University of Al-Maarif
College of Engineering
Department of Civil Engineering

TRAFFIC ENGINEERING

THIRTEENTH LECTURE

Lecture r:
Ass.Lec. Noor Jabbar Mahdi

Determination of Flow Rate

The next step in the determination of the LOS is the computation of the peak hour factor. The fifteen minute passenger-car equivalent flow rate (pc/h/ln), is determined by using following formula:

$$v_p = \frac{V}{(PHF * N * f_{HV} * f_p)}$$

Where:

v_p = 15-min passenger-car equivalent flow rate (pc/h/ln),

V = hourly volume (veh/h),

PHF = peak-hour factor,

N = number of lanes,

f_{HV} = heavy-vehicle adjustment factor, and

fp = driver population factor.

Determination of Flow Rate

PHF represents the variation in traffic flow within an hour. Observations of traffic flow consistently indicate that the flow rates found in the peak 15-min period within an hour are not sustained throughout the entire hour. The PHFs for multilane highways have been observed to be in the range of 0.75 to 0.95. Lower values are typical of rural or off-peak conditions, whereas higher factors are typical of urban and suburban peak-hour conditions. Where local data are not available, 0.88 is a reasonable estimate of the PHF for rural multilane highways and 0.92 for suburban facilities.

Besides that, the presence of heavy vehicles in the traffic stream decreases the FFS because base conditions allow a traffic stream of passenger cars only. Therefore, traffic volumes must be adjusted to reflect an equivalent flow rate expressed in passenger cars per hour per lane (pc/h/ln). This is accomplished by applying the heavy-vehicle factor (f_{HV}). Once values for ET and ER have been determined, the adjustment factors for heavy vehicles are applied as follows:

Determination of Flow Rate

Once values for ET and ER have been determined, the adjustment factors for heavy vehicles are applied as follows:

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$$

Where:

E_T = equivalents for trucks and buses,

E_R = equivalents for for recreational vehicles (RVs),

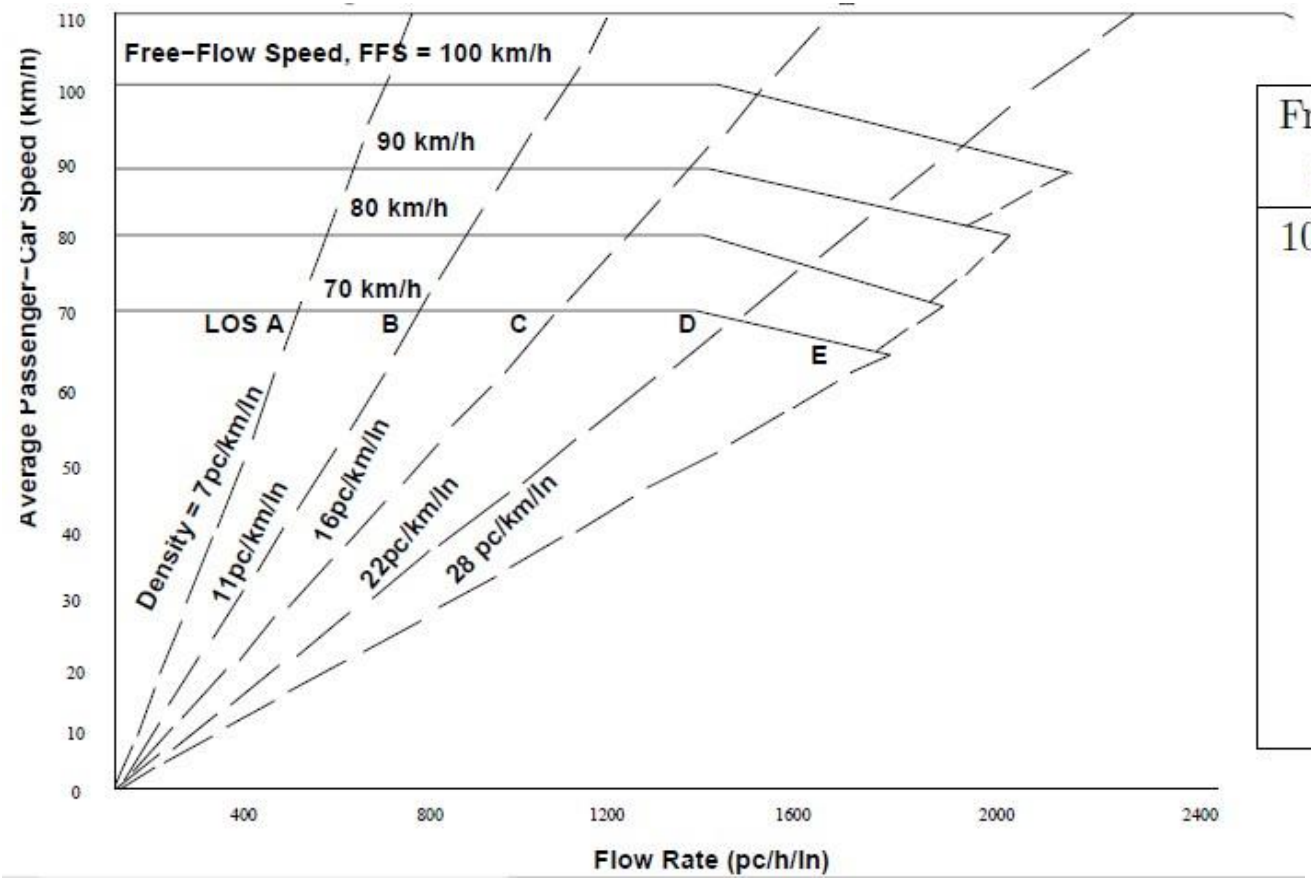
PT = proportion of trucks and buses, and

PR = proportion of RVs.

Factor	Type of Terrain		
	Level	Rolling	Mountainous
ET (Trucks and Buses)	1.5	2.5	4.5
ER (RVs)	1.2	2.0	4.0

Determination of Level of Service

The level of service on a multilane highway can be determined directly from Figure or Table below based on the free-flow speed (FFS) and the service flow rate (v_p) in pc/h/ln.



Free-Flow Speed	Criteria	(LOS) A	(LOS) B	(LOS) C	(LOS) D	(LOS) E
100 km/h	Max. density (pc/km/ln)	7	11	16	22	25
	Average speed (kmph)	100	100	98.4	91.5	88
	Max. volume capacity ratio	0.32	0.50	0.72	0.92	1.00
	Max. service flow rate (pc/h/ln)	700	1100	1575	2015	2200

Determination of Level of Service

The procedure to determine LOS as follows:

1. Define a segment on the highway as appropriate. The following conditions help to define the segmenting of the highway,

- Change in median treatment
- Change in grade of 2% or more or a constant upgrade over 1220 m
- Change in the number of travel lanes
- The presence of a traffic signal
- A significant change in the density of access points
- Different speed limits
- The presence of bottleneck condition

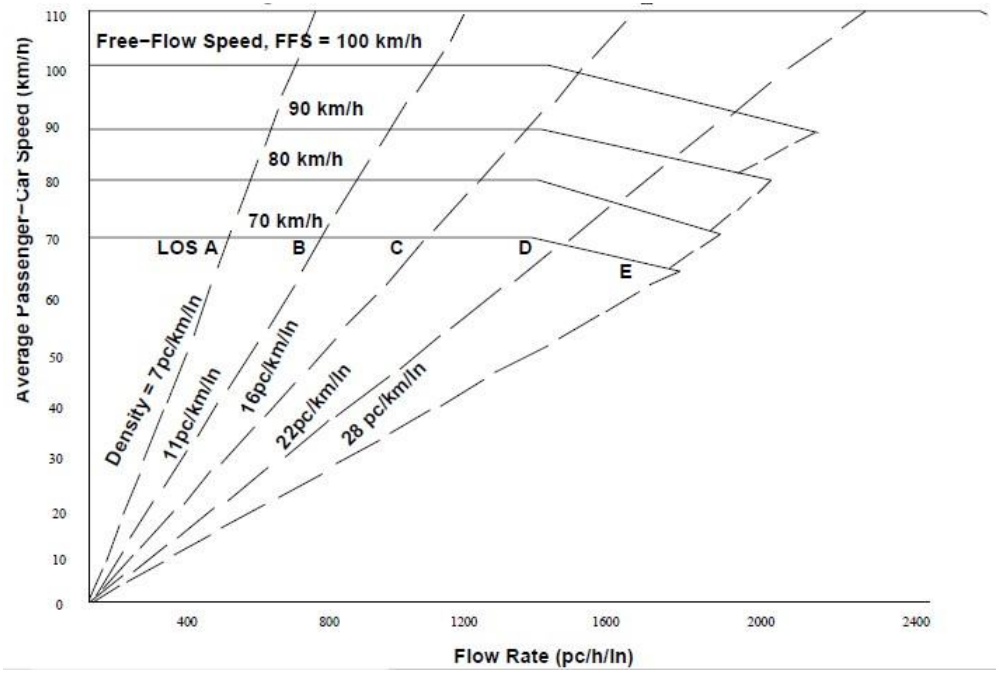
In general, the minimum length of study section should be 760 m, and the limits should be no closer than 0.4 km from a signalized intersection.

Determination of Level of Service

2. On the basis of the measured or estimated free-flow speed on a highway segment, an appropriate speed-flow curve of the same as the typical curves is drawn.
3. Locate the point on the horizontal axis corresponding to the appropriate flow rate (v_p) in pc/hr/ln and draw a vertical line.
4. Read up the FFS curve identified in step 2 and determine the average travel speed at the point of intersection.
5. Determine the level of service on the basis of density region in which this point is located. Density of flow can be computed as:

$$D = \frac{v_P}{S}$$

Where:
D = density (pc/km/ln),
v_p = the flow rate (pc/h/ln), and
S = the average passenger-car travel speed (km/h).



Determination of Level of Service

The level of service can also be determined by comparing the computed density with the density ranges shown in table given by HCM.

To use the procedures for a design, a forecast of future traffic volumes has to be made and the general geometric and traffic control conditions, such as speed limits, must be estimated. With these data and a threshold level of service, an estimate of the number of lanes required for each direction of travel can be determined.

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Determination of Level of Service

Example: A segment of undivided four-lane highway on level terrain has field-measured FFS 74 km/h, lane width 3.4 m, peak-hour volume 1900 veh/h, 13 percent trucks and buses, 2 percent RVs, driver population factor is 1, and 0.90 PHF. What is the peak-hour LOS, speed, and density for the level terrain portion of the highway?

Solution:

LOS can be calculated by knowing flow rate and free flow speed. Flow rate (Vp) is calculated from the equation

$$v_p = \frac{V}{(PHF * N * f_{HV} * f_p)}$$

Since f_{HV} is unknown it is calculated from the equation

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)} = \frac{1}{1 + 0.13(1.5 - 1) + 0.02(1.2 - 1)} = \mathbf{0.935}$$

Determination of Level of Service

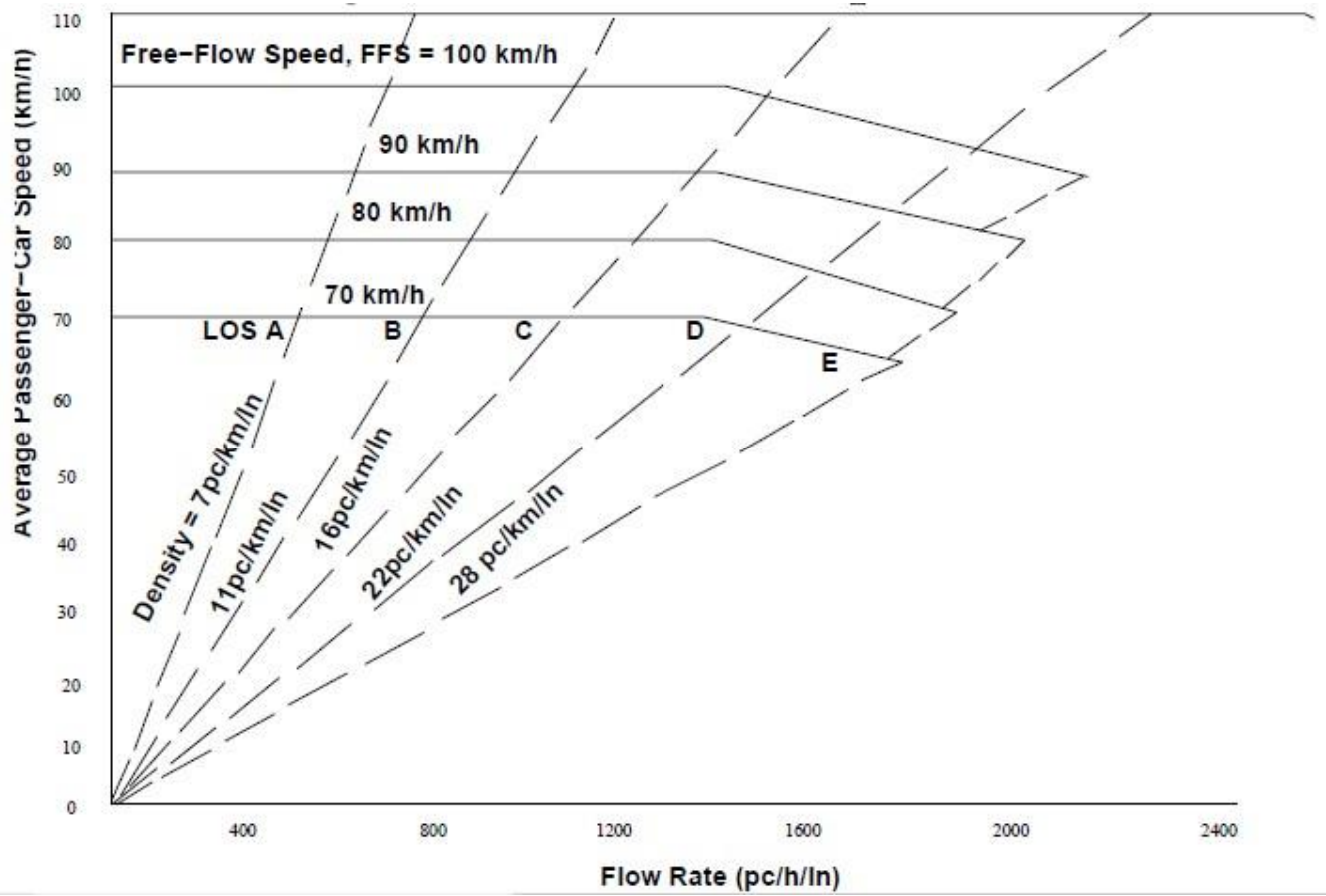
$$v_p = \frac{V}{(PHF * N * f_{HV} * f_p)} = \frac{1900}{(0.9 * 2 * 0.935 * 1)} = 1129\ pc/hr/ln$$

FFS = S = 74 km/h,

$$D = \frac{v_p}{S} = \frac{1129}{74} = 15.3\ pc/km/ln$$

from the speed-flow diagram

LOS = C



THANK YOU FOR LISTENING