

Selection of Traffic Paint by Performance Tests

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TRAFFIC paints are purchased on the basis of several considerations. Price is generally a dominant factor. Selection may be based on (1) a brand product or equal, (2) formula specification, (3) past performance, or (4) annual performance test.

Traffic paint used by the Nebraska Department of Roads and Irrigation from 1930 to 1941 was procured in the most part on a price and formula specification basis or on a price and past performance basis. The formula specification basis was found to be unreliable because of considerable differences encountered in the service life of paints made by different manufacturers but complying with a given specification. The past performance basis of selecting traffic paint, due to the purchasing procedures used at that time, resulted in a specification based on paint which had a record of acceptable performance. Subsequent purchases on this basis usually did not provide paint comparable in performance to the paint which had a good service life, unless furnished by the same manufacturer. This experience resulted in an investigation which indicated the desirability of an annual performance test as a means of selecting traffic paint.

Performance testing of paints prior to purchase was started in 1942 but was discontinued after that year until 1950 due to World War II and post war conditions. A limited program of performance testing was conducted during 1950. From 1950 to the present, an annual performance test of traffic paints has been made. In this program manufacturers submit samples of paint that they can furnish for the following calendar year, if awarded a contract. The paints are tested in service on typical portland cement concrete and bituminous surfaced highways. At the end of 24 weeks comparative ratings of the paints are made.

In order to utilize the information gained from performance testing, it was necessary to establish a purchasing arrangement different than that previously used. Bids on traffic paint are invited from manufacturers of paints found to be acceptable in performance tests. The paint which is purchased is selected on the basis of lowest cost per mile per 100 days of useful life.

The performance test procedure and purchasing arrangement encourage manufacturers to produce and offer high quality paint. Manufacturers have shown their interest in this procedure of selecting traffic paints by improving the quality of their paints and by regularly submitting samples for the annual test. They have also been cooperative in furnishing complete information on their paints and in limiting their bids to the paints which were considered acceptable as a result of the performance test.

Less than one-half of the traffic paints tested during the past five years have shown acceptable performance in service. Selection of traffic paints by performance tests has enabled Nebraska to take advantage of the improvements made by manufacturers in paints and paint materials and to consistently obtain a paint that will give the most service at the lowest cost.

● THE selection and purchase of traffic paints is usually based on price and one or more of the following: (1) brand product or equal, (2) formula specification, (3) past performance and (4) annual performance test.

The question then becomes one of selecting the considerations or limitations that are most necessary to provide a serviceable paint at the lowest cost.

The selection of paint on a brand product or

equal basis is complex since a large number of factors must be considered to determine the equality of two or more products. The most commonly used procedure for procuring traffic paint is by formula specification and price. The past performance basis usually results in a specification and price procedure. One of the principal disadvantages of the past performance basis is that it does not allow for change in climatic trends, change in traffic volume and similar factors that affect traffic paint performance. The annual performance test as a procedure for selecting traffic paints is in general similar to the past performance procedure except that performance tests are made each year in order to permit an evaluation which includes factors not covered in the past performance procedure.

NEBRASKA EXPERIENCE WITH SELECTION OF TRAFFIC PAINTS BY FORMULA SPECIFICATION AND BY PAST PERFORMANCE

Prior to 1942 most of the traffic paints used in Nebraska were purchased on a formula specification and price basis. Various formula specifications were used. The specifications were usually chosen on the basis of past performance records of similar paints in other states and recommendations of major pigment and paint companies.

In several cases, a formulation that was satisfactory in another State was found to be lacking when tried in Nebraska. This sometimes resulted even when the same manufacturer produced the same paint for both States. The differences in performance were believed to be due in part to differences in climatic conditions. Because of the importance of this factor, several manufacturers were asked to formulate paint that would perform acceptably under the conditions typical in Nebraska.

The policy at that time was to purchase a quantity of the manufacturer's recommended formulation paint and apply it during the regular striping program. The paints were in some cases good and in other cases very bad.

Whenever a paint was found to give acceptable performance, an attempt was made to obtain more of that paint. In order to do this it was necessary to request bids from manufacturers for a paint having a formulation identical to that of the paint which was found to be acceptable. The paints so obtained from different manufacturers often showed considerable variation in performance although

there was practically no difference in their formulations. The fact that the paint of any one manufacturer, for a given formulation, was usually quite consistent in performance characteristics from one year to the next was brought out during this time. However, the State had no control over the source of purchase since all purchasing was on a lowest bid price basis. The only requirement was that the paint comply with the formula specification.

From our experience it was concluded that it was not satisfactory to select and purchase traffic paints on the basis of an available formula specification. In order to improve on the previous procedures which were found lacking in many respects, an investigation of the apparent advantages and disadvantages of an annual performance test was made. It was concluded that an annual performance test program should be undertaken.

EARLY EXPERIENCES WITH PERFORMANCE TESTING

In 1942, the first major performance test program was carried out under the somewhat unfavorable circumstances of a war year. Ten manufacturers submitted 33 white and yellow traffic paints for performance tests. The test stripes were applied on one portland cement concrete surfaced highway and on one bituminous mat surfaced highway near Lincoln, Nebraska. The test stripes were evaluated during a six month test period. Due to the extensive demands of World War II, it was not possible to continue the work at the end of the 1942 test period.

As is well known by paint users, during the war years and for several years following, it was almost entirely a seller's market. The paint purchased during these years by Nebraska was on the basis of availability.

In 1950 it appeared that conditions were sufficiently stable to resume an annual performance test procedure to select traffic paints. During the year a number of traffic paint formulations were evaluated by means of a limited performance test on portland cement and bituminous surfaced highways. The test results were used as a basis for purchasing the traffic paints used in Nebraska during 1951.

The 1950 test results were open to criticism because of the type of application equipment used in applying the test stripes. The equipment used was of the rolling washer type and

it was not possible to control application rate close enough with this type of equipment.

Prior to the start of the 1951 performance test program, Nebraska purchased a Model B-3, Kelly-Creswell striping machine equipped with special accessories for applying test stripes. Since 1951 it has been possible to apply test stripes of traffic paint at any desired rate by using this machine and application procedures based on those developed by Custer and Zimmermann (1).

Experience gained from the 1950 and 1951 tests showed that factors influencing the selection and purchase of traffic paints other than evaluation of the paints require considerable attention. The entire procedure for selecting and purchasing traffic paints by annual performance tests requires extensive cooperation, not only between the manufacturers and the State, but between the State Purchasing Agent and other State Departments. It is necessary to plan a complete performance test and purchasing procedure beginning with invitations to paint manufacturers to submit test samples to the final award of a contract to the manufacturer.

PRESENT PROCEDURE FOR INVITING MANUFACTURERS TO SUBMIT SAMPLES

In our present procedure for selecting traffic paints on the basis of performance tests, all paint manufacturers who have furnished paint to the State in the past and any other manufacturer who may so request, are sent invitations to submit samples of traffic paint for a performance test. The invitations are usually sent out in early spring by the Purchasing Agent. Our invitation requires that the manufacturer submit only samples of the paint which he could furnish if awarded a contract the following calendar year. The invitations contain no restrictions on the formulation of the paint the manufacturer may furnish. Spraying properties, finish, consistency and drying time are the only characteristics which are specified.

Manufacturers are invited to submit a four-gallon sample of conventional white, conventional yellow, premixed reflectorized white and premixed reflectorized yellow traffic paints which they could furnish. They are requested not to submit more than two formulations of

each of these paints. A deadline for receipt of the paint samples is necessary in order that a definite schedule for application of test stripes may be set up.

APPLICATION OF TEST STRIPES

Experience has shown that it is desirable to secure performance test ratings of traffic paint at several locations and on highways of different ages and surface textures, and on different highway surface types. Test samples are usually applied at three different locations on portland cement concrete highways and at two different locations on bituminous (asphaltic concrete & bituminous mat) surfaced highways. Selection of test sites at these locations is based on recommendations made in A.S.T.M. Designation: D 713-46 entitled "Method of Conducting Road Service Tests on Traffic Paint".

Performance test stripes are applied at the same rate as that used for our regular highway marking. All conventional type traffic paint stripes are applied on our highways at the rate of 15 ± 1 , gallons per mile and premixed reflectorized paints at a rate of 17 ± 1 , gallons per mile. These rates are for a solid line, four inches in width. Experience on Nebraska highways has shown that these application rates result in a favorable economy and performance balance.

Following receipt and identification of samples, at least two one-gallon cans are repackaged into one-quart cans for use in applying performance test stripes. Laboratory tests to determine consistency and unit weight per gallon are made on all paints as soon as possible in order to provide data needed for measuring application rates. Application of the performance test stripes is usually started in June of each year.

All performance test stripes are applied perpendicular to the line of traffic from the centerline to the slab edge. Application is closely controlled by means of weighing the paint sprayed on tared, one-foot square, sections of roofing paper which are placed in the path of the striper in test runs before the actual test stripe is applied. Frequently two and three test runs must be made on a sample of paint before the application rate is adjusted to the prescribed limits. A small field shelter is necessary to house the balance used for control weighing.

Normally a crew of seven men is assigned to apply test stripes. The crew consists of two flagmen, a machine operator, a man to stir and prepare paint samples, a man to weigh application rate squares, a man to check drying time and a supervisor.

EVALUATION OF PERFORMANCE TEST STRIPES

Following application of test stripes, inspections for a minimum period of 24 weeks are made in accordance with the inspection schedule recommended in A.S.T.M. Designation D 713-46 (Method of Conducting Road Service Tests on Traffic Paint). Each test stripe is rated on a scale from 10 to 0 where 10 is perfect.

After 24 weeks of service, the performance test stripes are rated and manufacturers that have submitted samples are then advised of the status of acceptability of their paints. In the 1950 and 1951 performance test programs, paints were considered acceptable which received a minimum rating of 7 on appearance, color and film failure.

In subsequent test programs the minimum rating for acceptance was raised due to an increase in the number of paints that showed good performance characteristics. In order to assure competitive bidding, the minimum rating for acceptance is always such that at least three manufacturers are eligible to bid on their respective paints. Manufacturers are not advised of the comparative ratings of their paint before bids are submitted. Manufacturers of the paints that are not considered acceptable are advised that bids on unacceptable paint will not be considered. This information is also given to the Purchasing Agent who then asks for bids on the acceptable paints.

In order to assist the Purchasing Agent to purchase paint at the lowest cost per unit of service, the following formula (2) is used to compute the actual cost of service that may be expected from a traffic paint, based on performance test results:

FORMULA FOR CALCULATION OF THE COST PER MILE PER 100 DAYS OF USEFUL LIFE OF ACCEPTABLE TRAFFIC PAINTS

$$\text{Cost per mile per 100 days of useful life} = \frac{(\text{Bid price of paint per gallon} + \text{application cost of paint per gallon}) \times 100}{\text{Days of service test} \times \frac{R_p - R_r}{R_p - R_n} \times \text{miles of stripe per gallon}}$$

	Conventional	Premixed Reflectorized
Bid price of paint per gallon.....	—	—
Application cost of paint per gallon (estimated).....	\$0.75	\$0.75
Days of service test.....	(*)	(*)
R_p (perfect rating).....	10	10
R_r (replacement rating)†.....	7	7
R_n (rating at end of service test).....	—	—
Miles of stripe per gallon (4 inch stripe).....	0.0667	0.0588

* The usual Nebraska service test period is a minimum of 168 days.

† Rating at which it is considered necessary to reapply centerlines. The denominator of the formula which is based on our service test results is the Service Factor of the paint.

INFORMATION PROVIDED BY PERFORMANCE TESTS

Performance tests provide considerable information on durability and other characteristics of traffic paints. The following are examples of some of the information that may be obtained:

1. *Dirt Retention.* The differences in dirt retention characteristics of traffic paint stripes have been found to be most evident during the 24 hour period following application. Some paints pick up dirt for longer periods. With few exceptions, test stripes that show dirt retention soon after application, begin to clean up under traffic within two or three weeks and attain a completely satisfactory appearance. For one type of paint, dirt retention of the test stripes was found to increase with age of the paint sample.

2. *Comparison of Performance of Preliminary and Shipment Samples.* Our procedure provides for a side-by-side performance test of the traffic paint furnished by a manufacturer under contract and the paint sample originally submitted for test. Samples representing shipments received have in all cases shown as good or better performance than the preliminary samples on which the selection was based.

3. *Effect of Traffic Intensity on Traffic Paint Performance.* Tests have shown that traffic intensity has considerable bearing on paint failure particularly when the traffic volume is about 10,000 vehicles per day. Where traffic intensity is around 2,500 to 6,000 vehicles per day, other variables such as age, surface texture and width of pavement, and weather conditions influence film failure as much or more than traffic volume.

4. *Effect of Rain on Newly Applied Traffic Paint Stripes.* An unscheduled test on traffic paint test stripes was made when a sudden rainstorm occurred about two hours after a series of yellow traffic paints were applied in a test section on portland cement concrete. The rain continued intermittently for about 24 hours. In order to obtain a comparison of service life of these paints with service life of paints not exposed to similar rain conditions, all paints in this section were reapplied four days later. No rain fell on these stripes for about 72 hours after application. The stripes which were exposed to the early rain showed appreciably more failure under subsequent conditions than did stripes of the same paints which were not exposed to early rain.

5. *Effect of Pretreatment on Traffic Paint Durability.* One phase of experimental work conducted with the annual service tests was to study the effects of treating portland cement concrete pavements with different materials to improve the durability of the paint applied to the treated area. Phosphoric acid in methanol, in denatured alcohol and in water was found to be an effective treating agent. Where this pretreatment was used, the service life of the traffic paint applied to the treated area was very significantly improved.

Other treatments such as the addition of commercial water-proofing agents to paint before application were found to be of little if any value.

PARTICIPATION OF PAINT MANUFACTURERS IN ANNUAL PERFORMANCE TESTS

From the inception of our traffic paint performance test program, manufacturers have shown a steadily increasing interest in the tests. Samples are usually received from manufacturers on the east and west coasts as well as from manufacturers in the midwest. During the past five years the number of traffic paints submitted for tests each year has averaged 49. The number of manufacturers submitting samples for the annual test has varied from 10 to 12.

Some manufacturers have submitted samples for each test conducted during the past five years without furnishing a sample of paint having acceptable durability. Although manufacturers are required to furnish complete formulation data on the paints which are submitted for tests, only one manufacturer has

indicated he would not do this, because, by his own admission, he "had the best traffic paint in the world".

PERFORMANCE TESTING PROVIDES HIGH QUALITY PAINTS

Due to the increased traffic volume and to the resultant increased service required of traffic paints by highway departments, the need for higher quality traffic paint has become quite evident. The selection of traffic paints on a performance basis during the past five years, together with improvements in materials by the paint industry, has resulted in providing consistently high quality traffic paints for use in Nebraska.

Performance tests have regularly shown that less than one-half of the paints submitted could be considered acceptable on our evaluation basis. Performance testing, therefore limits selection to the better paints. Not only does it do this, but the selection of paints by performance together with the procedure used to purchase paints, also encourages the manufacturer to produce better traffic paints.

Selection of paints on the basis of performance has provided a suitable reply to claims for a particular paint, often made by paint company sales personnel. Any manufacturer may submit samples for test in accordance with our prescribed procedure and in the event the paint is found to be of exceptional durability he has a good opportunity to sell his product to the State.

It should be mentioned that selection of paints on the basis of performance tests does not necessarily imply that the paints considered unacceptable are inferior in all climates and conditions. It is very possible that many of the paints we found to be unsatisfactory for our particular conditions may be suitable for another set of conditions.

Paint manufacturers state that they are in a position to provide traffic paint of considerably higher durability than that now available if the consumer will pay a higher price for the paint. One manufacturer has indicated that some of the traffic paint samples currently under test are of this type.

SUMMARY

The use of annual performance test by the Nebraska Department of Roads and Irrigation as a basis for selection of traffic paints has

been the result of unfavorable experiences with other methods of paint selection. Performance tests require more time and work than most other methods of paint selection, however, the end results have consistently provided durable, quality paints for use on Nebraska highways at costs no greater than those for inferior paints.

Performance testing has also enabled the following conclusions to be made: (1) At least one-half of the traffic paints offered in the Nebraska area are unsatisfactory from the standpoint of economy and durability. (2) Paints can be selected that are most satisfactory under the traffic and climatic conditions prevalent at the time of use. (3) It is possible to buy large quantities of traffic paint which will give performance equal or superior to the test samples on which selection was based. (4) Manufacturers are encouraged to

produce better paint. (5) Experimental considerations can be evaluated under typical traffic conditions.

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Evaluation of the California Sand-Equivalent Test

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DATA from several thousand tests of base materials and mineral aggregates are portrayed in graphical form and the relationships between the California Sand-Equivalent Test results, plasticity index test results and the amount passing the No. 200 sieve are reported. As the plasticity index and the amount passing No. 200 sieve are considered to be two of the most important factors in judging the quality of mineral aggregates and base materials, it is concluded that the sand-equivalent test results reflect the quality of the material and that the test is of definite value as a rapid field test to determine the acceptability of materials. Sand-equivalent values recommended for determining the quality of materials are as follows:

0 to 14, unsatisfactory; 15 to 24, doubtful but usually unsatisfactory; 25 to 34, doubtful but usually satisfactory; 35 to 54, almost always satisfactory; 55 to 100, satisfactory.

● THE California Sand-Equivalent Test is a method proposed for determining the quality of aggregates for bituminous mixes and untreated bases. It was developed by F. N. Hveem, Materials and Research Engineer, California Division of Highways. The development of the test, the detailed procedure and the test limits for different classes of aggregates as specified by the California Highway Department have previously been re-

ported. F. N. Hveem, "Sand-Equivalent test for Control of Materials During Construction", Proceedings, Highway Research Board, Vol. 32, p. 238 (1953).

The sand-equivalent test appears to have certain inherent advantages which make it very desirable. Very little equipment is required. Balances and drying ovens are not used. The equipment is easily transportable and the test may be performed at the pit