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

TRAFFIC ENGINEERING

SIXTH LECTURE

Lecturer:

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Density

Density (concentration): is number of vehicles occupying 1km (1 mile) length of a road at certain instant. units: veh/km (vpkm).

$$Spacing = \frac{1000}{Density}$$

Example: Spacing = 10 m, Find Density.

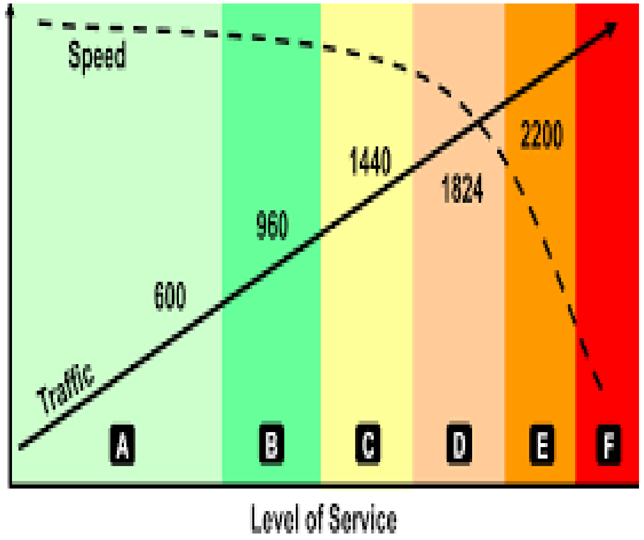
Solution:

$$10 = \frac{1000}{Density} \rightarrow Density = \frac{1000}{10} = 100\ veh/km$$

Density

Level of Service (LOS): is qualitative measurement describing the operational condition within the traffic stream.

LOS	Description	Operating speed (km/hr)
A	Free flow	96
B	Stable flow	88
C	Stable flow with some restriction	72
D	Approaching unstable flow	56
E	Unstable flow	48
F	Forced flow (stop and go)	<48



L.O.S	Density Range (pc/mi/ln)
A	0-11
B	>11-18
C	>18-26
D	>26-35
E	>35-45
F	>45

Density

Design service flow rate: Maximum hourly flow rate at which vehicle can be expected to pass a point or section of a lane or roadway during one hour without falling below a pre- selected level of service.

LOS	Design service flow rate (pc ph pl)
A	660
B	1080
C	1550
D	1980
E	2200

* **Capacity** = Design service flow rate for LOS E

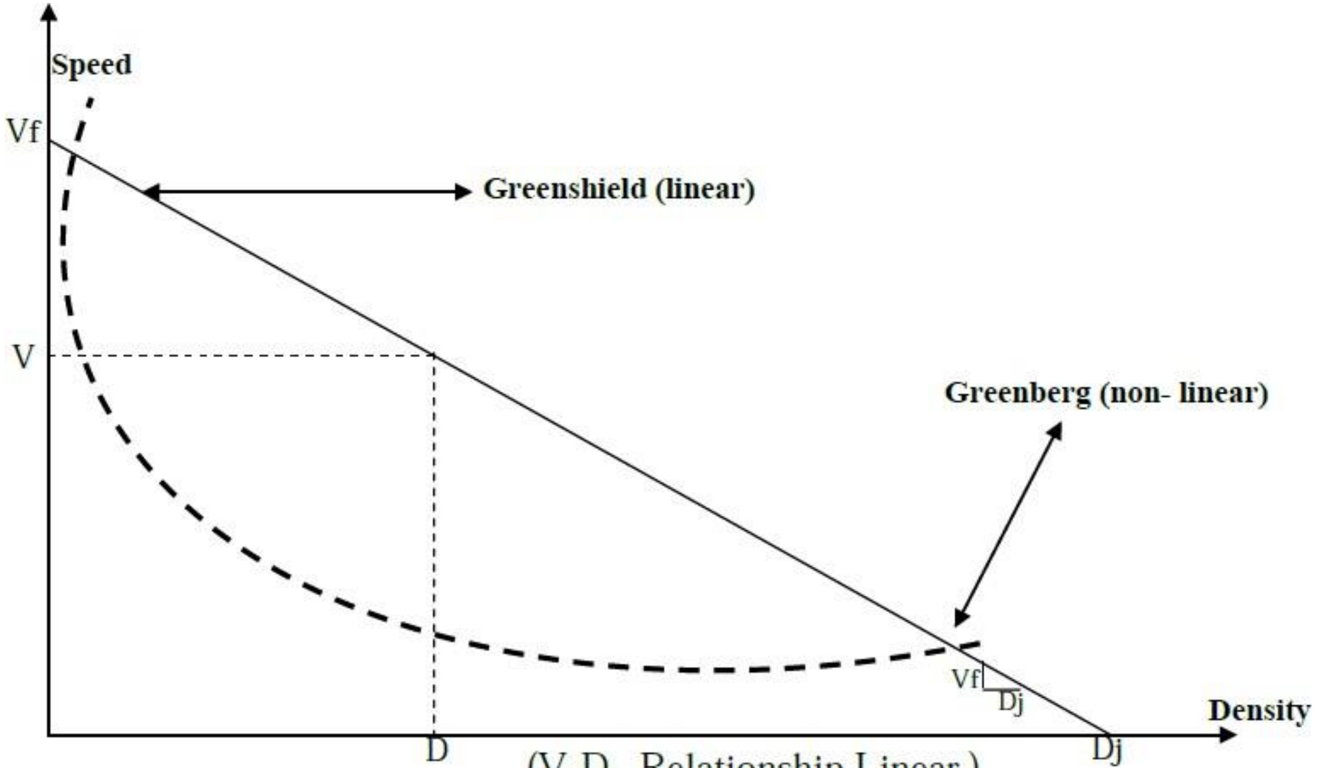
Design level of service

Highway	Flat	Rolling	Mountain
Principle Arterial	B	B	C
Minor Arterial	B	B	C
Collector	C	C	D
Local	D	D	D

Flow - Density - Speed Relationships

V_f: free flow speed, D_j : jam density

at V_f - D = 0 vpkm, at D_j - V = 0 kmph

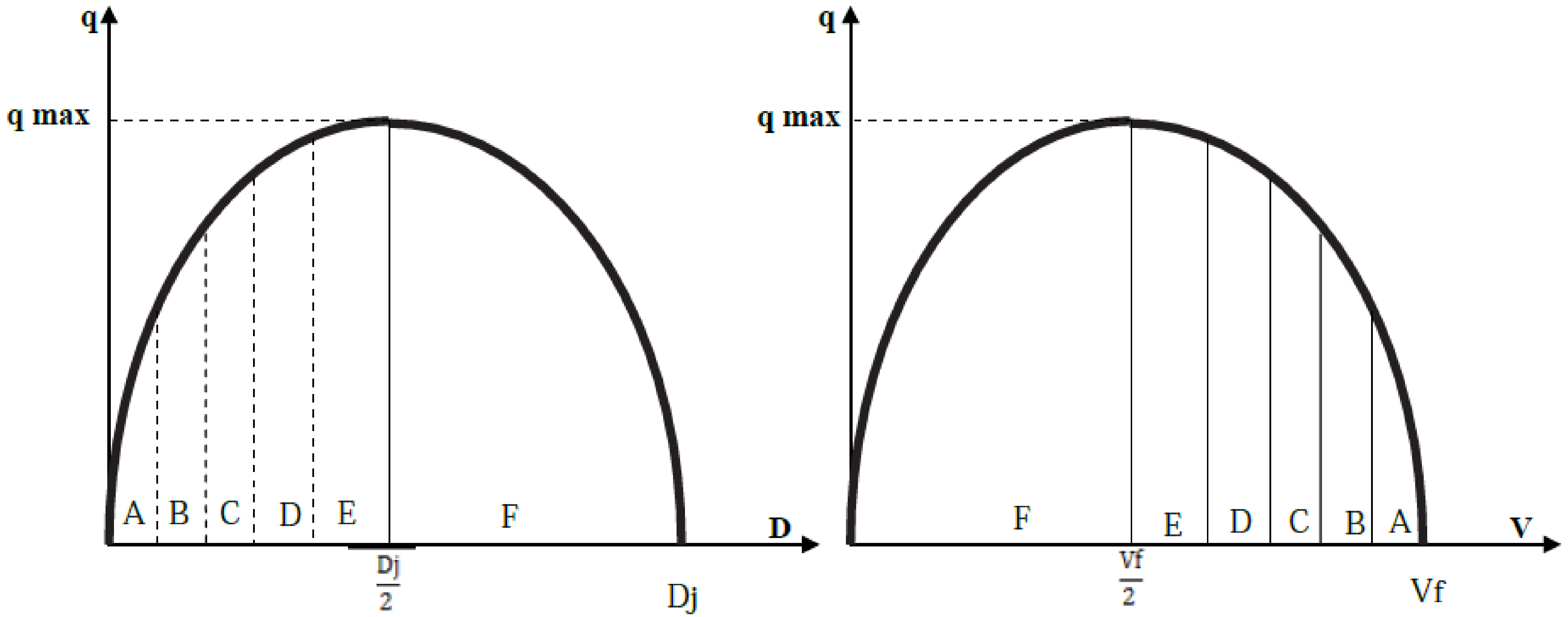


(V-D Relationship Linear)

$$V = Vf - D\frac{Vf}{Dj} \quad \text{or} \quad D = Dj - V\frac{Dj}{Vf}$$

qmax = capacity

Flow - Density - Speed Relationships



Flow - Density - Speed Relationships

$$q = V * D$$

$$\frac{veh.}{hr} = \frac{km}{hr} * \frac{veh.}{km}$$

$$\because V = V_f - D\frac{V_f}{D_j}$$

$$\therefore q = \left[V_f - D\frac{V_f}{D_j}\right] * D = DV_f - D^2\frac{V_f}{D_j}$$ **……..(q-D relationship)**

$$\because D = D_j - V\frac{D_j}{V_f}$$

$$\therefore q = V * D_j - V\frac{D_j}{V_f} = VD_j - V^2\frac{D_j}{V_f}$$ **……..(q-V relationship)**

Flow - Density - Speed Relationships

Example: At which density (D) , Capacity or q max occur?

Solution:

from the q- D plot , since its symmetrical about the midline , therefore:

$$D \ at \ q_{max} = \frac{D_j}{2}$$

Also:

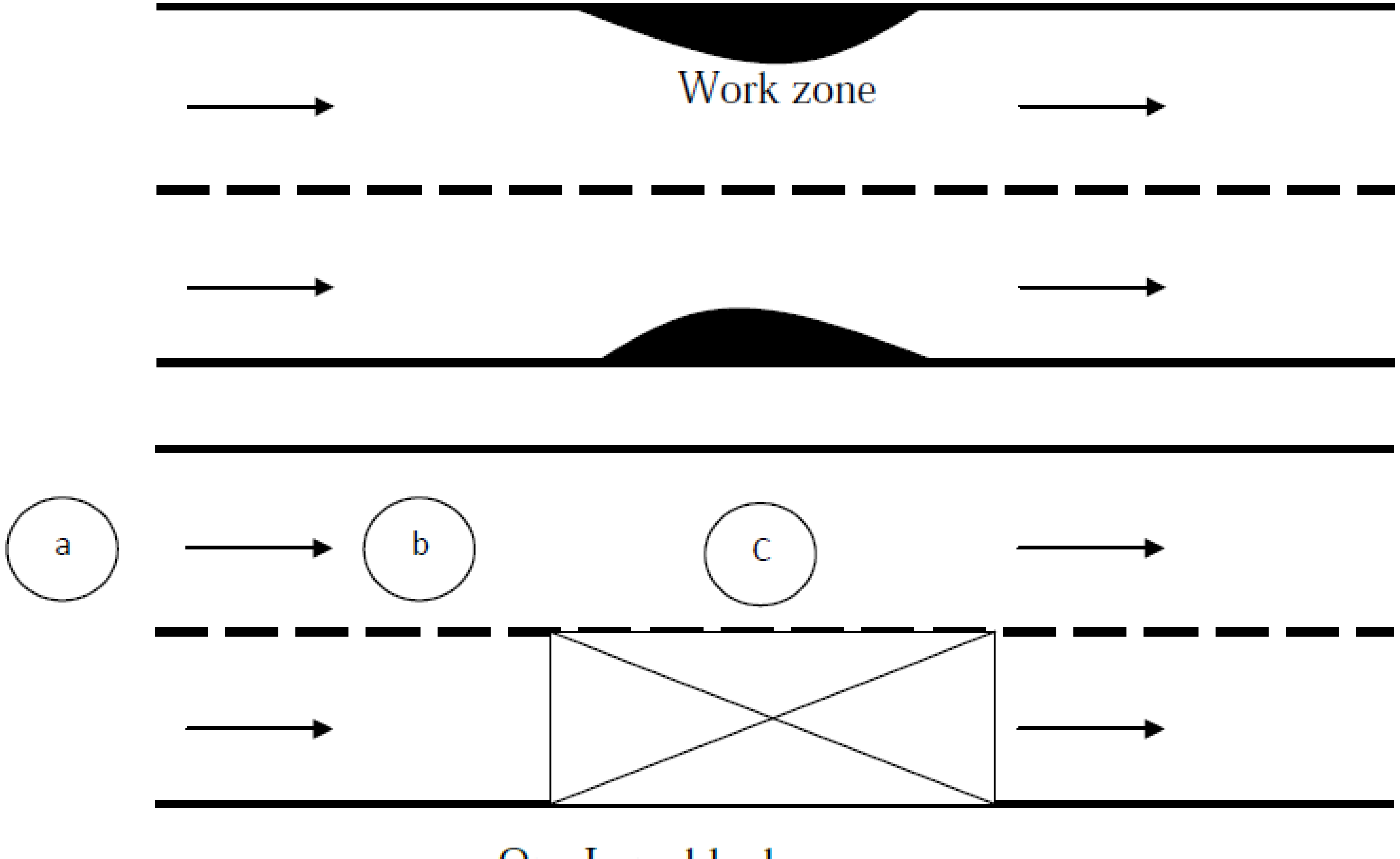
$$V \ at \ q_{max} = \frac{V_f}{2}$$

since q = V*D

$$\therefore q = \frac{V_f}{2} * \frac{D_j}{2} = \frac{V_f D_j}{4}$$

Flow - Density - Speed Relationships

Bottleneck: Bottleneck or shockwaves occur in traffic stream due to sudden reduction in roadway capacity which may be occur due to the reduction for number of lanes, work zones, restricted bridge size, crashes or signal turning red.



Flow - Density - Speed Relationships

Example 1: It was noted that on length of highway the free speed (V_f) was 80 km/hr and the jam density was 70 veh/km find the required below:

1- What is the max flow which could be expected on this highway?

2- At what speed it would be occur?

3- At what density it would be occur?

Solution:

V_f = 80 km/hr

D_j = 70 veh/km

$$\boldsymbol{q_{max} = \frac{V_f D_j}{4} = \frac{80 * 70}{4} = 21400\, veh/h}$$

$$\boldsymbol{V\ atq_{max} = \frac{V_f}{2} = \frac{80}{2} = 40\ km/h}$$

$$\boldsymbol{D\ atq_{max} = \frac{D_j}{2} = \frac{70}{2} = 35\, veh/km}$$

THANK YOU