**A Review on decorative cement**

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***Abstract:*** In this research, a group of the most important researches related to the cement used for decorative purposes, which is colored cement, which is the main material in the production of colored concrete, was reviewed. It has been concluded that the use of inorganic pigments is better than natural pigment, the percentage of inorganic pigment powders must not exceed 2% wt. of cement, because the pigment's particle size is smaller than that of cement, it tends to decrease the workability of concrete and mortar. In some applications we need to improve workability, in these cases may be adding superplasticizer and the percentage of pigments in the liquid state cannot be determined because they depend on several variables.

Keywords: decorative cement, colored cement, colored concrete, pigment.

**1-Introduction:**

Concrete in which colored cement is used as a binding material is called colored concrete [1]. Colored cement or decorative cement are prepared by adding coloring pigment to white Portland cement [2].

Decorative cement was first developed in the early 1950s. When iron oxide has been suggested, it was added to the gray concrete mix by Davis engineers in California using a waste product from chemical industry. The standard gray concrete could be dyed in a variety of earth colors by mixing in such colored powder. In the last six decades, cement coloring has expanded quickly; in the year 2004, no less than 204 million pounds of iron oxide were utilized to color cement-based products as a staple in North America alone [3].

**2-Literature Review:**

* G. H. Rowe and S. M. Bruce have conducted research in 1992. The concrete block paving industry frequently uses the fundamental properties of 9 pigments (black two, Marigold, light brown, dark brown, yellow, and red "three sorts"). Each pigment's characteristics of water consumption are obviously influenced by its shape and particle size. All pigment are much finer than cement and when added at a 2% dose rate (depending on the cement block), there is a significant decrease in operability compared with mixed control. The pigments identified as containing longitudinal particles with high surface area (marigold and yellow) show a relatively high demand for water, which reduces their workability when tested at a constant rate of percentage. Pigments made of spherical particles have a lower demand on water than long molecules. Softness in terms of the specific surface is the most useful guide to water demand in these pigments. Adding pigment with high water demand reduces the relative ease of this operability. If water is added to the mix to maintain operability, the subsequent increase in w/c ratio will reduce durability with potential reduction in performance parameters such as physical and chemical weathering and corrosion resistance [4].
* L. Hyun-soo et al. investigated how iron oxide pigments affected the characteristics regarding concrete interlocking blocks in 2003. They presented the details of the experimental results and pointed to the flourishing of the interlocking concrete blocks pigmented and found that the interlocking blocks mixed with iron oxide pigments gained a higher color strength than those found in brown iron oxide because iron oxide pigments are finer compared to the other. A unique correlation between the absorption ratio as well as the bending strength regarding pigmented blocks was discovered through additional study. They discovered that the pigment to cement proportion must not be more than 4% when using iron oxide pigments to create colorful concrete interlocking blocks [5].
* D. F. Lin and H. L. Luo investigated how the surface color regarding mortar samples made of sludge ash changed at various temperatures in 2007. Additionally, the impact of temperature on variations in the mortar surface's color was investigated. Three distinct sewage sludge ash percentages (10, 20, and 30%) as well as six various temperatures (25, 200, 400, 600, 800, and 1000 ° C) are used to compensate for certain cement percentages, which are after that adjusted. The findings show that the surface color change is significantly influenced by the addition of sludge ash to mortar. Ash additions lessen the intensity of blue, red, and green. The presented work demonstrates how the use of grayscale might be crucial for evaluating high-temperature fires [6].
* The impacts of adding 5 types of inorganic pigments (iron oxide red, iron oxide yellow, chromium oxide green, iron oxide black, and ultramarine blue) to architectural self-compacting concrete were researched by Sungur and Karaguler in 2007. The main results of experimental work are the red concrete has largest value of water absorption while the lowest value appears with green concrete, at 28 day compressive strength of blue, yellow and black pigment-doped mixture is reduction (18%, 11% and 8%) respectively while red and green are not noted reduction in compressive strength. The flexural values at 28 day have no much effect [7].
* The idea of creating colored structural concrete and colored floor tiles, bricks, and precast concrete products was investigated by B. Alkharabsheh and M. Reshedat in 2007. Zercon Sand, Red Zeolitic Tuff, Black Zeolitic Tuff, Red & Black Zeolitic Tuff, Lime "by product," and Bentonite with particle size of (45) μm have been utilized as processed natural and locally accessible raw materials, with the exception of red Zeolitic Tuff pigment (45 and 500 μm, to add to white cement. The experimental investigation has been concentrated on two separate goals: the color of concrete and the strength of concrete that was intended to be utilized as structural concrete. Thus, using the traditional testing methods for flexure, compression, direct tension, splitting, and direct shear, the features regarding the generated colored concrete were characterized. The results regarding each test will have specification limitations of (ASTM C-979), Additionally, the bonding between the colored paste and aggregates was examined in the microstructure regarding concrete created in this study with the use of XRD and SEM analysis [8].
* In 2008, G.Juan et al. examined the performance of colored white cement with blue pigment. Performance is illustrated by the metal changes that occur in the replacement of cement by 5, 10, 15 and 20%. Concrete and mortars were produced to be studied to 3, 7, 28 and 90 days of the curing. The pigment which is suitable for C3A of cement and water, and was found to allow large amounts of initial exchange (irregular and dispersed in the matrix) to be produced, because of its sulfur content. It means an increase in the mechanical strength of the cement blended with the ultramarine blue pigment by up to 45% to 90 days of curing [9].
* With the use of earthenware powder, M. Inoue et al. (2008) investigated the mechanical characteristics and assessed the color related to colored concrete. Thus, as the ratio regarding earthenware powder replacement rose, the strength of concrete and coloring effect also improved [10].
* In 2009, A. Lopez et al. has examined the advantages of using colored self-compacting concrete (C-SCC) mortar-based mixture design methodology. In the case when cement mortar is utilized, there is a possibility for observing the impact of pigments on C-SCC viscosity as well as evaluating certain aspects like color homogeneity, color parameters, and surface finishing along with quickly and easily identifying mixtures, including rapid types of cements, mineral additives, chemical additives, and pigments [11].
* In the year 2012, Mohammed Ali Abdulrehman et al. concentrated on examining how the environment affected a few physical and mechanical characteristics regarding colored concrete; pigments are sold locally and are also imported from countries other than Iraq. Through testing specimens for modulus of rupture, compressive strength, and water absorption under varying situations including acidic medium, high temperatures, rain, the experimental study has addressed a few physical and mechanical aspects of concrete. Also, the researchers found that for all used colors (Yellow, Red and Black), it has been found that 2% of pigment give the best properties of colored concrete (compressive strength, modulus of rupture and absorption water), however, 1% of pigment in black colored concrete gives the best properties than other percentage of black colored concrete but this percentage makes the concrete appear with gray color and this color can be achieved without using any pigment, which is the normal color of Portland cement [12].
* With studying the pigments in liquid case with fly ash  (the second alternative), V. Hospodarova et al. (2015) investigated a few of the mechanical and physical features regarding pigment compounds (in liquid case) in the first alternative. The water absorption, density, and compressive strength related to concrete compounds were a few of the significant materials' attributes that were examined. The results indicated that pigments can reduce the density, increase the water absorption by a slight increase of 1% and increase the strength in compressive up to 20%. Addition of fly ash to the mixture can reduce the density, increase the absorption of water slightly, as the compressive strength is slightly lower compared to the reference sample. The mixture, which contains fly ash and pigment is capable of attaining compressive strength at the comparative reference sample level (27.64 MPa). From the results obtained, the use of pigment in concrete does not have a negative impact on physical properties and strength regarding the concrete [13].

**3-Conclusion:**

1. The use of inorganic pigments is better than natural pigment.
2. The percentage of inorganic pigment powders must be not exceed 2% wt. of cement.
3. The pigment’s particle size is finer compared to the particle size of cement and that tends to reduce the workability of mortar and concrete.
4. In some applications we need improve workability, in this cases may be adding super plasticizer.
5. The percentage of pigments in the liquid state cannot be determined because they depend on several variables.

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**مراجعة عن السمنت المستعمل لأغراض الديكورات**

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**الخلاصة:** في هذا البحث ، تمت مراجعة مجموعة من أهم الأبحاث المتعلقة بالإسمنت المستخدم لأغراض الديكور ، وهو الأسمنت الملون ، والذي يعد المادة الرئيسية في إنتاج الخرسانة الملونة. لقد استنتج أن استخدام الخضاب غير العضوية أفضل من الخضاب الطبيعي ، يجب ألا تتجاوز نسبة مساحيق الخضاب الغير العضوية 2٪ نسبة وزنية للإسمنت ، يكون الحجم الحبيبي للخضاب أدق (انعم) من الحجم الحبيبي للأسمنت والذي يميل إلى تقليل قابلية التشغيل للمونة والخرسانة والخرسانة ، وفي بعض التطبيقات نحتاج إلى تحسين قابلية التشغيل ، في هذه الحالات قد تضيف الملدن الفائق وأما النسبة المئوية للأصباغ في الحالة السائلة لا يمكن تحديدها لأنها تعتمد على العديد من المتغيرات.

الكلمات الدلالية: السمنت المستخدم لأغراض الديكورات ، السمنت الملون ، الخرسانة الملونة ، الخضاب.