

MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

STUDY OF
1950 TRAFFIC PAINT OPERATIONS.

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Part of a General Investigation of
Reflectorized Pavement Marking Paints
Devoted to the improvement of materials
and application methods.

Highway Research Project 47 G-36

Research Laboratory
Testing and Research Division
Report No. 158
March 15, 1951

STUDY OF
1950 TRAFFIC PAINT OPERATIONS

This is a report concerning an investigation of traffic marking paint operations for the 1950 season. The study was made at the request of Commissioner Charles M. Ziegler at a meeting held January 20, 1950, with respect to the Department's 1950 pavement marking program. It was agreed at that meeting that the research program should include the following objectives.

1. Hold a school for the paint crew personnel and roving superintendents to be handled jointly by the Maintenance, Planning and Traffic, and Testing and Research Divisions.

2. Keep daily records of the operations of each paint rig, including number of hours and lengths of striping.

3. The assignment of a representative of the Testing and Research Division to follow actual field applications and study all factors affecting wearing qualities.

All objectives were successfully completed and will be reported on as presented above.

PAINT SCHOOL

The paint school was held at Department Maintenance Garage in Mount Pleasant May 2 through May 5, 1950. All phases of traffic paint operations, applicable to paints, beads, and application details were discussed before the group by personnel from the Testing and Research laboratories, Planning and Traffic and Maintenance Divisions. The paint crews were also instructed on what was expected in the matter of securing field information and recording data.

At this time special field kits were made available to the paint crew foremen, each containing 1 wind gage, 1 sling psychrometer,

3 thermometers, 1 bottle of distilled water, 1 magnifying glass, pencils, printed forms and clean cloths, and the men concerned were instructed in the use of these instruments.

It was understood that each paint crew foreman would assume the responsibility of seeing that all record forms, samples appended, would be filled out completely, including two recordings in the morning and two in the afternoon. In addition, samples of the stripes would be taken at these same times, when possible, by the foremen, by placing metal "tins" where these would be passed over by the spray guns and bead dispensers. The tins were furnished by the Research Laboratory.

It was also arranged that Mr. Tom Green of Testing and Research Division would act in the capacity of inspector and observer, and would visit each of the paint crews in rotation throughout the State, wherever they should be operating at the time. Mr. Green was equipped with duplicate apparatus, and with forms to be filled out personally.

Complete daily operational records are in the Maintenance Division files.

FIELD OBSERVATIONS

The arrangements agreed upon at the paint school worked out fairly well during the course of the painting season, in spite of the added burden placed on the men. In general, the persons who actually took down the data are to be complimented on doing a good job. Nearly a thousand determinations were made of air temperature, air movement, slab temperature and relative humidity, and over half a thousand determinations of air pressures and drying times for white, yellow and black paint.

Hundreds of actual field samples were received by the laboratory. Field data has been summarized in Table I for reference.

The importance of relative humidity on drying time of paint and operation conditions was for the first time clearly revealed by the study. Further, additional data were secured on the phenomenon of paint wetting of beads and its effect on wearing properties of the paint stripe.

Effect of Relative Humidity on Drying Time of Paint

Soon after field operations had started, the paint crews encountered abnormally long drying times. This caused considerable tracking in dense traffic areas. A special study of the situation revealed that the prevailing high relative humidity at the time of paint application was causing the trouble.

Figure 1 shows the daily variation in relative humidity values for the State of Michigan over a five-year period for the months of June through August. From the curves in Figure 1, it may be observed that, at the time paint crews would ordinarily start operating in the morning, 7:30 A.M., the relative humidity would be in the neighborhood of 70 to 90 percent, then dropping to 40 to 60 percent around noon, gradually increasing in the afternoon. The inference from these data would be that painting operations should not start before 8:30 or 9:00 in the morning.

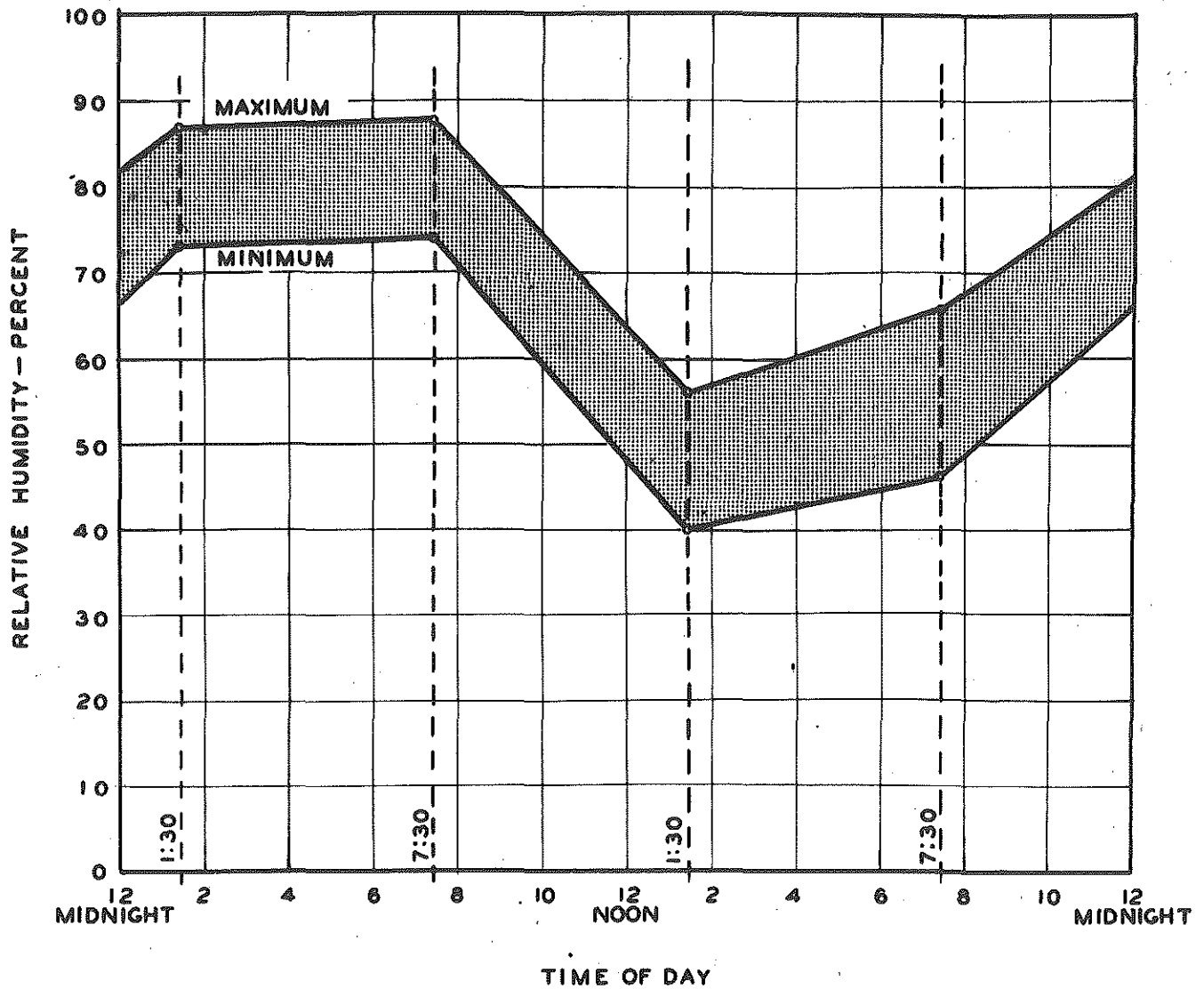
In view of this situation, instructions relative to painting, Supplement No. 3, were issued on June 20, 1950, to the effect that: "If the relative humidity is not more than 65 percent, and is falling it shall be considered satisfactory to paint. If, however, the relative humidity is more than 60 percent, and is rising, painting shall be deferred until the humidity drops below 65 percent and continues to fall."

TABLE I

TRAFFIC MARKING STRIPE DATA
1950 Construction Season

Crew No.	Air temp., degrees F.		Rel. humidity, percent		Air movement, m.p.h.		Slab temp., degrees F.		White paint				Yellow paint				Black paint										
	Cases	Ave. temp.	Cases	Ave. rel. hum.	Cases	Ave. velocity	Cases	Ave. temp.	Air pressure, average, psi.		Drying time, ave., minutes		Air pressure, average, psi.		Drying time, ave., minutes		Air pressure, average, psi.		Drying time, ave., minutes								
									On paint	Atomization	On paint	Atomization	On paint	Atomization	On paint	Atomization	On paint	Atomization									
									Cases	psi.	Cases	psi.	Cases	min.	Cases	psi.	Cases	psi.	Cases	min.	Cases	psi.	Cases	psi.	Cases	min.	
Inspector's Reports																											
1	12	82	12	69	12	6.7	12	100	5	55	5	75	5	29	11	55	11	75	11	33	11	31	11	75	11	15	
3	18	69	18	61	19	13.8	19	78	8	79	8	88	7	36	11	63	11	76	9	47	13	33	13	45	11	24	
4	36	73	36	69	36	12.5	37	90	28	89	28	91	30	50	12	57	12	74	13	53	34	56	34	72	36	17	
5	23	73	23	69	23	11.3	23	88	16	52	16	79	19	62	14	50	14	77	21	52	16	41	16	79	13	12	
6	33	73	33	72	32	9.9	34	84	20	95	20	92	20	54	7	90	7	102	7	43	25	65	25	91	25	19	
7	29	77	29	60	26	8.0	26	95	16	65	16	73	13	35	5	61	5	71	7	27	31	47	31	57	24	24	
8	30	66	30	52	29	11.8	25	74	20	75	20	86	15	58	7	66	7	79	6	47	61	38	61	56	57	16	
Totals (1)	181		181		177		176		113		113		109		67		67		74		191		191		177		18
Ave's (1)		73		65		10.9		87		77		85		51		61		78		45		46		66		18	
7 (a)	7	73	7	68	9	7.4	6	88	7	69	7	79	4	35	1	65	1	75	3	21	--	--	--	--	--	--	
8 (a)	38	76	38	60	37	12.2	36	95	30	97	18	106	25	30	15	70	15	80	13	32	--	--	--	--	--	--	
Totals (2)	45		45		46		42		37		25		29		16		16		16		--		--		--	--	
Ave's (2)		76		61		11.3		94		92		98		31		70		79		30		--		--		--	
Totals (3)	226		226		223		218		150		138		138		83		83		90		191		191		177		18
Ave's (3)		73		64		10.9		88		80		87		46		63		79		42		46		66		18	
Paint Crews' Reports																											
1	34	68	34	59	34	9.6	31	75	5	54	5	68	5	38	29	56	29	69	24	32	21	39	21	70	20	26	
3	122	71	122	59	119	11.4	120	81	66	68	66	81	59	47	99	68	99	81	97	41	112	36	112	59	111	25	
4	96	71	96	57	92	11.2	96	81	59	83	59	84	45	47	27	58	27	71	21	34	74	55	74	72	70	18	
5	172	71	171	52	123	11.4	162	84	66	52	66	31	75	61	108	50	108	81	110	45	139	39	139	81	127	27	
6	132	69	132	58	132	14.3	127	73	67	63	68	85	55	42	29	66	29	87	21	45	105	62	106	89	94	31	
7	85	75	85	60	85	12.5	84	77	56	56	56	66	56	33	11	55	11	65	11	36	75	50	75	60	73	34	
8	55	71	54	63	55	11.0	53	79	38	74	38	82	39	48	17	67	17	78	16	33	42	39	42	53	34	30	
Totals (4)	696		694		640		673		357		358		334		320		320		300		568		569		529		28
Ave's (4)		71		58		12.0		79		65		80		47		59		79		41		46		72		28	
Totals (5)	877		875		817		849		470		471		443		387		387		374		759		760		706		25
Ave's (5)		71		59		11.7		81		68		81		48		60		79		42		46		70		25	
Totals (6)	922		920		863		891		507		496		492		403		403		390		759		760		706		25
Ave's (6)		71		59		11.7		81		70		82		45		60		79		41		46		70		25	

Notes: Totals (1) and Averages (1) are for Districts 1-3, inspector's reports.
 Totals (2) and Averages (2) are for Districts 7,8; inspector's reports for white and yellow, 4 lb/gal. No. 2 beads in, 2 lb/gal No. 1 beads on.
 Totals (3) and Averages (3) are Totals (1) plus (2) and Averages of Averages (1) and (2).
 Totals (4) and Averages (4) are for Districts 1-8, paint crews' reports.
 Totals (5) and Averages (5) are Totals (1) plus (4) and Averages of Averages (1) and (4); white and yellow have 6 lb/gal No. 1 beads on paint, no beads in. Compare with Averages (2).
 Totals (6) and Averages (6) are Grand Totals and Grand Averages of all reports for all M.S.H.D. 1950 standard practice, including both Type 1 and Type 2 bead application.



MAXIMUM-MINIMUM MONTHLY MEAN RELATIVE HUMIDITY

INCLUDING JUNE - JULY - AUGUST - FOR 5 YEAR PERIOD - 1945-1949
LANSING, MICH.

FIGURE I

By Supplement No. 4, dated June 26, Supplement No. 3 was corrected as follows: "Notice is hereby given to all paint spray crews that, effective immediately, painting shall not be started prior to 8:30 A.M. Painting shall be continued for a regular working day thereafter." All supplementary instructions relative to painting operations including Supplements 1 through 4, are appended to this report.

A breakdown of all field reports of average daily relative humidity by months is shown below.

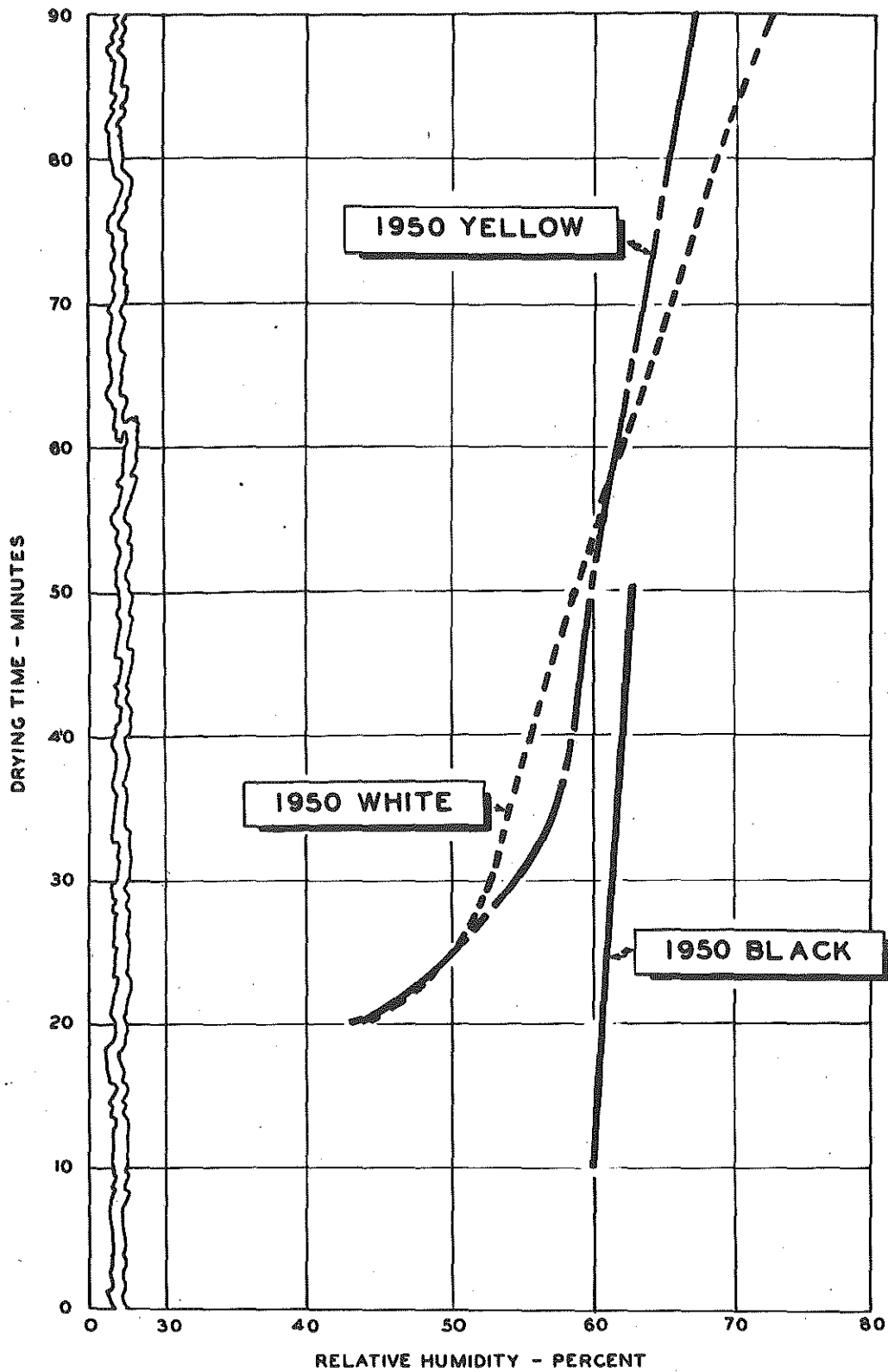
<u>Month</u>	<u>Average Relative Humidity in Percent</u>
March	56
June	60
July	64
August	62
September	62
October	69

The data from field reports show a pronounced and definite relationship between drying time and relative humidity for both white and yellow paints. No such relationship was noted in the case of black paint products. See Figure 2. It is indicated from the curves in Figure 2 that in case of white and yellow paints, drying times from 20 to 60 minutes may be expected as normal. However, wind velocity, air, and pavement temperature will have considerable influence in lowering this figure in many instances.

Durability in Relation to Climatic Conditions

Until such time as further condition surveys have been made, little can be said about the effect of climatic conditions during painting upon the durability of the paint stripes.

There is, however, some early evidence that relative humidity at the time and site of application is without effect on the durability of standard



RELATIONSHIP BETWEEN DRYING TIME OF MSHD
 PAVEMENT MARKING PAINT AND RELATIVE HUMIDITY
 AT TIME AND SITE OF APPLICATION
 1950 PAINTING SEASON

FIGURE 2

traffic marking stripes applied this year. See Figures 3 and 4. Further surveys will be required to substantiate or disprove this.

Wetting of Beads by Paint in Relation to Stripe Durability

It has been recognized that the surface attraction between paint and bead, which results in the wetting or non-wetting of the bead by the paint, must have considerable bearing on the length of time the bead remains embedded in the paint under constant bombardment by traffic and the elements and thus a pronounced effect on ultimate life of the paint stripe. Paints exhibiting a high tendency to climb up the sides of the beads and form deep, high-walled craters should be expected to retain the beads longer than paints which do not wet the beads as extensively or which may even repel the glass surfaces.

An attempt was made to follow the wetting of the beads by 1950 traffic paint and to compare this with other paint-bead combinations whose wetting properties have been recorded.

Reference to Figures 5 through 12 shows the excellent wetting of 1950 beads by 1950 white and yellow paints as compared with very poor wetting in the case of 1949 beads and paint.

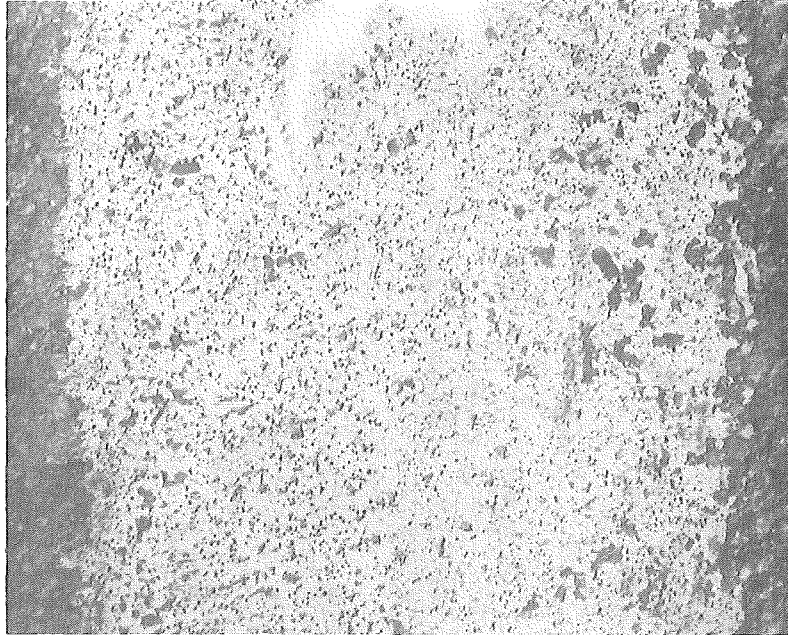


FIGURE 3

1950 WHITE, US-16-WEST OF PORTLAND AT 5 MONTHS.
APPLIED AIR TEMP 70°F; REL. HUMIDITY 36%; CLEAR.
PAINT REMAINING 70% OCTOBER 18 1950.

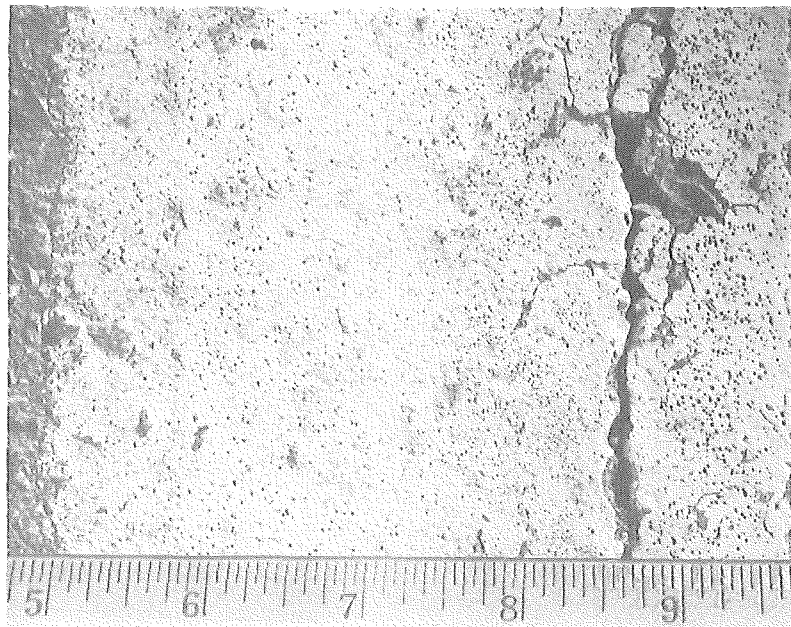


FIGURE 4

1950 WHITE; US-27-S. OF ST. JOHNS, AT 5 MONTHS.
APPLIED AIR TEMP. 85°F. REL. HUMIDITY 66% OVERCAST.
PAINT REMAINING 85%, OCTOBER 20, 1950.

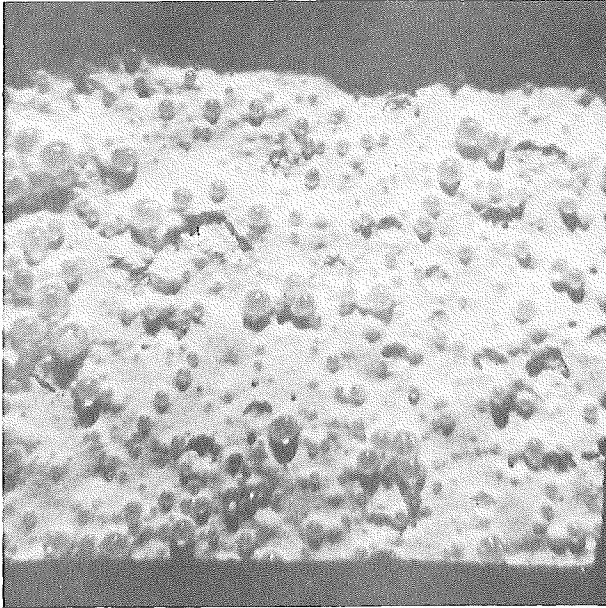


FIGURE 5
1949 WHITE: POOR BEAD WETTING.
AGE: LESS THAN 24 HOURS.

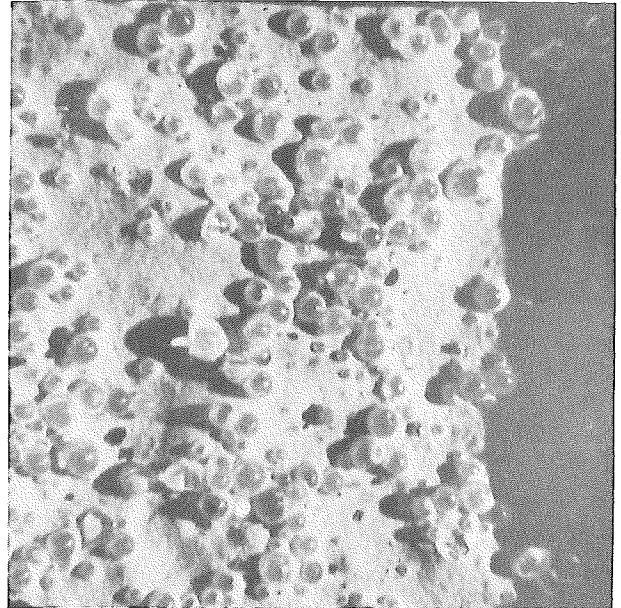


FIGURE 6
1949 YELLOW: POOR BEAD WETTING.
AGE: LESS THAN 24 HOURS.

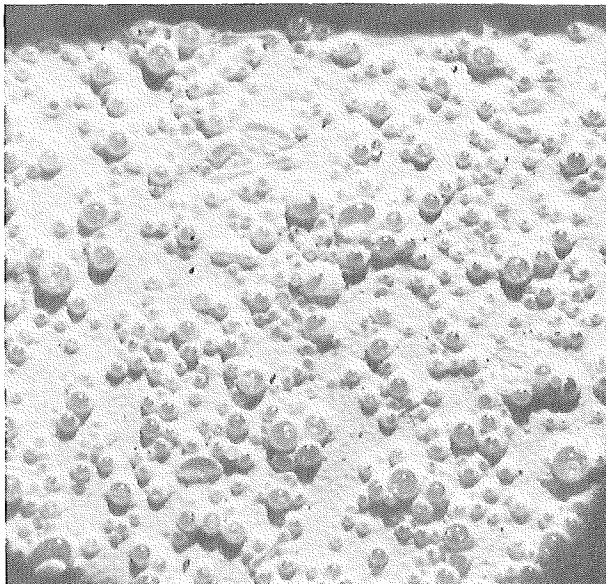


FIGURE 7
1950 WHITE: EXCELLENT BEAD WETTING.
AGE: LESS THAN 24 HOURS.



FIGURE 8
1950 YELLOW: EXCELLENT BEAD WETTING.
AGE: LESS THAN 24 HOURS.

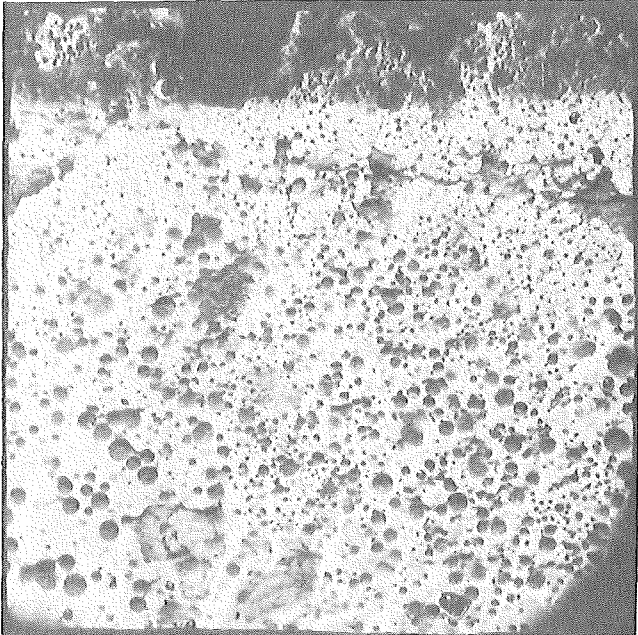


FIGURE 9
1949 WHITE: TOTAL BEAD LOSS,
US 16 - EAST LANSING - WILLIAMSTON
AGE: 7 1/2 MONTHS.

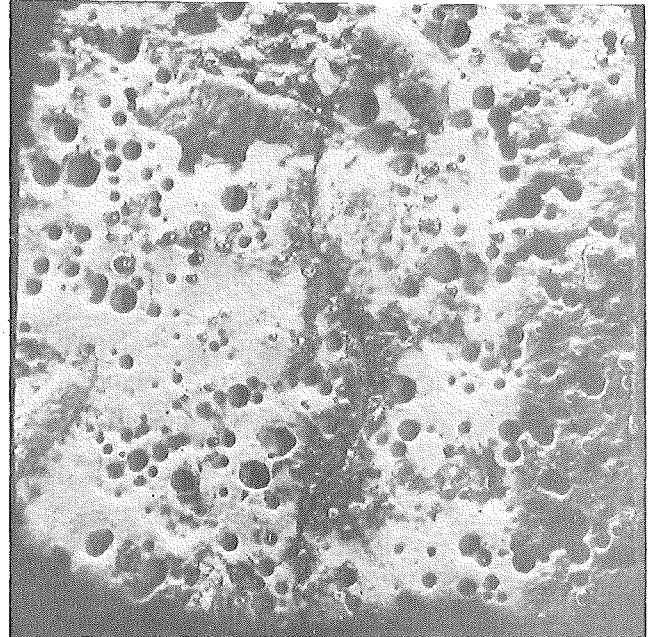


FIGURE 10
1949 YELLOW: LARGE BEAD LOSS,
US 16 - EAST LANSING - WILLIAMSTON
AGE: 7 1/2 MONTHS.

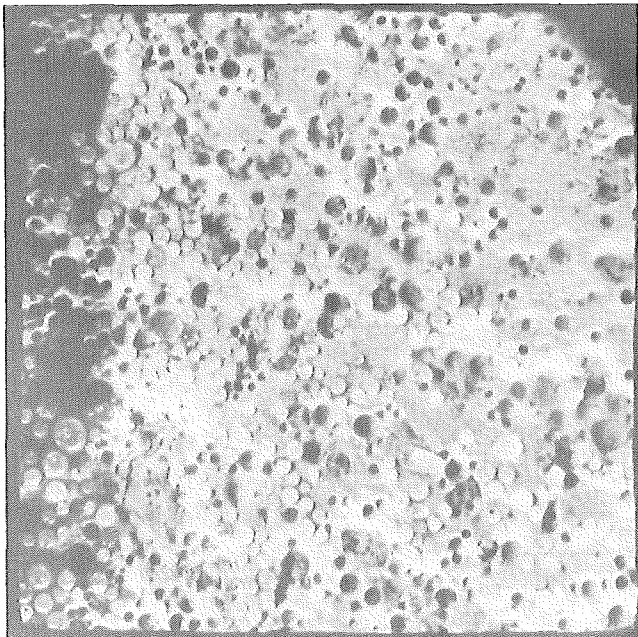


FIGURE 11
1950 WHITE: BEADS INTACT, PAINT GOOD.
US 16 - EAST LANSING - WILLIAMSTON
AGE: 8 MONTHS.

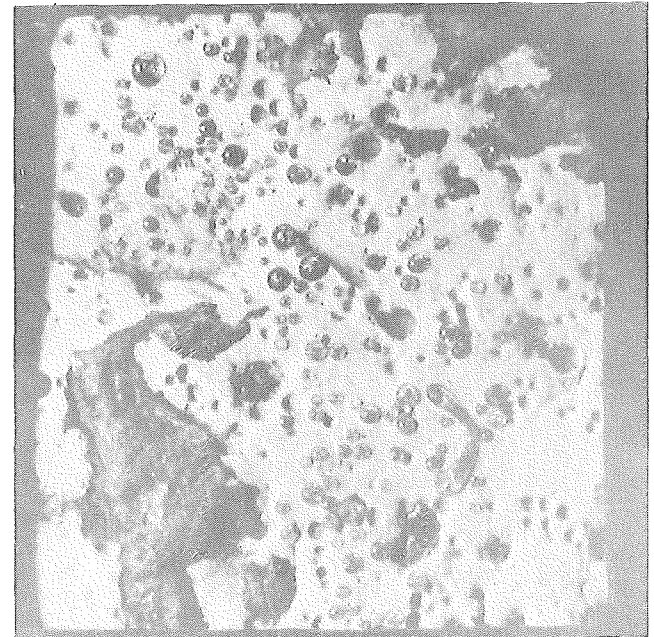


FIGURE 12
1950 YELLOW: BEADS INTACT, PAINT GOOD.
US 16 - EAST LANSING - WILLIAMSTON
AGE: 8 MONTHS.

SPECIAL TEST AREAS

During the course of the 1950 painting program, special traffic stripe test areas were established on M-43 between Lansing and East Lansing, on M-43 and US-16 in East Lansing, on US-16 west of Lansing City Limits, on US-27 at North City Limits of Lansing, and on US-16 between Fowlerville and New Hudson. In these test areas, paints and beads from various manufacturers were applied to determine the wearing qualities and bead retention properties of these traffic paints as compared to the Department's specification materials.

Personnel of the Testing and Research Division have made periodic inspections of these test installations and the results of their findings will be presented shortly in a separate report as a part of the Research Laboratory's general investigation on traffic marking paints.

SUMMARY

I. The following changes were made in 1950 operating conditions which were bound to give better traffic stripe performance in 1950 as compared to 1949.

1. The efficiency of the paint crews was materially increased by the paint school. Not only was the knowledge of the men increased on the subject of traffic paints, beads, and their application, but they were imbued with the desire to do a better job because of the interest being shown by the Administration.
2. The influence of humidity on drying time of the paint was determined and consequently immediate steps were taken to conform painting operations with humidity conditions to decrease drying time and insure minimum of tracking. Instructions were issued accordingly to all paint crews.
3. Better wetting of the beads by both 1950 white and yellow paints was obtained through modification of 1949 paint formulas.
4. The modifications in 1949 paint formulas were also directed toward producing a longer life product for 1950.
5. Better police control was experienced in 1950. More State Police were made available to control traffic, They were also more severe on persons crossing fresh traffic stripes. Scheduling of paint operations was better than in the past.
6. A greater educational program was put into effect by the Department through news release and radio warning motorists not to cross freshly painted traffic stripes.

II. As a result of the continuous field study during the 1950 painting program, additional changes have been made in 1950 paint and bead specifications which should produce even better wearing qualities for 1951. They are:

1. The diameter of the beads has been reduced to insure better penetration into the paint film and thus produce better bond and consequently impart longer wearing qualities to the stripe.
2. The white paint formula has been modified to produce a harder paint film, thus improving its wearing properties.

III. It is possible to realize even better paint wearing qualities through the following improvements:

1. Use of a paint stripe with small beads premixed in the paint and a quantity of large beads applied on top of the paint film.
2. By continuing studies to improve paint formulas, beads, and application methods.

CONCLUSION

Through the concerted efforts of those involved in the 1950 paint program there has resulted a definite improvement in workmanship accompanied by a marked increase in production. Also the wearing qualities and bead retention properties of the 1950 traffic paints have been found to be considerably better than those used in previous years.

MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

Traffic Marking Stripe Investigation
Highway Research Project 47 G-36

INSTRUCTIONS FOR TAKING PAVEMENT MARKING DATA

SUPPLEMENT NO. 1

Under item "REMARKS", include the exact number of hours the paint striping machine worked and the exact length in miles of each color and type of striping done during the day.

Research Laboratory
Testing and Research Division
May 8, 1950

MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

Traffic Marking Stripe Investigation
Highway Research Project 47 G-36

INSTRUCTIONS FOR TAKING PAVEMENT MARKING DATA

SUPPLEMENT NO. 2

1. Revision to Supplement No. 1 (5-8-50).

Change the wording "and the exact length in miles of each color and type of striping done during day" to read - "and the total miles of each type of stripe laid during the day".

In other words, disregard the break-down of miles completed each day by color. This information is what you normally record on your daily report sheet.

2. Reports received to date indicate a very cooperative spirit from the paint crews and the data submitted so far is very complete. However, we would like at this time, to stress care in recording data. For example, we note such irregularities as failure to record both air pressures; reversing the recordings of wet and dry bulb readings; also not recording data in proper place on forms. Such things will no doubt disappear as the work progresses.

General information about the work being supplied under "REMARKS" is quite satisfactory and of great value.

Research Laboratory
Testing and Research Division
May 17, 1950

MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

Traffic Marking Stripe Investigation
Highway Research Project 47 G-36

INSTRUCTIONS RELATIVE TO PAINTING

SUPPLEMENT NO. 3

Notice is hereby given to all paint spray crews that, effective immediately, the relative humidity of the air will be considered as a factor in determining whether or not to paint.

If the relative humidity is not more than 65 percent, and is falling, it shall be considered satisfactory to paint. If, however, the relative humidity is more than 60 percent, and is rising, painting shall be deferred until the humidity drops below 65 percent and continues to fall.

The data forwarded to the Laboratory have made possible a correlation of drying time with relative humidity which makes this step appear advisable at this time. It is hoped that by following this procedure, a considerable amount of trouble with traffic pick-up will be eliminated.

Research Laboratory
Testing and Research Division
June 20, 1950

MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

Traffic Marking Stripe Investigation
Highway Research Project 47 G-36

INSTRUCTIONS RELATIVE TO PAINTING

SUPPLEMENT NO. 4

Notice is hereby given to all paint spray crews that, effective immediately, painting shall not be started prior to 8:30 a.m. Painting shall be continued for a regular working day thereafter.

This supplement does not replace previous instructions but is in addition to them. All provisions of previous supplements are still in effect.

Research Laboratory
Testing and Research Division
June 26, 1950

TRAFFIC MARKING STRIPES - FIELD METEOROLOGICAL AND PAVEMENT DATA

Operation No. _____ Date _____ Location* _____

General weather conditions _____

Time of Day	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	1:30	2:00	2:30	3:00	3:30	4:00	4:30	5:00	
Dry																				
Wet																				
Relative humidity																				
Clear																				
Cloudy																				
Raining																				
Fog																				
Wind																				
Direction																				
Velocity																				
Direction of work																				
Type																				
Portland																				
Bituminous																				
Width																				
Number of lanes																				
Longitudinal																				
Joint																				
Dry																				
Wet																				
Clean																				
Dirty																				
Oily																				
Smooth																				
Rough																				
Bituminous patches																				
Old paint																				
*Location																				

Remarks _____

TRAFFIC MARKING STRIPES - APPLICATION DATA

Operation No.		Date	Location*																	
Equipment No.		Personnel																		
Time of day		8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	1:30	2:00	2:30	3:00	3:30	4:00	4:30	5:00
Pavement	Type	Portland																		
		Bituminous																		
	Width																			
Number of lanes																				
Paint	Type																			
	Color																			
	Vendor																			
Beads	On Paint (1)	Brand																		
		Vendor																		
		Coverage #/gal.																		
	In Paint (2)	Brand																		
	Vendor																			
		Concentration #/gal.																		
Application	Kind of stripe																			
	Air Pressure	On paint																		
		Atomization																		
	Drying Time	To touch																		
		To no pickup																		
	Stripe closed to Traffic	Time																		
		Length																		
	Paint Film	Thickness																		
		Gallons/mile																		
	Equipment	Speed																		
		Direction of travel																		
		Mechanical trouble																		
	Total gallons paint applied																			
Total lbs. beads used	Type 1																			
	Type 2																			
Total miles involved																				
Paint wetting beads?																				
Paint film uniform?																				
Bead coverage uniform?																				
Edges sharp or ragged?																				
Edge thickening?																				
Bleeding?																				
Blistering?																				
Tracking?																				
Bead retention, %																				
Bead penetration, %																				
Hunter meter readings																				
Nos. of photographs taken																				
Nos. of photomicrographs																				
Nos. of sheet metal samples																				
*Location																				

Remarks

MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

Form 522

TRAFFIC MARKING STRIPES - PAVEMENT MARKING CREW DATA

Date _____ Equipment No. _____ Route _____
 Location A _____ B _____
 _____ C _____ D _____

TIME	A _____ A.M.	B _____ A.M.	C _____ P.M.	D _____ P.M.
Dry Bulb				
Wet Bulb				
Rel. Humidity				
Wind	Direction			
	Velocity			
Weather				
Direction of work				
Speed				
Pavement	Type			
	Condition			
	Width			
	Temperature			
Beads	Brand			
	In Paint			
	On Paint			
Stripe	Kind (C.L.N.P.)			
	Color			
	Vendor			
Air Pressure	On Paint			
	Atomization			
Drying Time				
Gallons Paint per Mile				
Faint Wetting Beads				

Remarks: _____

Signed _____