

Introduction to Road Safety

Audit: Approach and Methodology

by

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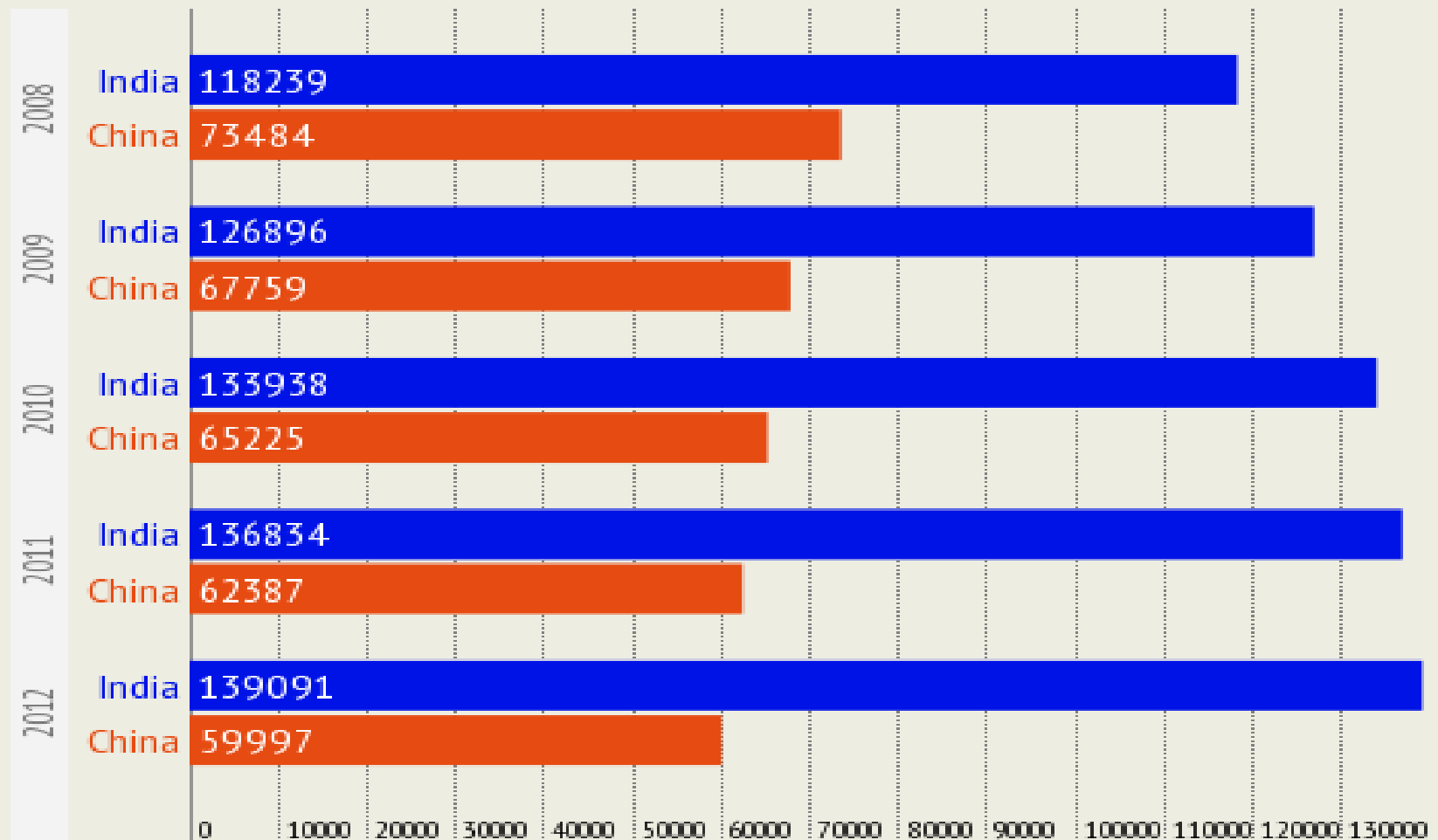
PRESENTATION OUTLINE

- ✓ **Back Ground on National Road Crash Scene AND ITS Comparison with China**
- ✓ **Evolution of the Philosophy of Safe Roads**
- ✓ **Road Safety Audit Process and Stages**
- ✓ **Summary and Inferences**

Increasing Trend of Road Deaths in India

Year	Total Deaths
2000	78,911
2001	80,888
2002	84,674
2003	85,998
2004	92,618
2005	94,968
2006	105,749
2007	114,444
2008	119,860
2009	126,896
2010	133,938
2011	142,485
2012	139,091
2013	1,37,900
2014	1,41,523

A COMPARATIVE DATA ON ROAD ACCIDENT FATALITIES BETWEEN INDIA AND CHINA



Source : National Crime Records Bureau, 2012 & Statista, The Statistics Portal

Share of Urban and Rural (India)

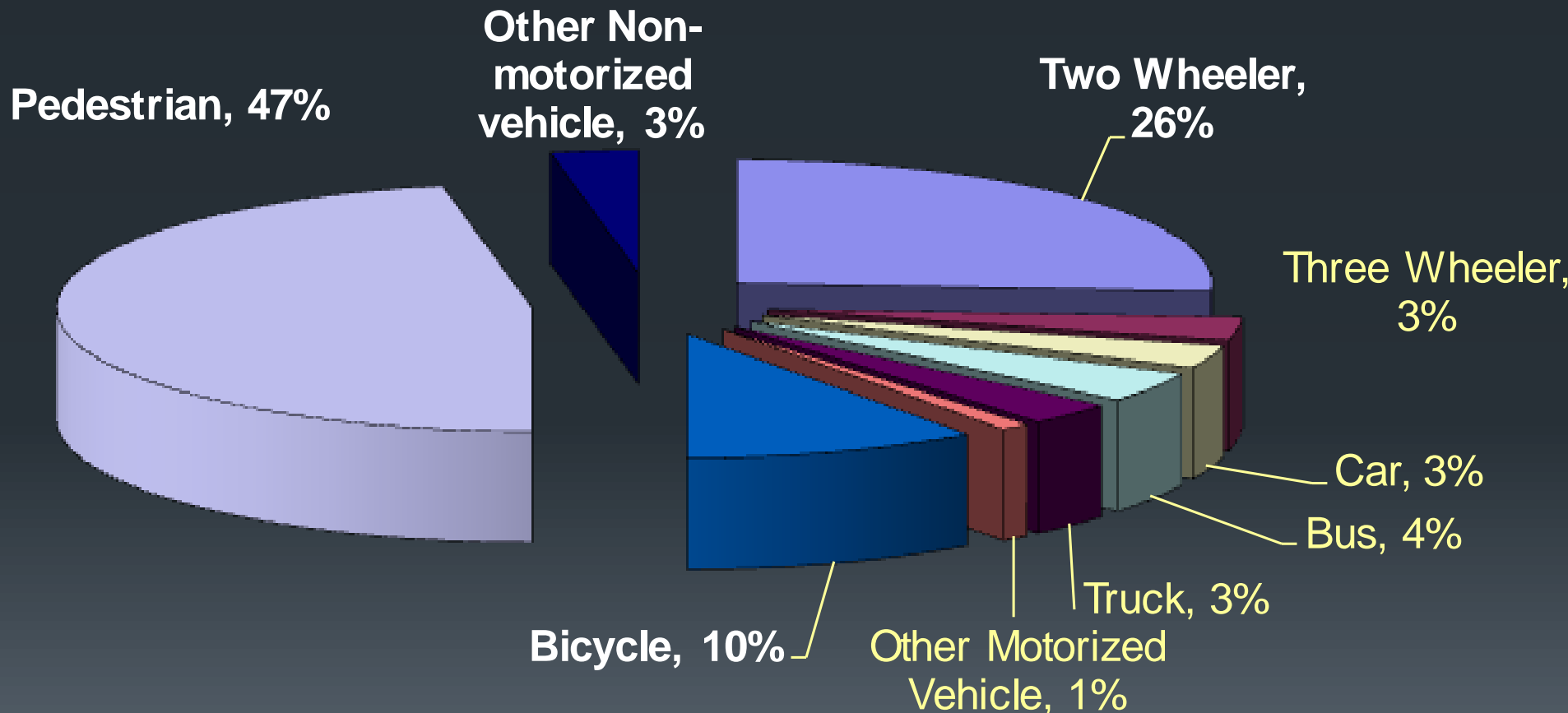
Years	Total Killed		Total Injured	
	Urban	Rural	Urban	Rural
2011	52,197	90,288	2,07,544	3,03,850
2010	53,049	81,464	2,21,998	3,05,514
2009	48181	77479	2,05,019	3,10,439
Avg. Share	38%	62%	41%	59%

Type of Motor Vehicle	% share
Pedestrians	13.20
Two Wheelers	21.10
Car, Taxis etc.	13.20
Buses	7.20
Bicycles	5.90
Auto Rickshaws	6.30
Trucks	11.30
Other Motor Vehicles	8.80
Non-motorized vehicles & other objects	13.00

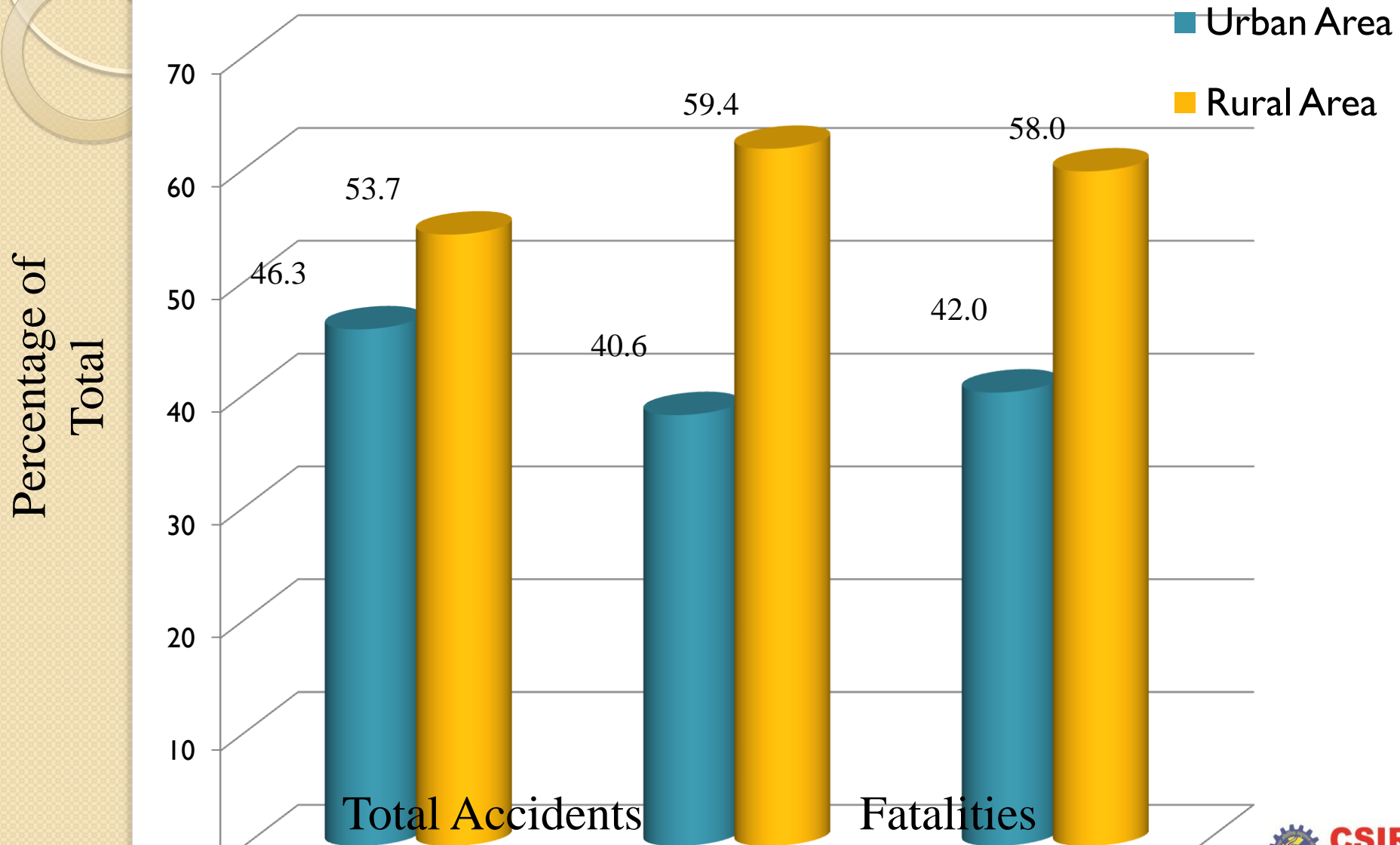
Overall Share of victims from Vulnerable Road User (VRU) category - 60% at Pan India Level

Fatalities by road user type, *Delhi*

Share of VRUs at City Level - 86%

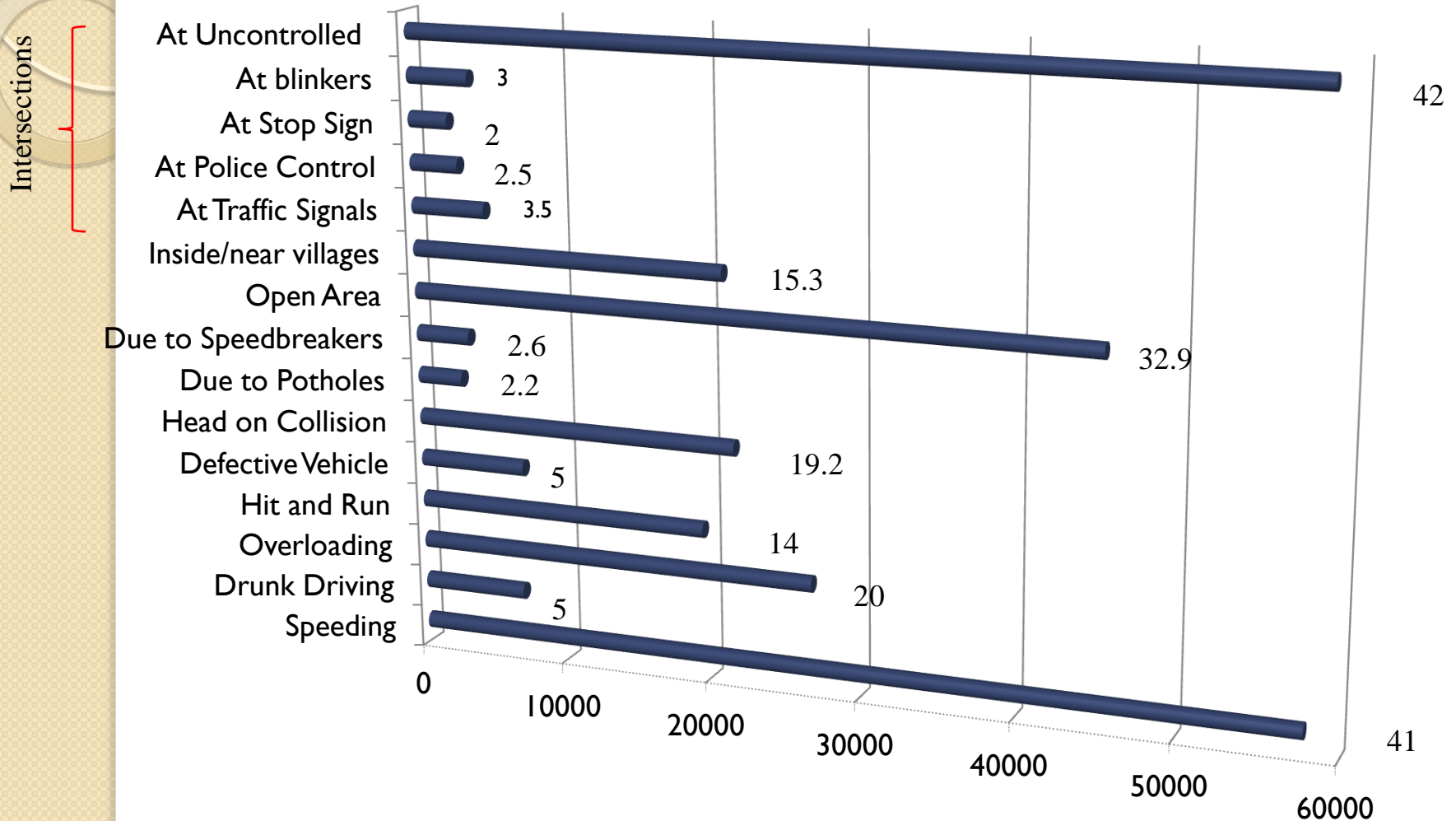


Road Crashes / Fatalities / Injuries in Urban and Rural Areas



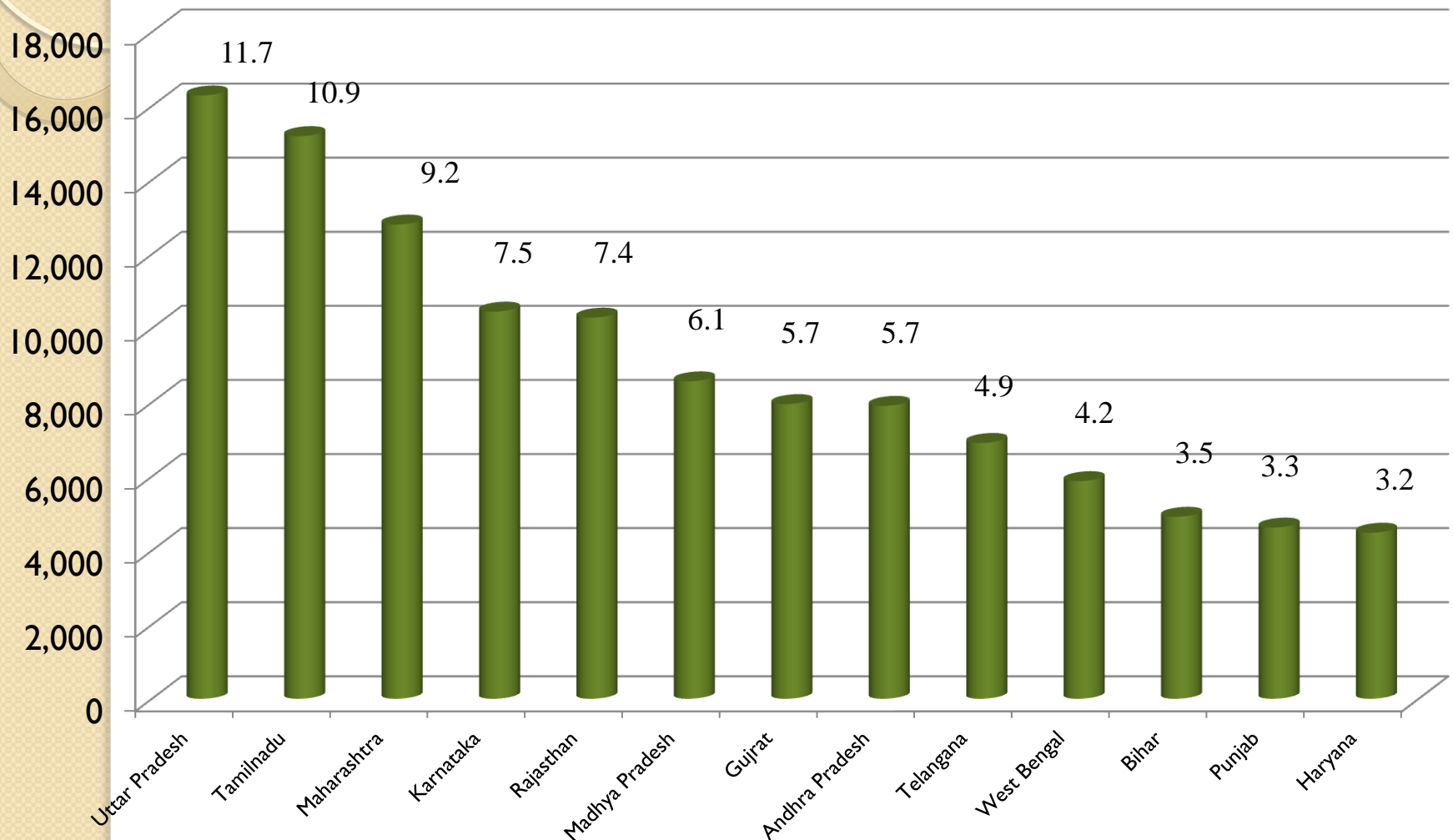
(Source: Road Accidents In India 2014, Ministry Of Road Transport & Highways Transport Research Wing)

Major Causative factors for Fatalities



(Source: Road Accidents In India 2014, Ministry Of Road Transport & Highways Transport Research Wing)

States with high fatalities



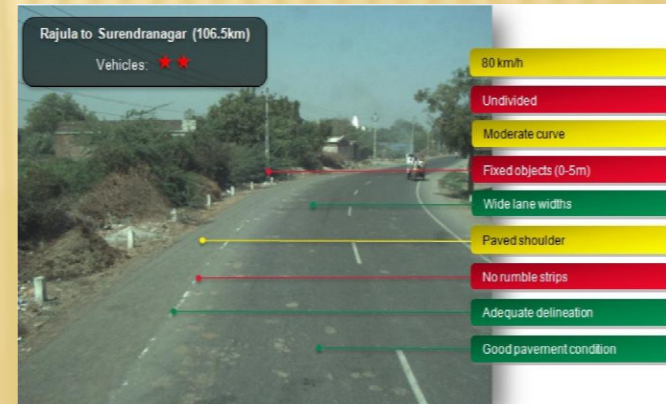
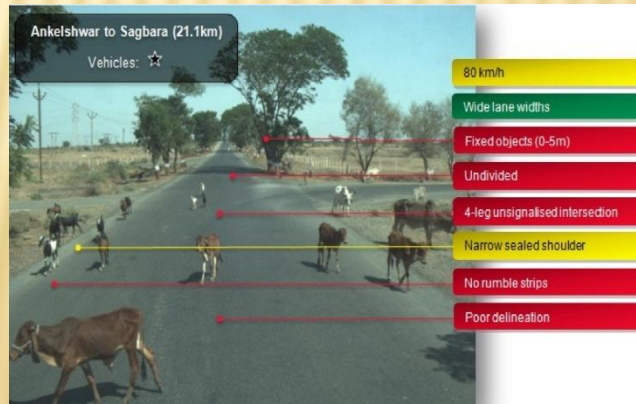
(Source: Road Accidents In India 2014, Ministry Of Road Transport & Highways Transport Research Wing)

INDICATIONS FROM AVAILABLE DATA

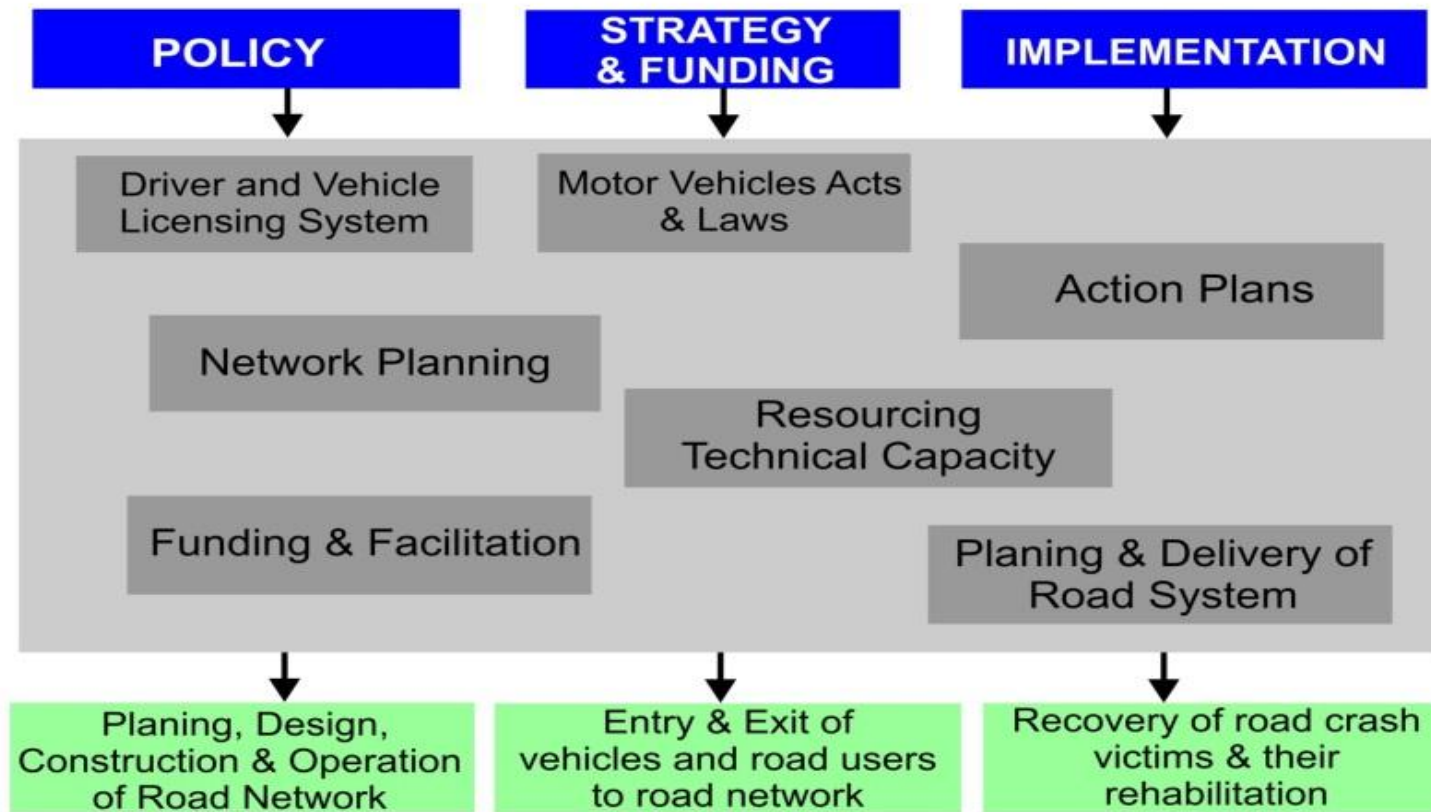
- ❑ Growth of fatalities much higher than crashes ➡ High speeds but unsafe roads
- ❑ Fatalities in roads in rural area is about 1.5 times than urban ➡ Unsafe rural highways
- ❑ Developed and underdeveloped states have high fatalities ➡ No attention to road safety irrespective of development
- ❑ > 50% victims are of productive group ➡ Avoidable economic loss to nation
- ❑ National and State Highways account for > 60% of accidents ➡ More attention for safe infrastructure for NHs and SHs
- ❑ Intersections account for about 57% of fatalities ➡ More attention to intersections
- ❑ Drivers fault is cause of accidents (?) ➡ Safe infrastructure to account for human failings and shortcomings
- ❑ Accident trend in India much higher than other countries ➡ Immediate dedicated efforts are needed

iRAP REPORT FOR SOME INDIAN STATES

- ❑ International Road Assessment Programme (iRAP) Report in April 2012 for Andhra Pradesh, Assam, Gujarat and Karnataka
- ❑ 3000 km roads (2-lane, single carriageway rural network) surveyed and assessed for system of star ratings
 - 5 star rating is safest and 1 star is least safe
 - None of the network achieved a 5-star rating and only 11% achieved a 4-star rating for vehicle occupants and motorcyclists.



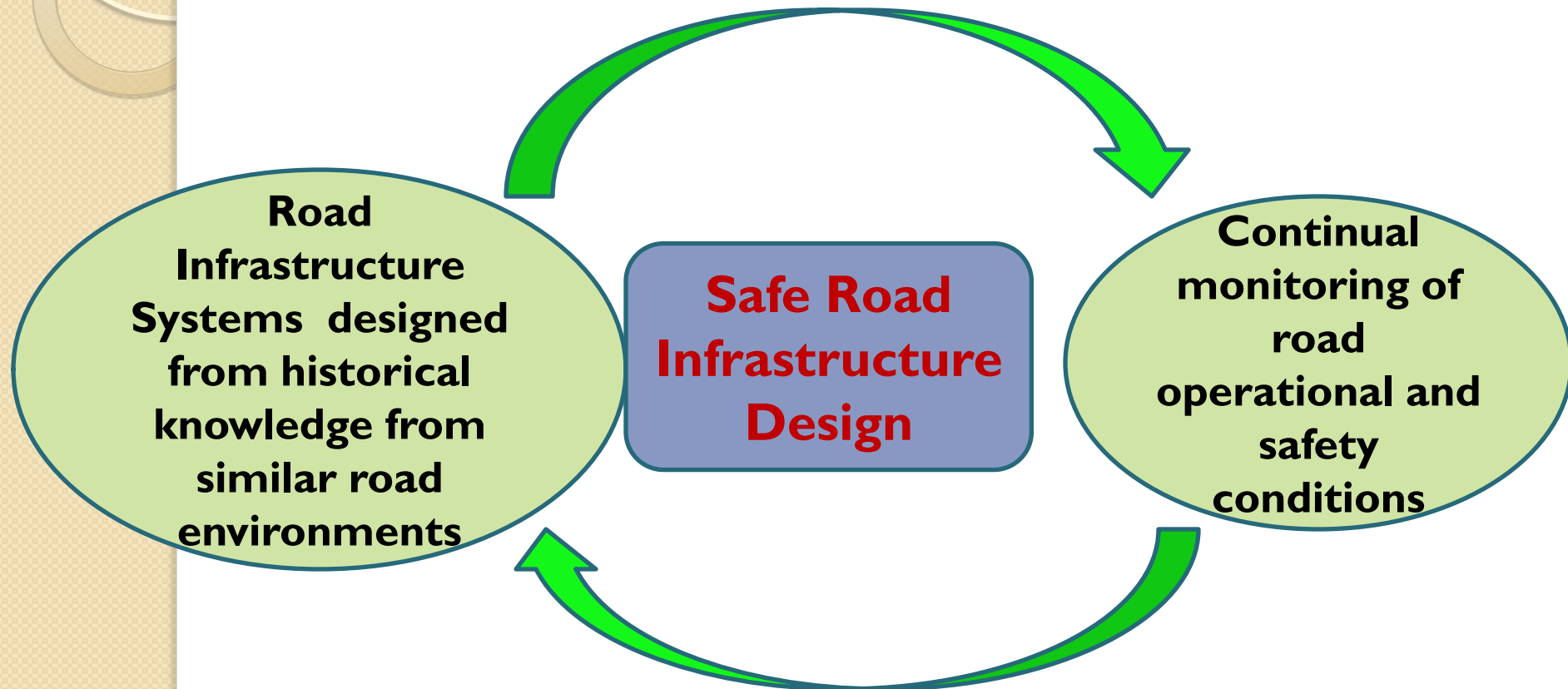
Complexities to be Tackled



Implementation of successful road safety models from the developed countries hinges on:

- **Proper regulatory framework with necessary laws / legislations**
- **Obtaining adequate political priority for organizational reform and enactments of laws**

Basic Requirement for Safe Road Environment



Safety in Stages

Road Safety can be enhanced by Highway Engineers at all the various stages of a project as follows:

- 1. Planning Stage***
- 2. Design Stage***
- 3. Construction Stage***
- 4. Maintenance and Operation Stage***

Safety in Planning Stage

- *Through Land Use Control*
- *Providing Bypasses for congested towns and linking them by Spurs*
- *Creating self contained zones to avoid non essential traffic in the neighborhood*

Safety in Design Stage

- Designing “**self explaining roads**” and “**forgiving roadside**” by selecting the most desirable design standards (and NOT the minimum standards) involving
 - Design Speed
 - Horizontal and Vertical Geometry
 - Cross-sectional elements,
 - Design of at-grade and grade separated junctions,
 - Provision of service roads for segregation of slow and fast traffic,
 - Designing effective road furniture viz. Guard Rails, Traffic signage, roadside illumination provisions etc.

Safety in Construction Stage (shall strictly conform IRC:SP-55 [2013])

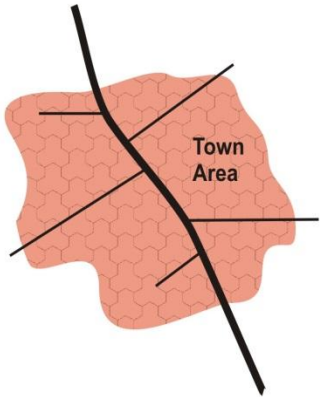
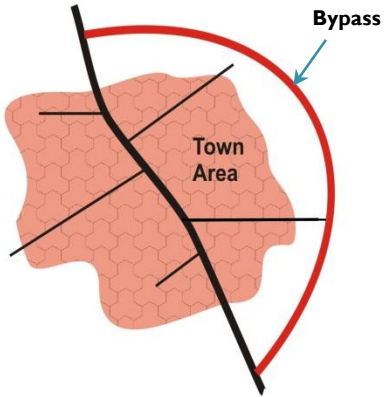
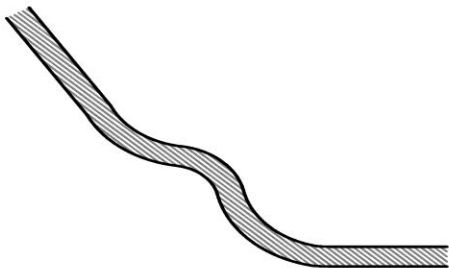
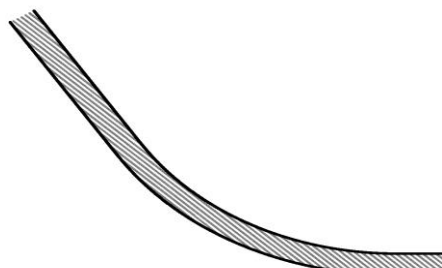
- *Proper Separation of the construction zone through effective barricading*
- *Construction of proper traffic diversions*
- *Provision of Road Signage*
- *Environmental controls including dust, noise and air pollution*

Safety in Maintenance and Operation Stage

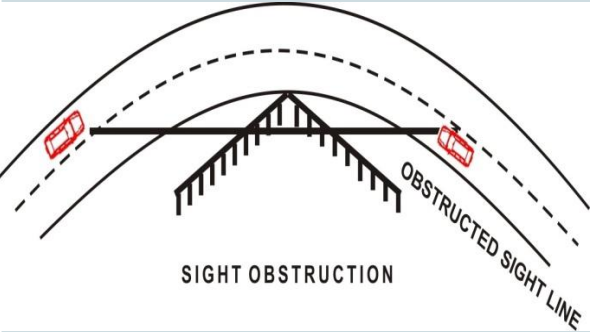
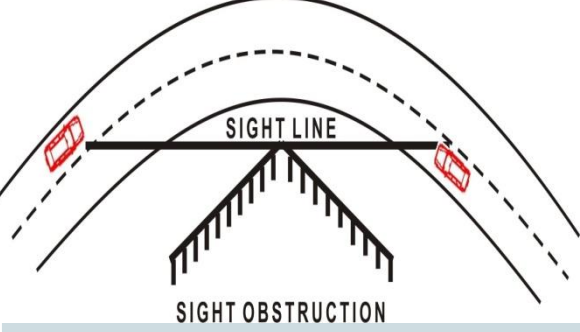
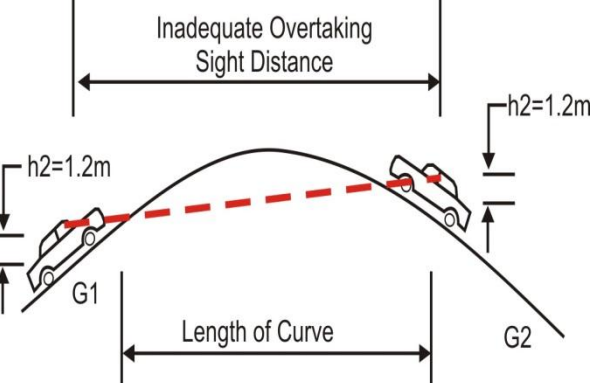
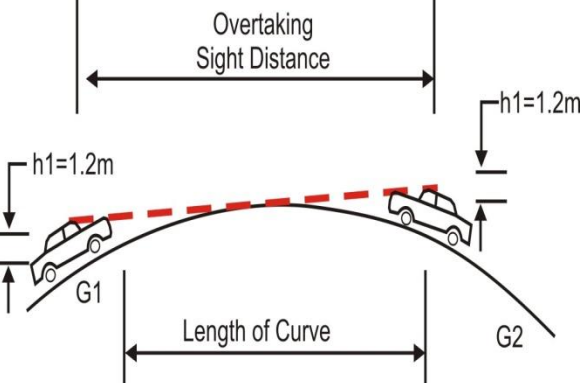
Providing an Automated Traffic Management System (ATMS) for safe operation of traffic and Incident Management. This may include providing

- *Dissemination of Traffic Information Through Variable Message Signs (VMS),*
- *Weigh-in-Motion (WIM) System and*
- *Establishment of Central Control Room for Traffic Surveillance*
for the high density road corridors to start with

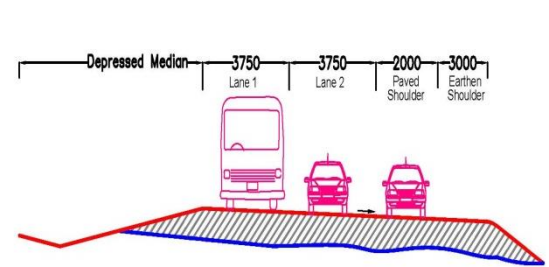
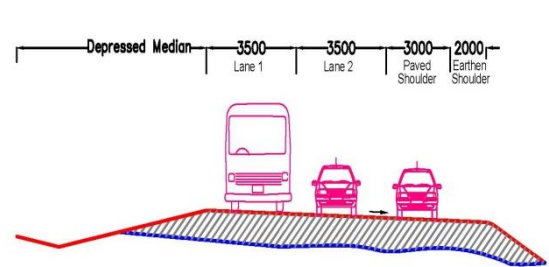
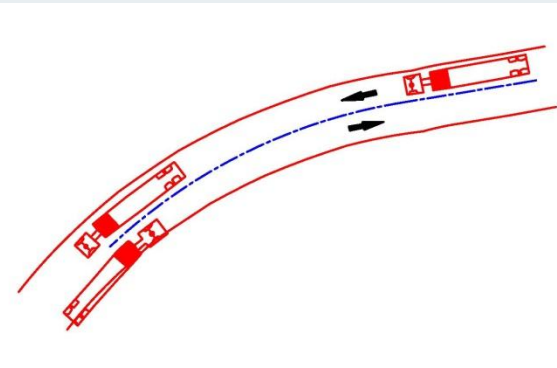
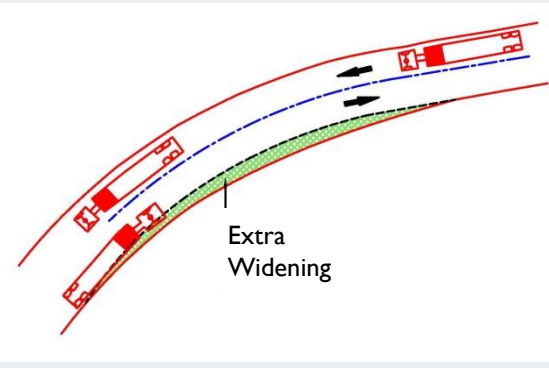
Design for Safety

Design/ Planning Element	Undesirable	Desirable	Principle to be Applied
Alignment Selection and Land Use			Major Arterials and Expressways should bypass major towns which should be connected by Spurs . There should be clear zones identified for linear land use control
Horizontal Geometry			Consistency of horizontal geometry avoiding monotonous straight lines or abrupt change of speed.

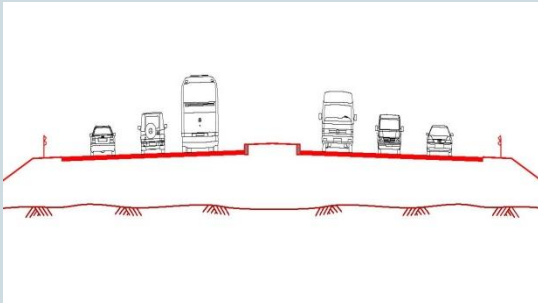
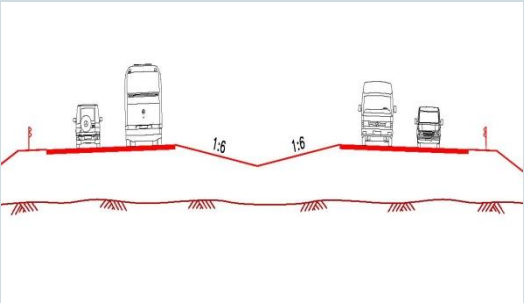
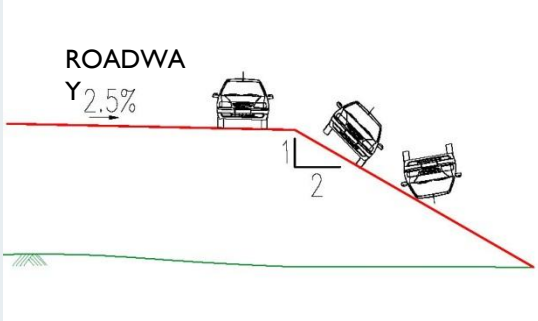
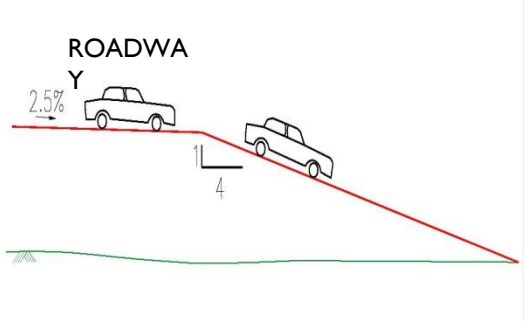
Design for Safety (Contd...)

Design/ Planning Element	Undesirable	Desirable	Principle to be Applied
Horizontal Geometry	 <p>The diagram shows a road with a central median barrier. A dashed line represents the 'OBSTRUCTED SIGHT LINE' which is blocked by the barrier. Two cars are shown on either side of the barrier, with their sight lines intersecting at a point behind the barrier. The text 'SIGHT OBSTRUCTION' is written below the barrier.</p>	 <p>The diagram shows a similar road layout, but the sight line is clear over the barrier. A solid line labeled 'SIGHT LINE' connects the two cars, passing above the barrier. The text 'SIGHT OBSTRUCTION' is written below the barrier.</p>	Adequate off-set distance from natural road side features.
Vertical Geometry	 <p>The diagram shows a road with a curve. Two cars, labeled G1 and G2, are on the curve. The sight line between them is dashed and labeled 'Inadequate Overtaking Sight Distance'. The height of the cars is indicated as $h_2 = 1.2\text{m}$. The 'Length of Curve' is also shown.</p>	 <p>The diagram shows a similar road layout, but the sight line between the cars G1 and G2 is solid and labeled 'Overtaking Sight Distance'. The height of the cars is indicated as $h_1 = 1.2\text{m}$. The 'Length of Curve' is also shown.</p>	Undivided Carriageways designed desirably for Overtaking Sight Distance (OSD)

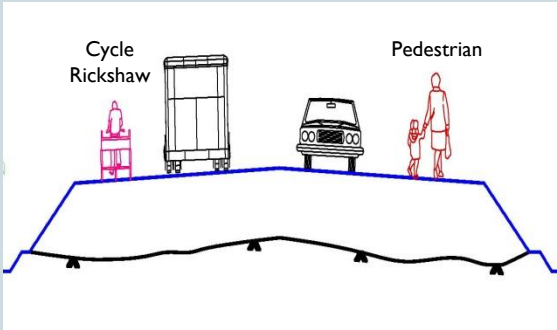
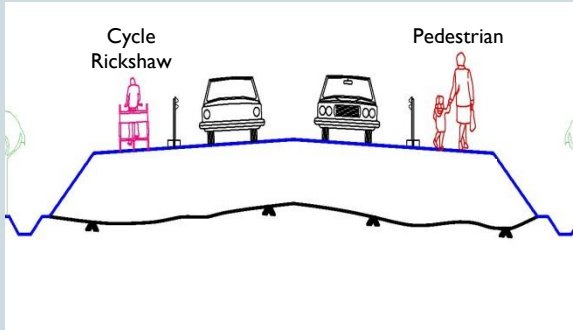
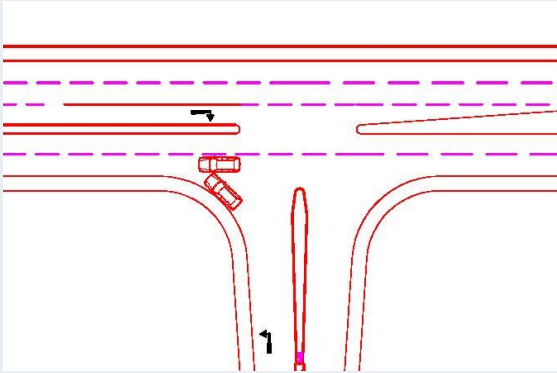
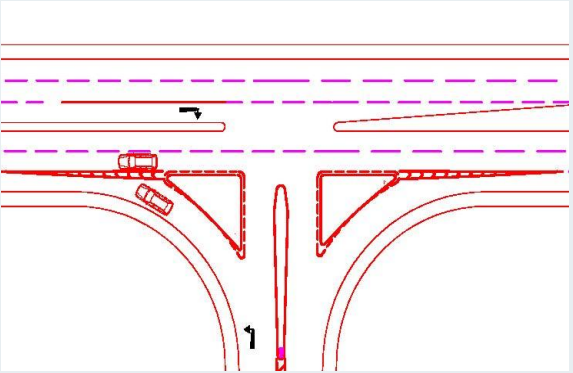
Design for Safety (Contd...)

Design/ Planning Element	Undesirable	Desirable	Principle to be Applied
Cross- sectional Elements			<p>Wider Lane widths and shoulders for high speed roads especially expressways.</p>
Cross- sectional Elements			<p>Inside widening for sharp curves</p>

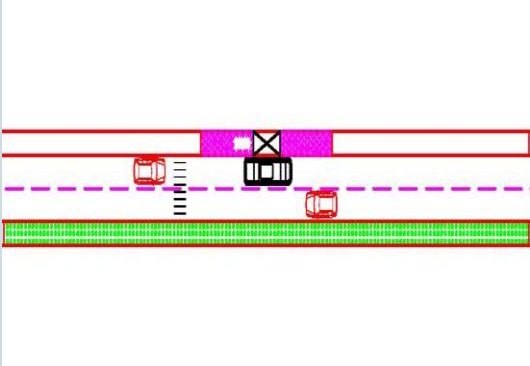
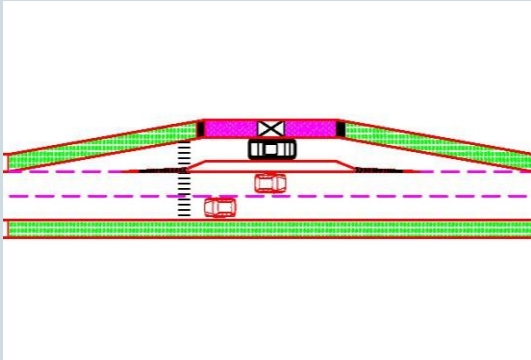
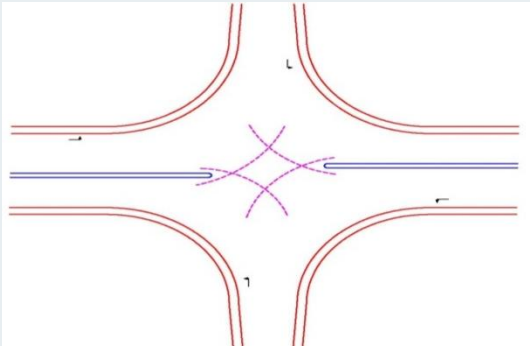
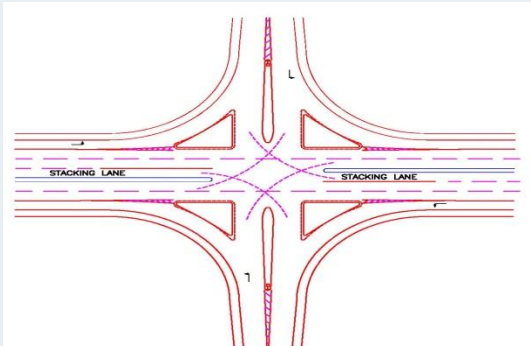
Design for Safety (Contd...)

Design/ Planning Element	Undesirable	Desirable	Principle to be Applied
Cross- sectional Elements			Wider depressed median for high speed roads to prevent glare and jumping of Vehicles
Cross- sectional Elements			Recoverable slopes for out of control vehicles

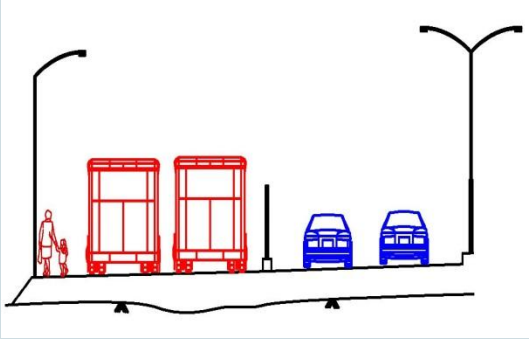
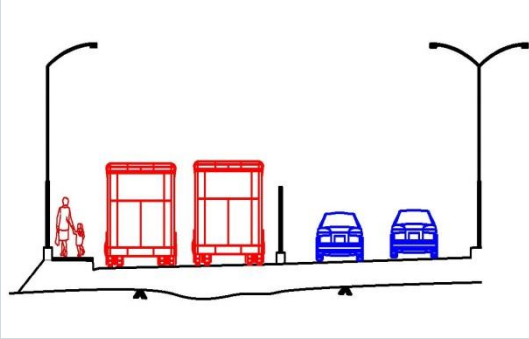
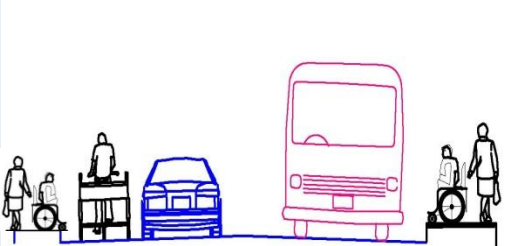
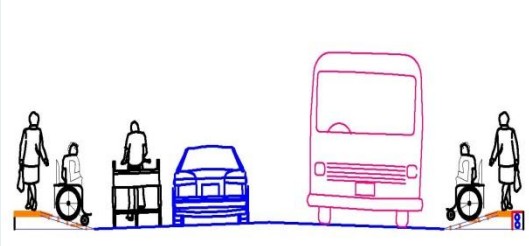
Design for Safety (Contd...)

Design/ Planning Element	Undesirable	Desirable	Principle to be Applied
Cross- sectional Elements			Separate slow moving non – motorized traffic (cycles, rickshaw etc) from fast moving traffic
Entry/ Exit			Entry Exit only through slip lanes with proper acceleration and deceleration lanes

Design for Safety (Contd...)

Design/ Planning Element	Undesirable	Desirable	Principle to be Applied
Passenger Transit			Separate Lay bye for buses and taxis to avoid restriction and improve visibility
Junction Design			Channelization, provision of stacking lanes, adequate turning radii

Design for Safety (Contd...)

Design/ Planning Element	Undesirable	Desirable	Principle to be Applied
Pedestrian Facilities in Urban Areas			Provision of Raised Footpath for pedestrians in Urban Areas
Facilities for differently abled	 <p>Road Crossing Location</p>	 <p>Road Crossing Location</p>	Footpath merging in a slope with a cross street, bus bays flushed with foot boards etc.

Design for Safety (Contd...)

Design/ Planning Element	Undesirable	Desirable	Principle to be Applied
Barriers			Barriers should be designed to deflect the vehicle and not crash it.
Road Signs			The road signs should be standardized throughout the country and need for Spacing between successive Signs
Traffic Calming	 Non-standard Hump	 Standard Hump	Properly designed traffic calming devices like speed humps, rumble strips, Chicaning etc. as per IRC-67 (2012)

Good Practice of Safe Design



**Mild Side Slope
(Forgiving Roadside
Treatment)**

**Recovery Zone
(Hard Shoulder)**



Good Practice of Safe Design (Contd...)



**Road Side Feature
(Protected with
W-Beam Crash Barriers)**

**Bevelled End of a
concrete culvert
(Safer Design)**



Good Practice of Safe Design (Contd...)



Recoverable Fill Slope

**Rock face
cutting
shielded with
safety barrier**



Good Practice of Safe Design (Contd...)



**Safer road Design :
roundabout
(At Grade with Non-
motorized mode
segregation)**

**Safer road Design :
Grade Separation
At Busy Intersection
(with segregated
passage for pedestrians
and local traffic)**



Good Practice of Safe Design (Contd...)



**Safer road design :
Depressed Median**

**Safer Road Design :
Speed Camera /
Radar Photo**



Good Practice of Safe Design (Contd...)



**Safer Road Design:
Speed Limit
Painted on the Micro Bitumen
Asphalt**

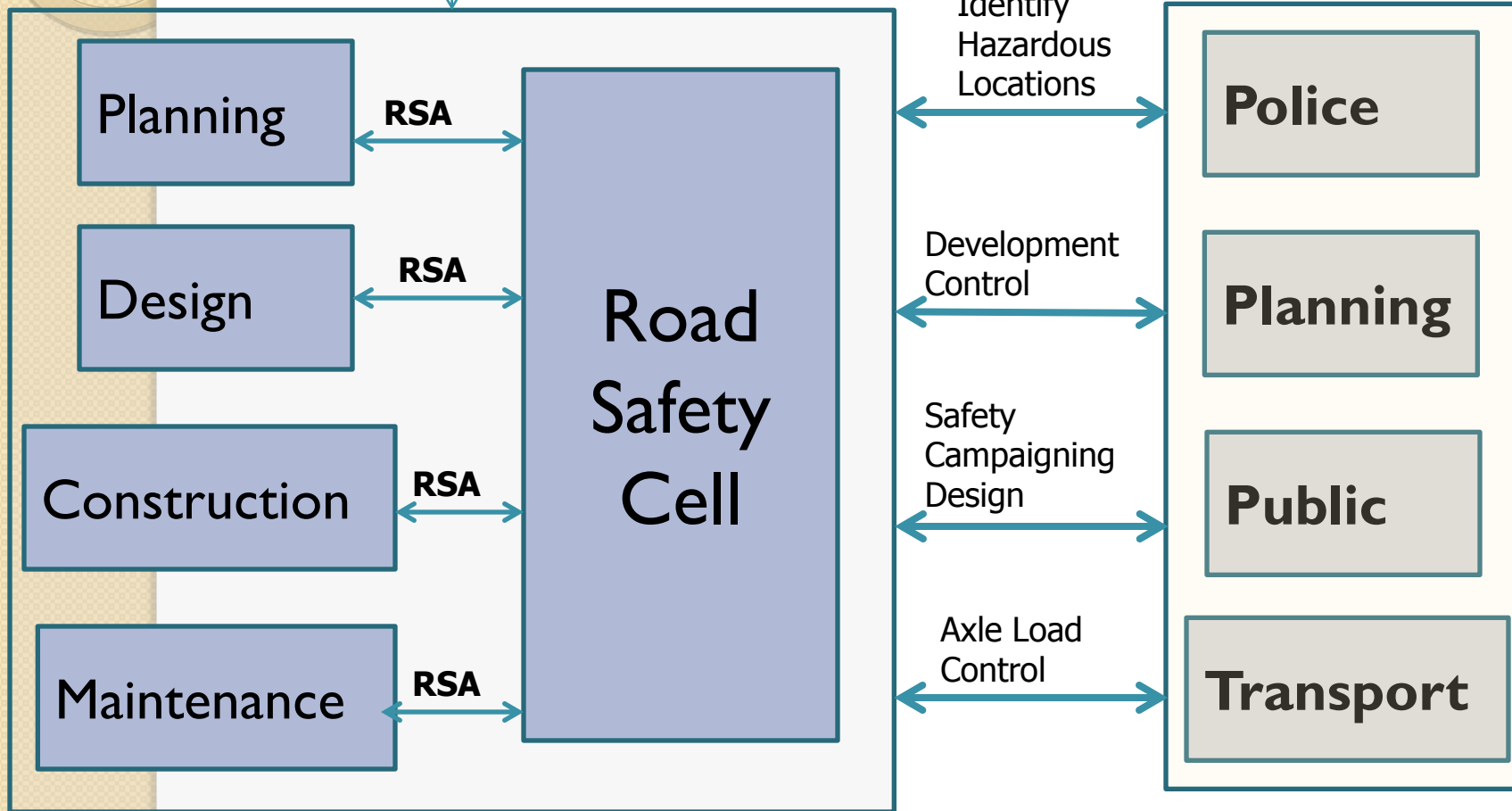
**Safer road design :
Speed Calming
Measures**



Roads Authority

Key Stakeholders

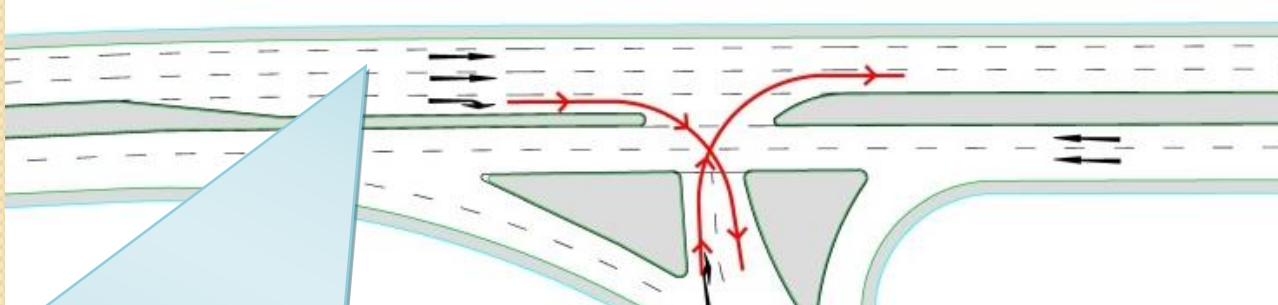
Key Functions



Negligence by Designers (Contd...)



Safety Issues: The junction was originally proposed as left-in/left-out, but later-on median opening given under some compulsion. This will cause high speed movement from NH to side road.



Suggestions: Layout shown above will compel turning traffic to turn at lower speed and also the side road has been aligned perpendicular to NH. These techniques would have great impact on safety of junction, which can be accomplished without any more land acquisition.

Negligence by Designers (Contd...)

SH 21 - Nayagarh



Negligence by Designers (Contd...)

SH 65 – Cuttack District



Negligence by Designers (Contd...)

NH 49, Sambalpur



Negligence by Designers (Contd...)



.....putting in speed breakers or rumble Strips as Quick Fix Solutions!

Placing signs that may look good but achieve little





Wrong installation of W-Beam Crash Barriers (too high, overlapped wrong way, posts facing wrong way)

History of RSA

Traffic engineers in U.K. developed the idea of RSA as a safety check for new and improved road projects and schemes in the early 1980's.

Countries like Australia, Denmark, New Zealand, Canada, France, Greece, Hong Kong, Iceland, Ireland, Italy, Malaysia, Netherlands, Perm, Singapore, U.S. etc. have developed RSA.

International Progress With Road Safety Audit

There is strong support for audit in several Canadian provinces, and several US states have carried out pilot audits. Interest is growing rapidly.

The USA is learning from Canada and others

International Progress With Road Safety Audit

Audit guidelines have been developed for Nepal, and Bangladesh by consultants working for the World Bank, Eritrea soon Vietnam and China have had road safety audits carried out by ADB and World Bank consultants.

Thailand has had a national seminar on RSA plus training courses

International Progress With Road Safety Audit

ITE, PIARC, TRB and AUSTROADS all have committees addressing RSA issues

In summary – road safety audit is progressing rapidly around the globe, in ways which best suit each country

Road Safety Audit Is a Positive Process

Road safety audit – the earlier, the better – safer, cheaper

Road safety audit may be the only time that road safety is explicitly considered in a project.

Road safety audits are a small part of the design cost
1-2% of total design costs

Road safety audits offer great benefits ... First year Rate of Return of 120% if audit recommendations had been followed

(Jordan study 1998)

**Road safety audits offer great benefits
...First Year Rate of Return of 146% due to
audit recommendations being implemented**

(Denmark study 1995)

**Very healthy BCR 36:1 for design stage
6:1 for existing roads**

(AUSTROADS study 2001)

ROAD SAFETY AUDIT IS:

1. Minimizing the likelihood of crashes occurring through safety-conscious planning and design;
2. Ensuring that, if a crash occurs, then the likelihood of the injury is minimized (such as provision of anti-skid surfacing and crash barriers);
3. Ensuring that safety related design criteria (e.g. critical sight distances) have been met;
4. Managing risks, such that the risk of major safety problems occurring is less than the risk of minor problems occurring
5. Reducing the whole-life cycle costs of a design (unsatisfactory designs are expensive to correct after they are built)
6. Minimizing the risk of crashes on the adjacent road network (particularly at intersections) as well as on the new road scheme
7. Enhancing the importance and relevance of road safety engineering in highway design work and to enhance consideration of the safety of all road users in all new and existing schemes.

Road Safety Audit is Not

1. A way of assessing or rating a project as good or poor;
2. A means of ranking or justifying one project against others in a works programme;
3. A way of rating one option against another;
4. A check of compliance with technical/ design standards;
5. An accident investigation;
6. A redesign of a project;
7. It is not a check on the designer's competence
8. It is not a technical audit
9. Something to be applied only to high cost projects or only to projects involving safety problems;
10. The name you use to describe informal checks, inspections or consultations;
11. An opportunity to raise subjective personal concerns.

A few things RSA is NOT:

- It is not a check on whether standards have been followed
- It is not a redesign

Who Does The Safety Audit?

To be effective, the safety audit needs to be carried out by specialists, who are independent of the design process so as to take a fresh look at the project focusing on safety. Audit team should possess expertise and experience in road safety engineering.

What Type of Projects should be Audited?

- **New expressways**
- **Major four-laning projects**
- **Reconstruction and realignment projects**
- **Intersection projects both signalized and non-signalized**
- **Pedestrian and bicycle routes**
- **Deviated access roads near project roads**
- **Local area traffic management schemes, and**
- **Accident reduction schemes**

A road safety audit is “ a formal examination of road/traffic project in which an independent, qualified team reports on the projects’s accident potential”

(AUSTROADS 2001)

Road Safety Audit is “ a formal procedure for assessing accident potential and safety performance in the provision of new road schemes, the improvement and rehabilitation of existing roads and in the maintenance of existing roads”.

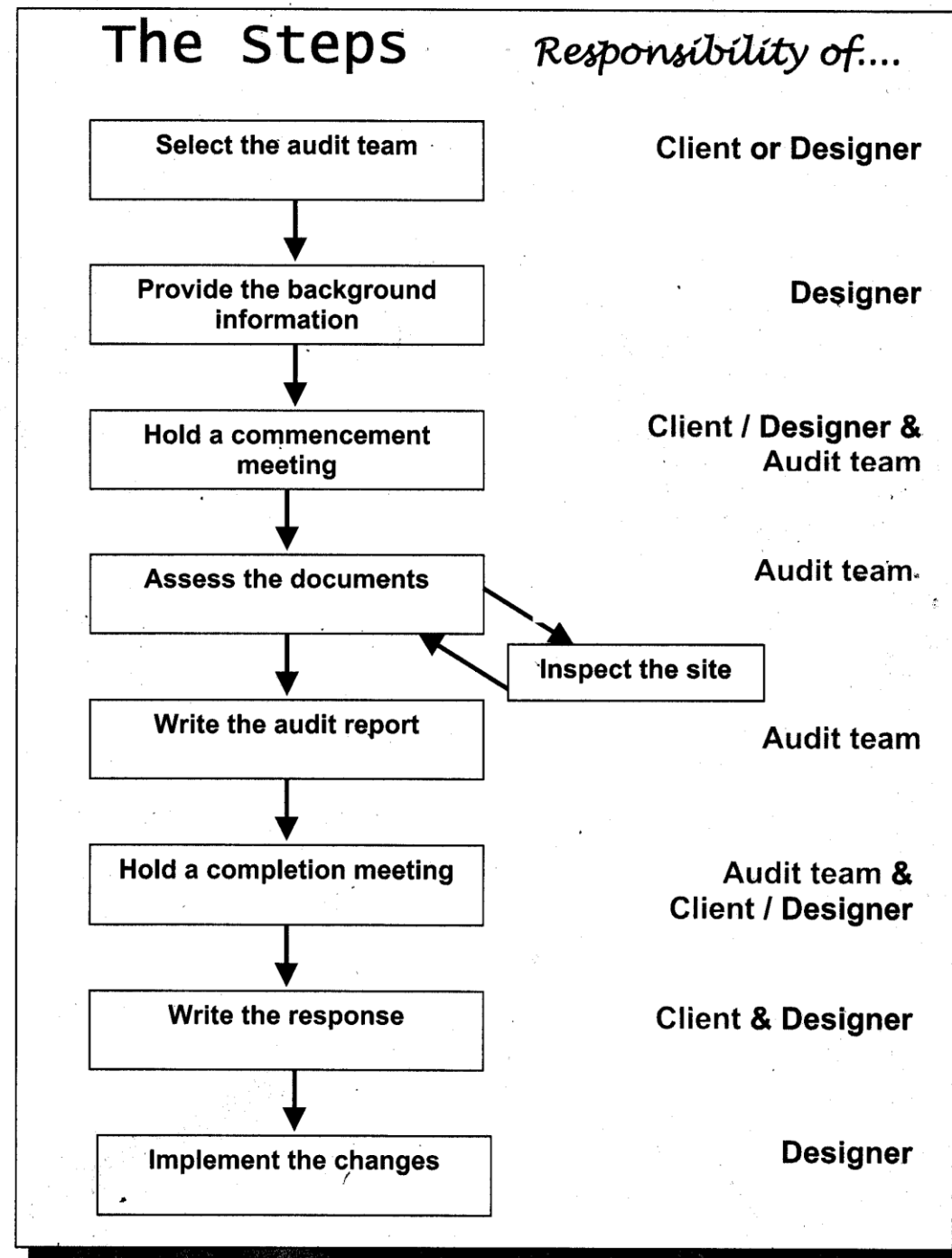
Manual for Safety in Road Design (India)

Objectives of Road Safety Audit

- **To ensure high levels of safety on new road projects**
- **Reduce whole-life costs of projects**
- **Minimise accident risk on the adjoining road network**
- **Promote the safety of all road users**
- **Promote road safety engineering**

Road safety audit combines art with science – the art of assessing how the road users will use the road, and the science of proven road safety engineering principles

Key Audit Steps ...



Background on Road Crashes: An epidemic

- ❑ **1.4 million** people are killed and **50 million** are injured worldwide per annum due to road crashes
- ❑ Developing countries account for **90% of the casualties**
- ❑ It's the leading cause of death of young people worldwide
- ❑ If unabated, the number of deaths will increase to **1.9 million per annum (worldwide)** by 2020
- ❑ The economic cost to developing economies amounts to around **\$100 billion a year.**
- ❑ India has poor track record as far as road safety is concerned with about 1.4 lakh fatalities & 5.5 lakh grievous injuries in a year.

Background (Contd...)

- World Health Organization (WHO) has declared 2011-2020 to be the Decade of Action for Road Safety with the following goal:***

Prevent five million road traffic deaths globally by 2020; India has rightly joined this endeavour

Road Safety Audit Process and Stages:

Two Basic Concepts of RSA

Prevention Is Better Than Cure

- ❑ **Safety audit seeks to minimize the risk of accidents occurring as a result of changes to the highway**

Drive, Ride, Walk in Safety

- ❑ **Highlight the needs of Vulnerable Road Users (*like Pedestrians, Cyclists and Two Wheelers*)**

Key RSA steps

- **Select Audit Team**

- **Gather Information**

- **Commencement Meeting**

- **Closely Review Drawings / Site Inspection**

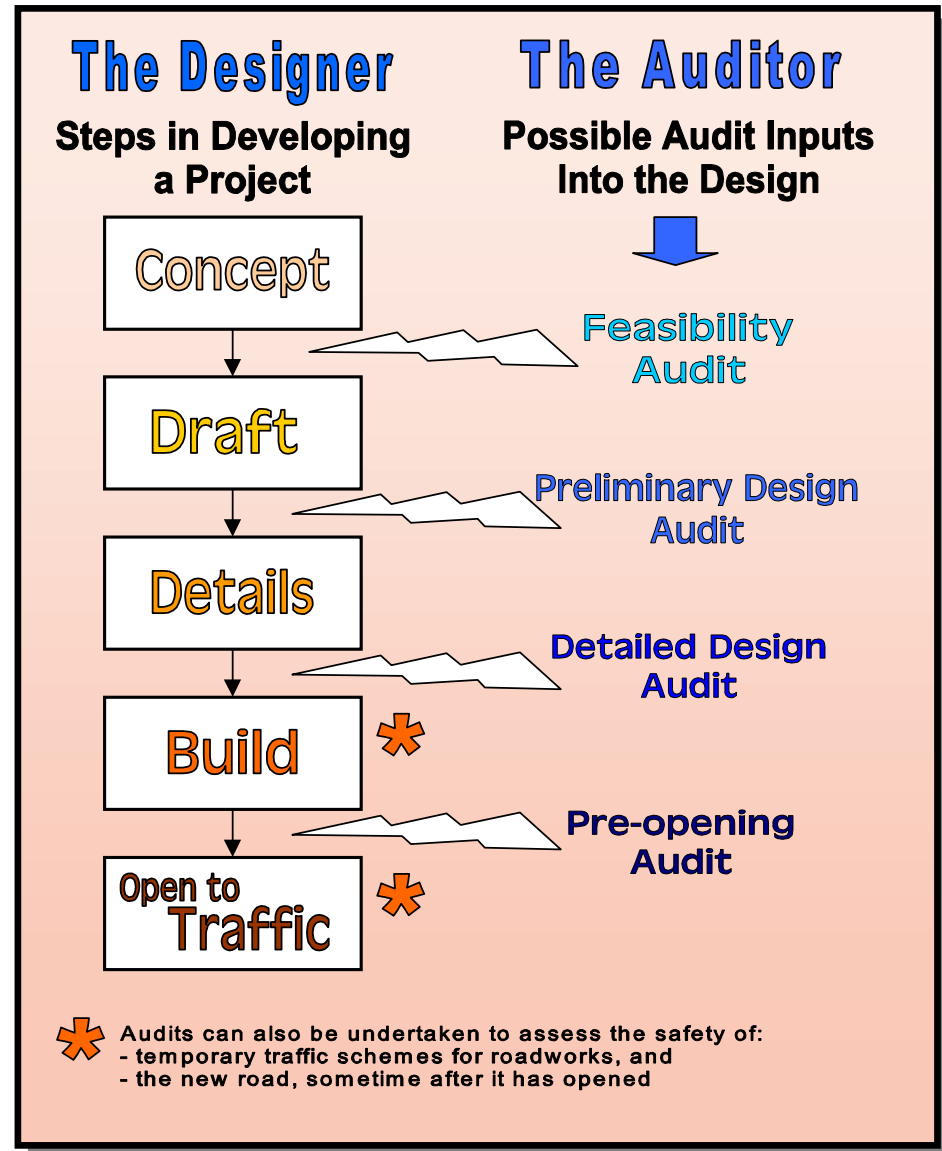
- **Write Report**

- **Closure Meeting**

- **Respond to Report**

RSA at Different Stages

- Feasibility study
- Preliminary design
- Detailed design
- During construction
- Pre-opening
- Existing roads



Stages of Road Safety Audit

- ✓ **Feasibility Stage**
- ✓ **Preliminary Design Stage**
- ✓ **Detailed Design Stage**
- ✓ **Construction Stage**
- ✓ **Pre - Opening Stage**
- ✓ **Existing Road**

Road Crash Site Improvement Programs

Identify Road Crash
Prone Sites

Preliminary Road Crash
Analysis

Final Diagnosis

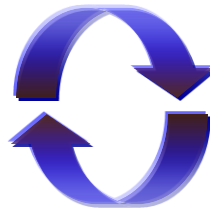
Site Visit

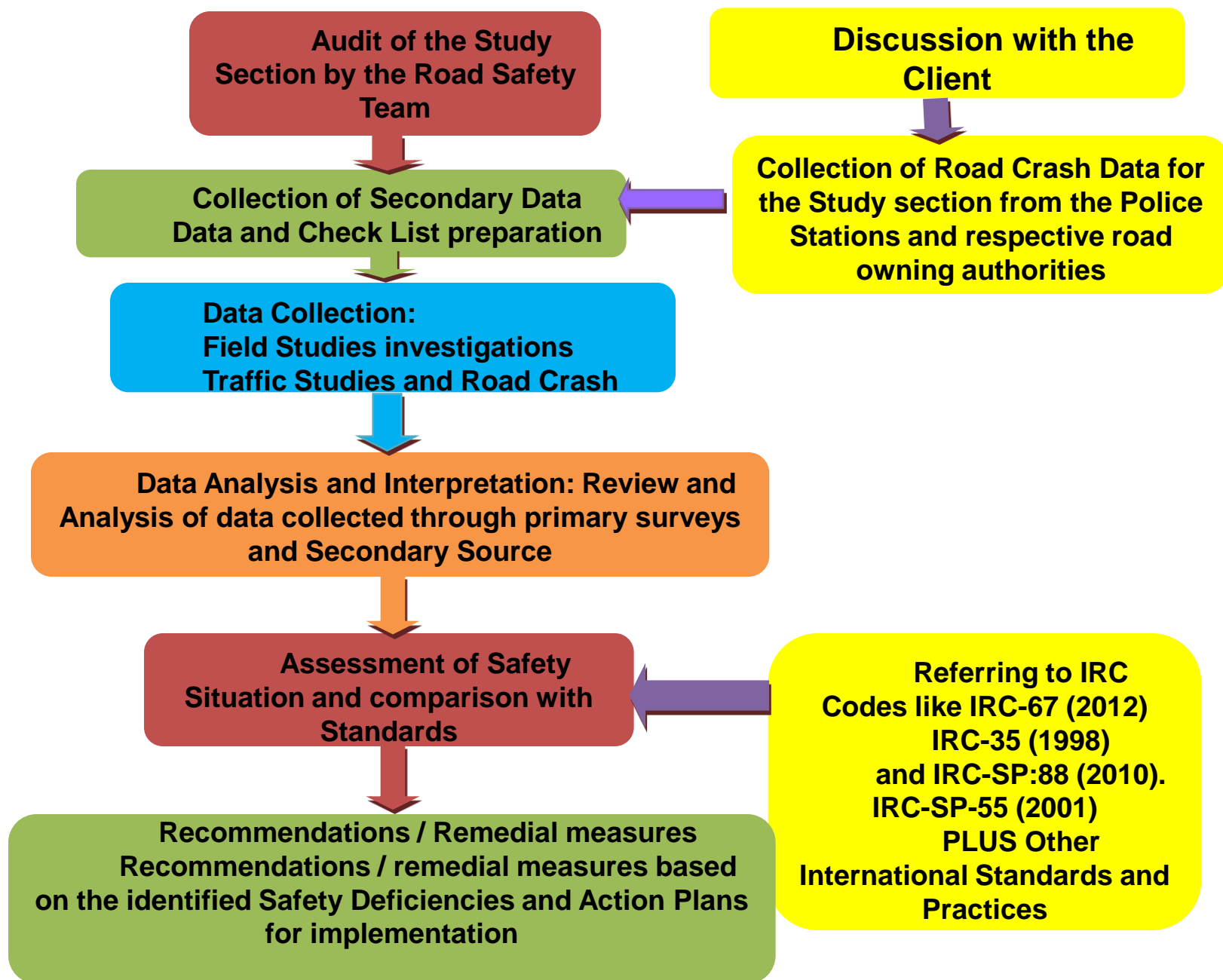
Develop
Countermeasures

Detailed Design

Monitoring & Evaluation

Implementation

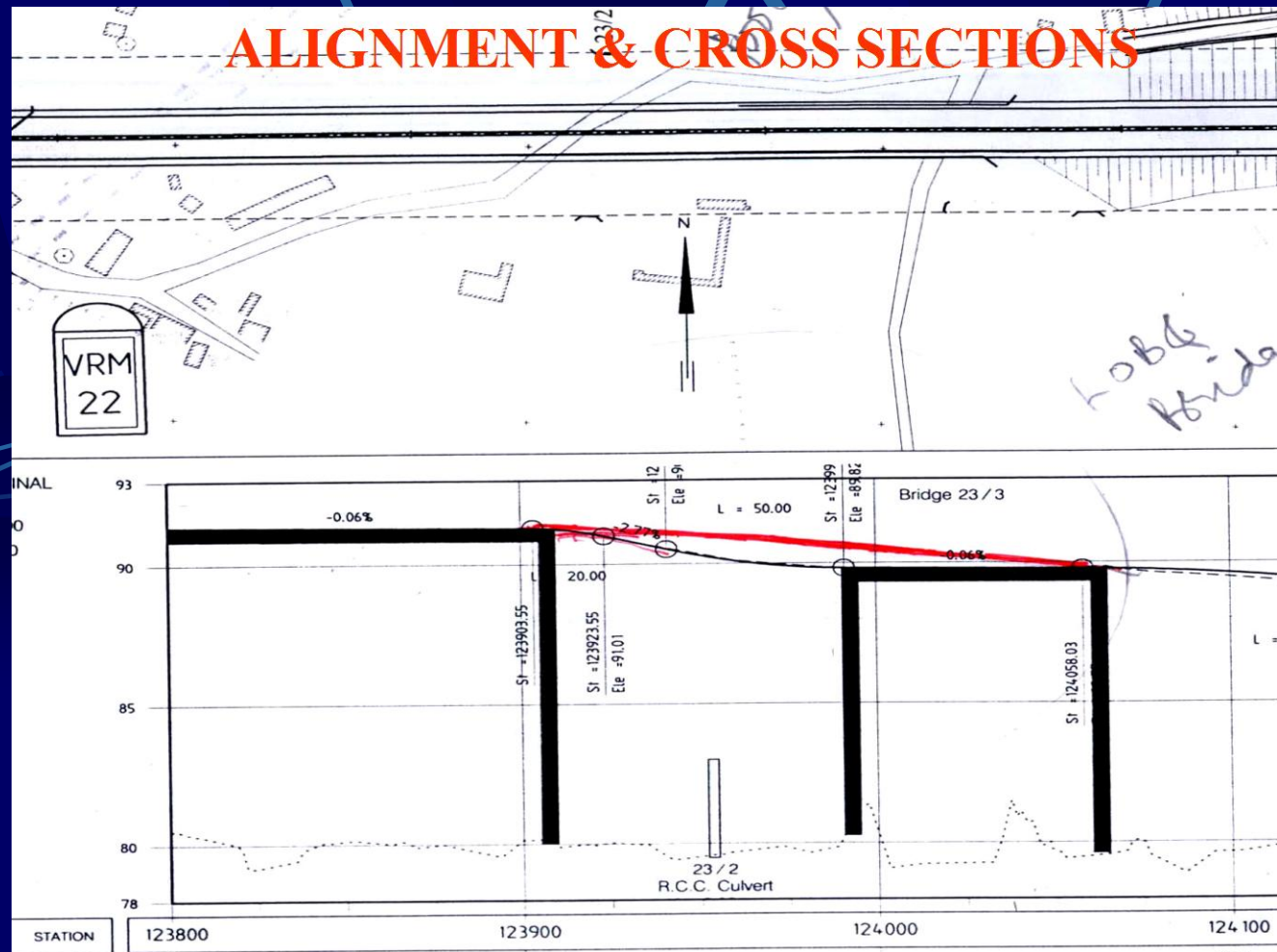




A Typical Study Methodology

Key audit steps

Closely review drawings



Key Audit Steps ...

Inspect site



Stages of Road Safety Audit

Feasibility

Preliminary design

Detailed design

During construction

Pre – opening

Existing road

Feasibility Stage Audits Consider ..

Route choice

Design standards

Impacts on the adjacent road network

Intersection types ... and much more

Preliminary Design Stage Audits Consider

Geometrics,

Alignments

Intersection layouts

Vulnerable road users and more

Detailed Design Stage Audits Consider

Clear zone issues

Signs / line marking

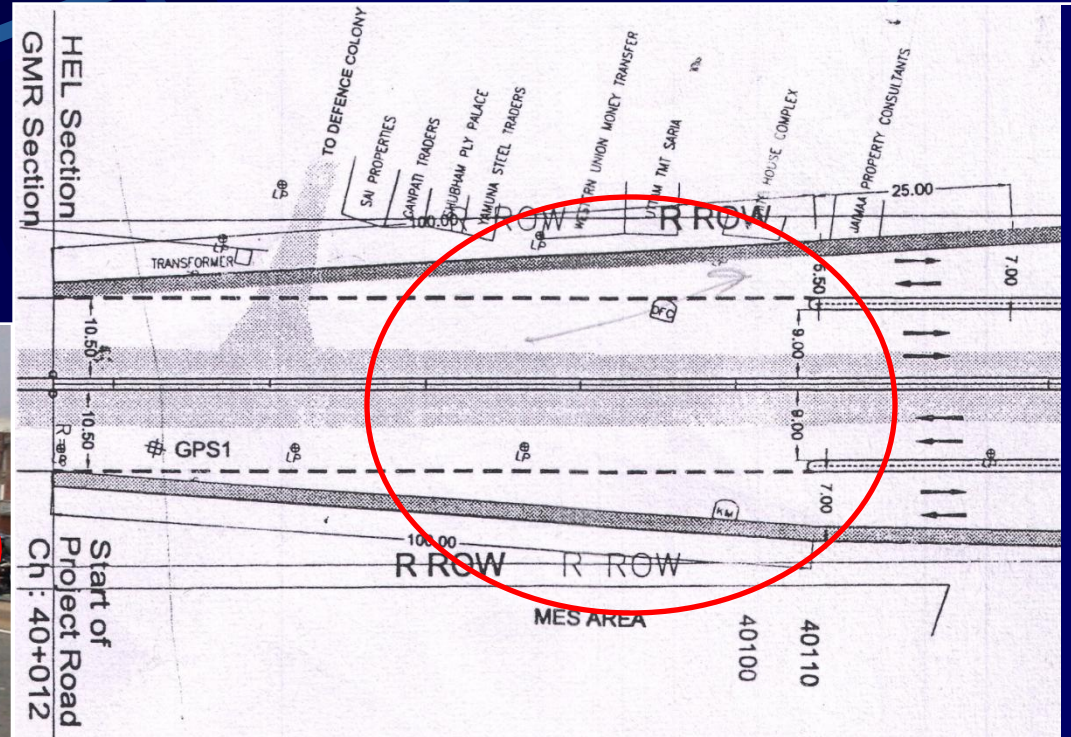
Crash protection

Traffic control

Lighting and more

Non provision of Service Road

- Non provision of service road at start of project road can promote lawless

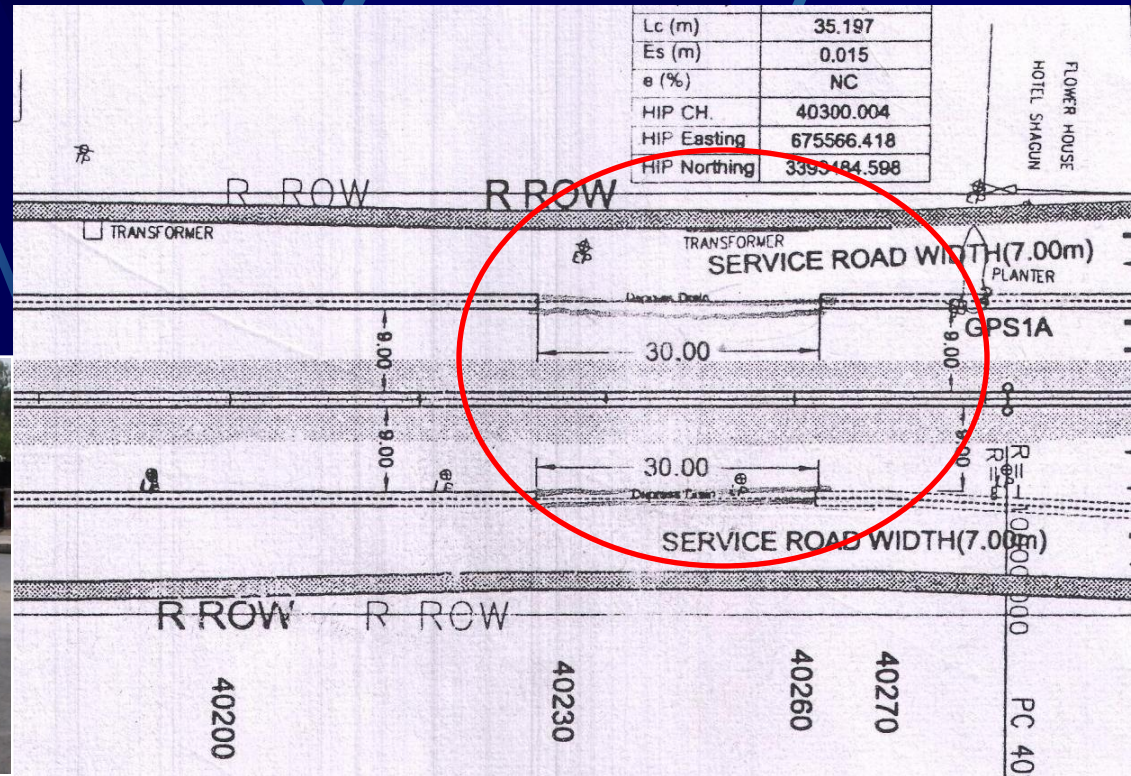


Recommendations

- Provide service road for safe management of traffic in built up areas from Zeerakpur intersection to start point of project road.

Plan and Profile: Gaps in dividers

- Closely spaced gaps in divider particularly near intersections, ramps and bus bays on service road can promote lawless movement.



Recommendations

- Provide minimum gaps in the divider with adequate acceleration/ deceleration zone, weaving/ merging/

Audits During Construction Consider

Crash Protection

Delineations

Traffic Control

Traffic Management

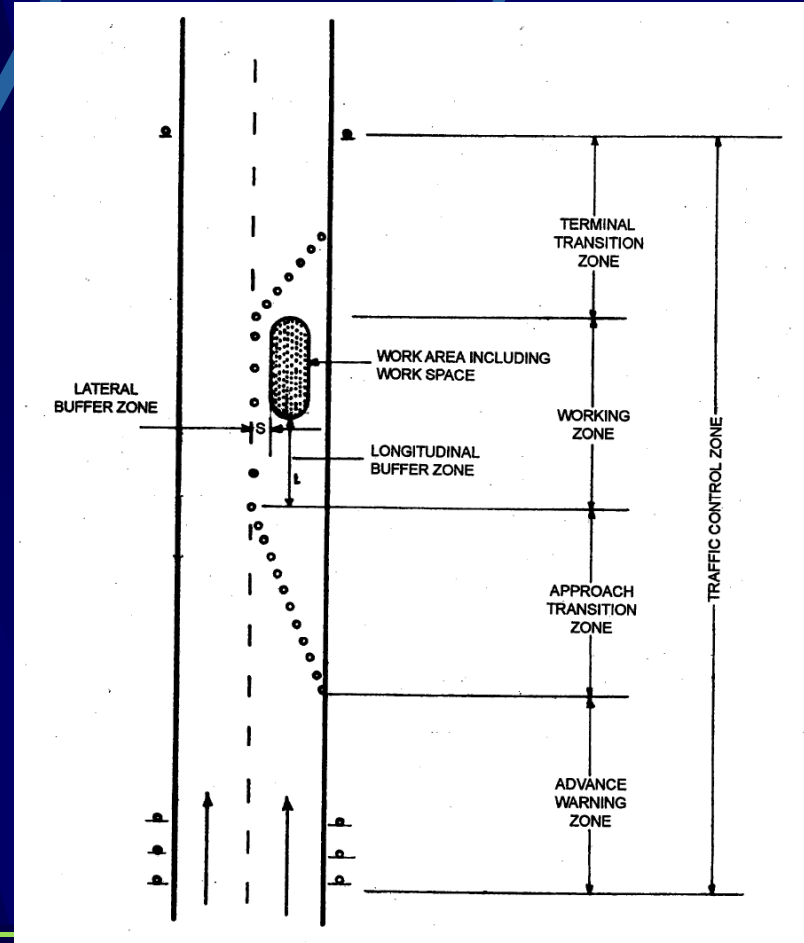
Signs, Lighting And more

Absence of information about commencement or end of work zone



Table: Recommended Length of Components of a Traffic Control Zone

Average Approach Speed (km/hr)	Length of Advance Warning Zone (m)	Length of Approach Transition Zone (m)	Length of Working Zone (m)
50 or less	100	50	Varies
51-80	100 - 300	50 - 100	
81-100	300 - 500	100 - 200	
More than 100	1000	200 - 300	



Non-usage of PPE



Various situations on work sites on NH 22 bye-pass which show scant respect for observance of safety guidelines for use of PPE by construction workers

AN AUDIT OF THIS WORK WOULD HIGHLIGHT THE DANGERS OF FELLING TREES ON TO ROADS



An Audit of This Maintenance Work Would Highlight a Lack of Delineation and Warning, Plus Unsafe Work Practice



Pre Opening Audits Consider ..

Previous audit issues

Roadside crash protection

Correctness of signs/markings

The users view and more

AUDITS OF EXISTING ROADS CONSIDER

**ALL ISSUES RELEVANT TO THE
ACCIDENT POTENTIAL OF THE ROAD**

RSA of Existing Roadway Sections

- *Road Inventory*
- *Classified Volume Counts*
- *Speed Surveys*
- *FLR's from Police Stations*

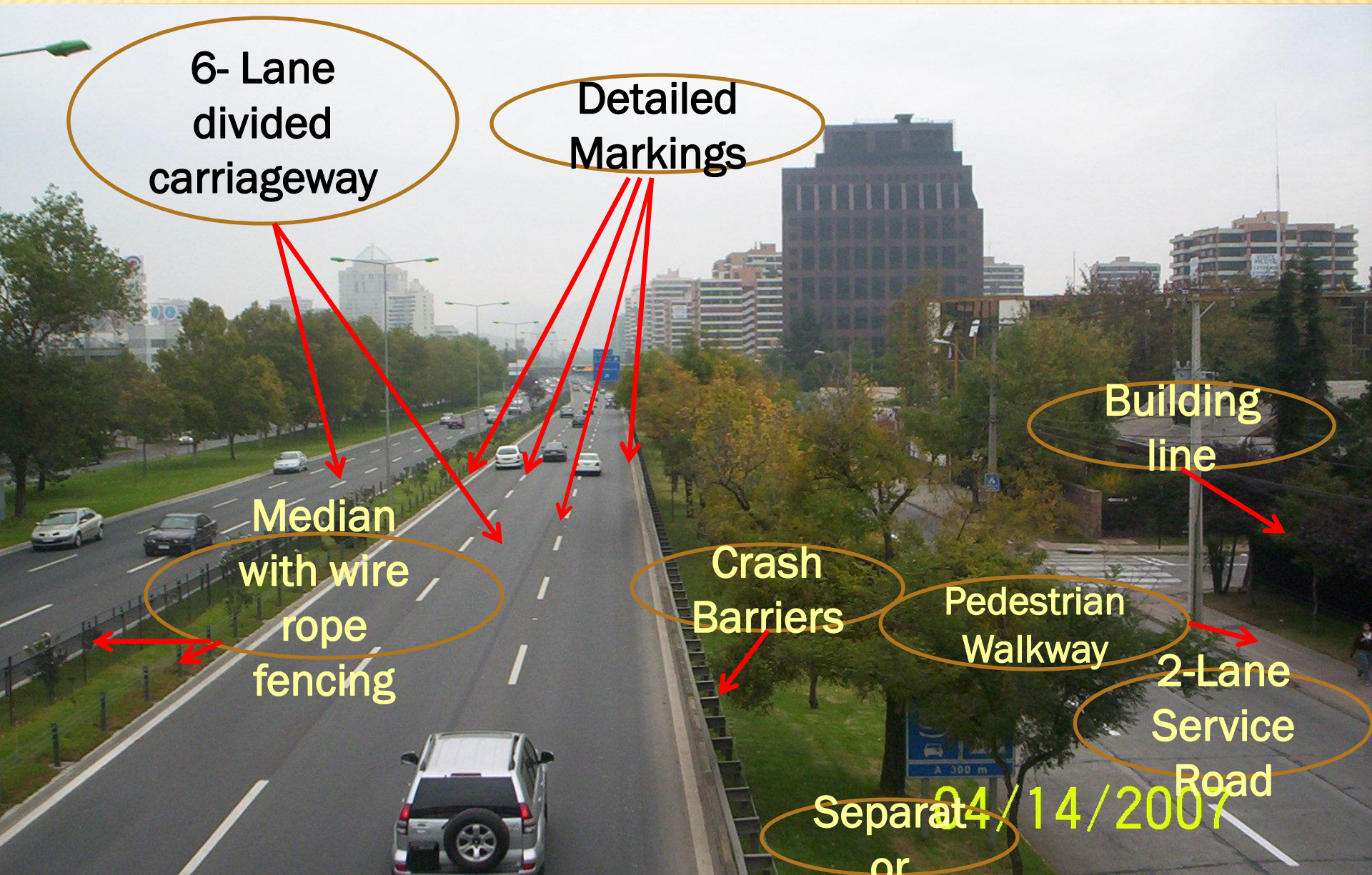
Audits of Existing Roads ...

Can be useful if an independent team looks at the road with crash potential as its only issue.

Can assist if there is no or incomplete crash data.

But – the maintenance crew and local traffic engineers should already be improving safety on the existing network.

URBAN EXPRESSWAY IN SANTIAGO



6- Lane
divided
carriageway

Detailed
Markings

Median
with wire
rope
fencing

Crash
Barriers

Pedestrian
Walkway

Building
line

2-Lane
Service
Road

Separat
or

04/14/2007

Thank you