SPEED STUDY

Lecture Outline

1. Definition
2. Objectives of Speed Study
3. Fundamentals of Traffic Flow
4. Types of Speed
5. Different Forms of Speed
6. Methods of speed Measurement
7. Spot Speed Study
8. Analytical Problems related to Speed Study

Sum (Volume Study)

For an urban Radial Route determine the peak hour volume (PHV) from the following information. Consider directional design hour volume (DDHV) as PHV and assume any missing data:

a. AADT= 18,400
b. Proportion of AADT occurring at the thirtieth highest peak hour (30 HV) of the year = 10 % (0.1 as decimal)
c. 60% of the peak hour traffic is travelling in the peak direction

What are the **use** of PHV?

REF

References

"Traffic Engineering Design" by Mike Slin and others

"Highways and Traffic", Volume 1, Second Edition, 1983. **O'Flaherty, C.A.**,

Transportation Research Board, "Highway Capacity Manual", Special Report 209, Third Edition, 1994.

Traffic and Highway Engg Fourth edition Garber & Hoel

Traffic Speed Study

Speed – The rate of movement of a vehicle, generally expressed in fps, kph or mph.

- It is a basic measure of traffic and roadway performance
- Influence the traveler in selecting routes or transportation modes.

Objectives

The main objectives of speed studies are:

- Capacity studies(LOS)
- Geometric design
- Accident analysis
- Economic studies

Objectives

- Performance study of a traffic control measure (before and after studies)(Right turn ban, speed reducing devices etc.)
- Planning and designing traffic control measures viz.
  - Traffic signal design (new or improvement/ signal phase)
  - Designing road signs (for school/ hospital/ bazaar)
  - Designing pedestrian crossings (at midblock or intersection)
  - Establishing speed limits (for varied road classification)
  - Speed zoning (along a corridor)
  - Placing speed reducing devices (where applicable)

Fundamental Principals of Traffic Flow

6.1.2 Primary Elements of Traffic Flow

- ❑ flow,
- ❑ density,
- ❑ speed
- ❑ the gap or headway between two vehicles in a traffic stream

Flow

Flow (q) is the number of vehicles passing a specified point during a stated period of time. It is expressed in vehicles per hour.

It can be determined by:

$$q = \frac{n \times 3600}{T} \text{ veh/h} \qquad (6.1)$$

Where

n = the number of vehicles passing a point in the roadway in T sec

q = the equivalent hourly flow

Fundamental Principals of Traffic Flow

Density:

- *Density (k)*
- *sometimes referred to as **concentration**,*
- the number of vehicles traveling over a unit length of highway at an instant.
- The unit length is usually 1 kilometer (km)
- the unit of density is vehicles per km (veh/km).

Types of Speeds

- **Time-mean speed:** The speed obtained when the sum of all values is divided by the number of observation. It gives **arithmetic mean** of the spot speeds of vehicles passing a point. Useful for traffic regulating purposes.

$$v_t = (1/m)\sum_{i=1}^{m} v_i$$

Where m represents the number of vehicles passing the fixed point

Space-mean speed: **Harmonic mean** of speeds passing a point during a period of time. It also equals the average speeds over a length of roadway. Useful for establishing Speed-Flow relationships.

$$v_s = (n/\sum_{i=1}^{n}(1/v_i)$$

Where n represents the number of vehicles passing the roadway segment

The space-mean speed is the distance traveled divided by an average travel time, whereas the time-mean speed is *an average of individual vehicle speeds*.

Vehicle No.	Distance d (ft)	Travel Time t (s)	Speed (ft/s)
1	1,000	18.0	1,000/18 = 55.6
2	1,000	20.0	1,000/20 = 50.0
3	1,000	22.0	1,000/22 = 45.5
4	1,000	19.0	1,000/19 = 52.6
5	1,000	20.0	1,000/20 = 50.0
6	1,000	20.0	1,000/20 = 50.0
Total	**6,000**	**119**	**303.7**
Average	**6,000/6 = 1,000**	**119/6 = 19.8**	**303.7/6 = 50.6**

TMS = 50.6 ft/s

SMS = 1,000/19.8 = 50.4 ft/s

- Time mean speed (v_t) = arithmetic mean of speeds of vehicles passing a point

$$\overline{v}_t = \frac{1}{N}\sum_{n=1}^{N} v_n$$

- Space mean speed (v_s) harmonic mean of speeds passing a point during a period of time. It also equals the average speeds over a length of roadway

$$\overline{v}_s = \frac{N}{\sum_{n=1}^{N}\frac{1}{v_n}} = \frac{NL}{\sum_{n=1}^{N} t_n}$$

where

N = number of vehicles

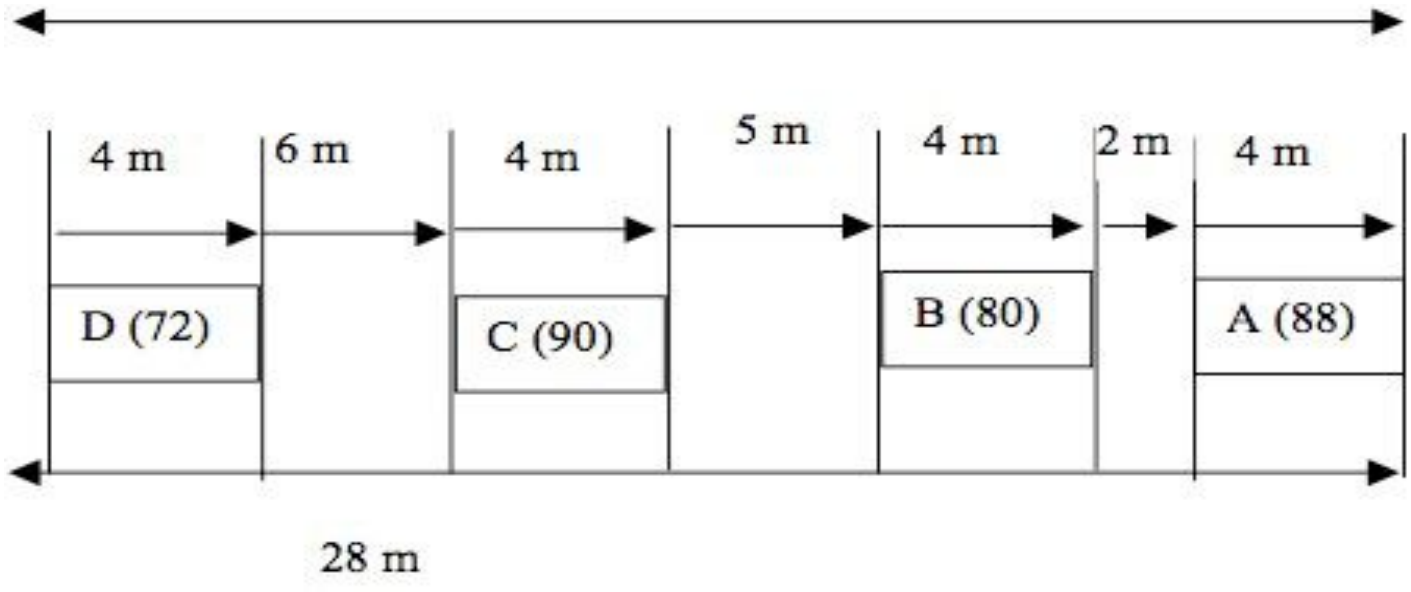
t_n = time it takes n^{th} vehicle to traverse a section of highway

v_n = speed of n^{th} vehicle

L = length of section of highway

Problem

Four vehicles are traveling at constant speeds between sections X and Y with their positions and speeds observed at an instant in time. An observer at point X observes the four vehicles passing point X during a period of **15 seconds**. The speeds of the vehicles are measured as 88, 80, 90, and 72 km/hr respectively. Calculate the flow, density, time mean speed, and space mean speed of the vehicles.



Solution: Flow, Density, Time Mean Speed

- Flow
- Density
- Time Mean Speed

$$q = N\left(\frac{3600}{t_{measured}}\right) = 4\left(\frac{3600}{15}\right) = 960 veh/hr$$

$$k = \frac{N}{L} = \frac{4}{28} = 142 veh/km$$

$$\overline{v_t} = \frac{1}{N}\sum_{n=1}^{N} v_n = \frac{1}{4}(72+90+80+88) = 82.5 km/hr$$

Solution: Space Mean Speed

$$\bar{v}_s = \frac{N}{\sum_{n=1}^{N} \frac{1}{v_i}} = \frac{4}{\frac{1}{72}+\frac{1}{90}+\frac{1}{80}+\frac{1}{88}} = 81.86$$

$$t_i = L / v_i$$

$$t_A = L / v_A = .028 / 88 = 0.000318 hr$$

$$t_B = L / v_B = .028 / 80 = 0.000350 hr$$

$$t_C = L / v_C = .028 / 90 = 0.000311 hr$$

$$t_D = L / v_D = .028 / 72 = 0.000389 hr$$

$$\bar{n}_s = \frac{NL}{\sum_{n=1}^{N} t_n} = \frac{4 * 0.028}{(0.000318+0.000350+0.000311+0.000389)} = 81.87 km / hr$$

The following travel times were observed for 4 vehicles traversing a 1 mile segment of highway:

Vehicle	Time (min)
1	1.6
2	1.2
3	1.5
4	1.7

Calculate the space and time mean speeds of the vehicles.

More math....

The following travel times were observed for 4 vehicles traversing a 1 mile segment of highway:

Vehicle	Time (min)
1	1.6
2	1.2
3	1.5
4	1.7

Calculate the space and time mean speeds of the vehicles.

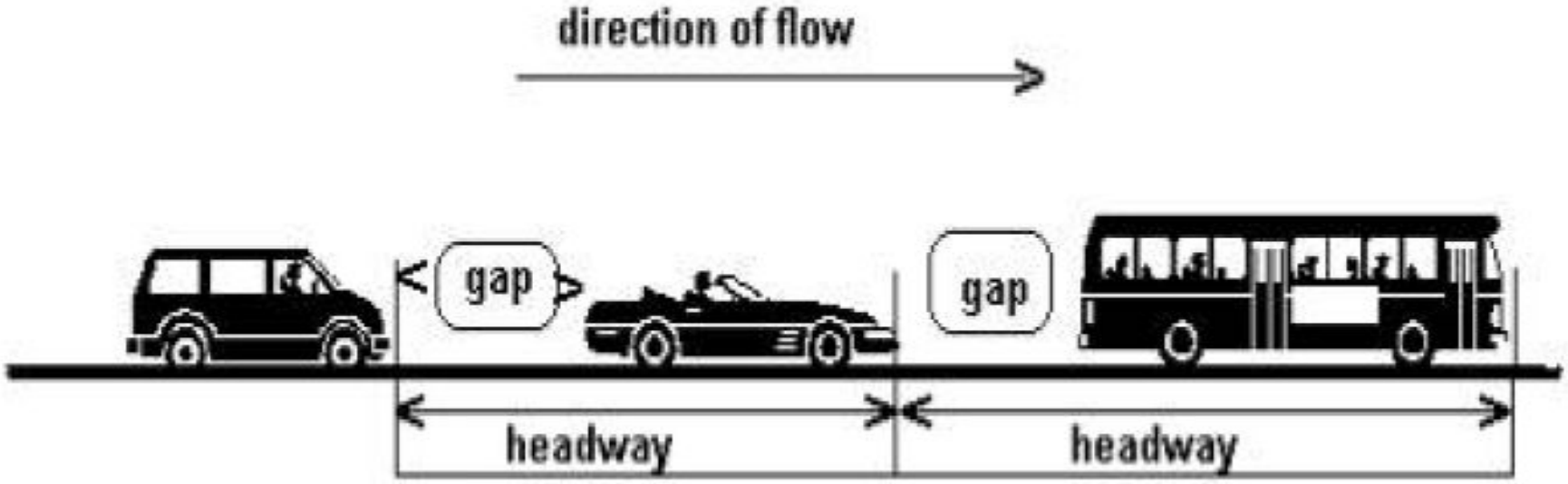
Time Mean Speed = [(1/1.6)+(1/1.2)+(1/1.5)+(1/1.7)]/4
= 0.68 miles per minute = 40.8 mph

Space Mean Speed = 4/(1.6+1.2+1.5+1.7)
= 0.67 miles per minute = 40.0 mph

Headway:Time Headway (*h*) v/s Space Headway

Time headway: **difference between the time** the front of a vehicle arrives at a point on the highway and the time the front of the next vehicle arrives at the same point.

Space headway : **distance between** the front of a vehicle and the front of the following vehicle.



Time Headway

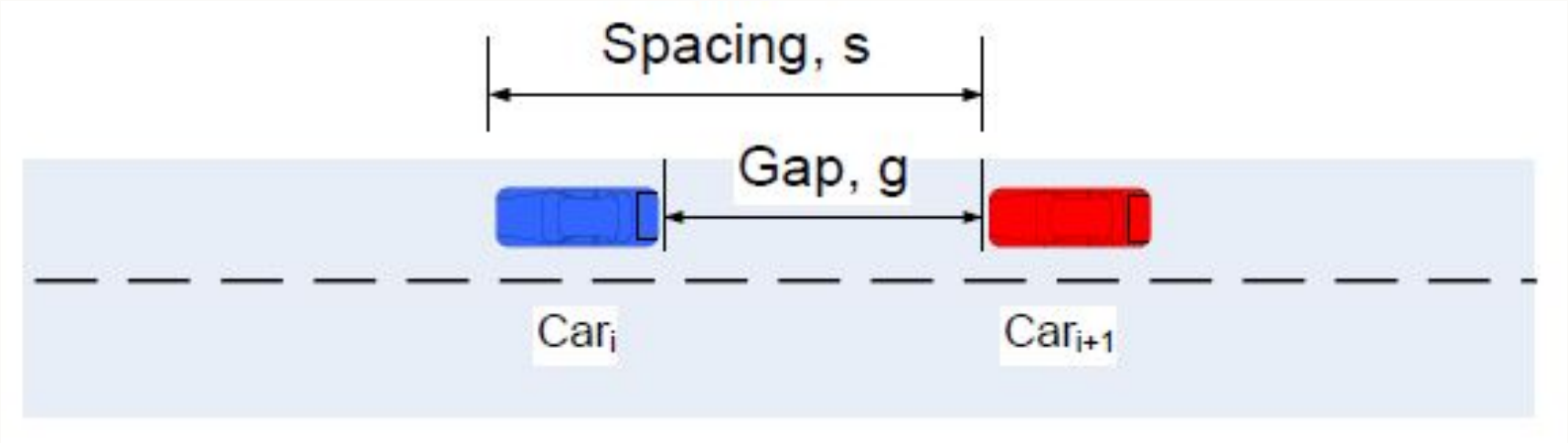
Time headway (h) = time "gap" between successive vehicles as they pass a point on the roadway.

Vehicle #	Time (s) Passing Pt. A	Headways
4	1.62	$h_{4-5} = 4.54$ s
5	6.16	$h_{5-6} = 2.44$ s
6	8.60	$h_{6-7} = 4.47$ s
7	13.07	

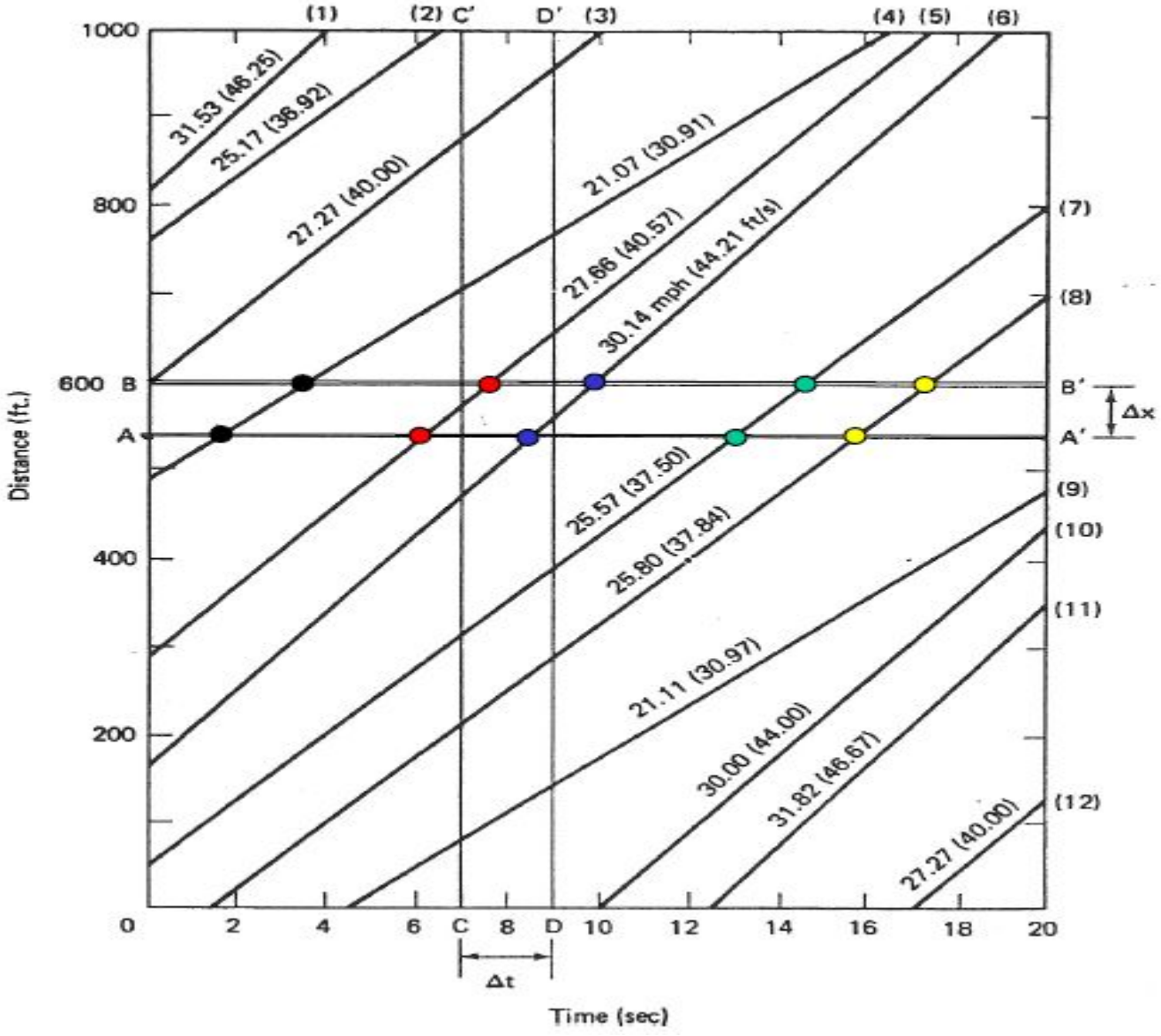
Distance Headway

Spacing or Distance Headway (s)

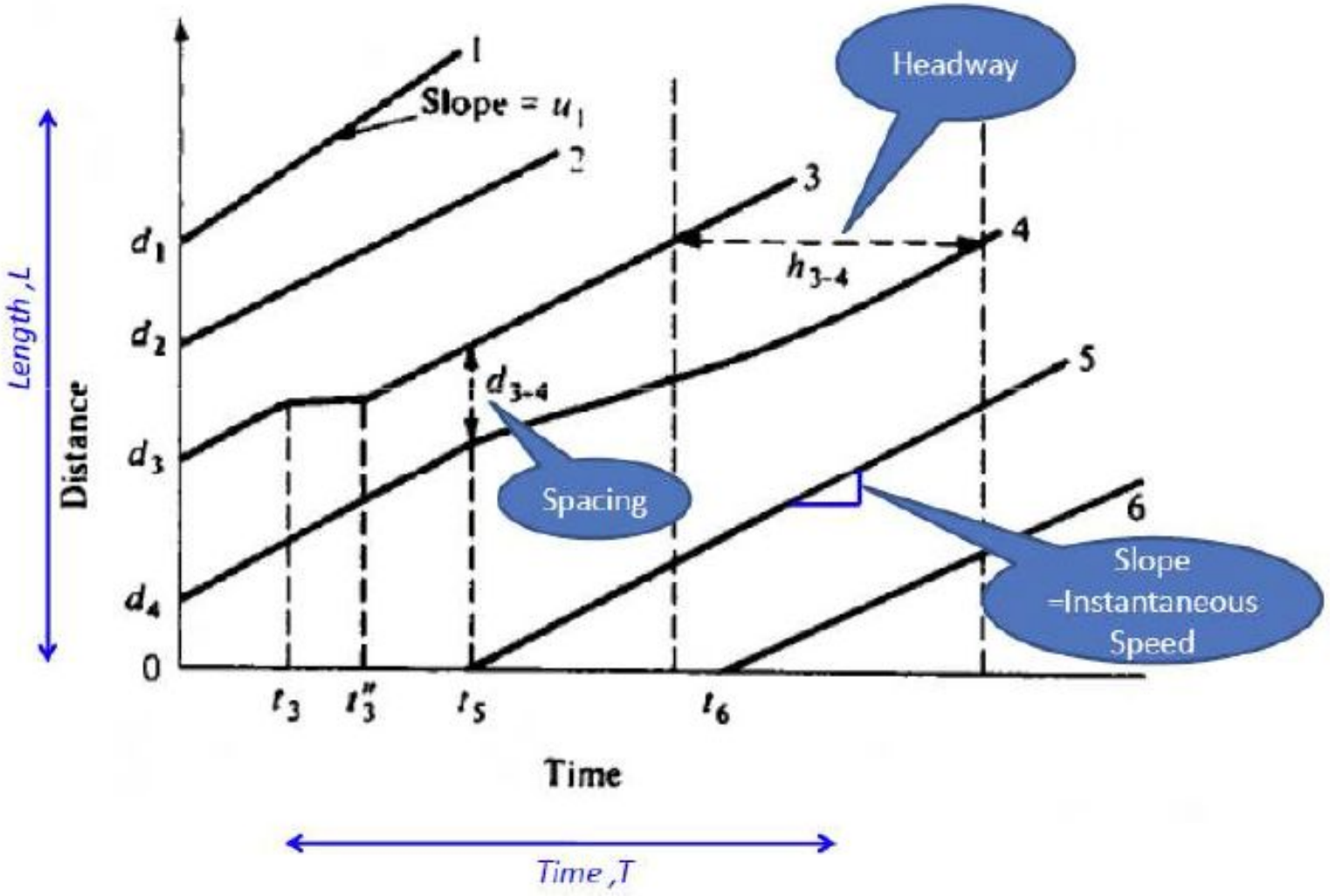
- = distance between successive vehicles in a traffic stream as measured from two corresponding points on the vehicles (e.g. front bumpers)



Time-Space Plot of Vehicle Paths



Time Space Diagram



Different Forms of Speed

- **Spot speed:** Instantaneous speed of a vehicle at a point.
- **Running speed:** Average speed while in motion
- **Journey speed:** Overall speed including stops.
- **Free Flow speed:** When drivers face no restriction in driving and can maintain their desired speeds.

OPERATING SPEED

- The **operating speed** of a road is the speed at which motor vehicles generally operate on that road.
- The precise definition of "operating speed", however, is open to debate. Some sources, such as the AASHTO, have changed their definitions recently to match the common use of the word. In 1994, the AASHTO *Green Book* defined the operating speed as "the highest overall speed at which a driver can travel on a given highway under favorable weather conditions and under prevailing traffic conditions without at any time exceeding the safe speed as determined by the design speed on a section-by-section basis," a definition which a majority of US states still use.In July 2001, however, the AASHTO revised their definition for the new edition of the *Green Book* and defined it as "the speed at which drivers are observed operating their vehicles during free-flow conditions."

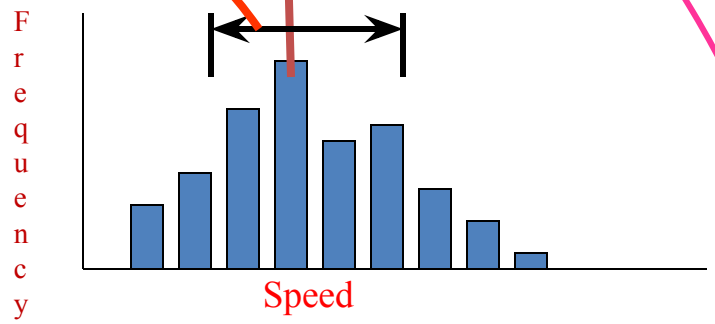
Different Forms of Speed

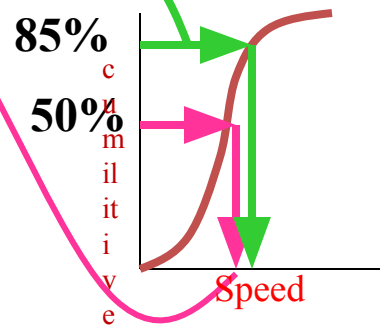
- **Safe speed: 85th** percentile speed.
- **Design speed:** 98th percentile speed.
- **Median speed:** 50th percentile speed.
- **Modal speed:** Speed at the highest frequency.
- **Pace:** **It** is the range of speed—usually taken at 10-mi/h intervals—that has the greatest number of observations. For example, if a set of speed data includes speeds between 30 and 60 mi/h, the speed intervals will be 30 to 40 mi/h, 40 to 50 mi/h, and 50 to 60 mi/h, assuming a range of 10 mi/h. The pace is 40 to 50 mi/h if this range of speed has the highest number of observations
- **Speed limits:** Upper limit at 85th percentile speed.; Lower limit at 15th percentile speed.

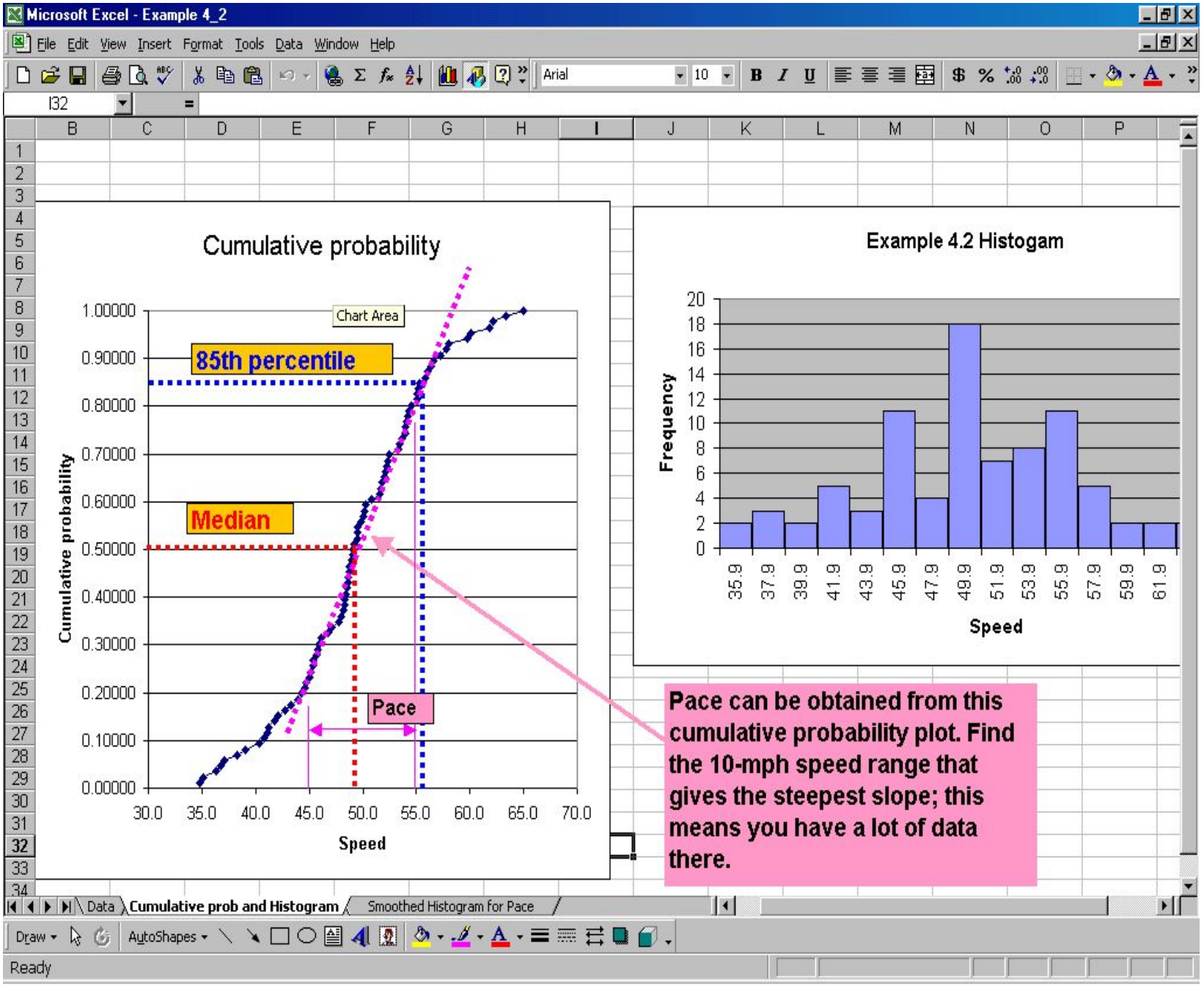
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Types of Speed Measurements

Median speed	The speed at the middle value in a series of spot speeds. Or, 50th-percentile speed
Modal speed	The speed value that occurs most frequently in a sample of speeds
ith-percentile speed	The spot speed below which i percent of the vehicles travel, e.g. 85th-percentile speed
Pace	The range of speed that has the greatest number of observations; usually 10-mph range






Microsoft Excel - Example 4_2
File Edit View Insert Format Tools Data Window Help
Arial
10
I32
Cumulative probability
Chart Area
85th percentile
Median
Pace
Cumulative probability
1.00000
0.90000
0.80000
0.70000
0.60000
0.50000
0.40000
0.30000
0.20000
0.10000
0.00000
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
Speed
Example 4.2 Histogam
Frequency
20
18
16
14
12
10
8
6
4
2
0
35.9
37.9
39.9
41.9
43.9
45.9
47.9
49.9
51.9
53.9
55.9
57.9
59.9
61.9
Speed
Pace can be obtained from this cumulative probability plot. Find the 10-mph speed range that gives the steepest slope; this means you have a lot of data there.
Data
Cumulative prob and Histogram
Smoothed Histogram for Pace
Draw
AutoShapes
Ready

Methods of Speed Measurement

Spot/ Time Mean Speed: Measured at free flow/unobstructed conditions by using:

- Manual method- measuring travel time over a short distance.
- Automatic method-
  - ✔ Radar speed meters.
  - ✔ Pressure contact strip.
  - ✔ Video camera method.
  - ✔ Tachometer/ graph

Methods of Speed Measurement

Travel/ Space-mean speed: **Measured at existing operating condition by using:**

- License plate method.
- Floating car method- by use of test vehicle.
- Elevated observer method

General

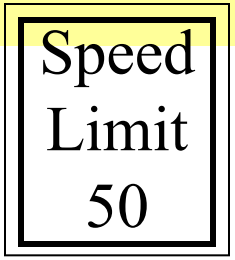
- The data is to be used for assessing general speed trends and for setting speed limits.
- The equipment for data collection procedure is a hand-held radar.




MILITARY POLICE

When are spot speed studies needed?

Spot speed studies are conducted to estimate the distribution of speeds of vehicles in a stream of traffic at a particular location on a highway.



Used for:

- ✔ Establish **speed zones**
- ✔ Determine whether complaints about speeding are valid
- ✔ Establish **passing and no-passing zones**
- ✔ Design **geometric alignment**
- ✔ Analyze **accident data**
- ✔ Evaluate the effects of **physical improvements**, etc., etc.

Data Collection

4.1.2 Time of Day and Duration of Spot Speed Studies

The time of day for conducting a speed study depends on the purpose of the study. In general, when the purpose of the study is to establish posted speed limits, to observe speed trends, or to collect basic data, it is recommended that the study be conducted when traffic is free-flowing, usually during off-peak hours. However, when a speed

The duration of the study should be such that the minimum number of vehicle speeds required for statistical analysis is recorded. Typically, the duration is at least 1 hour and the sample size is at least 30 vehicles.

- Choose section of road
- Not close to intersection, at midblock
- Off-peak period during daylight hours on a typical weekday

Spot Speed Study
Data Collection Form

Location:_____ Observer/s (group #)_____
Date:_____ Time:_____ Direction of Travel:_____ Posted Speed:_____

Weather Conditions: _____
Safety officer_____

Vehicle number	Speed, mph	Vehicle number	Speed, mph	Vehicle number	Speed, mph	Vehicle number	Speed, mph

Math

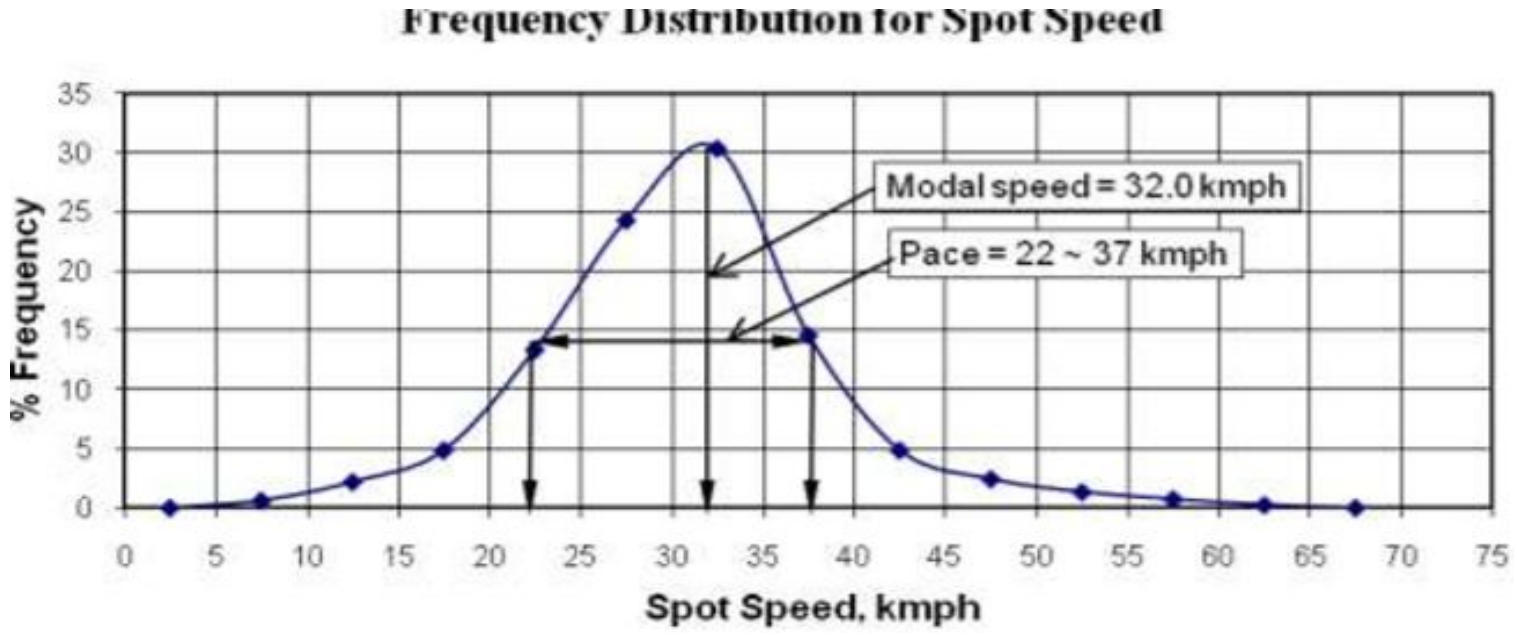
Following data was collected while conducting spot speed studies at certain stretch of a road within the urban area. Determine:

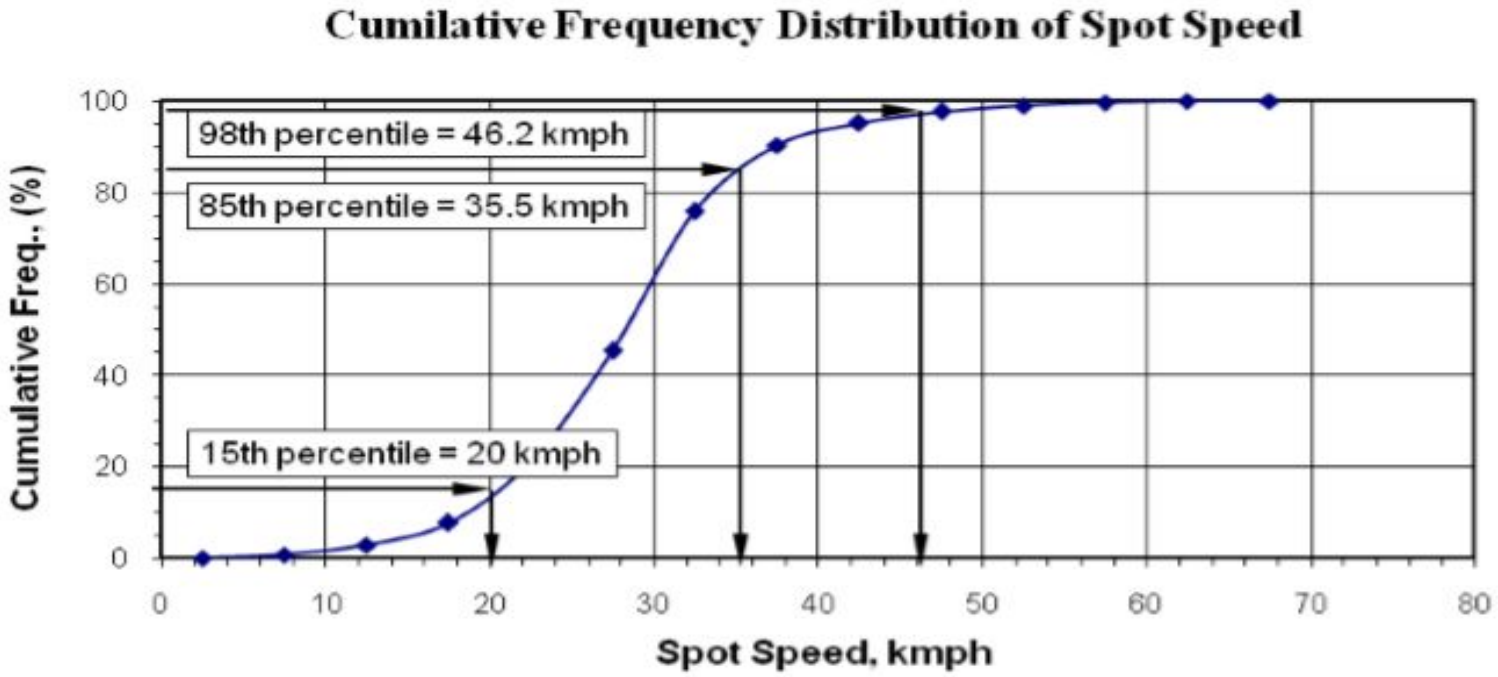
- Average speed of traffic speed.
- Modal speed and pace of the traffic stream.
- Upper and lower values of speed limits for regulation.
- Design speed for checking the design speed.

Solution

Speed Range (kmph)	No. of vehicle observed (f)	Mid-speed, V (kmph)	% Frequencies	Cumulative % Frequencies
0 - 5	0	2.5	0.00	0.00
5 - 10	5	7.5	0.61	0.61
10 - 15	18	12.5	2.19	2.80
15 - 20	40	17.5	4.87	7.66
20 - 25	110	22.5	13.38	21.05
25 - 30	200	27.5	24.33	45.38
30 - 35	250	32.5	30.41	75.79
35 - 40	120	37.5	14.60	90.39
40 - 45	40	42.5	4.87	95.26
45 - 50	20	47.5	2.43	97.69
50 - 55	11	52.5	1.34	99.03
55 - 60	6	57.5	0.73	99.76
60 - 65	2	62.5	0.24	100.00
65 - 70	0	67.5	0.00	100.00
Total	822			

V_{avg} = Sum (f * V)/Sum(f)
= 30.73 mph


Frequency Distribution for Spot Speed
% Frequency
Spot Speed, kmph
Modal speed = 32.0 kmph
Pace = 22 ~ 37 kmph
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75


Cumilative Frequency Distribution of Spot Speed
Cumulative Freq.. (%)
Spot Speed, kmph
98th percentile = 46.2 kmph
85th percentile = 35.5 kmph
15th percentile = 20 kmph
0
20
40
60
80
100
10
30
50
70

6. **Standard Deviation of Speeds** which is a measure of the spread of the individual speeds. It is estimated as

$$S = \sqrt{\frac{\sum (u_j - \bar{u})^2}{N - 1}} \tag{4.2}$$

where

S = standard deviation
$\bar{u}$ = arithmetic mean
u_j = jth observation
N = number of observations

However, speed data are frequently presented in classes where each class consists of a range of speeds. The standard deviation is computed for such cases as

$$S = \sqrt{\frac{\sum f_i (u_i - \bar{u})^2}{N - 1}} \tag{4.3}$$

where

u_i = midvalue of speed class i
f_i = frequency of speed class i

Probability theory is used to determine the sample sizes for traffic engineering

Sample Size of Speed Data

The minimum sample size depends on the precision level desired. The precision level is defined as the degree of confidence that the sampling error of a produced estimate will fall within a desired fixed range. Thus, for a precision level of 90–10, there is a 90 percent probability (confidence level) that the error of an estimate will not be greater than 10 percent of its true value. The confidence level is commonly given in terms of the level of significance (α), where α = (100 − confidence level). The commonly used confidence level for speed counts is 95 percent.

The basic assumption made in determining the minimum sample size for speed studies is that the normal distribution describes the speed distribution over a given section of highway. The normal distribution is given as

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2} \text{ for } -\infty < x < \infty \qquad (4.4)$$

μ = true mean of the population
σ = true standard deviation
σ^2 = true variance

The properties of the normal distribution are then used to determine the minimum sample size for an acceptable error d of the estimated speed. The following basic properties are used (see Figure 4.1):

1. The normal distribution is symmetrical about the mean.
2. The total area under the normal distribution curve is equal to 1 or 100%.
3. The area under the curve between $\mu + \sigma$ and $\mu - \sigma$ is 0.6827.
4. The area under the curve between $\mu + 1.96\sigma$ and $\mu - 1.96\sigma$ is 0.9500.
5. The area under the curve between $\mu + 2\sigma$ and $\mu - 2\sigma$ is 0.9545.
6. The area under the curve between $\mu + 3\sigma$ and $\mu - 3\sigma$ is 0.9971.
7. The area under the curve between $\mu + \infty$ and $\mu - \infty$ is 1.0000.

The last five properties are used to draw specific conclusions about speed data. For example, if it can be assumed that the true mean of the speeds in a section of highway is 50 mi/h and the true standard deviation is 4.5 mi/h, it can be concluded that 95 percent of all vehicle speeds will be between $(50 - 1.96 \times 4.5) = 41.2$ mi/h and $(50 + 1.96 \times 4.5) = 58.8$ mi/h. Similarly, if a vehicle is selected at random, there is a 95 percent chance that its speed is between 41.2 and 58.8 mi/h. The properties of the normal distribution have been used to develop an equation relating the sample size to the number of standard variations corresponding to a particular confidence level, the limits of tolerable error, and the standard deviation.

The formula is

$$N = \left(\frac{Z\sigma}{d}\right)^2 \qquad (4.5)$$

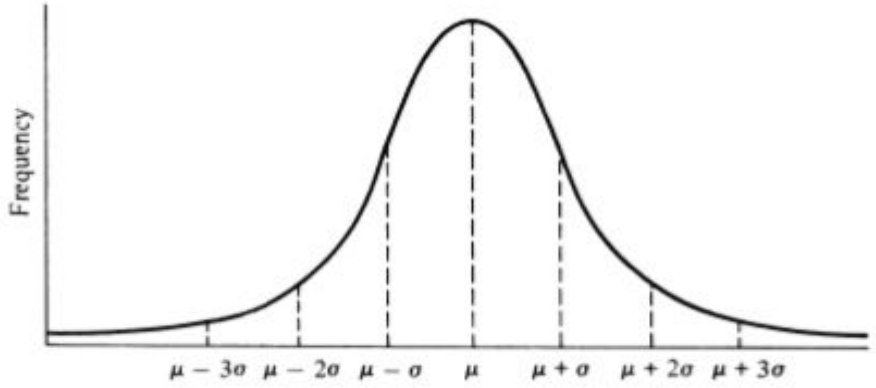


Figure 4.1 Shape of the Normal Distribution

Table 4.1 Constant Corresponding to Level of Confidence

Confidence Level (%)	*Constant Z*
68.3	1.00
86.6	1.50
90.0	1.64
95.0	1.96
95.5	2.00
98.8	2.50
99.0	2.58
99.7	3.00

$$N = \left(\frac{Z\sigma}{d}\right)^2 \tag{4.5}$$

where

N = minimum sample size
Z = number of standard deviations corresponding to the required confidence
= level 1.96 for 95 percent confidence level (Table 4.1)
σ = standard deviation (mi/h)
d = limit of acceptable error in the average speed estimate (mi/h)

The standard deviation can be estimated from previous data, or a small sample size can first be used.

As part of a class project, a group of students collected a total of 120 spot speed samples at a location and determined from this data that the standard variation of the speeds was ± 6 mi/h. If the project required that the confidence level be 95% and the limit of acceptable error was ± 1.5 mi/h, determine whether these students satisfied the project requirement.

Solution: Use Eq. 4.5 to determine the minimum sample size to satisfy the project requirements.

$$N = \left(\frac{Z\sigma}{d}\right)^2$$

where

$Z = 1.96$ (from Table 4.1)
$\sigma = \pm 6$
$d = 1.5$

$$N = \left(\frac{1.96 \times 6}{1.5}\right)^2$$
$$= 61.45$$

Therefore, the minimum number of spot speeds collected to satisfy the project requirement is 62. Since the students collected 120 samples, they satisfied the project requirements.

More math....

The following travel times were observed for 4 vehicles traversing a 1 mile segment of highway:

Vehicle	Time (min)
1	1.6
2	1.2
3	1.5
4	1.7

Calculate the space and time mean speeds of the vehicles.

Time Mean Speed = [(1/1.6)+(1/1.2)+(1/1.5)+(1/1.7)]/4
= 0.68 miles per minute = 40.8 mph

Space Mean Speed = 4/(1.6+1.2+1.5+1.7)
= 0.67 miles per minute = 40.0 mph

Discussion

Comparison of Mean Speed

* Before-after study of spot-speeds is needed to measure the effectiveness of a counter measure.
* This is done by comparing the difference between two sample mean speeds by using statistical Z-test.
* Assuming that two sample means are from the same distribution.
* In traffic engineering studies, it is usual to perform the test at 95% confidence level.

Check if $Z = |u_1 - u_2|/S_d > Z_{critical}$

Where; $S_d = \text{sqrt}[S_1^2/n_1 + s_2^2/n_2]$

u_1 = mean speed of before study

u_2 = mean speed of after study

n_1 = sample size for before study

n_2 = sample size for after study

S_d = standard deviation of the difference in means

S_1 = standard deviation for before study

S_2 = standard deviation for after study

$Z_{critical}$ = Critical value at a particular confidence level

= 1.96 at 95% C.L. or 5% LOS

Spot speed data were collected at a section of highway during and utility maintenance work. The speed characteristics are given below. Determine whether there was any significant difference between the average speed at the 95% confidence level.

$u_1 =$ 35.5 mph $\quad u_2 =$ 38.7 mph

$S_1 =$ 7.5 mph $\quad S_2 =$ 7.4 mph

$n_1 =$ 250 $\quad n_2 =$ 280

Solution:

$S_d = \text{sqrt}[S_1^2/n_1 + S_2^2/n_2]$

$= \text{sqrt}[7.5\text{^}2/250 + 7.4\text{^}2/280]$

$= 0.65$ mph

$Z_{critical} = 1.96$ at 95%confidence level

Now, $Z = |u_1 - u_2|/S_d$

$= |35.5 - 38.7|/0.65$

$= 4.92$

As $Z > Z_{critical}$, it can be concluded that the difference in mean speeds is significant at 95% confidence level.

Assignment/Math

Speed data collected on an urban roadway yielded a standard deviation in speeds of ±4.8 mi/h.

(a) If an engineer wishes to estimate the average speed on the roadway at a 95% confidence level so that the estimate is within ±2 mi/h of the true average, how many spot speeds should be collected?

(b) If the estimate of the average must be within ±1 mi/h, what should the sample size be?

An engineer wishing to obtain the speed characteristics on a bypass around her city at a confidence level of 95%, and an acceptable limit of ± 1.0 mi/h collected a total of 130 spot speed samples and determined that the variance is 25 $(mi/h)^2$. Has the engineer met with all of the requirements of the study?

An engineer wishing to determine whether there is a statistically significant difference between the average speed of passenger cars and that of large trucks on a section of highway, collected the data shown below. Determine whether the engineer can conclude that the average speed of large trucks is the same as that for passenger cars.

	Trucks	*Passenger Cars*
Average Speed (mi/h)	62	59
Standard deviation of speed ± mi/h	5.5	6.3
Sample size	275	175

Introduction

- It is a modified form of the speed studies
- It measures the average journey time.

Objectives

- To find out the locations, causes and duration of the delay/congestions
- To asses the quality/efficiency of road network.
- To prescribe the remedied measures of congestions.
- For economic evaluation of improvement measures
- To evaluate the performance of particular measures.
- For travel demand management /route guidance.

Causes of Delay

Fixed Causes/Geometric delay:

- Delay incurred due to roadway geometry.
- It occurs mainly due to road intersections/ signals, narrow road/bridges, sharp horizontal and vertical curves etc.
- It is unavoidable and almost same for all vehicles.

Causes of Delay

- **Operational Delay:** It is mainly caused by road-side and inter-vehicular frictions such as:
  - Road side parking
  - Road side non-motor activities.
  - Road side pedestrian movements and random crossing.
  - Bus stoppage near intersections.
  - High traffic volume and lack of roadway capacity.
  - Merging, turning, lane changing/overtaking or weaving maneuvers etc.

Delay/Congestions

It indicates the situation when extra time is needed to travel through a roadway facility.

Types of Delay/Congestion

- **Non-recurrent Delay:** Which is **unpredictable** in nature and occurs due to the following **random events**.
  - Flow break down at peak periods (make shock wave – which quickly amplify and propagate to down stream).
  - Accidents
  - Special events (sports, national events).
  - Signal Malfunctions etc.

Types of Delay/Congestion

- **Recurrent Delay: Which occurs periodically at particular locations and particular time of a day.**
  - **Daily morning/evening peak period congestions due to rush commuter movements.**
  - **Congestions other than the peak periods on all purpose roads due to increased flow level.**

Data Collection Methods

- Manual
  - Floating Car Method
  - Random Car Selection Method
- Based on in-vehicle tachometer and GPS antenna

Data Collection Methods (cont..)

- Auto Data Acquisition Techniques
  - Based on road occupancy rate- Inductive loop detectors
  - Based on vehicle speeds- radar devices (ultra sound/ infrared beams)
  - Based on travel time- between
  - ✔ Two consecutive CCTVs with machine vision license plate reader (LPR)
  - ✔ Two granties with microwave transmitters and in-vehicle electronic card/ tag system

Study Procedure

- Test Vehicle:
  - Floating Car
  - Average Car
  - Moving Car
- No Test Vehicles:
  - License plate studies
  - Interviews

Study Procedure

Floating Car:

Measure the time to traverse a test section while overtaking and being overtaken by an equal number of vehicles

- Pass as many cars as pass the test car
- Record travel time and distance to calculate average speed
- Can also record stopped delay separately

Study Procedure

Average Car:

Measure the time to traverse a test section traveling at the average speed of the traffic stream (highly subjective)

- Driver mimic average road conditions
- Easier than floating car but driver interprets average conditions
- Record travel time and distance to calculate average speed
- Can also record stopped delay separately

Study Procedure

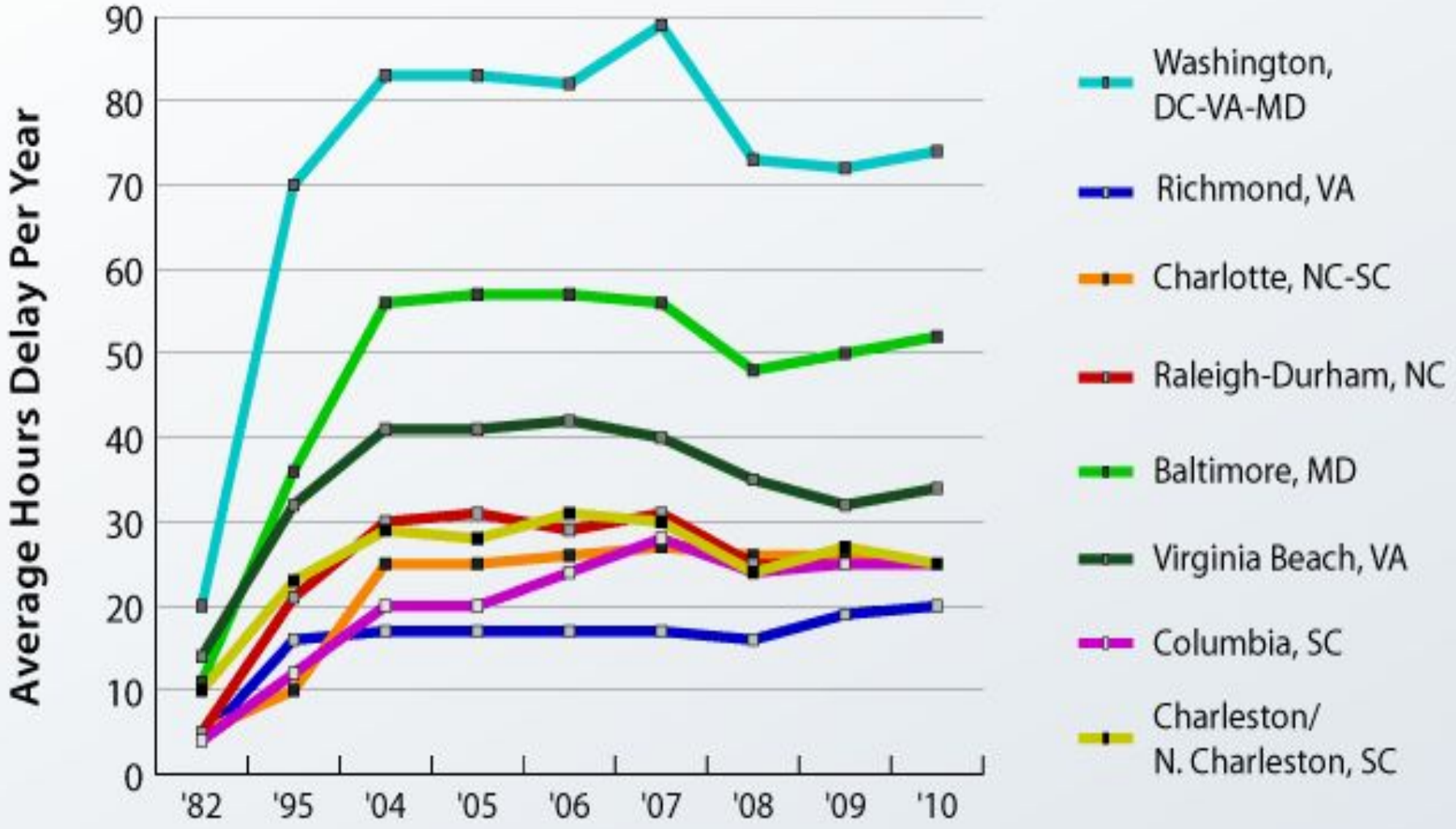
License Plate Method:

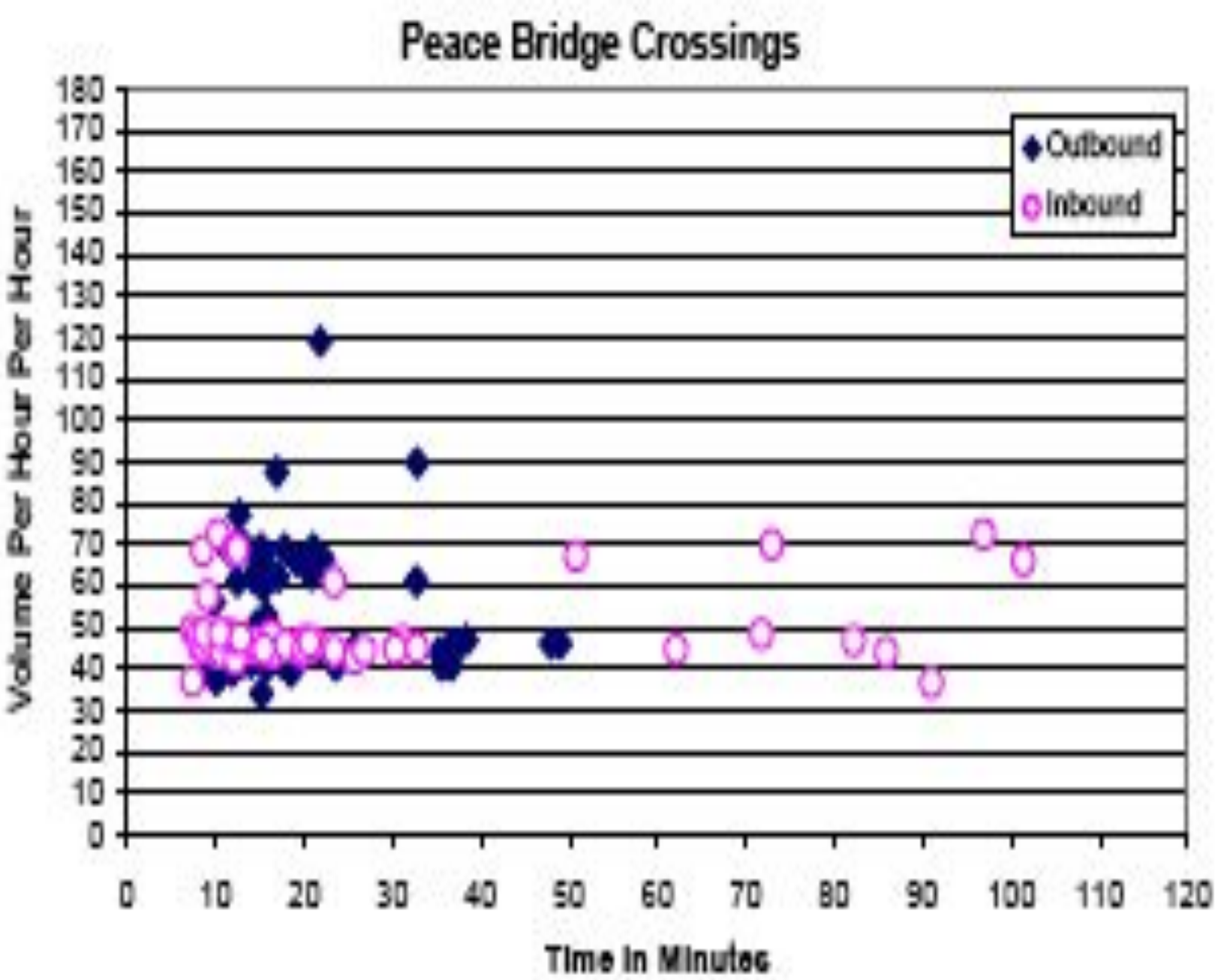
- It provides information about travel time and delay.
- It also provide information about circulation patterns.
- It relies on vehicle matching from observations at two synchronized locations.
- Often done using video cameras.

Presentation of Results

Speed and delay data may be presented in tabular or graphical form to show speeds and speed variation profiles along the route being studied together with the locations, causes and duration of delays

Annual Hours of Delay per Traveler, by MSA




Peace Bridge Crossings
Volume Per Hour Per Hour
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Outbound
Inbound
0
10
20
30
40
50
60
70
80
90
100
110
120
Time in Minutes

Speed data collected on an urban roadway yielded a standard deviation in speeds of ±4.8 mi/h.

(a) If an engineer wishes to estimate the average speed on the roadway at a 95% confidence level so that the estimate is within ±2 mi/h of the true average, how many spot speeds should be collected?

(b) If the estimate of the average must be within ±1 mi/h, what should the sample size be?