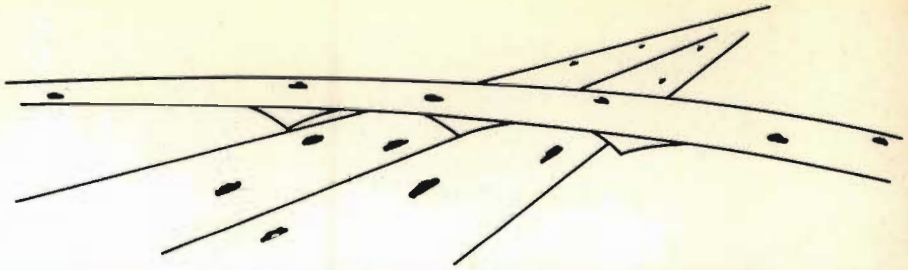

DEPARTMENTAL RESEARCH

Report Number SS 1.1

SURVEY OF STRUCTURAL FAILURES IN A CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

SURVEY OF STRUCTURAL FAILURES IN A CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

By

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Special Study No. 1.1

Highway Design Division, Research Section

TEXAS HIGHWAY DEPARTMENT

October 1969

PREFACE

This report documents a survey made by Texas Highway Department personnel to locate and measure distressed areas in a Continuously Reinforced Concrete Pavement in Walker County, Texas.

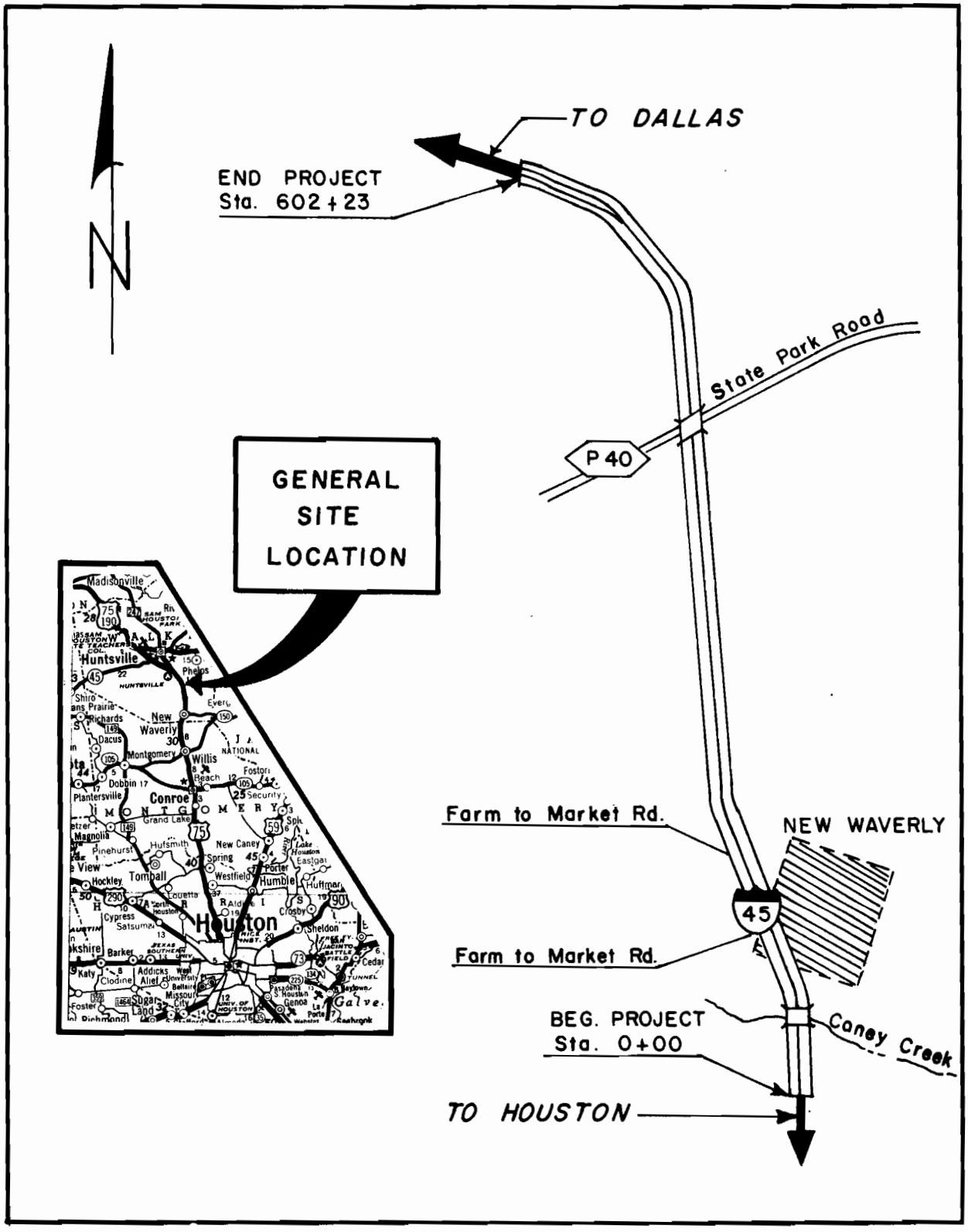
It is intended that the application of procedures discussed herein will enable other THD field personnel to obtain similar data with a degree of statewide uniformity in operations and data presentation.

A summary of the measurements obtained is indicated in the following table entitled "Summary of Percent Distress per Wheel Path-Walker County", and is discussed further in the report.

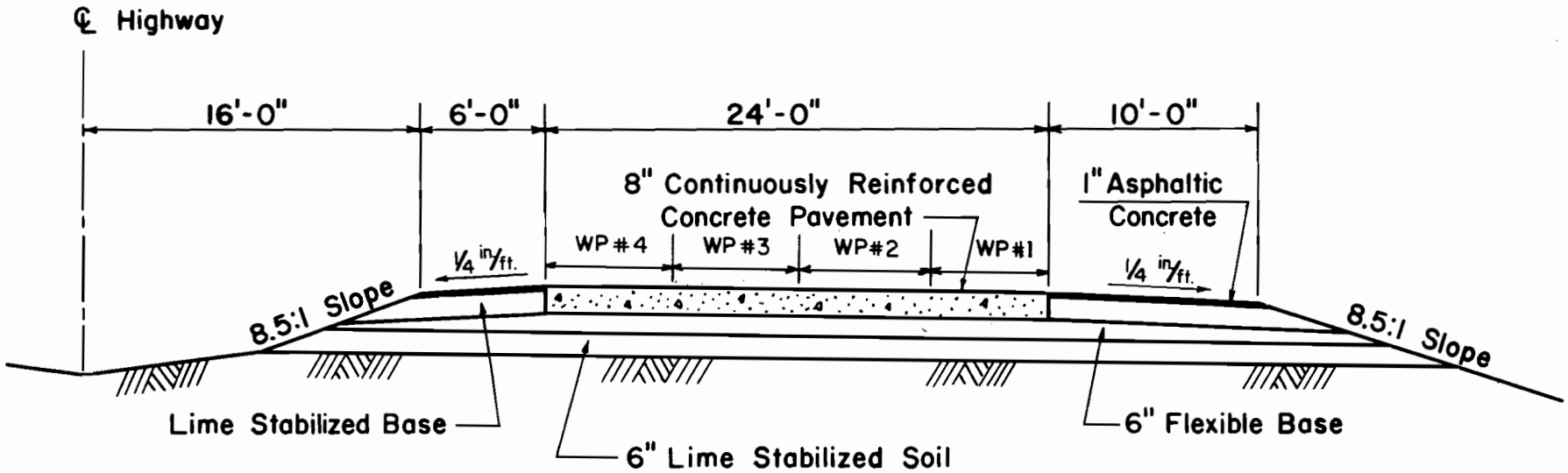
Summary of Percent Distress per
Wheel Path-Walker County
(Rounded Values)

	Southbound Lane				Northbound Lane			
	*Wheel Path				*Wheel Path			
	1	2	3	4	1	2	3	4
Total Length of Failure, Feet	3,494'	1,850'	432'	390'	2,278'	1,718'	412'	344'
Percent Failure	6.4	3.4	0.8	0.7	4.2	3.2	0.8	0.6

*Wheel paths are numbered consecutively, increasing from the outer separation to the median.



LOCATION AND LAYOUT OF
WALKER COUNTY PROJECT



TYPICAL HALF SECTION FOR WALKER COUNTY PROJECT

TABLE OF CONTENTS

SURVEY OF STRUCTURAL FAILURES IN A CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

Introduction

A design procedure for determining the thickness of asphaltic concrete overlay to place on a deteriorating continuously reinforced concrete pavement has been developed (Ref. 1). It became apparent during its development that the amount of structural failure or distressed areas now present in the CRCP would be required as a quantitative parameter to help define the pavement structure. Additionally, this measure of failure was to give the designer a "feel" for the confidence level that should be used in the design procedure.

Proper referencing of the failures observed was necessary so that future observations of the same failures could be made after the placement of an overlay.

Definition of Areas of Distress and Data Collection Technique

For this survey, areas of distress in the concrete pavement were defined by the following criteria (See Appendix B for example photographs).

1. Portland Cement Concrete Repairs (Patches)
2. Asphaltic Concrete Repairs (Patches)
3. Longitudinal cracks
4. Transverse cracks with spalling wider than 1¼"

A previous field party measuring deflections with a Dynaflect instrument marked station numbers along the pavement edge every 1/10 of a mile (approximately) on both the southbound and northbound roadway. These Dynaflect station numbers can be referenced to the center line station of the main lanes prior to the placement of an overlay as provided in Appendix C.

A "Rollatype" measuring wheel four feet in circumference and calibrated to the nearest one-tenth of a foot was used to measure each failure occuring in the CRCP. The wheel was rolled along the outside shoulder parallel to the main lanes. The distance to the beginning and the ending of each distressed or failed area from the previous Dynaflect station number was recorded; this distance was recorded on the prepared data sheet. (See Appendix A for explanation of the data sheet). The wheel path of each failure was also recorded as was the type of failure, i.e., concrete patch, asphalt patch, construction joint, etc. The original field data is in the files of the Research Section, Highway Design Division and is available upon request.

Discussion of Data Summary Tables and Figures

Table 1 depicts percent failure per wheel path for both the northbound and southbound roadway found by taking the total length of failure measured and dividing by the length of the roadway. The failure length for each isolated, spalled, transverse crack (See 4. above) was considered to be two feet.

Table 1. Summary of Percent Distress per Wheel Path-Walker County (Rounded Values)

	Southbound Lane				Northbound Lane			
	*Wheel Path				*Wheel Path			
	1	2	3	4	1	2	3	4
Total Length of Failure, Feet	3,494'	1,850'	432'	390'	2,278'	1,718'	412'	344'
Percent Failure	6.4	3.4	0.8	0.7	4.2	3.2	0.8	0.6

To satisfactorily accomplish the design of an overlay, the worst condition or the wheel path with the highest percentage of failure was taken as the governing criteria. This data was plotted by Dynaflect station number as shown in Figure 1 and this plot was used to divide the roadway into test sections of equal performance considering the failures as an indicator of performance. (See Appendix D for tabulation of data).

Using the statistical analysis of variance tests (Ref. 2) the sections were compared and combined until the adjacent sections were sufficiently different at the 95% confidence level. The results of this study are presented in Table 2, in terms of the station limits, average failures for the outside wheel path of the outside lane, and the standard deviation of the failures for each section.

*Wheel paths are numbered consecutively, increasing from the outer separation to the median.

Design Sections
with
Significantly Different Percentages Distress
in Wheel Path No. 1
(95% Confidence Level)

Lane	Limits (Dynaflect Stations)	Average of Failure Linear Ft/Ft Wheel Path No. 1	Standard Deviation
	0-36	2.37	3.74
	36-57	.64	0.78
North	57-Overlay	7.82	6.23
Bound	Overlay-104	8.34	9.06
	104-End	1.20	1.13
	0-Overlay	3.60	3.56
	Overlay-41	15.65	5.57
	41-45	3.40	1.85
South	45-47	23.10	6.79
Bound	47-62	3.08	2.60
	62-86	11.72	7.70
	86-97	1.32	1.74
	97-99	13.65	3.61
	99-108	3.30	2.02
	108-End	0.60	0.71

Table 2

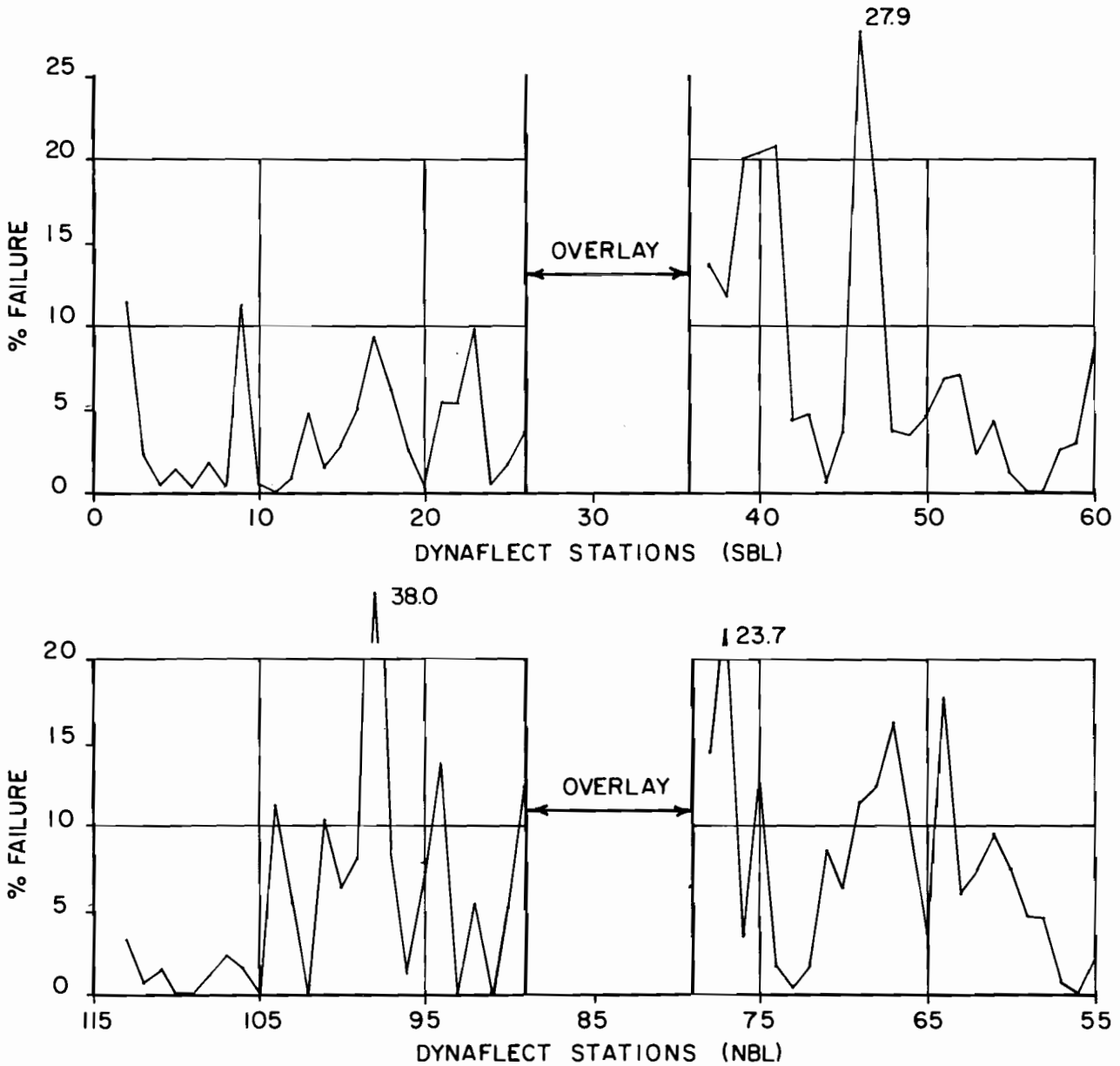
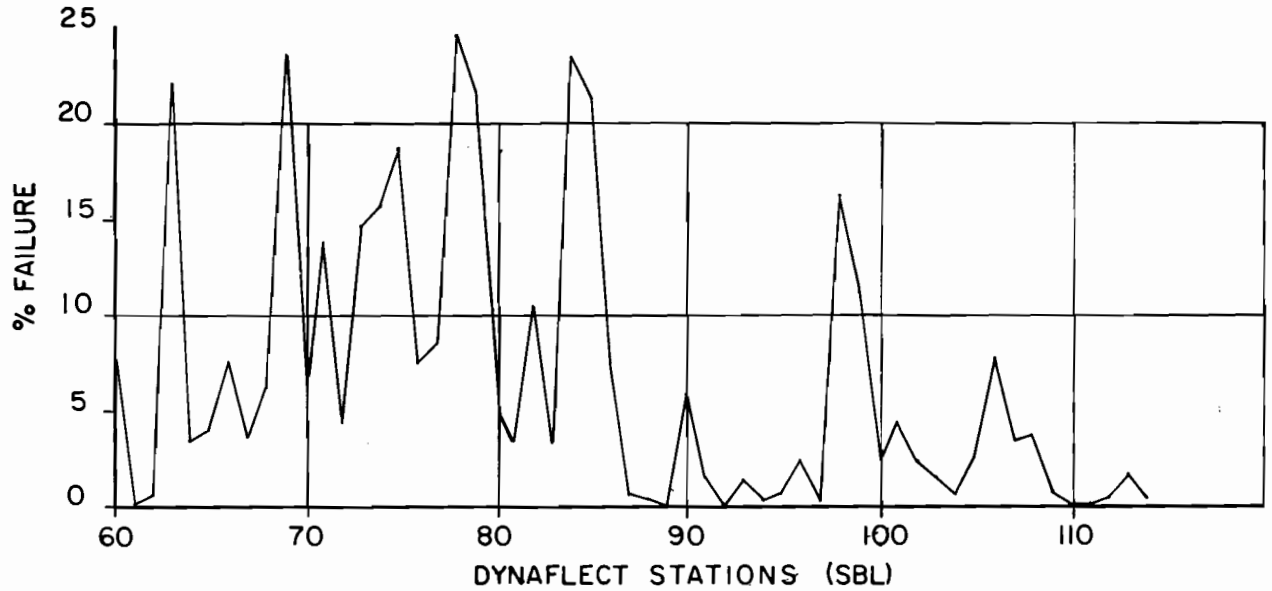


FIGURE 1. PROFILE OF PERCENT FAILURES



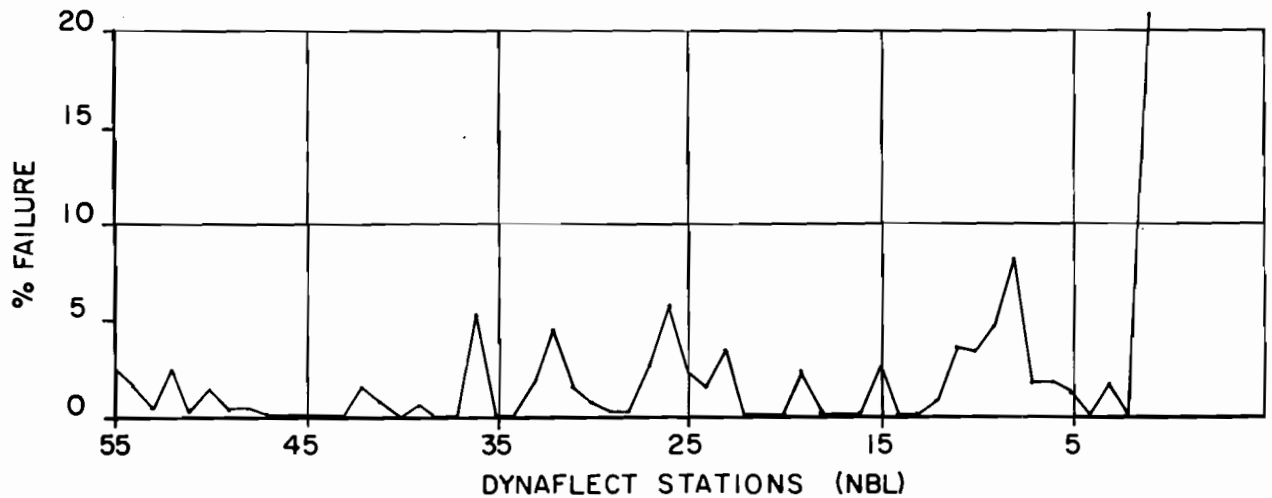


FIGURE I CONTINUED

Discussion and Conclusions

The percent failures per wheel path obtained from this survey quantified the results of a visual inspection of this section of IH 45. They indicate that the outside wheel paths of both the Southbound and Northbound Roadways which are traveled by the highest number of vehicles, including heavy trucks, are failing more rapidly than the adjacent wheel paths.

With the percentages shown in Table 1, it is now possible to check the predicted failures obtained from the overlay design procedure.

In future surveys of this type, if possible, one individual should estimate the failure areas throughout the entire survey. If more than one individual is used to survey a project then great care should be taken to insure that the different individuals are surveying with the same criteria for failure.

For the location of failures the calibrated wheel was a convenient method used in this survey. The survey team consisted of a wheel operator, a data recorder, and vehicle operator who provided protection from traffic. With careful planning, the wheel operator could record data by use of a tape recorder. It is probable that more convenient methods of failure quantification could be devised for future projects.

For future projects it is recommended that center line stations be established prior to the location of pavement failures. This will allow direct referencing of failures to center line stations and eliminate the conversion of stationing as shown in Appendix C.

References

1. B. F. McCullough, A Pavement Overlay Design System Considering Wheel Loads, Temperature Changes, and Performance, University of California, Berkeley, July 1969.

2. Alder, Henry L. and Roessler, Edward B., Introduction to Probability and Statistics, W. H. Freeman and Company, Third Edition, 1964. Chapter 17, pp. 253 to 254.

APPENDIX A

Sample Field Data Sheet and Definition of Coding

direction _____
date _____
highway _____
control _____

PAVEMENT DETERIORATION STUDY

1 Asphalt Patch
2 Repair
3 Cracked
4 Construction Joint

Dynaflect Stat. No.	Distance to Deterioration		Wheel Paths				TYPE	Comments
	Begin	End	Outside Lane		Inside Lane			
			1	2	3	4		
1 2 3 4 5 6	7 8 9 10 11	12 13 14 15 16	17	18	19	20	21	22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51
+	.	.						
+	.	.						
+	.	.						
+	.	.						
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+	.	.						
+	.	.						
+	.	.						
+	.	.						
+	.	.						

Definition of Coding Shown on Field Data Sheet

Code 1 — Code 1 represents an asphalt patch covering most of a failed area. (Photograph 10, Appendix B).

Code 2 — Code 2 represents a previously failed area repaired with a concrete patch in good condition at present. (Photographs 3,11,17, Appendix B).

Code 3 — Code 3 represents a failed or distressed area. Examples and Photograph references for Appendix B are listed below.

(a) Asphalt patch where concrete around this patch has failed. Photographs 5,8,10,19.

(b) Concrete patch where concrete around it has failed. Photograph 9.

(c) Concrete patch where patch itself has failed. Photograph 16.

(d) Any longitudinal concrete crack. Photographs 6,14,15,19.

(e) Spalled transverse crack greater than 1¼'. Photographs 6,13,18,19.

Code 4 — Code 4 represents a construction joint. Photographs 10,20.

APPENDIX B

Sample Photographs of Distressed Areas

Photograph #1

A distressed area prepared for a concrete patch. Wheel Path #1.

Photograph #2

(Same comment as Photograph #1)

Photograph #3

Concrete Patch in place approximately two days. Wheel Path #1.

Photograph #4

(Same comment as Photograph #1)

Photograph #5

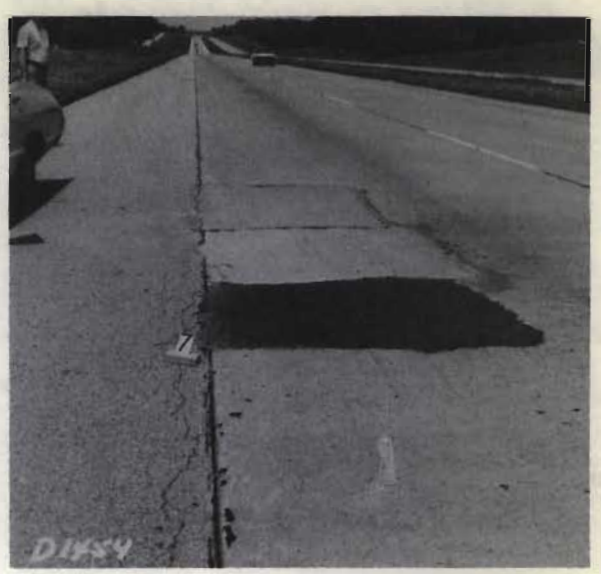
Asphalt Patch Wheel Path #1

Photograph #6

Median size longitudinal crack. Wheel Path #1.

Photograph #7

Mixture of Concrete and Asphalt Patches. Wheel Path #1.



Photograph #8

Failure where Concrete is breaking out under traffic adjacent to small asphalt patch. Wheel path #1.

Photograph #9

Old Concrete Patch Wheel Path #1.

Photograph #10

Construction Joint with Asphalt Patch. Failure in Wheel Path #1 & 2.

Photograph #11

"New" and "Old" Concrete Patches. Most Failures in Wheel Path #1.

Photograph #12

Typical Transverse Cracks with minor spalling not called failure in this survey.

Photograph #13

Typical Spalling Wheel
Path 1 & 2.

Photograph #14

Typical Longitudinal
Failure with spalling.
Wheel Path #1.

Photograph #15

Transverse and Longitudinal
failures.

Photograph #16a

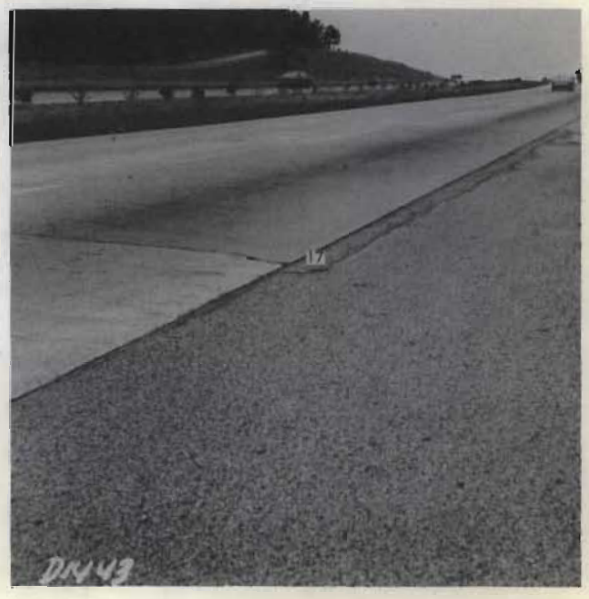
Concrete patch failures
Wheel Path land 2.

Photograph 16b

View showing general
area of 16a.

Photograph #17

Largest Concrete patch
old, but in good shape.



Photograph #18

Spalling failures
Wheel Path # 3 & 4.

Photograph #19

Failures - Wheel Paths 1 & 2
Rocker failure Wheel Path #2.

Photograph #20

Good Construction Joint

APPENDIX C

Location of Distressed Areas

(Indicates wheel path and the failure length in feet is referenced to the preceeding Dynaflect Stations)

Location of Failure						
South Bound Lane					Date: 4/28/69	
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
Begin		512.8	525.9			1,2
		567.0	597.6			1,2
		608.0	633.4			1,2
2		0.0	6.3			1
		66.0	67.4			1
		249.3	-----			1,2
3		180.3	-----			1
		459.3				2
4		21.7	26.4			1*
		375.5	379.5			2*
5		121.3	-----			1
6		46.7	-----			1
		303.7	313.0			1
7		358.1	-----			2
8		51.2	-----			1
		54.5	55.0			1
		58.1	63.8			1,2
		80.5	82.2			1
		90.0	92.9			1
		111.5	-----			1
		113.2	115.9			1
		128.4	130.7			2
		128.4	142.4			1
		409.9	419.3			1
		413.0	419.3			2
		455.0	456.5			1
		456.5	461.2			1*
9		0.0	-----			2,3
		36.0	37.4			1
10		-----	-----	-----	-----	-----
11		70.2	-----			3
		122.1	-----			1
		403.5	404.6			2
		407.0	407.5			1
12		159.0	163.5			1
		253.6	259.5			1
		352.5	362.8			1
13		254.8	-----			1
		425.5	429.6			1,2
14		131.2	-----			1
		259.0	263.2			1*
		392.2	396.3			1
		433.0	-----			1
15		0.0	7.8			1,2,3
		115.8	117.0			1,2,3,4
		439.6	443.3			1
		459.7	465.7			1,2
16		102.0	107.0			1

* Represents a concrete patch.

Location of Failure						
South Bound Lane					Date: 4/28/69	
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		161.0	-----			1
		162.0	168.3			1*
		178.0	188.9			1*
		188.9	192.4			1
		210.2	214.6			1
		216.5	-----			1
		246.6	255.3			1
17		26.4	-----			1
		41.7	48.9			1*
		70.9	78.1			2*
		446.0	454.7			1,2
		456.3	458.1			1,2
		519.6	525.7			1,2,3,4
18		301.3	312.1			1*
		310.0	312.1			2*
		312.1	319.0			2
		417.2	-----			1,2,3,4
19		92.2	94.2			1,2
		113.7	116.9			3*4*
		350.5	-----			1,2
20		36.2	-----			1,2
		106.2	116.7			1,2
		469.2	494.0			1,2
		505.7	521.2			1
		1039.0	1042.0			1
		-----	-----	-----	-----	-----
22		0.0	7.0			1,2
		49.0	50.7			1,2,3,4
		101.7	110.0			1,2
		298.8	302.7			1,2
		345.0	348.7			1,2,3,4
		348.7	362.6			1*
		348.7	357.6			2*
		473.5	474.5			1
		502.8	-----			1,2
23		-----	------	-----	-----	------
24		275.3	287.7			1,2
25		40.0	-----			2
		90.0	-----			1
		100.4	-----			1,2,3,4
		117.8	-----			1,2
		404.4	411.3			1,2,3,4
		422.2	-----			1,2,3,4
		445.5	-----			1,2,3,4
26		Begin Overlay				
35		End Overlay				

Location of Failure						
South Bound Lane						Date: 4/29/69
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		205.1	-----			1,2
		215.0	-----			1,2
		344.0	-----			1,2,3,4
		435.8	453.8			1,2
		493.0	495.3			1,2,3,4
		503.0	509.1			1,2
36		19.1	21.0			1,2,3,4
		42.0	45.0			1,2
		82.2	83.0			1,2
		154.0	165.1			1,2
		202.0	204.2			1
		225.3	227.6			1,2
		264.6	-----			1,2,3,4
		303.0	304.7			1
37		2.0	15.0			1
		34.0	-----			1,2
		40.7	44.0			1
		53.2	-----			1,2
		56.0	68.0			1
		73.8	77.0			1
		89.2	94.2			1
		144.3	-----			1
		166.1	167.1			1
		175.4	-----			1
		201.0	-----			1,2
		335.5	-----			1,2,3,4
		346.3	-----			1
		427.0	428.3			1
		435.0	437.1			1
38		103.3	112.9			1,2
		208.6	225.0			1
		243.6	252.5			1
		261.7	264.9			1
		270.4	281.0			1
		290.0	-----			1
		366.0	372.0			1
		372.0	380.4			1*
		405.0	411.5			1
		431.0	432.0			1
		450.3	456.6			1,2
		468.4	478.9			1
39		25.1	36.0			1
		52.0	55.0			1
		55.0	64.5			1*
		82.0	126.6			1
		205.2	207.4			1
		231.0	233.5			1

Location of Failure						
South Bound Lane						Date: 4/29/69
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		297.1	302.9			1
		323.6	325.4			1,2
		349.2	355.6			1*
		376.4	386.4			1,2
		417.0	423.2			1
40		70.4	72.5			1,2
		172.1	178.7			1
		191.2	193.4			1,2
		283.6	298.4			1,2
		393.1	441.0			1,2
41		0.0	12.1			1,2,3,4
		249.6	-----			1
		457.9	462.2			1
42		12.6	14.5			1
		153.7	155.9			1
		160.3	170.9			1
		386.3	393.6			3
		526.7	531.7			1
43		336.4	339.6			1
44		55.3	-----			1,2,3,4
		195.7	197.8			1,2
		400.1	403.3			1,2
		507.8	515.7			1
45		0.0	10.4			1
		172.0	179.4			1,2
		227.7	334.4			1
		411.0	432.0			1,2
46		35.6	42.0			1
		57.3	64.6			2
		87.9	114.6			1
		246.2	-----			1,2
		344.7	346.8			1
		398.1	407.9			1,2
		422.0	427.1			1
		434.7	458.8			1
		503.2	513.4			1
47		34.4	36.4			1
		90.7	91.8			1
		107.0	-----			1,2,3,4
		156.0	161.5			1
		186.7	-----			1
		303.9	-----			1,2,3,4
		404.5	-----			1
48		177.8	191.4			1,2,3,4
		384.7	-----			1,2,3,4
		484.2	-----			4
49		90.0	-----			3,4

Location of Failure

South Bound Lane — Date: 4/29/69

Dynaflect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		149.0	-----			3,4
		172.9	-----			4
		183.4				4
		197.2	-----			3,4
		263.4	275.7			1
		346.0	-----			1,2,3,4
		351.3	359.2			1*
		474.0	-----			3,4
50		52.5	-----			1,2
		96.9	-----			3
		121.3	-----			3,4
		155.8	160.6			1
		178.1	185.7			1
		233.3	243.3			1*
		285.0	-----			3,4
		287.6	-----			1
		391.4	-----			2
		447.0	451.0			1
		526.0	-----			4
51		15.8	24.3			1
		64.0	-----			4
		150.2	153.0			1
		336.5	-----			3,4
		339.0	-----			1,2
		341.0	346.0			1*
		343.5	346.0			2*
		346.0	350.0			1,2
		358.0	-----			4
		368.2	-----			4
		418.0	-----			1
		446.0	-----			4
		486.4	-----			4
		521.0	-----			4
52		60.5	71.8			1,2
		71.8	79.9			2*
53		259.7	264.0			1*
		264.0	272.7			1,2
		531.5	537.3			1,2
54		0.0	4.7			1,2
		172.6	-----			4
		394.0	-----			4
		434.5	-----			4
		481.8	-----			2
55		461.6	-----			2,3
56		210.2	-----			4
		421.0	-----			2
		522.0	-----			4

Location of Failure						
South Bound Lane						Date: 4/29/69
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
57		131.6	132.5			1,2
		199.3	-----			4
		203.0	-----			1
		204.3	209.3			1*
		284.2	-----			3
		393.0	395.0			1,2
58		22.0	27.3			1*
		43.1	-----			1,2
		214.7	-----			4
		311.8	-----			4
		366.1	368.0			1
		504.0	506.0			1
59		25.0	-----			1,2,3,4
		45.9	-----			1,2
		51.3	-----			1,2
		61.2	-----			1,2,3,4
		73.3	-----			1
		110.0	117.0			1
		145.0	-----			1,2,3
		188.6	-----			3,4
		230.3	-----			2,3
		237.4	-----			3
		326.7	-----			1,2,3,4
		365.0	375.0			1,2
		401.6	411.8			1
		401.6	421.4			2
60		496.0	498.3			2
61		37.2	-----			2
		510.0	-----			1
62		41.0	50.6			1
		69.4	72.3			1
		128.5	-----			1
		147.0	-----			1
		153.0	-----			1,2,3,4
		249.4	281.3			1,2
		291.6	307.4			1,2
		334.1	-----			1,2,3
		367.0	401.7			1
		458.0	-----			2
63		54.9	60.8			1,2,3,4
		170.0	176.5			1
		486.6	-----			1,2
64		34.4	-----			1
		111.1	-----			1
		218.2	-----			1
		263.0	273.1			1,2
		362.6	364.7			1

Location of Failure						
South Bound Lane						Date: 4/29/69
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		400.8	-----			3
65		3.0	------			3
		115.5	-----			1
		144.8	152.7			1,2,3,4
		201.2	206.2			1
		255.2	-----			2
		371.7	-----			1
		420.6	-----			3
		436.0	442.6			1*
		450.7	-----			1
		471.0	476.8			1,2
		489.0	-----			1,2,3,4
66		11.9	-----			1
		180.7	187.8			1
		194.0	201.5			1,2
67		265.4	274.3			1,2
		283.8	288.0			1,2,3
		353.5	364.5			1
		516.4	518.0			1
68		0.0	7.4			1
		57.6	68.4			1*
		83.6	88.6			1*
		88.6	92.2			1
		92.2	100.7			1*
		129.0	135.5			1*
		208.0	209.9			1
		212.3	222.8			1
		222.8	227.5			1*
		227.5	239.0			1
		239.0	243.8			1*
		243.8	266.7			1
		266.7	271.7			1*
		271.7	279.2			1
		353.8	360.0			1
		519.6	525.0			1
69		86.1	88.0			1*
		179.2	-----			2
		258.2	260.8			1*
		274.0	-----			1
		325.1	335.6			1
		395.0	403.4			1*
70		34.4	37.8			1,2,3,4
		78.3	-----			2
		198.4	-----			1
		255.1	263.4			1
		306.6	354.2			1
		482.7	492.0			1

Location of Failure						
South Bound Lane						Date: 4/29/69
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		513.0	-----			1
71		280.6	285.3			1*
		328.3	329.4			1
		392.0	400.5			1
		400.5	405.7			1*
72		41.0	49.9			1*
		194.4	204.1			1,2
		220.8	225.2			1*
		321.7	325.1			1*2*
		332.1	336.7			1,2
		359.8	373.3			1,2,3,4
		418.1	419.8			1,2
		525.0	527.3			1,2
73		0.0	8.4			1,2,3
		22.9	31.8			1,2
		98.0	99.9			1
		100.3	102.3			1,2
		130.6	137.2			1*,2*
		149.5	151.7			1
		201.7	205.0			1,2,3,4
		259.0	263.0			1
		308.5	310.5			1
		320.5	325.4			1,2
		341.4	349.2			1,2
		431.5	440.3			1,2
		473.0	-----			1,2
		500.6	-----			1,2
74		23.0	-----			1,2,3,4
		71.5	74.1			1*
		107.2	109.4			1
		164.3	176.6			1
		184.8	-----			1,2
		237.2	241.7			1,2
		251.4	-----			1,2
		262.0	265.0			1,2
		270.0	274.1			1,2
		284.9	-----			1
		309.6	314.7			1,2
		346.7	355.5			1,2
		364.5	368.8			1,2
		397.9	418.5			1,2
		459.4	462.4			1,2
		476.2	477.8			1,2
		488.3	-----			1,2
75		10.6	13.2			1*,2*
		21.0	-----			1
		46.3	48.5			1*2*

Location of Failure						
South Bound Lane						Date: 4/29/69
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		56.7	62.5			1,2
		266.7	-----			1,2
		330.4	336.3			1*
		350.5	354.5			1,2
		379.2	381.7			1
		470.3	-----			1
76		144.7	-----			3
		155.9	-----			1
		227.7	-----			1,2
		265.0	269.8			1*
		337.3	-----			1,2,3,4
		357.8	359.9			1*
		484.6	511.4			1,2
		509.6	511.4			3,4
77		0.0	34.5			1,2,3,4
		74.0	95.6			1,2
		108.8	128.5			1,2
		140.5	-----			1,2
		276.9	280.1			1,2
		417.9	419.0			1,2
		437.4	-----			1,2,3,4
		497.4	499.6			1,2
		519.8	539.0			1,2
78		21.0	31.0			1,2
		123.0	-----			1,2,3,4
		215.5	303.0			1,2
		417.0	421.5			1*
		447.8	451.5			1*
79		154.7	182.0			1,2
80		29.1	36.6			1
		138.1	-----			1,2,3,4
		293.8	-----			2
		432.9	-----			1,2
		445.3	448.3			1,2
		445.3	-----			3,4
		498.0	-----			1,2,3,4
81		14.5	24.0			1,2
		192.1	-----			1,2,3
		442.4	448.8			1,2
		489.0	499.2			1,2
		514.0	535.6			1,2
82		2.5	6.6			1,2
		257.1	259.8			1*
		281.0	283.7			1
		490.0	492.3			1
83		48.5	55.6			1*
		67.4	-----			1
		110.0	-----			1

Location of Failure						
South Bound Lane						Date: 4/29/69
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		119.3	122.7			1*
		174.2	180.9			1*
		212.0	214.4			1*
		232.5	236.8			1*
		243.8	247.6			1*
		255.0	258.8			1*
		341.6	349.4			1*
		393.8	-----			3,4
		426.8	437.4			1*
		437.4	455.2			1
		455.2	458.6			1*
		462.7	471.8			1*
		487.5	511.5			1,4
		533.6	535.7			1
84		69.0	86.3			1,2
		100.1	120.0			1,2
		153.0	169.2			1,2
		184.2	220.9			1,2
		442.5	449.2			1
		505.3	-----			4
85		11.8	-----			1
		35.0	47.0			1,2
		70.7	78.3			1,2
		268.1	271.3			1,2
		429.2	438.0			1,2
86		245.7	-----			1
		254.7	-----			1
87		52.2	-----			1
		234.0	-----			3
		459.2	-----			3,4
88		80.8	97.3			2,3,4
89		6.1	13.0			1,2
		64.3	66.7			1
		149.8	152.4			1,2,3,4
		420.2	427.3			1,2
		493.6	500.8			1,2
90		67.4	-----			1,2,3,4
		177.0	180.6			1
		177.0	-----			2,3,4
		228.0	-----			1,3,4
		228.0	232.6			2
91		-----	-----	-----	-----	------
92		40.3	44.2			1,2
		329.3	-----			1
		403.0	405.6			2
93		15.7	-----			1,2,3,4
		139.0	-----			2
94		61.6	62.0			1,2

Location of Failure						
South Bound Lane					Date: 4/29/69	
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		161.6	-----			1,2,3,4
95		68.4	74.2			1,2
		86.6	-----			1
		175.0	177.9			1,2,3,4
96		161.6	-----			1,2,3,4
97		25.4	26.9			1
		59.9	65.2			1,2
		152.0	154.0			1
		182.4	191.1			1,2,3,4
		292.5	309.2			1,2
		394.3	406.0			1,2
		423.3	425.4			1
		473.2	483.4			1,2
		490.8	506.0			1,2
98		76.8	-----			1,2,3,4
		129.3	-----			4
		151.4	187.0			1
		209.8	216.3			1,2
		231.5	241.1			1,2
99		54.8	56.9			1
		91.0	-----			3,4
		412.6	413.8			2
		450.6	454.9			1
		509.7	511.7			1
100		0.0	2.0			1,2
		26.6	31.2			1,2,3,4
		221.6	231.6			1,2,3,4
		441.4	442.6			1
101		69.8	76.1			1
		360.0	362.0			1
102		210.6	213.8			1,2
103		415.7	418.3			1,2
		453.4	455.1			2
104		27.3	-----			3
		221.1	231.1			1,2,3,4
		372.8	-----			3,4
		393.0	-----			3,4
		403.7	-----			1,2,3,4
105		9.5	-----			1
		225.7	234.9			1,2,3,4
		319.0	320.5			1
		352.3	361.8			1
		405.5	415.8			1,2,3,4
		509.4	511.8			1
		517.9	-----			1,2,3,4
106		169.5	177.0			1,2
		197.3	-----			1,2

Location of Failure						
South Bound Lane						Date: 4/29/69
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		338.5	345.5			1,2
107		204.3	207.6			1
		368.0	369.2			1,2
		442.0	455.5			1,2
108		142.7	-----			1,2,3,4
		249.8	-----			1,2,3
109		-----	-----	-----	-----	-----
110		-----	-----	-----	-----	-----
111		52.5	53.5			1,2
		494.0	-----			2,3
112		302.0	-----			1
		303.5	304.5			1
		403.3	405.0			1
		417.0	-----			1
113		123.0	-----			1
End						

Location of Failure						
North Bound Lane					Date: 4/29/69	
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
Co. Line=0+00						
		350.0	415.2	3+50.0	4+15.2	1
		492.0	544.5	4+92.0	5+44.5	1
1		529.0	-----			2,3
2		0.0	-----			1,2
		194.0	-----			3,4
		517.0	524.0			1,2
3		-----	-----	-----	-----	-----
4		84.8	-----			1,2,3,4
		90.0	-----			1,2
		467.8	468.8			1,2
5		494.1	502.0			1
6		162.5	-----			3,4
		480.0	-----			1,2
		505.0	511.6			1,2
7		63.0	73.4			1,2
		140.1	145.2			1,2
		286.0	291.3			1,2
		321.4	326.2			1,2
		360.3	366.9			1,2
		410.6	412.9			1,2
		431.6	-----			1,2
		493.2	-----			4
8		74.0	76.0			1,2
		87.0	95.2			1,2,3
		343.0	-----			3
		391.0	-----			1
		497.1	497.9			1,2
		501.0	-----			1,2,3,4
9		124.6	134.0			1
		344.1	-----			3,4
		394.0	-----			2
		438.6	445.4			1
10		15.0	-----			3
		422.6	441.7			1,2,3,4
		474.2	-----			3,4
11		0.0	-----			1,2,3,4
		65.3	-----			2
		73.1	-----			1,2,3,4
		77.1	-----			4
12		91.3	104.5			2
		461.0	464.8			2,3
13		-----	-----	-----	-----	-----
14		232.4	249.0			3,4
		249.0	261.0			1,2
15		-----	-----	-----	-----	-----

Location of Failure						
North Bound Lane					Date: 4/29 & 30/69	
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
16		74.5				3,4
17		-----	-----	-----	-----	-----
18		173.5	176.8			1,2,3,4
		220.0	227.0			1,2,3,4
19		-----	-----	-----	-----	-----
20		532.2	-----			2
21		6.6	-----			3
		110.3	-----			2
22		475.0	-----			1
		497.6	512.2			1
23		163.9	164.6			1
		221.9	227.3			1,2
24		25.5	27.4			1,2
		492.6	498.3			1
25		62.8	68.8			1,2
		80.8	91.5			1,2
		155.6	162.0			1,2
		244.7	226.7			1
26		87.0	97.9			1
		111.4	112.4			1
27		379.2	383.4			1
28		30.7	35.1			1
29		186.7	189.3			1,2
30		100.0	-----			2
		484.6	491.9			1
31		20.6	30.8			1
		73.6	83.6			1,2
32		74.3	82.6			1,2*
33		-----	-----			-----
34		-----	-----			-----
35		57.8	84.2			1,2*
36		-----	-----			
37		281.0	282.5			2
38		349.2	-----			1,2,3,4
		357.1	-----			1,2
39		-----	-----	-----	-----	-----
40		26.0	29.0			1,2,3,4
41		169.1	175.8			1,2
42		-----	-----	-----	-----	-----
43		-----	-----	-----	-----	-----
44		-----	-----	-----	-----	-----
45		-----	-----	-----	-----	-----
46		-----	-----	-----	-----	-----
47		130.0	-----			1,2,3,4
		332.2	-----			3,4
48		366.3	367.0			1,2
49		34.0	39.0			1
		177.5	-----			3
		440.5	-----			1

Location of Failure						
North Bound Lane					Date: 4/30/69	
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
50		372.8	-----			1
51		25.3	-----			1,4
		215.7	220.0			1,2
		290.6	293.8			1,2
52		7.3	-----			1,2
53		12.6	-----			1
		293.2	-----			2
		421.3	428.6			1,2
54		243.2	250.3			1,2,3,4
		422.0	-----			1,2,3
		452.0	-----			3
		536.1	-----			1,2,3
55		-----	-----	-----	-----	-----
56		4.6	-----			3
		20.4	-----			3
		326.6	-----			1
		428.2	-----			1
		483.7	-----			3
57		27.0	33.0			1
		193.8	195.2			1
		284.0	-----			1
		326.0	337.6			1,2,3,4
58		108.6	132.7			1,2
59		144.3	145.4			1,2
		177.7	-----			1,2
		418.6	426.0			2,3,4
		432.6	442.5			1,2,3,4
		529.6	535.0			1,2
60		0.0	2.6			1,2
		24.4	-----			1,2,3,4
		35.3	-----			1,2,3,4
		57.4	83.2			1,2,3
		130.4	132.6			1
		379.0	383.7			1,2,3.4
		411.1	-----			1,2
		476.1	482.6			1,2,3,4
61		47.1	-----			4
		49.1	-----			4
		61.3	72.6			1,2
		183.1	189.3			1,2
		237.0	240.8			1,2,3,4
		332.1	334.2			1,2,3
		443.0	450.8			1,2,3,4
62		8.1	-----			1,2
		45.8	48.3			3,4
		107.5	-----			3,4
		120.3	-----			3,4

Location of Failure						
North Bound Lane					Date: 4/30/69	
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		134.6	-----			3,4
		158.0	-----			1,2
		175.5	-----			4
		245.2	251.2			1
		316.2	321.0			1,3,4
		411.0	414.9			1,2,3,4
		453.0	-----			3
		478.0	484.8			1,2,3
63		13.4	14.7			1,2
		22.3	30.5			1,2*
		22.3	30.5			3,4
		116.0	146.7			1,2,3,4
		179.2	-----			3,4
		215.0	242.4			1,2,3,4
		258.6	264.3			1,2
		345.3	355.0			1,2,3,4
		469.6	472.8			1,2
64		55.6	-----			1
		189.4	196.9			1,2*
		490.0	498.2			1,2
65		17.1	21.0			1,2,3,4
		32.2	35.0			1,2
		109.4	112.3			3,4
		161.8	192.0			1,2
		213.8	-----			3,4
		320.3	321.7			1,2,3,4
		363.6	370.7			1,2,3,4
		487.5	-----			1,2
66		23.6	30.3			1,2
		177.7	179.8			1,2
		208.5	235.3			1,2,3,4
		299.6	308.2			1,2
		397.6	409.0			1,2*
		463.7	465.5			1,2
		470.0	475.1			2*
		502.2	522.6			1,2
67		41.6	43.6			1,2
		71.7	95.4			1,2
		224.6	237.7			1,2
		316.6	321.7			1,2
		409.6	411.7			1,2
		455.0	457.9			1
		492.5	497.3			1
		519.8	-----			1
68		48.9	58.7			1,2
		84.5	90.6			1
		112.2	-----			3,4
		163.7	169.4			1*

Location of Failure						
North Bound Lane					Date: 4/30/69	
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		199.3	203.6			1*
		333.5	341.0			1,2,3,4
		370.8	-----			1,2
		408.3	424.6			1,2
69		356.4	366.7			1,2
		390.0	402.0			1,2
		438.7	445.2			1,2
70		164.0	165.0			1
		255.8	272.7			1,2
		455.3	467.5			1
		484.5	496.5			1
71		10.0	10.8			1
		263.7	268.0			1,2
		436.6	437.6			1,2
72		527.6	-----			1
73		233.2	235.5			1,2
		273.9	284.7			2
		348.0	349.0			1,2
		523.4	525.8			1,2
74		58.5	68.3			1,2
		260.4	262.5			1
		309.4	325.1			1
		342.0	359.1			1,2
		418.7	423.6			1,2
		439.5	-----			4
		482.3	492.1			1*
75		31.1	37.5			2*
		228.5	229.6			1
		491.0	496.4			1,2
		524.6	532.4			1*
76		40.0	42.1			1
		160.2	165.1			1*
		191.2	216.6			1,2
		276.3	288.5			1,2*
		312.0	367.3			1,2
		488.3	490.4			1
		508.7	523.2			1,2
77		37.0	42.1			1,2
		84.2	92.5			1,2
		145.3	162.6			1,2
		257.8	262.1			1,2
		363.0	380.2			1,2
		416.4	420.4			1,2
		431.3	437.8			1,2
78		-----	-----	-----	-----	-----

Location of Failure						
North Bound Lane					Date: 4/30/69	
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
overlay		248.5	252.5			1
88		131.4	133.5			1,2
		163.5	171.6			1
		201.7	207.8			1,2
		256.3	260.5			1
		308.1	317.9			1,2*
		376.1	386.2			1,2
		497.5	510.2			1,2
89		119.1	136.4			1,2
		195.5	201.0			1
		246.1	-----			1
90		-----	-----	-----	-----	-----
91		65.4	79.8			1,2
		154.5	158.7			1,2
		231.0	235.5			1
		506.1	-----			3,4
92		227.0	-----			3,4
		268.7	-----			3,4
		486.0	489.6			2
93		69.2	132.1			1,2
		261.2	270.6			1
94		149.3	152.2			1,2
		157.2	164.4			1
		483.0	507.8			1
95		124.0	128.7			1
96		11.8	35.6			1,2
		174.7	179.8			1
		302.6	309.0			1,2
		397.1	401.0			1,2
97		58.0	65.1			1,2
		65.1	66.6			1*
		88.6	155.0			1,2
		171.0	189.2			1,2
		217.2	262.0			1
		272.8	282.7			1,2
		288.1	336.2			1*
98		8.2	18.3			1*
		269.6	295.8			1*
		377.2	380.2			1,2
99		69.7	71.5			1
		215.1	223.4			1,2
		422.6	430.6			1,2*
		502.1	510.7			1
100		117.7	127.0			1
		163.8	166.0			1*
		222.0	230.3			1*

Location of Failure						
North Bound Lane					Date: 4/30/69	
Dyna-flect Sta.	Center-Line Station	Begin Failure	End Failure	Begin Centerline Station	End Centerline Station	Wheel Path
		249.3	255.0			1,2
		266.1	269.4			1,2
		361.5	369.6			1,2
		524.0	532.1			1,2
101		-----	-----	-----	-----	-----
102		114.0	118.0			1,2
		207.1	215.2			1,2
		251.7	264.5			1,2
103		228.0	232.0			1,2
		232.0	286.6			1,2*
104		-----	-----	-----	-----	-----
105		152.8	161.5			1,2
106		15.7	-----			3,4
		282.1	292.4			1,2
		359.8	-----			3,4
107		50.2	54.8			1,2
108		-----	-----	-----	-----	-----
109		-----	-----	-----	-----	-----
110		57.5	59.6			1
		405.0	407.2			1
111		458.6	460.4			1,2
112		86.3	89.6			1
		102.0	-----			1,2,3,4
End 112+185.0'		-----	-----	-----	-----	-----

APPENDIX D

Tabulation of Percent Failures

TABULATION OF PERCENT FAILURES

SBL		NBL	
DYNAFLECT STATION	% FAILURE	DYNAFLECT STATION	% FAILURE
2 + 00	11.4	113 + 00	3.3
3 + 00	2.2	112 + 00	0.9
4 + 00	0.4	111 + 00	1.5
5 + 00	1.1	110 + 00	0.0
6 + 00	0.4	109 + 00	0.0
7 + 00	1.9	108 + 00	1.1
8 + 00	0.4	107 + 00	2.2
9 + 00	11.2	106 + 00	1.8
10 + 00	0.4	105 + 00	0.0
11 + 00	0.0	104 + 00	11.4
12 + 00	0.8	103 + 00	5.6
13 + 00	4.9	102 + 00	0.0
14 + 00	1.5	101 + 00	10.4
15 + 00	2.9	100 + 00	6.4
16 + 00	5.0	99 + 00	8.2
17 + 00	9.2	98 + 00	38.0
18 + 00	6.1	97 + 00	8.7
19 + 00	2.6	96 + 00	1.1
20 + 00	1.1	95 + 00	7.2
21 + 00	5.4	94 + 00	13.7
22 + 00	5.4	93 + 00	0.0
23 + 00	9.9	92 + 00	5.3
24 + 00	0.4	91 + 00	0.0
25 + 00	1.8	90 + 00	5.1
26 + 00	3.7	89 + 00	12.3
27 + 00	Overlay	88 + 00	Overlay
28 + 00	"	87 + 00	"
29 + 00	"	86 + 00	"
30 + 00	"	85 + 00	"
31 + 00	"	84 + 00	"
32 + 00	"	83 + 00	"
33 + 00	"	82 + 00	"
34 + 00	"	81 + 00	"
35 + 00	"	80 + 00	"
36 + 00	"	79 + 00	"
37 + 00	13.6	78 + 00	14.6
38 + 00	11.9	77 + 00	23.7
39 + 00	20.0	76 + 00	3.4
40 + 00	20.2	75 + 00	13.0
41 + 00	20.9	74 + 00	1.9
42 + 00	4.3	73 + 00	0.4
43 + 00	4.8	72 + 00	1.9
44 + 00	0.7	71 + 00	8.9
45 + 00	3.8	70 + 00	6.4
46 + 00	27.9	69 + 00	11.6
47 + 00	18.3	68 + 00	12.4

TABULATION OF PERCENT FAILURES

SBL		NBL	
DYNAFLECT STATION	% FAILURE	DYNAFLECT STATION	% FAILURE
48 + 00	3.7	67 + 00	16.3
49 + 00	3.4	66 + 00	10.3
50 + 00	4.9	65 + 00	3.7
51 + 00	6.9	64 + 00	17.8
52 + 00	5.2	63 + 00	6.0
53 + 00	2.3	62 + 00	7.5
54 + 00	4.1	61 + 00	9.7
55 + 00	1.1	60 + 00	7.5
56 + 00	0.0	59 + 00	4.9
57 + 00	0.0	58 + 00	4.8
58 + 00	2.6	57 + 00	0.8
59 + 00	3.0	56 + 00	0.0
60 + 00	8.6	55 + 00	2.2
61 + 00	0.0	54 + 00	1.9
62 + 00	0.4	53 + 00	0.4
63 + 00	22.0	52 + 00	2.3
64 + 00	3.4	51 + 00	0.4
65 + 00	4.0	50 + 00	1.5
66 + 00	7.6	49 + 00	0.4
67 + 00	3.8	48 + 00	0.4
68 + 00	6.2	47 + 00	0.0
69 + 00	23.5	46 + 00	0.0
70 + 00	5.6	45 + 00	0.0
71 + 00	13.8	44 + 00	0.0
72 + 00	4.5	43 + 00	0.0
73 + 00	14.8	42 + 00	1.5
74 + 00	15.7	41 + 00	0.8
75 + 00	18.8	40 + 00	0.0
76 + 00	7.5	39 + 00	0.8
77 + 00	8.6	38 + 00	0.0
78 + 00	24.8	37 + 00	0.0
79 + 00	21.4	36 + 00	5.3
80 + 00	5.6	35 + 00	0.0
81 + 00	3.7	34 + 00	0.0
82 + 00	10.5	33 + 00	1.9
83 + 00	3.4	32 + 00	4.5
84 + 00	23.5	31 + 00	1.5
85 + 00	21.1	30 + 00	0.7
86 + 00	7.5	29 + 00	1.1
87 + 00	0.8	28 + 00	1.1
88 + 00	0.4	27 + 00	2.6
89 + 00	0.0	26 + 00	5.9
90 + 00	6.0	25 + 00	2.3
91 + 00	1.6	24 + 00	1.5
92 + 00	0.0	23 + 00	3.4
93 + 00	1.5	22 + 00	0.0
94 + 00	0.4	21 + 00	0.0
95 + 00	0.8	20 + 00	0.0
96 + 00	2.6	19 + 00	2.3

TABULATION OF PERCENT FAILURES

SBL		NBL	
DYNAFLECT STATION	% FAILURE	DYNAFLECT STATION	% FAILURE
97 + 00	0.4	18 + 00	0.0
98 + 00	16.2	17 + 00	0.0
99 + 00	11.1	16 + 00	0.0
100 + 00	2.7	15 + 00	2.6
101 + 00	4.4	14 + 00	0.0
102 + 00	2.3	13 + 00	0.0
103 + 00	1.8	12 + 00	0.8
104 + 00	0.8	11 + 00	3.6
105 + 00	2.7	10 + 00	3.4
106 + 00	7.9	9 + 00	4.8
107 + 00	3.4	8 + 00	8.3
108 + 00	3.7	7 + 00	1.9
109 + 00	0.8	6 + 00	1.9
110 + 00	0.0	5 + 00	1.1
111 + 00	0.0	4 + 00	0.0
112 + 00	0.4	3 + 00	1.9
113 + 00	1.9	2 + 00	0.0
114 + 00	0.5	1 + 00	20.8