

**SUMMARY REPORT ON METHODS OF
GLASS BEAD REFLECTORIZATION OF TRAFFIC PAINTS**

**Traffic Paint Subcommittee
A. J. Permoda, Chairman**

**Research Laboratory Division
Office of Testing and Research
Report No. 320
Research Project 47 G-36**

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**Michigan State Highway Department
John C. Mackie, Commissioner
Lansing, December 1959**

SUMMARY REPORT ON METHODS OF GLASS BEAD REFLECTORIZATION OF TRAFFIC PAINTS

At a meeting of the Department's Traffic Paint Committee on June 15, 1956, it was decided that the drop-in method of reflectorizing traffic paints be adopted exclusively for the statewide striping program and specifications were revised accordingly in an issue dated June 15, 1956. This decision was based on results of comparative tests of the two methods, drop-in and overlay (premix), conducted on US 27 between Lansing and Charlotte in 1954-55, which showed that the drop-in method was at least as good as the overlay method, and possibly a little better. The results of the tests were first presented to the Traffic Paint Committee in a report by the Working Subcommittee dated June 13, 1956, and later included in Research Laboratory Division Report 271, prepared for the Highway Research Board annual meeting in January 1957.

The current specifications, allowing only drop-in reflectorization of traffic paints, have thus been in effect since June 1956. Recently, however, some interest has been shown in reopening specifications to premix traffic paints. The purpose of the present report, therefore, is to review the history and summarize factual data on Department methods of glass reflectorization to provide the Traffic Control Devices Committee with information on which to base further action.

HISTORY

According to unofficial records, the Office of Maintenance of the Michigan State Highway Department first applied beads premixed with traffic paint on M 21 west of Jenison in Ottawa County in 1942. There is no written record of this experiment. One year later, in 1943, the Minnesota Highway Department experimented with this type of application, with in-

conclusive results. Apparently no further work along this line was done in Michigan during the war, and at the request of the Office of Maintenance a study of reflectorized traffic stripes (Research Project 47 G-36) was begun in 1947 by the Research Laboratory Division.

After some preliminary laboratory work, the first attempt to apply beads by premixing was made in May 1948. Two test sections of longitudinal stripes were put down, one in Grand Rapids and the other near Lansing. These tests were described in Research Laboratory Division Report 115, "Operational Comparison of Premixed and MSHD Specification Materials for Reflectorized Centerlines" by L. L. Peterson and F. Ballew (Aug. 25, 1948). These tests did not provide a reliable comparison because of the application difficulties encountered. It was learned at the outset that existing Department equipment would have to be modified in order to handle premix applications satisfactorily.

Later, in November 1948, the Research Laboratory Division in cooperation with the Office of Maintenance installed a small test section on Michigan Ave. in East Lansing, this time using a small experimental striping machine to spray transverse stripes across one lane. The test had four objectives: 1) to study the effect of bead grading on reflectance and durability; 2) to develop procedures and equipment for field testing; 3) to obtain comparative data on drop-in and premix applications; and 4) to obtain comparative data on several marking materials used by the Department in recent years. These tests were described in Research Laboratory Division Report 121, "Field Tests of Reflectorized Traffic Stripes" by L. L. Peterson (Jan. 26, 1949). Both this experiment and the earlier one indicated that the premix with a 2-lb overlay was better than the drop-in application. Both reports, however, carried the warning that the tests could not be considered completely reliable because of the lack of proper control in application.

In the meantime, the Minnesota Mining and Manufacturing Co. had applied for its first patent on premixed beads and paint on October 26, 1945. Shortly after the Michigan tests mentioned above, the same company applied for its second patent on August 6, 1949, both patents being granted on November 13, 1951. These patents were subsequently upheld in a test suit and all vendors of premixed products must be licensed by and pay a royalty to the 3M Co.

Results of the two Michigan tests previously mentioned were deemed sufficiently promising to warrant a large-scale field testing program and specifications for the drop-in and premix beads, Types I and II respectively, were issued on January 25, 1950. Beads were purchased under

these specifications and in July 1950, six test sections of longitudinal stripes were put down near Lansing by a Department paint crew using regular striping equipment. Again, the primary purpose of the test was to compare drop-in with premix application and to compare proprietary paints with paints produced under the Department's formula specification. Results of this work were given in Research Laboratory Division Report 160, "Comparative Field Study of Different Traffic Paints and Striping Practices," a joint report of the Research Laboratory Division and the Office of Maintenance (Oct. 10, 1951). According to this report, paint produced under the current Department specifications equaled the performance of two well-known proprietary products, and the prebeaded MSHD paint with a 2-lb overlay was superior to unbeaded paint with all 6 lb of beads dropped in.

On the basis of these tests, Department crews began the 1952 state-wide striping program with an overlay application using 4 lb of Type II beads per gal premixed and 2 lb of Type I dropped in. Almost immediately, complaints were received from the striping crews about the difficulties of handling prebeaded paints. These difficulties were explained by Messrs. W. J. Larkin and F. Ballew:

1. Premixed beads and paint were hard to put through the lines of the machine. Pressures had to be increased and sometimes truck speed reduced in order to get the proper rate of application.

2. With existing pumping equipment and paint shipping containers, the beads had to be dumped directly into the paint tank on the truck, since prebeaded paint could not be pumped from drum to tank with the equipment currently used for that purpose. As a result of this dumping of dry beads, bearings of the compressor and air motor were being damaged by fine beads drifting and being carried by the wind into vents and other openings of the equipment.

3. Beads were likely to settle out in the paint tanks, especially the yellow paint, which is used only intermittently. As a result of this tendency to settle, the proportion of beads in the premix decreased somewhat as the paint tank emptied.

4. Beads clumped somewhat in the paint tank through failure of the paint to wet the fine beads, resulting in intermittent bursts of dry beads from the gun.

5. Premixed beads indented the valve seats and scored the valve stems of the spray guns, resulting in frequent interruptions for gun repair to keep the white paint from leaking over the black segment of the stripe (the white paint valve opens and closes every 50 ft).

In spite of these difficulties, some of which were eventually overcome, premixing continued on a limited basis through 1952, 1953, and partially in 1954. By June 1954, considerable opposition to the premix application had developed in the striping crews and a special meeting of the Traffic Paint Committee was called for July 19, 1954, to consider the problem. At that meeting Mr. Larkin reported considerable damage and repair of the painting equipment due to application of premixed beads. He also stated that some of the crews were applying the beads exclusively by the drop-in method instead of the standard overlay method (4-lb premix with 2-lb drop-in). Mr. Downey recommended that further attempts be made to solve the problem before officially discontinuing the premix method and that the comparative performance of the drop-in and overlay methods be re-evaluated. It was decided at this meeting that the overlay method employing a 4-lb premix be continued pending the results of this restudy. Also, the Research Laboratory Division was instructed to investigate field equipment problems and report to the Committee at the next meeting.

A field investigation was made by C. C. Rhodes and W. J. Larkin and another committee meeting held on July 28, 1954. Several of the original problems of application, such as clumping of beads in the paint had been solved by the paint crews themselves, but three major ones remained: 1) excessive wear on paint gun components; 2) excessive shut-down time and maintenance expense caused by damage to the needle valves of the guns; and 3) damage to equipment bearings by windborne fine beads. No solution was found for these problems at that time, and total extra expense for applying premix was estimated by Mr. Larkin at \$10,000 per year. The Research Laboratory Division volunteered to conduct a series of controlled tests to again evaluate the drop-in and overlay methods of reflectorization. Because of existing equipment difficulties it was decided that statewide striping would be done by the drop-in method until the tests were completed. New specifications for drop-in beads, Type III, were issued October 29, 1954, for 1955 purchase; both these specifications and the drop-in method have been used exclusively since then.

The comparative tests of the premix and drop-in methods were initiated by application of test stripes in September and October of 1954. Three important features distinguished these tests from previous ones: 1) the newly developed performance test striping machine was used to deposit the stripes, thus assuring positive film-thickness control; 2) the overall bead gradation and quantity of paint were exactly the same for the companion stripes applied by the two methods; and 3) stripes were evaluated on the basis of performance throughout the life of the stripes rather than by terminal condition alone. In former tests none of these factors was

controlled or taken into account. It was felt that bead gradation was especially important and the fact that the drop-in method had not shown up more favorably in previous tests might have been due to the presence of a much higher proportion of small beads in the premix application.

The outcome of the tests is now well-known and was stated in the introduction to this report. There was little difference in performance of two brands of white and yellow paint applied by the two methods and in most cases any observable difference favored the drop-in application. The drop-in method, therefore, was continued as standard for statewide striping.

PERTINENT CONSIDERATIONS

In addition to actual performance, several other practical aspects of procurement and use of traffic paints have important implications, which should be considered before making any change in specifications to accommodate premixed paints:

1. Current specifications allowing only one method of reflectorization of paint and one size-range of beads are in the simplest form of any to date, with fewest problems in handling products covered by the specifications. Opening the traffic paint specifications to optional forms of reflectorization will be at the expense of simplification. The additional problems introduced would depend on what additional reflectorization methods were allowed under new specifications. The reflectorization methods could be: 1) factory premixing of paints, and 2) paints intended for field premixing. If all were allowed, it would be a regression to original performance specifications.

The number of size-ranges of beads and their different rates of application to effect reflectorization complicated the handling of products under the former "all inclusive" specifications. Under the current specifications the Department uses only one size-range type of glass beads, Type III. Under the former, original specifications the Department handled three types at three application rates:

- a. Type I beads were used for overlay application at the rate of 2 lb per gal of paint.
- b. Type II beads were used for field premixing at the rate of 4 lb per gal.

- c. Type III beads are used for drop-in application at the rate of 6 lb per gal. It should be noted that 2 lb of Type I beads plus 4 lb of Type II is about equal to 6 lb of Type III beads, on the basis of sieve analysis.

If in any one year paints for highway striping were procured to be reflectorized by two different methods (i. e., yellow by one method and white by another), then up to three types of glass beads would have to be ordered, inventoried, handled, and applied, depending on the combination of paint types secured under an "all inclusive" specification.

Limiting the traffic paint reflectorization methods allowed by specifications accordingly limits the bead types required.

2. Laboratory analysis, performed on paint batches (usually 1,000 gal) procured for roadway striping and required to ensure that paint duplicates the performance sample, is easiest and least costly on unbeaded paints.

Analysis of factory prebeaded paint is more costly and time consuming because it requires an added determination of the amount and gradation of the beads. The amount and gradation of premixed beads can sometimes be determined satisfactorily by sieving. However, determining amount and gradation cannot be done when the bead sizes and pigment sizes overlap, or when a paint contains a coarse extender pigment as do about 25 percent of those submitted for annual performance tests. The gradation and amount cannot be determined easily by chemical tests since both the beads and common extender pigments have a similar silicate structure. Determining the amount would be important, since a producer might mistakenly substitute 1 cent per lb extender for 10 cents per lb beads, in paint furnished for roadway striping.

3. Opening specifications to factory premix paints would introduce two complicating situations: a) all products competitive with those of 3M would be subjected to a 25 cents per gal royalty to the patent holder, thus putting the producers at a cost disadvantage and, conversely, putting the patentor in a decidedly favorable position; and b) while the application properties of the 3M product are quite well known and have not given as much trouble as field premix tried in the past (as shown in Research Laboratory Division Report 319 "1959 Road Test on 1000 Gallons of 3M Prebeaded Traffic Paint"), the factory premix of some other manufacturer might have a considerably greater adverse effect on equipment, and it would be extremely difficult to evaluate this effect without going back to the 1000-gal test application by Department crews.

4. It is entirely possible, too, that if factory prebeaded paints were admitted some paint manufacturers would want their products tested and used as premix but would prefer not to purchase beads and mix them at the plant. Acceding to such requests would put the Department back in the field premixing business with its additional difficulties and expense.

5. Finally, data showing the relative standings in annual performance tests of traffic paints reflectorized by the various methods in accordance with choices allowed under effective specifications, are tabulated below. The tabulation shows that in 1953, the first year of tests, the majority of paint suppliers requested to have paints evaluated as field premixes, which as white paints ranked first, second, third, seventh, eighth, ninth and tenth in the performance ratings. The remaining entries show the relative standings of white and yellow traffic paints through the 1956 tests.

Test Year	Color	Performance Standing by Method of Reflectorization		
		Drop-In	Field Premix	Factory Premix
1953	White	4	1, 2, 3, 7, 8, 9, 10	5, 6
	Yellow	4	1, 2, 6, 7, 8, 9, 10	3, 5
1954	White	1, 2, 6, 7, 8, 9	3, 10	4, 5
	Yellow	1, 2, 3, 7, 8, 10, 11	5, 9, 12	4, 6
1955	White	2, 3, 4, 8, 9, 10	1, 5	6, 7
	Yellow	1, 2, 4, 5, 9, 13	3, 8, 10, 11, 12	6, 7
1956*	White	1, 2, 3, 4, 5, 6, 7, 8, 9, 10		
	Yellow	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11		

* First year under specifications allowing drop-in beading only.

This tabulation shows that the test traffic paints were distributed among all three methods of reflectorization.

CONCLUSIONS

The Subcommittee herewith summarizes points discussed previously in this report:

1. The current traffic paint specifications are the simplest of any to date. Opening specifications to more types would be at the expense of simplified standardization.

2. Results of field tests do not show the factory prebeaded types or field premixed types to have any consistent advantage in performance over the currently specified drop-in type.

3. The field premixed type is found the most objectionable of all types. Subcommittee members representing the Office of Maintenance object to its use because: a) it requires handling of multiple bead types; b) striping crews would have to perform an additional operation of pre-mixing to produce a paint having, in all likelihood, erratic sprayability; and c) maintenance of field equipment would reportedly cost the Department an additional \$10,000 annually.

4. Factory prebeaded types would not be objectionable to Subcommittee members representing the Office of Maintenance, providing Type III beads were specified for overlay reflectorization rather than Type I as previously required under the original specifications. Such a revised procedure would effect reflectorization of both drop-in and factory prebeaded paint types with a single type of bead, Type III.

5. Factory prebeaded types would be objectionable to the Subcommittee member representing the Office of Testing and Research for the following reasons: a) such an addition would require handling two types of paint in performance testing; and in acceptance testing, b) no known method exists for determining amount and gradation of beads in all prebeaded paints; and c) the Department would have to spend an additional \$2,250 annually for maintenance of field equipment, providing the paint had spraying characteristics equivalent to the recently evaluated 3M paint.

6. The Subcommittee would object to use of factory prebeaded paints if their admission under specifications would require the Department to purchase 1,000-gal samples for performance evaluation and an additional sprayability evaluation, as required under the original specifications. Under the current specifications, permitting only unbeaded traffic paints, 50-gal lots are found adequate.

7. It should be noted that both factory and field premix types of paints, in effect, reduce the capacity of paint tanks on road-stripping equipment. With premix the paint tank must act as a paint receiver and also as a bead hopper: a 120-gal paint tank can only hold 100 gal of paint plus the normal allotment of 400 lb of premixed beads. Department replacement striping trucks are being equipped with 120-gal paint tanks, in place of former 60-gal tanks, to provide crews with greater paint carrying capacity and the refore greater striping ranges between reloadings.