Road Tests of Traffic Paints

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SYNOPSIS

THROUGH the cooperation of the Pennsylvania Department of Highways, the Titanium Pigment Corporation has made road tests of new traffic paints. Some of the results of these tests are presented in this paper.

Road testing of traffic paints is important as there are no laboratory techniques or tests which will give quick, accurate durability evaluations of the paints.

Early tests indicated that it was possible to use the calcium sulfate extended rutile titanium pigment in a traffic paint without sacrificing durability. Tests were continued with this pigment as it was one of the most economical methods of introducing hiding into the paint.

Results are given showing that the alkyd-type vehicle is preferable for traffic paints of better than average durability. Formulation changes produce distinct variations in durability even in an alkyd vehicle.

The road tests have shown the versatility of the alkyd type traffic paint. There are indications that this type of paint might be used as an all-purpose paint on all highways, either with or without reflectorizing beads.

ABOUT 5 years ago, the Pennsylvania Department of Highways and the Technical Service Department of the Titanium Pigment Corporation started a cooperative study of traffic paints. When the test program started, the objective was to improve the durability of traffic paints. As the work progressed, a more definite aim was established. The test work was directed toward formulating a traffic-marking paint which would serve as a bead binder as well as an unbeaded paint for use on all types of surfaces. It was realized that such a multipurpose paint would require compromises, particularly with respect to drying time and, perhaps, bleeding over bituminous surfaces. However, it was resolved to try to keep these compromises to a minimum.

In the early work, along with the problem of improving the durability of traffic paints, it was hoped that some laboratory method could be found to predict durability. It was recognized that the road application of traffic paints for test purposes has been, by necessity, a time-consuming and cumbersome operation. The length of time before results become known is often too long. Yet, in spite of this, road testing appears to be necessary. Many tests have been devised by various highway departments throughout the country to give a rapid evaluation of a traffic paint. In certain cases, it appears that these tests might be adequate within certain limitations. For example, a flexibility test might properly evaluate a sample of traffic paint, providing all the samples had relatively the same vehicle and similar pigmentation. Likewise, some type of wheel designed to exert wear upon samples of traffic paint might give a fair evaluation of durability. But once again, the limitations appeared to be that the paints must be very similar in nature to make the evaluation valid. These conclusions were borne out by the comparisons of road tests with various laboratory evaluations. The conclusion has been reached that so far no laboratory method has been devised to properly evaluate the durability of traffic paints of varied composition. Until such a time that an adequate test procedure is devised, road testing will continue to be important.

It is quite apparent that road testing cannot be classed as an exact procedure. The variety of surfaces to which the paints are applied, the differences in weather conditions during application, and the amount of traffic over the surfaces on which the paints are applied prevent exact

TABLE 1

Pigmentation 50% Titanium Pigment-20% ZnO-15% Mg Sil-15% Pumice
50% Pigment Volume

Vehicle: Oleoresinous varnish - 15 gal. oil length

	DURABILITY[a]						
	TRANSVERSE LINE			LONGITUDINAL LINE			
Length of exposure (Mos.)	2	4	6	4	6	8	10
Titanium Pigment							
Titanium-Barium Pigment	8	7	4	9	7	5	4
Rutile Titanium-Calcium Pigment	8	6+	4	9	7	5+	4

[a]Durability is expressed in numbers 0 to 10 indicating the percentage of line remaining on the road. 10 equals 100%, 8 equals 80%, etc.

results from being obtained from any one set of road tests. The Pennsylvania Department of Highways has made a big contribution in devising a procedure for applying test paints to the road. The procedure has been described previously in a paper by Custer and Zimmermann (1). Essentially, with this procedure, the film thickness of the paints is closely controlled. This method helps to eliminate any differences in results which might develop due to variations in paint consistencies. Thus, results obtained may be attributed to changes in pigmentation or vehicle composition. Nevertheless, the results presented should be viewed as being as reliable as possible within the limitations of road testing.

In the early traffic paints, titanium-barium pigment and lithopone were used to produce the necessary hiding. Perhaps in a few instances pure titanium dioxide was used. However, the titanium-barium pigment was by far the most popular pigment in use. Eventually, for economic reasons, the manufacture of titanium-barium pigment was discontinued. A newer pigment, rutile titanium-calcium pigment was produced and suggested as a replacement for the titanium-barium pigment. There was a reluctance on the part of many paint manufacturers, as well as state highway departments, to use or specify this rutile titanium-calcium pigment in traffic paints. The fact that this pigment is extended with calcium sulfate which has some water solubility, has been a deterring factor in its acceptance for use in traffic paints. Yet, an examination of published tables shows that the water solubility of pure calcium sulfate is relatively small. This low water-solubility factor, coupled with the fact that this pigment would be used in a water-resistant binder, indicates that there should be little fear that the calcium-sulfate-extended pigment would degrade materially the durability of traffic paints. Repeated road tests have demonstrated quite clearly that the rutile titanium-calcium pigment may be used to produce high-hiding, white traffic paints having excellent durability.

In 1947 there were a number of test comparisons made of the rutile titanium-calcium pigment with the anatase titanium-barium pigment. All the comparisons indicated that a replacement of titanium-barium pigment by rutile titanium-calcium pigment would be satisfactory from a durability standpoint.

The results expressed in Table 1 illustrate that, in this particular formula, rutile titanium-calcium pigment may be used in place of titanium-barium pigment without effecting adversely the durability. This substitution is just one example of the comparisons made. Results of comparisons of the rutile titanium-calcium pigment with other hiding pigments have been reported previously (1). The results indicated that this rutile titanium-calcium pigment may be used to produce a durable, white traffic paint.

It was quickly apparent, from early road tests, that while the pigmentation of a traffic paint was important, the vehicle was of even greater importance. The vehicle of a traffic paint should bind the pigments together properly, adhere to a variety of surfaces, be resistant to alkali and moisture, and have the ability to dry quickly under various atmospheric conditions. Of all the qualifications of a good traffic paint, probably the greatest stress was laid on the drying time. The demand for fast-drying traffic paints brought about the use of paint with very limited durability. The quick-drying types of paints usually fail rather early by scaling and flaking. In addition to this, their brittleness made them inefficient as bead binders. The beading of these fast-drying types of traffic paint caused even larger areas of the film to lose adhesion. Fortunately, as shown in a recent survey (2), the importance of service life has taken preference over the requirement for drying time. With less emphasis placed on quick drying by the various state highway departments, it is considerably easier to formulate a good durable traffic paint.

As the test program progressed, the search for a more-durable traffic paint continued. The emphasis was not on the pigmentation but on the type of vehicle. The results of one group of tests, for example, gave every indication that the alkyd-type vehicle was superior in durability to the oleoresinous type.

These three types of paints were also used as bead binders. In our test work, the usual procedure is to put down the longitudinal traffic line (parallel to the flow of traffic) about 70 to 80 ft. in length. The first half of this line is applied without beads either in the paint or applied on top. The second half is applied with beads added to the top of the paint in the normal manner. In this manner, there are two tests for each paint.

In testing the paints in Table 2 as bead binders, the alkyd-type traffic paints once again proved to have superior durability. In this case, as in almost all other cases, the reflectorized paints had approximately twice the life of the same paints unbeaded.

Using different rutile titanium-calcium and titanium-dioxide pigmentations in each of the three vehicles mentioned in Table 2, the alkyd vehicle again produced the most-durable traffic line. It did not matter whether it was beaded or used without beads, it was still the most durable traffic paint.

The alkyd vehicle has many points in its favor for use in a traffic paint. It has good adhesion to nearly all surfaces used in road construction. It has good water and alkali resistance and good flexibility. Its abrasion resistance, once it has dried thoroughly, is good. However, it appears to have one major fault: It does not dry with the speed that is generally specified by the various state highway departments. In addition to this,

TABLE 2

Pigmentation: 50% Rutile titanium calcium pigment-20% ZnO-15% Mg Sil-15 % Pumice 50% Pigment Volume

	DURABILITY						
	TRANSVERSE LINE			LONGITUDINAL LINE			
Length of exposure (Mos.)	2	4	6	4	6	8	10
Vehicles							
15 gal. oil length oleoresinous var.	7	5	4	8	7	6	4
20 gal. oil length oleoresinous var.	8	6	4	8	7	6	5
Medium oil length alkyd	9	8	6	9	8	8	7

Pigmentation: 16.5% Titanium Dioxide-20% ZnO-48% Mg Sil-15% Pumice 50% Pigment Volume

	DURABILITY						
	TRANSVERSE LINE			LONGITUDINAL LINE			
Length of exposure (Mos.)	2	4	6	4	6	8	10
Vehicles							
15 gal. oil length oleoresinous var.	6	4	3	7	6	4	2
20 gal. oil length oleoresinous var.	8	6	4	8	7	5	4
Medium oil length alkyd	9	7	5	9	9	8	7

due to its slow setup (or tack-free time) it discolors considerably when applied over asphalt or tar surfaces. This slow setup allows the thinners remaining in the paint to act on the bituminous surface, dissolving the bitumens and causing discoloration.

In order to overcome this deficiency in alkyd traffic paint, other paints which had good records for no bleeding on bituminous surfaces were re-examined. It was found that such paints took advantage of fast-evaporating, low-solvency thinners to prevent or to minimize bleeding. Several combinations of such thinners in various concentrations were tried with the alkyd vehicle. Finally, it was found that a medium oil length alkyd, based on either soya or linseed oil, might be used satisfactorily in a traffic paint for use on bituminous roads if that alkyd were cut to 50 percent solids in V. M. and P. naphtha (initial boiling point 190 to 225 F.) instead of the usual mineral spirits, (initial boiling point 300 F.). A paint such as this still showed some discoloration, particularly when the rest of the thinner used in the paint was mineral spirits. The use of common-type mineral spirits for the thinner in an alkyd type traffic paint makes the setup time much too slow. However, it was found that if the paint was made with an alkyd cut in V. M. and P. naphtha and thinned to the proper consistency with a fast-evaporating, low-solvency thinner, such as textile spirits or rubber solvent (Initial Boiling Point 110 to 150 F.), discoloration was held to a minimum. This alkyd traffic paint, using the lower solvency thinner, has been tested on tar, bituminous-concrete, and cement-concrete roads. The durability has been excellent. The resistance to bleeding, when it was applied on bituminous concrete roads, has been good. Some bleeding was observed when the paint was used on a tar road. Nevertheless, there is still good contrast during the daytime between the line and the tar road. Under no circumstances did the discoloration of the line from any source effect the night visibility of this paint.

It has been found that the alkyd traffic paint, using the proper thinners, is satisfactory for use on bituminous-concrete and cement-concrete roads without the use of beads. The same paint may be used on any type surface as a reflectorized paint, giving excellent durability and excellent night visibility.

Once it had been found that the alkyd vehicle would produce a durable traffic paint, the pigmentation was again examined to determine a suitable combination of pigments. Since it had been determined in the early test work that no harm would result from the use of rutile titanium-calcium pigment as the hiding pigment, its use was adopted in the alkyd paint. A titanium-dioxide pigmentation was not selected for economical reasons. Traffic paints are generally formulated as flat paints or as paints having a high pigment volume concentration. In this range of pigment-volume concentration, the rutile titanium-calcium pigment produces more hiding per pound of pigment at less cost than other hiding pigment combinations. It will produce a paint with a raw material cost of 15 to 20 cents per gal. lower than a paint with equal hiding made with rutile titanium dioxide as the hiding pigment. There has been no evidence that a combination of rutile titanium dioxide and extender would not be as durable as the rutile titanium-calcium pigment combination. But from an economical standpoint, it was logical to select the least-costly pigment combination.

With the adoption of rutile titanium-calcium pigment as the hiding portion, the remainder of the pigmentation had to be selected. Several combinations of pigments were tried with the rutile titanium-calcium pigment to determine durability. There were a number of pigmentations that gave satisfactory durability, with no one in particular showing outstanding characteristics. From this work it appeared that the rutile titanium-calcium pigment with extender would provide as lowcost durable pigmentation as any of the others tested.

Since magnesium silicate had been used in most of the earlier work, it was assumed that this extender would give good results. However, the testing of other extender pigments in combination with rutile titanium-calcium pigment indicated that equal or better results might be obtained. One of the extenders which

TABLE 3

TRAFFIC PAINT

Pigmentation	Pounds Non-Vol.	Total Pounds	Gallons
Rutile titanium calcium pigment		650	24.1
Natural Whiting[a]		350	15.4
Aluminum Stearate[b]		5	0.6
Vehicle			
Alkyd Solution (50% Solids)[c]	334.0	668.0	87.3
Lead Naphthenate (24%)		13.9	1.4
Cobalt Naphthenate (6%)		3.4	0.43
Anti-Skinning Agent[d]		0.8	0.1
Thinner[e]		112.5	19.0

Pigment - 55.7 %
Pig.Vol. Conc. - 52.5 %
Weight per Gallon - 12.2 lb.

Vehicle - 44.3 %
Non-Volatile - 41.8 %

Pigment per Gallon of Paint - 6.8 lb.
Viscosity - 70-75 (Stormer)

[a]A low oil absorption, natural calcium carbonate such as Oolitic F, York Whiting, etc., may be used.

[b]The Aluminum Stearate should be equivalent to Metasap Chem. Co.'s V Grade.

[c]General Electric's Glyptal 2464, Jones Dabney's Syntex 32, U.S.I.'s Aroplaz 1085, etc. cut in V.M.&P. Naphtha may be used.

[d]The anti-skinning agent should be Nat'l Analine Co.'s ASA or equivalent.

[e]Any petroleum thinner with an Initial Boiling Point of 110-150 deg. F. may be used.

gave outstanding results was natural whiting. This whiting should be a natural, low-oil-absorption calcium carbonate. It did not give good results when it was used as a straight weight replacement for the magnesium silicate. Yet, with a pigment volume adjustment, this extender helped to improve the durability of the alkyd traffic paint. Repeated road tests showed that a combination of rutile titanium-calcium pigment and natural whiting at a pigment-volume concentration between 50 and 55 percent in an alkyd vehicle would give excellent results either with or without beads.

At various times during the cooperative testing work with the Pennsylvania Department of Highways, many ways were tried to improve the durability of traffic paints. Various vehicle combinations were used, pigment changes were tried, and methods of application were varied in attempt to find a paint which would give the greatest length of service. Two interesting facts came to light. It was found that a traffic paint is not a great deal different from any other type of surface coating subject to wear. Its service life is proportional to the film thickness. This, of course, is based on the assumption that the paint will fail by a combination of erosion and abrasion and not by flaking and scaling. The road tests indicated that a practical dry-film thickness for all alkyd traffic paint should be approximately 0.01 in. (or that a gallon of paint should produce a 4-in. line 340 to 375 ft. long). This film thickness appears to give maximum durability whether as an unbeaded or a reflectorized line.

The other interesting fact developed in connection with an investigation of the dispersion of traffic paints:

In actual manufacture, as well as in the laboratory, it has been the practice to do very little grinding of the paint. Practically all the paints tested until recently had a 0 grind on the North Standard of

Fineness Gauge. A road test was made of two paints identical in all respects with the exception that one had a 0 fineness of grind while the other paint was ground to a fineness of 3 to 4. The better-ground paint failed mainly by erosion. The paint with the poor dispersion showed early flaking and scaling. As a result, the durability appeared to be increased by 15 to 20 percent by improving the dispersion of the pigment in the paint. Later comparisons seemed to indicate that small differences in durability formally attributed to minor changes in pigmentation or to vehicles of different manufacturers were minimized.

Summing up all these results, it is believed that it is now possible to formulate one paint that will do a complete job as a traffic marking paint. This traffic paint may be used as a bead binder on any type of highway construction, or it may be used as an unbeaded line on practically all kinds of roads. To some highway departments the use of this paint would necessitate compromises of drying time, for it does not dry quite as rapidly as a lacquer or oleoresinous type of traffic paint. It will dry tack free in 20 to 30 min. and may be opened to traffic within 45 to 60 min. By accepting a slightly slower drying paint, the service life has been increased appreciably. It should give 9 to 12 months service as an unbeaded line and well over 12 months as a reflectorized line. This estimated service would mean that for all roads, with the exception of intersections and sharp curves, repainting would be only necessary once a year. Naturally, those spots subjected to heavy wear would require repainting at shorter intervals.

In Table 3 is given the formulation of a paint which has been developed. It is an illustration of a type of paint that has given good results. Pigments, resins, and thinners from various sources might cause changes in drying time and package stability. Laboratory examination of samples of paints made according to this formulation would check variations in the physical characteristics of the paint.

It is believed that this paint meets the specification for a multipurpose traffic-marking paint fairly closely. However, not all the problems of highway marking will be answered by this paint. But it is expected, through continued road tests and laboratory investigations, improvement will be made in traffic-marking paints. This will be undoubtedly true as more information is obtained of latex-emulsion paints and of new synthetic resins and vehicles. These new materials will perhaps add greater durability and visibility to the traffic paints now in use.

REFERENCES

1. Custer, H.R. and Zimmermann, E.K., "Field Evaluations of Traffic Paints of Known Composition," Proceedings of the 29th Annual Meeting of the Highway Research Board, December, 1949.

2. Ashmen, G.W., "Present Preferences for Traffic Paint," Highway Research Board, Bulletin 36, 1951.