TRAFFIC SURVEY

The availability of highway transportation has provided several advantages that contribute to a high standard of living. However, several problems related to the highway mode of transportation exist. These problems include highway-related crashes, parking difficulties, congestion, and delay. To reduce the negative impact of highways, it is necessary to adequately collect information that describes the extent of the problems and identifies their locations. Such information is usually collected by organizing and conducting traffic surveys and studies.

Traffic studies may be grouped into three main categories: (1) inventories, (2) administrative studies, and (3) dynamic studies. Inventories and administrative studies involve record keeping as well as management of studies obtained during dynamic traffic studies. Therefore what concerns the traffic engineer most is the dynamic studies.

Traffic studies/traffic surveys (dynamic studies) are collected by the traffic engineer to evaluate current conditions, identify problems or areas of improvement and then develop solutions. These studies involve collection of data such as speed, traffic volume, parking and accidents, under operational conditions. The subsequent headings describe these studies.

SPOT SPEED STUDIES

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. The speed of a vehicle is defined as the rate of movement of the vehicle; it is usually expressed in miles per hour (mi/h) or kilometers per hour (km/h). A spot speed study is carried out by recording the speeds of a sample of vehicles at a specified location. Speed characteristics identified by such a study will be valid only for the traffic and environmental conditions that exist at the time of the study.

Application of spot speed data:

- Establish parameters for traffic operation and control, such as speed zones, speed limits (85th-percentile speed is commonly used as the speed limit on a road), and passing restrictions.
- Evaluate the effectiveness of traffic control devices, such as variable message signs at work zones.
- Monitor the effect of speed enforcement programs, such as the use of drone radar and the use of differential speed limits for passenger cars and trucks.
- Evaluate and or determine the adequacy of highway geometric characteristics, such as radii of horizontal curves and lengths of vertical curves.
- Evaluate the effect of speed on highway safety through the analysis of crash data for different speed characteristics.
- Determine speed trends.
- Determine whether complaints about speeding are valid.

Locations and time for Spot Speed Studies

The following locations generally are used for the different applications listed:

1. Locations that represent different traffic conditions on a highway or highways are used for *basic data collection*. As such, all types of highway are checked (e.g. expressway, freeways etc).

2. Accident prone areas, such as Mid-blocks of urban highways and straight, level sections of rural highways, are good location for spot speed studies. This will especially be useful for *speed trend analyses*.

3) The points where traffic signals and traffic signs are to be installed can also be selected as a location.

The time for the study is advised to be during free flow of traffic usually during off-peak hours. The study should last for minimum of 1 hour with at least 30 vehicles as sample size. This is to ensure that enough vehicles required for statistical analysis have been recorded.

Methods of spot speed studies

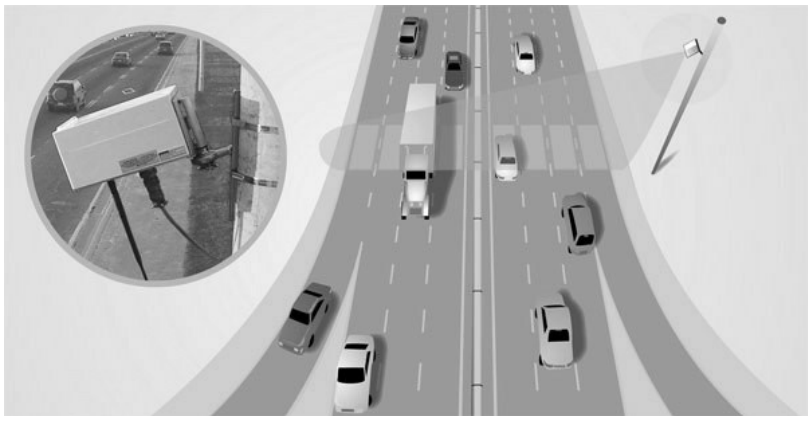
The methods used for conducting spot speed studies can generally be divided into two main categories: manual and automatic. However the manual method is time consuming and is gradually going obsolete. The automatic methods which can be used to obtain instantaneous speeds of vehicle, on the other hand, is of various types and can be grouped under three headings:
(1) those that use road detectors,
(2) those that are radar-based, and
(3) those that use the principles of electronics.

1) Road detectors

Road detectors can be classified into two general categories: pneumatic road tubes and induction loops. These devices can be used to collect data on speeds at the same time as volume data are being collected. This method involves burying or laying tubes or wire loop on the road. While the inductive loop can be buried below the pavement, the pneumatic tube is laid on the road. When road detectors are used to measure speed, they should be laid such that the probability of a passing vehicle closing the connection of the meter during a speed measurement is reduced to a minimum. This is achieved by separating the road detectors by a distance of 3 to 15 ft.
The advantage of the detector meters is that human errors are considerably reduced. The **disadvantages** are that (1) these devices tend to be rather expensive and (2) when pneumatic tubes are used, they are rather conspicuous and may, therefore, affect driver behavior, resulting in a distortion of the speed distribution.

2) Radar-Based Traffic Sensors

Radar-based traffic sensors work on the principle that when a signal is transmitted onto a moving vehicle, the change in frequency between the transmitted signal and the reflected signal is proportional to the speed of the moving vehicle. The difference between the frequency of the transmitted signal and that of the reflected signal is measured by the equipment and then converted to speed in mi/h. In setting up the equipment, care must be taken to reduce the angle between the direction of the moving vehicle and the line joining the center of the transmitter and the vehicle.
The advantage of this method is that because pneumatic tubes are not used, if the equipment can be located at an inconspicuous position, the influence on driver behavior is considerably reduced.



A representation of the radar based principle

3) Electronic-Principle Detectors

In this method, the presence of vehicles is detected through electronic means, and information on these vehicles is obtained, from which traffic characteristics, such as speed, volume, queues, and headways are computed. **The great advantage** of this method over the use of road detectors is that it is not necessary to physically install loops or any other type of detector on the road. A technology using electronics is video image processing, sometimes referred to as a machine-vision system. This system consists of an electronic camera overlooking a large section of the roadway and a microprocessor. The electronic camera receives the images from the road; the microprocessor determines the vehicle's presence or passage. This information is then used to determine the traffic characteristics in real time.

TRAFFIC VOLUME STUDIES

Traffic volume studies are conducted to collect data on the number of vehicles and/or pedestrians that pass a point on a highway facility during a specified time period. This time period varies from as little as 15 minutes to as much as a year depending on the anticipated use of the data. The data collected also may be put into subclasses which may include directional movement, occupancy rates, vehicle classification, and pedestrian age (especially when special facilities are necessary for school children).

Some of the uses of traffic volume are:

- Planning the traffic control and operation of the existing roads and designing new roads.
- Pedestrian study is useful for planning cross walks and sidewalks for pedestrians
- This study usually gives an idea of relative importance of roads and helps to decide the need for expansion and improvement of roads.
- It can be used to plan one way traffic and other regulatory measures on the road

The following are data that can be obtained from volume studies

1. Average Annual Daily Traffic (AADT): is the average of 24-hour counts collected every day of the year. AADTs are used in several traffic and transportation analyses for:

a. Estimation of highway user revenues
b. Computation of crash rates in terms of number of crashes per 100 million vehicle miles
c. Establishment of traffic volume trends
d. Evaluation of the economic feasibility of highway projects
e. Development of freeway and major arterial street systems
f. Development of improvement and maintenance programs

2. Average Daily Traffic (ADT): is the average of 24-hour counts collected over a number of days greater than one but less than a year. ADTs may be used for:
a. Planning of highway activities
b. Measurement of current demand
c. Evaluation of existing traffic flow

3. Peak Hour Volume (PHV): is the maximum number of vehicles that pass a point on a highway during a period of 60 consecutive minutes
a. Design of geometric characteristics of a highway, for example, number of lanes.
b. Functional classification of highway
c. Capacity Analysis
d. Development of programs related to traffic operations, for example, one-way street systems
e. development of Parking regulations

4. Vehicle classification: (VC) records volume with respect to the type of vehicles, for example, passenger cars, two-axle trucks, or three-axle trucks
a. Adjustment of traffic counts obtained by machine
b. Structural design of highway pavements, bridges and so forth
c. Design of geometric characteristics with particular reference to lane widths, turning radii requirement and so forth.

Methods of Traffic counting

a) Manual Method

Manual counting involves one or more persons recording observed vehicles using a counter. With this type of counter, both the turning movements at the intersection and the types of vehicles can be recorded. Note that in general, the inclusion of pickups and light trucks with four tires in the category of passenger cars does not create any significant deficiencies in the data collected, since the performance characteristics of these vehicles are similar to those of passenger cars. In some instances, however, a more detailed breakdown of commercial vehicles may be required which would necessitate the collection of data according to number of axles and/or weight. However, the degree of truck classification usually depends on the anticipated use of the data collected.
The main disadvantages of the manual count method are that (1) it is labor intensive and therefore can be expensive, (2) it is subject to the limitations of human factors, and (3) it cannot be used for long periods of counting.

b) Automatic Method

Automatic counters can be classified into two general categories: those that require the laying of detectors (surface or subsurface), and those that do not require the laying of detectors. Automatic counters that require the laying of surface detectors (such as pneumatic road tubes) or subsurface detectors (non invasive, such as magnetic or electric contact devices) on the road, detect the passing vehicle and transmit the information to a recorder, which is connected to the detector at the side of the road.
Automatic counters that do not require the laying of detectors use one of many technologies including electronics: Doppler principles, laser scanning, and infrared. The electronic equipment described in spot speed studies can also be used for volume study. The general principle of the laser technology in traffic count equipment uses laser beams to scan the roadway and the vehicles that pass through the field of the laser beams.

Types of Volume Count

Cordon counts

Periodic counts

Screen line counts

Pedestrian volume counts

Intersection counts

Periodic volume counts

PARKING STUDIES

Any vehicle traveling on a highway will at one time or another be parked for either a relatively short time or a much longer time, depending on the reason for parking. The provision of parking facilities is therefore an essential element of the highway mode of transportation. The need for parking spaces is usually very great in areas where land uses include business, residential, or commercial activities. Also, there is a growing trend of vehicle owners transporting themselves to bus parks or rail station before boarding (termed "park and ride") which tend to increase the need for parking spaces for their vehicles. In areas of high density, where space is very expensive, the space provided for automobiles usually has to be divided between that allocated for their movement and that allocated for parking them.

Providing adequate parking space to meet the demand for parking in the bus/rail stations may necessitate the provision of parking bays along curbs which reduces the capacity of the streets and may affect the level of service. This problem usually confronts a city with high population and limited spaces.

Off-street parking

These facilities, privately or publicly owned are parking spaces that are situated away from the road/street. They include surface lots and garages. Self-parking garages require that drivers park their own automobiles; attendant-parking garages maintain personnel to park the automobiles.

On-street parking

These are also known as curb facilities. Parking allowances are provided alongside the kerbs on one or both sides of the street. These bays can be unrestricted parking facilities if the duration of parking is unlimited and parking is free, or they can be restricted parking facilities if parking is limited to specific times of the day for a maximum duration. Parking at restricted facilities may or may not be free. Restricted facilities also may be provided for specific purposes, such as to provide handicapped parking or as bus stops or loading bays.

Methodology of Parking Studies

A comprehensive parking study usually involves (1) inventory of existing parking facilities, (2) collection of data on parking accumulation, parking turnover and parking duration, (3) identification of parking generators, and (4) collection of information on parking demand. Information on related factors, such as financial, legal, and administrative matters, also may be collected.

1) Inventory of Existing Parking Facilities

An inventory of existing parking facilities is a detailed listing of the location and all other relevant characteristics of each legal parking facility, private and public, in the study area.

The inventory includes both on- and off-street facilities. The relevant characteristics usually listed include the following:
• Type and number of parking spaces at each parking facility
• Times of operation and limit on duration of parking, if any
• Type of ownership (private or public)
• Parking fees, if any and method of collection
• Restrictions on use (open or closed to the public)
• Other restrictions, if any (such as loading and unloading zones, bus stops, or taxi ranks)
• Probable degree of permanency (can the facility be regarded as permanent or is it just a temporary facility?)

2) Data on parking accumulation, turnover and duration: This data gathers information on the number of vehicles that are parked (accumulation) and the duration for which they were parked during a specified space of time. It also includes the rate of use of a parking system (turnover).
3) Identification of parking generators: This phase involves identifying parking generators (for example, shopping centers or transit terminals and locating these on a map of the study area.
4) Information on parking demand: Information on parking demand is obtained by interviewing drivers at the various parking facilities listed during the inventory.

TRAVEL TIME AND DELAY STUDIES

A travel time study determines the amount of time required to travel from one point to another on a given route. In conducting such a study, information may also be collected on the locations, durations, and causes of delays. When this is done, the study is known as a travel time and delay study. Data obtained from travel time and delay studies give a good indication of the level of service on the study section. These data also aid the traffic engineer in identifying problem locations, which may require special attention in order to improve the overall flow of traffic on the route.

Applications of Travel Time and Delay Data

The data obtained from travel time and delay studies may be used in any one of the following traffic engineering tasks:
• Determination of the efficiency of a route with respect to its ability to carry traffic
• Identification of locations with relatively high delays and the causes for those delays
• Performance of before-and-after studies to evaluate the effectiveness of traffic operation improvements
• Determination of relative efficiency of a route by developing sufficiency ratings or congestion indices
• Determination of travel times on specific links for use in trip assignment models
• Compilation of travel time data that may be used in trend studies to evaluate the changes in efficiency and level of service with time
• Performance of economic studies in the evaluation of traffic operation alternatives that reduce travel time

Definition of Terms Related to Time and Delay Studies

Let us now define certain terms commonly used in travel time and delay studies:
1. Travel time is the time taken by a vehicle to traverse a given section of a highway.
2. Running time is the time a vehicle is actually in motion while traversing a given section of a highway.
3. Delay is the time lost by a vehicle due to causes beyond the control of the driver.

4. Operational delay is that part of the delay caused by the impedance of other traffic. This impedance can occur either as side friction, where the stream flow is interfered with by other traffic (for example, parking vehicles), or as internal friction, where the interference is within the traffic stream (for example, reduction in capacity of the highway).
5. Stopped-time delay is that part of the delay during which the vehicle is at rest.
6. Fixed delay is that part of the delay caused by control devices such as traffic signals. This delay occurs regardless of the traffic volume or the impedance that may exist.
7. Travel-time delay is the difference between the actual travel time and the travel time that will be obtained by assuming that a vehicle traverses the study section at an average speed equal to that for an uncongested traffic flow on the section being studied.

ORIGIN AND DESTINATION STUDIES (O&D)

This study gives an idea of the number of vehicular traffic, their origin and destination in each zone of study. These studies are mostly essential during improvement of existing roads and the planning of new roads.

Application of origin and destination study

1. To enable the planning of new network of roads and to judge the adequacy of existing ones.
2. To locate express ways or major routes along the desired lines
3. To locate terminals and plan terminal facilities
4. To locate bus stops for public transport
5. To plan transportation system and mass transit facilities in cities
6. To establish preferential routes for various categories of vehicles (e.g. BRT lane)

Methods of collecting O and D study

- Road side interview
- License plate
- Return post card
- Tag on car
- Home interview

Assignment (develop the 5 methods based on explanation in class)

Information gathered during O & D

1) Why people travel (purpose)
2) When people travel (time and direction of travel)
3) How people travel (type of vehicle/mode)
4) Where people go (place from and to)
5) Where and when people stop (parking facilities/stoppages)

ACCIDENT STUDIES

Traffic accidents are always disheartening with threats to lives and properties in which the degree of casualty can range from just slight injuries to loss of lives. Accident study is therefore essential to understand the cause of the accidents and identify remedial measures that can be undertaken to prevent future occurrence.

Accidents can take the form of collision with other vehicles, fixed objects or pedestrian. It can also take the form of non collision that means a standalone accident. This for example is when the car overturns or when the car veer off the road way and lost balance. There can be many causes of accidents but the main causes are:

- Deficiency in the vehicle
- Surprise element (e.g. a bike coming your way all of a sudden)
- Defective pavement
- Violation of traffic rules

- Lack of proper lighting

The occurrence of any of these listed causes can lead to fatal accidents most especially when two of them occur together. For example brake failure and surprise element.

Steps for accident study

The following steps are usually taken during accidents studies:

1) Collection of accident data: for this step, information such as general information about the accident, the location, vehicle description, driver condition before accident, cause of accident, road and weather condition, type of traffic at the period of the accident, cost of the accident and so on.
2) Accidents records: The accident records collected are then compiled as appropriate to give easy identification for future reference. It can be stored as a collision diagram, condition diagram, spot maps or location file. The first three are usually with the engineers while the location file will be with the police station.
3) Suggestions for remedial measures: these include providing a safe and reliable road system, maintaining good vehicles and taking street lighting as important. Also various road enforcing practices should be maintained. The public should constantly be lectured on how to prevent accidents.

TRAFFIC CAPACITY STUDIES

Traffic capacity is the maximum number of vehicles on a road that can pass a given point in 1 hour. It is different from Volume studies as volume studies responds to variation in traffic demand while this depends on many things.

Types of capacity studies

1) Basic capacity: Also known as theoretical capacity. It is defined as the maximum no of passenger cars that can pass through a point on the roadway.
2) Possible capacity: It is the maximum no of passenger cars that can pass through a point on the roadway within 1 hour under prevailing conditions of the roadway and traffic. This capacity is usually less than basic capacity
3) Practical capacity or designed capacity: It is the maximum no of passenger cars that can pass through a point on the roadway within 1 hour under prevailing conditions of the roadway and traffic without causing unreasonable delay or hazard to traffic. It is the capacity the engineer is concerned about.

Factors affecting practical capacity

- Width of the lane
- Lateral clearance
- Width of shoulders
- Type of vehicle
- Presence of Intersection

Calculation of basic capacity

$C = 1000V/S$

Where C is the capacity of a single lane, unit is veh/lane

V is designed speed in kmph

S is space headway

S = stopping distance + average length of vehicle

$S = 0.278Vt + L$

Example

Find the theoretical capacity of a traffic lane with one lane traffic flow at a stream speed of 45kmph. Assume: t = 0.7secs, L =5m

Solution

V = 45kmph, t = 0.7secs, L =5m,

S = 0.278Vt +L = 0.278 x 45 x0.7 + 5 = 13.76

C = 1000V/S = 1000 x 45/13.76

= 3425 veh/hour/lane