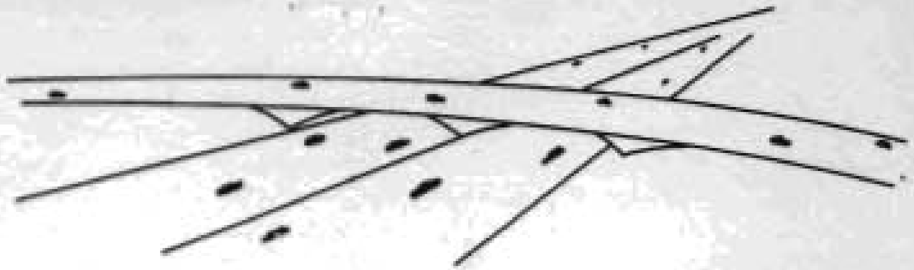

DEPARTMENTAL RESEARCH

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REPORT ON CONCRETE PAVEMENT GROOVING IN TEXAS

by

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TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

This report is based upon testing of several methods of improving skid resistance and observations of concrete pavement grooving and its apparent effect in reducing accidents on a slick pavement section in San Antonio, Texas. Material was gathered from reports prepared by those persons involved in the pavement grooving operation and opinions expressed herein are formulated upon general observations of the limited data available concerning this study.

I. INTRODUCTION

A. Background

According to the best available information, the pavement grooving technique has been utilized only in two places in Texas. The first grooving technique on asphaltic concrete pavements was performed in the Beaumont District. This work consisted of running a farm-type disk plow over the asphaltic concrete pavement to roughen up the surface. According to reports from the District, they felt that this did help the skid resistant qualities of the pavement for a short period of time but there were no skid tests made and this was strictly an observation. The second place where pavement grooving was utilized in Texas occurred in San Antonio, Texas, in 1962. At this location the accident record was soaring to a very high rate, and according to some newspaper accounts, the City Police often had to close down the Expressway to stop accidents caused by slick pavements. Figure 1 portrays the number of traffic accidents experienced on a section of Interstate Highway 35 in the downtown area of San Antonio between the years 1959 and 1962.[2] You will note that in any given year approximately 50% of the accidents were occurring during rainy weather, or a condition of wet pavement. Therefore, the analysis indicated that this high accident rate could possibly be attributed to the pavement surface condition made slick during wet weather.

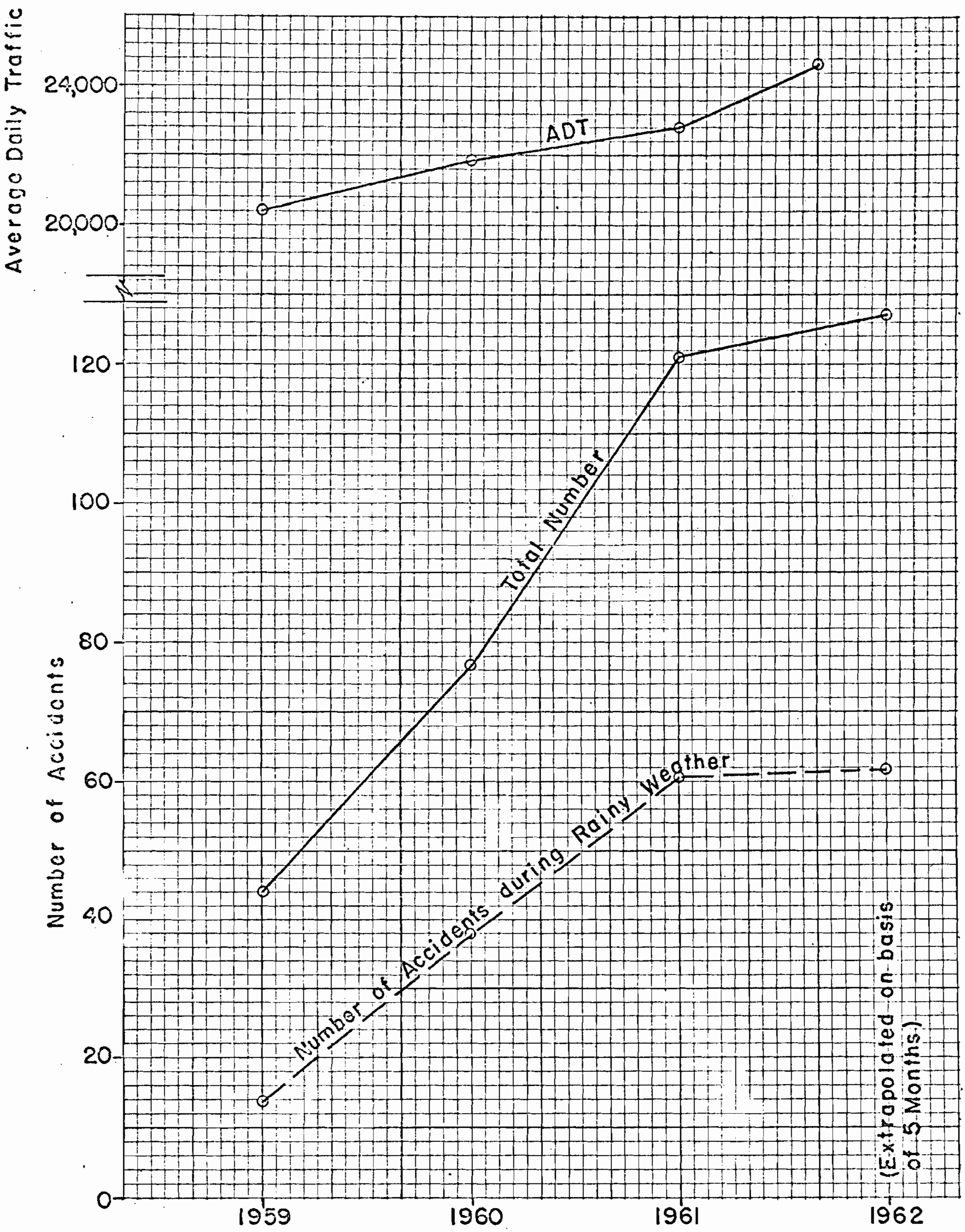

FIG. I Increasing Number of Accidents on Slick Section

B. Objective

The pavement on Interstate Highway 35 in San Antonio was sound and in excellent condition from a structural performance standpoint, but in view of the high accident rate which was being experienced, the District initially submitted a proposal for overlaying the concrete pavement with asphaltic concrete. The objective was to provide a surface which would not become so slick during wet weather. Therefore, the District personnel in conjunction with personnel from the Research Section began an investigation as to the most feasible method for obtaining a so-called skid resistant surface. A study of various methods of skid proofing this section of concrete pavement was made. The various methods considered were:

	Method		Est.Cost Per S.Y.
1.	The Saw Cut Method	-	$ 0.36 - 0.50
2.	Silica Sand Asphalt (Slurry Seal)	-	$ 0.40 - 0.50
3.	Asphalt Concrete Overlay	-	$ 0.25 - 0.35
4.	Epoxy Resin	-	$ 2.30 - 2.80
5.	Seal Coat	-	$ 0.10 - 0.12
6.	Acid Treatment	-	?

Although the saw grooving operation was not considered to be the most economical of the six methods studied, it was selected because of the fact: there would be no change in the crown of the road, the concrete surface would remain uncovered, contrast of existing pavement would be maintained with the asphaltic shoulders which were in place, the operation could be performed at any time in any type weather and construction could be restricted to short sections or one lane widths. The other reason for choosing the concrete saw cut method, which probably had more influence than the factors listed heretofore, was the fact that this District had a considerable mileage of concrete pavement within the San Antonio urban area that had maintained its original smooth riding surface and they were very interested in trying a new concept to help alleviate the slick surface problem.

II. OTHER CORRECTIVE MEASURES TESTED

A. Hydrochloric Acid

Acid etching was given consideration to attain the desired rough surface texture. Various solutions of hydrochloric acid were used from five thru fifty percent on short test sections within the limits of this project. A chemical reaction was observed for about the first minute after which no further reaction was noted and acid was then washed off the pavement. Based upon this placement of a test section, the benefit of acid etching could not be observed and this method was abandoned.

B. Slurry Seal

A sample of medium-set cationic emulsion was obtained and mixed with silica sand. Various mixes were made with the percent of emulsion ranging from fifteen to twenty-two percent. A small section of slurry seal was placed in the District Maintenance Yard. However, use of this material was not considered in view of maintaining the color contrast between the pavement and shoulders. Also, the slurry seal had a disadvantage in the length of curing time and special equipment needed to apply the material.

III. OPERATION OF THE CON-CUT BUMP CUTTER (GROOVING)

A view of the con-cut bump cutter used in the project is shown in Figure 2.[1] This machine was very portable and manuevered quite easily considering that it was some twenty-four feet in length. The blades were spaced at one-half inch centers and were operated at an average depth of one-eighth of an inch. A longitudinal cutting pattern was selected in order to increase the production rate and also to prevent interference with traffic operation and cut down on road noise. The operation of the machine utilized a considerable quantity of water to cool the blades and under normal conditions, according to the operator, the blades should last approximately nine months, but without water they would only last about forty five seconds.

Work started on this project on July 10, 1962, and was completed September 14, 1962, with a total of fifty-eight working days used. Naturally, the work period was during the off-peak traffic period. As soon as the equipment was moved off the project at the end of each days work, the entire section was again opened to traffic. The final cost per square yard for sawing was approximately thirty-nine cents.

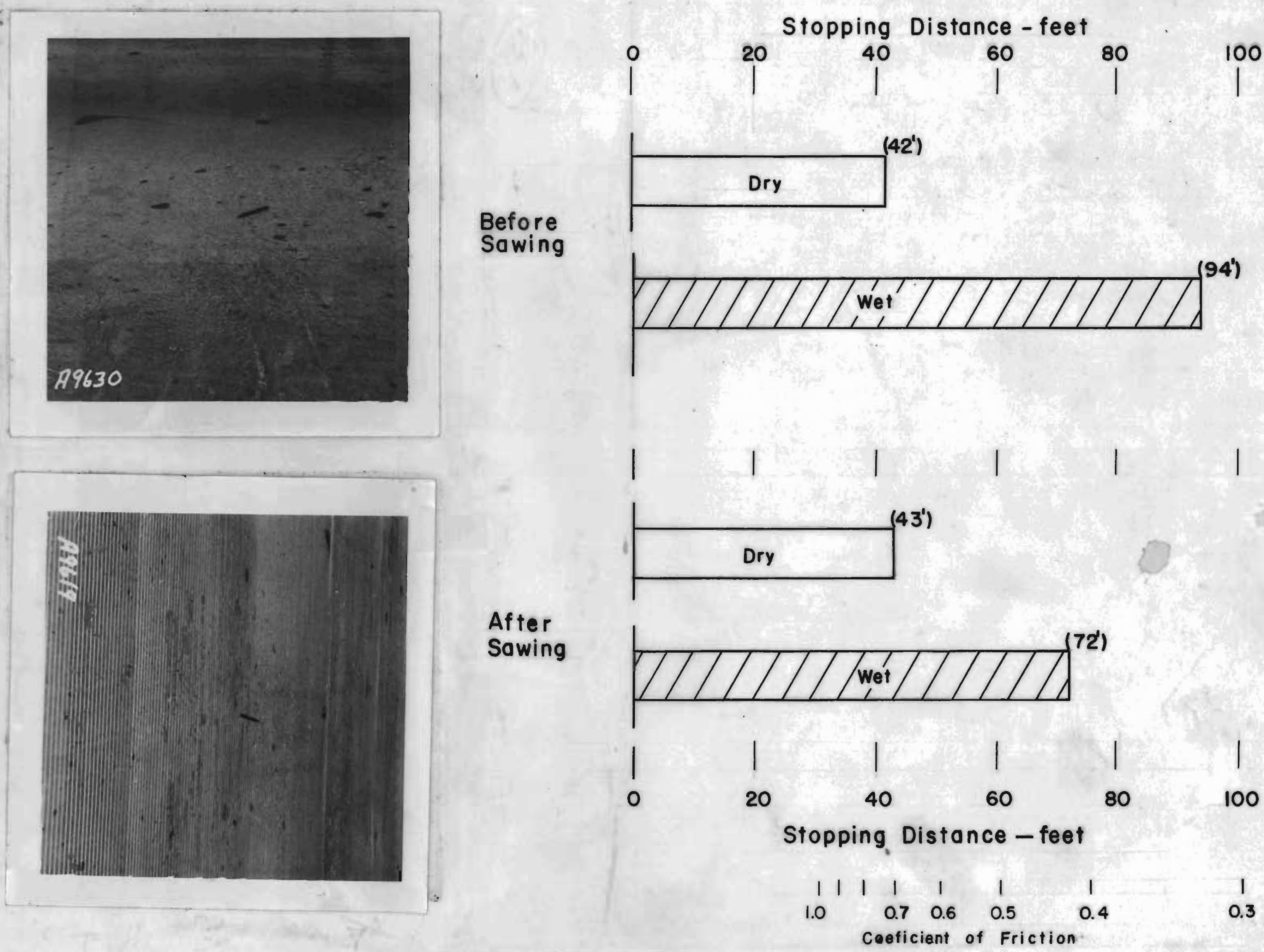

FIG. 3 Results of Stopping Distance Tests Before and After Sawing

IV. EVALUATION OF THE SAW CUT METHOD

In order to evaluate this method of skid-proofing, it was felt that some field test should be performed for comparison purposes. After examining several methods, it was decided that the stopping car method would be utilized. At that time, the skid-trailer was not available. The scope of the test was to compare the friction coefficient before sawing and after sawing both in wet and dry conditions. To obtain satisfactory comparisons, three tests were performed for each condition. The average of the three was used as a representative value for the above condition. The stopping distance was measured according to the total distance required for the vehicle to make an emergency stop from a speed of thirty miles per hour. The test vehicle was a 1962 Plymouth sedan, with a chalk gun mounted on the rear bumper to trigger a mechanism which was attached to the brake light system. The wet condition for the before and after test was obtained by spraying the pavement with a water hose attached to tank trucks.

V. RESULTS OF FIELD TEST

The results of the stopping distance test are presented by Figure 3.[3] You will note that the saw-cut operation increased the coefficient of friction from 0.32 before sawing

VIEW OF CONCUT BUMP CUTTER

FIGURE 2

to 0.42 after sawing as measured by the stopping distance method at 30 miles per hour with wet pavement conditions. Later measurements utilizing a skid trailer on the sawed concrete pavement indicated that the coefficient of sliding friction was 0.28. The skid trailer had not been completed in time to measure the before sawing coefficient.

The main benefit obtained by pavement sawing was a change in the skidding pattern. In the before condition, some degree of skidding was always experienced on both wet and dry pavements and the wet pavement vehicle generally always ended up in the other lane. After the pavement was sawed, the vehicle always skidded in a straight line for the both wet and dry pavement conditions. Side skidding was not experienced in any of the after condition tests. The driver of the test vehicle stated, he had absolute control of the vehicle during the after-condition test whereas in the before-condition, he felt as if the vehicle was completely out of control during emergency stops.

VI. ACCIDENT DATA AFTER SAWING OF CONCRETE PAVEMENT

The results of accidents were closely observed on a monthly basis after sawing. Two adjacent sections of the same type concrete pavement (approximately 1.2 miles in length each) were selected to compare to the section which had been sawed which was also approximately 1.2 miles long. For the first five months, the wet pavement accidents were negligible where the concrete pavement had been sawed, although the adjoining sections still had a high wet pavement accident record. However, at the end of this five month period, the wet accident rate again went up considerably and in August of 1963 a type "D" asphaltic concrete pavement overlay was placed on a section of the sawed concrete pavement. Again in April of 1964 other sections of the sawed concrete pavement were overlayed with trap rock asphaltic concrete pavement. Therefore, according to observations and the accident records, it appeared that the life of the sawed concrete was only some six months insofar as skid-proofing the concrete pavement. This was probably attributable to the soft limestone aggregate which was used in the concrete mixture.

VII. TRANSVERSE SAWING

Adjacent to this same section of freeway, sawing was also performed on the concrete pavement in 1966. The short test section some hundred feet in length was placed by using a new type of concrete saw and the saw cuts were made transverse to the centerline in lieu of the longitudinal type saw cuts. In July of 1966, a skid trailer was utilized in measuring the coefficient of friction by averaging five skids and the results before sawing indicated a coefficient of friction of 0.25 at forty miles per hour. After sawing, the coefficient of friction was 0.58 at forty miles per hour. Forty five days after the transverse sawing on the short test section, the coefficient of friction measured 0.38, approximately 60 days later the coefficient of friction measured 0.37 and approximately 10 months later the coefficient of friction measured 0.30. This also indicates that the aggregate in the concrete pavement was very soft and polished down at a rapid rate.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Based upon the observations of these studies, it appears that grooving of concrete pavements with soft aggregates does improve the skid resistance for a short period of time. However, the source of the primary problem is the soft aggregates themselves and such a treatment is not long lived.

From results of this study one of the primary advantages of longitudinal grooving was the change of the skidding pattern. After the pavement was sawed, the vehicle always skidded in a straight line. Therefore, it appears that longitudinal sawing might be advantageous at certain locations where the material in the pavement has sufficient durability to provide a lasting skid resistance and longitudinal sawing might provide an additional safety benefit by keeping the car from going out of control during an emergency stop at hazardous locations.

Another possible use of grooving is in helping to eliminate hydroplaning by providing drainage channels to remove the water from between the tires and pavement surface.

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