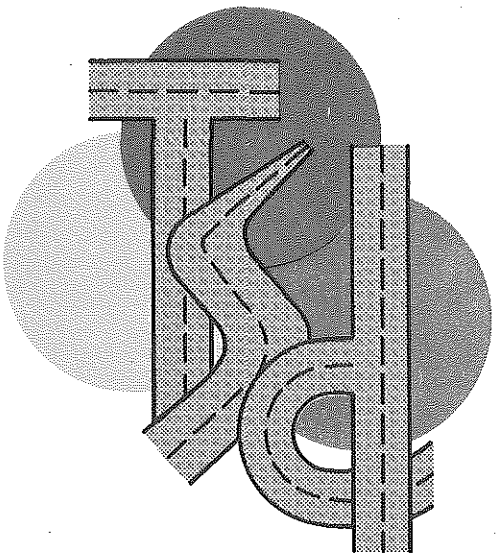
Metro Module Traffic Signals

M-13 (Washington) and Genesee
M-13 (Washington) and Federal
City of Saginaw, Saginaw County



TRAFFIC and SAFETY DIVISION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS
AND TRANSPORTATION

TSD 491-81

Metro Module Traffic Signals

M-13 (Washington) and Genesee
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City of Saginaw, Saginaw County

A "Before and After" Study

TSD-491-81

by
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December 1981

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Acknowledgement

The authors would like to acknowledge the helpful assistance of Karen McDonald of the Safety Programs Unit and Donald Mercer of the Technical Services Unit, Traffic and Safety Division, Michigan Department of Transportation.

Abstract

A review of accidents was conducted (using 50 state trunkline signal locations in the city of Saginaw, Michigan, as control locations) for three years preceding and following the installation of "Metro Module" [1/] signal units at two intersections in Saginaw. Adverse effects upon traffic safety were shown in the after period.

1/ Metro Module is a trade name for a complete system of street furniture components for vehicular and pedestrian functions manufactured exclusively by Crouse-Hinds Company, Syracuse, New York. Components include architecturally styled street lights, traffic and pedestrian signals, signs and graphic panels, phone booths, litter containers, benches, and other pedestrian elements.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PHOTOGRAPHS

Summary

The purpose of this study was to evaluate and analyze the effects of installing "Metro Module" [1/] signals in terms of accident experience. The Metro Modules were installed at two intersections in the city of Saginaw, Michigan in 1976. They consisted of pedestal signals located on the near right and far left corners and an approximately 8-foot long mast arm located on the far right corner of all approaches to the intersections but one. That approach, the one-way, westbound Federal approach, does not have the near right pedestal signal. The "before" period included three years of data preceding and the "after" period included data for three years following completion of the project in December, 1976. Fifty state trunkline signal locations in the city of Saginaw were used as control sites. Metro module signal installation costs were about two and one-half times the cost of span-wire installations erected in the same period.

There was a statistically significant increase in accidents following the installations. Total accidents increased 54 percent, from 94 in the three year before period to 145 in the three years after installation, compared to a 24 percent increase at the control intersections. No conclusions can be drawn from an examination of light conditions prevailing during the reported accidents. Angle accidents increased approximately 700 percent, from 8 to 65. Twenty-eight percent of the motorists involved in the angle accidents either failed to see the signals or were confused by them. Based on this experience, no further signal installations of this type (i.e., with a short mast arm on a multi-lane roadway) are recommended.

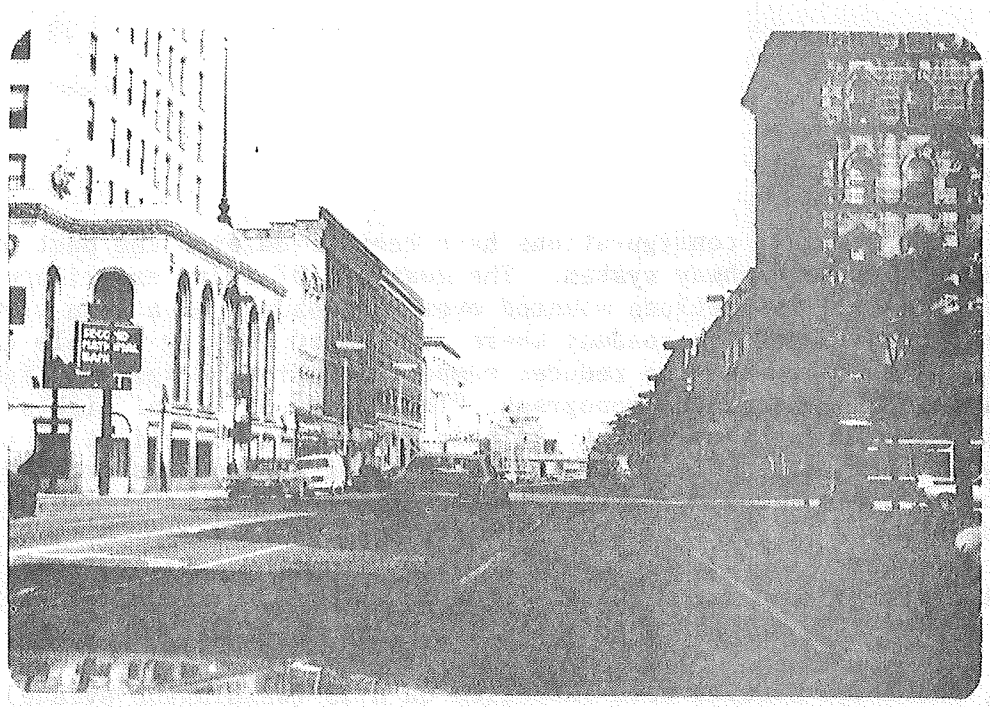
[1/] Metro Module is a trade name for a complete system of street furniture components for vehicular and pedestrian functions manufactured exclusively by Crouse-Hinds Company, Syracuse, New York. Components include architecturally styled street lights, traffic and pedestrian signals, signs and graphic panels, phone booths, litter containers, benches, and other pedestrian elements.

Introduction

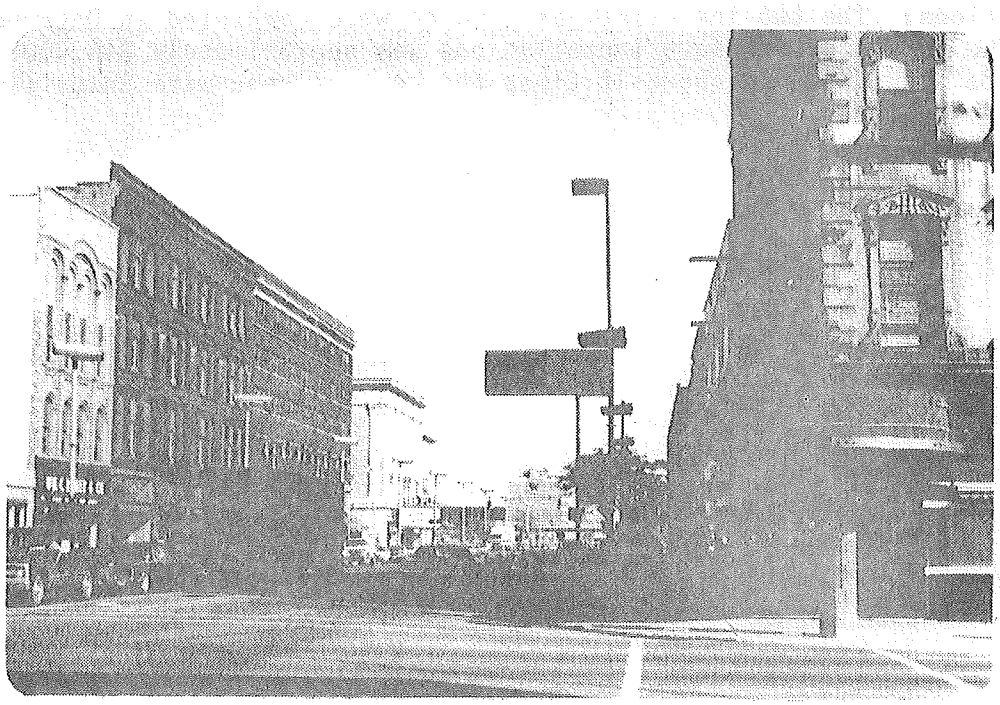
Various traffic signal configurations have been tried over the past 50 years on Michigan's state highway system. The most satisfactory experience has been achieved with dual indications mounted over the roadway on a span wire. This places the signal over the roadway where it is most readily visible to the motorist. This location also reduces competition from background lights. A National Bureau of Standards monograph, "The Colors of Signal Lights", states, "The background of a signal light can have a considerable effect on its conspicuity and its recognition. The conspicuity of a signal is greatly reduced if it must be seen among a number of other lights from which the observer receives an equal or greater illuminance...The loss of conspicuity because of competing lights is not as serious a problem with city traffic lights as it would otherwise be because drivers become accustomed to the exact location of traffic lights with reference to the driving lane in their own city..."

In 1976, two Metro Modules were installed on M-13 (Washington Avenue) as part of a street beautification project. In contrast to the span-wire installation, the Metro Module configuration (see Photographs 1-4) places the signal indications over the curb lane and sidewalk areas. Various architectural improvements were made to street hardware, store fronts, and plantings. The use of illuminated signs was held to a minimum.

The purpose of this study was to assess the operational safety of Metro Module installations. The two installations studied were completed in December, 1976. The total cost of both installations was approximately $46,000. These costs were about two and one-half times the cost of span-wire installations made at that time.

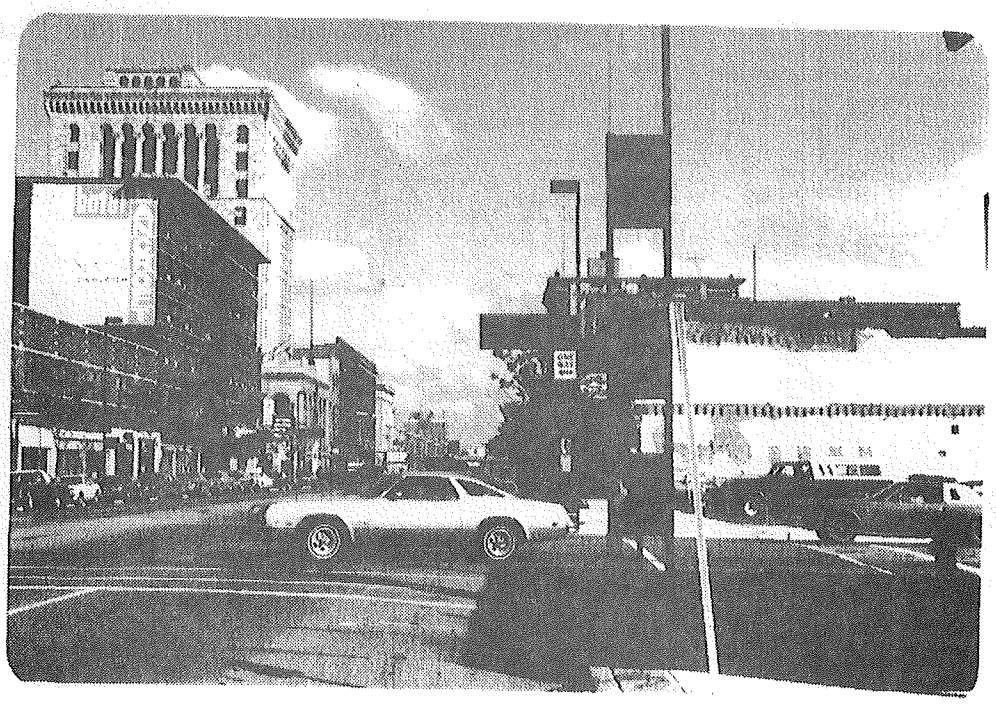


Photograph 1
M-13 (Washington) at Genesee
Looking North
Green Indication



Photograph 2
M-13 (Washington) at Genesee
Looking North
Red Indication

Photograph 3
M-13 (Washington) at Federal
Looking East
Pedestrian Signal and Green Indication



Photograph 4
M-13 (Washington) at Federal
Looking North
Red Indication

Conclusions

This analysis is limited by the small number of Metro Module installations available for evaluation. Although the city of Grand Rapids has ten Metro Modules installed, only two are operational and for too short a time to allow collection of sufficient accident data. At least one other Michigan city is currently considering the installation of these signals in its downtown area. Therefore, the feeling that some immediate effort should be made to assess the traffic safety aspects of these signals was the impetus for this study.

There was a statistically significant increase in accidents at the two study locations. No conclusions can be drawn from an examination of the light conditions during these accidents. There was a substantial increase in angle accidents at these locations. An examination of the reports for the angle accidents revealed that 28 percent of the motorists involved stated they either failed to see the signals or were confused by them. This confusion and/or lack of conspicuity may be the result of having typical span-wire installations on either side of the Metro Module installations along M-13 (Washington). Longer mast arms and a far left side mast arm might provide conspicuity similar to a span-wire installation on multi-lane roadways of this type. The increase in angle accidents might decrease as motorists become familiar with the Metro Module installations at these and other locations. However, it appears that increases in the total number of accidents and angle accidents could be expected until that familiarity is achieved. Based on this experience, no further signal installations of this type (i.e., with a short mast arm on a multi-lane roadway) are recommended.

History of Traffic Control Improvements at M-13 (Washington) and Genesee

A standard 3-color traffic signal was installed at this location on March 9, 1948. A second 3-color indication was added in 1950. In November, 1957, the installation was modernized with new traffic signal heads, span wire, and a 3-dial controller. A southbound Washington-to-eastbound Genesee left-turn phase was authorized in August, 1972. Two-phase operation was restored in May, 1976. The Metro Module was placed into operation in December, 1976.

History of Traffic Control Improvements at M-13 (Washington) and Federal

Department records indicate that a traffic signal was installed before August, 1950, and was modernized, including dual indications, in the winter of 1957. The Metro Module was placed into operation in December, 1976.

Accident History

Collision diagrams for 1972, 1973, and 1974 were reviewed by department personnel prior to installation of the Metro Module. These diagrams showed seven angle collisions occurring in that period. No major change in the frequency or pattern of accidents at Washington and Federal was anticipated by department engineers. At Washington and Genesee, the 1976 termination of the left-turn phase led department personnel to expect a modest change in the accident pattern as rear-end accidents decreased and head-on, left-turn, and angle accidents involving northbound and east/westbound traffic increased. This was expected because the left-turn phase afforded a "built-in" all-red interval following termination of the northbound through movement.

Field Investigation

Both locations were observed several times over a 3-year period to evaluate the operating characteristics of the intersection. The Metro Module installation consisted of pedestal signals located on the near right and far left corners and a signal mounted on an approximately 8-foot long mast arm located on the far right corner of all approaches to the intersections but one. That approach, the one-way westbound Federal approach, does not have the near right pedestal signal. Pedestrian fiber optic modules were installed on each corner of both intersections. The near-side signals were obscured by trees planted as part of the beautification project. From the beginning, the light output of the pedestrian signals appeared to be inadequate. Dirt collection on their lenses reduced visibility further.

M-13 (Washington) is 64-feet wide at both intersections. Federal is 46-feet wide west of the intersection and 44-feet wide east of it. Genesee is 72-feet wide west of the intersection and 70-feet wide east of the intersection. There are span-wire installations at intersections on M-13 (Washington) on both sides of the Metro Module installations.

Method of Analysis

Accident data were obtained from the Michigan Department of Transportation's computer files. All signalized state trunkline intersections in the city of Saginaw were originally used as control locations. Three locations were subsequently deleted from consideration due to data processing problems, resulting in a total of 50 locations being utilized as study control locations. The accident data are summarized in Tables 1 and 2 and detailed in the appendix.

The numbers of accidents expected to occur at the study sites in the "after" period were calculated using the percentage change in before-and-after accidents at the control locations. The "after expected" accident experience was then compared with the "after observed" experience using the Chi-square test (see Appendix).

Accident rates (Table 2) were calculated for the test locations only. The number of control locations made it impractical to calculate an average accident rate for them. The statistical significance of the test location accident rate changes was evaluated using the paired t-test (see Appendix).

Accidents were classified by light conditions, and these data are shown in Table 3. Statistical tests for the overall changes in accidents by light conditions and accidents by types were not performed due to the small numbers in each category and the nonuniform percentage changes. Table 4 summarizes the number of accidents by type and percentage changes at both the control and test locations. Actual accident reports were obtained for all angle accidents, before and after installation, to determine the reasons motorists gave for disobeying the red signal (Table 5).

Table 1

Accident Frequencies

	Accidents	Before Total	After Total	Percentage Change
Control Intersections	Total	1,652	2,055	+ 24
	PDO	1,184	1,429	+ 21
	Injury/Fatal	468 (3)	626 (2)	+ 34
Test Intersections	Total	94	145	+ 54
	PDO	77	110	+ 43
	Injury/Fatal	17 (1)	35	+106

( ) Denotes fatal accidents

Table 2

Accident Rates (ACC/MV)

Test Locations	Average Daily Total Approach Volume		Total Accident Rate			PDO Accident Rate			Injury/Fatal Accident Rate		
	Before	After	Before	After	Percent Change	Before	After	Percent Change	Before	After	Percent Change
1. M-13 (Washington) at Genesee	31,250	29,700	2.13	3.44	+62	1.69	2.61	+54	0.44	0.83	+89
2. M-13 (Washington) at Federal	21,050	18,900	0.91	1.59	+75	0.82	1.21	+48	0.09	0.39	+333

Table 3

Accidents By Light Conditions

	Control Intersections			Test Intersections		
Light	Before	After	Percentage Change	Before	After	Percentage Change
Daylight	1180	1453	+ 23	74	116	+ 57
Dawn/Dusk	53	52	- 2	5	4	- 20
Dark	416	547	+ 31	14	25	+ 79
Unk.	3	3	0	1	0	-100
Total	1652	2055	+ 24	94	145	+ 54

Table 4

Accidents By Type

Type	Control Locations			Test Locations		
	Before	After	Percentage Change	Before	After	Percentage Change
Head-On	14	17	+ 21	0	1	----
Sideswipe	78	45	- 42	11	6	- 45
Angle	376	626	+ 66	8	65	+713
Left-Turn	292	312	+ 7	13	12	- 8
Right-Turn	49	71	+ 45	9	10	+ 11
Rear-End	519	655	+ 26	27	28	+ 4
Backing	24	24	0	3	3	0
Parking	152	57	- 63	15	8	- 47
Pedestrian	10	18	+ 80	1	3	+200
Animal	0	0	0	0	0	0
Fixed-Object	88	102	+ 16	5	2	- 60
Train	1	1	0	0	0	0
Bike	11	18	+ 64	1	0	-100
Other	38	109	+187	1	7	+600
Total	1652	2055	+ 24	94	145	+ 54

Table 5

Angle Accidents - Test Locations

Motorist's Responses	Before Period					After Period				
	1973	1974	1975	Total	Percent of Total	1977	1978	1979	Total	Percent of Total
Didn't See Signal	0	0	0	0	0	10*	2	5**	17	26
"Confused by Signal"	0	0	0	0	0	1	0	0	1	2
Vehicle Entered Intersection on Amber	0	1***	1	2	25	2	1	4	7	11
Both Drivers Claimed Signal was Green for Them	1****	1	0	2	25	4	2	3	9	14
Didn't See the Light Turn Red	0	1	0	1	13	0	0	0	0	0
Disobeyed Red Signal	1	0	1	2	25	10	11	8	29	45
Emergency Vehicles	0	0	0	0	0	0	1	1	2	3
Other	0	0	1	1	13	0	0	0	0	0
Total	2	3	3	8	101	27	17	21	65	100

*One driver was "talking to friends"
**One driver was "watching next signal"
***Driver stated didn't "know what color signal was...maybe yellow"
****Driver stated "didn't run any red light"...what color the signal was thought to be was not stated

Results

The observed numbers of all categories of accidents were greater than the calculated "expected" numbers of those accidents at both test locations. The overall increase in total accidents and combined injury/fatal accidents was significant at the 99 percent confidence level and the overall increase in PDO accidents was significant at the 90 percent confidence level.

Total, PDO, and combined injury/fatal accident rates (ACC/MV) increased at the test locations. The overall increase in the total accident rate was statistically significant at the 90 percent confidence level and the overall increase in the combined injury/fatal accident rate was statistically significant at the 95 percent confidence level.

Daylight and dark accidents increased a greater amount at the test locations than at the control locations. Dusk/dawn accidents decreased a greater amount at the test locations than at the control locations.

Analysis of changes in the types of accidents which occurred at the study sites revealed that left-turn accidents decreased at the test locations while they increased at the control locations. Right-turn and rear-end accidents showed smaller increases at the test locations than at the control locations. Parking accidents decreased at both the test and control locations; however, the decrease at the control locations was greater. Sideswipe accidents decreased similarly for both groups. Angle accidents increased approximately 700 percent at the test locations, while they increased by 66 percent at the control locations.

Analysis of accidents at the Washington-Genesee intersection is complicated by the removal of the south-to-east left-turn phase in 1976. This phase afforded an "all-red interval" for northbound through traffic. This movement was involved in 16 angle accidents in the 3-year "after" period. Deleting these accidents from the total leaves 49 "after" period angle accidents, a 513 percent increase from the eight in the "before" period, which remains a substantial increase.

Evaluation of the accident reports showed that 28 percent of the angle accidents in the after period were caused by motorists who stated they did not see the signals or were confused by them. Of the eight angle accidents in the before period, none responded that they did not see the signals or were confused by them.

Appendix

Accident Summary
and
Statistical Analysis

Accident Summary

Test Intersections	Accidents	BEFORE 1973	1974	1975	TOTAL	AFTER 1977	1978	1979	TOTAL	Percent Change
	Total	25	29	19	73	37	38	37	112	+ 53
1. M-13 (Washington) at Genesee	PDO	20	23	15	58	25	30	30	85	+ 47
	Injury/Fatal	5(1)	6	4	15(1)	12	8	7	27	+ 80
2. M-13 (Washington) at Federal	Total	4	7	10	21	12	11	10	33	+ 57
	PDO	3	7	9	19	11	5	9	25	+ 32
	Injury/Fatal	1	0	1	2	1	6	1	8	+300
Control Intersections	Total	567	555	530	1652	716	678	661	2055	+24
	PDO	401	405	378	1184	518	470	441	1429	+21
	Injury/Fatal	166(1)	150	152(2)	468(3)	198(1)	208	220(1)	626(2)	+34

( ) denotes fatal accident

Total Accident Frequencies
(Chi-Square Test)

Control Intersections	Before	After	Percentage Change
	1652	2055	+ 24

Test Intersections	Before	After		$\frac{(O-E)^2}{E}$
		Expected	Observed	
1. M-13 (Washington) at Genesee	73	73+(73x.24)=91	112	4.85
2. M-13 (Washington) at Federal	21	21+(21x.24)=26	33	1.88
	94	117	145	X^2=6.73

df = 1
$0.010 > P > 0.005$
∴ There is a significant difference at the 99% confidence level

PDO Accident Frequencies
(Chi-Square Test)

Control Intersections	Before	After	Percentage Change
	1184	1429	+ 21

Test Intersections	Before	After		$\frac{(O-E)^2}{E}$
		Expected	Observed	
1. M-13 (Washington) at Genesee	58	58+(58x.21)=70	85	3.21
2. M-13 (Washington) at Federal	19	19+(19x.21)=23	25	0.17
	77	93	110	X^2=3.38

df = 1
$0.10 > P > 0.05$
∴ There is a significant difference at the 90% confidence level

Combined Injury/Fatal Accident Frequencies
(Chi-Square Test)

Control Intersections	Before	After	Percentage Change
	468	626	+ 34

Test Intersections	Before	After		$\frac{(O-E)^2}{E}$
		Expected	Observed	
1. M-13 (Washington) at Genesee	15	15+(15x.34)=20	27	2.45
2. M-13 (Washington) at Federal	2	2+(2x.34) = 3	8	8.33
	17	23	35	X^2=10.78

df = 1
P < 0.005
∴ There is a significant difference at the 99% confidence level

Total Accident Rates (ACC/MV)

Test Intersections - Paired-t Test

	Before	After	$d=X_A-X_B$	d^2
1. M-13 (Washington) at Genesee	2.13	3.44	1.31	1.7161
2. M-13 (Washington) at Federal	0.91	1.59	0.68	0.4624
			$\sum = 1.99$	$\sum = 2.1785$

$N = 2$

$\bar{d} = \sum d/N = 1.0$

$S = \sqrt{\frac{2.1785-(1.99)^2/2}{2-1}} = 0.45$

$t = \frac{1.0-0}{0.45/\sqrt{2}} = 3.14$

$df = 1 \quad 0.10 > P > 0.05$

∴ There is a significant difference in before and after accident rates at the 90% confidence level

PDO Accident Rates (ACC/MV)

Test Intersections - Paired-t Test

	Before	After	$d=X_A-X_B$	d^2
1. M-13 (Washington) at Genesee	1.69	2.61	0.92	0.8464
2. M-13 (Washington) at Federal	0.82	1.21	0.39	0.1521
			$\sum = 1.31$	$\sum = 0.9985$

$N = 2$

$\bar{d} = \sum d/N = 0.66$

$S = \sqrt{\frac{0.9985-(1.31)^2/2}{2-1}} = 0.37$

$t = \frac{0.66-0}{0.37/\sqrt{2}} = 2.52$

$df = 1 \quad 0.25 > P > 0.10$

∴ There is no significant difference in before and after accident rates

Combined Injury/Fatal Accident Rates (ACC/MV)

Test Intersections - Paired-t Test

	Before	After	$d=X_A-X_B$	d^2
1. M-13 (Washington) at Genesee	0.44	0.83	0.39	0.1521
2. M-13 (Washington) at Federal	0.09	0.39	0.30	0.0900
			$\Sigma = 0.69$	$\Sigma = 0.2421$

$N = 2$

$\bar{d} = \Sigma d/N = 0.35$

$S = \sqrt{\frac{0.2421-(0.69)^2/2}{2-1}} = 0.06$

$t = \frac{0.35 - 0}{0.06/\sqrt{2}} = 8.25$

$df = 1 \quad 0.05 > P > 0.025$

∴ There is a significant difference in before and after accident rates at the 95% confidence level

12-7-81
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