

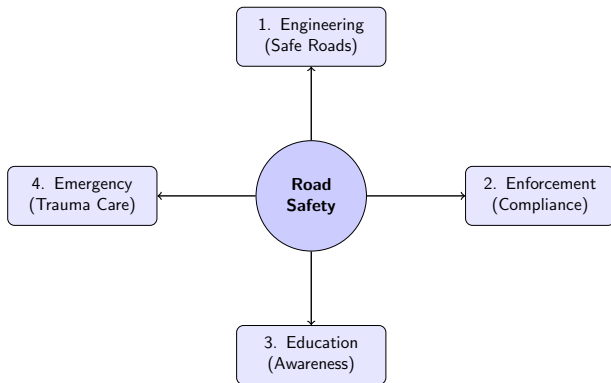
Lecture 5.36

5.3 Road Safety Measures

The '4 Es' Framework of Road Safety

The '4 Es' model provides a universally accepted structural framework for developing holistic traffic safety management programs at national, state, and local levels.

The four pillars are: 1. Engineering (designing safe road infrastructure and vehicles), 2. Enforcement (mandating compliance with traffic rules through police and tech), 3. Education (training drivers and raising public awareness), and 4. Emergency Care (providing rapid post-crash trauma care).



Engineering Measures: Geometric Improvements

Civil engineers directly enhance safety by modifying roadway geometric features to eliminate physical hazards, improve sight lines, and reduce driver workload.

Key geometric interventions include widening lanes and paved shoulders, easing sharp horizontal curves, providing proper superelevation, increasing Stopping Sight Distance (SSD), installing medians on two-way roads, and re-engineering high-risk grade intersections into roundabouts or grade-separated interchanges.

- Curve Realignment: Increasing radius and adding transitions to prevent run-off-road crashes
- Paved Shoulders: Providing recovery zones for errant vehicles and breakdown space
- Median Separation: Installing physical central dividers to eliminate head-on collisions
- Intersection Redesign: Replacing hazardous 4-way intersections with modern roundabouts

Engineering Measures: Safety Devices and Traffic Calming

Roadside safety devices and traffic calming measures are engineered features designed to protect vehicle occupants and slow down traffic in high-pedestrian zones.

Key devices include crash barriers (W-beam steel guardrails, concrete New Jersey barriers), rumble strips (transverse tactile alerts before curves/tolls), retro-reflective hazard markers, crash attenuators (impact cushions), raised pedestrian crosswalks, speed humps, and speed cushions.

- W-Beam Guardrails: Absorbing kinetic energy and redirecting errant vehicles safely
- Rumble Strips: Generating audible and tactile vibration to alert drowsy drivers
- Crash Attenuators: Protecting vehicles from colliding with rigid structure piers/gantries
- Traffic Calming: Speed humps, chicanes, and raised tables in residential/school zones

Black Spot Identification and Remediation

A Black Spot (or hazardous location) is a specific road stretch (typically 500m) or intersection where an abnormally high frequency or severity of crashes occurs over a 3-year observation window.

MoRTH defines a black spot as a stretch of 500m where either 5 fatal crashes or 10 total fatal/grievous crashes have occurred in the last 3 years.

Remediation involves site diagnostic surveys, collision analysis, and targeted low-cost or high-cost engineering corrections.

Category	Details
Criteria	5 fatalities OR 10 severe crashes over 500m in 3 years
Diagnostic	Field inspections to identify geometric/operational flaws
Low-Cost Fixes	High-visibility signs, solar blinkers, rumble strips
High-Cost Fixes	Grade separators, bypasses, road realignment

Road Safety Audit (RSA)

A Road Safety Audit (RSA) is a formal, systematic, and independent safety evaluation of a new highway project or existing road, conducted by a qualified team of independent safety experts.

RSA aims to identify potential safety hazards during the planning and design stages before roads are constructed and opened to traffic, thereby preventing built-in geometric flaws.

- Proactive Tool: Prevents crashes by catching design errors before construction
- Independence Requirement: Performed by auditors independent of the design team
- RSA Stages: Feasibility, Preliminary Design, Detailed Design, Pre-Opening, Existing Road
- IRC Guidelines: IRC:SP:88 provides detailed checklists for safety auditing

Enforcement Measures: Traffic Regulations and Policing

Enforcement measures rely on police vigilance and legal penalties to ensure road user compliance with safety laws established under the Motor Vehicles Act.

Key enforcement focuses include speed limit enforcement using radar speed guns, curbing drunk driving via breathalyzers, enforcing mandatory helmet and seatbelt compliance, preventing mobile phone usage while driving, and penalizing overloading of commercial vehicles.

- Speed Enforcement: Deployment of hand-held radar guns and interceptor vehicles
- Sobriety Checks: Random breathalyzer testing at high-risk night corridors
- Safety Gear Mandates: Strict penalties for unhelmeted riding and unbelted driving
- Overload Checking: Weigh-in-motion (WIM) bridges at toll plazas to curb vehicle overloading

Automated Enforcement Systems

Modern smart cities and high-speed expressways increasingly rely on automated Intelligent Transportation Systems (ITS) for continuous traffic law enforcement without human bias.

Technologies include Automatic Number Plate Recognition (ANPR) camera networks, Red Light Violation Detection (RLVD) systems, section-speed monitoring cameras (average speed enforcement), and automated e-challan ticketing platforms.

System	Function
ANPR	Reads license plates instantly to issue automated citations
RLVD	Captures vehicles crossing stop lines on red signals
Section-Speed	Calculates travel time to detect average speeding
E-Challan	Digital ticketing linked to vehicle registry

Educational Measures and Public Awareness

Educational safety measures aim to cultivate a safety-conscious road culture by imparting knowledge, altering risky behaviors, and instilling discipline in all road user groups.

Initiatives include rigorous driver training and standardized licensing examinations, road safety awareness weeks, integrating traffic safety curricula into school education, public campaigns against drink-driving, and defensive driving workshops for commercial operators.

- Driver Licensing Reform: Standardized driving skill tests and simulator-based testing
- School Curricula: Teaching basic traffic signs, pedestrian safety, and bicycle safety early
- Public Awareness Campaigns: Media drives targeting helmet use, seatbelts, and speed limits
- Commercial Driver Training: Mandatory refresher courses for hazardous material and bus drivers

Emergency Medical Services and the 'Golden Hour'

Emergency Medical Care focuses on post-crash survivability. The 'Golden Hour' refers to the first 60 minutes following a traumatic injury, during which prompt medical intervention offers the highest probability of saving lives.

Key emergency components include GPS-tracked highway ambulances (108 emergency service), strategically located Level-1 trauma centers, highway helipads, training bystanders in basic life support, and legal protections under the Good Samaritan Act.

- Golden Hour Concept: Critical 60-minute window for medical trauma intervention
- Highway Ambulances: Well-equipped Advanced Life Support (ALS) ambulances stationed on toll plazas
- Trauma Center Networks: Establishing emergency care hospitals along major corridors
- Good Samaritan Protection: Legal safeguards shielding helpful bystanders from police harassment

Policy Framework and Motor Vehicles Amendment Act

Institutional policies and legislative frameworks provide the legal backing and financial backing required to implement multi-sectoral road safety initiatives.

The Motor Vehicles (Amendment) Act 2019 introduced enhanced penalties for traffic violations, established the National Road Safety Board, mandated recall of defective vehicles, and formalized driver training and automated testing station rules.

- MV Act 2019 Amendments: Strict penalty escalation for dangerous driving and offenses by juveniles
- National Road Safety Board: Advisory body on safety standards and traffic management
- Mandatory Vehicle Recalls: Legal provisions compelling manufacturers to recall defective parts
- Road Safety Fund: Earmarking traffic fine revenues for safety engineering projects

Summary of Road Safety Measures

This lecture detailed the '4 Es' of road safety: Engineering, Enforcement, Education, and Emergency Medical Care.

Combining proactive engineering measures (such as Road Safety Audits and black spot remediation) with automated enforcement, public safety education, and rapid Golden Hour medical response creates a resilient highway safety ecosystem.

- The 4 Es framework requires synchronized action across multiple disciplines
- Engineering interventions eliminate physical hazards through geometry, barriers, and audits
- Black Spot remediation targets high-crash stretches for immediate engineering fixes
- Automated enforcement (ANPR, RLVD) ensures unbiased compliance with traffic rules
- Golden Hour emergency care and Good Samaritan laws maximize post-crash survival rates