DOT-FH-11-8608

Task Order No. 17

FIELD EVALUATION OF PAVEMENT MARKING MATERIALS

"NONTOXIC YELLOW PAINT"

FINAL REPORT

Report No. 537-1F

Prepared by

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INTRODUCTION

As environmentalists become more entangled in our way of life, more and more pressure is exerted to eliminate all forms of materials that for one reason or another are considered as being environmentally unsafe or as being a health hazard. For this reason, millions of dollars are being spent to try to totally and completely eliminate lead and lead compounds from materials and/or products utilized by the population.

The environmentalists even want lead compounds removed from traffic marking materials. A review of standards for traffic markings, and in particular for yellow markings, reveals that even in dense urban areas there is no concentrated use of the yellow marking materials in any small area. There is no data or information available to indicate that any contamination of the environment with lead is caused by traffic markings on the roadway.

Be that as it may, the Federal Highway Administration (FHWA) initiated a program to develop a lead-free yellow traffic paint. Two chlorinated rubber-alkyd-chlorinated paraffin yellow traffic paints were developed utilizing organic yellows. One of the paints, FHWA Code 49, exhibits a color very close to that achieved with medium chrome yellow. The other paint is similar in color to light chrome yellow and is designated FHWA Code 52.

On November 3, 1979, FHWA entered into a contract with the Texas State Department of Highways and Public Transportation (SDHPT) to evaluate the two formulations and a 50/50 mix of SDHPT standard white and yellow traffic paint. The contract called for SDHPT standard yellow traffic paint to be used as a control. All of the traffic paints were to be evaluated on asphaltic concrete (ACP) and portland cement concrete (PCCP) pavements.

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SUMMARY

Evaluations of traffic paint markings were conducted in an effort to determine their daytime and nighttime functionality.

Included in the project initially were two formulations supplied by FHWA, a 50/50 blend of the white and yellow traffic paint currently used by the SDHPT, and the yellow traffic paint currently used by SDHPT. These traffic markings were evaluated for a period of eight months.

Color photographs exhibit night and day appearance of the traffic paints evaluated initially and after eight months of exposure to traffic.

IMPLEMENTATION

Based on findings in this evaluation, it is recommended that the use of lead-free or low-lead traffic paints not be implemented at this time.

CONCLUSIONS

As a result of this study, it is apparent that lead-free yellow traffic paints can be formulated to function properly under both day and night conditions.

Two batches of both Code types (49 and 52) were submitted by FHWA for evaluation. Since the initial characteristics (in particular viscosity) of the various batches have not been submitted to the author, it is impossible to conclude whether the two formulations exhibit poor can stability or whether the different batches were not manufactured to meet specification requirements. One batch of each type placed three and one-half months after manufacture exhibited good application characteristics. Batch number 380121 of Code 49 placed five months after manufacture was extremely thick, required thinning, and exhibited poor application characteristics. Batch number 380122 of Code 52 placed five months after manufacture was very thin, settled rapidly, and blistered on application. This material surface-dried rapidly and trapped solvent.

Even though it is apparent from this project that yellow traffic paints can be formulated using non-lead pigments, it is equally apparent to the author that the formulations of the paints submitted by FHWA for evaluation are only rough formulations and need to be refined before they are of practical usage.

RECOMMENDATIONS

It is recommended that any future studies on a lead-free yellow traffic paint proceed as follows:

1. Laboratory samples be prepared and run through heating and cooling cycles to determine can and storage stability.

2. Durability of color be determined in a weatherometer on beaded and unbeaded panels.

3. Abrasion resistance be determined by an accelerated blasting method in the laboratory.

4. When the above three are optimized with respect to durability and cost, have two small production batches produced under careful inspection. Place this paint for evaluation on roadways where the wear characteristics of traffic paint are known. At the same time and on the same roadways, place a current specification traffic paint having known durability characteristics.

5. Throughout the above work, the researcher should keep in mind that the main objective is not to necessarily develop a completely lead-free system, but to develop a system that is economically feasible and as lead-free as possible to satisfy economic and environmental desires.

6. Determine the availability of suitable lead-free yellow pigments.

7. Develop a rapid test to determine the weatherability of lead-free yellow pigments that could be used for quality control immediately prior to or during paint production.

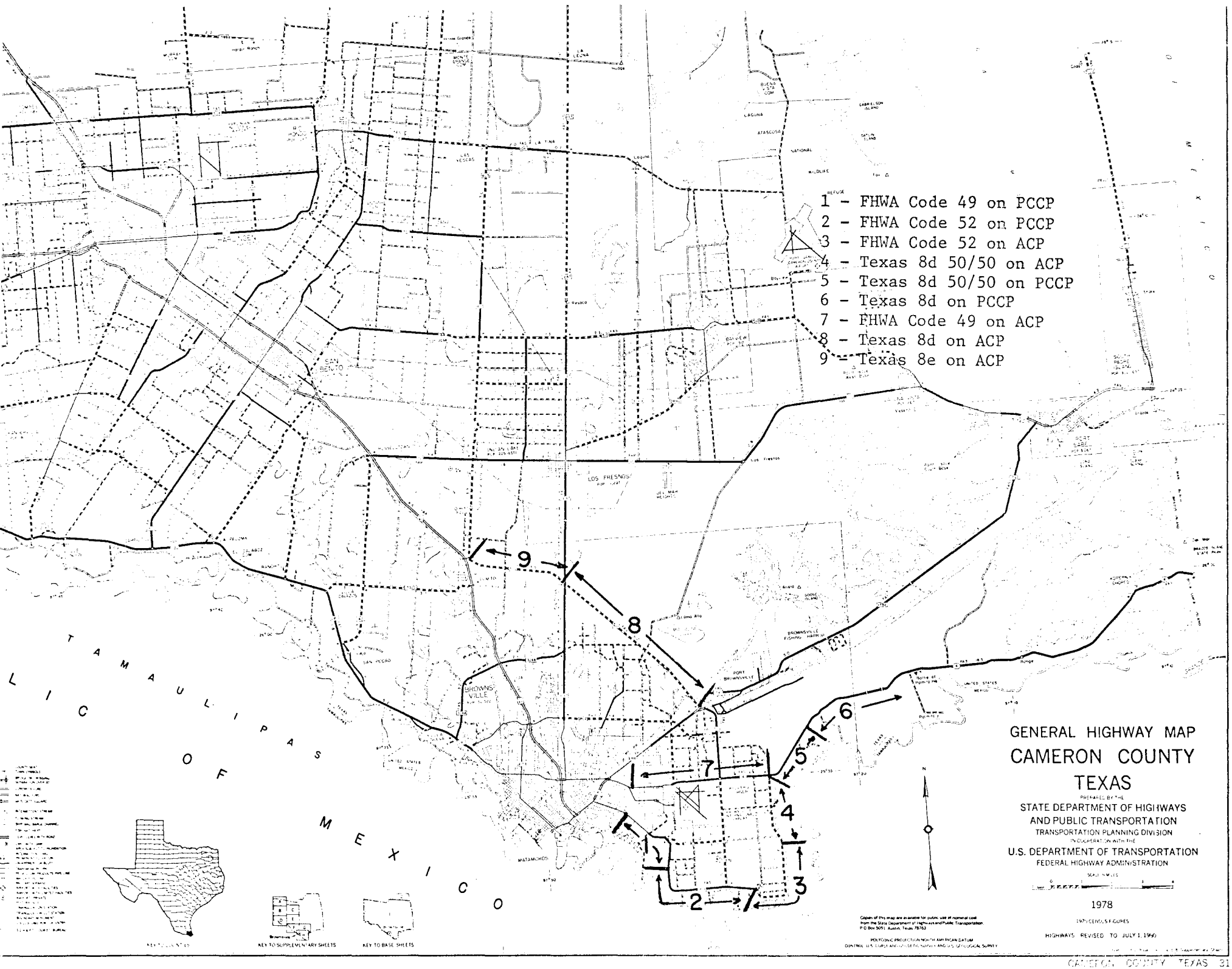
DISCUSSION

In order to accomplish contractual agreements, a location was selected in the Rio Grande Valley wherein all systems could be placed on asphaltic and Portland cement concrete surfaces and experience a minimum of travel between test sections. Some of the ACP surfaces are actually PCCP with ACP overlays. (See Figure 1.)

All systems were placed on the roadway February 5, 6 and 7, 1980. Photos 2 through 17 (See Appendix) show day and night appearance of each system on ACP and PCCP the day the system was placed and the first night after placement.

Samples were taken of the Code 49 and Code 52 paints and tested in the laboratory. Both paints had very close characteristics except for set-to-touch time (20 seconds for Code 49 and 45 seconds for Code 52). This difference in set-to-touch time was exhibited during application in that the Code 49 paint "capped" over and had a slight tendency to blister. All other application characteristics appeared to be identical.

During the week of application, observers were run through the project during the day and then again at night. Each observer was given a form (see Figure 2) and was asked to check the column that best described his opinion. All observers were passengers with a driver as a guide. Upon reaching the approximate middle of a test section, the driver would ask the observer to rate the marking and fill in the comment if he so desired. The driver


1 - FHWA Code 49 on PCCP
2 - FHWA Code 52 on PCCP
3 - FHWA Code 52 on ACP
4 - Texas 8d 50/50 on ACP
5 - Texas 8d 50/50 on PCCP
6 - Texas 8d on PCCP
7 - FHWA Code 49 on ACP
8 - Texas 8d on ACP
9 - Texas 8e on ACP
GENERAL HIGHWAY MAP
CAMERON COUNTY
TEXAS
PREPARED BY THE
STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION
TRANSPORTATION PLANNING DIVISION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
1978
1970 CENSUS FIGURES
HIGHWAYS REVISED TO JULY 1, 1990
TAMAULIPAS
MEXICO
BROWNSVILLE
MATAMOROS
KEY TO SUPPLEMENTARY SHEETS
KEY TO BASE SHEETS

Surface: Asphalt

Test Section	Color Distinguishability Distinct	Easily	Difficult	Very Difficult
1				
2				
3				
4				
5				

Comments

1

2

3

4

5

Surface: PC Concrete

Test Section	Color Distinguishability Distinct	Easily	Difficult	Very Difficult
1				
2				
3				
4				

Comments

1

2

3

4

Figure 2

attempted to distract the observer from observing the markings until he was ready to have the marking evaluated.

The observers experienced no difficulty in easily or distinctly identifying the color of the stripe when initially placed.

Observations were made again after the markings were four months old. Again all markings exhibited easy or distinct color distinguishability at night on all surfaces. Several observers commented that the Code 49, Code 52 and 50/50 mix at night were light yellow or white yellow, depending on the individual's terminology. Further questioning of these observers revealed that they meant the color was a lighter yellow than the markings they were used to observing.

Daytime observations at the four-month interval showed that the 50/50 mix exhibited easy color definition on normal hot-mix ACP, but difficult color definition on a short section of seal coat utilizing a white rock.

After eight months there continued to be a steady decline in the color distinguishability, particularly in the daytime, except for the SDHPT yellow traffic paint which continued to be rated as "distinct".

Figures 3 and 4 are samples of typical data taken on the four month day and night evaluation. The key to the data is as follows: ACP Asphalt 1 - Code 49, 2 - Code 52, 3 - 50/50 mix, 4 - SDHPT yellow, and 5 - experimental yellow developed by SDHPT containing 1.25 pounds medium chrome yellow per gallon (this paint is currently SDHPT standard yellow traffic paint, see Photo 1); Concrete 1 - Code 49, 2 - Code 52, 3 - 50/50 mix, and 4 - SDHPT yellow traffic paint.

Surface: Asphalt

Test Section	Color Distinguishability: Distinct	Easily	Difficult	Very Difficult
1 - A		✓		
2 - A	✓			
3 - A		✓		
4 - A		Hot Mix ✓	White Rock ✓	
5 - A		✓		

Comments

1 Pale color - blends with white rock

2 Favors white - doesn't stand out on white rock

3 Looks good beginning to fade

4 Looks red-orange in color

5 Looks good

Surface: PC Concrete

Test Section	Color Distinguishability: Distinct	Easily	Difficult	Very Difficult
1 - C		✓		
2 - C			✓	
3 - C		✓		
4 - C	✓			

Comments

1 Color fading - good reflection

2 Looks yellow-white, good reflection

3 Favors white - good reflection

4 Better on concrete than Hot mix

Day 6-25-80

Figure 3

Surface: Asphalt

Test Section	Color Distinguishability: Distinct	Easily	Difficult	Very Difficult
1	✓			
2	✓			
3	✓			
4	✓			
5	✓			

Comments

1 Light yellow color - good reflection

2 Flat yellow color - good reflection

3 Light yellow color - fair reflection

4 Yellow-orange color - good reflection

5 Bright yellow - very good reflection

Surface: PC Concrete

Test Section	Color Distinguishability: Distinct	Easily	Difficult	Very Difficult
1		✓		
2		✓		
3	✓			
4	✓			

Comments

1 Looks white - good reflection

2 looks Beige white color - fair reflection

3 Concrete makes it look yellow - good reflection

4 Yellow-orange - good reflection

Night 6-25-80

Figure 4

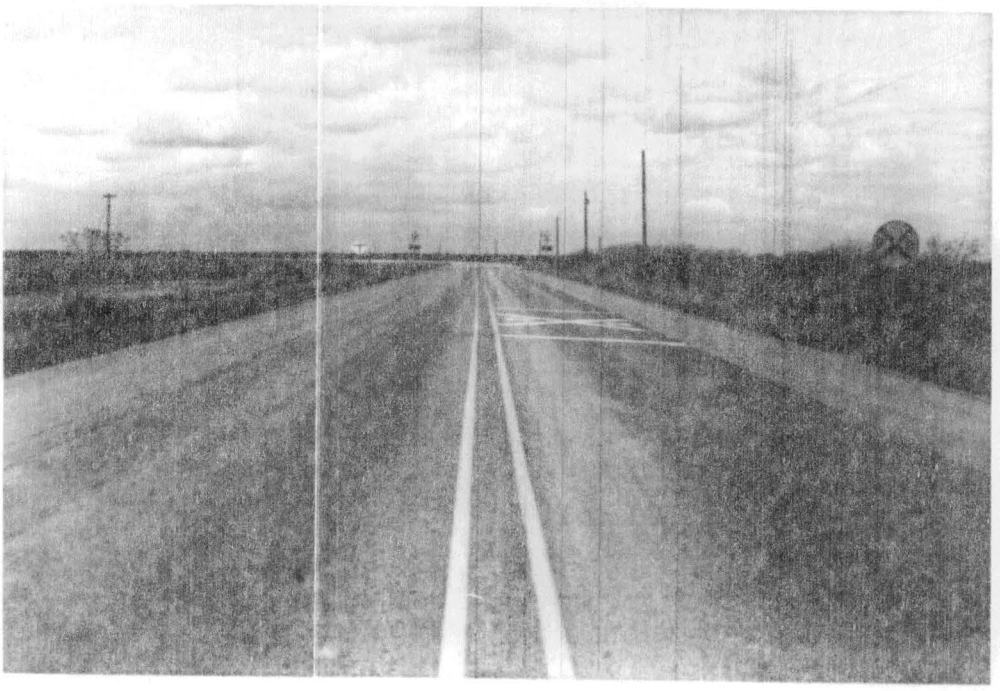


Photo 1

Texas YPT-8d - 1.75 lbs medium chrome yellow per gallon in foreground, YPT-8e - 1.25 lbs medium chrome yellow per gallon in background.

To get a true reflection of the data, one must consider the ratings, the comments, and the fact that all of the observers knew the stripe was supposed to be yellow. Due to insurance requirements, it was decided that only Department personnel should be used as observers. The author feels that if non-Department observers had been used results would be different. It is the author's experience, from talking to motorists on CB radio at night about pavement markings and their opinions of the markings, that many motorists have no idea what color a stripe should be or what the colors mean. It is also the author's opinion that, regardless of the motorist's knowledge about the color requirements for various pavement markings, it is the responsibility of the various municipal, county, state and federal agencies responsible for traffic markings to place markings on

the roadway of a color purity that is easily distinguished by the motorist and that meets color requirements, both day and night, throughout the useful life of the marking.

Photos 20 through 35 (see Appendix) are day and night photographs of the various paints at the end of eight months of exposure.

In April, additional Code 49 and Code 52 paint was received from FHWA. It was decided to retain this paint and restripe each section when the evaluation period was complete. This would give some information about can stability of the traffic paints and retracing characteristics.

Slightly over five months after date of manufacture, the additional paint was placed on the roadway. The Code 49 paint was extremely thick and had to be thinned for application. Photo 2 shows the resulting stripe for Code 49 paint.

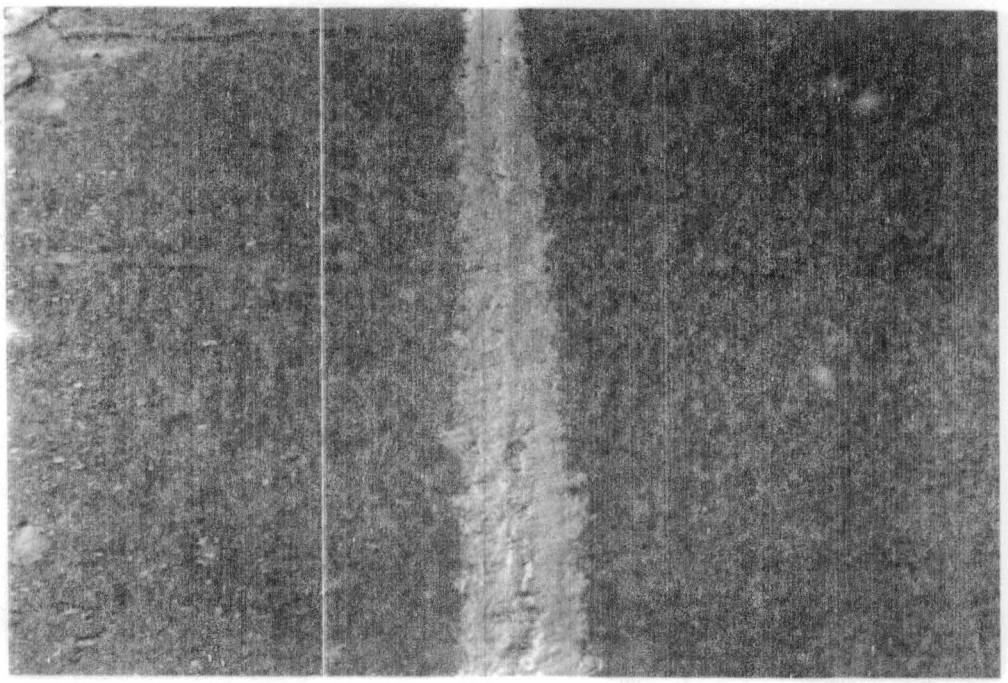


Photo 2
Applied FHWA Code 49 traffic paint after 5-1/2 months of storage.

The Code 52 paint was extremely thin, badly settled, the hiding power was less than desirable, and it blistered extremely bad upon application. (See Photo 3.) Since initial results on viscosity are not available, it is indeterminable as to whether the paints have poor can stability or whether they were manufactured outside the specification.

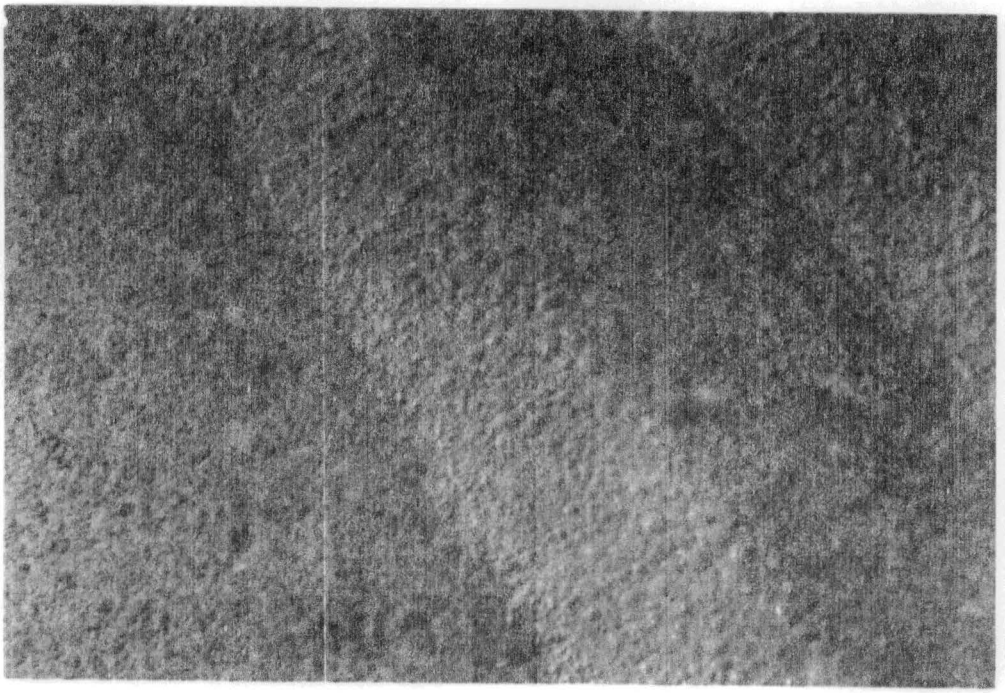


Photo 3

Applied FHWA Code 52 traffic paint after 5-1/2 months of storage.

Photos 36 through 41 (see Appendix) exhibit the day appearance of markings retraced with Code 49, Code 52 and SDHPT yellow traffic paints.

As a result of this study and the author's experience with traffic paint formulation, production and quality control, storage and application, it is his opinion that yellow traffic paints can be formulated with non-lead pigments. It is also his opinion that the formulations or paints sub-

mitted by FHWA were either not workable formulations or were not manufactured to meet specification requirements (which could include the use of nonspecification raw materials).

ACKNOWLEDGEMENTS

The author wishes to thank the following individuals and groups of individuals within the Texas State Department of Highways and Public Transportation for their efforts and assistance in the successful completion of this project.

1. Mr. Samuel G. Cox - District Maintenance Engineer, District 21.

2. Mr. Rumaldo R. Rivera - Maintenance Construction Supervisor, Brownsville.

3. District 21 Striping Crew.

4. Mr. Donnie W. Killgore - Paint Engineer, Materials and Tests Division.

APPENDIX

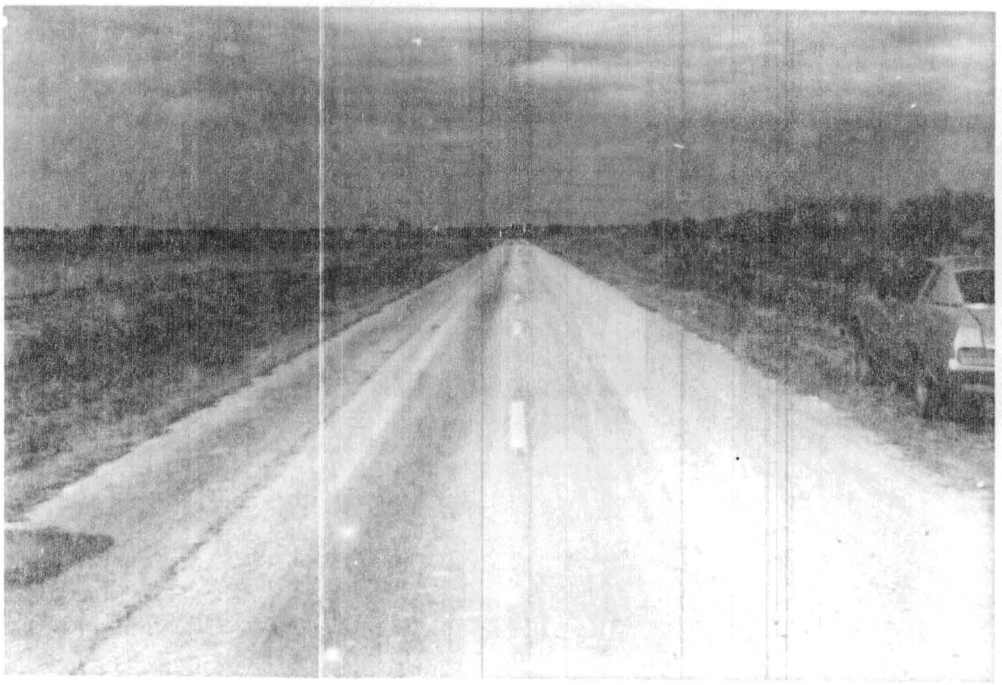


Photo 4
Day Appearance of FHWA Code 49
Traffic Paint on ACP

Photo 5
Night Appearance of FHWA Code 49
Traffic Paint on ACP

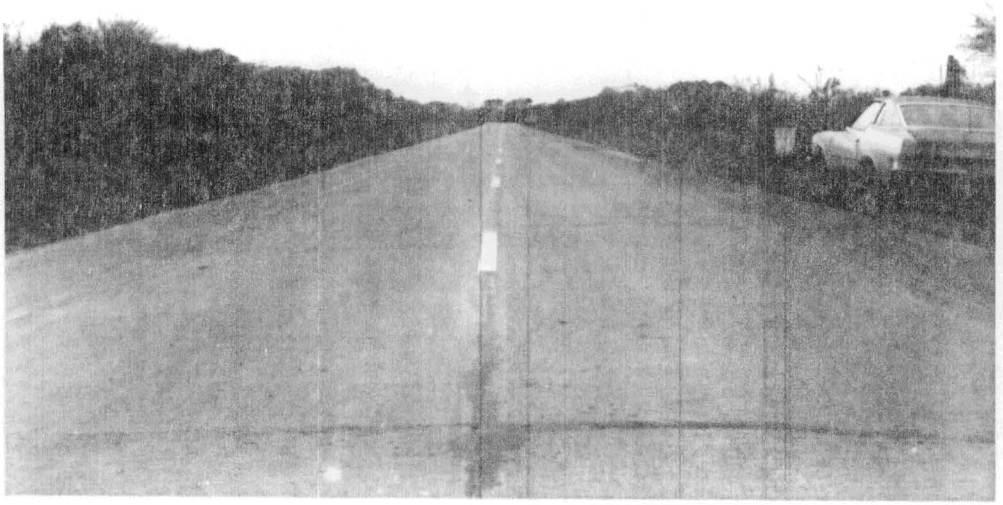


Photo 6
Day Appearance of FHWA Code 49
Traffic Paint on PCCP

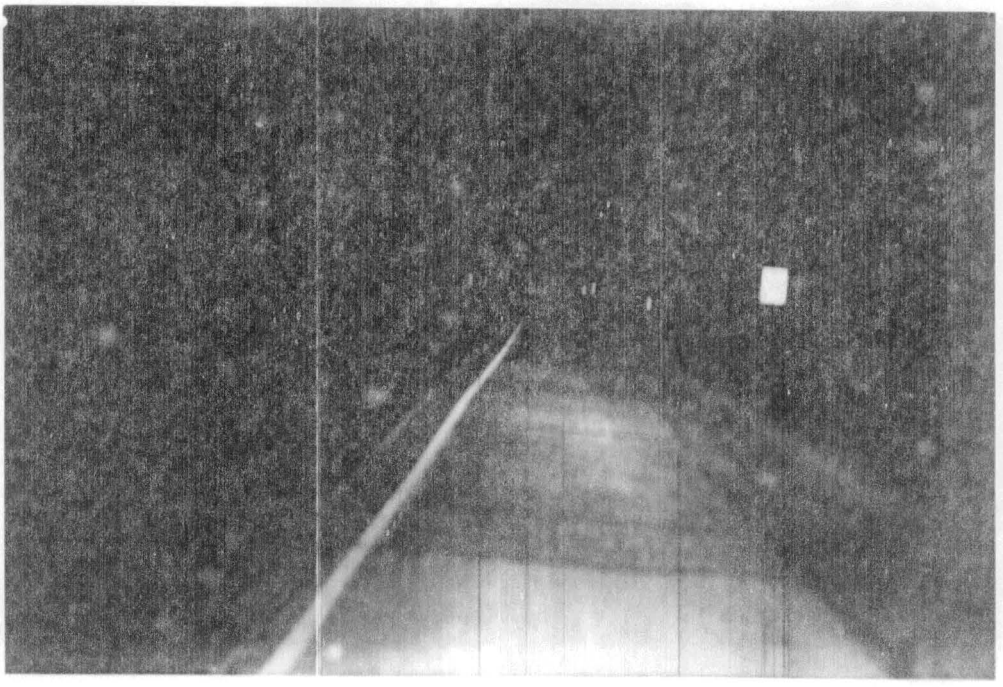


Photo 7
Night Appearance of FHWA Code 49
Traffic Paint on PCCP

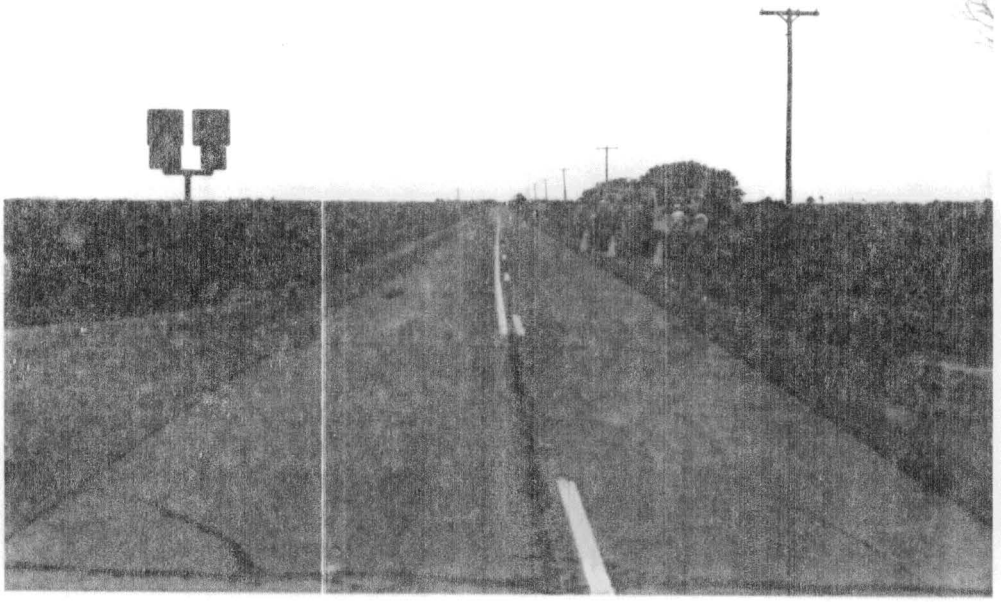


Photo 8
Day Appearance of FHWA Code 52
Traffic Paint on ACP

Photo 9
Night Appearance of FHWA Code 52
Traffic Paint on ACP

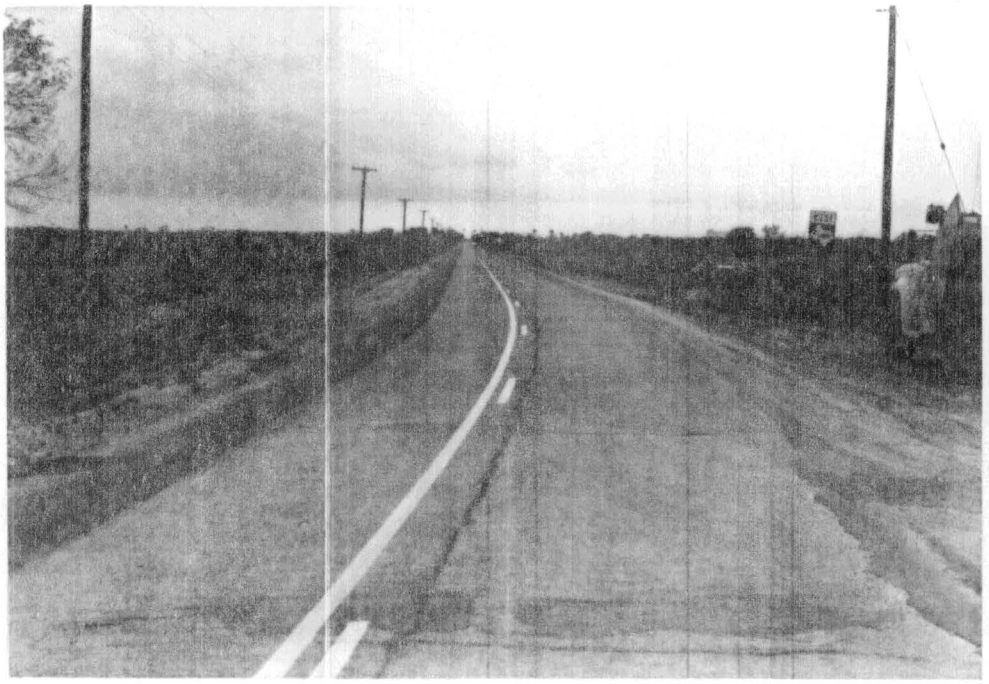


Photo 10
Day Appearance of FHWA Code 52
Traffic Paint on PCCP

Photo 11
Night Appearance of FHWA Code 52
Traffic Paint on PCCP

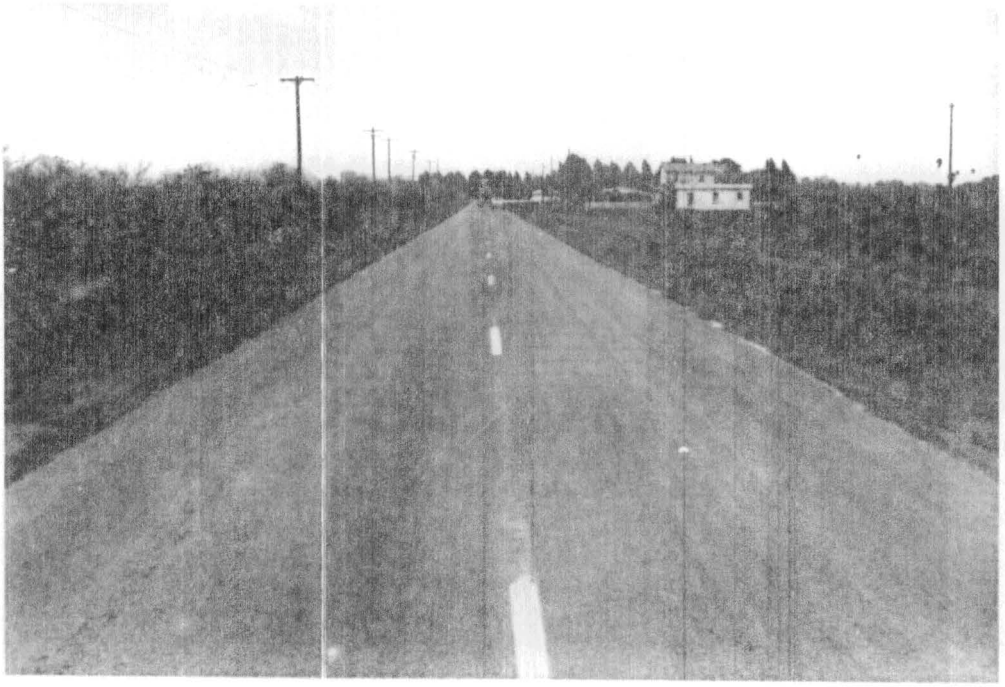


Photo 12
Day Appearance of 50/50 Mix of
Texas Specification White and Yellow Traffic Paint on ACP

Photo 13
Night Appearance of 50/50 Mix of
Texas Specification White and Yellow Traffic Paint on ACP

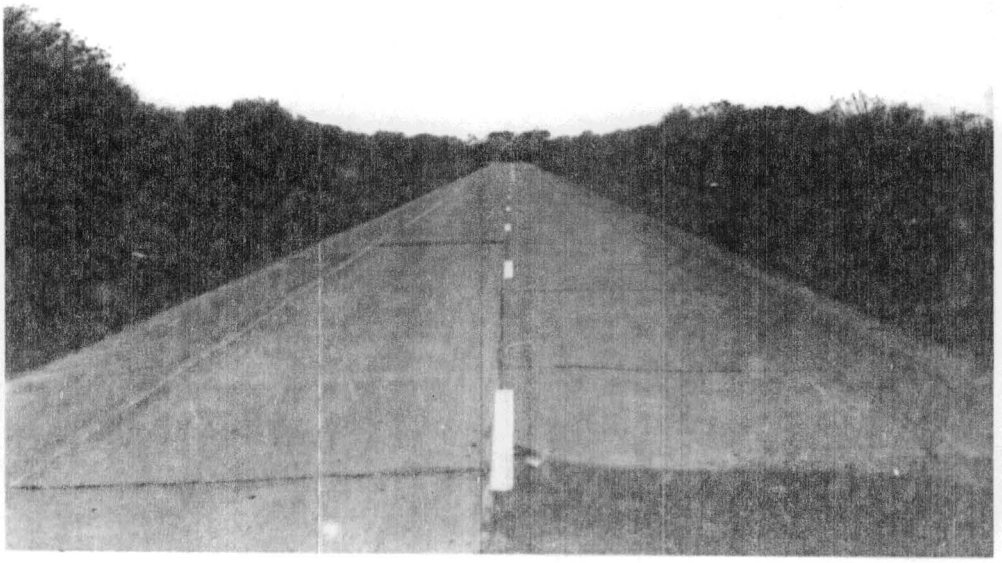


Photo 14
Day Appearance of 50/50 Mix of Texas
Specification White and Yellow Traffic Paint on PCCP

Photo 15
Night Appearance of 50/50 mix of Texas
Specification White and Yellow Traffic Paint on PCCP

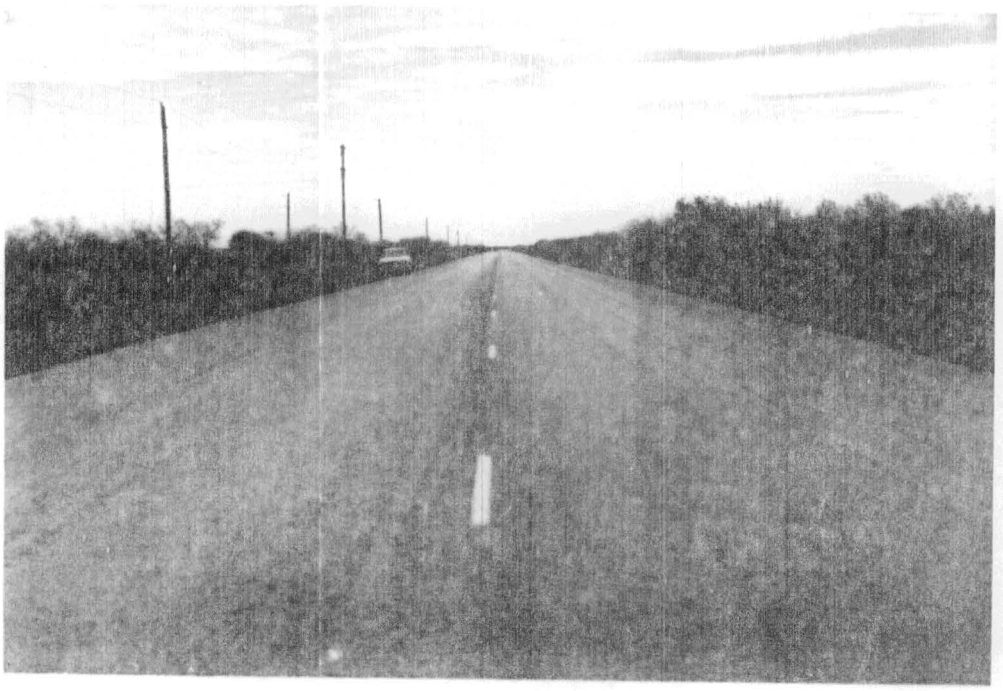


Photo 16
Day Appearance of Texas Specification
Yellow Traffic Paint on ACP

Photo 17
Night Appearance of Texas Specification
Yellow Traffic Paint on ACP

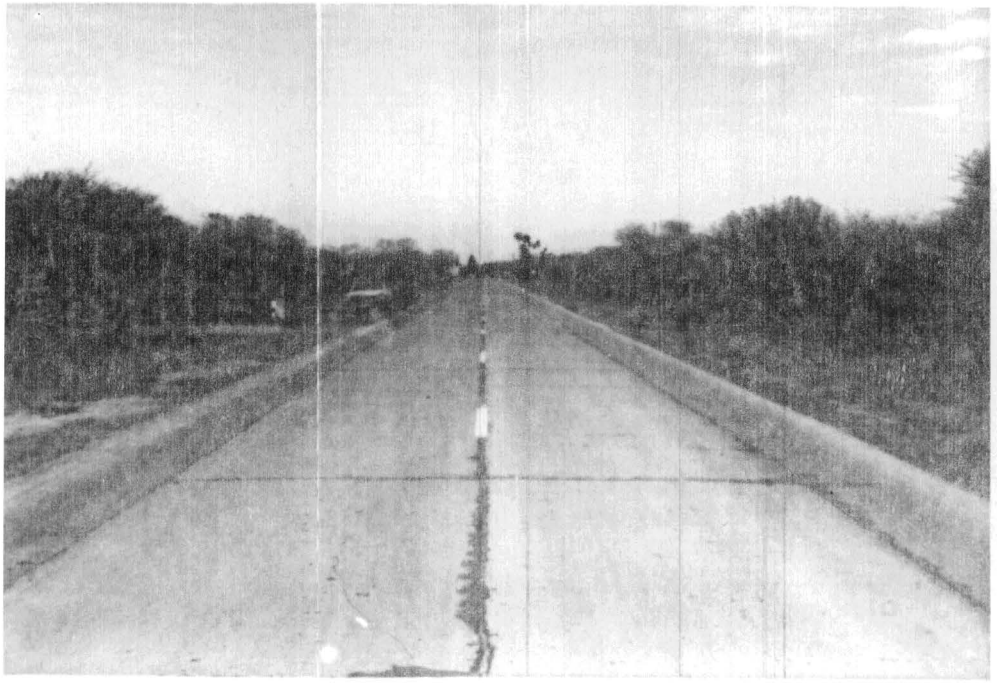


Photo 18
Day Appearance of Texas Specification
Yellow Traffic Paint on PCCP

Photo 19
Night Appearance of Texas Specification
Yellow Traffic Paint on PCCP

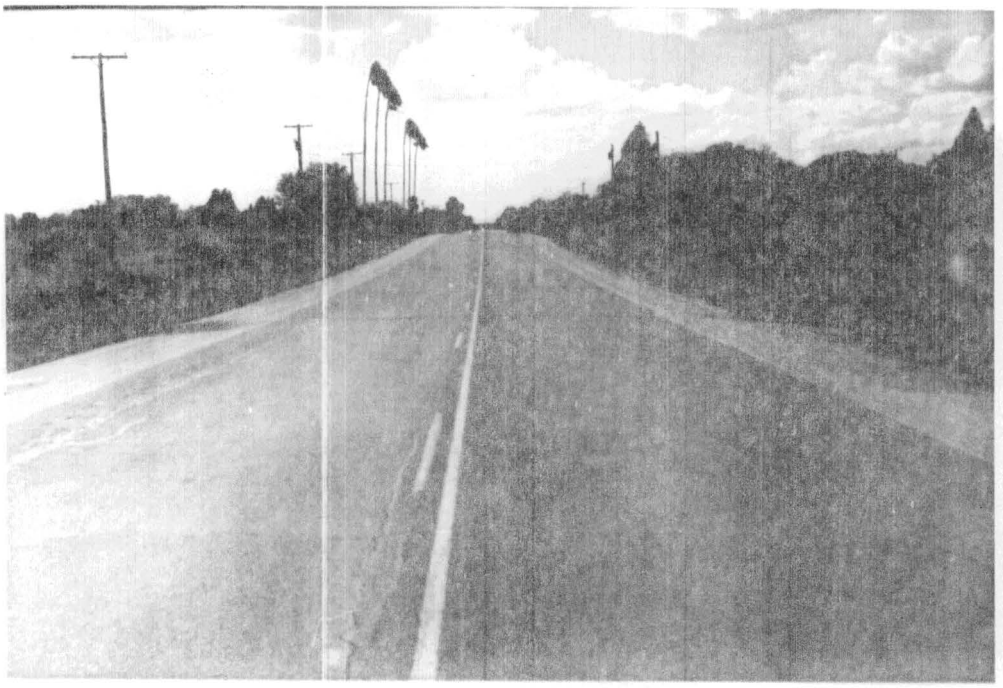


Photo 20
Day Appearance of FHWA Code 49 Traffic
Paint on ACP After Eight Months Exposure

Photo 21
Night Appearance of FHWA Code 49 Traffic
Paint on ACP After Eight Months Exposure

Photo 22
Day Appearance of FHWA Code 49 Traffic
Paint on PCCP After Eight Months Exposure

Photo 23
Night Appearance of FHWA Code 49 Traffic
Paint on PCCP After Eight Months Exposure

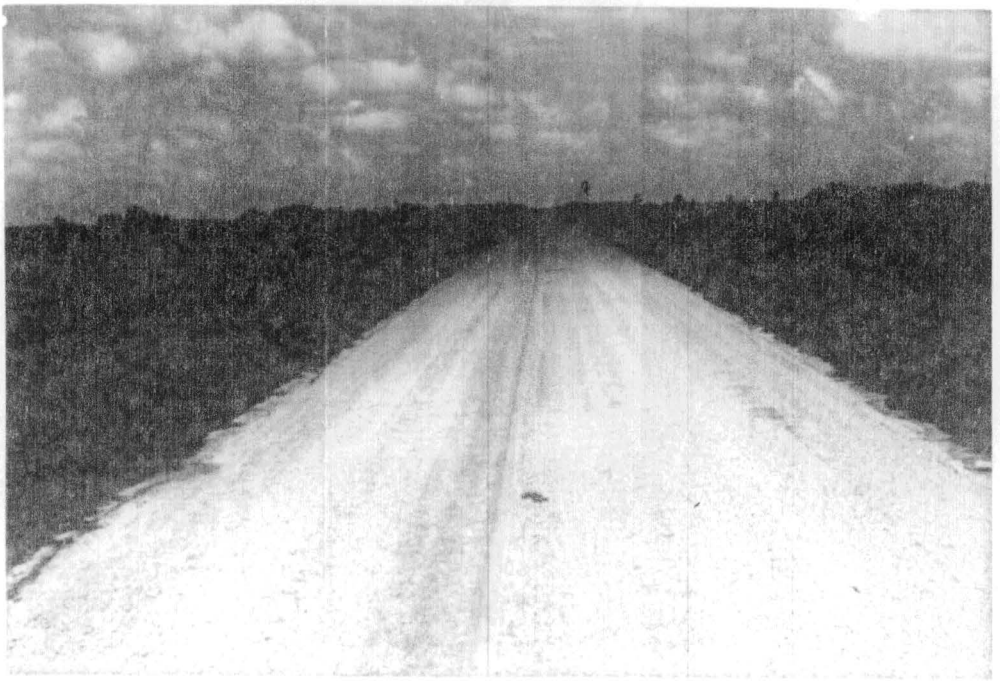


Photo 24
Day Appearance of FHWA Code 52 Traffic
Paint on ACP After Eight Months Exposure

Photo 25
Night Appearance of FHWA Code 52 Traffic
Paint on ACP After Eight Months Exposure

Photo 26
Day Appearance of FHWA Code 52 Traffic
Paint on PCCP After Eight Months Exposure

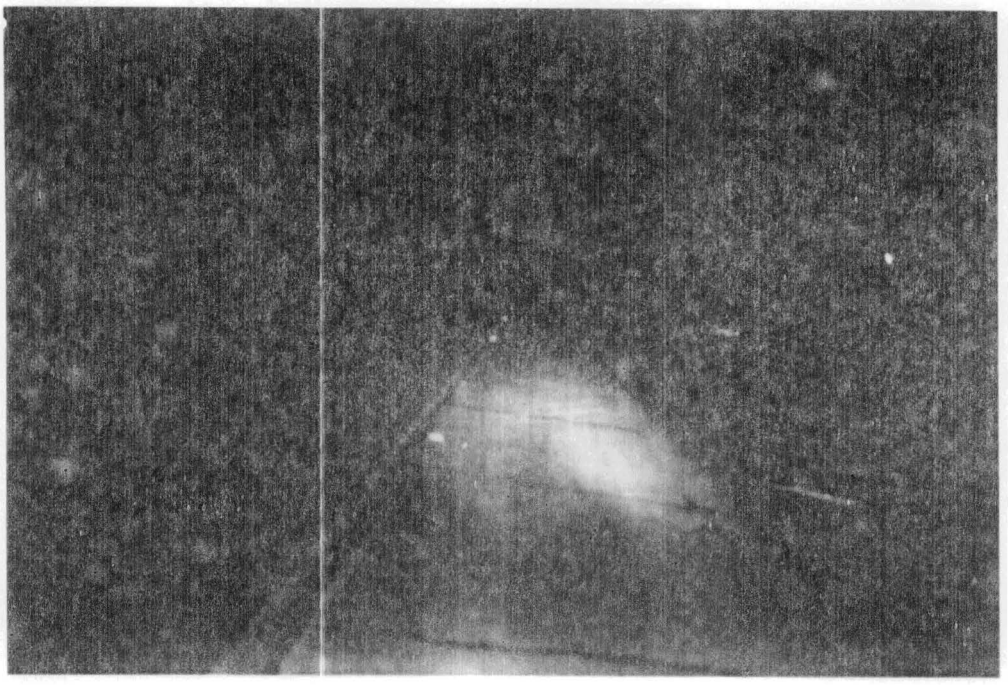


Photo 27
Night Appearance of FHWA Code 52 Traffic
Paint on PCCP After Eight Months Exposure

Photo 28
Day Appearance of 50/50 Mix Traffic
Paint on ACP After Eight Months Exposure

Photo 29
Night Appearance of 50/50 Mix Traffic
Paint on ACP After Eight Months Exposure

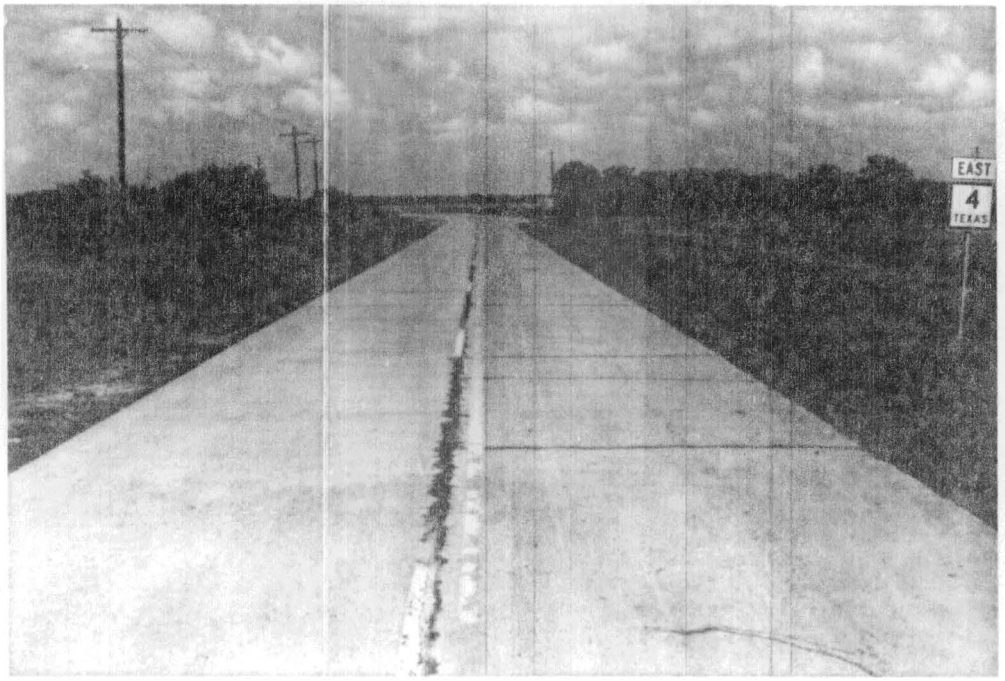


Photo 30
Day Appearance of 50/50 Mix Traffic
Paint on PCCP After Eight Months Exposure

Photo 31
Night Appearance of 50/50 Mix Traffic
Paint on PCCP After Eight Months Exposure

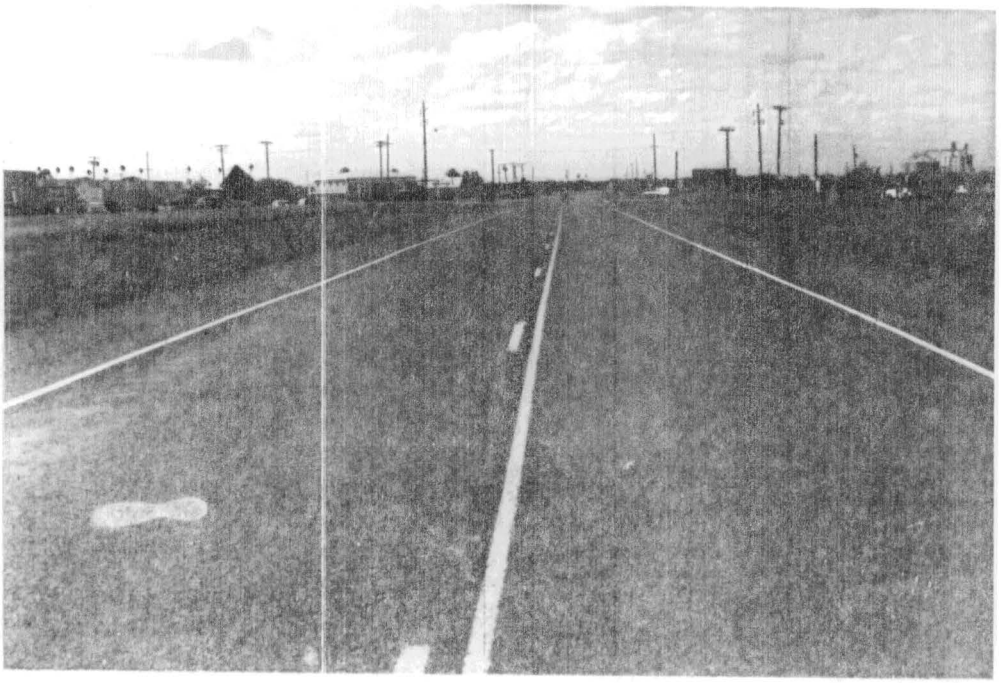


Photo 32
Day Appearance of Texas Specification Traffic
Paint on ACP After Eight Months Exposure

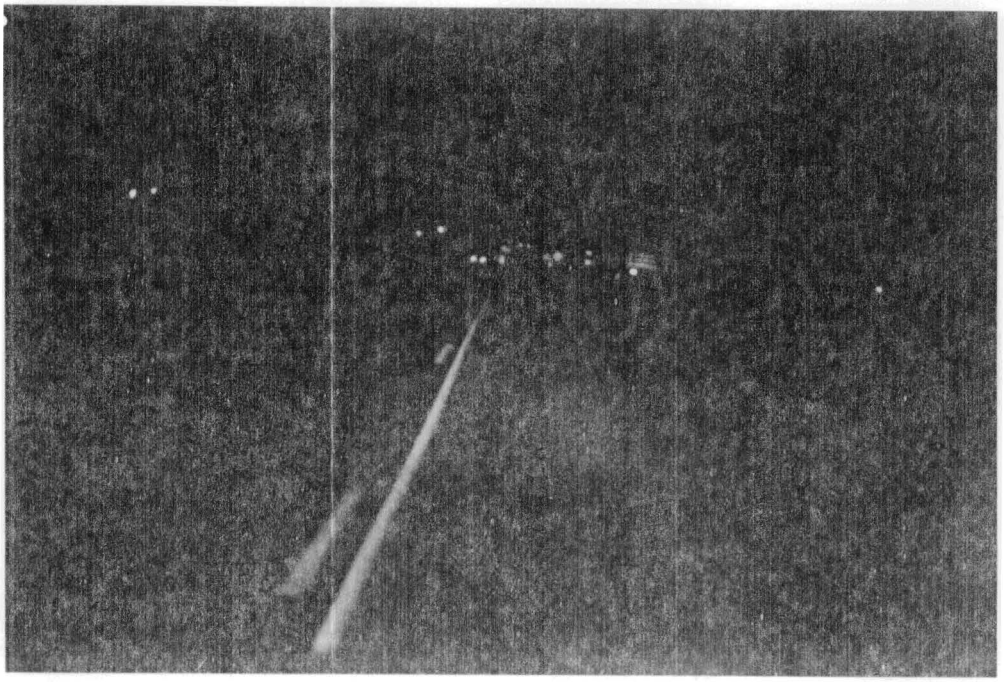


Photo 33
Night Appearance of Texas Specification Traffic
Paint on ACP After Eight Months Exposure

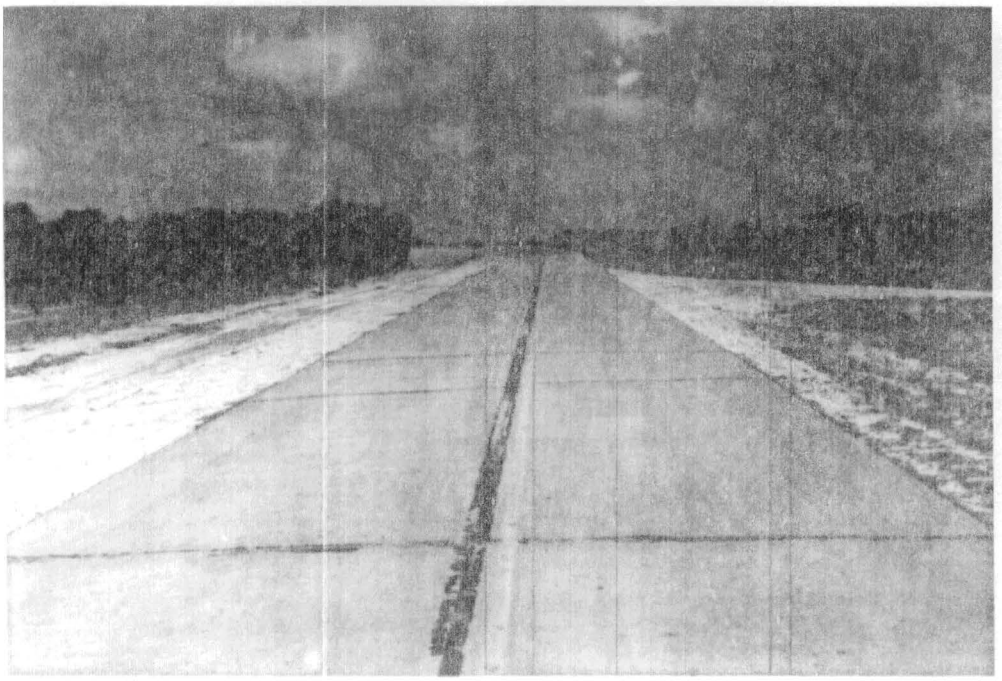


Photo 34
Day Appearance of Texas Specification Traffic
Paint on PCCP After Eight Months Exposure

Photo 35
Night Appearance of Texas Specification Traffic
Paint on PCCP After Eight Months Exposure

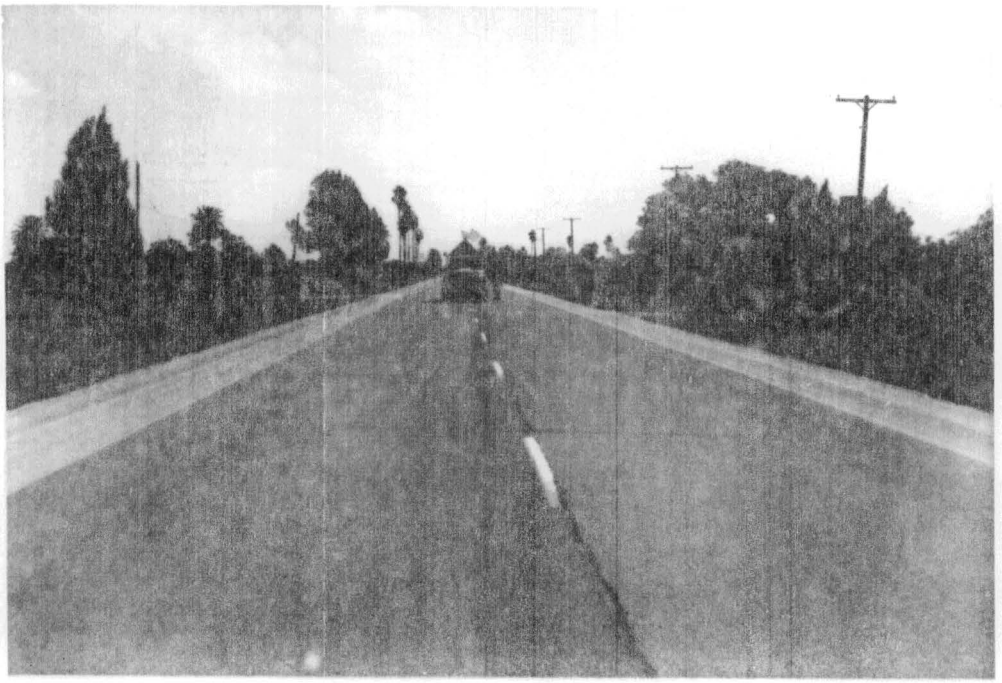


Photo 36
Day Appearance of Restripe With
FHWA Code 49 Traffic Paint on ACP

Photo 37
Day Appearance of Restripe With
FHWA Code 49 Traffic Paint on PCCP

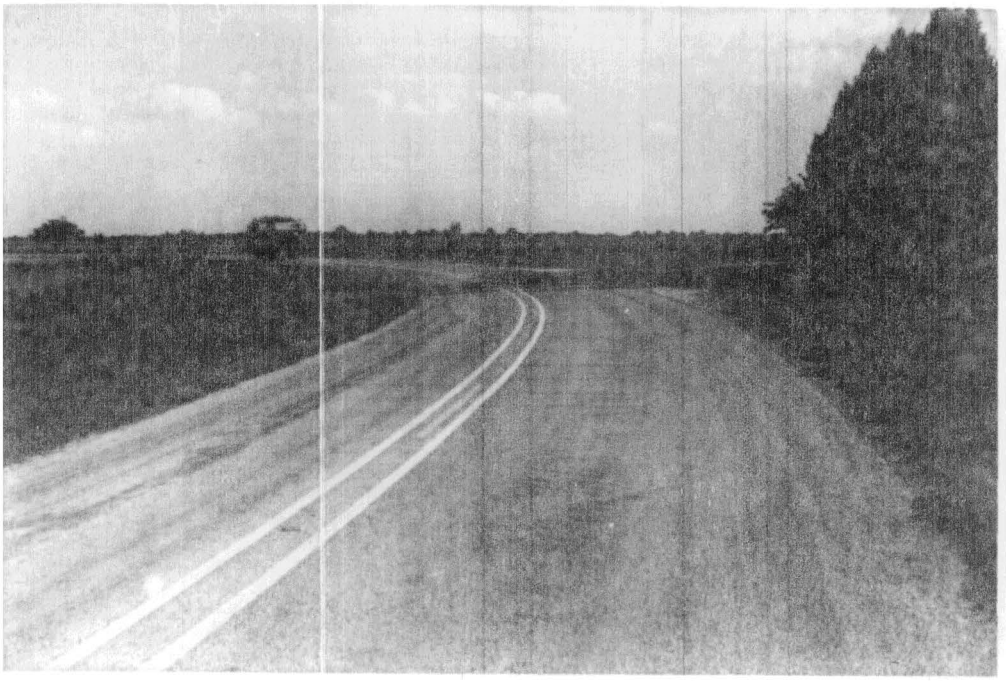


Photo 38
Day Appearance of Restripe With
FHWA Code 52 Traffic Paint on ACP

Photo 39
Day Appearance of Restripe With
FHWA Code 52 Traffic Paint on PCCP

Photo 40
Day Appearance of Restripe With
Texas Specification on ACP

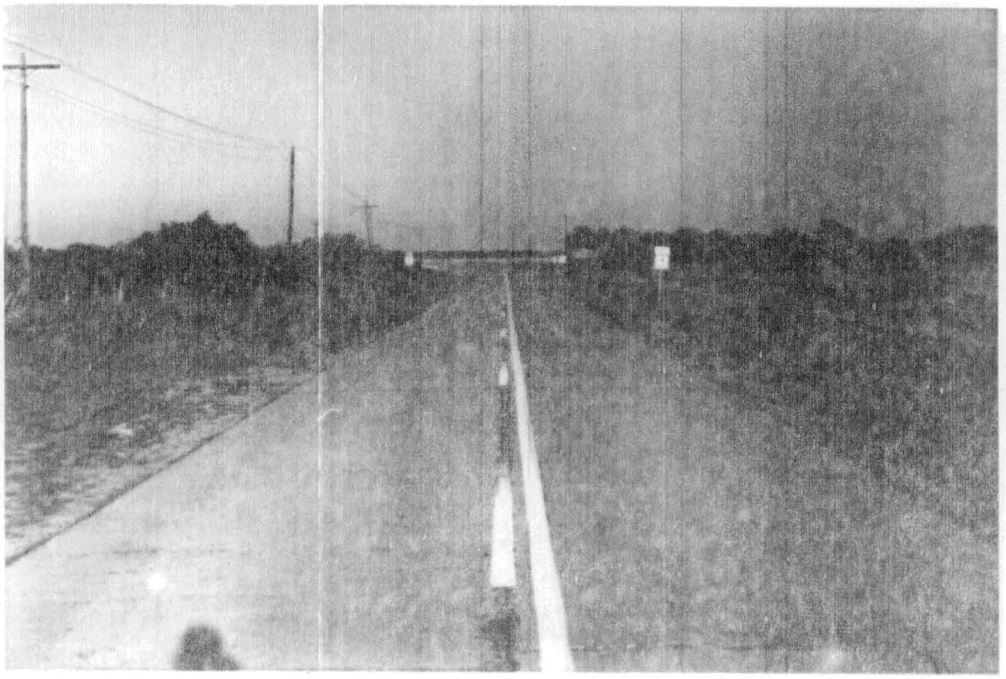


Photo 41
Day Appearance of Restripe With
Texas Specification on PCCP