

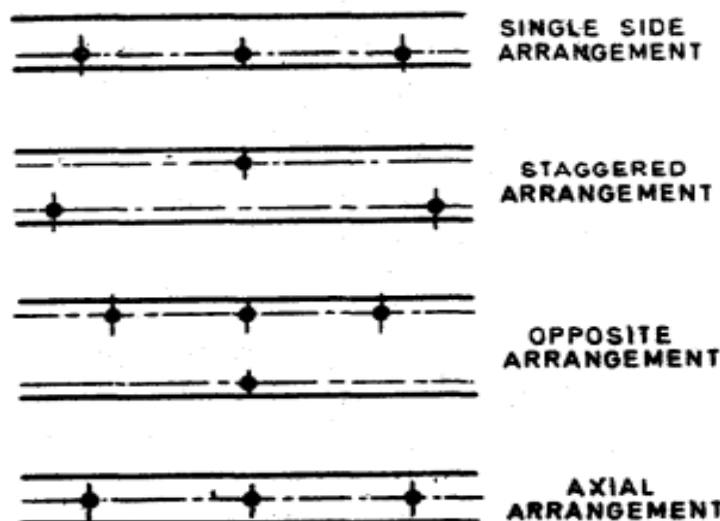
**Module -4: Traffic Safety and Environment:**

Road accidents, Causes, effect, prevention, and cost, Street lighting, Traffic and environment hazards, Air and Noise Pollution, causes, abatement measures, Promotion and integration of public transportation, Promotion of non-motorized transport.

**1. Indicate and explain how the spacing of street lighting is decided.**

Design factors for highway lighting are

- Lamps – the various types of lamps in use for highway lighting are filament, fluorescent lamps, sodium or mercury vapour lamps.
- Luminaire distribution of light- the distribution of light should be downward so that high percentage of lamp light is utilized for illuminating the pavement and the adjacent areas. The distribution of luminaire should cover the pavement between the kerbs and provide adequate lighting the adjacent areas i.e., 3 m to 5 m beyond the pavement edges. According to Indian Standards Institution, an average level of illumination of 30 lux on important roads carrying fast traffic and 15 lux on main roads, the ratio of minimum to average illumination being 0.4
- Spacing of lighting units – large lamps with high mountings and wide spacings would be preferred from economy point of view.
- Height and overhang of mounting – usually mounting height range from 6 m to 10 m.
- Lateral placement – the street lights should not be too close to the pavement edge. For roads with raised kerbs, the pole should be at a distance of 0.3 m to 0.6 m from the edge of the kerb.
- Lighting layouts – this can be either single sided, staggered or central.



Spacing (s) of street lamp can be computed as

$$s = \frac{\text{Lamp lumen} \times \text{coefficient of utilization} \times \text{Maintenance factor}}{\text{average flux} \times \text{width of the road}}$$

**2. Describe the main functions of traffic control devices**

The different types of traffic control devices are

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- (i) Traffic signs
- (ii) Traffic signals
- (iii) Road markings
- (iv) Traffic islands

### Traffic signs

- Traffic signs and road markings are silent speakers to the road users
- They give advance information about road conditions ahead.
- Road markings also give orders, warning or guidance to drivers or riders
- It increases safety in road transport

### Types of Traffic signs

#### 1. Mandatory Signs



**Figure: Stop sign, give way sign, signs for no entry, sign indicating prohibition for right turn, vehicle width limit sign, speed limit sign**

#### 2. Cautionary Signs / Warning signs



**Figure: speed breaker, school, Right hand curve sign board, signs for narrow road, sign indicating railway track ahead)**

#### 3. Informatory Signs



### Traffic signals

They are control devices that direct traffic to stop and proceed the intersections using red and green traffic light signals automatically.

#### Advantages of traffic signals

- (i) Provide an orderly movement of traffic
- (ii) Reduce accidents especially by right angled collisions
- (iii) Pedestrians can cross the road safely at the signalised intersection
- (iv) There is reasonable speed in a signal controlled intersection
- (v) Quality of traffic flow is improved
- (vi) Pedestrians can cross the signal safely
- (vii) Signals allow crossing of heavy traffic flow safely

### Road markings

Road markings are defined as lines, patterns, words or other devices, except signs, set into applied or attached to the carriageway or kerbs or to objects within or adjacent to the carriageway, for controlling, warning, guiding and informing the users.

They can be

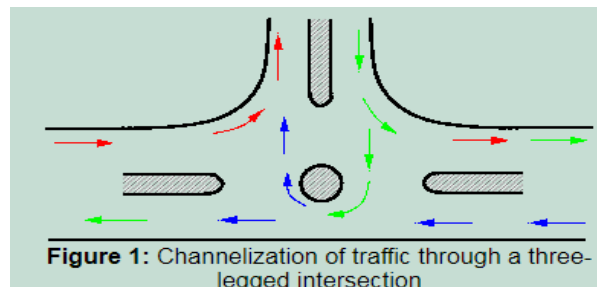
- Longitudinal markings
- Transverse markings
- Object markings
- Word messages

### Traffic islands

Vehicles approaching an intersection are directed to definite paths by islands, marking etc. and this method of control is called channelization

Advantages:

- Provides more safety and efficiency.
  - Reduces the number of possible conflicts
  - Reduces the area of conflicts available in the carriageway.
  - The presence of traffic islands, markings etc. forces the driver to reduce the speed and becomes more cautious while manoeuvring the intersection.
- A channelizing island also serves as a refuge for pedestrians and makes pedestrian crossing safer



Rotary intersection is an example of channelized intersection

### 3. Explain road side arboriculture

Arboriculture means planting and growing of trees along road sides. It gives good appearance to the road. It also gives shade to the road users. This includes:

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- Flat side slopes in embankment and cut, rounded to blend to original surface.
- Wide right of way and shoulders in rural highways.
- Consistent and smooth horizontal and vertical alignments, pleasant views and parking places.
- Suitable planting of trees and shrubs including its proper maintenance.

Objectives of Road Arboriculture:

- To provide beautification & natural landscape of roadsides
- To provide shade and comfort to the road users.
- To act as a wind breakers.
- To yield fruit and useful timber.
- To break the monotony of the road
- To protect the road surface from hot sun
- To prevent the movement of sand in desert area
- To absorb noise

**4. Explain the vehicular abatement measures followed in India.**

Different measures are

- (i) Improve vehicle design and maintenance.
- (ii) Use of small cars instead of big ones.
- (iii) Patronage of public transport system.
- (iv) Use of alternative fuels and method of propulsion.
- (v) Restraining traffic through road pricing.
- (vi) Stopping engines at the time of delays at intersections
- (vii) Constructing bypasses and ring roads.
- (viii) Staggering work hours
- (ix) Institution of parking restraint.
- (x) Change in the design of vehicles- in India, Motor vehicles Act has made provisions to frame rules to control the noise produced by motor cycles.
- (xi) Changes in tyre/ surface characteristics- smooth surfaces result in less noise.
- (xii) Elimination of noisier vehicles- old vehicles produce more sound.
- (xiii) Modifications in traffic operations- rerouting commercial vehicles and buses from residential areas, providing by-pass to prevent high speed traffic from entering towns, ensure continuous and smooth and eliminate acceleration noise, prohibiting blow horns.
- (xiv) Designing streets, buildings and areas for producing less noise- narrow streets create noise conditions (canyon effect). Hence, streets should be wide to reduce noise pollution. Shrubs, trees and grass on the side of the road act as sound barriers.

**5. What are the major environmental hazards due to traffic?**

The different detrimental effects of traffic on environment are

- (i) Safety – this is the most important parameter that poses a big challenge to the society and the environment

- (ii) Noise - Noise is the unwanted sound. Noise in cities is the result of a number of activities such as road traffic, aircraft, railways and industrial and constructional works.
- (iii) Air pollution - Pollution of the atmosphere by fumes and smell emitted by the motor vehicles makes the urban streets extremely unpleasant. The major source of air pollution is the exhaust gas emitted by the internal combustion engine, although evaporative losses from the fuel tank and the carburetor and losses from the crank case also account for some proportion of the hydrocarbons.
- (iv) Vibration – this include vibration generated in the contained air, underground vibrations, surface vibrations and so on.
- (v) Visual intrusion and degradation of aesthetics
- (vi) Severance and land consumption

**6. What is air pollution? Explain the different air pollutants.**

Pollution of the atmosphere by fumes and smell emitted by the motor vehicles makes the urban streets extremely unpleasant. The major source of air pollution is the exhaust gas emitted by the internal combustion engine, although evaporative losses from the fuel tank and the carburetor and losses from the crank case also account for some proportion of the hydrocarbons. The different components of the exhaust gas that can cause pollution are

1. Carbondioxide
2. Water vapour
3. Unburnt petrol
4. Organic compounds produced from petrol
5. Carbon monoxide
6. Oxide of nitrogen
7. Lead compounds
8. Carbon particles (smoke)

**7. List the various causes of air pollution.**

Pollutant	Source	Consequences
NO <sub>2</sub>	Vehicular exhaust	It forms smog and ozone, It causes respiratory illness, pulmonary disease, bronchitis etc
CO	Vehicle's exhaust as a result of incomplete combustion, Emissions from trucks, autos are significant	It interferes with the blood's ability to carry oxygen to the brain, heart, and other tissues. Unborn or newborn children and people with heart disease are in greatest danger from this pollutant, but even healthy people can experience headaches, fatigue and reduced reflexes and even death
SO <sub>2</sub>	Fuel containing sulfur is burned in diesel engines	Asthma, lung diseases, irritate mucus membrane, bronchitis, pulmonary diseases It can effect plants, animals and also properties

<b>O<sub>3</sub></b>	Secondary formation from the vehicular exhaust gases such as reaction of NO <sub>2</sub>	It forms smog, ozone reacts with lung tissue. It can inflame and cause harmful changes in breathing passages, decrease the lungs' working ability, and cause coughing and chest pains.
<b>Particulate matter (PM)</b>	Particulate matter includes microscopic particles and tiny droplets of liquid which comes from combustion of the fuel in vehicles	PM are very fine in size and they go deep into the lungs, where they may become trapped and cause irritation. Exposure to particulate matter can cause wheezing, asthma, respiratory illness, PM can serve as a vector for toxic air pollutants which may be carcinogenic
<b>Lead</b>	Lead can emitted from leaded petrol, However, usage of un leaded petrol resulted in significant drop in public exposure to outdoor lead pollution	Lead poisoning can reduce mental ability, damage blood, nerves, and organs, and raise blood pressure. Even small ingestions or inhalations of lead can be harmful because lead accumulates in the body
<b>Hydrocarbons</b>	Vehicular exhaust	Many hydrocarbons are carcinogenic

### 8. What are the abatement measures to reduce air pollution?

- (i) Improve vehicle design and maintenance.
- (ii) Use of small cars instead of big ones.
- (iii) Patronage of public transport system.
- (iv) Use of alternative fuels and method of propulsion.
- (v) Restraining traffic through road pricing.
- (vi) Stopping engines at the time of delays at intersections
- (vii) Constructing bypasses and ring roads.
- (viii) Staggering work hours
- (ix) Institution of parking restraint.

### 9. Explain noise. How noise is measured?

#### Noise pollution

Noise is the unwanted sound. Noise in cities is the result of a number of activities such as road traffic, aircraft, railways and industrial and constructional works.

Effect of noise: This can be classified into three

- (i) Subjective effects: this include disturbance, noisiness etc and is difficult to be measured.
- (ii) Behavioural effects: the noise can influence the behavior of people like sleeplessness, disturbance in studies, distraction in student's mind etc.
- (iii) Physiological effects: it can cause startle or fright phenomenon. Considerable exposure can even cause deafness

Generation of noise is by

- (i) Various parts of the vehicle.
- (ii) Interaction between vehicle and road surface
- (iii) Noise dependent upon speed, flow and density of traffic.

Vehicle noise are attributed to

- Engine
- Inlet
- Exhaust
- Propulsion and transmission including gears
- Brakes and horns
- Chassis
- Body structure
- Loads in the vehicle
- Door slamming

Measurement of noise levels:

The unit of noise measurement is decibel. A weighted decibel is commonly employed for measuring the relative levels of noise produced by different traffic conditions. L10 and L50 are the mean sound decibels that is exceeded 10% and 50% respectively. Generally noise level of 60dB is considered as quiet whereas noise levels of 90dB and above will be rated as extremely noisy.

**10. What are the ways to reduce traffic pollution in India?**

Pollution owed to traffic can be classified as (i) Air pollution and (ii) Noise pollution

Measures to reduce air pollution:

- (x) Improve vehicle design and maintenance.
- (xi) Use of small cars instead of big ones.
- (xii) Patronage of public transport system.
- (xiii) Use of alternative fuels and method of propulsion.
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Measures to reduce noise pollution:

- (i) Change in the design of vehicles- in India, Motor vehicles Act has made provisions to frame rules to control the noise produced by motor cycles.
- (ii) Changes in tyre/ surface characteristics- smooth surfaces result in less noise.
- (iii) Elimination of noisier vehicles- old vehicles produce more sound.
- (iv) Modifications in traffic operations- rerouting commercial vehicles and buses from residential areas, providing by-pass to prevent high speed traffic from entering towns, ensure continuous and smooth and eliminate acceleration noise, prohibiting blow horns.

- (v) Designing streets, buildings and areas for producing less noise- narrow streets create noise conditions (canyon effect). Hence, streets should be wide to reduce noise pollution. Shrubs, trees and grass on the side of the road act as sound barriers.

**11. Discuss the different initiatives of Indian government towards promoting Public transport service.**

**Public Transport** consists of mass rapid transit (MRT); Para-transit and personalized PT. MRT, both rail and road based and including city bus is the backbone of city transport as they are the only modes that carry very large number of people using minimum space. Paratransit Modes i.e. tempos and mini buses supplement MRT in large cities and can be the main mode of PT in medium and small size cities.

***Initiatives towards improving Public Transport services***

**1. Integrating land use and transport planning:** Provide 50% of the cost of preparing comprehensive city transport plans and detailed project reports and reduce travel demand by better integration of land-use and transport planning.

**2. Development of Suburban rail and metro systems.** Cities like Delhi, Mumbai, Chennai, Kolkata, Bangalore, and Hyderabad have all been either expanding or improving their rail systems.

**3. Privatization of bus services.** Compared to the publicly owned, operated, and subsidized bus services in the same cities, the privately run services have higher productivity, lower costs, more passengers per bus, and higher revenues per bus km of service.

**4. Improve motor vehicle technology and fuels.** The most successful measure was the complete phasing out of lead in fuels. The allowable levels of sulphur and benzene in fuels were also reduced. Expert commission of the Indian Government has recommended successively adopting the increasingly stringent Euro II, Euro III, and Euro IV emission standards for all new cars, taxis, trucks, and buses, first in the largest cities and then for the entire country (Ministry of Petroleum and Natural Gas, 2002).

**5. Jawaharlal Nehru National Urban Renewal Mission (JnNURM)** is a reform-based mission with due emphasis on urban transport. This mission emphasises on the commuter comfort while traveling in public transport at reasonable cost.

**6. Better cooperation among different transport agencies,** departments, and ministries as well as better overall coordination of transport and land-use policies.

**7. Central Government Initiatives like Atal Mission for Rejuvenation and Urban Transformation –AMRUT, Smart Cities Mission** emphasises on increasing the amenity value of cities by switching on to public transport or constructing facilities for non-motorized transport e.g. walking and cycling.

**12. Discuss the different initiatives of Indian government towards promoting Public transport service and non-motorized transport.**



*NMT* i.e. walk, cycle and cycle rickshaw are green modes of transport that belong to the low carbon path, do not consume energy or cause pollution, provide social equity and in addition provides employment.

***Initiatives towards improving non-motorized transport (NMT)***

1. *National Urban Renewal Mission (NURM)* of Central Government would give priority to the construction of cycle tracks and pedestrian paths in all cities.
2. *Formulation and implementation of specific “Area Plans” in congested urban areas* that propose appropriate mix of various modes of transport including exclusive zones for NMT.
3. *Central Government Initiatives like Atal Mission for Rejuvenation and Urban Transformation –AMRUT, Smart Cities Mission*
4. Construction of segregated rights of way for walk and cycles.
5. Segregation of vehicles moving at different speeds would enable full trips using NMT but also as a means of improving access to Public Transport stations.
6. Creative facilities like shade giving landscaping, provision of drinking water and resting stations along bicycle corridors
7. The use of the central verge along many roads, along with innovatively designed road crossings.
8. Pedestrian and cycle facilities including crossing facilities at busy intersections should be well-maintained and kept free of encroachments.

**13. Describe the different issues with non-motorized transport.**

The main barriers towards implementing a successful NMT policy are :

- Private-vehicle-oriented transport and spatial planning, which is business-as-usual in most countries, particularly developing.
- Public perception and status: walking, cycling (and public transport) is perceived as the transportation mode for the poor. The richer part of the population often has a disproportionate decision power, which makes NMT-focused policy risky. Often in developing countries there is a gender bias towards male cyclists.
- Safety: pedestrians and particularly cyclist are vulnerable, and therefore need separate road space, or at least be respected and taken note of by vehicle users.
- Lack of social safety, especially for females can also be a barrier. NMT users have a higher risk of being involved in accidents than car users, particularly in developing countries.
- Lack of convenient public transport, which is required to make NMT a good option for multi-modal trip (i.e. the combination of cycling and rapid bus or rail systems).
- Chicken-and-egg problem: people don't start cycling if there are few cycle lanes, and planners don't build these when there is no interest in cycling.
- Lack of overall long-term, integrated vision and planning.
- High costs for bicycles, including taxes.

**14. What are the different strategies for prevention of accidents?**

3 E's such as Engineering, Enforcement and Education can be utilized to reduce accidents.

**Safety measures related to engineering**

Road designs:

- Sight distances, width, horizontal and vertical alignment, intersection design elements
- Pavement surface characteristics, skid resistance values
- Necessary bypasses may be constructed
- Grade separated intersections

Preventive maintenance of vehicle

- braking system, steering system, lighting system should be checked regularly
- Heavy penalty on defective vehicles
- Special checks on public carriers

Before and after study

- By comparing the condition and collision diagnosis "before and after" the introduction of preventive measures
- After necessary improvements in design and enforcing regulation

Road lighting

- Proper road lighting especially at the intersections, bridge sites and at places where there are restriction in traffic movement

**Safety measures related to enforcement**

Speed control:

- Checks on spot speed of all vehicles should be done at different locations and timings and legal actions on those who violate the speed limit should be taken

Training and supervision

- The transport authorities should be strict while issuing licence to drivers of public service vehicles and taxis.
- Driving licence of the driver may be renewed after specified period, only after conducting some tests to check whether the driver is fit

Medical check

The drivers should be tested for vision and reaction time at prescribed intervals of time

**Safety Measures related to education**

The various measures of education that may be useful to prevent accidents are enumerated below.

Education of road users:

- The passengers and pedestrians should be taught the rules of the road, Correct manner of crossing etc.
- Introducing necessary instruction in the schools for the children and
- Posters exhibiting the serious results due to carelessness of road users.

Safety drive: Documentaries and films for road users and drivers

- Training courses and workshops
- Imposing traffic safety weeks

**15. What are the different causes of accidents?**

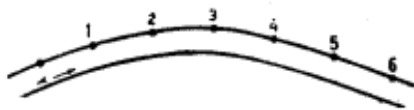
There are four basic elements in a traffic accident

- (i) The road users
- (ii) The vehicles
- (iii) The road and its condition
- (iv) Environmental factors

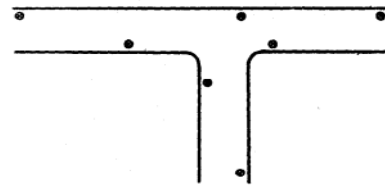
The different factors can be enlisted as follows:

- (i) Drivers : excessive speed, carelessness, violation of rules and regulations, sleep, alcohol
- (ii) Pedestrians: violation of rules, carelessness
- (iii) Passengers : alighting or boarding the moving vehicles
- (iv) Vehicle effects – failure of brakes, steering system, lighting system, tyre bursts any other defect in the vehicles
- (v) Road condition : slippery or skidding road surfaces, pot holes, ruts and other damaging conditions on the road surfaces
- (vi) Road design: defect in geometric design like inadequate sight distance, inadequate width of shoulders, improper kerb design, improper lighting and improper traffic control devices.
- (vii) Weather : unfavourable weather conditions like fog, mist, snow, dust, smoke or heavy rainfall and so on
- (viii) Animals : stray animals on the road
- (ix) Other causes : incorrect signs or signals, ribbon development, level crossing, advertisement boards and so on.

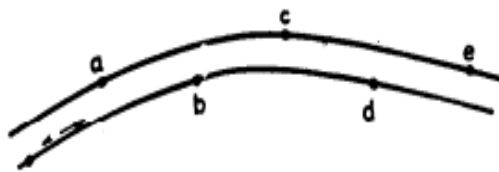
16. **Draw typical street lighting configuration for roads.**



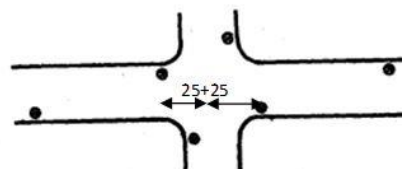
5A Single Side Arrangement of Luminaires on a Bend



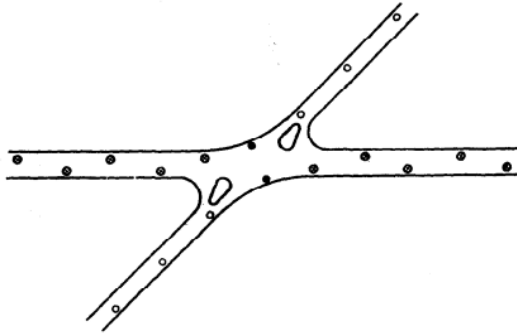
SITING RECOMMENDED AT A T-JUNCTION



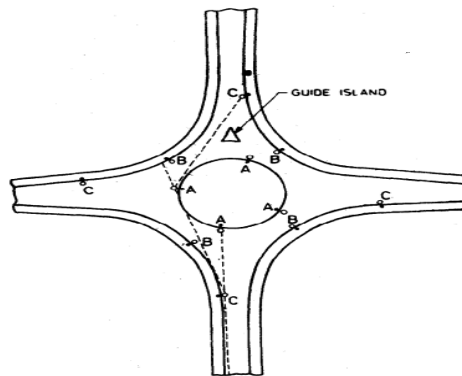
6A Staggered Arrangement on a Curve



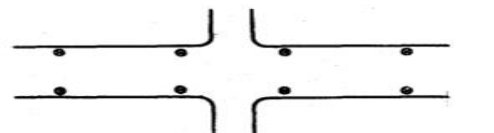
SITING RECOMMENDED AT THE INTERSECTION OF TWO  
ROADS LIGHTED WITH STAGGERED ARRANGEMENT



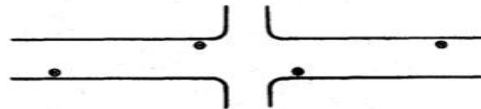
SITING RECOMMENDED AT ROAD WITH GUARD ISLAND



TYPICAL LAYOUT AT A ROUNDABOUT



Siting Recommended for the Intersection of a Lighted Road with Opposite Arrangement and an Unlighted Road



Siting Recommended at the Intersection of a Lighted Road with Staggered Arrangement and an Unlighted Road

SITING RECOMMENDED AT THE INTERSECTION