

INFLUENCE OF PIGMENTS ON MECHANICAL PROPERTIES OF COLORED CONCRETE

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Abstract

Influence of pigments on mechanical properties of colored concrete is presented in this paper. The paper is focus on the issue of dosing a powder pigment in the form of iron oxide into a prefabricated dry concrete mixture and its effect on mechanical properties of mixture. Based on the performed experimental tests, it follows that the proportion of added pigment has a fundamental influence not only on the resulting color intensity of concrete, but also on its mechanical properties. The measured values of flexural and compressive strength show a significant decrease with increasing amount of pigment contained.

Materials

Seven concrete mixtures with different amounts of added pigment to the dry precast concrete mix were tested. The prefabricated mixture minimizes the influence of the composition and production of concrete on the measured properties and guarantees better objectivity of the results. Black and red iron oxide powder pigments were used as color additives. The reason for choosing these two pigments was that color of concrete to resemble the look of brick. So the concrete can then replace, for example, damaged parts of the historic masonry structure or only visually complement the building appearance. The pigment was dosed into the mixture in batches from 0.25 to 1.2 weight percent of the total weight of the dry concrete mixture. The water content of each mixture was adjusted according to the optimal consistency. The ratios of the individual components of the colored concrete mixture are shown in Table 1.

Measurement

The density, as a fundamental physical characteristic of the material, can be used also for calculation of other parameters. Especially bulk density ρ_b [kgm^{-3}] was determined on the vacuum saturation principle using Archimedes' weight.

The color intensity was measured using the Color-catch-nano tester, which indicates and measures RGB values. The RGB value is a composite image of three basic colors: Red-Green-Blue. Combination of these three colors will create a one unique color. Colorcatch Nano colorimeter accurately measures the color of smooth or textured surfaces by technology allows to measure 50,000 pixels separately. It has a built-in internal camera and light source, so the resulting data not affected by external light conditions. The comparison of the RGB color range depending on the amount of pigment added.

The mechanical parameters were tested according to the ČSN EN 196-1 standard. Compressive and flexural strength were determined. Samples with dimension of 40 x 40 x 160 mm were prepared for each measurement.

Conclusion

The article deals with the influence of admixture in form of colored pigment on the mechanical properties of concrete. The results show that with increasing amount of pigment there is a decrease of mechanical properties, both in the compressive and flexural strength. By adding approximately 1 wt % of pigment to the mixture, the strength is reduced by 50%. Therefore it can be said that in order to maintain good mechanical properties, the amount of pigment in the mixture is limited and the resulting concrete colors are recommended in lighter shades.

When comparing RGB scanning values taken from the sample surface, different colors were measured. However, when visually comparing the appearance of the sample, there is no obvious difference in the samples, where the amount of pigment varies in the order of tenth wt%.

In order to design buildings made of richly colored exposed concrete, it is therefore necessary to replace the normal concrete mixture to ultra-high performance concrete, denote as UHPC. UHPCs are mixtures that are defined by high values of mechanical properties. By designing the appearance of resulting structure, it is necessary to take into account the specific color of the pigment, because different kinds can affect the resulting properties differently.

Acknowledgements

This work was supported by the Grant Agency of the Czech Technical University in Prague, grant No. SGS18/198/OHK1/3T/15

Tab. 1: Composition of the concrete mixtures

Composition [g]	3E	3EI	3EII	3EIII	3EIV	3EV	3EVI
Dry mixture of concrete	1000	1000	1000	1000	1000	1000	1000
Pigment Red	1	3	4	5	5	5	6
Pigment Black	1.5	3	4	5	6	7	6
[%] by weight of the total amount of dry mixture	0,25	0,6	0,8	1,0	1,1	1,2	1,2
Water	160	170	170	175	175	180	180

Tab. 2: Basic physical properties of colored concrete

Sample	Bulk density [kg.m^{-3}]	Flexural strength [MPa]	Compressive strength [MPa]
3E	2006	8,0	40,7
3EI	2062	6,2	32,1
3EII	2024	4,8	28,7
3EIII	1997	4,5	23,1
3EIV	1943	6,5	22,6
3EV	1955	6,1	23,0
3EVI	1913	5,9	21,6

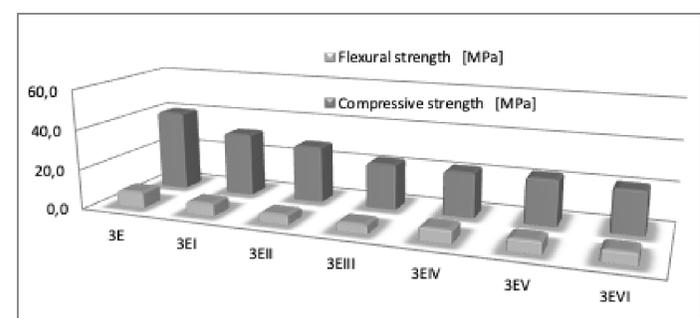


Fig. 1: Mechanical properties [MPa]



Fig. 2: Samples

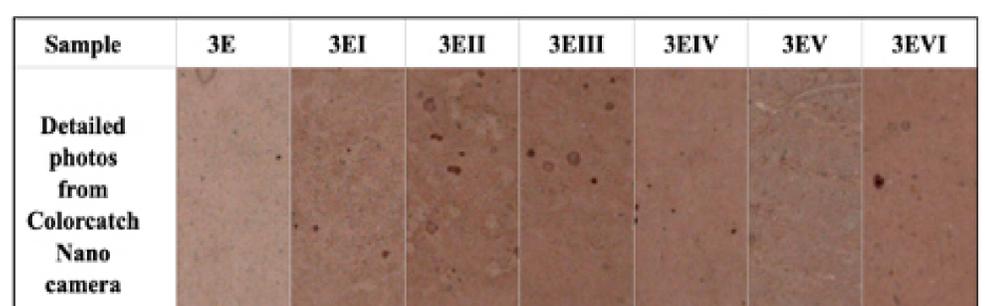


Fig. 3: Visual measurement of colored concrete surface