

REPORT OF THE COMMITTEE ON ROADWAY PAVEMENT MARKINGS

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During the past year efforts have been made in four general directions; (1) verifying and publicizing the results of a survey made last year on line-striping practices in the various states, (2) analysis of methods and equipment used in applying center and barrier lines, (3) collecting information on researches being carried out in this area, and (4) encouraging highway departments, experiment stations as well as colleges and universities to pursue research on various problems in this area.

The major effort of the Committee was focused on securing specific information on methods of striping from every state in the Union, a project in which every member took part and which was presented in an open meeting

of the Committee by Mr. Charles R. Waters of New York. Splendid cooperation was obtained from every state and it is the feeling of the Committee that some very worthwhile information has been assembled.

Any study or compilation of facts or information must be considered as being relative in its application. For example, our study shows that 39 states use plain unreflectorized paint for striping. The necessity for repainting varies from four months to three years with a median value around 12 months. This type of information must be tempered by judgment of the reader considering the amount of traffic, climatic effects on paint, type of paint used, type of surface painted and even by the pressure of public opinion.

METHODS AND APPLICATION PROCEDURES FOR PAVEMENT MARKING

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SYNOPSIS

Contact was made with every highway department in the country, in addition to several foreign provinces and countries, with the request that a form containing 70 or more items relating to types of paint, costs, methods of application, methods of protecting green paint, drying time, mixing of beads, when used, and other important aspects of pavement striping. The data are being put up in tabular and graphic form and will be presented as reported by the respective states.

Data on types, weight, cost and features of striping equipment will be presented. Reports were obtained from every state in the Union and some foreign countries.

Analysis of questionnaires indicates a growing interest in marking traffic lines on pavements as a means of safety on highways. Steps toward uniformity throughout the United States are indicated.

From 48 states reporting, 18 report that the strippers were designed and built in their own shops, 29 report that strippers were purchased from commercial sources and one state reports that their markings are placed by a contractor. The Provinces of Manitoba and Nova Scotia in Canada also contract for the placing of markings while Ontario, British Columbia and the Territory of Hawaii use purchased strippers.

Thirty states report using self-propelled units, nine trail the unit, eight use the push-mobile type and one did not report. Forty-four states use pressure nozzles while four

use the flow type. Thirty-eight states place preliminary markings for the equipment to follow while ten states do not.

Thirty-seven states plus four provinces reporting from Canada use reflectorized markings for increased night safety. Six states use non-reflectorized markings and five did not furnish definite information. Hawaii uses reflectorized markings. While a number of states place only reflectorized markings, the greater percentage also use plain paint, with the reflectorized markings used on main touring routes, No-Passing zones, troublesome intersections and railroad crossings at grade. The drying time of the paint is reported as varying from 15 minutes up to 2 hours.

Of the 43 states using dash lines, the length of the paint mark and the space between varies from a minimum of 9 - 15 ft. to a maximum of 70 - 70 ft. with 20 states using a 15 - 25 ft pattern. Most of the states have standardized on a four inch width marking although three report using a three inch line and one a six inch line. By reason of using a dash line, a saving in paint of from 50 to 80 percent is accomplished.

The cost of providing markings varies greatly according to quality of paint and application methods. Currently it is reported as varying between \$13.00 and \$63.00 for an unreflectorized line and between \$25.00 and \$80.00 for a reflectorized line. Operational costs are greatly responsible for this variance, it being reported that a low of 5 miles and a high of 100 miles of pavement is painted a day.

The most recent study by members of Project Committee No. 11 - Roadway Pavement Markings, Highway Research Board, has been completed. The Committee considered it would be advantageous to assemble information from all states regarding pavement marking procedures. Accordingly, a questionnaire prepared by the Committee was forwarded to officials of the State Highway Departments to be completed and returned for tabulation. Contact was made with every State Highway Department, in addition to several foreign countries and a number of the provinces in Canada. The questionnaire contained over 70 items relating to the types of equipment used, methods of application, drying time of paint, use of glass spheres for night reflectance together with other pertinent and important aspects of pavement marking.

This report, prepared from the data obtained, is purely factual and is based on the points covered in the questionnaire. The work of the present writer is that of compiling and tabulating the information collected by the regional sub-chairmen. No attempt is made in this report to evaluate the methods used in the various states, nor to make a judgment of evaluation on types or methods.

Some 36 states gave written statements that they are using the geometry or pattern of the system recommended

in the Federal Manual on Uniform Traffic Control Devices for Streets and Highways.

The data obtained from the questionnaires have been tabulated in chart form for detailed study. Pertinent information which is of principal interest follows in the order indicated on the charts.¹

EQUIPMENT USED FOR STRIPING

From 48 states reporting, 17 advise that strippers were designed and built in their own shops and 31 report that machines were purchased from commercial sources. The oldest of the strippers dates back to 1934, although 37 states or 77 percent report using equipment purchased or built subsequent to 1946, and 16 states report using equipment which is not older than one year. It is assumed that new devices and improvements have been added to the old equipment from time to time.

There is a great variance in the weight and the cost of equipment. The minimum weight of any unit as reported is 175 lb. which is only the weight of striping device. It does not include truck, paint tanks and miscellaneous equipment. The maximum weight of any one unit which includes the truck attached stripper, tanks and all equipment is

¹The charts are folded in at the end of this bulletin.

22,000 lb. From the reports, it is found that weights vary greatly according to type of equipment and the mileage to be painted. In some states, one or two large units cover the entire mileage while in others a number of small machines are employed.

While the cost of a shop-constructed striper whether pushed, pulled or mounted on the truck, may be relatively small, the cost of a commercial self-propelled unit, or truck mounted unit in which the truck cost is included, may seem to be exceedingly high.

COST OF PAINT AND PAINTING

The cost of pavement marking equipment is reported as varying from a minimum of \$700 to a maximum of \$16,000. Small self-propelled units capable of placing only 5 to 10 miles of line per day are in the lower range, while the fully equipped heavy duty equipment capable of placing up to 60 to 70 per day costs in the upper brackets. The total cost of all equipment as reported in the questionnaires is \$280,069.00, or an average of \$5,600 per unit.

In analyzing the information furnished regarding the number of vehicles required in placing the markings, it is found that, in general, the complete unit consists of either a self-propelled paint striper or a truck mounted striper and a service truck. The service truck in addition to carrying extra paint and supplies, picks up and returns to the paint striper the flags, blocks or other devices previously placed on the wet paint line to protect it while drying.

WIDTH OF ROAD EQUIPMENT USED

The overall width of the stripers varies according to type. The minimum width is 2 ft. 8 in. for a self-propelled unit, the maximum width 9 ft. 6 in. for a striper attached to the side of a truck. An average of all reporting is between 6 and 7 ft., which is standard width for a truck of medium size. Only two states report widths exceeding 8 ft., one 9 ft. and one 9 ft.

6 in. It appears that passing difficulty might be encountered when placing markings on a 16 or 18 ft. pavement when using a unit of excess width. In New York the Vehicle and Traffic Law prohibits the movement of vehicles having a width greater than 8 ft. over public highways unless a special permit is issued.

The data show that 31 states use a self-propelled unit, 9 trail the unit and 8 use the Pushmobile type. The self-propelled units include both commercial stripers operating under their own power and those mounted on trucks. The trailer type are those mounted in a framework running on low pneumatic tires towed immediately at the rear of the truck, and the Pushmobile types are those units built into a frame having both front and rear axles, pushed ahead of the paint truck.

PAINT CAPACITY OF STRIPERS USED AND PERSONNEL REQUIRED IN LAYING

The number of paint tanks in use varies from 1 to 4 having a capacity as low as 12 gallons and as high as 700 gallons. The 12-gallon tank is contained on the small self-propelled unit with the 700 gallon tank mounted on a large self-propelled unit. Fourteen states report using one paint tank, 14 states use 2 tanks, 15 states use 3 tanks and 5 states use 4 tanks. Twenty-one states or nearly 44 percent use a 60-gallon tank apparently for ease in filling, cleaning and space requirements. From the 48 states, 26 transfer the paint to the tank by hand using a pail or the original 5-gallon container while the remaining 22 states transfer it by either air pressure or mechanical pump. It appears that hand methods enter into the transferring of paint, and it is probable that if the paint is purchased in standard 5-gallon pails, it is emptied directly into the paint tank; if furnished in 30 or 60 gallon drums, the pump or air pressure method is used.

Pressure nozzles are used by 92 percent of the states, only 4 reporting the use of flow nozzles.

The personnel required to operate the strippers varies from one with the small self-propelled unit up to 11 on the large self-propelled units. In most cases, the questionnaire did not definitely state whether or not the personnel included men for operating the service truck. From the average of all 48 states, 4.5 men are required for a complete marking crew.

COST OF PRELIMINARY MARKING

Thirty-six states place preliminary markings for the guidance of the paint striper at a cost varying from 75 cents for center line and 70 cents for barrier line to \$35 for center line and \$15 for barrier line. Ten states do no preliminary marking and two states place preliminary markings only at certain locations. Replies were lacking from a number of states as to the cost of preliminary markings and 4 states reported no additional cost for placing the barrier line marks.

PROTECTION OF THE UNIT, DRYING, ETC.

For the protection and safety of the painting unit, 20 states report using a police escort while 27 do not; one state did not report on this question. Other means of protecting the unit include a car ahead to warn approaching traffic used by 9 states; signs or flagmen used by 22 states; and siren and flasher used by 5 states.

From 46 states reporting, 39 state that gaps are left in the markings at cross streets, 7 report in the negative; 27 report gaps left at cross roads while 20 report that markings are carried through the intersection.

The speed of travel of the marking equipment in miles per hour is reported to be from a low of 2 m. p. h. to a high of 20 m. p. h. The data show that 35 states, or 73 percent, traveled at a rate of from 5 to 10 m. p. h. Reports regarding the number of miles marked per day varies from 5 to 100. Thirty-six states, or 75 percent, report their equipment marks between 20 and 40 miles per day. A great many variables

such as type of equipment and drying time of paint enter into the number of miles which can be painted in a specified number of hours.

ADDITIONAL COST IN TWO COLORS

In reply to the question on the additional cost by reason of using two colors, one state reported 25 cents per mile, one \$1.65, one \$5.10, one \$9.30 and one \$11.34. Six reported no additional cost, two reported the additional cost to be negligible and the remaining states made no reply or do not use two colors.

From 42 states reporting on the question, "How many strips are required to mark a two-lane highway?", 37 stated the marking is completed in one trip, one state reported one to two trips, two states reported two trips and two states reported three trips.

TIME BETWEEN PAINTING

From 39 states using plain unreflectorized paint, one state reports the necessity for repainting every 4 to 6 months, four states repaint every 6 months, five states repaint every 6 to 12 months, one state repaints every 8 to 12 months, 18 repaint once a year, two repaint every 12 to 18 months, one repaints every 18 months, three repaint from 1 to 2 years, one repaints from 1 to 3 years, two repaint every 2 years, and one state reports that the time between repainting is variable. Traffic density, quality of paint and weather conditions dictate to a large degree the necessity for remarking the lines.

A variety of answers were received from 41 states reporting on the life of reflectorized markings either as a regular program or on an experimental basis. The most frequent repainting is reported as being every 6 months (only one state), the longest span between paintings, 3 years. A number of states report they are placed yearly but ten states definitely indicate an increase in the life of the marking by the use of reflectorized paint.

METHOD OF APPLYING REFLECTORIZED PAINTS

Regarding the method of placing reflectorized markings, 24 states report using the pre-mix method, 39 use the beads on wet paint method and five use a combination of the two known as overlay. Sixteen states use both the pre-mix and the beads on wet paint methods as a regular practice.

All except four states use either signs or protective devices to guard the wet paint markings against tracking by vehicles during the drying period. The devices vary from simple home-made wooden blocks to cones, Z guards, and pyramids manufactured commercially. In 21 states, police patrol the wet paint line during the drying period. In 15 states motorists are liable to arrest for driving on wet paint.

DRYING TIME

The reported drying time for reflectorized paint varies between ten and 120 minutes depending upon the formulation, pavement conditions, temperature, humidity and wind velocity. The greater percentage report the time as being between 20 and 40 minutes. Only two states report clogging trouble at the spray gun, all others stated they experienced no clogging or only minor difficulties.

Thirty-one states report good visibility of reflectorized paint before wear and 14 average visibility. The wearing quality is reported as good by 24 states, 16 report average wear, one reports variable wear, one average to poor and two poor.

LENGTH OF SEGMENTS PAINTED

Of the 43 states using dash lines, the length of the paint mark and the space between varies from a minimum of 9 ft. dash with 15 ft. gap to a maximum of 70 ft. dash with 70 ft. gap. From this number, 21 states or nearly 49 percent use a 15 ft. dash with a 25 ft. gap. Most of the states have standardized on a 4 in. width marking although one uses a 3 in., one a 4-1/2 in., two

use 5 in., and one uses a 6 in. width of line.

AMOUNT AND COST OF BEADS USED

Three states report using 4 lb. of glass spheres per gallon of paint, one state uses 4-1/4 lb., two states 4-1/2 lb., six states 5 lb., one state 4 to 6 lb., one state 5-1/4 lb., three states 5 to 6 lb., and 28 states or over 60 percent use 6 lb. per gallon of paint. A number of states purchase reflectorized paint as a packaged product; about 6 lb. of beads furnished with each gallon of paint.

The cost of the glass spheres per gallon of paint is reported as low as 64 cents when used at the rate of 4 lb. per gallon up to \$1.62 when used at the rate of 6 lb. per gallon. It is now generally known that beads may be purchased in carload lots for as little as 12 cents per pound.

By reason of using a dashed rather than a solid line, a saving varying from 50 to 80 percent is reported. States using a 20 ft. paint line with a 20 ft. gap or any pattern using the same length paint line and gap between, accomplish a 50 percent saving in paint. Three states reported using a 15 to 35 ft. pattern with a saving of 70 percent and one state saves 80 percent by using a 10 to 40 ft. marking.

COST OF VARIOUS PAINTS

Information regarding purchase cost and application cost of plain paint, asphalt paint, reflectorized white and reflectorized yellow paints was insufficient on a number of the returned questionnaires and it is therefore impracticable to arrive at any definite comparisons. Some states furnished the name of the manufacturer, others stated that the paint is purchased on bid while the paint for one state is manufactured at the State Prison.

Factors entering into the cost of paint include quality, freight rate, and whether or not the purchase is made on a competitive basis. Currently it is reported that plain white paint is purchased for as low as \$1.19 per

gallon and as high as \$3.00 per gallon. The average cost per gallon from 36 states reporting is \$1.69 per gallon.

Analysis of the information on the returned questionnaires indicates that while some states reported total cost per mile on the basis of using a dashed line, others reported on the basis of using a single solid line. For this reason, we are unable to furnish a comparison of cost per mile figures. However, all information obtained has been indicated on the tabulation chart and may be studied by the individual for detailed costs in any particular state. It is reasonably safe to assume that any figure indicating under 9 gallons of paint used per mile is for a dashed line and any figure over 12 refers to the single solid line. The cost as reported varies between \$13.00 and \$63.00 per mile for a plain unreflectorized marking. Application methods are largely responsible for this variance as between 5 and 100 miles of pavement are reported to be painted a day.

Fifteen gallons of paint per mile for a solid line 4 in. in width and 6 gallons per mile for a 15 ft. dash with a 25 ft. gap line are practical to use for estimating purposes.

Ten states furnished limited information on the use of asphaltic type of paint. The cost varies between 17 cents and 46 cents per gallon for purchased paint. One state reports a cost of \$1.00 per gallon for asphaltic paint.

Thirty-two states furnished current prices on reflectorized white paint, the low being \$1.94 - the high \$4.50 per gallon. The average cost per gallon is indicated at \$3.14. As high as 23 gallons per mile and as low as 12 gallons per mile is reported as being used. It is assumed that these figures are based on a single solid line.

In nearly all states the additional cost of providing a reflectorized marking may be attributed to the increase in the cost of the painting material, as cost of application is practically the same in either case.

Twenty-three states furnished limited information regarding reflectorized

yellow paint. From 16 states using both white and yellow reflectorized paint, it is found that the average cost of white is \$3.28 and the average cost of yellow is \$3.47 per gallon. This is an increase of 19 cents per gallon or 5.8 percent when using yellow reflectorized paint.

REPORTS FROM OUTSIDE THE UNITED STATES

In addition to receiving completed questionnaires from all 48 states, replies were received from the provinces of British Columbia, Manitoba, Nova Scotia, Ontario and New Brunswick in Canada and the Territory of Hawaii. Two of the provinces contract for the placing of their markings, two use commercially manufactured equipment and one has constructed its own striper. Hawaii uses a purchased unit.

The length of the paint cycle in the Canadian Provinces is reported as varying between 30 and 120 ft. The length of the dash line varies from 10 to 20 ft. with a 20 to 100 ft. gap. Three place a 4 in. width marking, one a 4-1/2 in. and one a 5 in. width. Hawaii places a 6 ft. dash line with a 9 ft. gap, using a 4 in. width line.

SUMMARY

The foregoing information is based purely on the data reported by the respective states and provinces. The information has been tabulated by states alphabetically in the charts, which are folded in at the end of this bulletin.

It is the thought of the Committee that the results of this project should prove of value to the several states in securing greater effectiveness and economy in pavement marking methods and procedures; also that this report together with future studies will contribute greatly toward establishing greater uniformity in marking practices, ultimately leading to the evolution of a form of markings which will be best from a standpoint of safety as well as from other points of view.