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MICHIGAN  
STATE HIGHWAY DEPARTMENT  
G. Donald Kennedy  
State Highway Commissioner

COLOR TREATMENT  
OF  
CONCRETE PAVEMENTS  
FOR CAMOUFLAGE PURPOSES

By  
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MICHIGAN  
STATE HIGHWAY DEPARTMENT

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G. DONALD KENNEDY  
State Highway Commissioner

INTRA-DEPARTMENT COMMUNICATION

TO: Mr. H. C. Coons

DATE: July 7, 1942

FROM: Mr. W. W. McLaughlin

SUBJECT: Coloring of Concrete Pavement at Willow Run Bomber Plant

This is in reply to your request of June 25th, relative to a letter from H.B. Hanson, Power and Construction Engineer of the Ford Motor Company to Commissioner G. Donald Kennedy, dated June 22nd, concerning the practicability of coloring concrete pavement slabs during construction for camouflage purposes at the Willow Run Bomber Plant. It is inferred from the letter that Mr. Hanson means the pavement slabs being constructed under the jurisdiction of the State Highway Department.

Portland cement concrete can be somewhat permanently colored successfully at the time of placing by any one of the following methods, integrally combining the color pigment with cement-sand and aggregates at the time of mixing, or by dusting onto the surface of the finished concrete a mixture of color pigment and cement which is troweled into the surface of the fresh concrete, or by applying the color pigment itself directly to the roughened concrete surface after which the concrete must be thoroughly troweled to combine the color with the fresh concrete. These three methods just mentioned, as well as different treatments for coloring hardened concrete are explained in detail in the attached resume on colored concrete.

From the standpoint of the Highway Department in specifying that color pigment be added to the concrete mixture during casting, that is a matter of routine procedure since colored concrete has been specified on certain parts of the various projects in the Bomber Plant area for ramps and directing traffic flow. As for the contractor, he should be able to adjust his personnel and equipment for the use of color pigment without much more effort than if he were required to use any one of the conventional types of admixtures except perhaps in the case where the color material is to be troweled in. In that event more labor is involved.

However, it was believed desirable to contact the proper officials of the Ford Motor Company, as well as the U. S. Army Engineers, pending final decision relative to this matter.

Consequently, on July 3rd, a meeting was held in Mr. Hanson's office at the Ford Motor Company, for the purpose of discussing further the practicability of coloring the pavement slabs during construction as referred to in Mr. Hanson's letter of June 22nd. This meeting was attended by Messrs. Kruger, Osgood, and E. T. Gregorie of the Ford Motor Company, Lieut. C. B. Spencer of the Air Plant Protection Corp., U. S. Army and E. A. Finney of the Highway Department

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It was the unanimous opinion of the group that it would be impractical for the Highway Department to specify that color pigment be added to the balance of the concrete pavement operations at the Willow Run Bomber Plant project.

The salient reasons for this opinion are as follows:

1. At the present time, the work has progressed to a stage that very little good could be accomplished from the standpoint of camouflage by permanently coloring the concrete. In fact, it might be undesirable from the standpoint of the final appearance of the project to have sections of natural color and colored areas of pavement in the same vicinity.
2. The camouflage division of the U. S. Army Engineering have studied the camouflage problem thoroughly and they have made suggestions as to materials, equipment and methods of adopting camouflage principles to such areas. They suggest the application of temporary colored surface treatments at a cost which is very little as compared with the cost involved in adding color pigments to the concrete. In addition, the method of applying surface treatments for color is very versatile in that it may be applied with considerable speed, the color may be changed to match the predominant colors prevailing at the different seasons of the year, and it may be used in blending the appearance of existing structures, landscapes, etc. into some desired pattern for the general purpose of confusing the enemy.
3. From the standpoint of aviation during peacetime, it is important to have the colored concrete surfaces restored to original color since they have a definite purpose in serving as guides and orientation objects for aviators. The army stressed that point because they are looking ahead to the readjustment of such units as the Willow Run Bomber Plant into peacetime occupation during the post-war period.
4. The point was mentioned by Lt. Spencer that in the case of an area designated as being critical by the Army Officials at Washington, such as the east and west coast areas, complete camouflage is usually considered necessary whereas in a location such as the Bomber Plant which has not been designated as a critical area as yet, it is only considered necessary to be in position to apply quickly those camouflage methods which will tend to confuse the enemy bombardiers. Such methods as temporary coloring the existing road surfaces, fog or smoke screens to conceal structures and disguising certain objects will usually suffice.

In critical areas a permanent color scheme is usually worked out that will harmonize with the operations of the plant during war time as well as peace time in which case the color is considered as part of the original project and is included accordingly. It is the Army's intent in all cases, to reduce the cost of camouflage operations as much as possible to the manufacturers.

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It was apparent from the conversation during the meeting that no general camouflage plan had up to the time of the meeting been worked out for the Bomber Plant. However, the exchange of ideas at the meeting did seem to produce the needed spark to set the wheels in motion and consequently, the Ford Motor Company are preparing, with the aid of the proper Army personnel, definite plans to take care of the situation immediately.

W. W. McLaughlin  
Testing and Research Engineers

WWM: EAF: MB

COLOR TREATMENT OF CONCRETE PAVEMENTS  
FOR  
CAMOUFLAGE PURPOSES

Portland cement concrete may be colored by any one of the five following methods, namely; the integral mix method, the dust-on method, the mixed-in-place method, by the application of stain to the surface or by an application of some type of colored surface treatment material such as specially prepared concrete paints. The proper method to employ on any given project will naturally depend upon such factors as intended purpose, expected intensity, permanency of color and funds available.

The Integral Mix Method

The integral mix method consists of combining the cement-color, sand and coarse aggregate integrally in a suitable mixer and applying the mixture as a separate top course at a specified depth. The thickness of color section recommended by the Portland Cement Association for concrete pavements is 2 inches.

The amount of pigment needed for the desired shade is determined in advance by trial, with the cement and aggregates that will be used in the work. From 2 to 4 pounds of color pigment is commonly used for 1 sack of cement. However, amounts of color pigment up to 10 percent the weight of cement may be used without detrimental effect.

Only commercially pure mineral pigments made expressly for coloring concrete and guaranteed by the manufacturer should be used. These colors should be subfast and limefast. Prices for color pigments vary from 18¢

to 60¢ in 100 pound lots depending upon the color desired. Current prices are as follows in 100 pound lots:

Yellow, iron oxide	50¢ per pound
Red, iron oxide	18¢ per pound
Brown, iron oxide	40¢ per pound
Green, oxide of chromium	60¢ per pound
Black, iron oxide	50¢ per pound
Blue, ultramarine blue	50¢ per pound

The cost per square yard of finished surface by the integral method will be quite expensive. The color pigment alone applied at the rate of 4 pounds per sack of cement will average 1.2 pounds of pigment per square yard of surface. The fact that two course construction must be employed will increase the labor cost per square yard over that of one course construction.

Recently, a new product has been introduced for obtaining black or gray concrete surfaces. The coloring agent is generally known as emulsified carbon black and is procurable from several pigment manufacturers under their respective trade names. The material comes in liquid form, weighing about 10 pounds per gallon. 3 to 4 pounds of the liquid are usually specified per sack of cement. The cost per pound is approximately 7¢, f.o.b. factory.

This material has been used quite successfully on different projects in Michigan for traffic strips and specially colored traffic lanes for division of traffic.

### The Dust-On Method

The dust-on method refers to dusting a dry mixture of color pigment and cement on to the surface of the finished concrete and troweling it into the concrete.

Dusting the color on to the surface gives deep colors with less pigment than would be required if it were admixed. The cement and color are intimately mixed dry using up to 15 pounds of color per sack of cement. The colored cement is then mixed with sand in the proportion of 1 sack of cement to 125 pounds of sand.

As soon as the concrete is finished, the colored cement-sand mixture is dusted evenly over it to a depth of 1/8 inch and floated until it becomes a part of the concrete beneath. It is then cured in the usual manner. The above mixture of color-pigment and sand on a basis of 1 sack of cement will cover approximately 22 square yards of pavement surface. At 50¢ per pound for color pigment the cost per square yard for materials will be approximately 37¢.

### Mixed-In-Place Method

The method consists of scratching or raking the fresh concrete to a depth of 3/8 inch and applying the color pigment dry as a powder. The pigment is spread with a brush and then rubbed into the concrete with a wood hand float. The pavement is cured in the ordinary manner.

This method has been used quite successfully by the Texas Highway Department in the construction of colored traffic strips. They use 2 pounds of color per 5 to 6 square yards of pavement surface.

At 50¢ per pound for color pigment the cost per square yard of treated surface for materials alone would be 15-20¢.

This method is not inductive to uniform results because of the difficulty in obtaining uniform distribution of the pigment throughout the surface. Consequently, there will exist areas in which the color pigment may be highly concentrated or very sparse.

The Staining Method

This method consists of applying to the prepared concrete surface a stain material which will combine chemically with the cement paste to produce a color effect of desired intensity and durability.

These stains may be applied to the concrete surface when fresh, or at any time after the concrete has set up.

At the present time concrete stain materials may be obtained from several firms specializing in concrete products. The Truscon Laboratories in Detroit are in position to furnish water soluble salts for staining concrete at a cost of \$1.00 to \$1.25 per gallon. A gallon will cover 100-200 square feet depending upon the intensity of color desired. Cost per square yard of surface 5-10¢. This cost would drop in large quantities.

The A.C. Horn Company, of Long Island City, New York, have a stain which costs 13-27¢ per square yard. They have developed this material in collaboration with the Army Engineers especially for camouflage work. In this connection, it is understood that they have treated at least 40 airport runways located along the eastern seaboard near Boston. The Army Engineers seemed to be satisfied with the use of the stain for camouflage purposes.

Surface Treatments

This method consists of painting the existing concrete surfaces with some suitable type of material which will adhere to the concrete and produce, at least temporarily, the desired results.



Paints applied to such surfaces are subjected to severe weathering conditions as well as wear and tear and the durability is dependent upon the binder employed.

The A.C. Horn Company state that they have a cement base paint for surface treatments which costs between 4-7¢ per square yard. They have 4 airports treated with this material in the east under surveillance of the Army Engineers.

It was learned from the U.S. Army Engineers that they are suggesting temporary color surface treatments since they are more versatile in their adaptation to camouflage principles, as well as the cost of such products is materially less than certain other treatments. They suggest the use of cold water paints such as kalsomine, casein base paints or mixtures of ferrous oxides, lime and water. Even ordinary white wash is effective where white surfaces are desired.

The materials are procured in powder form in large quantities at approximately \$10 per 100 pounds. They are readily mixed in cold water and the paint mixture can be applied rapidly over large areas by means of standard water spraying equipment. The cost per square yard of such treatments will be in the neighborhood of 2-3¢ per square yard or even less.