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# Highway & Traffic Engineering

# SPOT SPEED STUDIES

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# Chapter Description

Aims

This chapter has presented  students on the basic understanding on spot speed studies.

Expected Outcomes

- Identify method associated with spot speed studies
- Analyze speed data for specific application

# Contents

- **Introduction**
- **Methods in conducting Spot Speed Study**
- **Spot speed study analysis and data presentation**

# Introduction

- ***Speed Definition*** - Distance travelled by a vehicle during a unit of time and expressed in km/hr
- Used to describe the quality of journey and the performance of road network in accommodating traffic demand
- ***Spot speed study definition -*** speed of traffic at one point or spot on a traffic way (instantaneous speed).

# Spot Speed Study Purposes:

- Establishing the speed zone of new or existing speed limit or enforcement practices.
- To determine speeds at the problem locations; to validate whether speeds are too high
- For traffic operation and control;

  - to establish speed limits

  - to determine safe speeds at curves
- Establishing speed trends at the local, state and national level to assess effectiveness of speed limit policy.

# Locations For Spot Speed Studies

i. *Speed Trend Locations:*
   - Straight, level, open sections of rural highways
   - Midblock locations on urban streets

ii. *Representative locations of* different traffic conditions on a highway *for basic data survey*

iii. *Problematic locations (Specific traffic engineering problem ):*
   - High accident frequency purposes
   - At points where the installation of traffic signals facility may be necessary

# Factors effect spot speed studies:

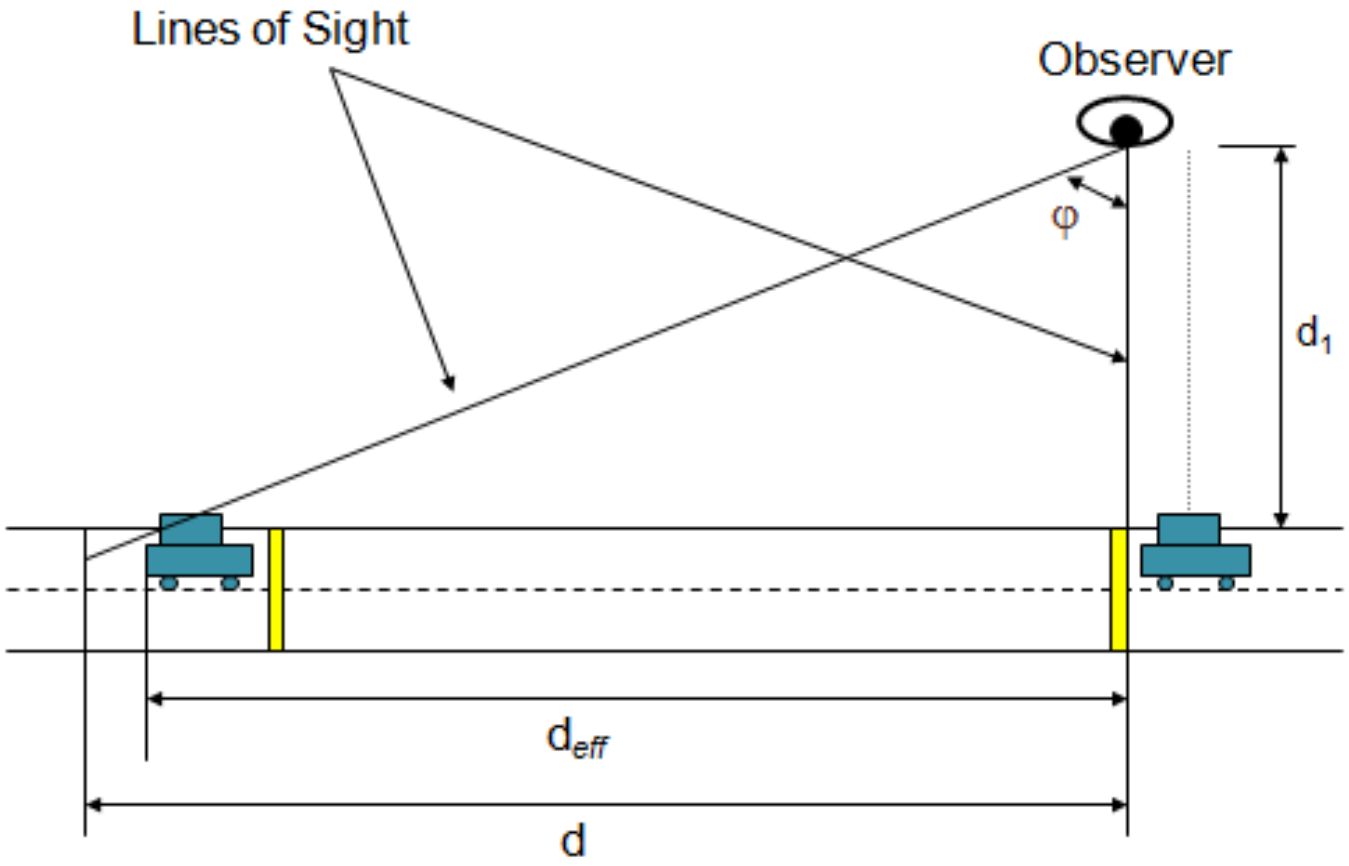
- Driver - Age, Gender, motive of the journey, distance of his trip;
- Vehicle - type, age, weight, manufacturer and horse power;
- Roadways and environment - the graphical locations, grade, sight distance, no. of lanes, spacing of intersections; including time of day and weather
- Traffic – heavy or less volume, density, passing movements, speed regulations;

# Methods in conducting Spot Speed Study

*Manual methods:*

- To observe the time required by a vehicle to cover a short distance.
- Two reference points are located at a roadway at a fixed distance apart.
- Observer starts and stops a stopwatch as vehicle enters and left the test section.
- It is most uncomplicated way.
- Disadvantage because of parallax effect.(refer following figure)

# Methods in conducting Spot Speed Study




Parallax Error Illustrated

# Function of Roads in Rural Area

- *Automatic method (*radar meter detector)*:*

  - Using reflected waves of very high frequency is directed from the radar speed meter to the moving vehicle.

  -The waves which is directly measurable is proportional to the speed at which the vehicle is moving.

  - The limitation of radar meter are:

    - The accuracy is varies, they are generally ± 1-2 mi/h.
    - The drivers might be slowing down, this affected the results.
    - A good measurement angle must be acquired.
    - Multilane traffics are difficult to studies.
    - In heavy traffics, it is impossible to record speed of each vehicles.

# Data Presentation & Analysis

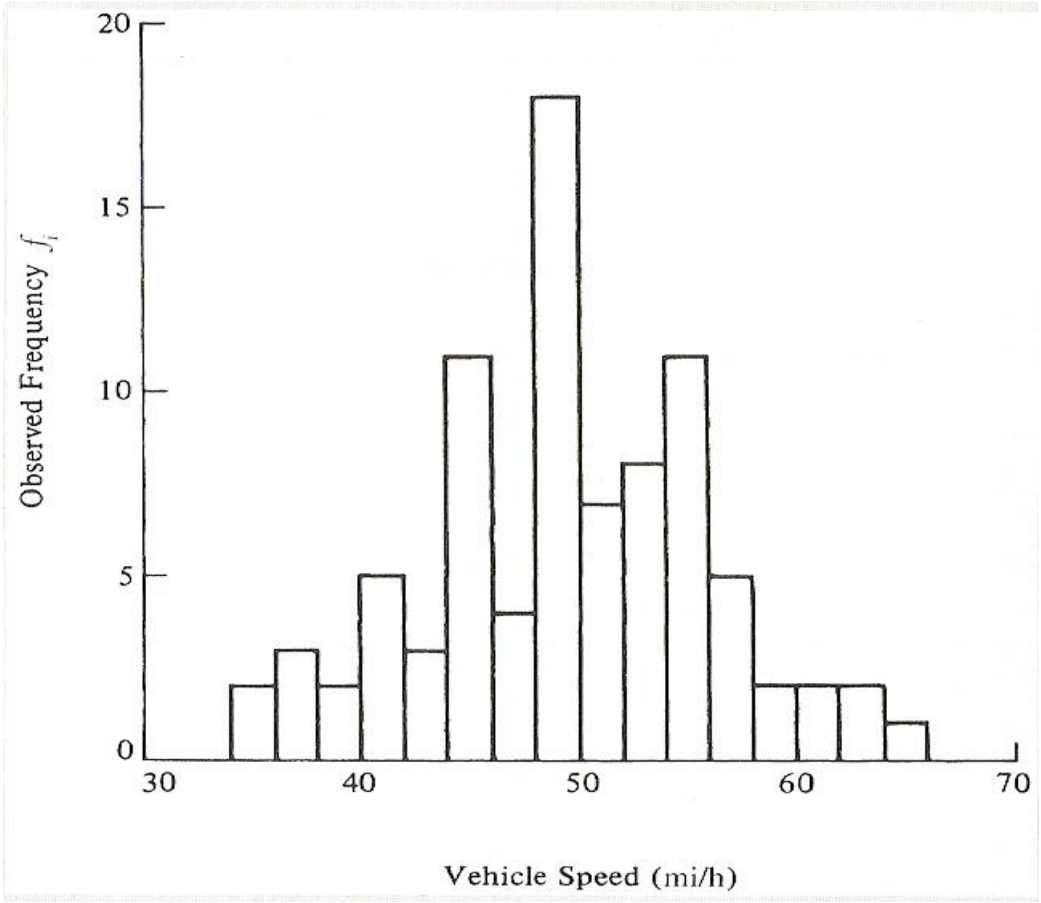
Graphical presentation:

i. Frequency histogram
ii. Frequency distribution curve
iii. Cumulative frequency curve;
   - 15 percentile speed
   - 50 percentile speed
   - 85 percentile speed
   - 95 percentile speed

Statistical analysis:

i. Arithmetic mean speed
ii. Median speed
iii. Modal speed
iv. Standard deviation

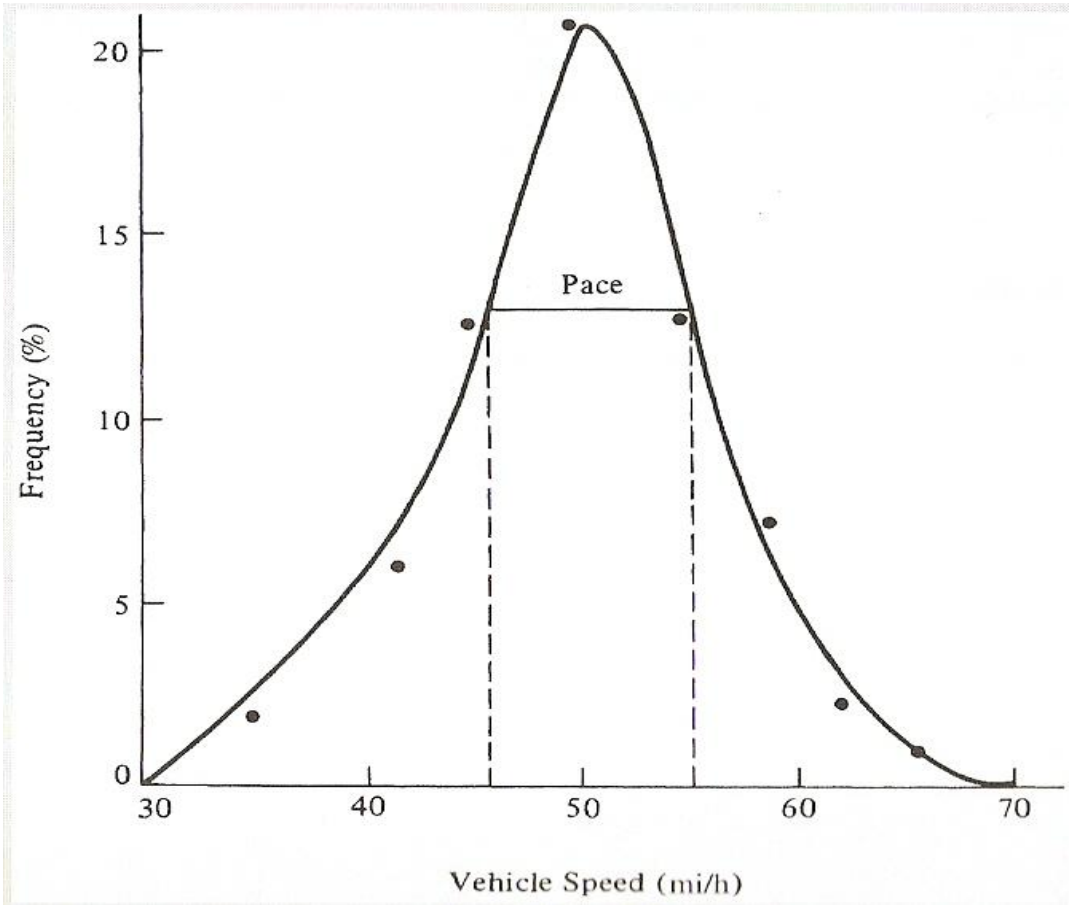
# Graphical Presentation




**Frequency histogram of observed vehicles' speeds**

Source: Figure 4.4, Garber and Hoel (2002).

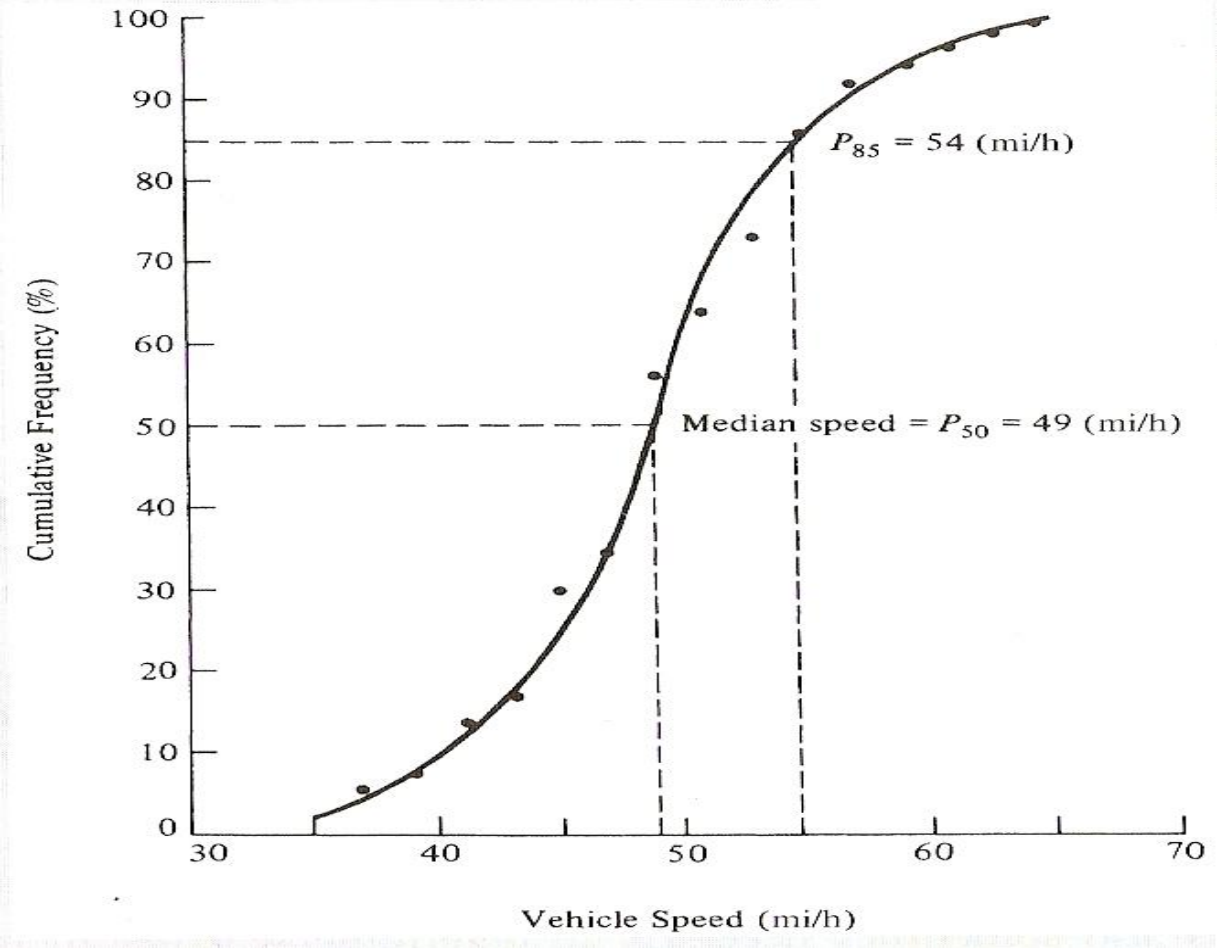
# Graphical Presentation




**Frequency distribution curve of observed vehicles' speeds**

Source: Figure 4.5, Garber and Hoel (2002).

# Graphical Presentation




**Frequency Cumulative Curve of observed vehicles' speeds**

Source: Figure 4.6, Garber and Hoel (2002).

# Statistical Analysis

i. Arithmetic mean speed

- is the average speed of all observed vehicles

$$\overline{X} = \frac{\sum fv}{n}$$

where ;

f = frequency of observation in the particular group

v = mean speed of each group

n = number of observations

# Statistical Analysis

***ii.*** ***Median Speed -*** The median speed is a middle volume speed in the distribution whole volumes which is arranged in ascending order

- It is also called 50$^{th}$ percentage speed (P50)

***iii.*** ***Modal speed*** is the speed value that occurs most frequently in a sample of spot speeds.

# Statistical Analysis

- ***Standard deviation of speeds*** is a measure of the spread of the individual speeds

$$sd = \sqrt{\frac{\sum fv^2}{n-1} - \frac{(\sum fv)^2}{n(n-1)}}$$

where ;

f = frequency of observation in the particular group

v = mean speed of each group

n = number of observations

# EXAMPLE

The accompanying data (Table Q2) shows spot speeds collected at Jalan Duta, Kuala Lumpur. Based on statistical method, determine the values of the following:

i) Arithmetic mean speed
ii) Mode speed
iii) Median speed
iv) Standard deviation

| Speed Class (km/hr) | No of vehicles |
|---|---|
| 10 – 14.9 | 2 |
| 15 – 19.9 | 6 |
| 20 – 24.9 | 5 |
| 25 – 29.9 | 4 |
| 30 – 34.9 | 7 |
| 35 – 39.9 | 1 |
| 40 – 44.9 | 8 |
| 45 – 49.9 | 9 |
| 50 – 54.9 | 5 |
| 55 – 59.9 | 6 |
| 60 – 64.9 | 4 |

# ANSWER

| Speed class (km/hr) | No of vehicles, f | Mean speed, V | $V^2$ | f.v | $(f.v^2)$ |
|---|---|---|---|---|---|
| 10 – 14.9 | 2 | 12.45 | 155.003 | 24.9 | 310.005 |
| 15 – 19.9 | 6 | 17.45 | 304.503 | 104.7 | 1827.015 |
| 20 – 24.9 | 5 | 22.45 | 504.003 | 112.25 | 2520.013 |
| 25 – 29.9 | 4 | 27.45 | 753.503 | 109.8 | 3014.01 |
| 30 – 34.9 | 7 | 32.45 | 1053.003 | 227.15 | 7371.018 |
| 35 – 39.9 | 1 | 37.45 | 1402.503 | 37.45 | 1402.503 |
| 40 – 44.9 | 8 | 42.45 | 1802.003 | 339.6 | 14416.02 |
| 45 – 49.9 | 9 | 47.45 | 2251.503 | 427.05 | 20263.52 |
| 50 – 54.9 | 5 | 52.45 | 2751.003 | 262.25 | 13755.01 |
| 55 – 59.9 | 6 | 57.45 | 3300.503 | 344.7 | 19803.02 |
| 60 – 64.9 | 4 | 62.45 | 3900.003 | 249.8 | 15600.01 |
| | 57 | | 18177.528 | 2239.65 | 100282.1 |

$$Arithmetic, x = \frac{\Sigma\, f.v}{n}$$

$$= \frac{2239.65}{57}$$

$$= 39.29 \text{ km/hr}$$

$$Median = L + \frac{(n/2 - f_i)}{f_m} xC$$

$$= 35 + \frac{(57/2 - 24)}{1} x4.9$$

$$= 57.05 \text{ km/hr}$$

$$\text{Standard deviation} = \frac{\sum f.v^2}{(n-1)} - \frac{(\sum fv)^2}{n(n-1)}$$

$$= \frac{(100282.1)^2}{(57-1)} - \frac{(2239.65)^2}{57(57-1)}$$

$$= 14.81 \text{ km/hr}$$

Mode speed = 45 – 49.9 km/hr

# References


- Nicholas J.Garber and Lester A. Hoel, Traffic & Highway Engineering 3rd Edition Brooks Cole 2002
- Roger P. Roess, Elena S. Prassas and William R. McShane, TRAFFIC ENGINEERING 3rd Edition, Pearson Education International, 2004.