLORTHERM®
- Chrome Oxide Green
- Purofer®
- Oxined®
- Slurry: Hydrocol, Hydroferrox, Fluined®, formirapid®, HobbyColor®
The quantities required from individual ready-mix concrete or pre-cast concrete manufacturers are normally relatively low, especially if pigments are used on a project-related basis. In other words, the manual mixing of pigments is generally regarded as sufficient. As an alternative to the portion-wise addition of powder pigments or preparations, in many cases the addition of pigments in water-soluble bags is advantageous. This procedure offers the advantage of enabling the clean usage of the pigments.

**Manual pigment dosage**

The inorganic pigments normally used for the building materials can be transported in liquid suspension form. These pigment suspensions—also called slurries in the following description—are both free-flowing and dust-free. With the appropriate pumps, they can also be fed from long distances into the mixture. Moreover, dosage proves to be relatively easy using dosage cylinders or hydrometers. In the process, the pigment user has the choice between a suspension, produced on site in a dedicated slurry tank, or purchasing a finished slurry from a pigment supplier.

**Slurry dosage**

The selection of the pigment is of crucial importance to the quality of the final product. Long-term evaluations of colored concrete that has been exposed to different climate conditions in various locations have shown that inorganic oxide pigments exhibit particularly good color fastness characteristics.

**The Pigment**

<table>
<thead>
<tr>
<th>Color</th>
<th>Name</th>
<th>Pigment name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Iron oxide black</td>
<td>Bayferrox® black</td>
</tr>
<tr>
<td>Red</td>
<td>Iron oxide red</td>
<td>Bayferrox® red</td>
</tr>
<tr>
<td>Yellow</td>
<td>Iron oxide yellow</td>
<td>Bayferrox® yellow</td>
</tr>
<tr>
<td>Brown</td>
<td>Iron oxide brown</td>
<td>Bayferrox® brown</td>
</tr>
<tr>
<td>Green</td>
<td>Chrome oxide green</td>
<td>Chrome Oxide Green</td>
</tr>
<tr>
<td>White</td>
<td>Titanium dioxide</td>
<td>e.g. TRONOX®</td>
</tr>
</tbody>
</table>
Dry/wet dosage

Unlike the slurry dosage, in which a larger quantity of pigment suspension is manufactured at any one time, in the dry/wet dosage process only the exact quantity of pigment is transferred to a suspension that is required for coloring the next concrete batch. During this procedure, the quantity of water necessary for the first batch is added in a small agitating tub, which also functions as a scale. Then the corresponding quantity of pigment is transferred into the agitating tub by means of a screw conveyor, which is controlled by the scale mentioned above. After a short period of agitation, the finished suspension can be pumped into the concrete mixer.

Dry dosage

In addition to the dosage methods specified above, the pigment (regardless of whether it is a powder pigment or a preparation such as granulates or compacted pigment) can also be metered in dry form. For this process, a broad range of gravimetric or pneumatic dosage systems are available. There are no universally valid guidelines for deciding which combination of pigment delivery form and dosage system is the best alternative in a specific case scenario. To reach an evaluation, both the specific local requirements and the various economic interests of the respective operation must be considered. Only careful prior consideration of the individual conditions can guarantee that the method decided upon proves correct in the long run.

ESO Hotel, Cerro Paranal, Chile.
Pigment: 2 % Bayferrox® 600 N, applied to cement.
Concrete: compression strength class C20/25 (B25) and C27/37 (B35).
Knowledge of the optimal pigmentation level helps save money so that no more pigment is used than is absolutely necessary. Increasing the amount of pigment per batch of concrete intensifies the color up to a certain point. However, upon further addition of pigment, one arrives at a range in which adding further quantities of pigment produces no substantial color intensity, and thus becomes economically inefficient. Generally speaking, adding pigment beyond 5% (based on cement) is normally not necessary.
**Water/cement ratio and concrete**

If one compares the color shades of different types of concrete with varying amounts of water, color shades will be different, even if the same amount of pigmentation has been added. As a basic rule: the higher the water/cement ratio, the lighter the concrete will be.

**Actual color of the cement**

Gray absorbs all colors wherever they occur. For this reason, concrete manufactured using ordinary Portland cement cannot be colored as brightly as concrete containing white cement. However, the increase in color purity obtained from using white cement depends on which pigment is used. If black is used, there is practically no difference between concrete consisting of white or gray cement. For a dark brown and red, the difference is small—for yellow, on the other hand, it is very pronounced. The brighter and purer the desired shade of color should be, the more white cement is necessary for attaining the target color.

**Dispersion of pigments**

The dispersion of pigments is an important criterion in the production of pigmented concrete. Colored goods require an even, satisfactory dispersion or distribution of the pigments. As described in the table, some important basic rules apply when mixing the raw materials.

<table>
<thead>
<tr>
<th>Recommended sequence for filling the mixer:</th>
<th>Breakdown of mixing time:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premix aggregates + pigment + cement + water</td>
<td>Sand + pigment: about 10–20 s</td>
</tr>
<tr>
<td>Mixing time 1.5–2 min</td>
<td>Sand + pigment + cement: about 15–20 s</td>
</tr>
<tr>
<td></td>
<td>Sand + pigment + cement + water: about 1–1.5 min</td>
</tr>
</tbody>
</table>

Each mixer has a minimum mixing time. If this full time is not completed, no homogeneous distribution of the pigment can be obtained even through changes to the individual mixing times or the addition of components into the mixer. Required mixing times largely depend upon the performance capability of the concrete mixer. The specifications for mixing times listed above are therefore only to be taken as rough indications.

Exceptions are possible when using suspensions. Here it may be possible to add the slurry into a mixture which is already wet.
WEATHER RESISTANCE

Weather resistance

The Roman aqueduct, which supplied Cologne, Germany with water from the Eifel Mountains 2,000 years ago, was built with trass cement. If one had colored this antique “concrete” with natural iron oxides, which at that time were already widely known, then the water pipeline, parts of which can still be visited, would still be colored today. Deviations from the original color would be minor. These color changes, which can be seen on uncolored and colored concrete alike, can be both temporary (e.g. efflorescence) and permanent (e.g. exposed aggregate) in character.

Efflorescence on concrete

Efflorescence is the scourge of all concrete manufacturers, especially when color is being used and aesthetic demands are placed on the concrete. It should be noted that neither Bayferrox® nor Chrome Oxide Green pigments have an influence on the occurrence of efflorescence. By nature, the white lime secretions are more easily recognizable on colored concrete than on natural gray or even white concrete. Efflorescence results from the formation of lime traces during the hardening of the cement. Already present in the mixing water (primary efflorescence) or in external water sources, e.g. rain or dew (secondary efflorescence), the lime deposits travel to the concrete surface. There, a reaction to carbon dioxide in the air turns the minerals into insoluble calcium carbonate.

Efflorescence disappears after a certain time by itself.


Church, Seoul, Korea
Concrete technology

The requirements placed on the pigments used to color building materials are stipulated in standards. In Europe, the use of pigments for coloring building materials is specified by EN 12 878 “Pigments for the coloring of building materials based on cement and/or lime”. In the United States, please refer to ASTM C 979 “Pigments for integrally colored concrete”.

EN 12 878

Conformance is validated by in-house production control and the resulting certification by a notified body (CE test mark). The notified body issues certificates that replace the previous certificates of compliance. The CE mark, which is also affixed to the packaging, documents this conformance. In EN 12 878, further tests are stipulated for reinforced concrete (Cat. B), in particular regarding their frequency. In order to meet the standard requirements, particularly regarding the documentation, these products are managed separately as so-called special formulations at LANXESS. In the test certificate, all required data on the respective batch are listed and the targeted application is defined.

ASTM C 979

In this standard, the requirements for pigments of colored concrete are specified. LANXESS pigments adhere to the standard requirements.
FOR ADDITIONAL INFORMATION, CONTACT THE LANXESS COUNTRY REPRESENTATIVE.

**Germany**
LANXESS Deutschland GmbH
Business Unit Inorganic Pigments
Rheinuferstraße 7–9
47829 Krefeld
GERMANY
Tel.: +49 221 8885 3974
Fax: +49 22151 88 4133

**USA**
LANXESS Corporation
Business Unit Inorganic Pigments
111 RIDC Park West Drive
Pittsburgh, PA 15275-1112
USA
Tel.: +1 412 809 1000
Fax: +1 412 809 1059

**Singapore**
LANXESS Pte. Ltd.
Business Unit Inorganic Pigments
3A International Business Park
#07-10/18 ICON@IBP Tower B
SINGAPORE 609935
Tel.: +65 6725 5828
Fax: +65 6725 4828

**Australia**
LANXESS Pty. Ltd.
Business Unit Inorganic Pigments
Unit 1/35 Carter Street
Lidcombe, NSW 2141
AUSTRALIA
Tel.: +61 28748 3910
Fax: +61 28748 3999

**Japan**
LANXESS KK.
Business Unit Inorganic Pigments
Marunouchi Kitaguchi Building 23F
1-6-5, Marunouchi, Chiyoda-ku
Tokyo 100-8215
JAPAN
Tel.: +81 3 5293 8017
Fax: +81 3 5219 9776

**Great Britain**
LANXESS Ltd.
Colour Works
Lightfield Road
Branston
Burton-on-Trent
Staffordshire, DE14 3WH
UNITED KINGDOM
Tel.: +44 1283 714200
Fax: +44 1283 714201

**Brazil**
LANXESS Indústria de Produtos Químicos e Plásticos Ltda.
Av. Maria Coelho de Aguiar, 215 Bloco B - 2º Andar
05804-902 São Paulo
BRASIL
Tel.: +55 11 3741 2615
Fax: +55 11 3741 3933

**Italy**
LANXESS Srl.
Segrener Business Park, Palazzo Y
Via San Bovio n.1/3
20090 - Milano San Felice - Segrate
ITALY
Tel.: +39 0230722644
Fax: +39 0230724298

**South Korea**
LANXESS Korea Ltd.
9F, Samsung Boramae Omni Tower 23, Boramae-ro 5-gil
Dongjak-gu, Seoul
07071, Korea
REPUBLIC OF KOREA
Tel.: +82 2 6715 5100
Fax: +82 2 847 3295

**Central and Eastern Europe**
LANXESS Central Eastern Europe s.r.o
EUROVEA
Central
2 Príbovova 6
811 09 Bratislava
Slovak Republic
Tel.: +421 2 3215 1626
Fax: +421 2 3215 1699

**Spain**
Europigments, S.L.
Business Unit Inorganic Pigments
Arquitectura, 27
Poligono Industrial Els Garrofers
08340 Vilassar de Mar
SPAIN
Tel.: +34 937 540 770
Fax: +34 937 540 784

**China**
LANXESS Specialty
Chemicals Co., Ltd.
No. 458 Hanjia Road
Jinanweilai Town
Shanghai, 200540
R.P. CHINA
Tel.: +86 21 5284 7860
Fax: +86 21 6250 0769

**India**
LANXESS House
Plot no. A162-164
Road No.27, MIDC
Wagle Estate
Thane (West) - 400604
Maharashtra, INDIA
Tel.: +91 22 25871000
Fax: +91 22 25871287

**France**
LANXESS S.A.S.
Inorganic Pigments
Le Doublon A
11, avenue Dubonnet
92407 Courbevoie Cedex
FRANCE
Tel.: +33 1 80 46 30 00
Fax: +33 1 80 46 30 45

**Germany**
LANXESS Deutschland GmbH
Business Unit Inorganic Pigments
Rheinuferstraße 7–9
47829 Krefeld
GERMANY
Tel.: +49 221 8885 3974
Fax: +49 22151 88 4133

**Singapore**
LANXESS Pte. Ltd.
Business Unit Inorganic Pigments
3A International Business Park
#07-10/18 ICON@IBP Tower B
SINGAPORE 609935
Tel.: +65 6725 5828
Fax: +65 6725 4828

**Australia**
LANXESS Pty. Ltd.
Business Unit Inorganic Pigments
Unit 1/35 Carter Street
Lidcombe, NSW 2141
AUSTRALIA
Tel.: +61 28748 3910
Fax: +61 28748 3999

**Japan**
LANXESS KK.
Business Unit Inorganic Pigments
Marunouchi Kitaguchi Building 23F
1-6-5, Marunouchi, Chiyoda-ku
Tokyo 100-8215
JAPAN
Tel.: +81 3 5293 8017
Fax: +81 3 5219 9776

**Great Britain**
LANXESS Ltd.
Colour Works
Lightfield Road
Branston
Burton-on-Trent
Staffordshire, DE14 3WH
UNITED KINGDOM
Tel.: +44 1283 714200
Fax: +44 1283 714201

**Brazil**
LANXESS Indústria de Produtos Químicos e Plásticos Ltda.
Av. Maria Coelho de Aguiar, 215 Bloco B - 2º Andar
05804-902 São Paulo
BRASIL
Tel.: +55 11 3741 2615
Fax: +55 11 3741 3933

**Italy**
LANXESS Srl.
Segrener Business Park, Palazzo Y
Via San Bovio n.1/3
20090 - Milano San Felice - Segrate
ITALY
Tel.: +39 0230722644
Fax: +39 0230724298

Health and safety information
Appropriate documentation was compiled with information on the health and safety measures that have to be observed in handling the LANXESS products mentioned in this brochure. For materials mentioned here that are not LANXESS products, the operational hygiene and other safety measures recommended by the respective manufacturers must be observed. Before working with these products, you must read and familiarise yourself with the available information on their dangers, proper use and handling. This point is of decisive importance.

Information is available in various forms: such as safety data sheets, product information and product labels. Please contact your LANXESS representative in Germany or the Department of Regulatory Affairs and Product Safety of LANXESS Deutschland. For business in the USA, please contact the LANXESS Product Safety and Regulatory Affairs Department in Pittsburgh, Pennsylvania.

Information on Regulatory Compliance
For some end use purposes of the products found in this brochure, the applicable regulations must be observed, including those of the FDA, BFR, NSF, USDA and CPSC. If you have any questions regarding the approval status of these products, please contact your representative at LANXESS Deutschland GmbH or the Department of Regulatory Affairs and Product Safety of LANXESS Deutschland GmbH or, for business in the USA, your representative at LANXESS Corporation, the LANXESS Regulatory Affairs Manager in Pittsburgh, Pennsylvania. How and for which purposes you utilise our products, our technical support and our information (oral, written or through product assessments) is beyond our control. The same applies for suggested formulations and recommendations. Therefore it is indispensable that you check our products, our technical support and our information for their suitability for the intended processes and purposes. The application-specific analysis must encompass at least suitability tests in regard to technical as well as health, safety and environmental aspects. Such testing has not necessarily been done by us. Unless agreed to otherwise in writing, all products are sold exclusively in accordance with our general terms and conditions for sale and delivery. Information and technical support are provided without warranty (we reserve the right to make changes at any time). It is expressly agreed that you release us from any possible liability resulting from the use of our products, technical support and information due to fault, contract or other reasons and that you assume this liability yourself.

Any statements and recommendations not contained in this brochure are not authorised and are not binding for you. None of the information in this brochure is to be interpreted as a recommendation to use the products in any way that violates commercial proprietary rights such as patents in regard to any materials or their use. Furthermore, neither explicitly nor implicitly is any licence granted under commercial proprietary rights such as patents.