

Lecture 2.11

2.6 Accident Studies

Importance of Traffic Safety and Accident Studies

Accident studies aim to systematically identify why traffic crashes occur and how engineering interventions can prevent future occurrences.

India accounts for a disproportionate share of global road traffic fatalities, highlighting the urgent need for rigorous accident analysis and safety engineering.

- Identifies high-risk collision locations (Blackspots) on road networks
- Determines root contributing factors (Human, Vehicle, Road, Environment)
- Evaluates the safety effectiveness of engineering modifications
- Provides statistical justification for traffic safety funding allocation

Causes of Road Accidents (The Four Main Factors)

Road crashes rarely result from a single isolated cause; they usually involve complex interactions between four major contributing factors.

Engineers analyze the relative contribution of each factor to design targeted safety countermeasures.

Human
(80-90%)
Speeding,
Distraction

Vehicle
(5-10%)
Brakes, Tires

Road
(5-15%)
Geometry, Sight

Environment
(Varies)
Rain, Fog, Ice

Objectives of Conducting Accident Investigations

Accident investigation gathers detailed factual evidence from crash scenes to reconstruct events and diagnose roadway deficiencies.

Civil engineers focus on physical evidence such as skid marks, sight obstructions, surface friction, and guardrail damage.

- Reconstructing vehicle trajectory and collision speed from skid marks
- Assessing structural damage to roadway furniture and vehicles
- Identifying recurring collision patterns at specific intersections
- Filing standardized police and highway department crash reports

Data Collection Procedures for Road Accidents

Accident data is collected from police First Information Reports (FIRs), hospital records, and on-site engineering surveys.

Standardized crash report forms record location details, weather, road surface condition, lighting, vehicle type, and driver demographics.

- Police Crash Report Forms: Primary source of official accident records
- GIS Crash Mapping: Geo-referencing accident coordinates on digital road maps
- In-depth Crash Investigation (IDCI): Specialized engineering inspection teams
- Hospital Emergency Records: Supplementing non-fatal unreported injury data

Condition Diagrams: Purpose and Components

A Condition Diagram is a scaled physical drawing showing all permanent physical features of an accident location or intersection.

It provides a visual map of physical conditions that might influence driver behavior or obscure sight lines.

- Roadway Geometrics: Pavement width, lane alignment, gradients, curb radii
- Physical Obstructions: Trees, signs, buildings, hedges blocking sight distance
- Control Devices: Traffic signals, stop signs, warning signs, pavement markings
- Road Surface: Pavement type, potholes, drainage grates, shoulder condition

Collision Diagrams: Preparation and Interpretation

A Collision Diagram is a schematic diagram showing the direction of movement, collision type, and time of all accidents occurring at a location over a given period (e.g., 3 years).

Standardized symbols represent different collision types, such as head-on, rear-end, angle, sideswipe, and pedestrian crashes.

- Uses arrows to indicate vehicle direction of approach and collision paths
- Displays crash date, time of day, weather, and severity code
- Clusters of identical crash types pinpoint specific engineering flaws
- e.g., Heavy rear-end crashes suggest inadequate signal amber timing

Analysis of High Accident Locations (Blackspots)

An Accident Blackspot is a highway location (intersection or road section) exhibiting a statistically higher crash frequency or severity than average.

Blackspots are prioritized for urgent engineering remedial measures to achieve maximum safety benefit per rupee spent.

- Identification Criteria: e.g., 5 or more fatal/serious crashes within 500 m in 3 years
- Weighted Severity Index (WSI): Assigns higher weight to fatal crashes over minor injuries
- Ranking blackspots across national, state, and urban road networks
- Developing site-specific countermeasure plans

Statistical Measures of Accident Rates

To compare safety performance across road segments with varying traffic volumes, raw crash counts must be converted into normalized accident rates.

Engineers compute crash rates per million entering vehicles (for intersections) or per 100 million vehicle-kilometers (for road links).

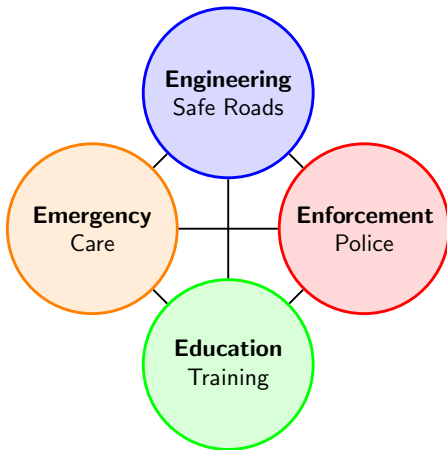
Measure	Formula	Variables
Intersection Rate	$R_{int} = \frac{A \times 10^6}{365 \times V_{daily}}$	A = Annual Accidents, V_{daily} = ADT
Link Rate	$R_{link} = \frac{A \times 10^8}{365 \times V_{daily} \times L}$	L = Segment Length (km)

Normalizing by volume prevents busy roads from appearing falsely unsafe.

The 4 Es Approach to Traffic Safety

Achieving sustainable road safety requires a holistic strategy encompassing four core pillars known as the 4 Es.

Civil engineers lead the Engineering component while collaborating with police, educators, and medical personnel.



Highway Safety Audit (HSA) Overview

A Highway Safety Audit (HSA) is a formal, independent safety evaluation of a highway project during its design, construction, or operational phase.

HSA proactively identifies potential crash hazards before roads are opened to traffic, preventing costly retrofits.

- Proactive safety tool applied at feasibility, draft design, and completion stages
- Conducted by an independent team of certified safety auditors
- Evaluates roadside hazard management, clear zones, and sign legibility
- Reduces long-term accident potential and municipal liability

Summary & Key Takeaways

Accident studies combine field investigation, condition/collision diagrams, and statistical rates to eliminate crash blackspots.

Applying the 4 Es framework and Road Safety Audits creates forgiving road infrastructure that protects vulnerable road users.

- Four crash factors: Human (majority), Vehicle, Road, Environment
- Condition diagrams map physical features; Collision diagrams map crash vectors
- Blackspots identified by IRC/MoRTH crash frequency and severity thresholds
- 4 Es: Engineering, Enforcement, Education, Emergency response