

Color measurement for quality control in cement, concrete and building materials using Sensegood spectrophotometer

Concrete can take almost any form, texture, and color to enhance the appearance of a building and its functional structural requirements. It offers surfaces that range from smooth to rough and a spectrum of color that ranges from the icy blue of quartz through the delicate pastels to the deep reds of decorative aggregates.



Photo: Shades of gray cement

Rise of integrally colored concrete:

Architectural concrete refers to concrete which is permanently exposed to view while providing an aesthetic finish to the building and also serves a structural function.

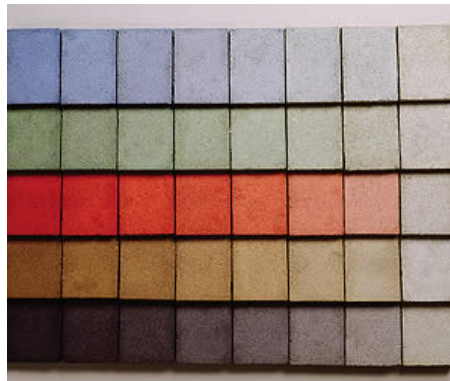


Photo: Choosing the right integrally colored concrete. Source: www.concretedecor.net

In above photo, the concrete samples show the impact of pigment dosage rates. The chips on the right are plain, uncolored concrete while the chips at the left are approaching the color saturation points of the pigments. Even low dosage rates can make a profound difference on the appearance of concrete and are an economical way to add value to decorative concrete. Concrete coloring with pigments is used in many different commercial and residential applications to create beautiful and unique surfaces.



Photo: Soccer City Stadium, Johannesburg; made of glass-fiber-reinforced concrete colored with Bayferrox pigments. Source: www.bayferrox.com

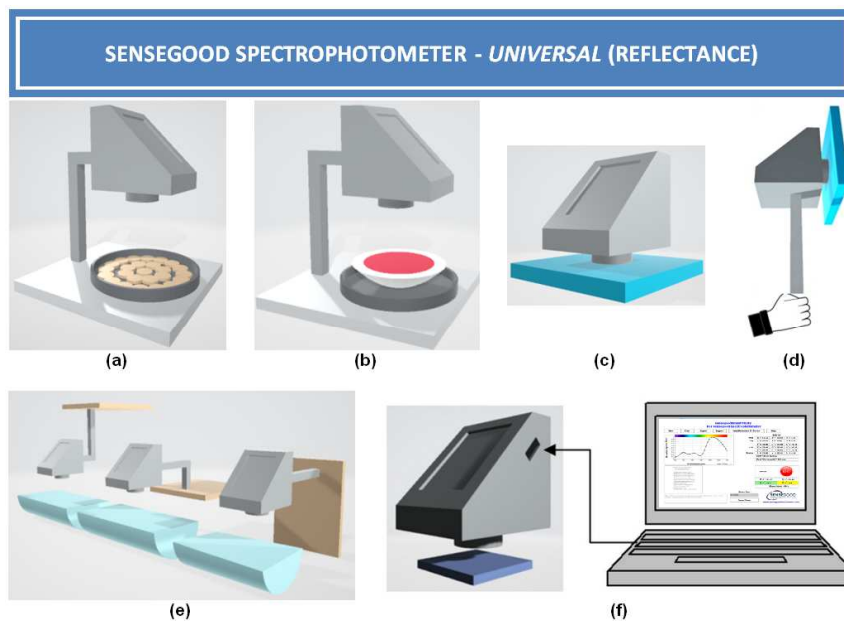
Nothing is more basic to architectural or decorative concrete than integrally colored concrete. In the early 1950s, the Davis Colors company introduced contractors in Southern California to the idea of adding synthetic iron oxide, at the time a waste product from chemical manufacturing, to their gray concrete mix. By adding this colored powder to traditional gray concrete, it became possible to achieve a wide range of earth tone colors.

Fast-forward fifty years, where in 2004 more than 204 million pounds of synthetic iron oxide were used to color cement-based products in North America alone. Decorative concrete is forecasted to continue to lead all other segments of concrete construction in growth well into the future. Since iron oxide pigments are used in most every decorative concrete product, and integrally colored concrete in itself is the largest decorative concrete market segment. [1]

“Right now, there’s a tremendous push from customers who want to add integral color to projects for the first time in a long time because of the exposure the industry is getting from these shows. People are adding integral color in residential projects as well as in more architectural buildings,” says Brian Raleigh, business and brand manager at Davis Colors. “The world has recognized that you can manipulate gray concrete and make it functional and beautiful if done correctly.” [2] As color is integral part, it won’t be affected by wear and tear. Also if there’s a chip or crack, there’ll still be color there.

Sensegood spectrophotometer in concrete color management:

Sensegood spectrophotometer has large viewing area due to which it can deliver accurate results. It is the versatile device that is engineered to work as handheld/portable, benchtop/table-top or in-process/online color measurement instrument. It has its own independent full spectrum LED light source which enables true object color measurement.



- ✓ Benchtop/ Tabletop: (a) (b) (Rotating sample platform)
- ✓ Handheld/ Portable: (c) (d)
- ✓ Online/ In-process: (e)

- ✓ Solid: (a) (c) (d) (e)
- ✓ Liquid: (b) (e)
- ✓ Paste: (b) (e)
- ✓ Powder: (a) (b) (e)

- ✓ Contact measurement: (c) (d)
- ✓ Non-contact measurement: (a) (b) (e) (Adjustable height)

- Works with:
- ✓ 5V adapter (cell phone charger)
- ✓ Power bank
- ✓ Computer/ Laptop (f)

- ✓ Averaging
- ✓ Auto repeat measurement mode
- ✓ Color match percentage
- ✓ Color indices (whiteness, yellowness, ...)

- ✓ *SensegoodSmart*
– computer interface software utility

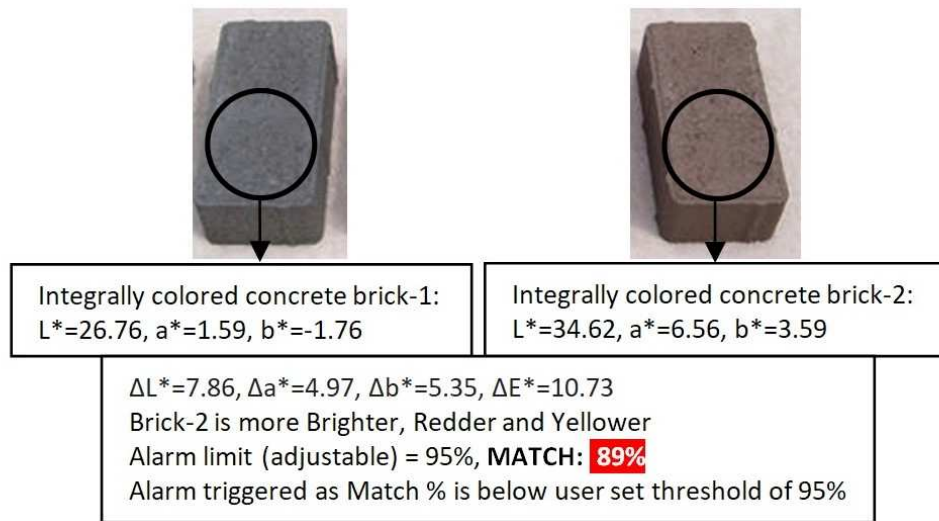
Photo: Sensegood spectrophotometer is a perfect color management solution for solid, liquid, paste and powder products. It can adapt various configurations to analyze color spectral distribution of concrete mix, cement slurry, integrally colored cement, and ingredients like sand and aggregate.

Gray base color of the concrete works along with the added color to form the final color we see. This is why colors (in gray cement) are all darker earth tone shades. To achieve lighter color shades, white cement can be used. Important consideration regarding gray cement is that they are not all the same shade of gray. Every cement, whether white or gray, has different inherent color tones as a result of slight differences in raw material ingredients and manufacturing processes. In a recent comparison study of Portland type I gray cement from multiple suppliers in Northern California, color ranged from almost white to battleship gray. [1] This reinforces the practice of maintaining batch-to-batch consistency to control these variables. Sensegood spectrophotometer assists architects, engineers, concrete ready mix suppliers and contractors to obtain consistent color results. It stands essential instrument in color quality control at all levels; from ensuring right colored ingredients in cement manufacturing to the consistently colored concrete mix.



Photo: Batch to batch quality and quantity of ingredients should be closely monitored and controlled to avoid such visible color difference. Source: www.concretenetwork.com

It is always desirable to ample test prior to pouring your entire concrete slab. You want to make sure the color matches your expectations. Experts use Sensegood spectrophotometer to measure color of the test sample and compare with the desired standard. This inherently boosts confidence and leads to assured success prior to job advancements.



Sensegood Spectrophotometer for color management and consistency control in concrete

Photo: Sensegood spectrophotometer assists by providing comprehensive color component information which can be used to control color quality at every stage; starting from ingredient selection to the last curing stage. Above photo shows two integrally colored concrete bricks. Brick-1 requires brightening agents and red-yellow pigments to achieve similar appearance that brick-2 has. Alarm limit is the color tolerance settable by user.

Further, curing is even more important in colored concrete because lack of curing produces inconsistent color. The use of a matching colored curing compound is always recommended when pouring colored concrete. Sensegood spectrophotometer assists in determining correct match.

Sensegood spectrophotometer for researcher community (concrete and construction industry in general):

Apart from industrial fraternity and archaeologists, Sensegood spectrophotometer is the accepted tool in researcher community to carry out various studies. Using CIELAB color space data produced by spectrophotometer, Spanish researchers successfully carried out early detection of greening of granite buildings. [3] The research has potential specifically in preventive conservation. While in concrete itself, the time dependent color variation is investigated and presented in a conference held at Ireland by group of researchers. [4] As environmental issues have become a topical subject in recent years, research groups are working toward sustainable green buildings. One of such research groups considered three waste materials, including wood chips, concrete, and waste newspaper, were mixed with gypsum and dissolved in thermo-

chromic material, which is made into bricks. The thermal radiation of sunlight can be absorbed by the bricks to change the hue. These allochroic bricks can be applied to the external walls of buildings, providing landscape, building, and interior designers with another media for artistic creation. [5] This may also help in maintaining indoor thermal comfort. Accurate color measurement is a fundamental feature for proper cultural heritage documentation, cataloging and preservation. Sensegood Spectrophotometer helps in accurately measuring and documenting our rich cultural history. Spectrophotometer is a tool to study the effects of temperature, humidity, pollution and other environmental parameters on change in building's appearance over time, for an example, the discoloration of the Taj Mahal due to particulate carbon and dust deposition. [6]

For manufacturers: cement, pigments, integrally colored cement:

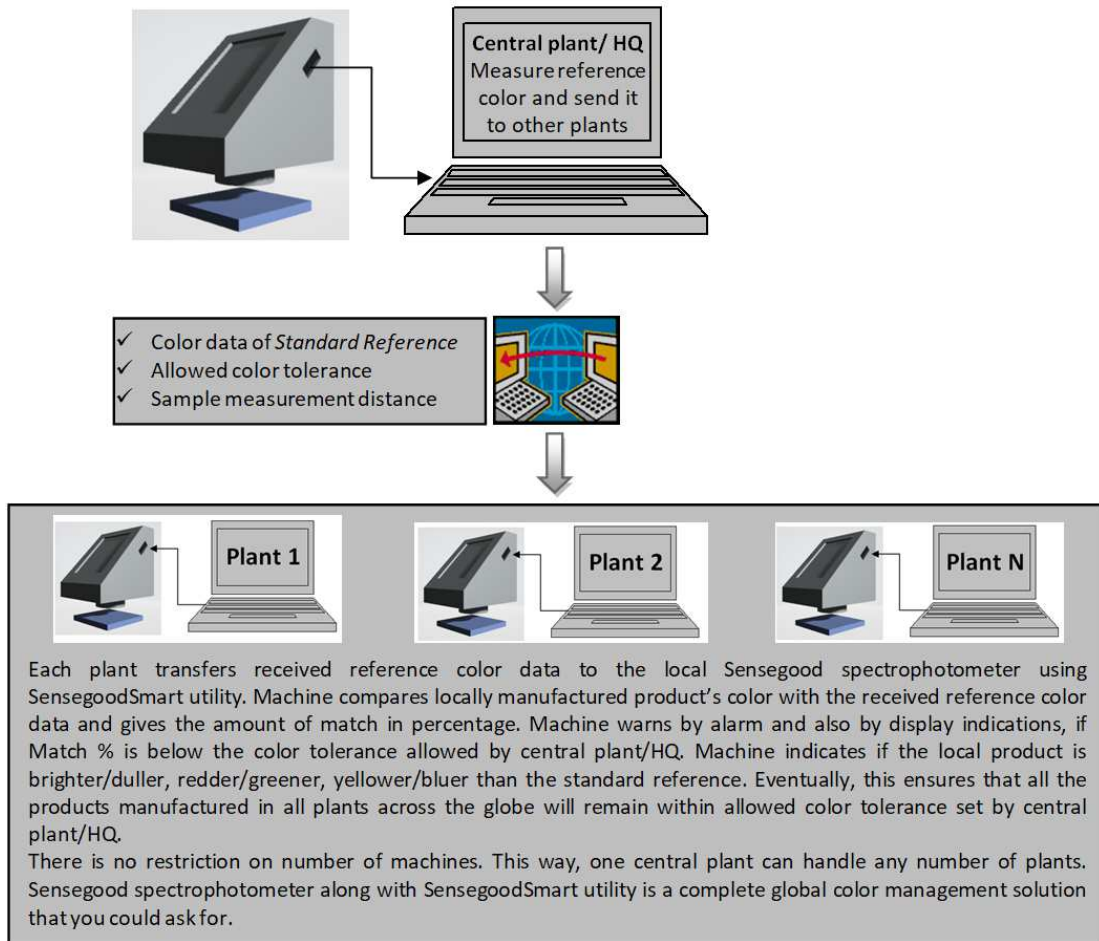


Photo: SensegoodSmart utility for color management across multiple production plants. Apart from this, SensegoodSmart utility enables user to store unlimited number of references to the computer. Any desired reference can be recalled and downloaded to Sensegood spectrophotometer whenever required. The utility provides all color related analytical information on single screen. This feature is even more desirable when using Sensegood spectrophotometer for in-process/online applications.

Sensegood spectrophotometer provides computer interface software *SensegoodSmart* which lets you to convey numeric color data across all production plants that may be located at multiple places across the globe. Each production plant uses Sensegood spectrophotometer to compare color attributes of the product manufactured in their plant with the numerical color information received from central plant or management. This enables them to reproduce each product consistently across all the plants.

References:

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- [2] The Inside Scoop on Integral Color for Concrete, by Erin Ansley, Jul 3, 2018, www.concretedecor.net
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- [5] Yuan-Hsiou Chang, Po-Hsien Huang, Bing-Yu Wu, Shang-Wen Changa, A study on the color change benefits of sustainable green building materials, Elsevier Journal of Construction and Building Materials, Volume 83, 15 May 2015, Pages 1-6. Available at: <https://doi.org/10.1016/j.conbuildmat.2015.02.065>
- [6] Bergin, Mike & Tripathi, Sachchida & Devi, J. Jai & Gupta, Tarun & McKenzie, Michael & Rana, K & Villalobos Igor, Ana & Schauer, James. (2014). The Discoloration of the Taj Mahal due to Particulate Carbon and Dust Deposition. Environmental Science & Technology. Available at: <https://doi.org/10.1021/es504005q>



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