

REPORT OF COMMITTEE ON TRAFFIC ZONE PAINT

J E MYERS, *Chairman*

ACCELERATED TESTING OF TRAFFIC ZONE PAINTS

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SYNOPSIS

The purpose of the investigation was to determine the practical value of laboratory tests used at the present time to evaluate the actual durability of traffic paints under service conditions

Nine paints were used in the investigation, 6 white and 3 yellow paints

In order to establish a standard by which the laboratory tests used to determine the relative durability of traffic paints could be evaluated, the paints were applied to roads in 12 localities for service tests. The relative service durability of the paints in the various localities was determined by observation, at the end of approximately 20 weeks

There was not complete agreement on the service results as reported by the different cooperators in the localities. Considering the white paints, there was 80 percent agreement as to which was the poorest paint and the same percentage held for the second poorest paint. There was 65 percent agreement on which was the best paint and this same percentage agreement held for the paint next to the best in service durability

The agreement on the relative service durability of the yellow paints ranged from 36 to 64 percent

The lack of perfect agreement in the service durability tests can probably be explained by the variation in weather conditions in the various localities in which the paints were applied. It is generally conceded that water is the agent which greatly affects the durability of traffic paints. Some types of traffic paints are more affected by water than are others. Hence the amount and distribution of the precipitation in the different localities would result in different service durabilities

Eight laboratories cooperated in laboratory tests of these paints. The tests used were various methods of abrasion and a flexibility test. Five laboratories used both the abrasion test and the flexibility test in evaluating the paints. Two laboratories used only the flexibility test and one laboratory used only the abrasion.

The abilities of the laboratories to rate the paints, on the basis of the laboratory results, in the order of relative durability as determined by the prevailing service results, varied from 33 to 78 percent correct ratings. With very few exceptions the laboratories were able to differentiate between the good paints and the poor paints but were not able to exactly classify the paints in the order of their relative durability as determined by the service results.

In general, the abrasion tests gave more reliable information on durability than did the flexibility tests

The general conclusion that can be drawn from this investigation is that no one laboratory test, or combination of the laboratory tests that were used are sufficient to evaluate correctly the relative durability of traffic paints, although the tests that were used do differentiate between paints that would be classed as good and paints that would be classed as poor

This investigation shows that additional laboratory tests are necessary in order to differentiate more correctly between traffic paints which have various degrees of service durability.

The value of accelerated methods of testing clear and pigmented coatings has been a topic of much discussion. In the paint industry there exists a very wide divergence of opinion on the subject, ranging from complete faith to complete skepticism. It is no surprise, therefore, that the same condition has prevailed regarding traffic zone marking paints, which explains the varying opinions regarding the properties for which these paints should be tested, and the testing methods to be used.

The wide differences of opinion regarding the testing of traffic paints is evidenced by the numerous different tests that are made by the many organizations interested in this type of paint. There are organizations that test paints thoroughly in the laboratory for abrasion resistance, toughness, flexibility, hardness, water resistance, weathering resistance, and drying. Other organizations test for only a few of the properties, while still others rely on road tests under service conditions for evaluating traffic zone paints. Even among the latter there is disagreement regarding best methods to use for testing paints on roads. For example, there is difference of opinion on such questions as application of uniform films, what types of roads and what spreading rates to use, and whether longitudinal or cross-stripes are more desirable.

Even if different organizations do agree that a certain property of a paint must be ascertained in the laboratory, it is often difficult for them to agree on the testing method to be used. For example, there are several different types of machines for testing abrasion resistance of paints and others are being designed.

The value of reliable accelerated methods of testing cannot be denied, and it is needless to present in this report the very well known arguments in favor of them. Also, it must be agreed that it would be beneficial to everyone concerned to keep the number of tests down to a minimum.

It was therefore decided by the Committee to start an investigation of methods now in use for testing traffic zone paints, hoping that some light might be thrown on the subject. Obviously, it was impossible to investigate simultaneously all testing methods for all properties of paints. It was decided to confine the effort for the time being to the single property of durability in service.

The object of the work described here was to determine how accurately the durability of traffic paints could be predicted by laboratory methods of testing.

The first steps in the work were the selection, preparation, and distribution of paint samples. The selection was made after a very careful study of results of road tests obtained with about 400 different paints over a period of four years. The most important point kept in mind during the selection was that a complete range of durability be covered. Six white paints and three yellow paints were selected. Two of the white paints had always given very similar results on road tests. The same was true of two of the yellow paints. It was recognized that it would be difficult for any laboratory test to foretell which of the two white paints (or yellow paints) was more durable. However, there was a definite gradation (from good to poor) in durability between the two similar white paints and the other four. Also, the third yellow paint had always been inferior to the two similar yellow paints.

The paints were prepared under strict supervision of experienced technical men. First, a 10-gal. batch of each vehicle was prepared. Then the paints were prepared in single batches of 11 to 12 gal. each. Uniformity of vehicle and paint was thus assured in every case, eliminating the possibility of any discrepancy arising from preparations of paints in different batches. All paints were then thinned to the same consistency, namely, 80 K U by the Krebs Modified Stormer Vis-

cosimeter. The paints were packaged and shipped immediately in cans of capacities desired by the co-operators. Thus every co-operator received samples of the same nine paints at approximately the same time (about June 15, 1941). The paints were numbered one to nine. Numbers 1, 2, 3, 4, 5, 9 were white paints, 6, 7, 8 were yellow paints

The co-operators applied the paints as soon as they were able on test roads of their own choosing. All details concerning the applications of the paints, such as type of road, method of application and spreading rate, were left to the discretion of each co-operator. The only requirement specified was that all paints be applied as received, with no further thinning. There was no hardship inflicted by this requirement, because the consistency of the paints was well suited for all types of applications.

All paints on all the roads chosen, except one, were applied perpendicular to the center line (cross-stripes) to insure all stripes getting the same amount of abrasion.

The performances of the paints were watched very carefully by the co-operators, and many pictures were taken at various intervals during the period of exposures. The paints were evaluated by the co-operators for each road application, although in a few cases tests had not reached completion and evaluation was made on the basis of indications. Those who have had previous experience with these paints believe this to be a safe procedure.

All of the data on road tests has been compiled in Table 1

For the sake of simplicity, it was decided to segregate the white paints from the yellow

Besides data on road results and laboratory abrasion the co-operators obtained considerable laboratory information on such properties as flexibility, water resistance, weather resistance, bleeding, drying

time, visibility and packaging characteristics. Of these, only flexibility, weather resistance, and water resistance lie within the scope of our objective, although all of the information obtained is of extreme interest. Data on all other properties do not, therefore, have a place in this report, but may be published at a later date.

As far as water resistance by laboratory immersion test only is concerned, all of the paints were very similar. For all practical purposes, it is safe to assume that the paints have the same resistance to water by immersion test and that the differences in durability among these particular paints were not due to differences in water resistance as indicated by laboratory immersion test only.

Weather resistance data are not complete but the results obtained thus far indicate that the effect of weather on the durability of traffic paints is of minor importance. Future data may be included in subsequent reports.

The following data are of direct concern at this time:

- 1 Data on road applications, including results of durability tests. Table 1 contains all this information.
- 2 Correlation between road durability results and results of laboratory tests for resistance of paints to abrasion. This is given in Table 2.
- 3 Correlation between road durability results and results of laboratory tests for flexibility of the paints. This also is given in Table 2

TESTING METHODS

In the appendix will be found either general descriptions of the testing methods used by the co-operators or references to publications which completely describe the methods.

TABLE 1
DATA ON ROAD TESTS WITH TRAFFIC ZONE PAINTS

Co-operator	Road No	Location of road	Type of road	Traffic count (24 hr)	Date of application	Method of application	Spreading rate ^b (gal per ft ²)	Weeks of service	Evaluation of paints from road test results (best to poorest)								
									White			Yellow					
K	1	Newport, Del	Concrete	4,000	1941	Lineograph	20	21	4	1	9	2	3	5	6	7	8
A	2	Long Beach, N. Y.	Concrete	4,000	6/24	Lineograph	10	17	9	1	4	2	3	5	8	6	7
Z	3	Palmerton, Pa	Concrete	10,000	7/10	Lineograph	20	19	9	1	4	2	3	5	8	6	7
N	4	Albany, N. Y.	Concrete	3,500	6/25	Brush ^c	15	21	1	9	2	4	3	5	6	7	8
M	5	Orono, Me	Concrete	1,400	6/26	Brush	14	14	1	9	4	2	3	5	6	8	7
Z	6	Palmerton, Pa	Rock asphalt	3,500	8/27	Lineograph	20	10 ^a	1	9	4	2	3	5	6	8	7
C	7	Sacramento, Cal	Asphalt	2,250	7/8	Spray	15	17	1	9	2	4	5	3	8	6	7
W	8	Wayne, Mich	Concrete	5,000	7/2	Spray	10	15	1	9	2	4	3	5	6	8	7
B	9	Washington, D. C.	Sheet asphalt	9,000	7/9	Brush	20	20	9	1	4	2	3	5	6	8	7
M	10	Orono, Me	Tar gravel	900	8/7	Brush	14 ^a	14 ^a	1	9	4	2	3	5	6	8	7
P	11	New Kingston, Pa	Concrete	3,200	8/27	Nissly mechanic brush	16	12	9	1	4	2	3	5	6	8	7
P	12	Higspire, Pa	Concrete	3,600	8/28	Nissly mechanic brush	16	12	1	9	4	2	3	5	6	8	7
P	13	Lingestown, Pa	Tar surface	200	8/29	Nissly mechanic brush	16	12	1	9	2	4	3	5	8	7	6
J	14	Lafayette, Ind.	Old concrete	2,400	7/7	Brush	10	20	1, 9	9, 1	4, 2	4	3	5	5	5	6
J	15	Lafayette, Ind	New concrete	1,800	7/11	Brush	13	20	1	9	4	2	3	5	5	5	6
J	16	Lafayette, Ind	New concrete	1,800	7/14	Brush	13	20	2	3	3	3	3
				Consensus					1	9	4	2	3	5	8	6	7

^a Evaluation made on basis of early indications.

^b Spreading rate—for 6-inch stripes.

^c "Brush" denotes hand brushing.

DISCUSSION OF RESULTS

Study of Table 1 reveals the following facts regarding the roads used for evaluating the paints under actual service conditions.

1. Practically all types of roads were used.
2. The roads were located in widely scattered sections of the country.
3. There was a wide variation of traffic involved, namely, from about 900 vehicles to 10,000 vehicles daily.
4. There were four different methods of application employed.
5. Spreading rates ranged from 10 to 20 gal. per mile for a 6-in stripe (264 to 132 sq. ft. per gal).

The remainder of Table 1 is devoted to the evaluations of the paints on the individual roads used. It will be noted that the periods of service at the time of evaluation varied from 10 to 21 weeks. In a few cases, failure had not progressed to the point where evaluation could be made easily. In those cases evaluations were made on the basis of indications at the time.

Before discussing the evaluations made by individual co-operators, it must be emphasized that paints Nos 1 and 9 have always given very similar service on about ten road tests over a period of four years. Almost always No. 1 was found to be very slightly superior to No 9. However, it has always been very difficult to evaluate these two paints relative to each other. The same has been true for yellow paints Nos 6 and 8 except that they have been found to be even closer in characteristics, if possible.

Practically all co-operators reported the expected difficulty. The differences between 1 and 9 and between 6 and 8 were found to be very small by all co-operators.

Considering the many personal factors and experimental errors involved, there was very close agreement among the in-

dividual evaluations. The consensus of evaluations was (from best to poorest) ·

White paints	1, 9, 4, 2, 3, 5
Yellow paints	.. 8, 6, 7

This checked the results obtained over the past several years with these paints and was therefore in accord with what had been expected. The main discrepancy among the white paints was that paint No 2 was rated superior to paint No. 4 on three of the roads used. The other discrepancies were few in number and were either to be expected (between 1 and 9) or were decidedly minor in nature. A point worth mentioning is that co-operator P averaged the results of his two concrete road applications on a rough quantitative basis (amount of wear), and his average evaluation checked perfectly with the consensus.

We are safe in saying, therefore, that evaluations of white paints by road tests checked very well. In the case of yellow paints, there was more disagreement, although the consensus of road evaluations turned out as expected. The reason for the disagreement is not apparent.

A study of Table 2 reveals that in one case only did the evaluation by laboratory abrasion test check with the consensus of road results. It is interesting to mention that the particular co-operator in this case (M) made two tests and averaged the results obtained. Also of interest is the fact that the equipment used was designed to approximate road conditions as closely as possible. It will also be noted that another co-operator (B) used a somewhat similar type of equipment and checked only fairly well with the consensus road evaluations. This type of equipment obviously tests a combination of properties of the film and from this point of view is desirable rather than undesirable, because the aim should be to obtain results by as few laboratory tests as possible. However, there is some modification required in existing equipment of

this type to make it fully reliable, especially if paints of about equal durability are to be tested.

The type of abrasion test used by co-operators B, N, C and J did not give as reliable results when used alone as the type used by co-operator M. Also, there was evidently more of a personal factor involved in that of N, C and J because the wear results obtained by the test used alone were not in very good agreement with each other. Also, except in the case of J, the results were quite different from the consensus road results. When co-operators N and C combined results obtained by abrasion machine with flexibility results, they both reported final laboratory evaluations which were in good agreement with the consensus road evaluations.

One of the laboratory abrasion tests used by co-operator Z (Ab 2) shows some promise because of its simplicity.

As far as flexibility alone is concerned, there was some rather startling disagreement among the co-operators in listing the paints in order of flexibility. However, there seems to be no direct relationship between flexibility and consensus road evaluations. Evidently, some flexibility is required of a paint film but it is not necessary to have excellent flexibility. Other properties are required which seem to be more important than flexibility.

The weathering data on test panels (which are not given here) are not complete but indications are that weathering is of secondary importance in the failure of traffic paint films

CONCLUSIONS

1. The most accurate method of testing these nine traffic zone paints was by actual road tests. Check results were obtained regardless of type of road, traffic count, method of application, and spreading rate. However, if paints are similar,

that is, if only slight differences are noted by one road test, it is advisable to make several tests on the same road or on different roads

2. The type of abrasion testing machine used by co-operator M seems to have the most promise and in the case of the nine paints studied possessed the advantage of being able to foretell service results by only one test in the laboratory. Indications are that as they now exist, a machine of this type evaluates durabilities of paints rather well if several tests are made on a series of paints and the final evaluations are made from an average of all the results. However, indications are also apparent that some modification is desired to improve the reliability of this method, especially when evaluating paints which are similar. Since, more often than not, paints submitted for test are similar and differ in some minor characteristics only, it is clear that the slight modification needed should be determined and made. No indications are apparent as to what type of modification is required

3 When used alone, the type of abrasion test used by co-operator M gave more reliable indications of the road durability of the nine paints studied than the abrasion tests used by the other co-operators. Also there was some difficulty involved in checking among different laboratories. However, when the individual laboratories evaluated paints by a combination of abrasion test data and flexibility data, they reported final laboratory evaluations of paints which were in closer agreement with the consensus road evaluations.

4 There was striking lack of agreement on the listing of paints in order of flexibility, indicating that methods of testing flexibility should be investigated. There was indication that it is not necessary for paints to possess good flexibility to be durable, although some degree of flexibility is doubtless required.

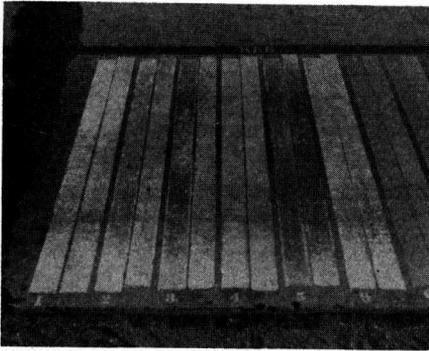


Figure 1. 22 Weeks' Exposure on Road No. 1

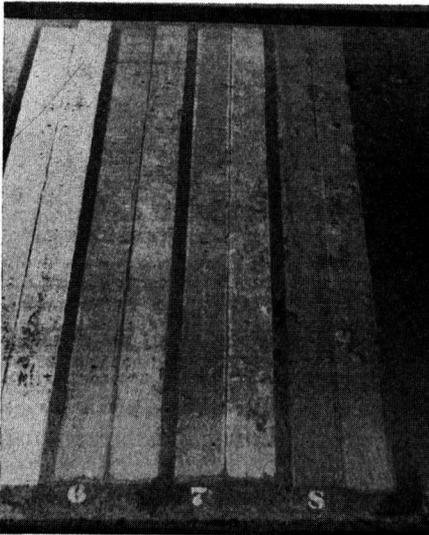


Figure 2. 22 Weeks' Exposure on Road No. 1

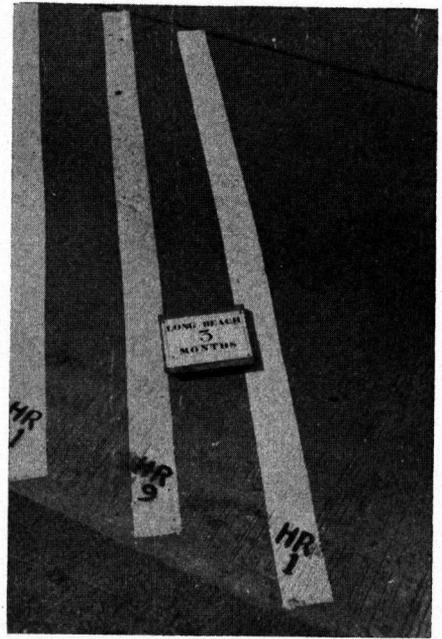


Figure 3. 3 Months' Exposure on Road No. 2

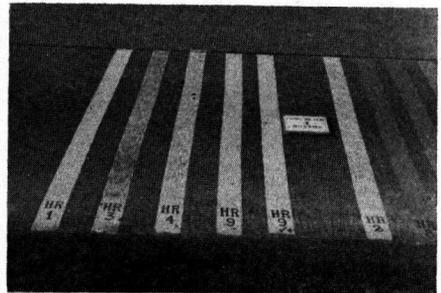


Figure 4. 4 Months' Exposure on Road No. 2

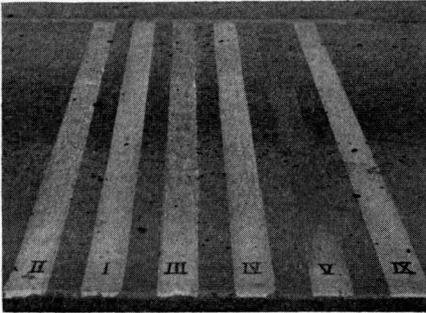


Figure 5. 19 Weeks' Exposure on Road No. 3

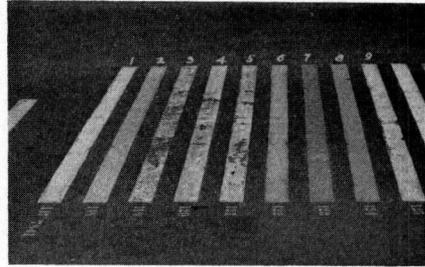


Figure 8. 17 Weeks' Exposure on Road No. 7

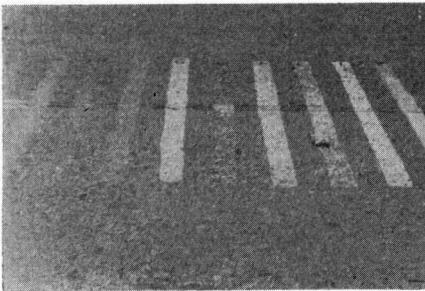


Figure 6. 14 Weeks' Exposure on Road No. 5

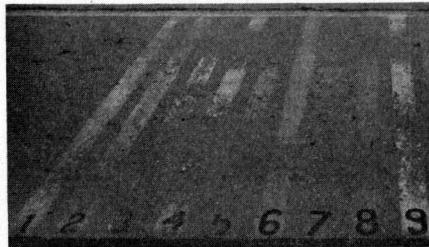


Figure 9. 15 Weeks Exposure on Road No. 8

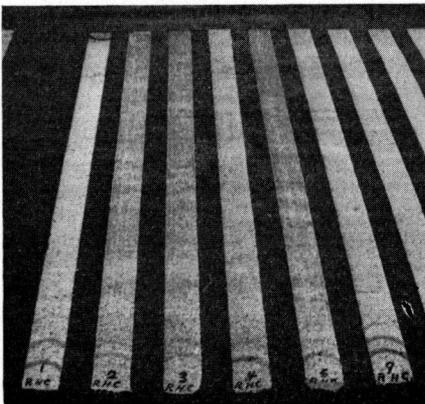


Figure 7. 10 Weeks' Exposure on Road No. 6



Figure 10. Exposure on Road No. 9

APPENDIX

TEST METHODS

ABRASION RESISTANCE TESTS

Co-operators N, C, J

The test used was that described in State of New York Executive Department, Division of Standards and Purchase, Specification for Traffic Paint Zone White, September 1, 1937.

Co-operator B

The test used was that described in Research Paper RP 1007, Journal of Research, National Bureau of Standards, Vol 19, July 1937

Co-operator M

The test used was that described in Maine Technology Experiment Station Paper No 19. The paints were applied 0.01 in thick with an instrument similar to a doctor's blade. The paints were applied in duplicate on a concrete wheel which is revolved and in turn revolves a truck tire which rests on the surface of the paints.

Co-operator Z

Two abrasion tests were conducted by this co-operator.

1 This method is the one developed and used by the Bell Telephone Company Laboratories. The films are abraded by a stream of carborundum powder impinging on all paints uniformly. The abrasion resistance of the paints is proportional to the weight of carborundum required to wear through a uniform thickness of film.

2 A weighted rubber wheel is run over sand distributed on the paint film. The abrasion resistance of the film is determined by the degree of removal of the film. The test was made on the dry film and on the film dampened by covering with a moist cloth for a period of 18 hours. The test was also made on the film which had been exposed to a weatherometer test for one month.

FLEXIBILITY TESTS

All flexibility tests were basically the same, namely, a dried or baked film was bent rapidly over a mandrel and the effect on the film noted.

WEATHERING TESTS

There are several methods being used to determine the resistance of the paints to weather alone. These are.

- 1 Applying paints on a short section of a concrete road on which there is no traffic
- 2 Applying the paints on cement, brick and concrete blocks and exposing the blocks horizontally to the weather.
- 3 Applying the paints to asbestos shingles and exposing them to weather
- 4 Weatherometer tests

ACKNOWLEDGMENT

The co-operation among the ten organizations participating in this work has been of great value. It is hoped that interest is great enough for continued co-operation on further studies of this kind.

For the sake of simplicity, each organization is referred to by code letter in this report. For those who are interested in the identities of the organizations and also to duly acknowledge the co-operation of all concerned, the codes and organizations are listed.

CODE DESIGNATIONS OF ORGANIZATIONS CO-OPERATING ON TRAFFIC ZONE PAINT COMMITTEE WORK

- B=National Bureau of Standards
 C=California State Highway Department
 J=Joint Highway Research Project, State Highway Commission of Indiana, and Purdue University
 K=Krebs Pigment and Color Corporation
 M=Maine State Highway Commission Testing Laboratories and Technology Experiment Station
 N=New York State Highway Department
 P=Pennsylvania State Highway Department
 W=Board of Wayne County Road Commissioners
 Z=The New Jersey Zinc Company
 A=American Gum Importers Association, Inc., Research and Development Laboratories