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16. Abstract

This report presents the description of an experiment conducted to study the effect of the average speed at which rigid-pavement condition surveys are performed on the accuracy of the distress information collected. Analyses of variance were carried out on the data gathered from continuously reinforced concrete (CRC) and jointed reinforced concrete (JRC) pavements. Personnel from the CTR and the Texas SDHPT participated in the field experiment, which permitted the evaluation of the effect of training or experience of the surveyors on the quality of the distress data collected.

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EVALUATION OF THE EFFECT OF SURVEY SPEED ON NETWORK-LEVEL COLLECTION OF RIGID-PAVEMENT DISTRESS DATA

by

Victor Torres-Verdin
Chhote Saraf
B. Frank McCullough

Research Report 388-2

Condition Surveys and Performance Monitoring
of Existing and Overlaid Rigid Pavements
Research Project 3-8-84-388

conducted for

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PREFACE

This report presents the description of an experiment to evaluate the effect of monitoring speed on network-level condition survey data, which was conducted by the Center for Transportation Research of The University of Texas at Austin.

The authors are indebted to the following persons, who participated in the field experiment: Jim Long, Jeff Varner, Ed Moore and Janis Cawthron at the CTR, and Richard Rogers, Jerry Daleiden, Larry Buttler and Gary Graham at the Texas SDHPT. Gratitude is also expressed to Lyn Gabbert and Rachel Hinshaw for typing the manuscript.

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LIST OF REPORTS

Report No. 388-1, "Development of a Deflection Distress Index for Project-Level Evaluation of CRC Pavements," by Victor Torres-Verdin, and B. Frank McCullough, presents the derivation of a new approach for project-level evaluation of CRC pavements from condition survey data. The main features of computer program DDI1, which incorporates the principal findings from the study, are discussed and an input guide for that program is provided along with a project-level condition survey manual.

Report No. 388-2, "Evaluation of the Effect of Survey Speed on Network-Level Collection of Rigid-Pavement Distress Data," by Victor Torres-Verdin, Chhote Saraf, and B. Frank McCullough, describes work done in relation with an experiment performed to evaluate the effect of monitoring speed on the quality of rigid-pavement distress data collected at the network level.

ABSTRACT

This report presents the description of an experiment conducted to study the effect of the average speed at which rigid-pavement condition surveys are performed on the accuracy of the distress information collected. Analyses of variance were carried out on the data gathered from continuously reinforced concrete (CRC) and jointed reinforced concrete (JRC) pavements. Personnel from the CTR and the Texas SDHPT participated in the field experiment, which permitted the evaluation of the effect of training or experience of the surveyors on the quality of the distress data collected.

KEYWORDS: Condition survey, rigid pavement, continuously reinforced concrete pavement (CRCP), jointed concrete pavement (JRCP), distress manifestation.

SUMMARY

The Rigid Pavement Evaluation System (RPES) currently under development by the Texas SDHPT requires that network-level condition surveys be expedited. In order to accomplish this objective, it was necessary to study the effect of increasing the survey speed on the accuracy of the distress information collected. The distress condition of a rigid pavement section is generally expressed by its corresponding distress index, which is the combination of distress manifestations to ascertain with a single number the amount of pavement deterioration. As the condition survey speed increases, the accuracy in recording the different types of distress manifestation decreases. Hence, it is important to arrive at the maximum condition survey speed that will still insure adequate distress data. For that purpose, an experiment was carried out by the CTR, in which a CRCP and a JRCP section were selected. Experienced and inexperienced persons surveyed both sections at different average speeds. The resulting data were analyzed using standard statistical methods, and conclusions and recommendations from the study were included in this report.

IMPLEMENTATION STATEMENT

The effect of survey speed on network-level collection of rigid-pavement distress data has been evaluated in this report. Likewise, the importance of training or experience of the crews in charge of conducting condition surveys has been found to be significant.

It is recommended that the findings of this study be implemented on the Rigid Pavement Evaluation System. The derivation of new distress-index equations should take into account the effect of survey speed on the accuracy of the distress information collected.

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CHAPTER 1. INTRODUCTION

As part of the development and implementation of a Rigid Pavement Evaluation System by the Texas State Department of Highways and Public Transportation (SDHPT), the Center for Transportation Research (CTR) of The University of Texas at Austin was asked to evaluate the effect of the speed at which rigid-pavement condition surveys are conducted on the accuracy of the distress information collected. It was considered necessary to increase the condition survey average speed of 5 mph (previously used by the CTR for network-level monitoring of rigid pavements throughout the state of Texas) as much as possible without losing significant accuracy in the information gathered so that the number of pavement sections surveyed by a given team could be maximized.

Analyses of variance were performed on data collected from both continuously reinforced concrete (CRC) and jointed reinforced concrete (JRC) pavement sections by both experienced and inexperienced crews selected from personnel at the Texas SDHPT and the CTR.

Condition survey data are required for estimating the distress index of every rigid-pavement section monitored; this index is a tool used in the process of prioritizing and scheduling the maintenance and rehabilitation needs of the rigid-pavement network of the state of Texas, by means of computer program PRPO1 (Ref 1). However, the increase in the average speed of the condition survey, necessary for the Rigid Pavement Evaluation System, will eliminate from the condition survey data those distress manifestations that cannot be satisfactorily recorded at higher speeds, and the terms representing those distress manifestations will have to be discarded from the pertinent equations included in computer program PRPO1.

The objective of this report is to describe the various analyses performed on the condition survey data collected from CRC and JRC pavements and to evaluate the effect of condition survey speed on the accuracy of the information gathered for different types of distress manifestations. Chapters 2 and 3 describe the analyses of variance for the CRCP and JRCP sections surveyed, respectively. Recommendations and conclusions from this report are presented in Chapter 4.

CHAPTER 2. ANALYSIS OF VARIANCE FOR CRCP DATA

A CRCP section on IH-10 near Schulenburg, Texas, was selected for the experiment. This four-lane divided section is 15.2 miles and had been previously surveyed by the CTR personnel. Three different two-person teams participated in this experiment so that the effect of training and experience on the accuracy of the condition survey data collected could be studied. Two survey teams included experienced persons, while the other team members had no previous experience in collecting condition survey data. In each team, one person recorded most of the specified distress manifestations, and the other drove and recorded the rest. Mechanical counters mounted on a board were used to record the data. The experimental section was divided into 0.4-mile segments, and the data were recorded at the end of each segment.

Distress data were collected at average survey speeds of 5, 15, and 25 mph. The experimental CRCP section was surveyed first at a within-segment average speed of 25 mph, and then at average speeds of 15 and 5 mph, respectively. This order was followed to insure that the raters had no information about the distress condition of the pavement prior to any of the three surveys; if the average survey speed had been gradually increased, the raters may have recalled the distress condition in their second and third surveys, thereby introducing some bias to the data. This would have nullified the assumption of independence of results between successive surveys.

Analysis of variance was used to study the effect of survey speed and training on the average number of distress manifestations recorded. Essentially, analysis of variance provides the basis for determining whether the means of several samples differ significantly (Ref 2); and, when it is desirable to test hypotheses concerning two variables, the test is referred to as a two-way analysis of variance.

The following distress manifestations were recorded at the end of each 0.4-mile segment: transverse cracks with severe spalling, minor punchouts, severe punchouts, asphalt patches and concrete patches.

Condition survey teams 1 and 3 had previous experience in collecting distress data, whereas team 2 was relatively inexperienced.

Table 2.1 presents the average number per segment of distress manifestations recorded by each team for the three different average survey speeds, and Figs 2.1 to 2.5 present the same data graphically. It can be observed that, in general, the average number of distress manifestations recorded decreases as the average survey speed increases.

Table 2.2 summarizes the results of the analysis of variance obtained from the statistical package of computer programs, SPSS (Ref 3). The significance values of the F ratios for average survey speed, the team number, and the interaction between these two factors are presented in Table 2.2 for different distress manifestations. The effect of average condition survey speed on the average number of transverse cracks with severe spalling and on minor punchouts is highly significant. In general, the team effect is also very important, and it is particularly significant for the average number of minor punchouts. The significance value of the F ratio for the interaction between the average number of minor punchouts and the team number is about 0.13, which indicates that the interaction of these two variables is very significant. These results show that as the average survey speed increases there is a significant loss of accuracy in the average number of transverse cracks with severe spalling and punchouts recorded, and that the effect of experience or training is sometimes more important than that of the average speed.

TABLE 2.1. AVERAGE NUMBER, PER 0.4-MILE SEGMENT, OF CRCP DISTRESS MANIFESTATIONS RECORDED BY THREE TEAMS AT VARIOUS AVERAGE SURVEY SPEEDS

CRCP Distress Manifestation	Team No.*	Within-Segment Average Survey Speed, mph		
		5	15	25
Transverse Cracks with Severe Spalling	1	12.47	8.58	4.63
	2	19.61	8.47	5.92
	3	12.32	6.34	5.79
Minor Punchouts	1	3.29	3.32	1.89
	2	4.05	3.47	3.76
	3	4.00	2.55	1.03
Severe Punchouts	1	0.61	0.39	0.39
	2	0.42	0.39	0.45
	3	0.32	0.34	0.37
Asphalt Patches	1	0.13	0.21	0.32
	2	0.16	0.11	0.16
	3	0.37	0.34	0.13
Concrete Patches	1	1.11	1.00	0.87
	2	0.97	0.89	0.79
	3	0.71	0.61	0.55

*Team No. 1: Long and Cawthron
Team No. 2: Butler and Varner
Team No. 3: Rogers

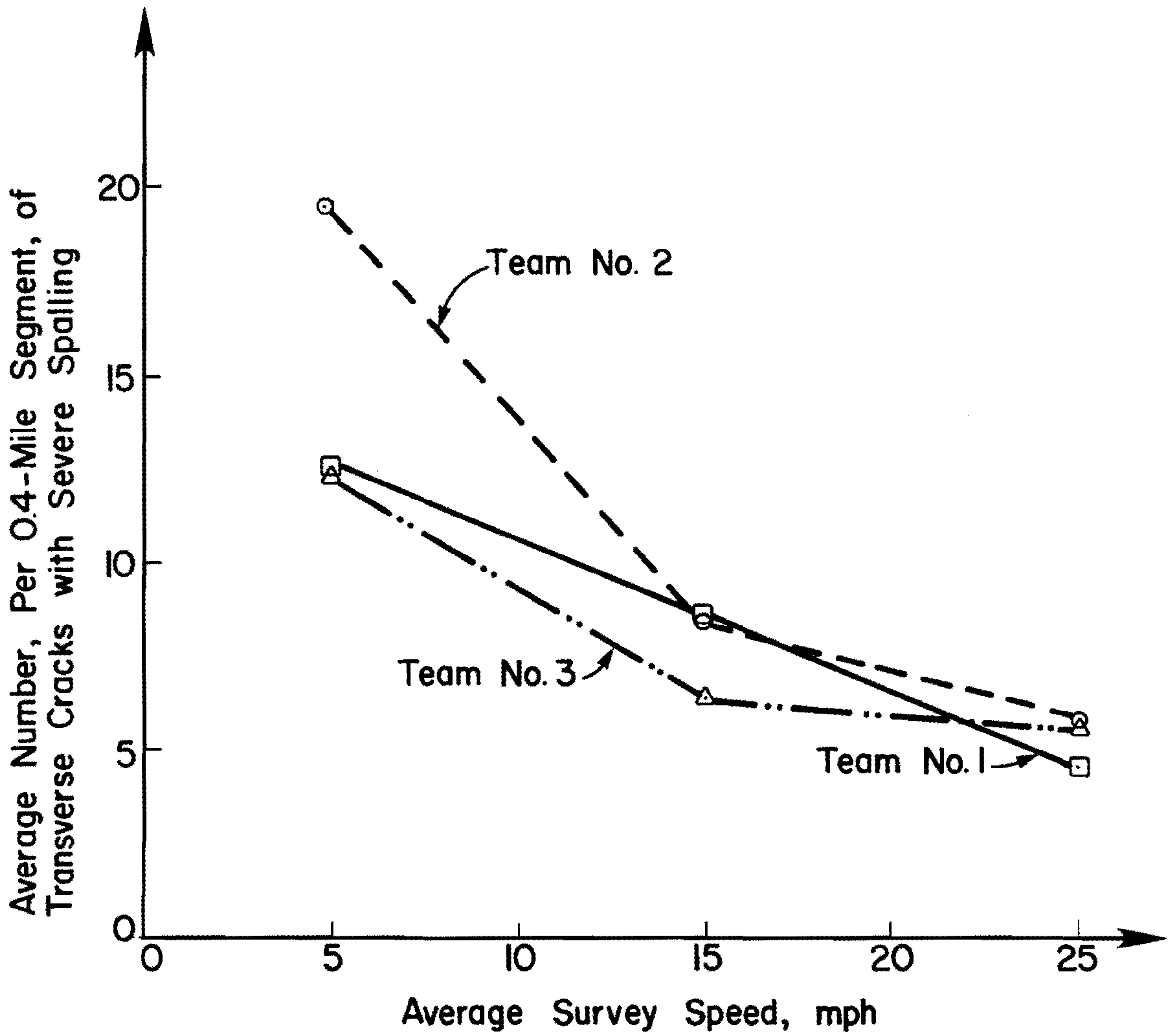

Fig 2.1. Average number of transverse cracks with severe spalling versus average survey speed.

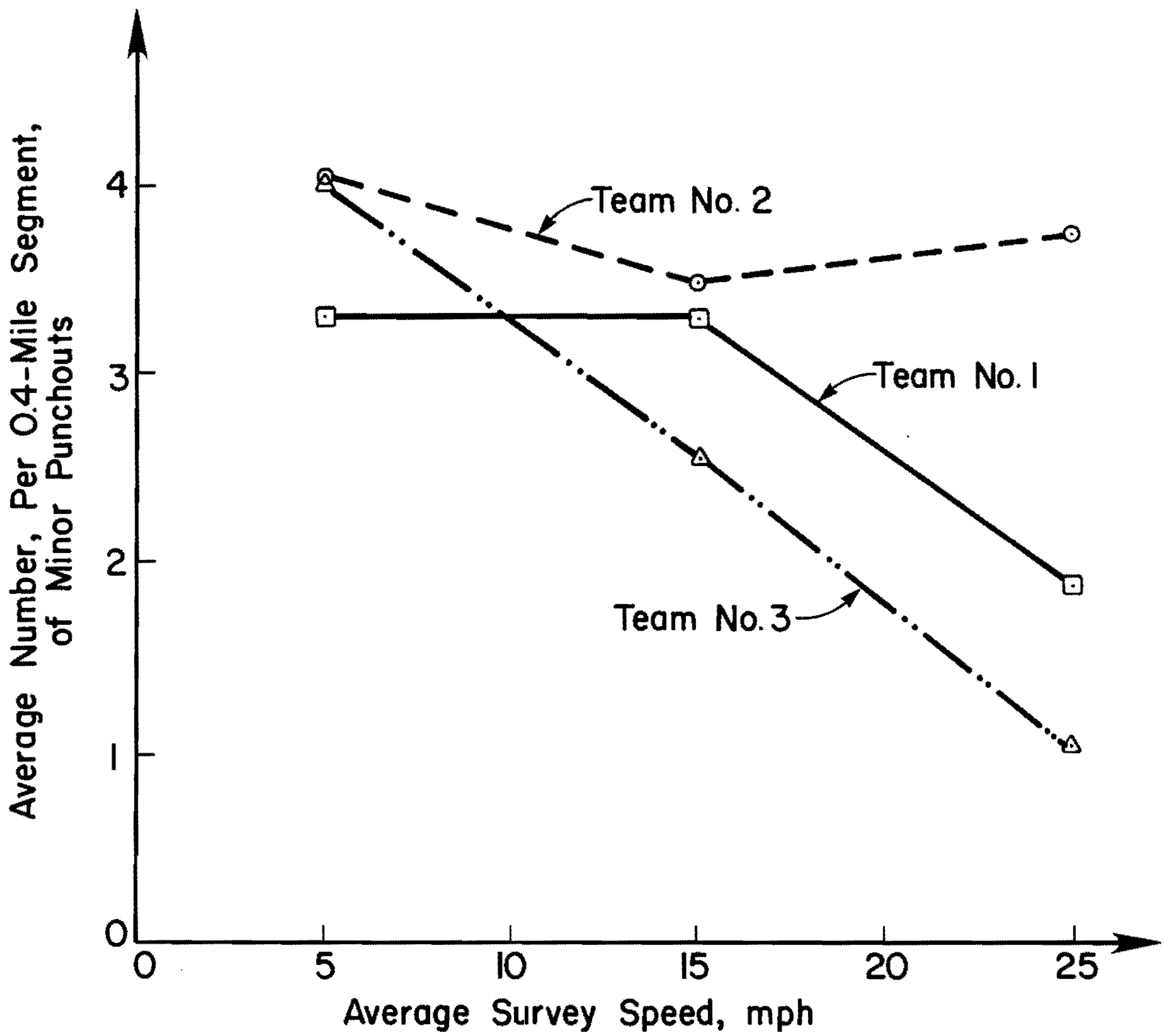

Fig 2.2. Average number of minor punchouts versus average survey speed.

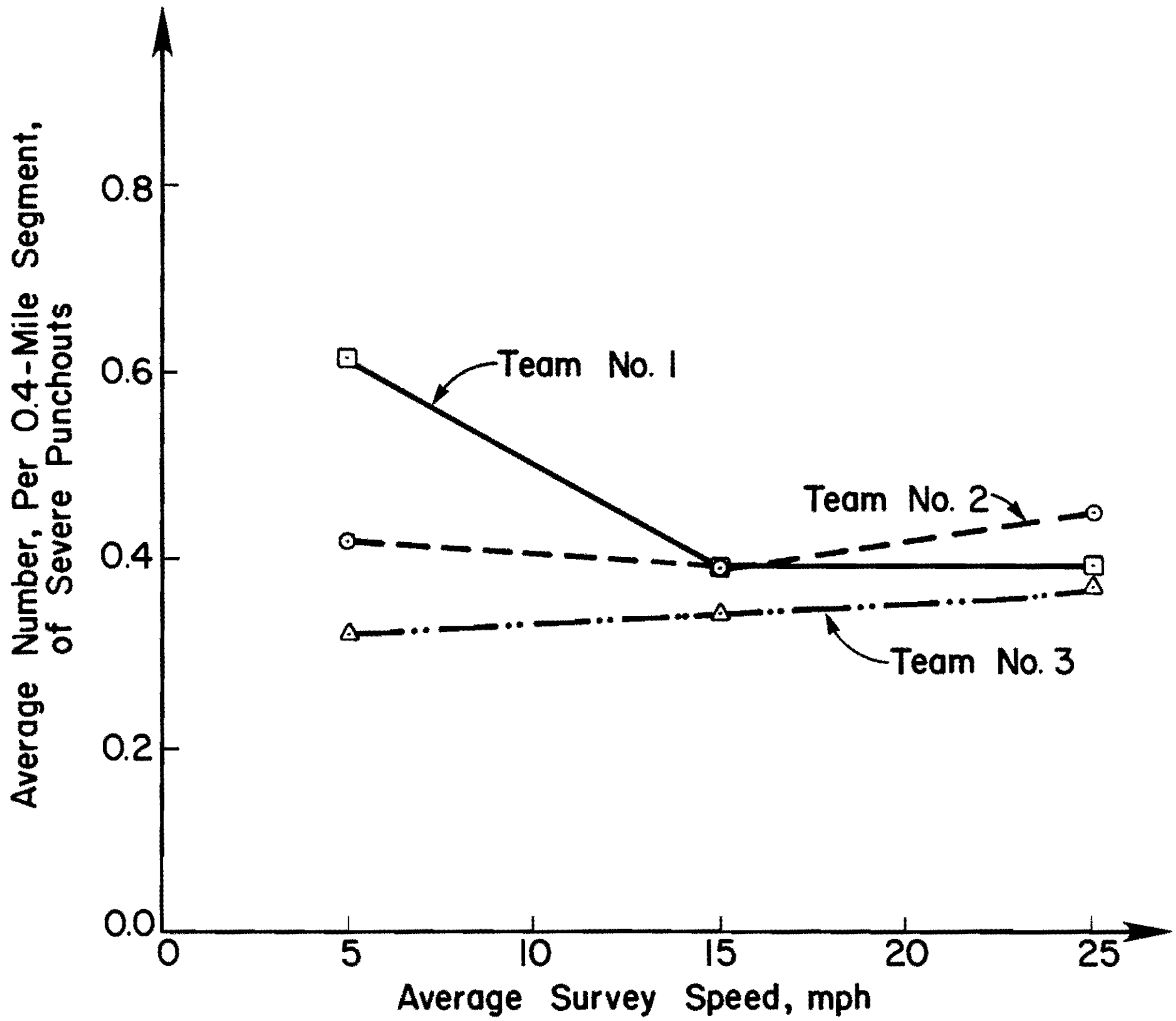

Fig 2.3. Average number of severe punchouts versus average survey speed.

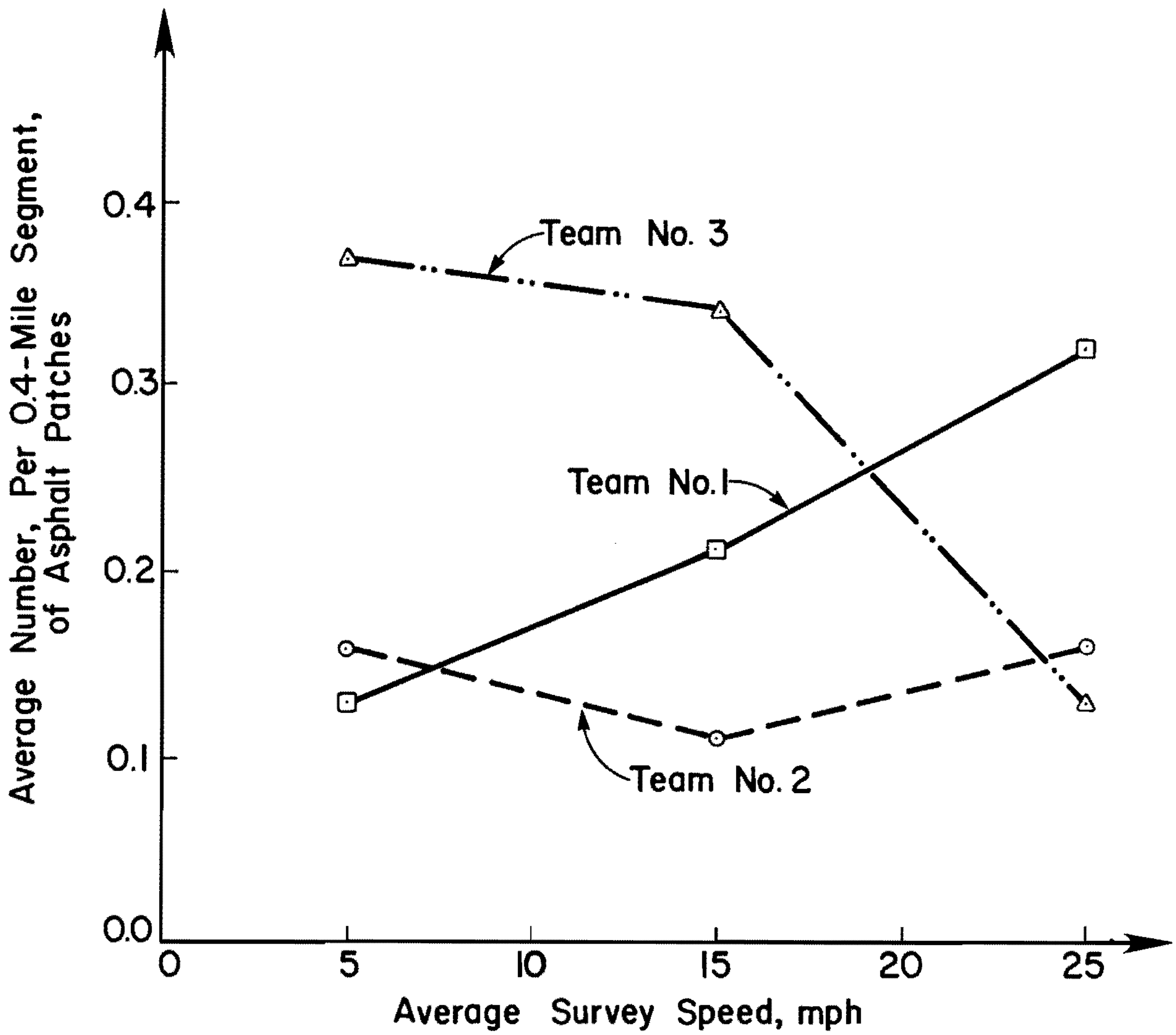

Fig 2.4. Average number of asphalt patches versus average survey speed.

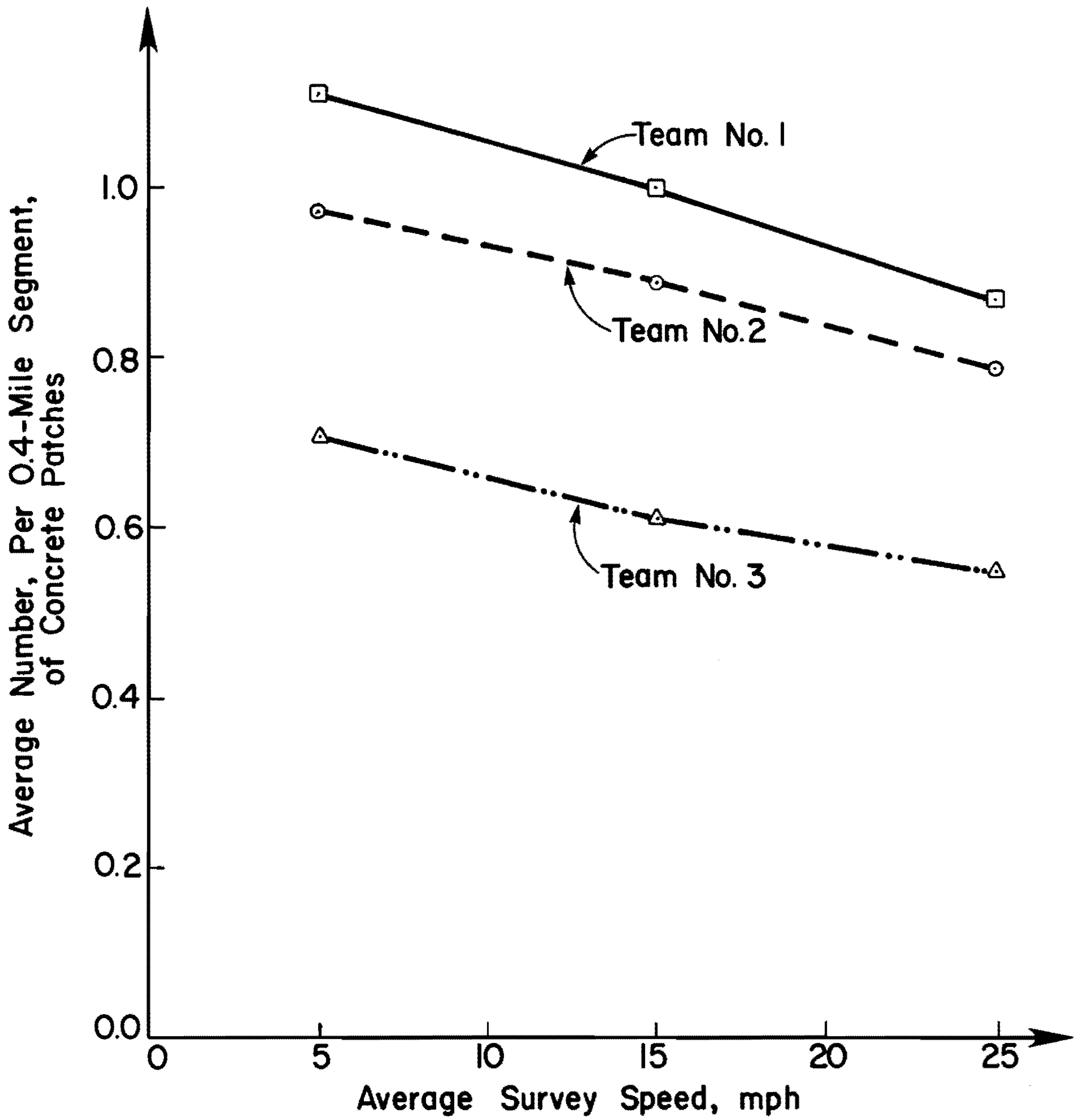

Fig 2.5. Average number of concrete patches versus average survey speed.

TABLE 2.2. SUMMARY OF THE RESULTS OBTAINED FROM THE TWO-WAY ANALYSIS OF VARIANCE ON THE CRCP CONDITION SURVEY DATA

	Significance of F Ratio		
CRCP Distress Manifestation	Average Survey Speed	Team Number	Interaction
Transverse Cracks with Severe Spalling	0.001	0.373	0.682
Minor Punchouts	0.003	0.020	0.125
Severe Punchouts	0.877	0.677	0.929
Asphalt Patches	0.975	0.292	0.366
Concrete Patches	0.692	0.242	0.999

CHAPTER 3. ANALYSIS OF VARIANCE FOR JRCP DATA

A JRCP section on IH-35, near Denton, Texas, was selected for the experiment. This four-lane divided section was surveyed in both directions so as to have a total length of pavement of 15.6 miles. The experiment was conducted in a way similar to that described in Chapter 2; three two-person teams surveyed the JRCP section at average speeds of 5, 15, and 25 mph and only one of the teams, Team No. 1, had previous experience in recording distress data in jointed pavements. The JRCP section was divided into 0.4-mile segments, each of which was first inspected at average speeds of 25, 15 and 5 mpn respectively.

The following were the items to be recorded: transverse cracks, spalled joints and cracks, faulted joints and cracks, corner breaks, slabs with longitudinal cracking, and patches. All the three teams experienced great difficulty in recording the number of faulted joints and cracks, and hence, this distress manifestation was not included in the statistical analysis of the collected data.

Again, the statistical technique of two-way analysis of variance was used to study the effect of average survey speed and training on the average number of distress manifestations recorded.

Table 3.1 presents the average number, per 0.4-mile segment, of distress manifestations recorded by each team for the three different average survey speeds, and Figs 3.1 to 3.5 present the same data graphically.

It can be observed in Figs 3.1 to 3.5 that the average number of distress manifestations recorded tends to decrease with the average within-segment survey speed, except for patches, and that Team No. 3 almost invariably provided the lowest average numbers of distress manifestations. It can be seen that there is more variation in the data obtained for the JRCP section than in the CRCP data.

A summary of the output data from the two-way analysis of variance is presented in Table 3.2. The effect of average survey speed on the average number of distress manifestations is relatively insignificant only for

TABLE 3.1. AVERAGE NUMBER, PER 0.4-MILE SEGMENT, OF JRCP DISTRESS MANIFESTATIONS RECORDED BY THREE TEAMS AT VARIOUS AVERAGE SURVEY SPEEDS

JRCP Distress Manifestation	No.*	Within-Segment Average Survey Speed, MPH		
		5	15	25
Transverse Cracks	1	9.33	9.82	10.23
	2	11.13	9.51	8.23
	3	8.79	8.56	8.00
Spalled Joints and Cracks	1	67.13	65.10	54.38
	2	36.26	28.03	18.21
	3	28.95	24.87	15.05
Corner Breaks	1	3.79	3.13	3.15
	2	2.97	3.26	3.92
	3	3.10	2.00	1.67
Slabs With Longitudinal Cracking	1	6.44	4.95	3.87
	2	4.38	4.41	3.62
	3	2.97	2.82	1.95
Patches	1	0.00	0.03	0.21
	2	0.92	2.08	1.59
	3	0.08	0.54	0.87

*Team No. 1: Long and Varner
Team No. 2: Moore and Cawthron
Team No. 3: Graham

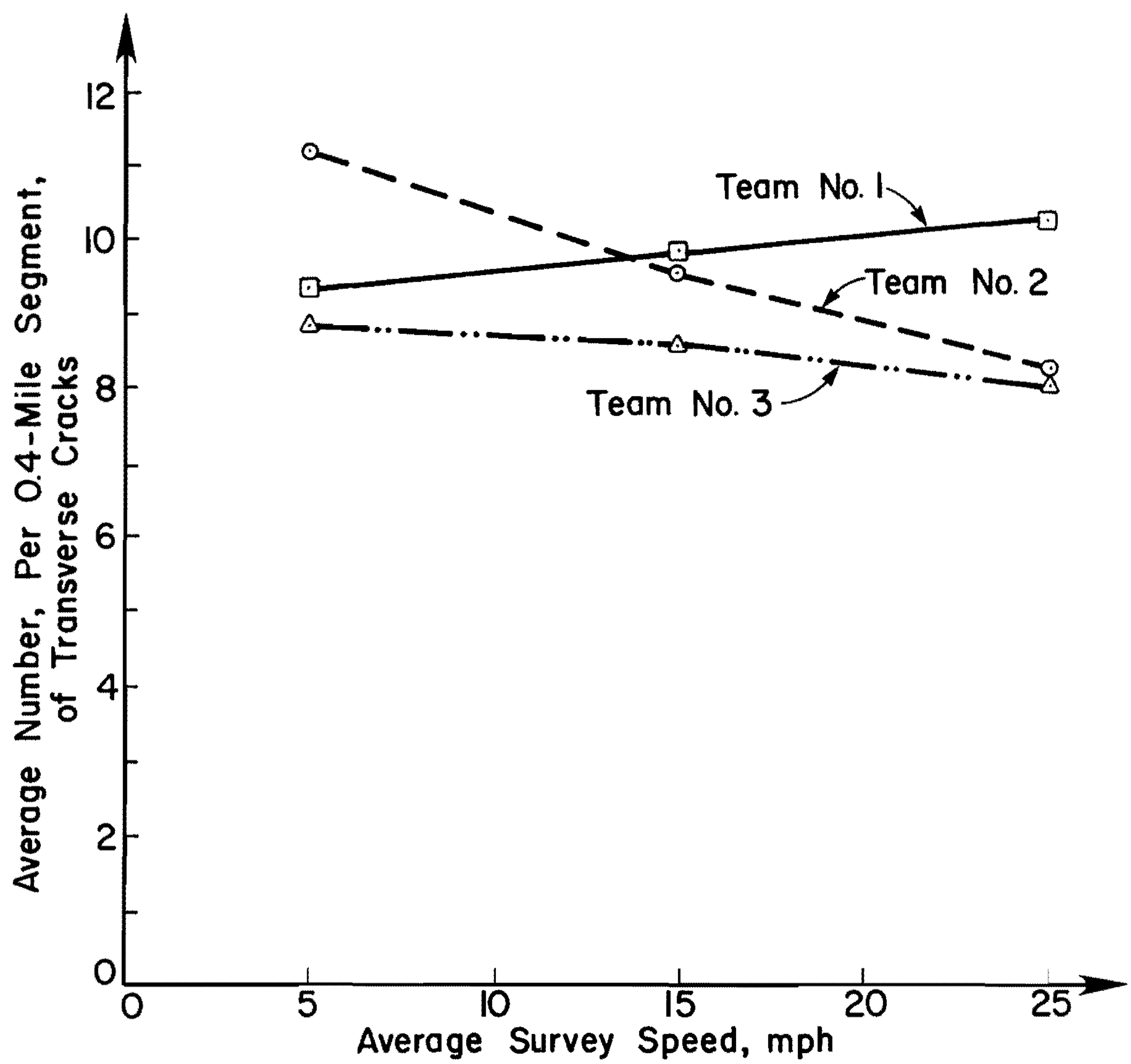

Fig 3.1. Average number of transverse cracks versus average survey speed.

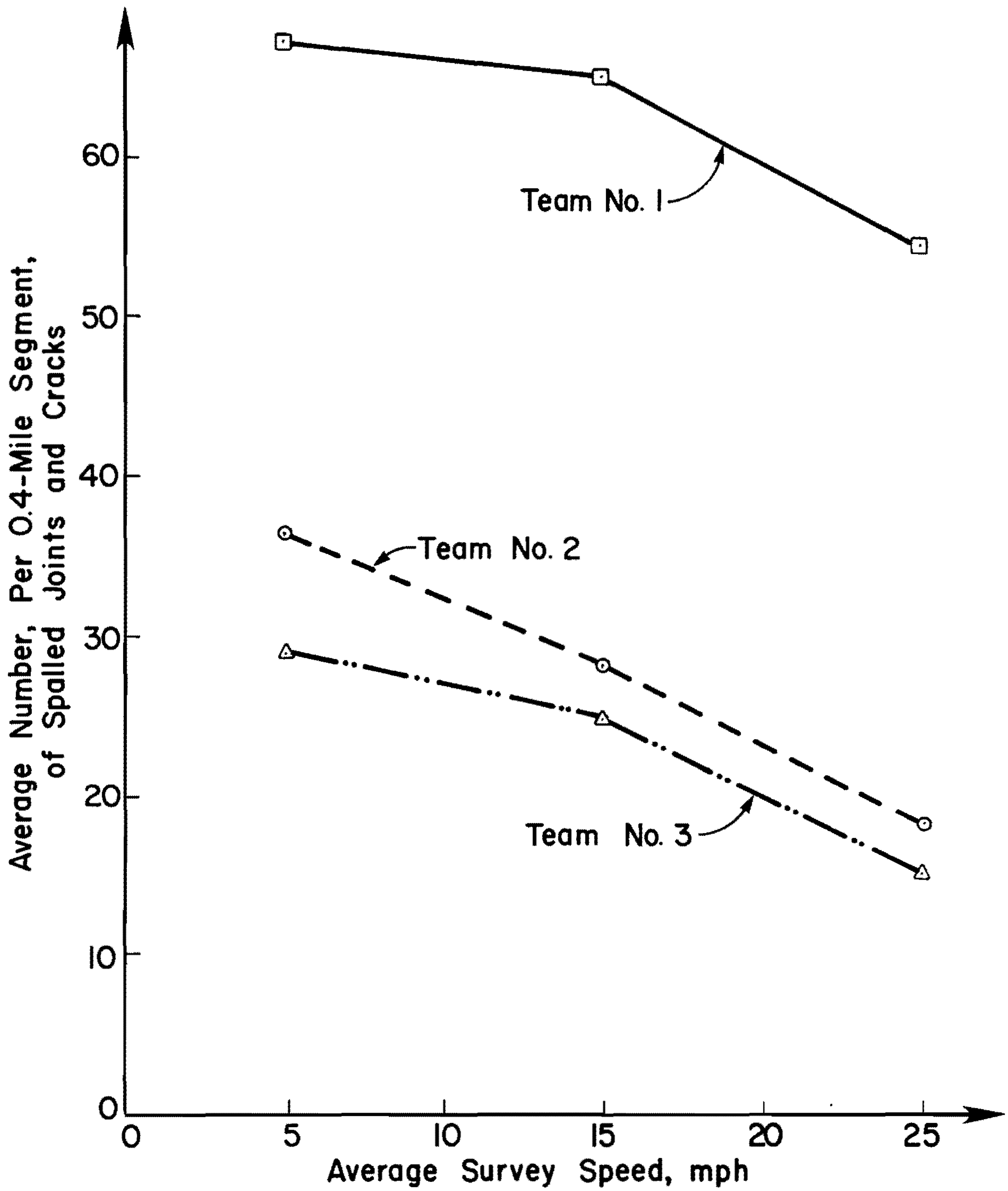

Fig 3.2. Average number of spalled joints and cracks versus average survey speed.

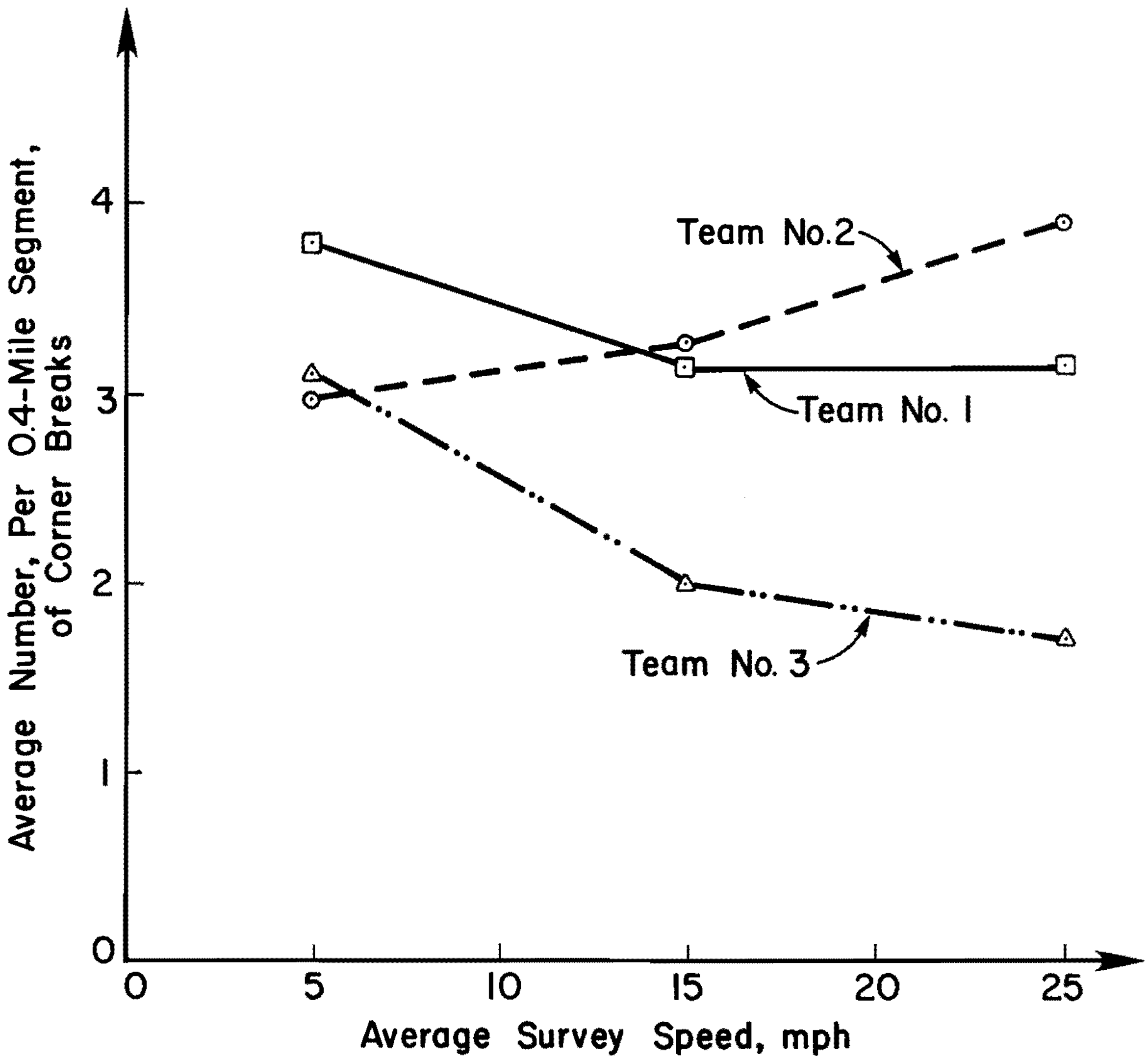

Fig 3.3. Average number of corner breaks versus average survey speed.

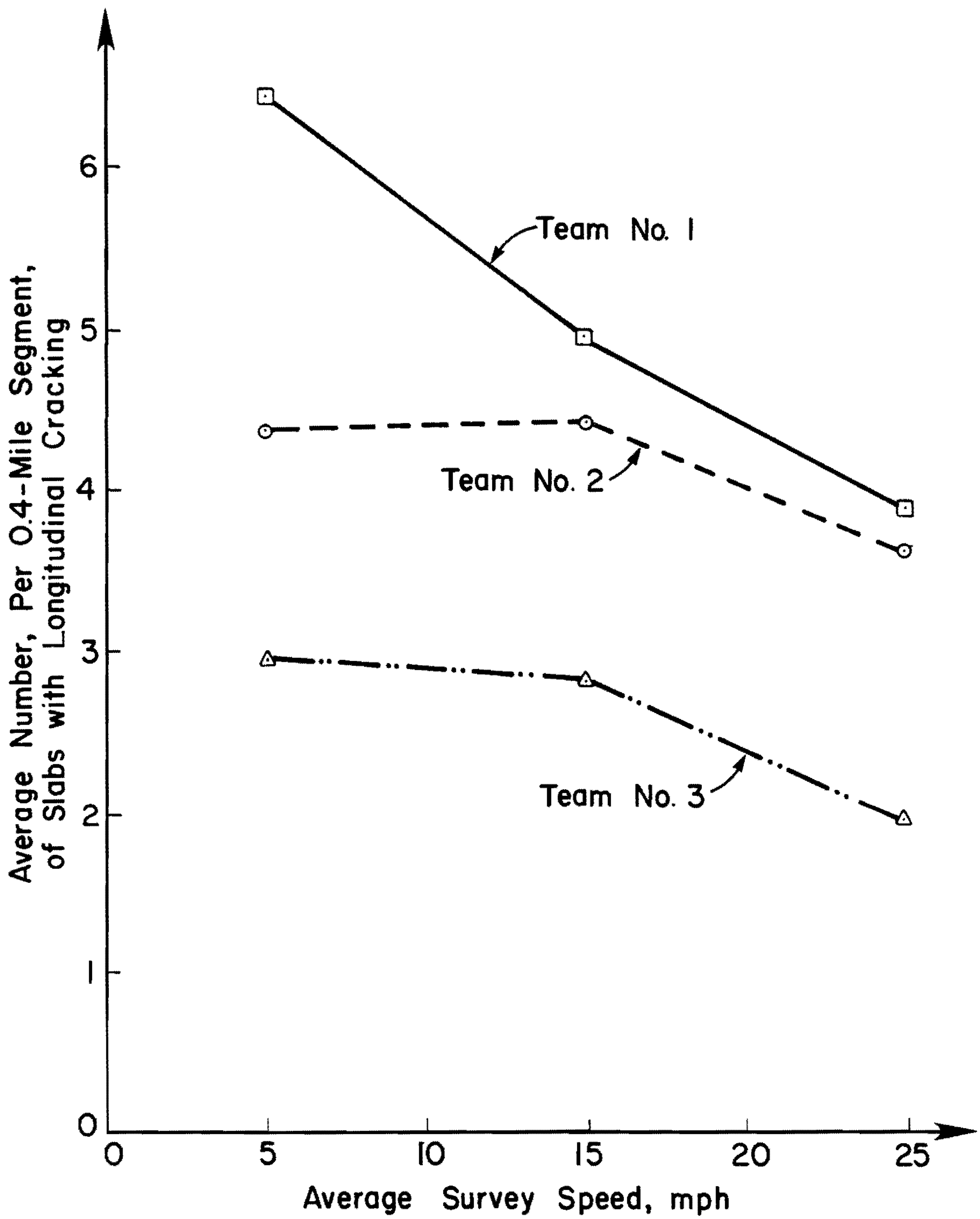

Fig 3.4. Average number of slabs with longitudinal cracking versus average survey speed.

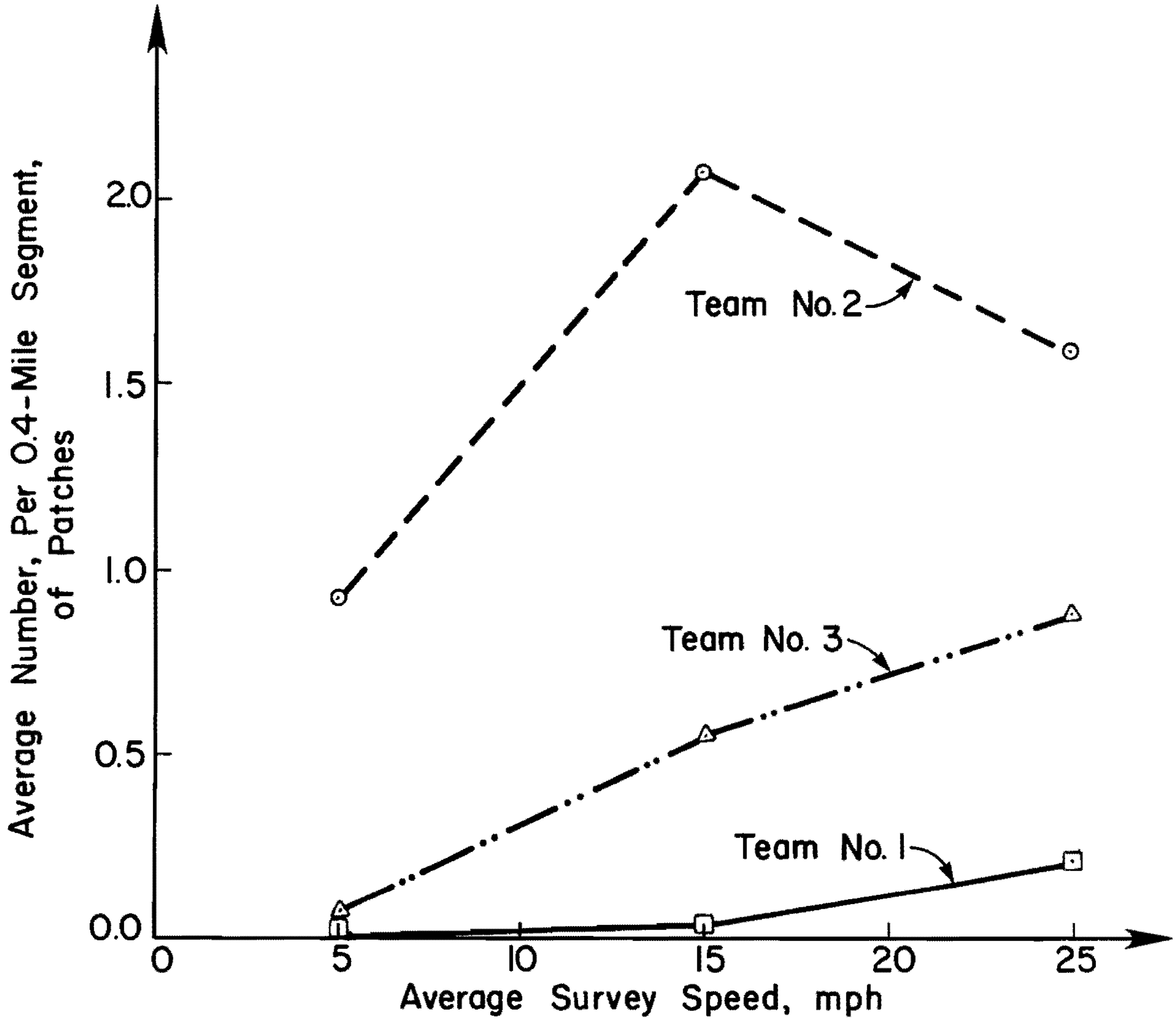

Fig 3.5. Average number of patches versus average survey speed.

TABLE 3.2. SUMMARY OF THE RESUTLS OBTAINED FROM THE TWO-WAY ANALYSIS OF VARIANCE ON THE JRCP CONDITION SURVEY DATA

JRCP Distress Manifestation	Significance of F Ratio		
	Average Survey Speed	Team Number	Interaction
Transverse Cracks	0.868	0.706	0.939
Spalled Joints and Cracks	0.001	0.001	0.946
Corner Breaks	0.625	0.055	0.480
Slabs with Longitudinal Cracking	0.031	0.001	0.668
Patches	0.019	0.001	0.252

transverse cracks and corner breaks. Moreover, the team effect is highly significant for four of the distress manifestations analyzed; experience or training appears to be an important factor in recording transverse cracks in JRC pavements. None of the F ratios for interaction can be considered to be highly significant.

CHAPTER 4. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Based on the results of this study, the following conclusions can be made:

(1) The effect of the survey speed on the accuracy of the distress information collected is very significant for some distress manifestations in both CRC and JRC pavements. Transverse cracks with severe spalling and minor punchouts could not be accurately recorded when the average survey speed was increased from 5 to 15 or 25 mph, while inspecting the CRCP section. The effect of survey speed on the collection of distress data was more significant in the JRCP section than in the CRCP section, since only two distress manifestations could be adequately recorded; i.e., transverse cracks and corner breaks.

(2) Previous experience or training in conducting condition surveys in rigid pavements appeared to have a very important effect on the collection of data for certain distress manifestations. There was no consistency at all among the three teams when recording minor punchouts along the CRCP section. Training was even more important for recording properly JRCP distress data, because transverse cracks were the only distress manifestation whose average number per 0.4-mile segment did not change significantly with team number.

RECOMMENDATIONS

(1) The survey speed should be selected to allow recording of at least the most significant variables included in the computation of distress index of rigid pavements. As the survey speed increases,

the number of distress manifestations that can be accurately recorded decreases.

(2) It is recommended that the personnel in charge of the network-level condition surveys be adequately trained to insure compatibility among the results provided by the various teams assigned to this task.

(3) Findings from this study should be considered in the preparation of network-level condition survey manuals for the Rigid Pavement Evaluation System.

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