PEDESTRIAN CROSSWALK SAFETY STUDIES

by

Donald E. Cleveland, Professor of Civil Engineering

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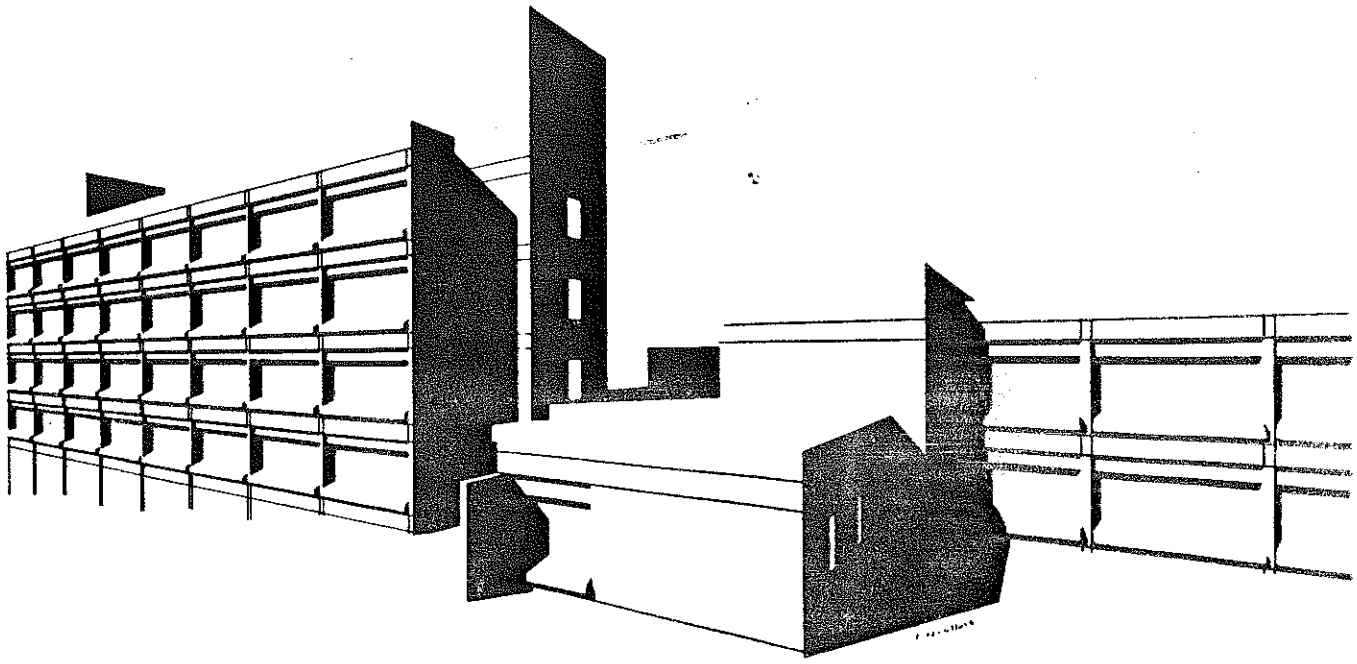
July 1969



HIGHWAY SAFETY RESEARCH INSTITUTE
THE UNIVERSITY OF MICHIGAN ANN ARBOR

Highway Safety Research Institute
The University of Michigan
Ann Arbor

PEDESTRIAN CROSSWALK SAFETY STUDIES

July 1969

Prepared for
The Pedestrian Safety Demonstration Project
City of Detroit

by

Donald E. Cleveland
Professor of Civil Engineering

In Cooperation With

The Highway Safety Planning Division
of the
Department of State Police
State of Michigan

and

The National Highway Safety Bureau
U. S. Department of Transportation

The manual is part of the work program of the Highway Safety Research Institute of the University of Michigan, in support of the City of Detroit's Pedestrian Safety Demonstration Project being conducted under the provisions of Section 402 of the Highway Safety Act of 1966, administered by the National Highway Safety Bureau and authorized by the Highway Safety Planning Division of the Department of State Police of the State of Michigan.

It is believed that this report, containing descriptions of eleven individual studies, is the first comprehensive compilation of techniques of studying pedestrian behavior at crosswalks. Each of these studies has been field tested and is being used as a part of the evaluation phase of the Pedestrian Safety Demonstration Project.

The program will include "before-and-after" type studies to be conducted at pedestrian crosswalks both before and following the installation of new pedestrian control devices. This manual contains descriptions of "before" studies. Descriptions of "after" studies such as evaluation of pedestrians' attitudes towards the control devices will be provided at a later date.

The contributions of Joseph V. Arthungal in compiling this report are hereby acknowledged.

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Pedestrian Crosswalk Safety Studies

OBJECTIVES OF STUDIES

The studies are the initial part of a program of collecting field data which is expected to contribute toward improved knowledge of the effects of highway traffic information and control devices on pedestrian safety.

Traffic information and control devices aid the pedestrian and the driver in safe and efficient use of the road by regulating assignment of the right-of-way and by giving information on crosswalks and their use. The effectiveness of these devices is judged by their capacity to command obedience and respect from road users.

In studying the effectiveness of a control device, it is necessary to take into account the prevailing traffic conditions. The field work involved in the present study program is designed to gather the data needed for this purpose. The attached sheets describe in detail studies which are being conducted.

7. A small sketch of the site is to be drawn in the Field Sheet in the space provided. Any unique feature of the site with regard to that particular study should be indicated in the sketch.

8. While conducting the study, the observer should station himself at a point where the traffic movements he is to observe and record are clearly visible. Also, the observer should keep himself as inconspicuous to the road users as possible so that his presence may have the least possible influence on their behavior.

9. "Small trucks" include single rear-axle vehicles. "Large trucks" have two or more rear axles.

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Pedestrian Crosswalk Safety Studies

LIST OF STUDIES

A. VEHICULAR STUDIES

1. Intersection Volume
2. Spot Speeds
3. Travel Time
4. Gaps
5. Access Point Volumes
6. Driver Response to Crosswalk

B. PEDESTRIAN STUDIES

1. Pedestrian Volumes
2. Pedestrian Personal Characteristics and Crossing Times
3. Pedestrian Gap Acceptance
4. Pedestrian Behavior at Signalized Intersections
5. Visual Record

A. VEHICULAR STUDIES

Pedestrian Crosswalk Safety Studies

A. VEHICULAR STUDIES
1. INTERSECTION VOLUME

PURPOSE OF STUDY

To count vehicles passing through the intersection during 15-minute periods.

TIME OF STUDY

From 12:00 noon to 10:00 P.M. continuously.

METHOD OF OBSERVATION

Vehicles in all lanes in both directions in the two intersecting roads are counted, using hand counters. Vehicles are classified into four categories: passenger cars, small trucks (single rear axle), large trucks (two or more rear axles), and buses. Three movements of vehicles are observed: left turn, straight through, and right turn.

RECORDING OF DATA

Field Sheet No. 1 is used. Each field sheet is designed for recording the data on traffic flow from one direction. L, S, R represent left turning, straight ahead, and right turning movements. The possible vehicular movements may be indicated on the site sketch at the top of the Field Sheet. In the first column of the Field Sheet, the successive 15-minute study periods are entered. The "Total" column under each category of vehicles is filled in at the end of each 15-minute period. The last "Total" column is filled in with the total of all categories of vehicles at the end of each 15-minute period. The "Totals" row is filled in with the totals of

the entries in the respective columns.

NUMBER OF OBSERVERS

One or more, depending on volume of traffic.

EQUIPMENT

Field Sheet No. 1
Watch for each observer
Hand counters
Tally
Clipboards (2 or 4)
Pencils
Erasers
Flashlight for each observer

Pedestrian Crosswalk Safety Studies

A. Vehicular Studies

1. Intersection Volume

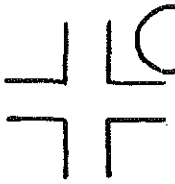
Field Sheet No. 1

Date.....Recorder.....Location.....

Weather.....

Road Surface Condition.....

Sketch of Site:
(Indicate North by Arrow)



Comments on site:

15-min. period ending	Passenger Cars				Small Trucks				Large Trucks				Buses				Total No. of vehicles
	L	S	R	Total	L	S	R	Total	L	S	R	Total	L	S	R	Total	
Totals																	
%																	
%																	

Pedestrian Crosswalk Safety Studies
A. Vehicular Studies
1. Intersection Volume

Summary Sheets A-1 (A), A-1 (B), A-1 (C)

DATA REDUCTION

The field data collected in Study A-1 will be reduced to the form shown in Summary Sheets A-1 (A), A-1 (B), and A-1 (C).

SUMMARY SHEET A-1 (A)

The frequency per hour (number of vehicles represented as x) of the six vehicular movements across the crosswalk as indicated in the site sketch in the Summary Sheet and their squares (x^2) are entered in the successive pairs of columns after the first. The row "Totals, Σx, Σx^2" will contain the summation of the values in the respective columns. Mean and variance of the movements (x values) are calculated as indicated at the foot of the Summary Sheet.

SUMMARY SHEET A-1 (B)

The details of the volumes of various categories of vehicles in the major street are summarized as indicated in the Summary Sheet.

SUMMARY SHEET A-1 (C)

The details of the volumes of various categories of vehicles in the minor street are summarized as indicated in the Summary Sheet.

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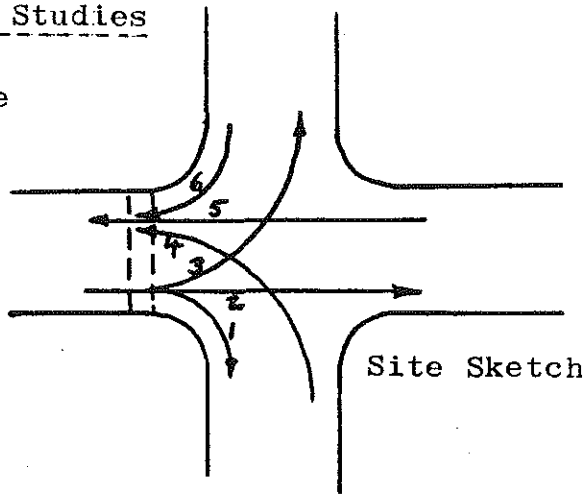
Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
1 - Intersection Volume

Summary Sheet A-1 (A)

Date.....

Location.....
.....
.....



Site Sketch

Hour of Study Ending	Movement 1		Movement 2		Movement 3		Movement 4		Movement 5		Movement 6	
	Frequency x	x^2	Frequency x	x^2	Frequency x	x^2	Frequency x	x^2	Frequency x	x^2	Frequency	x^2
1:00 PM												
2:00 PM												
3:00 PM												
4:00 PM												
5:00 PM												
6:00 PM												
7:00 PM												
8:00 PM												
9.00 PM												
10:00 PM												
Totals Σx Σx^2												
Mean		X		X		X		X		X		X
Variance		X		X		X		X		X		X

$$\text{Mean} = \frac{1}{10}(\Sigma x) = \frac{1}{10}(x_1+x_2+x_3.....+x_{10})$$

$$\text{Variance} = \frac{1}{100}\left[10(\Sigma x^2)-(\Sigma x)^2\right] = \frac{1}{100}\left[10(x_1^2+x_2^2+x_3^2+.....+x_{10}^2)-(x_1+x_2+x_3+.....+x_{10})^2\right]$$

Where x_1, x_2, x_3.....x_{10} represent entries in rows 1 to 10 of each column.

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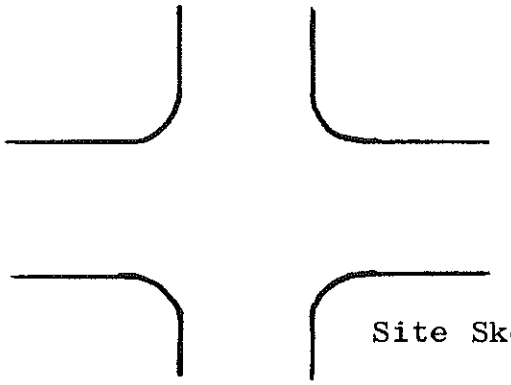
Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
1 - Intersection Volume
Summary Sheet A-1 (B)

Date .....

Location .....
.....
.....



Site Sketch

Hour of Study Ending	NUMBER OF VEHICLES IN THE MAJOR STREET									
	Total Volume x	x^2	Pass. Cars x	x^2	Small Trucks x	x^2	Large Trucks x	x^2	Buses x	x^2
1:00 PM										
2:00 PM										
3:00 PM										
4:00 PM										
5:00 PM										
6:00 PM										
7:00 PM										
8:00 PM										
9:00 PM										
10:00 PM										
Totals Σx, Σx^2										
Mean		X	—	X	—	X	—	X	—	X
Variance		X		X		X		X		X

$$\text{Mean} = \frac{1}{10}(\Sigma x) = \frac{1}{10}(x_1+x_2+x_3.....+x_{10})$$

$$\text{Variance} = \frac{1}{100}\left[10(\Sigma x^2)-(\Sigma x^2)\right] = \frac{1}{100}\left[10(x_1^2+x_2^2+x_3^2+...+x_{10}^2)\right.$$
$$\left.-(x_1+x_2+x_3+...+x_{10})^2\right]$$

Where x_1, x_2, x_3....x_{10} represent entries in rows 1 to 10 of each column.

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Pedestrian Crosswalk Safety Studies

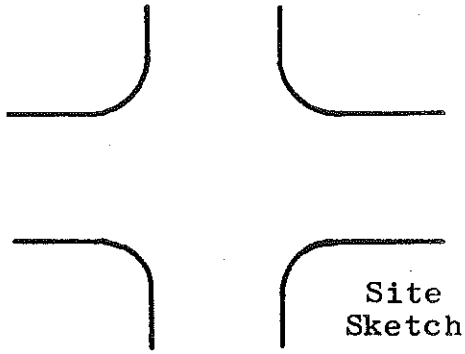
A - Vehicular Studies
1 - Intersection Volume
Summary Sheet A-1 (C)

Date.....

Location.....

.....

.....



Hour of Study Ending	NUMBER OF VEHICLES IN THE MINOR STREET									
	Total Volume x	x^2	Pass Cars x	x^2	Small Trucks x	x^2	Large Trucks x	x^2	Buses x	x^2
1:00 PM										
2:00 PM										
3:00 PM										
4:00 PM										
5:00 PM										
6:00 PM										
7:00 PM										
8:00 PM										
9:00 PM										
10:00 PM										
Totals $\Sigma x, \Sigma x^2$										
Mean		X		X		X		X		X
Variance		X		X		X		X		X

$$\text{Mean} = \frac{1}{10}(\Sigma x) = \frac{1}{10}(x_1+x_2+x_3+.....+x_{10})$$

$$\text{Variance} = \frac{1}{100}\left[10(\Sigma x^2) - (\Sigma x)^2\right] = \frac{1}{100}\left[10(x_i^2+x_2^2+x_3^2 + x_{10}^2) - (x_1+x_2+x_3.....+x_{10})^2\right]$$

Where x_1, x_2, x_3.....x_{10} represent entries in rows 1 to 10 of each column.

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Pedestrian Crosswalk Safety Studies

A - VEHICULAR STUDIES
2 - SPOT SPEEDS

PURPOSE OF STUDY

To determine the spot speed of vehicles approaching the intersection along the major street either by manual observation, or using a radar speed meter.

TIME OF STUDY

Three studies will be conducted at each intersection; the study periods will be 12:00 noon-3:00 P.M., 4:00-6:00 P.M., and 7:00-10:00 P.M. The length of the study period will be one hour or the time required to observe 50 vehicles, whichever is shorter.

I. MANUAL OBSERVATIONS

METHOD OF OBSERVATION

Speed measurements in each direction are taken. The general method with special cases indicated is as follows: 176-foot sections of the roadway are measured from the crosswalk and their boundaries marked with white chalk. Vehicles are grouped into four categories - passenger cars, small trucks, large trucks and buses.

Two observers station themselves, one at each of the two boundaries of the study section. The first observer (on the upstream side) should have a white kerchief in the daytime and a flashlight at night for signaling to the second observer near the intersection. The second observer should have a 0.1 second stop watch. Depending on conditions at the site, a single observer may be able to observe the vehicle crossing both boundary lines and record the measurement himself.

In low-volume traffic, it may be possible to observe each passing vehicle. In high-volume traffic, all passing vehicles cannot be observed. It is important that any vehicle whose speed is being observed should be free-moving: that is, that there is no vehicle close enough ahead to influence its speed. Therefore, when vehicles follow each other so closely that speeds of following vehicles are affected by vehicles ahead, only the leading vehicle should be selected for observation. In extremely high-volume traffic, it may be necessary to select every second, third or fourth free-flowing vehicle.

The first observer selects the vehicle to be timed and the second observer follows his signal.

In observing the spot speed of a vehicle, the first observer signals to the second observer the moment the vehicle passes his point (chalk line). Signaling can be done by white kerchief during the day and a flashlight during night. The second observer starts a stopwatch when the signal is received from the first observer. He notes the time (0.1 second) when the vehicle passes his point (chalk line). He can thus record the interval of time taken by the vehicle to traverse 176 feet.

RECORDING OF DATA

Field Sheet No. 2a is used. Each field sheet is designed for recording the data on traffic flow from one direction. In the first column, the successive 15-minute study periods are entered. The Travel Time" column under each category of vehicles is filled in with the observed travel time in seconds. The "Total" column under each category is filled in with the total of each category of vehicles

at the end of each 15-minute period. The last "Total Vehicles" column is filled in with the total of all categories of vehicles at the end of each 15-minute period. The "Totals" row is filled in with the totals of the entries in the respective columns.

NUMBER OF OBSERVERS

1 or 2 for each direction, depending on conditions at site.

EQUIPMENT

Field Sheets
Stopwatches (1 or 2)
Tape
Shite Chalk
Flashlight (2)
White Kerchief
Pencils
Erasers

II. RADAR SPEED METER

METHOD OF OBSERVATION

The radar speed meter directly displays the speeds of passing vehicles.

The basic criteria for selecting the vehicle for observation are described under (I). The following additional requirements must also be satisfied.

Vehicle spacing should be such that a specific vehicle can be associated with the recorded speed.

As a guide to selecting vehicles to be observed, the observer should use a minimum of 3 seconds in vehicle spacing. He should not attempt to take readings when vehicles are spaced less than three seconds apart or when vehicles are travelling side by side.

Certain traffic situations and their effects in radar beam and speed readings are explained below. Vehicle situations will be classified according to direction of travel and width of each lane.

A single vehicle presents no problem in accuracy or identification.

MORE THAN ONE VEHICLE MOVING IN SAME DIRECTION

(a) Large vehicle A in front of vehicle B.

Regardless of size of B, A will shadow B and the meter will show the speed of A.

(b) Small vehicle A travelling directly in front of large vehicle B.

A will be shadowed by B until A advances into the central radar beam area, at which time the meter will indicate the speed of A. If A is a small sports car, it will have to be very close to the radar antenna before it reflects sufficient signal to cause the meter to indicate the speed of A instead of that of B.

(c) Vehicle A travelling adjacent to vehicle B at identical speeds.

A and B will be read as a single vehicle.

(d) Vehicle B travelling in an adjacent lane to the rear of A and overtaking A.

The meter will initially read A. However, depending upon the speed of B relative to A and the size of B, the meter will fluctuate between A and B during and immediately after the overtaking process. As B travels away from A into the stronger radar beam area, the meter will read B.

TWO WAY ROADS

Vehicle A approaching, and in the radar beam; vehicle B some distance away.

If the radar beam extends into the lane of opposite direction travel and vehicle B, moving in the opposite direction, enters the beam first, the meter will read the speed of B until it reflects less of the beam signal, causing the radar to switch from B to A. Position spacing between vehicles travelling in opposite directions is important.

It is essential that the roadway section at which the study is made be straight with constant grade and that the radar operator have a clear, unobstructed view of the traffic lane.

The radar should be so placed that the angle between the path of travel of the vehicle and the radar beam is as small as possible.

RECORDING OF DATA

Field Sheet No. 2b is used. Each field sheet is designed for recording the data on traffic flow from one direction. In the first column of the field sheet, successive 15-minute study periods are entered. The "Speed" column under each of the four categories of vehicles are filled in with the observed speeds of vehicles. The "Total" column under each category of vehicles is filled in with the total at the end of each 15-minute period. The last "Total" vehicles column is filled in with the total of all categories of vehicles at the end of each 15-minute period. The "Totals" row is filled in with the totals of the entries in the respective columns.

NUMBER OF OBSERVERS

One

EQUIPMENT

Field Sheet No. 2b
Radar Speed Meter
Pencils
Erasers
Flashlight

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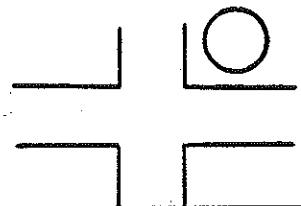
Pedestrian Crosswalk Safety Studies

A. Vehicular Studies
2. Spot Speeds
Field Sheet No. 2a

Date.................Recorder...............Location............

Weather...............Road Surface Condition........................

Sketch of Site:
(Indicate North
by arrow)



Comments on
Site:

15 min period ending	Passenger Cars		Small Trucks		Large Trucks		Buses		Total vehicles
	Speed	Total	Speed	Total	Speed	Total	Speed	Total	
Totals									

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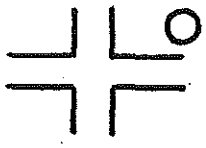
Pedestrian Crosswalk Safety Studies
A. Vehicular Studies
2. Spot Speeds
Field Sheet No. 2b

Date.....Recorder.....Location.....

Weather.....Road Surface Conditions.....

Comments on Site

Sketch of Site: (Indicate North by arrow)



15 min period ending	Passenger Cars		Small Trucks		Large Trucks		Buses		Total vehicles
	Speed	Total	Speed	Total	Speed	Total	Speed	Total	

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Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
2 - Spot Speeds

Summary Sheet A-2 (A)

DATA REDUCTION

The field data collected in Study A-2 will be reduced to the form shown in Summary Sheet A-2 (A).

SUMMARY SHEET A-2 (A)

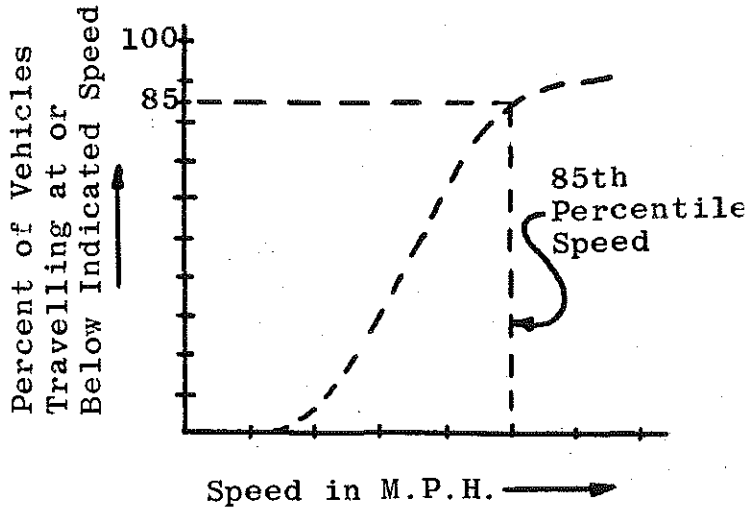
The number of vehicles falling in the range of speeds indicated in the first three columns are entered in Column 4. Each row in Column 5 contains the summation of values entered up to and including that level in Column 4. Each row in Column 6 contains the per cent measure of the corresponding entry in Column 5 over the total of all the entries in Column 5. Computations for entries in the last two columns and for the mean and variance are made as indicated in the Summary Sheet. Eighty-fifth percentile speed is calculated as follows:

The plot A-2 (A) is developed with speed in mph (values from Column 2) on the x axis and values from Column 6 as ordinates. The 85th percentile speed is read off as indicated in the plot.

Field data will be summarized separately for the following combinations for all vehicle types taken together.

1. Each study period (3 study periods)
2. Each direction of travel (2 directions)

Thus in all, there are 6 summary sheets.



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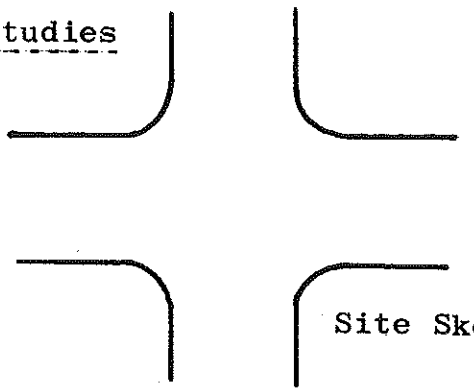
Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
2 - Spot Speed
Summary Sheet A-2 (A)

Date.....
Period of Study.....
Location.....
Direction.....



SPEED GROUPS			Frequency (No. of Veh. Observed f_i	CUMULATIVE		COMPUTATIONS	
Lower Limit	Mid-point x_i	Upper Limit		Frequency	Percent	$f_i x_i$	$f_i(x_i)^2$
20.00	21.00	21.90					
22.00	23.00	23.90					
24.00	25.00	25.90					
26.00	27.00	27.90					
28.00	29.00	29.90					
30.00	31.00	31.90					
32.00	33.00	33.90					
34.00	35.00	35.90					
36.00	37.00	37.90					
38.00	39.00	39.90					
Totals			n=				

Mean	
Variance	
85th Percentile	

$$\text{Mean} = \frac{\Sigma f_i x_i}{n}$$

$$\text{Variance} = \frac{\Sigma f_i (x_i)^2 - \frac{1}{n} (\Sigma f_i x_i)^2}{n-1}$$

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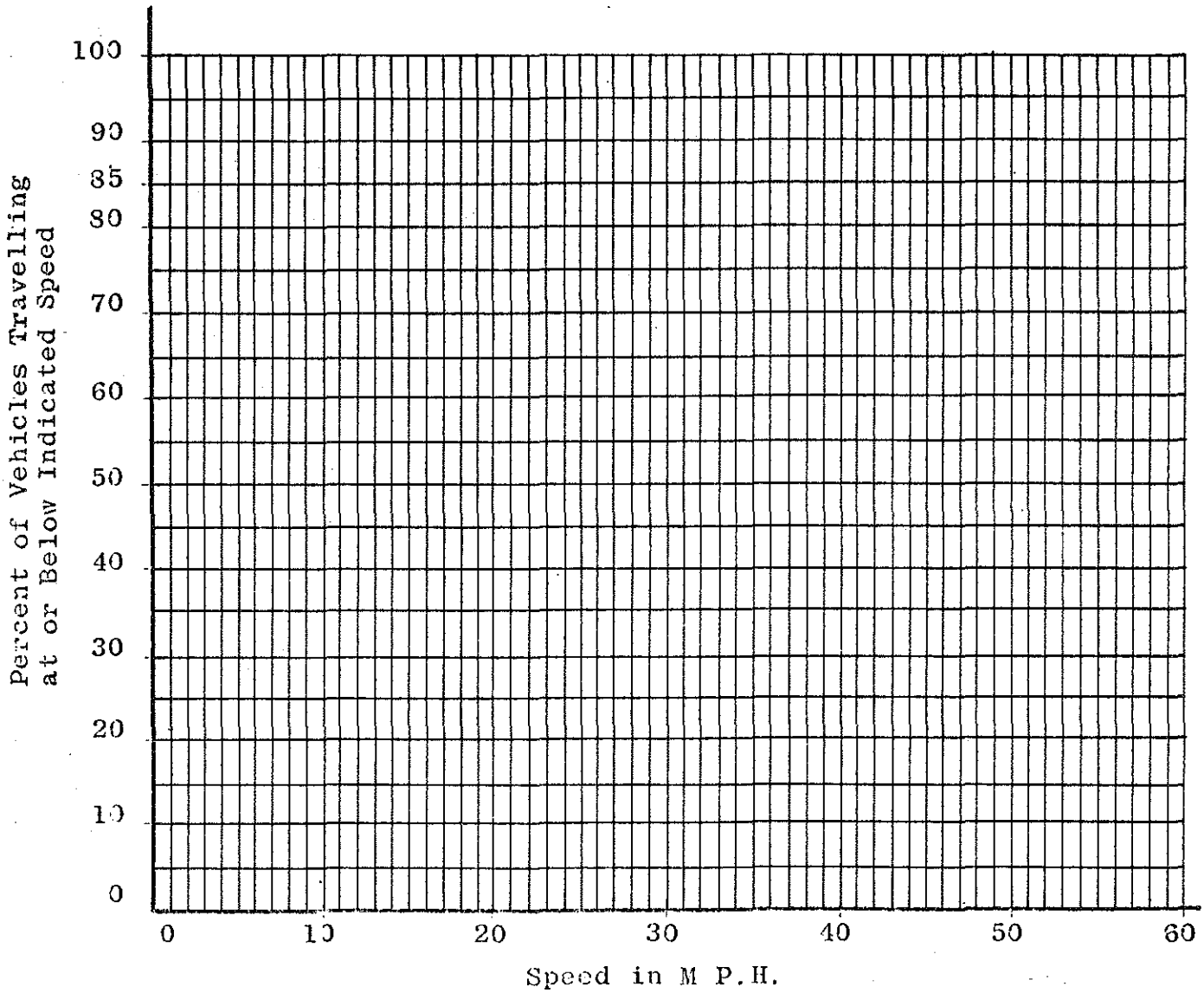
Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
2 - Spot Speed

Plot A-2 (A)



85th Percentile Speed	

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Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
3 - Travel Time

PURPOSE OF STUDY

To determine the time taken by major street vehicles to travel from a point 150 feet upstream from the crosswalk to another point 150 feet downstream.

TIME OF STUDY

Three studies will be conducted at each intersection, the study periods falling between 12:00 noon-3:00 P.M., 4:00-6:00 P.M., and 7:00-10:00 P.M. The length of study period shall be the lesser of (i) one hour or (ii) the time required to observe 50 vehicles.

METHOD OF OBSERVATION

Roadway lengths of 150 feet on either side of the center of the crosswalk are measured along the main street and the boundaries are marked with white chalk.

Two observers station themselves, one at each of the two boundaries of the section. The first observer (on the upstream side) has a white kerchief and a flashlight. The second observer (on the other side of the intersection) should have a stopwatch which can measure time to tenths of a second.

Depending on conditions at the site, a single observer may be able to observe the vehicle crossing at both boundary lines and record the travel-time measurements himself.

In observing the travel-time of a vehicle, the first observer signals to the second observer the moment the vehicle passes his point

(chalk line). The signaling can be done with a white kerchief during the day and a flashlight during the night. The second observer starts a stopwatch when the signal is received from the first observer. He notes the time correct to tenths of a second when the vehicle passes his point (chalk line). He can thus record the interval of time taken by the vehicle to traverse 300 feet. Each direction of travel on the main street will be observed.

Vehicles will be grouped into four categories - passenger cars, small trucks, large trucks, and buses. In high volume traffic, travel time cannot be observed for all passing vehicles. It is important that any vehicle whose travel time is being observed should be free moving; that is, there is no vehicle so close in front of it that it will influence its speed. Therefore, when vehicles follow so close to each other that the speed of the following vehicle is affected by the vehicle ahead of it, only the leading vehicle should be selected for observation. In extremely high volume traffic, it may be necessary to select every second, third or fourth free-flowing vehicle.

It is to be noted that the first observer always determines the vehicle to be observed and the second observer follows his signaling.

In low volume traffic, it may be possible to observe each passing vehicle.

RECORDING OF DATA

Field Sheet No. 3 is used. Each field sheet is designed for recording the data on traffic flow from one direction. In the first column of the field sheet, the successive 15 minutes of study period are entered. The "Travel Time" column for each of the four categories of vehicles is filled in with the observed travel time of vehicles to 0.1 second. The "Total" column for each of the four categories of vehicles is filled in with the total of each category of vehicles

at the end of each 15-minute period. The last "Total Vehicles" column is filled in with the total of all categories of vehicles at the end of each 15-minute period. The "Totals" row is filled in with the totals of the entries in the respective columns.

NUMBER OF OBSERVERS

Two for each direction

EQUIPMENT

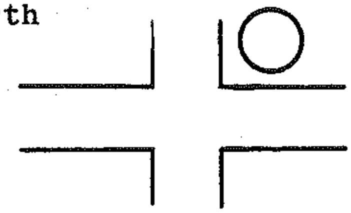
Field Sheets
Stop watches - 2
Tape
White Chalk
Flashlights - 2
White kerchiefs - 2
Pencils
Erasers

Pedestrian Crosswalk Safety Studies
A. Vehicular Studies
3. Travel Time
Field Sheet No. 3

Date................Recorder................Location...............

Weather.........................Road Surface Condition...............

Sketch of Site:
(Indicate North by arrow)



Comments on Site:

15 min period ending	Passenger Cars		Small Trucks		Large Trucks		Buses		Total vehicles
	Travel time	Total	Travel time	Total	Travel time	Total	Travel time	Total	
TOTALS									

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Pedestrian Crosswalk Safety Studies
A - Vehicular Studies
3 - Travel Time

Summary Sheet A-3 (A)

DATA REDUCTION

The field data collected in Study A-3 will be reduced to the form shown in Summary Sheet A-3 (A).

SUMMARY SHEET A-3 (A)

The numbers of vehicles falling in the range of travel times indicated in the first three columns are entered in Column 4. Each row in Column 5 contains the summation of values entered up to (and including) that level in Column 4. Each row in Column 6 contains the per cent measure of the corresponding entry in Column 5 over the total of all entries in Column 5. The entries in the last two columns and the mean and the variance are computed as indicated in the Summary Sheet.

Field data will be summarized separately for the following combinations for all vehicle types taken together:

1. Each study period (3 study periods)
2. Each direction of travel (2 directions)

Thus there are 6 Summary Sheets.

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Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
3 - Travel Time
Summary Sheet A-3 (A)

Date.....

Period of Study.....

Location.....
.....
.....

Direction.....

Site Sketch

TRAVEL TIME GROUPS			Frequency (Number Observed) f_i	CUMULATIVE		COMPUTATIONS	
Lower Limit	Mid-Point x_i	Upper Limit		Frequency	Per cent	$f_i \cdot x_i$	$f_i (x_i)^2$
3.5	4	4.4					
4.5	5	5.4					
5.5	6	6.4					
6.5	7	7.9					
7.5	8	8.4					
8.5	9	9.4					
9.5	10	10.4					
10.5	11	11.4					
11.5	12	12.4					
12.5	13	13.4					
Totals			n=				

Mean	
Variance	

$$\text{Mean} = \frac{\Sigma f_i \cdot x_i}{N}$$

$$\text{Variance} = \frac{\Sigma f_i (x_1)^2 - \frac{1}{n} (\Sigma f_i x_1)^2}{n-1}$$

HIGHWAY SAFETY RESEARCH INSTITUTE
THE UNIVERSITY OF MICHIGAN

Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
4 - Gaps

PURPOSE OF STUDY

To count and measure the number and duration of gaps exceeding 6 seconds duration occurring at the crosswalk between successive vehicles on the major street.

TIME OF STUDY

From 12:00 noon to 10:00 P.M. continuously.

METHOD OF OBSERVATION

A gap counter connected to a pressure sensitive tube laid across the roadway and adjacent to the crosswalk automatically records the gaps between successive vehicles passing over the pressure sensitive tube. Gaps of a duration less than 6 seconds are not recorded by the gap counter.

A gap study is conducted separately for each direction of traffic flow in the major street.

RECORDING OF DATA

The record charts used in the gap counter will be numbered serially. Field Sheet No. 4 is used. For the study period from 12:00 noon to 7:00 P.M., gaps are recorded into groups of 6 second increments starting with 6-second gaps, and ending with gaps of 30 seconds or more duration. Thus, the group sizes in seconds of gaps recorded are: $\geqslant 6 < 12$, $\geqslant 12 < 18$, $\geqslant 18 < 24$, $\geqslant 24 < 30$, $\geqslant 30$. For the study period from 7:00 P.M. to 10;00 P.M., gaps are recorded into groups of 6-second increments, starting with 6-second gaps and ending with gaps of 60 seconds or more. Thus, the group sizes in seconds of gaps recorded are: $\geqslant 6 < 12$, $\geqslant 12 < 18$, $\geqslant 24 < 30$, $\geqslant 30 < 36$, ... $\geqslant 54 < 60 \geqslant 60$.

NUMBER OF OBSERVERS

One

EQUIPMENT

Field Sheet No. 4
Gap Counter and Accessories

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Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
4 - Gaps

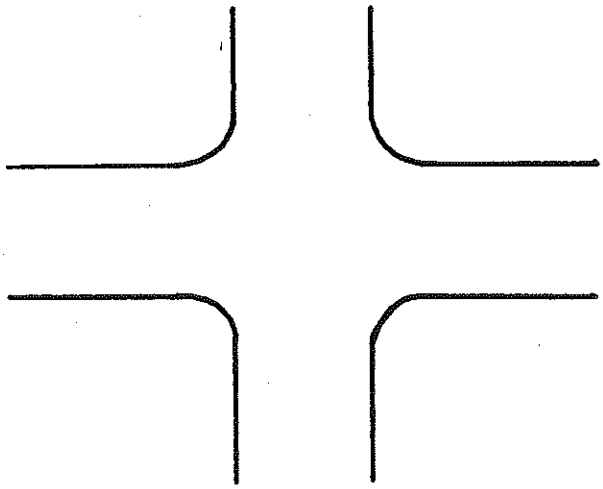
Field Sheet No. 4

Date.....Recorder.....Location.....

Weather.....Road Surface Condition.....

Sketch of Site:

(Indicate North, traffic lanes, directions of traffic flow - as A and B - in the major street)



Serial Number of the Record Chart used in the gap counter.....

Data being recorded.....

.....

Time recording starts.....

Remarks.....

.....

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Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
4 - Gaps
Summary Sheets: A-4 (A), A-4 (B), A-4 (C), A-4 (D)

DATA REDUCTION

The field data collected in Study A-4 will be reduced to the form in Summary Sheets A-4 (A), A-4 (B), A-4 (C), A-4 (D).

SUMMARY SHEET A-4 (A)

This summary sheet is used for reducing the data collected during the study period 12:00 noon-7:00 P.M. The successive 15-minute study periods are entered in the first column. The other columns contain the number of gaps of the indicated size ranges. The last row contains the totals of each column.

SUMMARY SHEET A-4 (B)

This summary sheet is used for reducing the data collected during the study period 7:00 P.M.-10:00 P.M. The method is as in the case of Summary Sheet A-4 (A) above.

SUMMARY SHEET A-4 (C)

This summary sheet is used to reduce further the data summarized in Summary Sheet A-4 (A). The number of gaps falling in the range of durations indicated in the first three columns are entered in Column 4. Each row in Column 5 contains the summation of values entered up to and including that level in Column 4. Each row in Column 6 contains the per cent measure of the corresponding entry in Column 5 over the total of all the entries in Column 5. Computations for entries in the last two columns and for the mean and variance are made as indicated in the Summary Sheet.

SUMMARY SHEET A-4 (D)

This summary sheet is used to reduce further the data summarized in Summary Sheet of A-4 (B). The method is as in the case of Summary Sheet A-4 (C) above.

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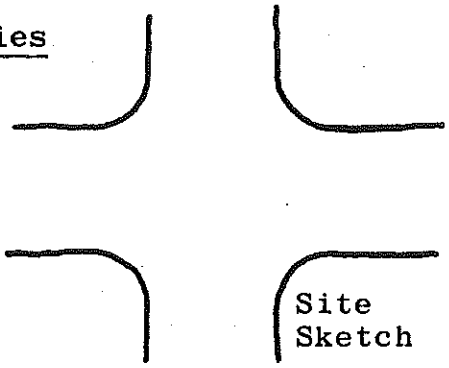
Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
4 - Gaps
Summary Sheet A-4 (A)

Date.....
Period of Study.....
Location.....
Direction of Traffic Flow.....
(Indicate as A or B in the Site Sketch)



15-Min. Period Ending	NUMBER OF GAPS OF GROUP SIZE (IN SECONDS)				
	≥ 6 < 12	≥ 12 < 18	≥ 18 < 24	≥ 24 < 30	≥ 30
Totals					

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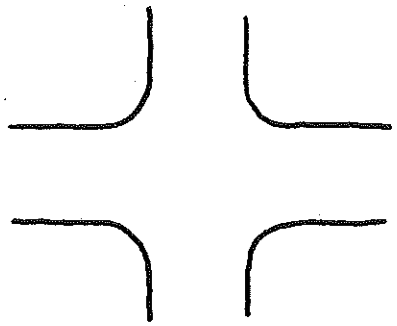
Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
4 - Gaps

Summary Sheet A-4 (B)



Date. . . . . .
Period of Study . . . . . .
Location. . . . . .
Direction of Traffic Flow . . . .
(Indicate as A or B in the site sketch)

15 Min. Period Ending	Number of Gaps of Group Size (in seconds)									
	≥6<12	≥12<18	≥18<24	≥24<30	≥30<36	≥36<42	≥42<48	≥48<54	≥54<60	≥60

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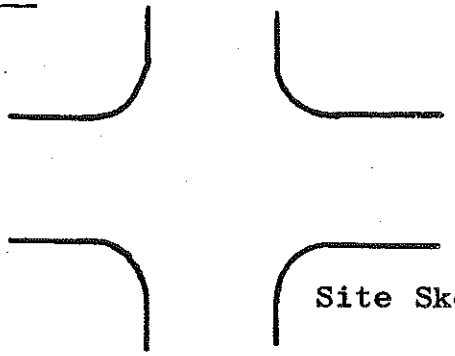
Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
4 - Gaps
Summary Sheet A-4 (C)

Date.....
Period of Study.....
Location.....
Direction of Traffic Flow
(Indicate as A or B in the
Site Sketch)



Site Sketch

GAP SIZE IN SECONDS			Frequency of Gaps Observed	CUMULATIVE		COMPUTATIONS	
Lower Limit	Mid-point x_i	Upper Limit	f_i	Frequency	Per cent	$f_i \cdot x_i$	$f_i(x_i)^2$
≥6	9	<12					
≥12	15	<18					
≥18	24	<24					
≥24	30	<30					
≥30							
	Totals		n=				

Mean	
Variance	

$$\text{Mean} = \frac{\Sigma f_i x_i}{n}$$

$$\text{Variance} = \frac{\Sigma f_i (x_i)^2 - \frac{1}{n}(\Sigma f_i x_i)^2}{n-1}$$

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Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
4 - Gaps
Summary Sheet A-4 (D)

Date.....

Period of Study.....

Location.....

Direction of Traffic Flow.....
(Indicate as A or B in the Site Sketch)

Site Sketch

GAP SIZE IN SECONDS			Frequency of Gaps Observed f_1	CUMULATIVE		COMPUTATIONS	
Lower Limit	Mid-point x_i	Upper Limit		Frequency	Per cent	$f_i.x_i$	$f_i(x_i)^2$
⩾ 6	9	< 12					
⩾ 12	15	< 18					
⩾ 18	21	< 24					
⩾ 24	27	< 30					
⩾ 30	33	< 36					
⩾ 36	39	< 42					
⩾ 42	45	< 48					
⩾ 48	51	< 54					
⩾ 54	57	< 60					
⩾ 60							
Totals			n=				

Mean	
Variance	

$$\text{Mean} = \frac{\Sigma f_i . x_i}{n}$$

$$\text{Variance} = \frac{\Sigma f_i (x_i)^2 - \frac{1}{n} (\Sigma f_i . x_i)^2}{n-1}$$

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Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
5 - Access Point Volumes

PURPOSE OF STUDY

The number of vehicles entering and leaving the major street through important driveways and other points of access and exit within 500 feet of the intersection is to be counted.

TIME OF STUDY

From 12:00 noon-10:00 P.M. continuously.

METHOD OF OBSERVATION

Vehicles will be counted without classification. There are four vehicular movements to be observed for each access point or exit: In-left, In-right, Out-left and Out-right. Numbers of vehicles using each of these four movements are counted separately for each access point or exit.

RECORDING OF DATA

Field Sheet No. 5 is used. The points of access and/or exit under study are to be identified on the site sketch in the Field Sheet. They may be numbered as Points 1, 2, 3, etc., with appropriate descriptions under "Comments on Site". Field Sheet No. 5 is designed to record observations for up to four points of access and/or exit. If more than four points of access and/or exit are studied, additional field sheets may be used with appropriate corrections for the numbers of access and/or exit points shown in the Field Sheet.

In the first column of the Field Sheet, the successive 15-minute study periods are entered. Vehicle counts of In-left, In-right and Out-lef

Out-right movements are entered in the respective columns under each point of access and/or exit. The last "Total column is filled in with the total of all categories of vehicle at the end of each 15-minute period. The "Totals" row is filled in with the totals of the entries in the respective column.

NUMBER OF OBSERVERS

One or more, depending on traffic flow into and out of the access points.

EQUIPMENT

Field Sheets
Watch for Each Observer
Hand Counters
Tally
Clip Boards (2 or 4)
Flashlight for Each Observer During Night

Pedestrian Crosswalk Safety Studies

A. Vehicular Studies

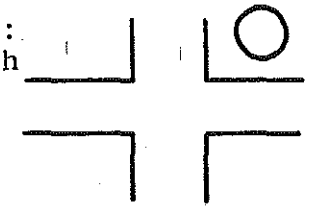
5. Access Point Volumes

Field Sheet No. 5

Date. . . . . Recorder. . . . . Location. . . . . .

Weather. . . . . Road Surface Condition. . . . . .

Sketch of Site: (Indicate North by arrow)



Comments on Site:

15 Min Period Ending	POINT 1				POINT 2				POINT 3				POINT 4				TOTAL
	In-Left	In-Right	Out-Left	Out-Right	In-Left	In-Right	Out-Left	Out-Right	In-Left	In-Right	Out-Left	Out-Right	In-Left	In-Right	Out-Left	Out-Right	
Total																	
%																	
%																	

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Pedestrian Crosswalk Safety Studies
A - Vehicular Studies
6 - Driver Response to Crosswalk

PURPOSE OF STUDY

To evaluate the response of drivers to the crosswalk.

TIME OF STUDY

Three studies will be conducted at each site during the following time periods:

12:00 noon - 3:00 P.M.

4:00 P.M. - 7:00 P.M.

8:00 P.M. -10:00 P.M.

In each time period, measurement continues until 250 vehicles are observed or until the end of the study period, whichever is attained first.

METHOD OF OBSERVATION

The observer will station himself in a position (about 100-150 feet from the crosswalk) where he will be able to judge the slowing-down behavior of the vehicle approaching the crosswalk. The flows in the two directions of travel in the main street are observed separately. Vehicles are classified into four categories: passenger cars, small trucks (single rear axle), large trucks (two or more rear axles), and buses. Four levels of vehicle slowing-down maneuvers are observed: (1) none (no slowing down), (2) deceleration without braking, (3) braking but not stopping, (4) stopping. Only the highest level of slowing-down observed will be recorded. For (1) and (2), the noticeable change from (1) to (2) alone is required, (3) and (4) can be established

by observation of brake lights and actual stopping.

For each vehicle observed, pedestrian presence at the crosswalk will be observed for the following 5 cases:

1. None: No pedestrian on the road or curb, nor approaching the curb.

2. Approaching: No pedestrian on the road or curb, but one or more pedestrians approaching the curb within such a range as to be visible to the approaching driver and influence his maneuver.

3. Waiting to cross: No pedestrian on the road, but one or more pedestrians waiting at the curb to cross.

4. Moving toward or within the lane of the vehicle: Pedestrian crossing the roadway, moving toward or within the lane of the approaching vehicle.

5. Crossing past the lane of the vehicle: Pedestrian crossing the roadway who is past the lane of the approaching vehicle.

Each vehicle observed should be free-flowing: that is, with no vehicle close enough ahead to influence its speed.

RECORDING OF DATA

Field Sheet No. 10 is used. The field sheet is designed for recording data on vehicle flow in one direction. The direction of flow being observed will be indicated in the site sketch at the top of the field sheet. In the first column, the successive 15-minute study periods are entered. The second column contains the number of observations (vehicles) made. In the third column, the classification of the vehicle observed will be entered as PC, ST, LT and B: passenger car, small truck, large truck, and bus. The highest level of slowing-down observed will be entered with a mark ( ) in the corresponding column. Pedestrian presence will also be noted in the appropriate column in a similar way.

NUMBER OF OBSERVERS

One

EQUIPMENT

Field Sheet No. 6
Watch
Hand Counter
Clipboards (1 or 2)
Pencils
Erasers
Flashlight for night use

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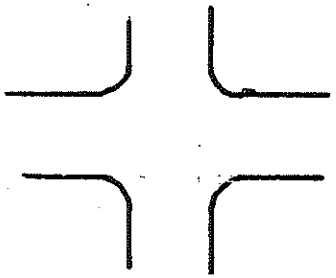
Pedestrian Crosswalk Safety Studies

A - Vehicular Studies
6 - Driver Response to Crosswalk
Field Sheet No. 6

Sketch of Site (Indicate North by arrow)



Date..... Recorder.....
Location..... Road Surface Condition.....
.....
Weather..... Comments on Site.....

15-Min. Period Ending	Serial No. of Observation	Classification of Vehicle	LEVELS OF VEH. SLOW DOWN				PEDESTRIAN PRESENCE				
			None	Deceleration	Braking	Stopping	None	Approaching	Waiting to Cross	Moving Towards or within Lane of Veh.	Crossing Past the Lane of the Vehicle

B. PEDESTRIAN STUDIES

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Pedestrian Crosswalk Safety Studies

B - Pedestrian Studies
1 - Pedestrian Volume

PURPOSE OF STUDY

The volume of pedestrians crossing the major roadway within the area of influence of the intersection and the various patterns of crossing maneuver of pedestrians are to be observed.

TIME OF STUDY

From 12:00 noon- 9:30 P.M.

METHOD OF OBSERVATION

The length of roadway to be observed on either side of the intersection along the major street will be the lesser of:

(i) The length of roadway visible from the crosswalk under study,

(ii) Half the distance to the next intersection (or to the next crosswalk if it occurs mid-block).

Pedestrians will be observed for the following five patterns of crossing in each direction:

1. Crossing in or very close to the crosswalk under study.

2. Crossing in or very close to the crosswalk on the opposite side of the intersection from the crosswalk under study.

3. Crossing diagonally across the road within the intersection.

4. Crossing elsewhere on the same side of the intersection as the crosswalk under study.

5. Crossing elsewhere on the opposite side of the intersection from the crosswalk under study.

The number of pedestrians crossing the roadway by each of the above five patterns of crossing will be observed for both directions

of crossing the roadway.

RECORDING OF DATA

Field Sheet No. 7 is used. The two directions of crossing across the roadway may be denoted as direction A and direction B in the sketch and tabulation in the Field Sheet. The first column in the Field Sheet is filled in at the completion of successive 15-minute periods of observation. The two columns under "Total" will be filled in with total numbers of pedestrians who crossed in each of the directions A and B by the end of every 15-minute period. The "Totals" row is filled in with the totals of the entires in the respective columns.

NUMBER OF OBSERVERS

1 or 2 depending on pedestrian volume.

EQUIPMENT

Field Sheet No. 7
Pencil
Eraser
Hand Counter
Flashlight for Each Observer During Night

Pedestrian Crosswalk Safety Studies

B. Pedestrian Studies

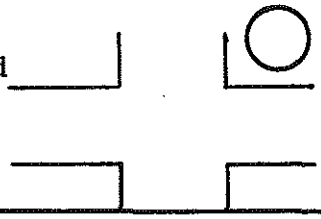
1. Pedestrian Volume

Field Sheet No. 7

Date.....Recorder.....Location.....

Weather.....Road Surface Condition.....

Sketch of Site:
(Indicate North and directions A & B (mentioned below) in the sketch)



Comments on Site:

5 min period ending	NUMBERS OF PEDESTRIANS CROSSING THE ROADWAY										TOTAL	
	In or very close to the crosswalk under study		In or very close to the crosswalk on the opposite side of intersection		Diagonally across the road within intersection		Elsewhere on the same side of intersection as the crosswalk under study		Elsewhere on the opposite side of the intersection			
	direction A	direction B	direction A	direction B	direction A	direction B	direction A	direction B	direction A	direction B	A	B
TOTALS												

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Pedestrian Crosswalk Safety Studies

B. PEDESTRIAN STUDIES
2. PEDESTRIAN PERSONAL CHARACTERISTICS AND CROSSING TIME

PURPOSE OF STUDY

The personal characteristics - party size, sex and age group - of pedestrians and their crossing time are to be observed.

TIME OF STUDY

The periods of study will be between 12:00 noon - 3:00 p.m., 4:00 - 6:00 p.m., and 8:00 - 10:00 p.m. The length of a study period will be such that about 100 observations will be made during each study period.

METHOD OF OBSERVATION

a. PERSONAL CHARACTERISTICS

The sizes of parties of pedestrians crossing the roadway at the crosswalk and their sex and age groups (preschool, school age, young adults, adults, and old people) are to be observed. A party may consist of one or more individuals. Age groups may be identified as follows:

Preschool	Below 5 years
School age	5 - 15 years
Young adults	15 - 25 years
Adults	25 - 65 years
Old people	65 and over

b. CROSSING TIME

The time taken by parties of pedestrians to cross the roadway at the crosswalk will also be observed. The observer starts the stopwatch when the pedestrian (or the party) steps into the roadway. The time in seconds and tenths taken to complete the crossing is

noted.

All the above observations will be made without reference to the directions of crossing.

RECORDING OF DATA

Field Sheet No. 8 is used. In the first column of the field sheet, the successive 15-minute study periods are entered. The "Total" column is filled in with the total number of observations at the end of each 15-minute period. The "Totals" now is filled in with the totals of the entries in the respective columns.

NUMBER OF OBSERVERS

One or two depending on pedestrian traffic.

EQUIPMENT

Field Sheets
Stopwatch - 1
Pencil
Eraser
Flashlight for each observer

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Pedestrian Crosswalk Safety Studies

B. Pedestrian Studies

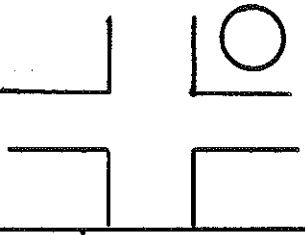
2. Pedestrian Personal Characteristics and Crossing Time

Field Sheet No. 8

Date.....Recorder.....Location.....

Weather.....Road Surface Condition.....

Sketch of Site: (Indicate North by arrow)



Comments on Site:

15 min period ending	Party Size	Sex		Age Groups					Crossing Time in seconds	Total
		Male	Female	Pre-school	School age	Young adults	Adults	Old people		
TOTALS										

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Pedestrian Crosswalk Safety Studies

B. PEDESTRIAN STUDIES
3. PEDESTRIAN GAP ACCEPTANCE

PURPOSE OF STUDY

The number and durations of gaps between vehicles rejected and accepted by pedestrians waiting to cross the roadway are to be measured.

TIME OF STUDY

Three studies will be conducted at an intersection. The time of these studies will be selected between 12:00 noon - 3:00 p.m., 5:00 p.m. - 7:00 p.m., 8:00 p.m. - 10:00 p.m. The length of study period will be such that about 100 observations are made during each study.

METHOD OF OBSERVATION

All the pedestrian and vehicular movements observed will be recorded on a 20 channel Esterline-Angus Recorder. Field Sheets Nos. 9A and 9B are also supplied. The time of an event (pedestrian or vehicular movement) is recorded by a click of the switch of the channel on which it is to be recorded.

The pedestrian selected for observation should be free-moving - that is, his evaluation and acceptance of vehicular gaps must be independent of those of any other pedestrian. But if a party of pedestrians is being observed, the behavior of the members of the party in regard to evaluation and acceptance of vehicular gaps will be studied as a collective, single action. It should also be obvious that the pedestrian (or the party) intends to cross the

roadway as soon as an acceptable gap appears in the traffic stream.

The arrival time of the pedestrian is the time he enters the area of influence of the crosswalk. This area is defined by the portion common to the two side walks which meet near the end of the crosswalk where the pedestrian begins to cross the roadway.

After arriving at the crosswalk, the pedestrian moves on to the curb where he waits for an acceptable gap to appear in the traffic stream. He may accomplish the crossing maneuver in one of the following two ways:

I. Having accepted a gap of sufficient duration, the pedestrian walks across the entire roadway width in one continuous (non-stop) movement.

II. Under conditions of heavy traffic and relatively great roadway width, the pedestrian may not cross the entire roadway width in one continuous (non-stop) movement. He may accept a relatively shorter gap appearing in traffic streams closer to him and cross a few lanes in one attempt.

There he may pause and wait for another acceptable gap to appear in traffic streams ahead. The maneuver is repeated and the pedestrian covers the entire roadway width in more than one attempt.

The observer has, therefore, first to determine which of the above two patterns of crossing maneuver a pedestrian is likely to adopt at the crosswalk under study. He will do this either by crossing the roadway himself a few times and/or by observing the behavior of a few pedestrians.

If it is concluded that the pedestrians generally cross the entire roadway width in one attempt, observations and recording will be made as indicated in TABLE I.

On the other hand, if it is concluded that pedestrians generally cross the entire roadway width in more than one attempt, the observer will make a close study and determine the successive set of lanes the pedestrian covers in successive attempts. Each set of lanes he crosses in each attempt will be treated as a SUBSTREAM of traffic. Thus, the entire roadway width will be divided into two more substreams. Observations and recording will be made as indicated in Table II.

RECORDING OF DATA

Data is recorded as indicated in TABLES I and II on Field Sheet No. 9A and Field Sheet No. 9B. Tables I and II are designed so that all vehicular passages over the crosswalk during the study period and all crossing maneuvers of the pedestrian under observation are recorded.

The observer will indicate on the sketch at the top of Field Sheet No. 9A, the number of lanes and directions of traffic flow (as direction A and direction B) in the major street being studied.

Each record chart used in the recorder will be numbered serially. The serial number of the record chart being used is entered in the first column of Field Sheet No. 9A. The various

channels selected for recording the observations being made and the respective data on each of the channels are entered on Field Sheet No. 9A as described in TABLE I or TABLE II, depending upon whether the pedestrian crosses the roadway in one attempt or more than one attempt.

NUMBER OF OBSERVERS

Two or more depending on pedestrian and vehicular traffic volumes and width of roadway.

EQUIPMENT

Twenty channel Esterline-Angus Recorder and accessories.
Watch (with second hand)
Pencils
Eraser
Flashlight for each observer during night
Field Sheet No. 9A
Field Sheet No. 9B

TABLE I

Channel Number	Data Recorded
	(NOTE: Recording of vehicular movements as detailed below is done continuously during the entire period of study.)
NA	The time the pedestrian arrives in the area of influence of the crosswalk.
Na	The time the pedestrian reaches the curb and starts waiting.
NV	The time each vehicle (without classification) passes over the reference line (center line of crosswalk width) in any specified direction (A - as indicated in sketch at the top of Field Sheet No. 9A) of traffic flow, in any lane.
Nv	The time each vehicle passes over the reference line in the opposite direction (B - as indicated in sketch at the top of Field Sheet No. 9A) of traffic flow, in any lane.
Ns	The time the pedestrian steps into the roadway and commences the crossing maneuver. (NOTE: Vehicles recorded on Channels NV and Nv after the pedestrian began to cross will be only those passing in lanes ahead of the walking pedestrian.)
NVb	The time each vehicle passes over the reference line in the opposite direction B behind the walking pedestrian, in any lane.
Nf	The time the pedestrian reaches the other side of the road.
	(NOTE: Recording on NVb and Nvb is continued only until the passage of the first vehicle after the pedestrian reaches the opposite side of the road. After that, all vehicular movements are recorded in channels NV and Nv until the start of another pedestrian crossing maneuver.)
Nc	Time check of the speed of movement of the record chart.

TABLE I (continued)

(NOTE: Channel notations NA, Na, NV... stand for any channel numbers. Time check of the speed of movement of the record chart (channel Nc) may be done with the second hand of a watch. A click of the switch followed by another after 60 seconds will give the length of record chart that moved in 60 seconds. This check may be carried out frequently by such of the observers as may find it possible to do it without affecting his other observations and recording. This check will show whether the rate of movement of the record chart is uniform or not.)

TABLE II

Channel Number	Data Recorded
	(NOTE: Recording of vehicular movements as detailed below is done continuously during the entire period of study.)
NA	The time the pedestrian arrives in the area of influence of the crosswalk.
Na	The time the pedestrian reaches the curb and starts waiting.
NV1	The time each vehicle (without classification) passes over the reference line (center line of crosswalk width) in any specified direction (A - as indicated in the sketch at the top of Field Sheet No. 9A) of traffic flow, in any lane in the first substream (closer to the pedestrian.)
NV2	The time each vehicle passes over the reference line in the specified direction B in any lane in the second substream.
	(NOTE: Similarly for NV3, NV4. . . . etc., depending upon the number of substreams.)
Ns1	The time the pedestrian steps into the roadway (first substream) and commences the crossing maneuver. (NOTE: Vehicles recorded on channels NV1, NV2, etc , after the pedestrian began to cross will be only those passing in lanes ahead of him in the respective substreams.)
NVb1	The time each vehicle passes over the reference line in the specified direction A behind the pedestrian in any lane in the first substream.
Nf1	The time the pedestrian finishes crossing the first substream and pauses and waits at the boundary between the first and second substreams.

TABLE II (continued)

Channel Number	Data Recorded
	(NOTE: All vehicular movements in the first substream hereafter will be recorded on channel NVb1 as indicated above.)
	(NOTE: The above process (from Ns1 through Nf1) repeats for every substream of traffic ahead with corresponding channel notations of Ns2 through Nf2, Ns3 through Nf3... until: Nsn through Nfn where n is the total number of substreams.
Nfn	The time the pedestrian reaches the other side of the road.
	(NOTE: Recording on NVbw is continued only until the passage of the first vehicle after the pedestrian reaches the opposite side of the road. After that, all vehicular movements are recorded again in channels NV_1, NV_2,...etc. until the start of another pedestrian crossing maneuver.
Nc	Time check of the speed of movement of the record chart.
	(NOTE: Channel notations NA, Na, NV1... stand for any channel numbers. Time checks on the speed of movement of the record chart (channel Nc) will be done as indicated at the end of TABLE I.)

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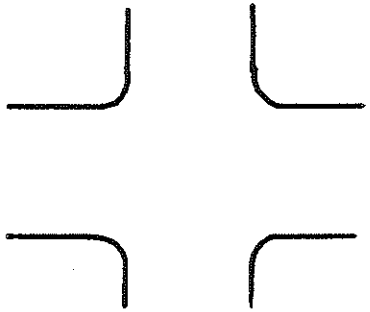
Pedestrian Crosswalk Safety Studies

B - Pedestrian Studies
3 - Pedestrian Gap Acceptance
Field Sheet No. 9A

Sketch of Site (Indicate North by Arrow)



Date..... Recorder.....
Location.....Road Surface Condition.....
.....Comments on Site.....
Weather .....

Serial Number of Record Chart	Time Recording Starts	DATA RECORDED ON CHANNEL NUMBER																				Remarks
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	

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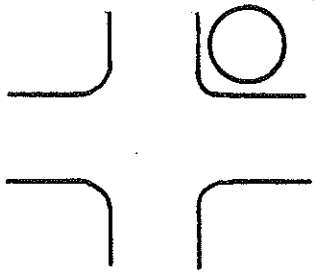
Pedestrian Crosswalk Safety Studies

B - Pedestrian Studies
3 - Pedestrian Gap Acceptance
Field Sheet No. 9B

Date.....Recorder.....

Location.....Road Surface Condition.....

Sketch of Site:
(Indicate North and crossing direction by arrow)



15-min. Period Ending	Serial Number of Pedestrian Being Observed	Sex of Pedestrian	Approximate Age of Pedestrian

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Pedestrian Crosswalk Safety Studies
B - Pedestrian Studies
3 - Pedestrian Gap Acceptance

Summary Sheet B-3 (A)

DATA REDUCTION

The field data collected in Study B-3 will be reduced to the form shown in Summary Sheet B-3 (A) and Summary Sheet B-3 (B).

SUMMARY SHEET B-3 (A)

The first column contains the successive 15-minute intervals of the study periods. Other columns are filled in with data read from Field Sheet No. 9B, and the record chart used in 20-channel Esterline-Angus recorder. The gaps (in seconds) rejected and accepted by the pedestrian in each substream are read from the record chart and entered in the appropriate columns.

SUMMARY SHEET B-3 (B)

The first (and fourth) columns contain the successive 2-minute intervals of the study period. Number of vehicles passing the crosswalk during the 2-minute intervals in the two substreams are entered in the second and third (fifth and sixth) columns. If the entire roadway width is studied as a single stream, the total vehicular volume in both directions will be entered under "Substream No. 1" in column 2, continued in column 5. Note that one summary sheet is sufficient for a two hour study period.

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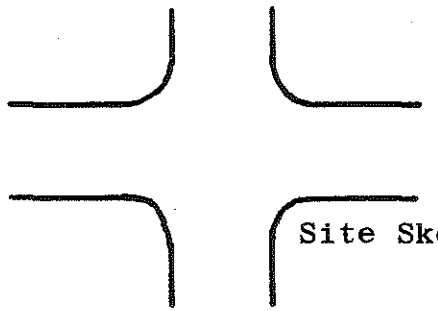
Pedestrian Crosswalk Safety Studies

B - Pedestrian Studies
3 - Pedestrian Gap Acceptance
Summary Sheet B-3 (A)



Site Sketch

Date. . . . . .

Location. . . . . .

Period of Study . . . . . .

5 Min. Period Ending	Pedestrian's Age	Pedestrian's Sex	Time Pedestrian Arrives AI*	Time Pedestrian Arrives Curb	d**	Waiting Time	GAP ACCEPTANCE Rej. gaps in sub-stream No. 1	GAP ACCEPTANCE Rej. gaps in sub-stream No. 2	GAP ACCEPTANCE Acc. gaps in sub-stream No. 1	GAP ACCEPTANCE Acc. gaps in sub-stream No. 2	Crossing Time (In Seconds) Sub-stream No. 1	Crossing Time (In Seconds) Waiting at Center	Crossing Time (In Seconds) Sub-stream No. 2	Crossing Time (In Seconds) Total

AI* - Area of Influence; d** - Difference; (Curb-AI)

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Pedestrian Crosswalk Safety Studies
B - Pedestrian Studies
3 - Pedestrian Gap Acceptance
Summary Sheet B-3 (B)

Two Minute Period Ending	VEHICULAR VOLUME		Two Minute Period Ending	VEHICULAR VOLUME	
	Substream No. 1	Substream No. 2		Substream No. 1	Substream No. 2

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Pedestrian Crosswalk Safety Studies

B. PEDESTRIAN STUDIES
4. PEDESTRIAN BEHAVIOR AT SIGNALIZED INTERSECTION

PURPOSE OF STUDY

Pedestrian behavior at signalized intersections will be studied for the following:

a. Time of pedestrian arrivals
b. Time of vehicle arrivals
c. If the pedestrian pushes the button for the crossing signal when he does so
d. After pushing the button, whether the pedestrian waits for the signal
e. When walk signal is displayed
f. If the pedestrian crosses the road without waiting for the walk signal, the pedestrian gap acceptance is studied.

TIME OF STUDY

Three studies will be conducted at an intersection. The time of these studies will be selected between 12:00 noon - 3:00 p.m., 5:00 p.m. - 7:00 p.m., 8:00 p.m. - 10:00 p.m. The length of study period will be such that about 100 observations are made during each study.

METHOD OF OBSERVATION

All the pedestrian and vehicular movements and signal indications observed will be recorded on a 20 channel Esterline-Angus recorder. Field Sheets Nos. 10A and 10B are also supplied. The time of an event (pedestrian or vehicular movement or signal indication) is recorded by a click of the switch of the channel on which it is to be recorded.

The pedestrian selected for observation should be free moving - i.e., his evaluation and acceptance of vehicular gaps must be

independent of those by any other pedestrian. But if a party of pedestrians is being observed, the behavior of the members of the party, in regard to evaluation and acceptance of vehicular gaps, will be studied as a collective single action. It should be obvious that the pedestrian or the party intends to cross the roadway as soon as an acceptable gap appears in the traffic stream.

The arrival time of the pedestrian is the time he enters the area of influence of the crosswalk. This area is defined by the portion common to the two sidewalks which meet near the crosswalk and where the pedestrian begins to cross the roadway. After arriving at the crosswalk the pedestrian may behave in one of the following ways:

a. He moves on to the curb and pushes the button of the crossing signal.
b. He moves on to the curb, does not push the button, but waits for an acceptable gap to appear in the vehicular stream.
c. If he pushed the button, some time afterwards he looks up for the "Walk" signal.
d. He may wait until the "Walk" signal is displayed.
e. After pushing the button, he may cross the road when an acceptable gap appears, before the "Walk" signal is displayed.
f. Having not pushed the button, he may wait and cross the road when an acceptable gap appears.

If he behaves as in e or f he may accomplish the crossing maneuver in one of the following two ways:

I. Having accepted a gap of sufficient duration, the pedestrian walks across the entire roadway width in one continuous (non-stop) movement.

II. Under conditions of heavy traffic and relatively great roadway width, the pedestrian may not cross the entire roadway width in one continuous (non-stop) movement. He

may accept a relatively shorter gap appearing in the traffic streams closer to him and cross a few lanes in one attempt. There he may pause and wait for another acceptable gap to appear in traffic streams ahead. The maneuver is repeated and the pedestrian covers the entire roadway width in more than one attempt.

The observer has, therefore, first to determine which of the above two patterns of crossing maneuver a pedestrian is likely to adopt at the crosswalk under study. He will do this either by crossing the roadway himself a few times and/or by observing the behavior of a few pedestrians.

If it is concluded that the pedestrians generally cross the entire roadway width in one attempt, observations and recording will be made as indicated in TABLE 1.

On the other hand, if it is concluded that the pedestrians generally cross the entire roadway width in more than one attempt, the observer will make a close study and determine the successive set of lanes the pedestrian covers in successive attempts. Each set of lanes he crosses in each attempt will be treated as a SUBSTREAM of traffic. Thus the entire roadway width will be divided into two or more substreams. Observations and recordings will be made as indicated in TABLE II.

RECORDING OF DATA

Data is recorded as indicated in TABLES I and II using Field Sheet No. 10A and Field Sheet No. 10B. Tables I and II are designed so that all vehicular passages over the crosswalk during the study period and all crossing maneuvers of the pedestrian under observation are recorded.

The observer will indicate on the sketch at the top of Field Sheet No. 10A the number of lanes and directions of traffic flow (as direction A and direction B) in the major streets being studied.

Each record chart used in the recorder will be numbered serially. The serial number of the record chart being used is entered in the first column of Field Sheet No. 10A as described in TABLE I or TABLE II, depending upon whether the pedestrian crosses the roadway in one attempt or in more than one attempt.

NUMBER OF OBSERVATIONS

Two or more depending on pedestrian and vehicular traffic volumes and width of roadway.

EQUIPMENT

20 Channel Esterline-Angus Recorder and accessories
Watch (with second hand)
Pencils
Eraser
Flashlight for each observer during night
Field Sheet No. 10A
Field Sheet No. 10B

TABLE I

Channel Number	Data Recorded
	(NOTE: Recording of vehicular movements as detailed below is done during the entire study period.)
NA	The time the pedestrian arrives in the area of influence of the crosswalk.
Np	The time the pedestrian reaches the curb and pushes the button of the crossing signal.
Na	The time the pedestrian reaches the curb and starts waiting (if he does not push the button.)
Nw	If pedestrian pushes the button, the time he looks for the "walk" sign.
NV	The time each vehicle (without classification) passes over the reference line (center line of crosswalk width) in any specified direction (A - as indicated in sketch at the top of Field Sheet No. 10A) of traffic flow, in any lane.
Nv	The time each vehicle passes over the reference line in the opposite direction (B - as indicated in sketch at the top of Field Sheet No. 10A) of traffic flow, in any lane.
Ns	The time the pedestrian steps into the roadway and begins the crossing maneuver, whether or not against the "walk" signal.
	(NOTE: Vehicles recorded on Channels NV and Nv after the pedestrian began to cross will be only those passing in lanes ahead of the walking pedestrian.)
NVb	The time each vehicle passes over the reference line in the specified direction A behind the walking pedestrian, in any lane.
Nvb	The time each vehicle passes over the reference line in

TABLE I (continued)

Channel Number	Data Recorded
	the opposite direction B behind the walking pedestrian, in any lane.
Nf	The time the pedestrian reaches the other side of the road.
	(Note: Recording on NVb and Nvb continues only until the passage of the first vehicle after the pedestrian reaches the opposite side of the road. After that, all vehicular movements are recorded in channels NV and Nv until the start of another pedestrian crossing maneuver.)
Nd	If pedestrian pushes the button, when "walk" signal is displayed.
Nc	Time check of the speed of movement of the record chart.
	(Note: Channel notations NA, Np, Na, NV... stand for any channel numbers.

Time check of the speed of movement of the record chart (Channel Nc) may be done with the second hand of a watch. A click of the switch followed by another after 60 seconds will give the length of record chart that moved in 60 seconds. This check may be carried out frequently by such of the observers as may find it possible to do it without affecting his other observations and recording. This check will show whether the rate of movement of record chart is uniform or not.

TABLE II

Channel Number	Data Recorded
	(NOTE: Recording of vehicular movements as detailed below is done continuously during the entire study period.)
NA	The time the pedestrian arrives in the area of influence of the crosswalk.
Np	The time the pedestrian reaches the curb and pushes the button of crossing signal.
Na	The time the pedestrian reaches the curb and starts waiting (if he does not push the button.)
Nw	If the pedestrian pushed the button, the time he looks for "Walk" sign.
NV1	The time each vehicle (without classification) passes over the reference line (center line of crosswalk width) in any specified direction (A - as indicated in the sketch at the top of Field Sheet No. 10A) of traffic flow, in any lane in the first substream (closer to pedestrian.)
NV2	The time of each vehicle passing over the reference line in the specified direction A in the second substream.
	(NOTE: Similarly, for NV3, NV4...etc., depending upon the number of substreams.)
Ns1	The time the pedestrian steps into the roadway (first substream) and begins the crossing maneuver, whether or not against the "Walk" signal.
	(NOTE: Vehicles recorded on channels NV1, Nv1, NV2, Nv2..., after the pedestrian began to cross will be only those passing in lanes ahead of him in the respective substreams.)

TABLE II (continued)

Channel Number	Data Recorded
NVbl	The time each vehicle passes over the reference line in the specified direction A behind the pedestrian in any lane in the first substream.
Nfl	The time the pedestrian finishes crossing the first substream and pauses and waits at the boundary between the first and second substreams.
	(NOTE: All vehicle movements in the first substream hereafter will be recorded on channel NVbl as indicated above.)
	(NOTE: The above process (from Nsl through Nfl) repeats for every substream of traffic ahead with corresponding channel notations Ns2 through Nf2, Ns2 through Nf3. . . until: Nsn through Nfn where n is the total number of substreams.)
Nfn	The time the pedestrian reaches the other side of the road.
	(NOTE: Recording on NVbn is continuous only until the passage of the first vehicle after the pedestrian reaches the opposite side of the road. After that, all vehicular movements are recorded in channels NVl, NV2...etc., until the start of another pedestrian crossing maneuver.)
Nd	If the pedestrian pushed the button, when the "Walk" signal is displayed.
Nc	Time check of the speed of movement of the record chart.
	(NOTE: Channel notations NA, Na, NVl... stand for any channel numbers.)
	Time check of the speed of movement of the record chart

will be done as indicated at the end of TABLE I.

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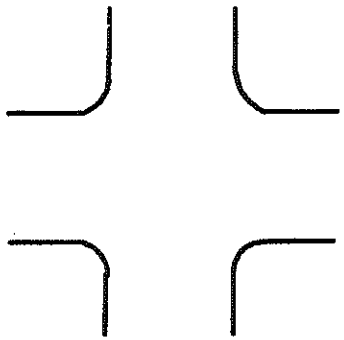
Pedestrian Crosswalk Safety Studies
B - Pedestrian Studies
4 - Pedestrian Behavior at Signalized Intersections
Field Sheet No. 10A

Sketch of Site (Indicate North by Arrow)



Date.....Recorder.....
Location.....Road Surface Condition.....
Comments on Site.....
Weather.....

Serial Number of Record Chart	Time Recording Starts	DATA RECORDED ON CHANNEL NUMBER																			Remarks
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	

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Pedestrian Crosswalk Safety Studies

B - Pedestrian Studies

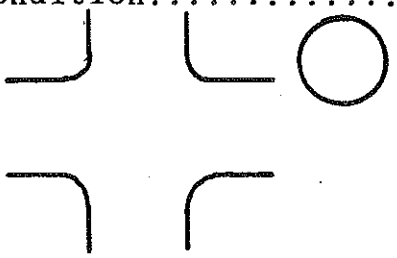
4 - Ped. Behavior at Signalized Intersections

Field Sheet No. 10B

Date.....Recorder.....

Location.....Road Surface Condition.....

Sketch of Site:
(Indicate North and crossing direction by arrow)



15-min. Period Ending	Serial Number of Pedestrian Being Observed	Sex of Pedestrian	Approximate Age of Pedestrian

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Pedestrian Crosswalk Safety Studies
B. Pedestrian Studies
4. Pedestrian Behavior at Signalized Intersections

Summary Sheet No. B-4 (A)

DATA REDUCTION

The field data collected in study B-4 will be reduced to the form shown in Summary Sheet B-4 (A) and Summary Sheet B-4 (B).

SUMMARY SHEET B-4 (A)

The first column contains the successive 15-minute intervals of the study periods. Other columns are filled in with data read from Field Sheet No. 10B and the record chart used in the 20-Channel Esterline-Angus recorder. The gaps (in seconds) rejected and accepted by the pedestrian in each substream are read from the record chart and entered in the respective columns.

SUMMARY SHEET B-4 (B)

The first (and fourth) columns contain the successive 2-minute intervals of the study period. Number of vehicles passing the crosswalk during the 2-minute intervals in the two substreams are entered in the second and third (fifth and sixth) columns. If the entire roadway width is studied as a single stream, the total vehicular volume in both directions will be entered under "Substream No. 1" in column 2, continued in column 5. Note that one summary sheet is sufficient for a two hour study period.

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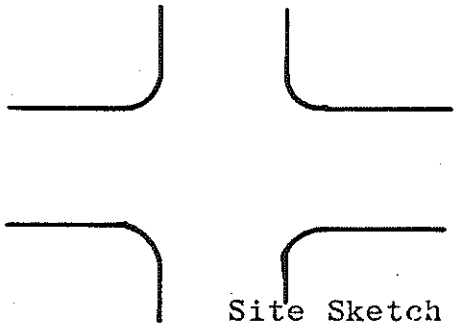
Pedestrian Crosswalk Safety Studies

B - Pedestrian Studies
4 - Pedestrian Behavior at Signalized Intersection
Summary Sheet B-4 (A)



Site Sketch

Date. . . . . .

Location. . . . . .

Min riod ding	Pedes- trian's		Time Pedestrian Arrives			Time He Looks For Walk Signal	Time He Pushes Button	Whether or not He Waits Until Signal		If YES, When is Signal Shown	IF NO, GAP ACCEPTANCE					Crossing Time (in Seconds)			
											Wait- ing Time	Rej. Gaps in Subs. No.[2]		Acc. Gaps in Subs. No.		Subs 1	Waiting at Center	Subs 2	Total
	Sex	Age	AI*	Curb	d[1]			YES	NO			1	2	1	2				

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Pedestrian Crosswalk Safety Studies
B - Pedestrian Studies
4 - Pedestrian Behavior at Signalized Intersections

Summary Sheet B-4 (B)

Two Minute Period Ending	VEHICULAR VOLUME		Two Minute Period Ending	VEHICULAR VOLUME	
	Substream No. 1	Substream No. 2		Substream No. 1	Substream No. 2

II. TELEVISING OF PEDESTRIAN CROSSING MANEUVERS

METHOD OF OBSERVATION

A portable Sony video-camera and tape recorder will be used to televise the pedestrian and vehicular movements at the crosswalk from the moment a pedestrian (or a party of pedestrians) start waiting to cross the roadway until he reaches the other side of the road. The entire period of study at a location will be about five minutes.

In the above studies, care will be taken to see that the photographer's presence and activities have the least possible effect on drivers and pedestrians.

III. TELEVISING OF PEDESTRIAN STUDY SITES FROM HELICOPTER

METHOD OF OBSERVATION

A portable Sony camera and tape recorder will be used to televise the crosswalk sites by an observer flying in a helicopter.

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Pedestrian Crosswalk Safety Studies
B. Pedestrian Studies
5. Visual Record
Field Sheet No. 11

Date. . . . . Recorder. . . . . .

Description of the camera and lens being used:

Description of the film being used:

Film Number	Serial Number of Photo	Name of Crosswalk Site	Time of Day	Direction of Shot	Lens Opening	Exposure Time