Highway & Traffic Engineering

SPOT SPEED STUDIES

by
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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;
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
• **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).
Frequency Cumulative Curve of observed vehicles' speeds

Source: Figure 4.6, Garber and Hoel (2002).
i. Arithmetic mean speed
   - is the average speed of all observed vehicles

\[ \overline{X} = \frac{\sum f v}{n} \]

where
- \( f \) = frequency of observation in the particular group
- \( v \) = mean speed of each group
- \( n \) = number of observations
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.
• **Standard deviation of speeds** is a measure of the spread of the individual speeds

\[
sd = \sqrt{\frac{\sum f v^2}{n-1} - \frac{(\sum f v)^2}{n(n-1)}}
\]

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

<table>
<thead>
<tr>
<th>Speed Class (km/hr)</th>
<th>No of vehicles</th>
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</thead>
<tbody>
<tr>
<td>10 – 14.9</td>
<td>2</td>
</tr>
<tr>
<td>15 – 19.9</td>
<td>6</td>
</tr>
<tr>
<td>20 – 24.9</td>
<td>5</td>
</tr>
<tr>
<td>25 – 29.9</td>
<td>4</td>
</tr>
<tr>
<td>30 – 34.9</td>
<td>7</td>
</tr>
<tr>
<td>35 – 39.9</td>
<td>1</td>
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<tr>
<td>40 – 44.9</td>
<td>8</td>
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<tr>
<td>45 – 49.9</td>
<td>9</td>
</tr>
<tr>
<td>50 – 54.9</td>
<td>5</td>
</tr>
<tr>
<td>55 – 59.9</td>
<td>6</td>
</tr>
<tr>
<td>60 – 64.9</td>
<td>4</td>
</tr>
</tbody>
</table>
### SPOT SPEED STUDIES

by Azlina Ismail

<table>
<thead>
<tr>
<th>Speed class (km/hr)</th>
<th>No of vehicles, f</th>
<th>Mean speed, V</th>
<th>$V^2$</th>
<th>f.v</th>
<th>(f.v$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 – 14.9</td>
<td>2</td>
<td>12.45</td>
<td>155.003</td>
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<td>753.503</td>
<td>109.8</td>
<td>3014.01</td>
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<td>18177.52</td>
<td>2239.65</td>
<td>100282.1</td>
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</table>

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

\[
\frac{2239.65}{57} = 39.29 \text{ km/hr}
\]

**Median**

\[
L + \left(\frac{n/2 - f_i}{f_m}\right) \times C
\]

\[
= 35 + \left(\frac{57/2 - 24}{1}\right) \times 4.9
\]

\[
= 57.05 \text{ km/hr}
\]

**Standard deviation**

\[
\frac{\sum f.v^2}{n} - \frac{(\sum f_i)^2}{n(n-1)}
\]

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

\[
= 14.81 \text{ km/hr}
\]

**Mode speed**

\[
= 45 – 49.9 \text{ km/hr}
\]
References