UNIT-II

Accident Analysis

Accident Analysis:

- Accident Investigations and Risk Management,
- Collection and Analysis of Accident Data,
- Condition and Collision Diagram,
- Causes and Remedies,
- Traffic Management Measures and Their Influence on Accident Prevention,
- Assessment of Road Safety, Methods to Identify and Prioritize Hazardous Locations and Elements,
- Determine Possible Causes of Crashes, Crash Reduction Capabilities and Countermeasures, Effectivenessof Safety Design Features,
- Accident Reconstruction.
- Application of computer analysis of accident data.

Accident Analysis:

- Accident analysis is **carried out in order to determine the cause or causes of an accident** (that can result in single or multiple outcomes) so as to prevent further accidents of a similar kind. It is part of accident investigation or incident investigation .

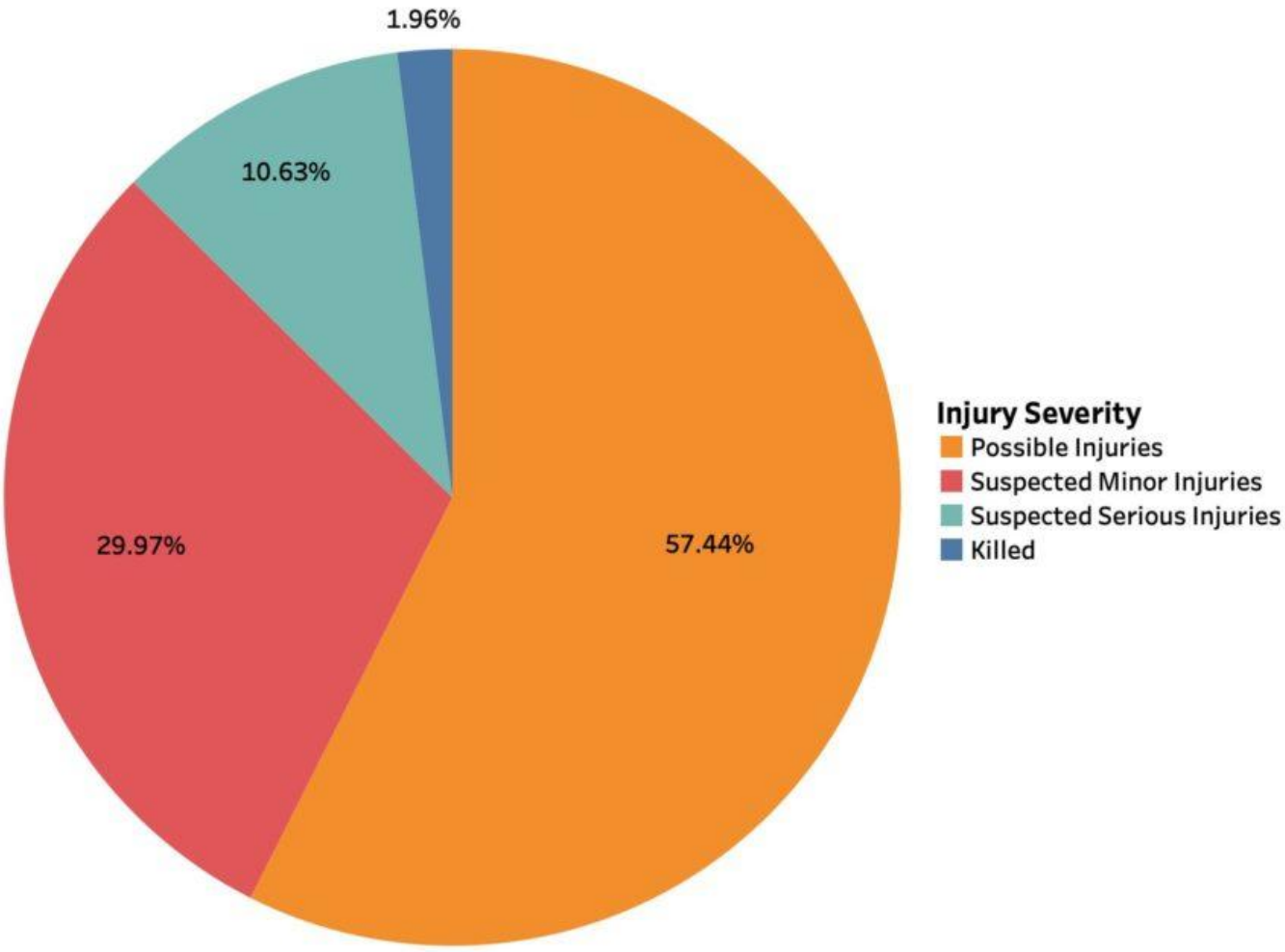
Period	Human factor	Vehicle Factor	Roadway Environment Factor
•Before (crash factor contributing increases risk of crash)	•Distraction •Fatigue •Inattention •Poor •Judgment, •Age •Cell phone usage. •Deficient driving habits	•Worn Tires, •Worn Brakes	•Wet pavement (ROAD) •Polished aggregate. •Steep down grade. •Poorly coordinated signal system. •No street lights.

Period	Human factor	Vehicle Factor	Roadway Environment Factor
•During Crash (crash factor contributing increases risk of crash)	•Vulnerability to injury •Age •Failure to ware seat belt •Driving speed •Not wearing Helmet.	•Bumper height •Energy absorption •Headrest design •Air bags operation	• Pavement (ROAD) friction •Grade •Road side environment.

Period	Human factor	Vehicle Factor	Roadway Environment Factor
•After Crash (crash factor contributing increases risk of crash)	•Age •Gender.	•Ease to remove injured person.	• Time and quality of the emergency services. •Response •Medical treatment

Road Accident Sampling System - India (RASSI): India's first in-depth scientific accident database

- This is conducted in co-operation with the police and ambulance agencies who notify researchers about an accident.
- Researchers, on reaching the crash scene, use internationally accepted methodologies customized for Indian conditions to examine crashes, collect data scientifically, and identify the factors that caused the accident and the resulting injuries.
- The analyzed data is reported to the government and industry to enable them to make data-driven decisions and come up with cost-effective measures to reduce accidents and injuries.



Scientific investigations and data collection

Source of road data.

- Footage from CCTV if available.
- From P.S (Police Station)
- Based on type of Injury.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S.no	Source	Type of Data	Observation
1	Police station	•No. of road traffic accidents, fatalities and injuries. •Type of road user as per gender, age. •Holding of Driving license. •Alcohol consumption. •Vehicle Registration number. •Collision diagram.	•The level of details varies from person to person •PS to PS •Sometimes police records are inaccessible. •Under reporting of crashes.

S.no	Source	Type of Data	Observation
2	Health Facility Institutes.	•Fatal and Non fatal injuries information. •Age of the victim •Gender and treatment cost. •Victims info and time and location.	•Details varies from each healthcare facilities. •Records will be inaccessible.


Insurance
Policy


CAR INSURANCE


INSURANCE CLAIM FORM
INSURANCE CLAIM FORM

S.no	Source	Type of Data	Observation
3	Insurance Firms	•Fatal and Non fatal injuries information. •Property damage details of damaged percent of vehicles. •Age of the victim •Gender and treatment cost.	•Data will be inaccessible.


सत्यमेव जयते
MoRTH
Ministry of Road Transport & Highways
Government of India


NATIONAL HIGHWAY
AUTHORITY OF INDIA
भा रा रा प्रा
NHAI

S.no	Source	Type of Data	Observation
4	Public Agencies (NHAI,MORTH)	•Vehicle population data. •Income data. •Pollution data. •Fuel consumption data. •Growth of vehicles.	•Data collected will be important for analysis of road traffic injuries as it comprises of the detailed info related to crash and income parameters.

- National Highway Authority of India (NHAI)
- Ministry of Road Transportation and Highway.

S.no	Source	Type of Data	Observation
5	Private Firms (Toll Plaza , Ola, Uber etc)	•Location time •Injury •Insurance	•Data is inaccessible.
6	Special Interest Groups (Research Institutions, NGO's, Victim support org, Transportation unions, Consulting firms	•Type Injury. •Type of crash. •Time, data, location. •(Detail study of socio economic impact)	•Data varies from org to organization. •NGO'S don't have in-depth of data.

Indicators to Define Road Traffic Injuries

Indicators	Description	Uses & Limitations
1 . No of Injuries	Absolute fig indicating the no of people injured in road traffic crashes. Injuries sustained may be serious or minor type.	Useful for planning at the local level, useful for calculating cost of medical case. Not very useful for making compositions [as large population of sight injuries are not reported]

Indicators	Description	Uses & Limitations
2. No of Death [Imp Indicator for comparison]	Absolute fig indicating the no of people who lost their life due to road traffic crash	It gives a partial estimate of the magnitude of road traffic injury problem in terms of death. It is also useful for planning at the local level for emergency medical services & other improvements

Indicator	Description	Uses & Limitations
3. Facilities per 10000 vehicles	Relative figure showing the ratio of facilities to the no of motor vehicles	This shows the probability of vehicles involved in fatal crashes. The number or value declines with increase in motorization. It omits the study assessment of non motorized transport

Indicator	Description	Uses & Limitations
4. Facilities per 100,000 population	It is the relative fig showing ratio of fatalities to population	This shows the impact of road crashes on human population as a public health problem. It is also useful for comparing road traffic injuries as a health problem with difficult communities, states and countries. It is also useful for estimating the severity of crashes at that particular location.

Indicator	Description	Uses & Limitations
5. Facilities per vehicle-km travelled.	It is the no of road deaths per-billion km's travel.	Useful for international comparisons. It decreases with increase in motorization. It does not take into account non-motorized travel

Indicator	Description	Uses & Limitations
6. Disability adjusted - {DALYS}	It measures the healthy life year lost due to disability and mortality 1DALY(Disability Adjusted Life Year) lost = 1year of healthy life lost. (Either due to premature death or disability)	DALYS – Combine both mortality & disability. DALYS do not include all the health consequences associated with the injury (ex-Mental health consequences)

Accident Investigations and Risk Management

For each type of accident, three questions should be asked:

1. What driver actions lead to the occurrence of such accidents?
2. What existing conditions at the site could contribute to drivers taking such actions?
3. What changes can be made to reduce the chances of such actions taking place?

Investigative approaches used to develop accident reduction programmers

- There are four main investigative approaches used to develop accident reduction programmes.
- These are described as:
  1. Single site schemes
  2. Mass action programmes.
  3. Route action programmes.
  4. Area action programmes.

Investigate approaches used to develop accident reduction programmes

- All involve four major planning Steps:

    a) Data collection, storage and retrieval,
    b) Identification of hazardous locations for further study
    c) Diagnosis of the accident problem(s), and
    d) The final selection of sites to be included in the remedial implementation programme

- The accident data collection is the first step in the accident study. the data collected of the accidents is primarily done by police. motorist accident reports are secondary data which are filled by motorists themselves. The data to be collected should compare all of these parameters :

- General - Date, time, person involved in accident, classification of accident like fatal, serious, minor.
- **Location** - Description and detail of location of accident
- **Details of vehicle involved** - Registration number, description of vehicle, loading detail, vehicular defects.
- **Nature of accident** - Details of collision, damages, injury and casualty
- **Road and traffic condition** -Details of road geometry, surface characteristics, type of traffic, traffic density etc..
- **Primary causes of accident** - Details of various possible cases (already mentioned) which are the main causes of accident.
- **Accident cost** - Financial losses incurred **due to** property damage, personal **injury and casualty**

These data collected need proper storing and retrieving for the following purpose. The purposes are as follows:

1. Identification of location of points at which unusually high number of accident occur.
2. Detailed functional evaluation of critical accident location to identify the causes of accidents.
3. Development of procedure that allows identification of hazards before large number of accidents occurs.
4. Development of different statistical measures of various accident related factors to give insight into general trends, common casual factors, driver profiles, etc.

The accident data collection involves following procedure:

1. **Reporting**: It involves basic data collection in form of “ **two** methods:

- **Motorist accident report -** It is filed by the involved motorist involved in all accidents fatal or injuries.
- **Police accident report -** It is filed by the attendant police officer for all accidents at which an officer is present. This generally includes fatal accidents or mostly accidents involving serious injury required emergency or hospital treatment or which have incurred heavy property damage.

2. **At Scene-Investigation:**

   It involves obtaining information at scene such as measurement of skid marks, examination of damage of vehicles, photograph of final position of vehicles, examination of condition and functioning of traffic control devices and other road equipments.

- **Technical Preparation:** This data collection step is needed for organization and interpretation of the study made. In this step measurement of grades, sight distance, preparing drawing of after accident situation, determination of critical and design speed for curves is done.

- **Professional Reconstruction:** In this step effort is made to determine from whatever data is available how the accident occurs from the available data. This involves accident reconstruction which has been discussed under Section No.7 in details. It is professionally referred as determining behavioral or mediate causes of accident.

- **Cause Analysis:** It is the effort made to determine why the accident occurred from the data available and the analysis of accident reconstruction studies.

- The purpose is to find the possible causes of accident related to driver, vehicle, and roadway. Accident analyses are made to develop information such as:

- **Driver and Pedestrian** - Accident occurrence by age groups and relationships of accidents to physical capacities and to psychological test results.
- **Vehicle** - Accident occurrence related to characteristic of vehicle, severity, location and extent of damage related to vehicles.

- **Roadway conditions** - Relationships of accident occurrence and severity to characteristics of the roadway and roadway condition and relative values of changes related to roadways.

- It is important to compute accident rate which reflect accident involvement by type of highway.
- These rates provide a means of comparing the relative safety of different highway and street system and traffic controls. Another is accident involvement by the type of drivers and vehicles associated with accidents.

i) Collection of Accident Data

- **General** : Date, time, persons involved in the accident and their particulars classifcation of accident like fatal, serious, minor etc.,
- **Location** : Description and details of the location of accident.
- **Details of vehicles involved**: Registration number makes and description of vehicles, loading details, vehicular defects.
- **Nature of accident** : condition of vehicles involved, details of collision and pedestrians or objects involved, damages, injuries casualty etc.
- **Road and traffic conditions** : Details of road geometrics, whether the road is straight or curved, surface characteristics such as dry, wet or slippery etc. Traffic condition- type of traffic, traffic density, etc.,

- Primary causes of accidents : various possible causes and the primary cause of the accident.
- Accident costs: The total cost of the accident computed in terms of rupees, of the various involvements like property damages, personal injuries and casualities.

ii) Accident report

- The accident should be reported to police authorities who would take legal actions especially in more serious accidents invilving injuries, casualities or severe damage to property.
- Accident report of the individuals involved may be separately taken.
- The accident data should be collected as given above and the accident report is prepared with all facts which might be useful in subsequent analysis, claims for compensation, etc.,

Condition and Collision diagram *(imp)

CONDITION DIAGRAM :

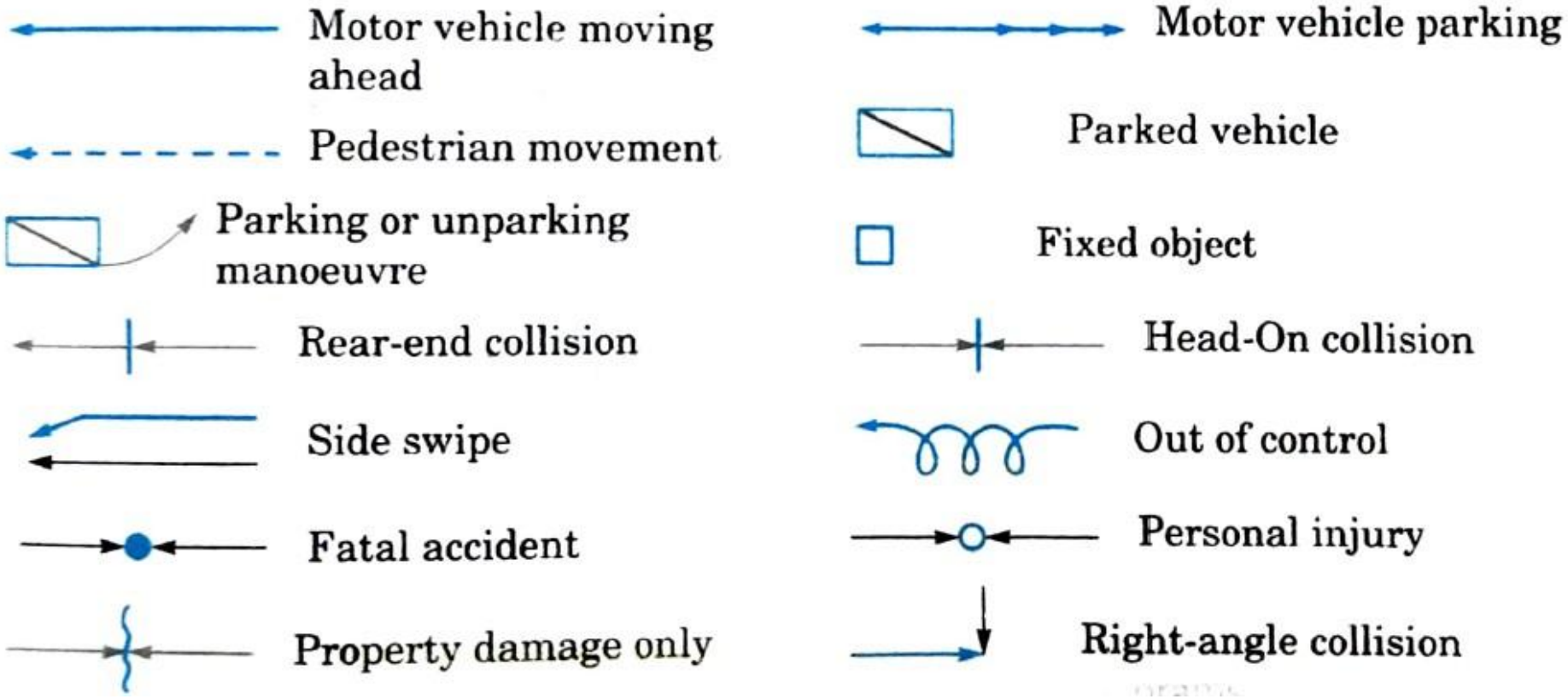
- A condition diagram is a drawing to a scale showing all important physical conditions of an accident location to be studies.
- Roadway limits, curves, kerb lines, bridges, culverts, trees, road conditions, obstruction to vision, property lines, signs, signals etc.,

The condition diagram and collision diagrams may be combined together in a single sketch, if necessary.

- **COLLISION DIAGRAM** :

These are diagrams showing the approximate path of veicles and pedestrians involved in the accident .

Collision diagrams are most useful to compare the accident pattern before and after the remidial measures have been taken.



COLLISION TYPE

HEAD-ON

RUN OFF ROAD

REAR END

SPIN ON ROAD

SIDESWAP

HIT FIX OBJECT

A

ANIMAL HIT

LEGEND:

TYPE OF VEHICLE

1 - CLASS 1

2 - CLASS 2

3 - CLASS 3

4 - CLASS 4

5 - CLASS 5

TIME

DAY

NIGHT

DAWN

WEATHER

GOOD

RAIN

FOG

CRASH SEVERITY

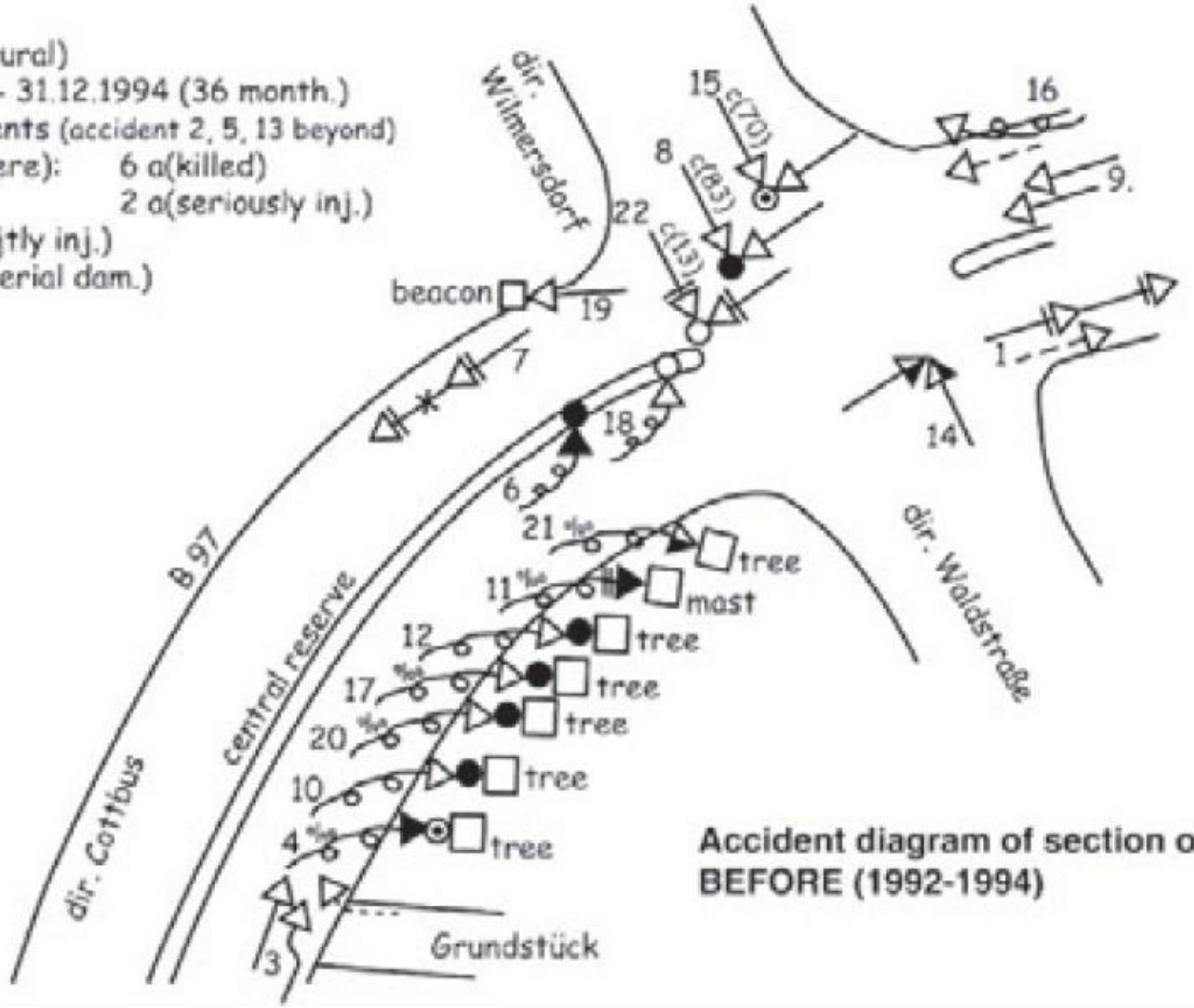
PDO

LIGHT INJURY

SERIOUS INJURY

FATAL

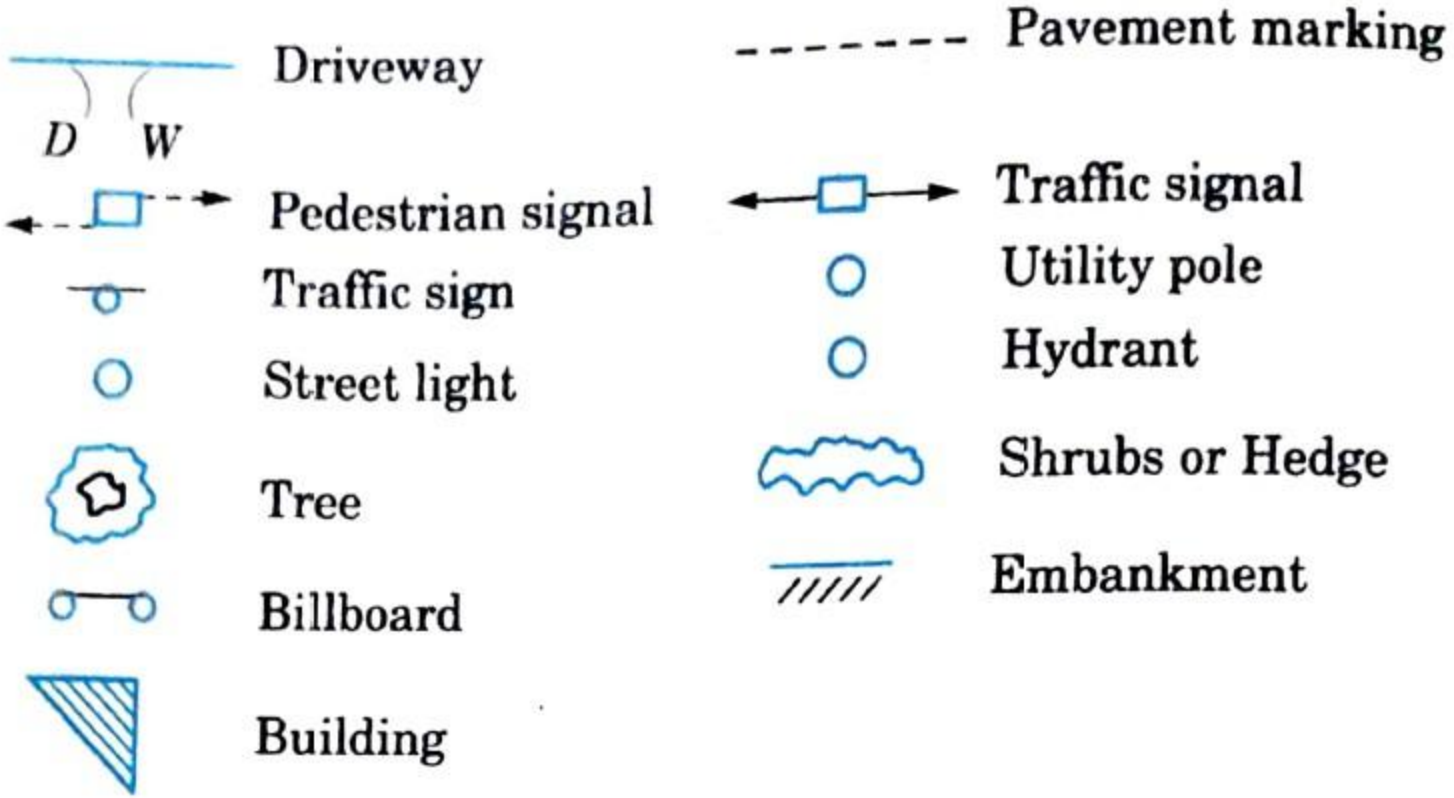
B 97 (rural)
1.1.1992 - 31.12.1994 (36 month.)
19 accidents (accident 2, 5, 13 beyond)
8 a(severe): 6 a(killed)
2 a(seriously inj.)
2 a(sligjtly inj.)
9 a(material dam.)



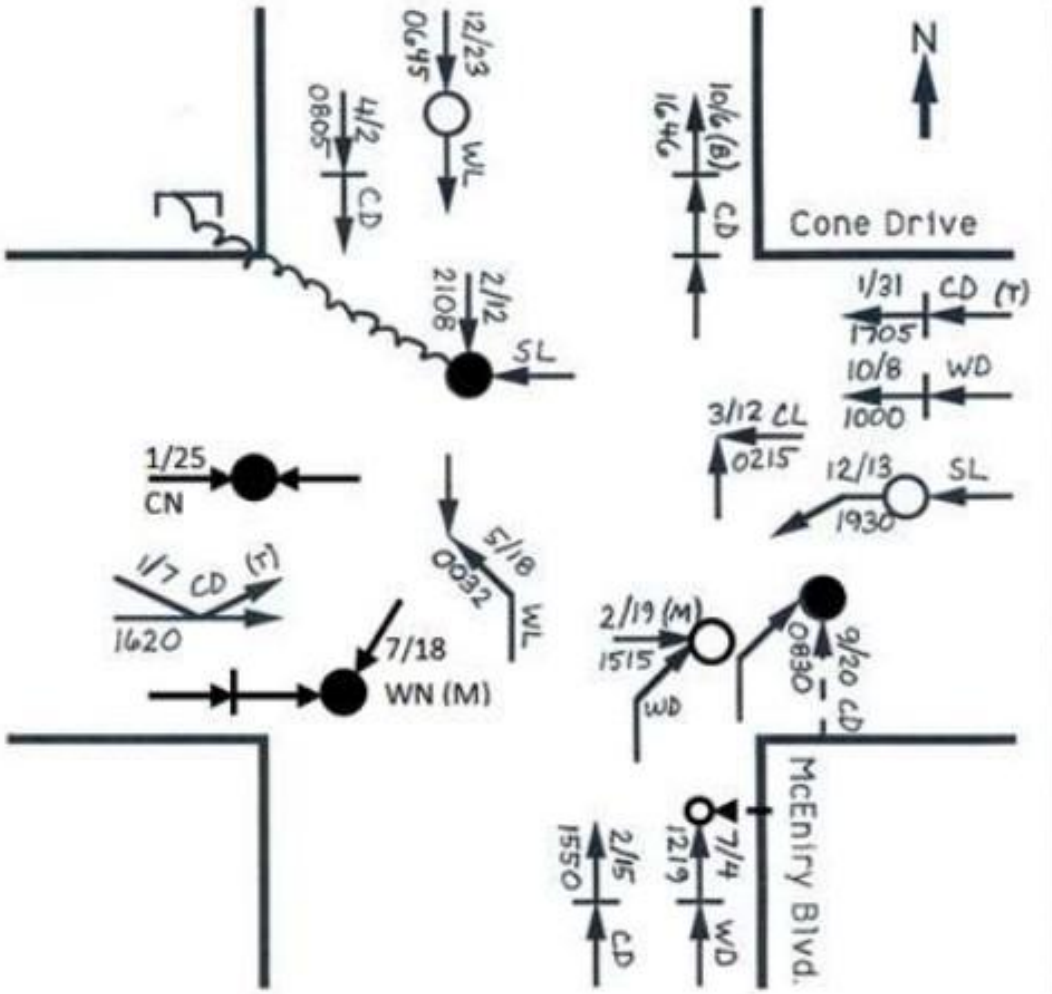
Accident diagram of section of interest BEFORE (1992-1994)

clues to the accident causation.

A typical collision diagram is given in Fig. 18.3.



1/1/09 – 12/31/09



Key to Collision Diagram Symbols

Vehicle Type

- Automobile
- (T) Truck
- (B) Bus
- (M) Motorcycle
- (O) Other
- Pedestrian
- Uninvolved

Vehicle Movement

- Left
- Right
- Straight
- Backing

Severity

- PDO
- Injury
- Fatal

Accident Type

- Rear-End
- Head-On
- Angle
- Sideswipe, Same Direction
- Sideswipe, Opposite Direction
- Out of Control
- Collision with Fixed Object

Road Surface

- C Dry, Clear
- W Wet
- S Snowy, Icy
- O Other

Lighting

- D Daylight
- N Dark, No Lights
- L Dark with Street Lights

Collision diagaram at a junction

It may be seen that the pedestrian path is indicated by dotted lines whereas the path of the vehicle is indicated by solid lines, and the direction of travel is indicated by arrows. The date and time (to the nearest hour) can be conveniently indicated on one of the arrows. Any extraordinary weather or road-way conditions or details of the persons involved in the accident can also be noted such as 'fog', 'ice', 'drunken driver', etc. 'Before' and 'after' collision diagrams will be useful in assessing the efficacy of the measures undertaken to improve the location. A diagram of traffic flow at the junction can help provide valuable

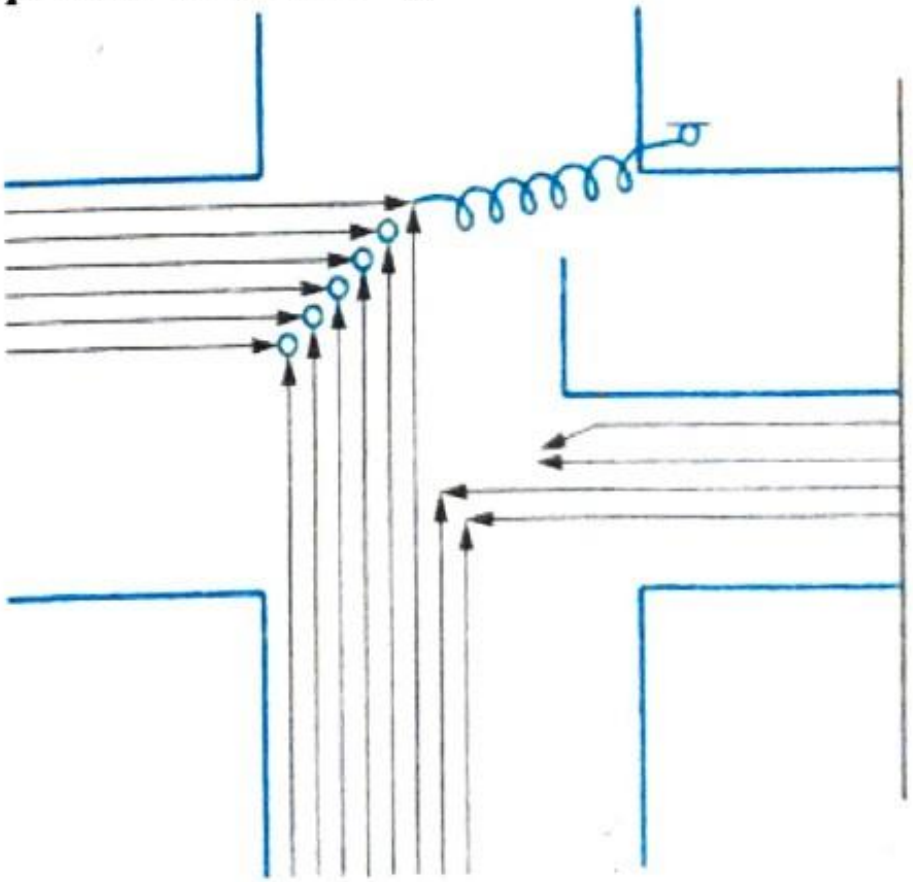


Fig. 18.3. Typical collision diagram at a junction.

Important Physical Features of Collision Diagram *

(*i*) Geometric features of the location, giving the street width, shoulder width, corner radii and curb lines.

(*ii*) Property lines.

(*iii*) Footways and driveways.

(*iv*) Separate cycle tracks, if any.

(*v*) Sight obstructions in the roadway.

(*vi*) Traffic signs, signals and markings.

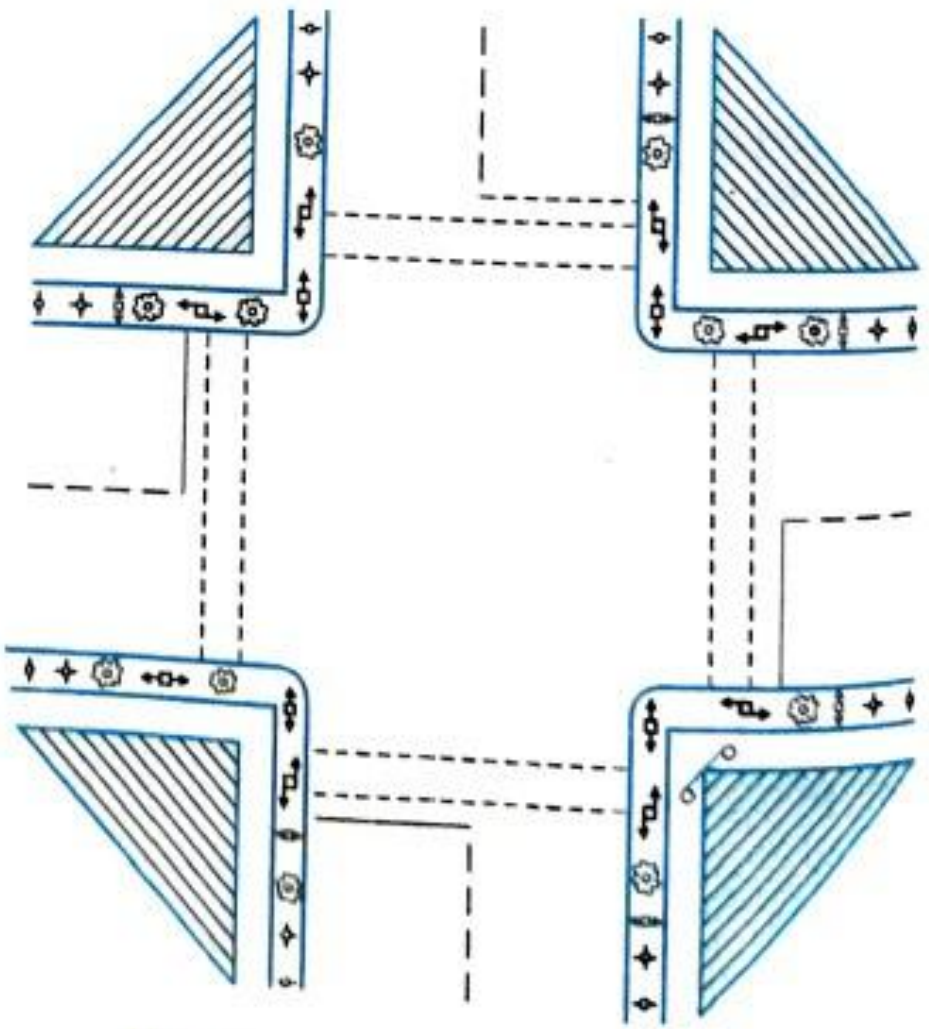
(*vii*) Street lighting.

(*viii*) Bridges, culverts, overbridges and underpasses.

(*ix*) Ditches along the roadway.

(*x*) Parking regulations.

The condition diagram is facilitated by the use of standard symbols. Fig. 18.4 indicates the standard symbols that are commonly employed.



Causes of accidents (collisions)
Causes of crash :

Pattern	*Probable Cause*
Left-turn head-on collisions	• Large volume of left turns • Restricted sight distance • Too short amber phase • Absence of special left-turning phase • Excessive speed on approaches
Right-angle collisions at signalized intersections	• Restricted sight distance • Excessive speed on approaches • Poor visibility of signal • Inadequate signal timing • Inadequate roadway lighting • Inadequate advance intersection warning signs • Large total intersection volume

Pattern	possible cause
Right-angle collisions at unsignalized intersections	• Restricted sight distance • Large total intersection volume • Excessive speed on approaches • Inadequate roadway lighting • Inadequate advance intersection warning signal • Inadequate traffic control devices
Rear-end collisions at unsignalized intersections	• Driver not aware of intersection • Slippery surface • Large number of turning vehicles • Inadequate roadway lighting • Excessive speed on approach • Lack of adequate gaps • Crossing pedestrians

Pattern	possible cause
Rear-end collisions at signalized intersections	• Slippery surface • Large number of turning vehicles • Poor visibility of signals • Inadequate signal timing • Unwarranted signals • Inadequate roadway lighting
Pedestrian-vehicle collisions	• Restricted sight distance • Inadequate protection for pedestrians • School crossing area • Inadequate signals • Inadequate phasing signal

Remedies of accidents (collisions)

Crash Reduction Capabilities:

- Shaping the road network for road injury prevention is one of the major step to be provided for operating the road network for safety
- Improved conditions of road has a great influence on reduction of number of accidents.

Road network for safety

1. Safe Speed.
2. Speed on curves.
3. Sign distances.
4. Super elevation.
5. Carriageway width.
6. Width and condition of shoulders.
7. Road signs and Road Markings.
8. Junction design
9. Widening of narrow bridges
10. Median width
11. Street lighting

1. **Safe Speed**:

   Classifying roads based on their utility and setting speed limits is important for road safety.

   The roads are classified as

- National Highways (NH),
- State Highways (SH),
- Major District Roads (MDR),
- Village Roads (VR).

2. **Speed on Curves** :

- The speed at which a vehicle can take a curve depends on radius of curvature of curve,
- Shape curves permit low speed and
- large radii curves permit to high speeds.
- Hence design of curves should be taken into consideration depending upon the road type.

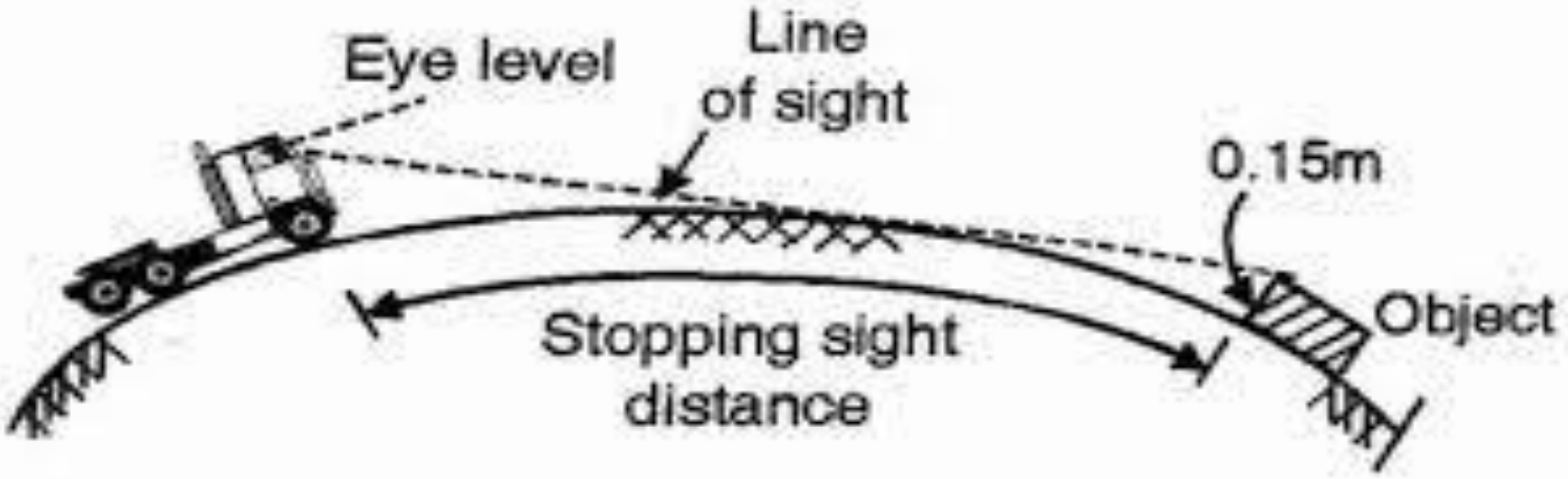
3. **Sight Distance** :

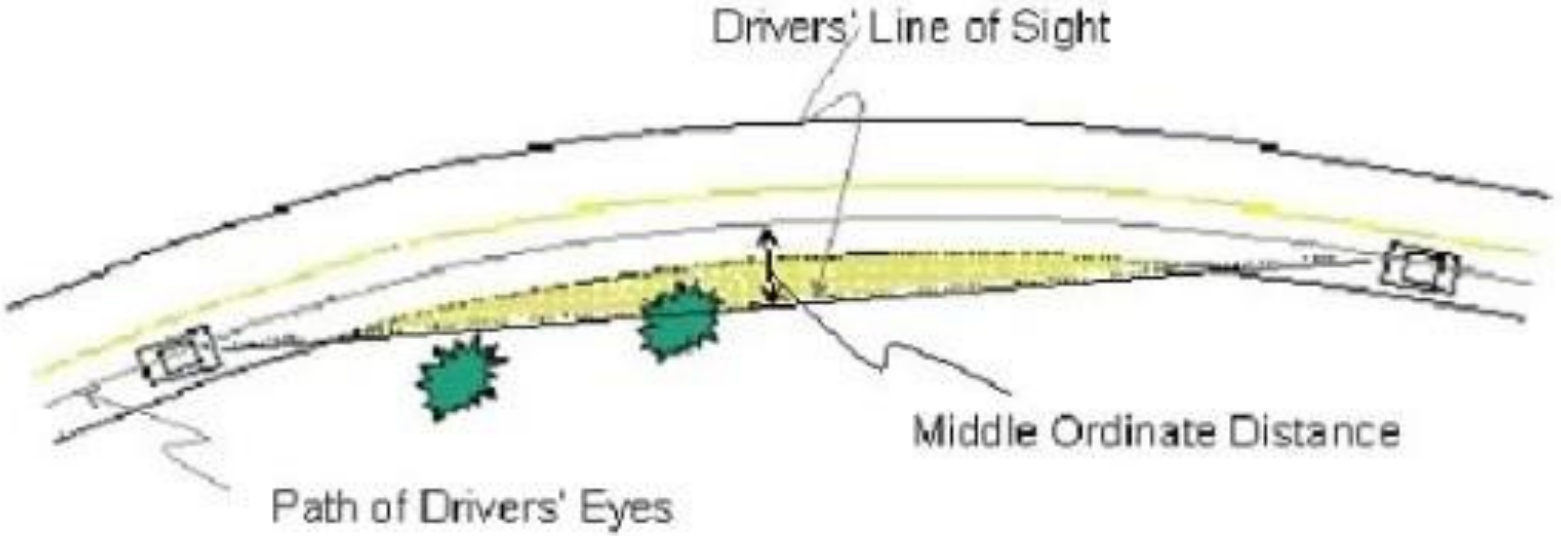
Safe stopping sight distance (SSD)

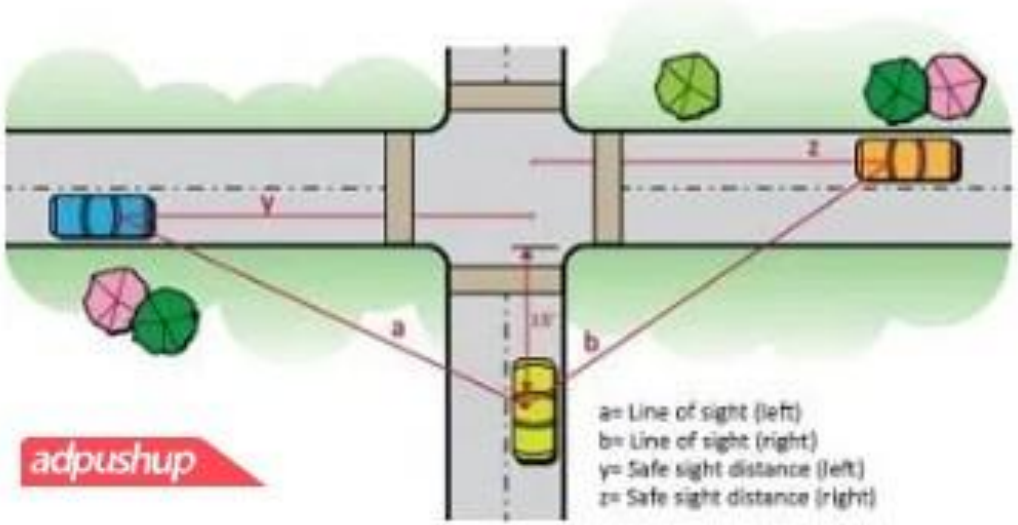
Overtaking sight distance (OSD)

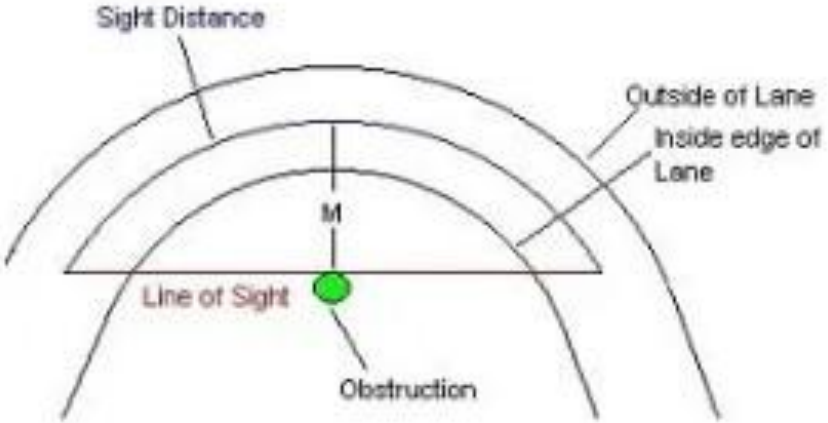
Safe stopping sight distance (SSD)

- The stopping sight distance is **the sum of the lag distance and the braking distance**. Lag distance is the distance the vehicle traveled during the reaction time t and is given by vt, where v is the velocity in m⁄sec2




Drivers' Line of Sight
Middle Ordinate Distance
Path of Drivers' Eyes


z
y
a
b
a= Line of sight (left)
b= Line of sight (right)
y= Safe sight distance (left)
z= Safe sight distance (right)


Sight Distance
Outside of Lane
Inside edge of Lane
M
Line of Sight
Obstruction

Stopping Sight Distance (SSD) Calculation

Minimum sight distance for the driver to stop without colliding at any point of the highway

$$SSD = Lag\ Distance\ (Reaction\ Time) + Braking\ Distance\ (After\ application\ of\ brakes)$$

$$SSD = vt + \frac{v^2}{2g\left(f \pm \frac{n}{100}\right)}$$

v – Speed of vehicle
t – Reaction time
f – Friction co.efficient
1 in n slope

Let Us analyze and solve the problem

Since

Stopping distance = Lag distance + Braking distance

$$= vt + \frac{v2}{2gf}$$

Here the value of v is in terms of kmph we should convert it in terms of m/sec

i.e.

$$V = 50\ kmph$$

- 1km/h= 0.277m/s
- 50km/h= 13.9 m/s

$$v = \frac{50}{3.6} = 13.9m/s$$

Given

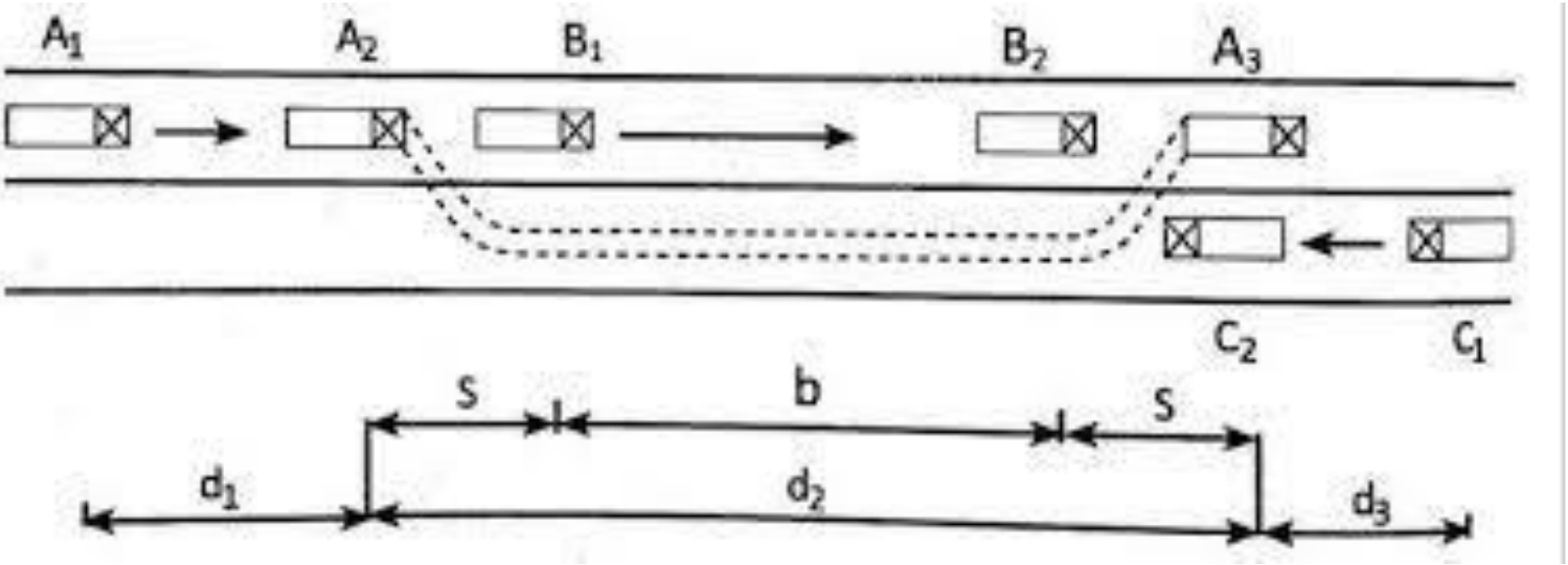
$$t = 2.5, \quad g = 9.8, \quad f = 0.37$$

$$\text{Stopping site distance} = 13.9\ X\ 2.5 + \frac{(13.9)2}{2\ X\ 9.8\ X\ 0.37}$$

$$= 61.4m$$

Overtaking sight distance (OSD)

- The overtaking sight distance is the minimum distance open to the vision of the driver of a vehicle intending to overtake the slow vehicle ahead safely against the traffic in the opposite direction



- **SUPER ELEVATION** :

  Superelevation is the transverse slope provided to counteract the effect of centrifugal force and reduce the tendency of vehicle to overturn and to skid laterally outwards by raising the pavement outer edge with respect to inner edge. superelevation is represented by “ e ”

CARRIAGE WAY WIDTH.

- According to Indian Road Congress, the width of carriageway is. (i) **3.75 m for single lane**. (ii) 7.0 m for two lanes without raised kerbs. (iii) 7.5 m for two lanes with raised kerbs.
- **Multi-lane pavement:** 3.5 m per lane
- **Two lanes, with raised kerbs:** 7.5 m
- **Single lane:** 3.75 m

- Accidents are caused due to overtaking and crossings across Carriage way.
- Carriage width should be designed And maintained as per Indian Standards.

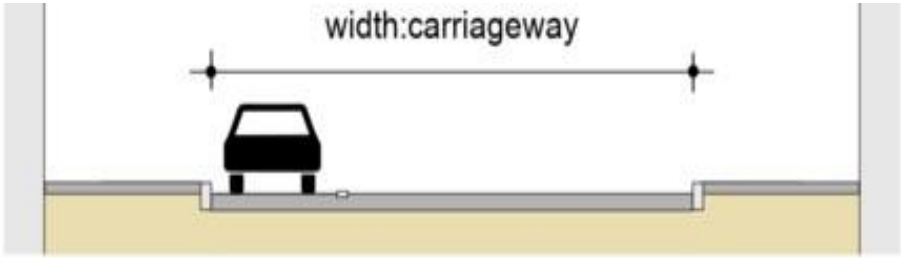
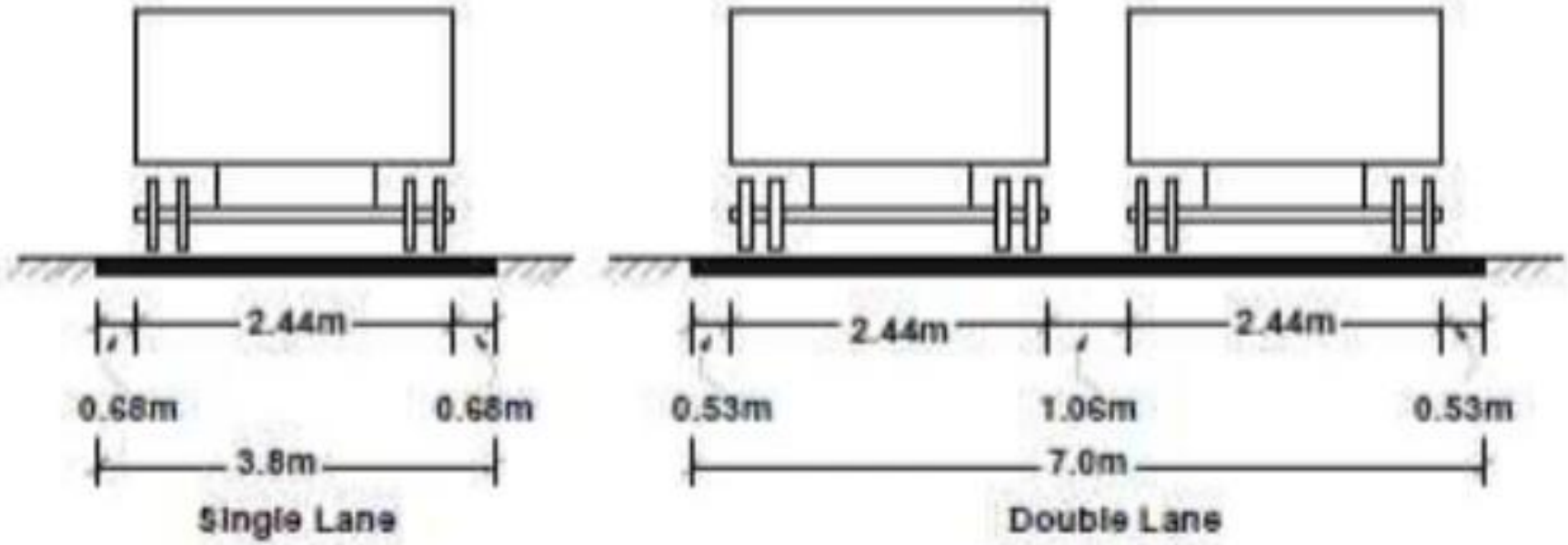


Table 12:2: IRC Specification for carriage way width

Single lane	3.75
Two lane, no kerbs	7.0
Two lane, raised kerbs	7.5
Intermediate carriage	5.5
Multi-lane	3.5



Width and condition of shoulders

- Shoulders are provided for parking, stopped vehicles.
- In Indian senario people use it for overtaking and crossing which leading to accidents.
- Hence shoulders should be provided with sufficient width.

ROAD SIGNS AND ROAD MARKINGS

- Road signs should be placed properly so that they can inform the driver about hazardous situations ahead.
- Similarly road markings like centre line markings, stop lines markings etc.. Can prevent acidents.

Junction Design

- Any deficency in the design of junction can cause accidents.
- Elements of junction design such as
- turning radius,
- width at entry & exit,
- Channelizing islands should receive proper attention.

Widening of narrow bridge :

- If bridges are narrow, there will be more accidents,
- Hence narrow bridges should be widened.

Median width :

A wide median prevents glare from opposite flow of traffic and promotes safety.

Street Lightning:

Adequate street lightning should be provide to prevent accidents.

TRAFFIC MANAGEMENT MEASURES AND THEIR INFLUENCE ON ACCIDENT PREVENTION

Measures for road disaster prevention:

- Recognizing the road enveronment as an interactive organic condition, road alignment, pavement materials, geological and hydrological conditions etc.
- Emphasizing highway planning and field investigations, before planning the construction of road various field tests should be carried out to analyze tectonic environment, hydrological environment etc.,

- Strengthening the monitoring severe weather and risk assessment. Weather forecasting should be strengthened and they should be timely released to public by radio, T.V.As accidents caused due to weather can be minimized.
- Speed limits should be fixed for different classes of roads.
- Headlights should be used & maintained properly for vehicles.
- Always use signals, even if traffic is very less at junctions.

Precautionary measures for road safety.

- Tightening of safety standards for vehicles.

  Like seatbelts, power steering, antilock breaking system etc., should be strictly used.
- Construction of bypass, flyover and ring roads.

  Which can be used in diversion of traffic which would prevent accidents.
- Maintenance of roads should be carried out frequently to save vehicle operating cost and thus improving safety.
  - Pedestrians should be kept in view in planning and designing a traffic facilities.

- Provision of parking facilities should be provided appropriately which may be a solution for footpath parking and road landing parking which are the major cause of traffic conjunction.
- Provision of proper drainage facilities, which is one of the cause of traffic accidents due to stagnation of water and pavement failure.
- Street lights and road signs : most of the roads are not having proper street lights and thus makes driving very difficult during nights which leads to accidents. Periodicall maintainence of the street light are needed with proper road signs where ever necessary.

ASSESMENT OF ROAD SAFETY

- LICENSING SYSTEM
- PUBLIC TRANSPORTATION
- INTELLIGENT TRANSPORT SYSTEMS (ITS)

EFFECTIVENESS OF SAFETY DESIGN FEATURES:

- VEHICLE DESIGN FACTORS :
- DRIVER CHARECTERISTICS: