



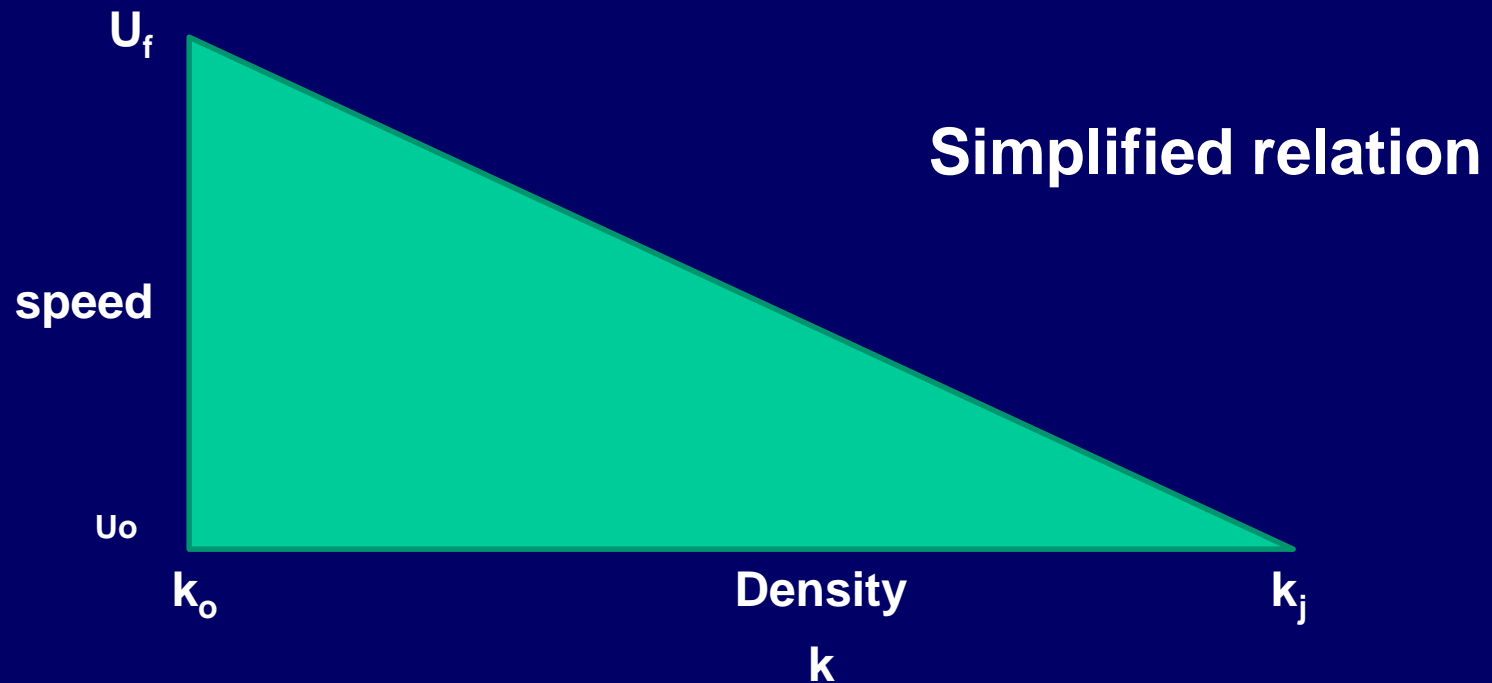
# Traffic Flow: Principles and Characteristics

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# Traffic Flow: Key Terms

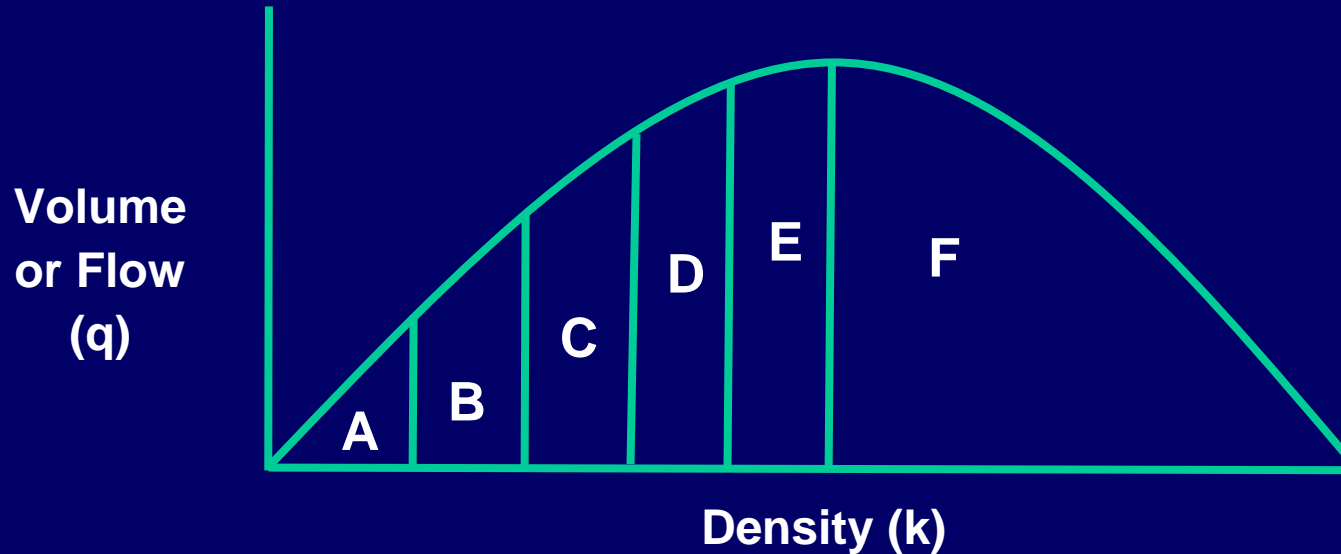
- **Density** : Number of vehicles per km
- **Speed** : Number of km per hour (rate of motion in distance)
- **Volume / Flow** : Number of vehicles per hour (that pass a given point on a road)
- **Flow = Density X Speed**

# Speed – Density Relation



- $U_f$  – Free Flow Speed when density is zero (also written as  $V_f$ )
- $k_j$  – Jam Density when speed is zero

# Notions of Congestion and Capacity





Capacity:	Maximum number of vehicles that can reasonably be expected to use the traffic facility in a given time period under prevailing roadway, traffic and control conditions
Service Volume:	Maximum amount of traffic that can be accommodated while maintaining the defined operating conditions is termed the service volume for that level of service.



# Levels of Service on Highway Facility

<b>Level of service</b>	<b>General operating conditions</b>
<b>A</b>	<b>Free flow</b>
<b>B</b>	<b>Reasonably free flow</b>
<b>C</b>	<b>Stable flow</b>
<b>D</b>	<b>Approaching unstable flow</b>
<b>E</b>	<b>Unstable flow</b>
<b>F</b>	<b>Forced or breakdown flow</b>



# Typical Illustration of LOS on Urban Roads

LOS	Description	Illustration
LOS-A	<p>Represents a condition of free flow. Individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is high. The general level of comfort and convenience provided to the road users is excellent.</p>	 A high-angle photograph of a multi-lane highway with a median. The traffic is sparse and moving smoothly. A timestamp in the top right corner reads '27-04-2016 08:54:25'. A small text 'TO SION JUN' is visible in the bottom left corner of the image frame.
LOS-B	<p>Represents a zone of stable flow, with the drivers still having reasonable freedom to select their desired speed and manoeuvre within the traffic stream. The level of comfort and convenience provided is somewhat less than the Level of Service A, because the presence of other vehicles in the traffic stream begins to affect individual behaviour.</p>	 A high-angle photograph of the same multi-lane highway. The traffic is denser than in the LOS-A image, with vehicles closer together. A timestamp in the top right corner reads '28-04-2016 11:34:23'. A small text 'TO SION JUN' is visible in the bottom left corner of the image frame.

# Typical Illustration of LOS on Urban Roads

LOS	Description	Illustration
LOS-C	<p>This also is a zone of stable flow but marks the beginning of the range of flow in which the operation of individual drivers starts getting affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and manoeuvring within the traffic stream requires vigilance on the part of the user. The general level of comfort and convenience starts declining at this level.</p>	 <p>The illustration shows a wide, multi-lane urban road with a moderate density of vehicles. There is a clear lane structure, and vehicles are moving in a steady flow. The road is flanked by trees and buildings. A timestamp in the top right corner reads '27.04.2016 13:33:12'. A sign in the bottom left corner says 'TO MUMBAI * NESCO'.</p>
LOS-D	<p>Represents the limit of stable flow, with conditions approaching unstable flow. Due to high density, the drivers are severely restricted in their freedom to select desired speed and manoeuvre within the traffic stream. The general level of comfort and convenience is poor. Small increase in traffic flow will usually cause operational problems at this level.</p>	 <p>The illustration shows a multi-lane urban road with a high density of vehicles, including cars, buses, and trucks. The traffic is slow-moving and appears congested. The road is flanked by trees and buildings. A timestamp in the top right corner reads '27-04-2016 17:26:33'. A sign in the bottom left corner says 'TO DAHSAR'.</p>

# Typical Illustration of LOS on Urban Roads

LOS	Description	Illustration
LOS-E	<p>Represents operating conditions when traffic volumes are at or close to the capacity level. The speeds are reduced to a low, but relatively uniform value. Freedom to manoeuvre within the traffic stream is extremely difficult and is generally accomplished by forcing a vehicle to give way to accommodate such manoeuvre. Level of comfort and convenience is extremely poor, and driver's frustration is generally high. Operations at this level are usually unstable. Small increases in flow or minor disturbances within the traffic stream will cause breakdowns.</p>	 A high-angle photograph of a multi-lane urban road during the evening. The road is filled with cars, motorcycles, and a few taxis. The traffic is moving slowly but appears to be in a steady, albeit congested, flow. A timestamp in the top right corner reads "27-04-2016 18:24:45". A watermark "TO DAHSAR" is visible in the bottom left corner.
LOS-F	<p>Represents zone of forced or breakdown flow. This condition occurs when the amount of traffic approaching a point exceeds the amount which can pass it. Queues form behind such locations. Operations within the queue are characterized by stop and go waves, which are extremely unstable. Vehicles may progress at a reasonable speed for several hundred meters and may then be required to stop in a cyclic fashion. Due to high volumes, break-down occurs, and long queues and delays result.</p>	 A high-angle photograph of the same urban road as in the previous image, but at a later time. The traffic is now in a state of severe congestion, with vehicles packed closely together and many cars with their red brake lights on. The flow is significantly slower and more chaotic. A timestamp in the top right corner reads "27-04-2016 19:00:42". A watermark "TO DAHSAR" is visible in the bottom left corner.



# Typical Volume: Capacity Ratios

LOS	V/C Ratio	PCUs / hr per lane
A	0.25	500
B	0.45	900
C	0.65	1300
D	0.85	1700
E	1.00	2000
F	>1.00	
Normally applicable for multi-lane highways and expressways		

## Two-Lane Roads

Capacity = LOS E = 2800 PCUs per hour (USA)

LOS B =  $0.45 \times 2800 = 1260$  PCUs per hour

Suppose Peak Hour = 8 percent of average daily

Daily volume at LOS B =  $\frac{1260}{8} \times 100 = 15750$  PCUs/day

Say 15000 PCUs per day

In hill areas, normally half of such figures to account for effect of gradients and curvature.

# Four-Lane Roads

- Design service volume at LOS B =  $900 \times 4 = 3600$  per hour
- Support it is 8% of Average Daily

Then Average Daily =  $\frac{3600}{8} \times 100 = 45000$  PCUs

# Indo HCM: Capacity at LOS E

- Two Lane – 3100 PCU / hour
- Intermediate Lane – 2150 PCU / hour
- Single Lane – 800 PCU / hour

# Traffic Projections

- Economic growth of state
- Trends in increase of vehicle ownership / registration
- Start system of traffic counts on NHs, SHs (twice a year)
- Publish hour-wise data of traffic at toll plazas
- Developing states will show higher annual growth (Low PCI)
- Developed states will show lower annual growth (High PCI)
- We also need to undertake axle load surveys in respect of trucks and buses

# **Access Management: Broad Principles**

## **(Some Thoughts)**

- **On NHs, SHs passing through urban areas**
  - **Option 1: Service roads / footpaths / cycle tracks depending upon abutting land use**
  - **Option 2: Bypass (with limited Entry / Exit)**
- **On multi-lane highways passing through non-urban areas**
  - **Option 1: Service roads**
  - **Option 2: Median openings (not less than 3 km apart)**
- **Develop expressways**

# **Phased Development Approach (Cost-Effective Strategy)**

- **Provide Capacity**
  - **Neither Too Much Too Early**
  - **Nor Too Little Too Late**
- **Optimal Timing**
  - **To achieve efficiency of investments**
  - **To spur economic growth**
- **We need mobility but not at cost of safety**
  - **So, we need to invest in safety**
  - **Side by side of investing in mobility**

**Thank you**

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