University of Basrah
College of Engineering
Civil Engineering Department

TRAFFIC ENGINEERING
MODULE 1: TRAFFIC STUDIES
II- VOLUME STUDIES

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TRAFFIC VOLUME STUDIES

➢ Traffic volume can be defined as the total number of vehicles that pass over a given point or section of a lane or roadway during a given time interval; volumes can be expressed in terms of annual, daily, hourly, or sub hourly periods.

➢ This time interval 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 such as directional movement and vehicle classification.

➢ Traffic flow can be defined as the equivalent hourly rate at which vehicles pass a given point on the roadway. The 15-minute volume can be converted to a flow by multiplying the volume by 4.

TRAFFIC VOLUME STUDIES

➢ **Average Annual Daily Traffic (AADT)** is the average of 24-hour counts collected every day of the year.

$$AADT = \frac{Total\ Traffic\ volume\ of\ the\ year}{365}$$

AADTs may be used for:

• Estimation of highway user revenues.

• Evaluation of the economic feasibility of highway projects.

• Development of freeway and major arterial street systems.

• Computation of crash rates (e.g. number of crashes per 100 million vehicle miles).

TRAFFIC VOLUME STUDIES

➤ **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.

$$ADT = \frac{Total\ Traffic\ volume\ during\ a\ given\ time\ period}{number\ of\ days}$$

ADTs may be used for:

- Planning of highway activities.
- Measurement of current demand.
- Evaluation of existing traffic flow.

TRAFFIC VOLUME STUDIES

➢ **Peak Hour Volume (PHV):** is the maximum number of vehicles that pass a point on a highway during a period of 60 consecutive minutes.

➢ **Vehicle Classification (VC):** records volume with respect to the type of vehicles, for example, passenger cars, two-axle trucks, or three-axle trucks.

➢ **Vehicle Miles of Travel (VMT) or Vehicle Kilometers of Travel (VKT):** is a measure of travel along a section of road. It is the product of the traffic volume (ADT) and the length of roadway in miles/kilometers.

METHODS OF CONDUCTING VOLUME COUNTS

Manual Method:

➢ This method involves one or more persons recording observed vehicles.

➢ Manual counts are typically used for periods of less than a day. Normal intervals for a manual count are 5, 10, or 15 minutes.

➢ Manual counts are recorded using one of three methods: tally sheets, mechanical counting boards, or electronic counting boards.
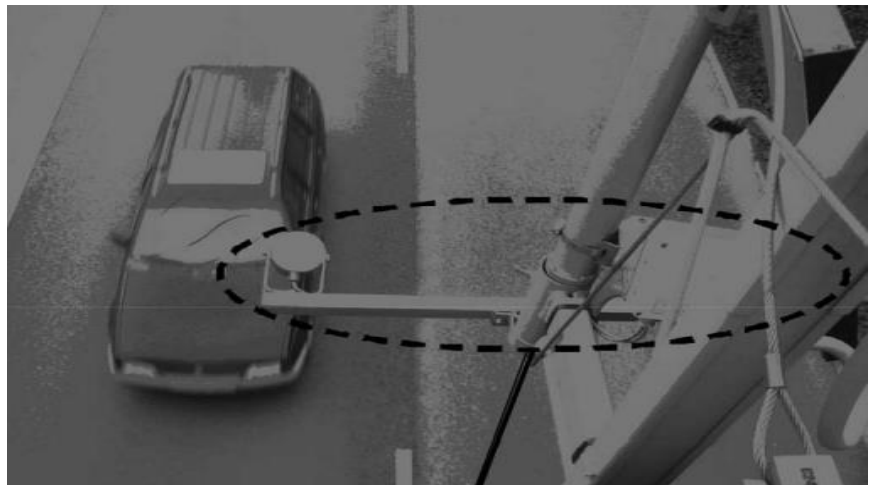
METHODS OF CONDUCTING VOLUME COUNTS

METHODS OF CONDUCTING VOLUME COUNTS

➤ Automatic Method:

Automatic counts are usually taken in 1-hour intervals for each 24-hour period. The counts may extend for a week, month, or year.

Several technology could be used such as camcorders, detectors, laser scanning, and infrared.

TYPES OF VOLUME COUNTS

➢ Cordon Counts

➢ Screen line Counts

➢ Intersection Counts

➢ Pedestrian Volume Counts

➢ Periodic Volume Counts (AADT) [Continues counts]
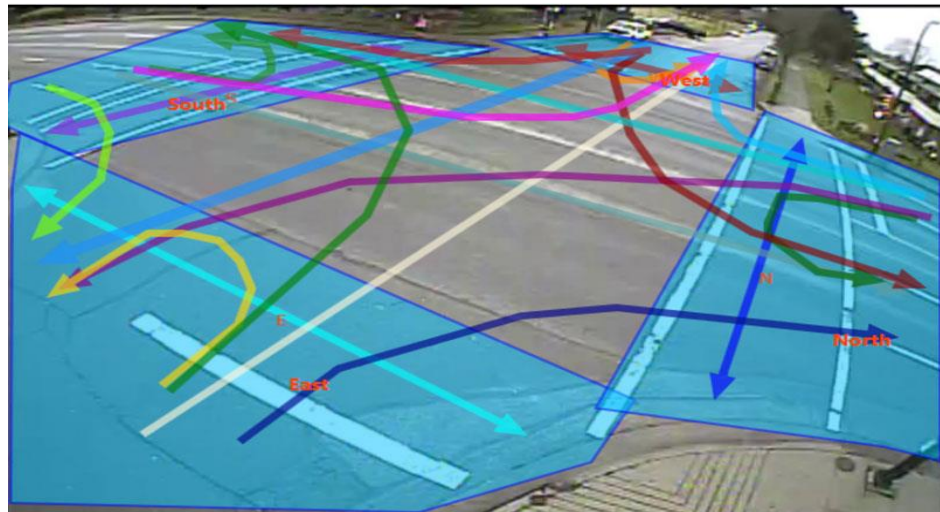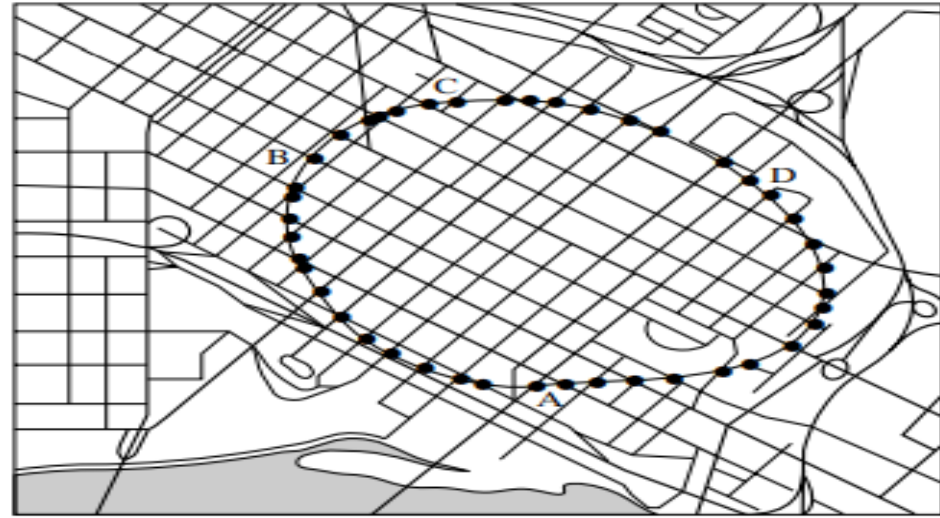
TRAFFIC VOLUME DATA PRESENTATION

➢ Traffic Flow Maps:

The volume of traffic on each route is represented by the width of a band.
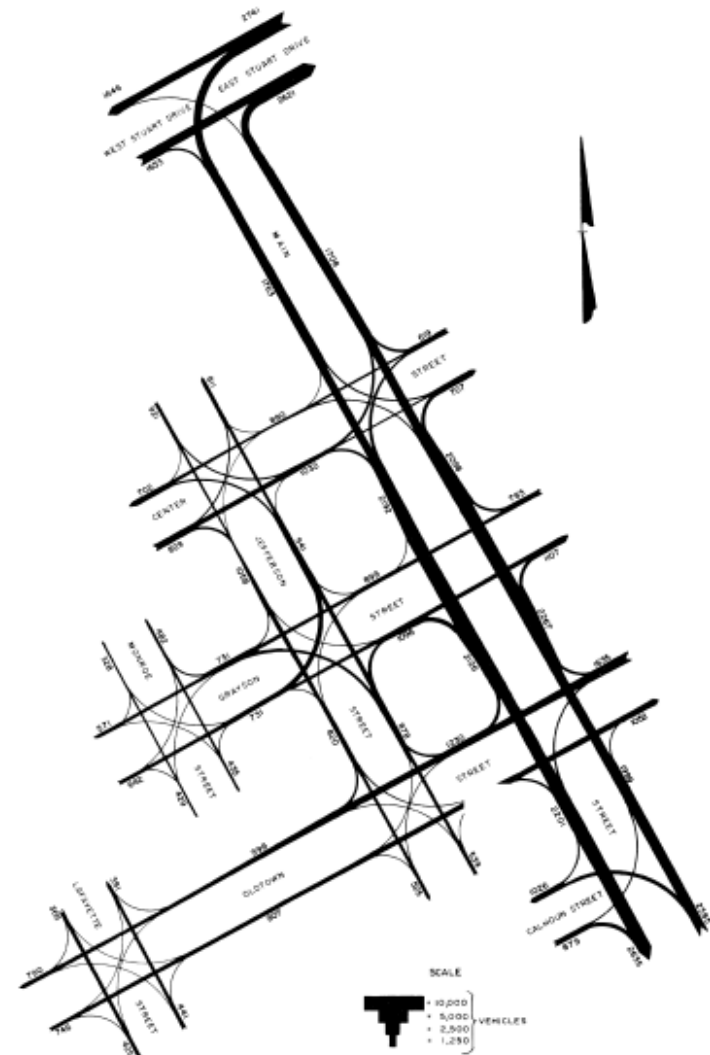
TRAFFIC VOLUME DATA PRESENTATION

➢ <u>Intersection Summary Sheets:</u>

These sheets are graphic representations of the volume and directions of all traffic movements through the intersection. These volumes can be either ADTs or PHVs, depending on the use of the data.

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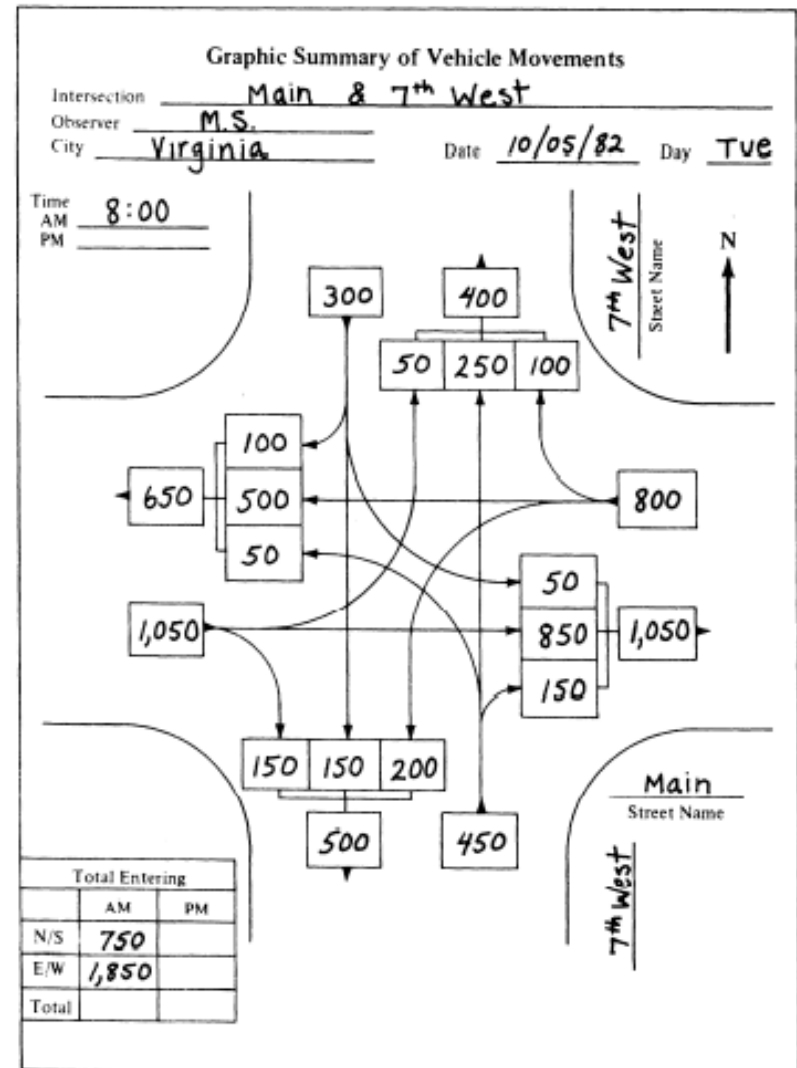
TRAFFIC VOLUME DATA PRESENTATION

➢ <u>Summary Tables:</u>

These tables give a summary of traffic volume data such as PHV, Vehicle Classification (VC), and ADT in tabular form.

Table 4.4 Summary of Traffic Volume Data for a Highway Section

PHV	430
ADT	5375
Vehicle Classification (VC)	
Passenger cars	70%
Two-axle trucks	20%
Three-axle trucks	8%
Other trucks	2%

TRAFFIC VOLUME CHARACTERISTICS

➢ A continuous count of traffic at a section of a road will show that traffic volume varies from hour to hour, from day to day, and from month to month. There are many reason for that fluctuation in traffic volume.

- Time of day

- Day of week

- Month of year / season

- Characteristics of road

- Direction

TRAFFIC VOLUME CHARACTERISTICS
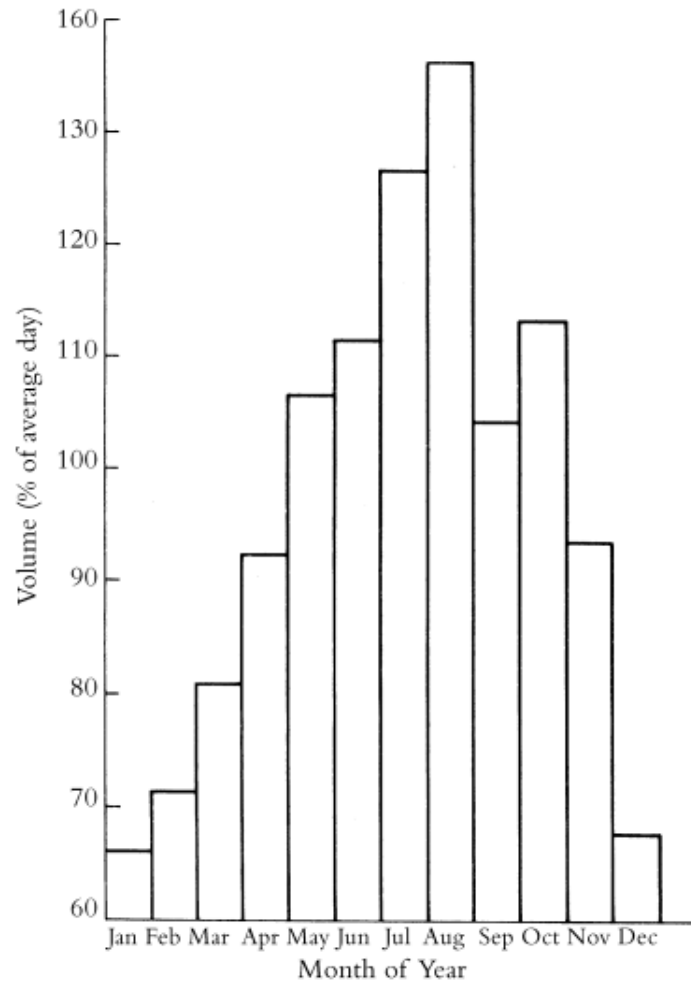
(a) Monthly traffic variation
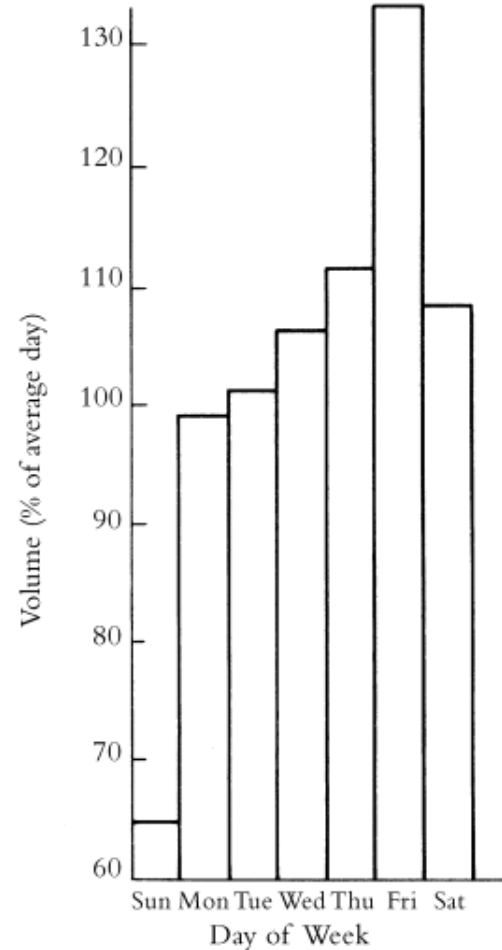
(b) Daily traffic variation

TRAFFIC VOLUME CHARACTERISTICS
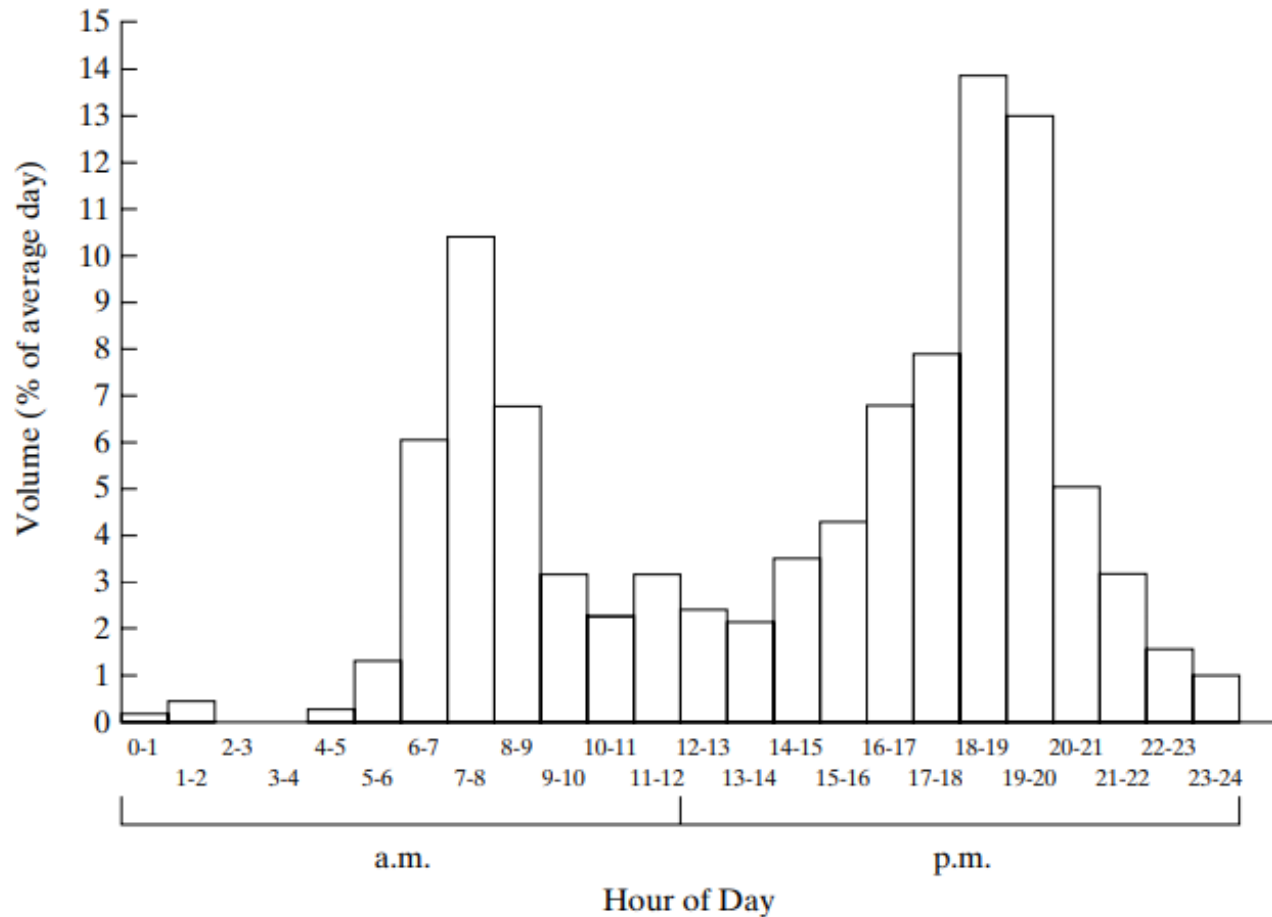
(c) Hourly traffic variation

ADJUSTMENT OF PERIODIC COUNTS

➢ **Expansion Factors from Continuous Count Stations.** Hourly, daily, and monthly expansion factors can be determined using data obtained at continuous count stations.

➢ **Hourly Expansion Factor (HEF)**

$$HEF = \frac{Total\ volume\ for\ 24\ hours\ period}{Volume\ for\ particular\ hour}$$

These factors are used to expand counts of durations shorter than 24 hour to 24-hour volumes by multiplying the hourly volume for each hour during the count period by the HEF for that hour and finding the mean of these products.

ADJUSTMENT OF PERIODIC COUNTS

➢ **Daily Expansion Factor (DEF)**

$$DEF = \frac{Average\ total\ volume\ for\ week}{Average\ volume\ for\ particular\ day}$$

These factors are used to determine weekly volumes from counts of 24-hour duration by multiplying the 24-hour volume by the DEF.

ADJUSTMENT OF PERIODIC COUNTS

➢ **Monthly Expansion Factor (MEF)**

$$MEF = \frac{AADT}{ADT\ for\ particular\ month}$$

The AADT for a given year may be obtained from the ADT for a given month by multiplying this volume by the MEF.

ADJUSTMENT OF PERIODIC COUNTS

Tables 4.5, 4.6, and 4.7 give expansion factors for a particular primary road in Virginia.

Table 4.5 Hourly Expansion Factors for a Rural Primary Road

Hour	Volume	HEF	Hour	Volume	HEF
6:00–7:00 a.m.	294	42.00	6:00–7:00 p.m.	743	16.62
7:00–8:00 a.m.	426	29.00	7:00–8:00 p.m.	706	17.49
8:00–9:00 a.m.	560	22.05	8:00–9:00 p.m.	606	20.38
9:00–10:00 a.m.	657	18.80	9:00–10:00 p.m.	489	25.26
10:00–11:00 a.m.	722	17.10	10:00–11:00 p.m.	396	31.19
11:00–12:00 p.m.	667	18.52	11:00–12:00 a.m.	360	34.31
12:00–1:00 p.m.	660	18.71	12:00–1:00 a.m.	241	51.24
1:00–2:00 p.m.	739	16.71	1:00–2:00 a.m.	150	82.33
2:00–3:00 p.m.	832	14.84	2:00–3:00 a.m.	100	123.50
3:00–4:00 p.m.	836	14.77	3:00–4:00 a.m.	90	137.22
4:00–5:00 p.m.	961	12.85	4:00–5:00 a.m.	86	143.60
5:00–6:00 p.m.	892	13.85	5:00–6:00 a.m.	137	90.14

Total daily volume = 12,350.

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ADJUSTMENT OF PERIODIC COUNTS

Table 4.6 Daily Expansion Factors for a Rural Primary Road

Day of Week	Volume	DEF
Sunday	7895	9.515
Monday	10,714	7.012
Tuesday	9722	7.727
Wednesday	11,413	6.582
Thursday	10,714	7.012
Friday	13,125	5.724
Saturday	11,539	6.510

Total weekly volume = 75,122.

ADJUSTMENT OF PERIODIC COUNTS

Table 4.7 Monthly Expansion Factors for a Rural Primary Road

Month	ADT	MEF
January	1350	1.756
February	1200	1.975
March	1450	1.635
April	1600	1.481
May	1700	1.394
June	2500	0.948
July	4100	0.578
August	4550	0.521
September	3750	0.632
October	2500	0.948
November	2000	1.185
December	1750	1.354

Total yearly volume = 28,450.
Mean average daily volume = 2370.

ADJUSTMENT OF PERIODIC COUNTS

Example:

A traffic engineer urgently needs to determine the AADT on a rural primary road that has the volume distribution characteristics shown in Tables 4.5, 4.6, and 4.7. She collected the data shown below on a Tuesday during the month of May. Determine the AADT of the road by using Expansion Factors.

7:00 – 8:00 am	400
8:00 – 9:00 am	535
9:00 – 10:00 am	650
10:00 – 11:00 am	710
11:00 – 12:00 pm	650

ADJUSTMENT OF PERIODIC COUNTS

Solution:

➢ Estimate the 24-hr volume for Tuesday using the factors given in Table 4.5.

7:00 – 8:00 am	**29.00**
8:00 – 9:00 am	**22.05**
9:00 – 10:00 am	**18.80**
10:00 – 11:00 am	**17.10**
11:00 – 12:00 pm	**18.52**

$$\frac{(400 * 29 + 535 * 22.05 + 650 * 18.8 + 710 * 17.1 + 650 * 18.52)}{5}$$

$$= 11959 \text{ veh/day}$$

ADJUSTMENT OF PERIODIC COUNTS

<u>Solution:</u>

➢ Adjust the 24-hr volume for Tuesday to an average volume for the week using the factors given in Table 4.6.

Total 7-day volume = 11,959 x 7.727

Average 24-hr volume = $\dfrac{11959 \; x \; 7.727}{7}$ = 13201 veh/day

ADJUSTMENT OF PERIODIC COUNTS

Solution:

➢ Since the data were collected in May, use the factor shown for May in Table 4.7 to obtain the AADT.

AADT = 13,201 x 1.394 = **18402** veh/day

DESIGN HOURLY VOLUME

➢ **Design Hourly Volume (DHV):** is the number of vehicles that travel through a segment of roadway during the design hour. The DHV is used for making roadway structural and capacity design decisions because traffic volume varies by hour and from day to day throughout the year. The formula for calculating the DHV is:

$$DHV = K * AADT$$

➢ The DHV is normally expressed as a percentage of AADT (K-factor which is in range of 0.1-0.2)

➢ K = 8 to 12% for urban areas.

➢ K = 12 to 16% for rural areas.

DESIGN HOURLY VOLUME
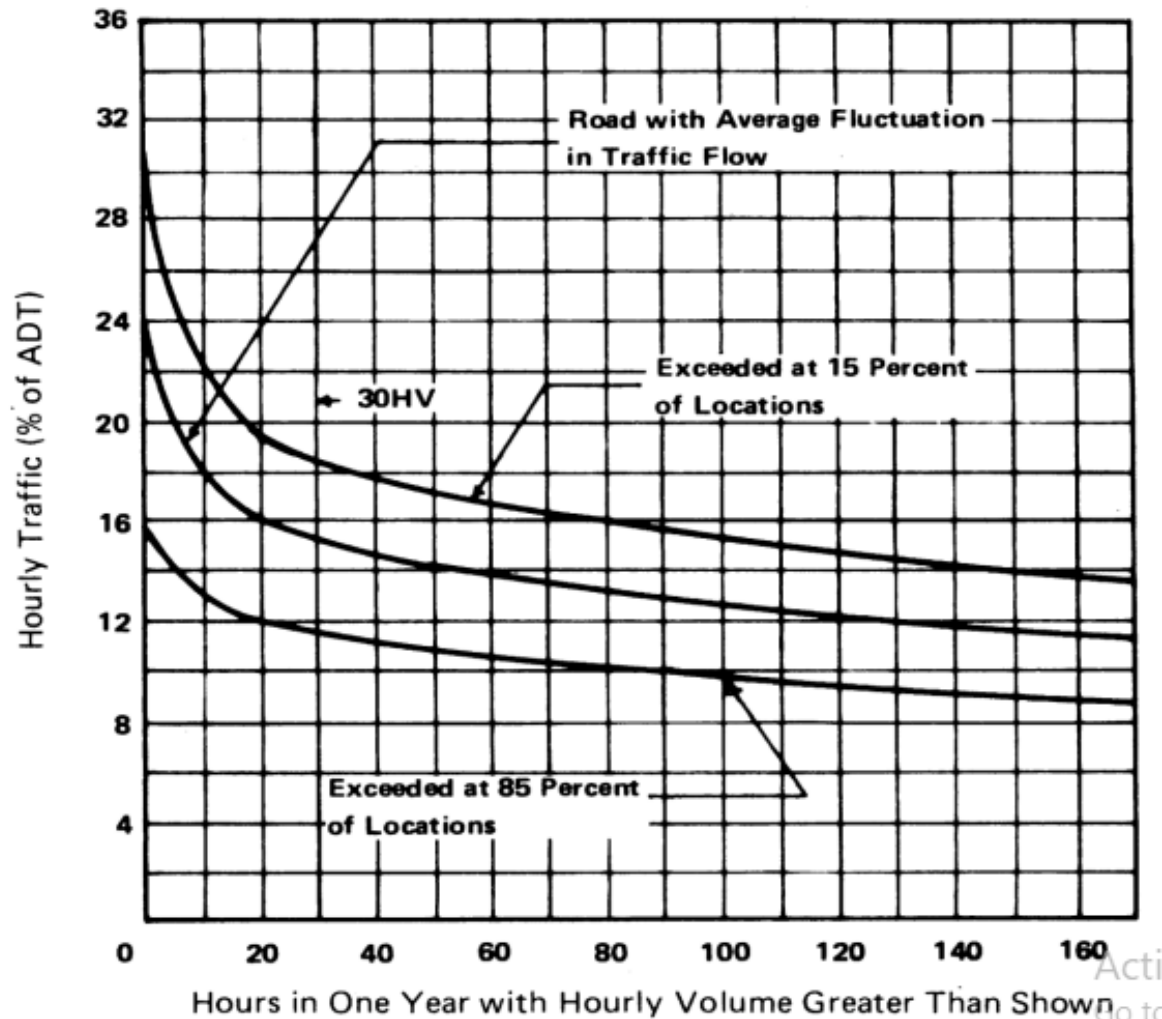
DESIGN HOURLY VOLUME

➢ The figure in previous slide shows the relationship between the highest hourly volume and ADT on rural arterial. Based on the figure, it is recommended that the hourly traffic volume that should be used in design is the 30 highest hourly volume of the year (30 HV).

➢ The reason is that curve steepens quickly to the left on the point of 30 HV and indicates only few hours with higher volume (i.e. it is not economical to design based on higher traffic volume). The curve flattens to the right and indicates many hours in which the volume is not much less than the 30 HV.

DIRECTIONAL DISTRIBUTION

➢ During any particular hour, traffic volume may be greater in one direction than in the other. Directional distribution is an important factor in highway capacity analysis.

➢ According to the Highway Capacity Manual (HCM, 2010), the proportion of traffic in peak direction (i.e. directional distribution, D) is about 0.60.

➢ Therefore, the directional design hourly volume (DDHV) is:

DDHV = AADT * K * D

or

DDHV = DHV * D

DIRECTIONAL DISTRIBUTION

➢ <u>Example :</u>

Assuming a 60/40 directional split (60% in the peak direction) and a design hour factor (K) is 12%, what is the projected directional design hour volume on this extension. If AADT is 20,000 veh/day

Solution:

DHV = 20000*0.12 = 2400 veh/hr

DDHV = 20000*0.12*0.6 = 1440 veh/hr/dir.

PASSENGER CAR EQUIVALENCIES

➢ Deferent type of vehicles could be observed on the highways such as cars, vans, minibuses, buses, trucks and heavy goods vehicles (HGVs).

➢ for the purpose of calculating the traffic flow, the traffic data may be converted into passenger car equivalent (unit) per hour [pce or pcu].

➢ According to the Highway Capacity Manual (HCM, 2010), the flow rate may be adjusted to account for vehicle stream characteristics by using factors given in the table below.

Vehicle Type	Passenger Car Equivalent, E_T
Passenger car	1.0
Heavy vehicle	2.0

EXAMPLE

A two-lane highway is expected to serve AADT of 5000 veh/day. Find DHV and DDHV in vehcles and pcu if the following information is given:

➢ Traffic composition includes 80% passenger cars and 20% trucks.

➢ K=0.1

➢ D=0.6

EXAMPLE

Solution:

DHV (veh) = AADT * K

        = 5000 * 0.1= 500 veh/hr

DHV (pcu) = 500*0.8*1 + 500*0.2* 2 = 600 pcu/hr

DDHV (veh) = ADT * K * D

        = 5000 * 0.1 * 0.6 = 300 veh/hr

DDHV (pcu) =300*0.8*1 + 300*0.2*2 = 360 pcu/hr

FLOW RATE

➢ Flow rate (q) is the equivalent hourly rate at which vehicles pass over a given point or section of a lane or roadway during a given time interval of less than 1 hr, usually 15 min.

$$q = peak\ volume * number\ of\ interval\ per\ 1\ hour$$

➢ The peak hour volume is the volume of traffic during the hour of the day that observes the highest traffic volumes.

➢ Peak flow rates and hourly volumes produce the peak-hour factor (PHF), the ratio of total hourly volume to the peak flow rate within the hour, computed by the following Equation:

$$(PHF) = Peak\ hour\ volume/(4*Peak\ fifteen\ minute\ volume)$$

EXAMPLE 1

Traffic volume data has been collected for 15 min time intervals as shown below. Find the total hourly volume, flow rate and peak hour factor (PHF).

Time	7:30 – 7:45	7:45 – 8:00	8:00 – 8:15	8:15 – 8:30
Volume	250	350	300	200

Solution:

Volume = 250+350+300+200 = 1100 veh

Flow rate (q) = peak volume * number of intervals per 1 hour

$$= 350 * 4 = 1400 \text{ veh/hr}$$

PHF= 1100/1400 = 0.786

EXAMPLE 2

Traffic volume data has been collected for 10 min time intervals as shown below. Find the total hourly volume, flow rate and PHF.

Time	7:30–7:40	7:40–7:50	7:50–8:00	8:00–8:10	8:10–8:20	8:20–8:30
Volume	150	200	300	200	150	100

Solution:

Volume = 150+200+300+200+150+100 = 1100 veh

Flow rate (q) = peak volume * number of intervals per 1 hour

$$= 300 * 6 = 1800 \text{ veh/hr}$$

PHF = 1100/1800 = 0.61

EXAMPLE 3

It is commonly known in your area that the heaviest traffic flow rates occur between 4:00 PM and 6:30 PM. Find the peak hour volume, peak hour factor (PHF), and the flow rate for an existing one-lane approach. Values are as shown in the table, for each fifteen-minute interval.

Time Interval	Interval Volume (pcu)
4:00 – 4:15	67
4:15 – 4:30	76
4:30 – 4:45	71
4:45 – 5:00	94
5:00 – 5:15	103
5:15 – 5:30	114
5:30 – 5:45	135
5:45 – 6:00	113
6:00 – 6:15	90
6:15 – 6:30	77

EXAMPLE 3

Solution:

Time Interval	Interval Volume (pcu)
4:00-4:15	67
4:15-4:30	76
4:30-4:45	71
4:45-5:00	94
5:00-5:15	103
5:15-5:30	114
5:30-5:45	135
5:45-6:00	113
6:00-6:15	90
6:15-6:30	77

EXAMPLE 3

Solution:

➢ The peak hour volume is just the sum of the volumes of the four 15 minute intervals within the peak hour (**465 pcu**).

➢ The peak 15 minute volume is 135 pcu in this case. The peak hour factor (PHF) is found by dividing the peak hour volume by four times the peak 15 minute volume.

➢ PHF = 465 /(4 * 135) = **0.861**

➢ The flow rate can be calculated by dividing the peak hour volume by the PHF [465/0.861 = **540 pcu/hr**] or by multiplying the peak 15 minute volume by four [4 * 135 = **540 pcu/hr**].