Need for Design Stage Road Safety Audit

Invited Talk by

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International Road Federation

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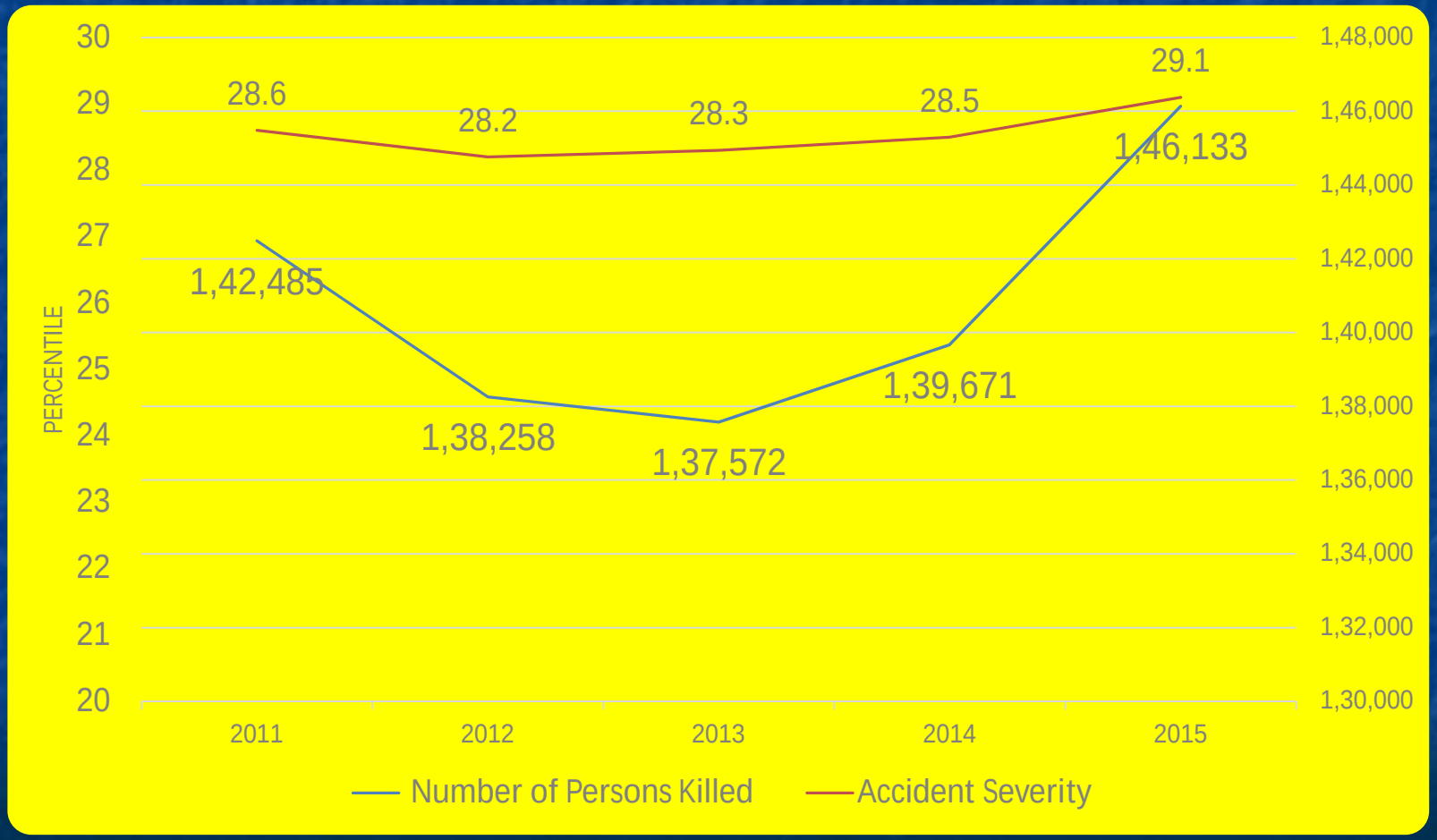
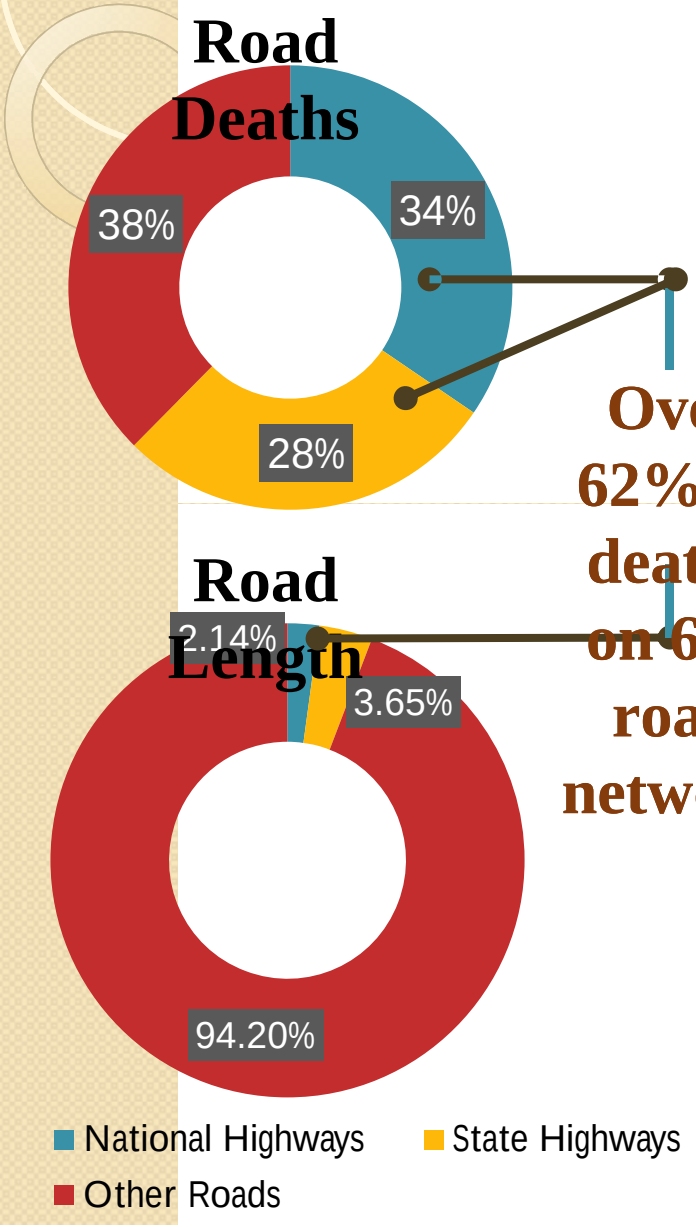
Presentation Focus on

- Profile of Road Crashes and Design Stage Audit
- Aspects covered under Design Stage Audit
- Design Stage Audit: Typical Illustration on Alignment and Intersection Audit Issues
- Need for Special Focus on
  - Intersection and Interchange RSA
  - Concerns of Vulnerable Road Users during Design
  - Road Signs and Markings

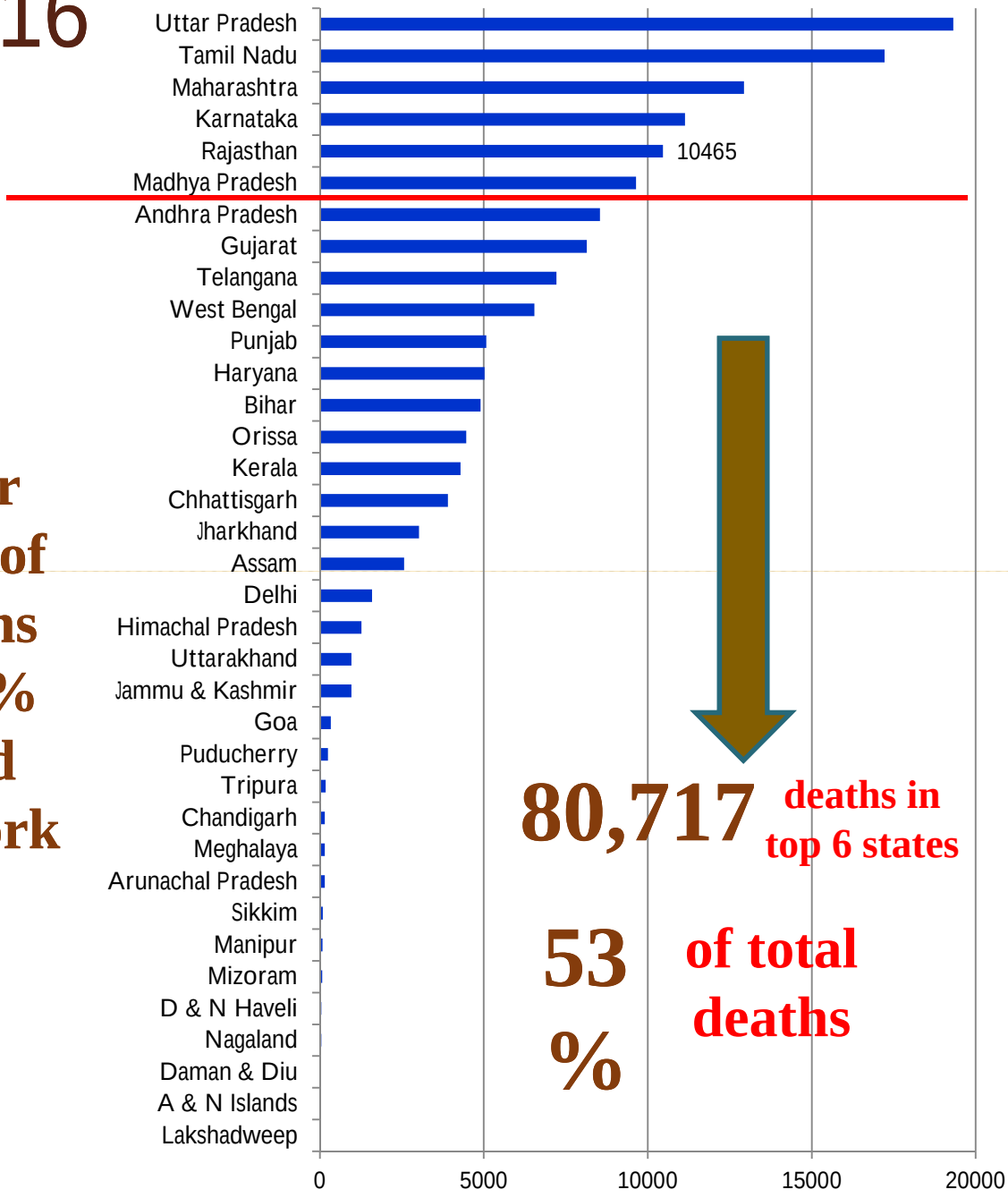
Profile of Road Crash Statistics in India from 2011 to 2015



Fatalities in 2016



Over 62% of deaths on 6% road network

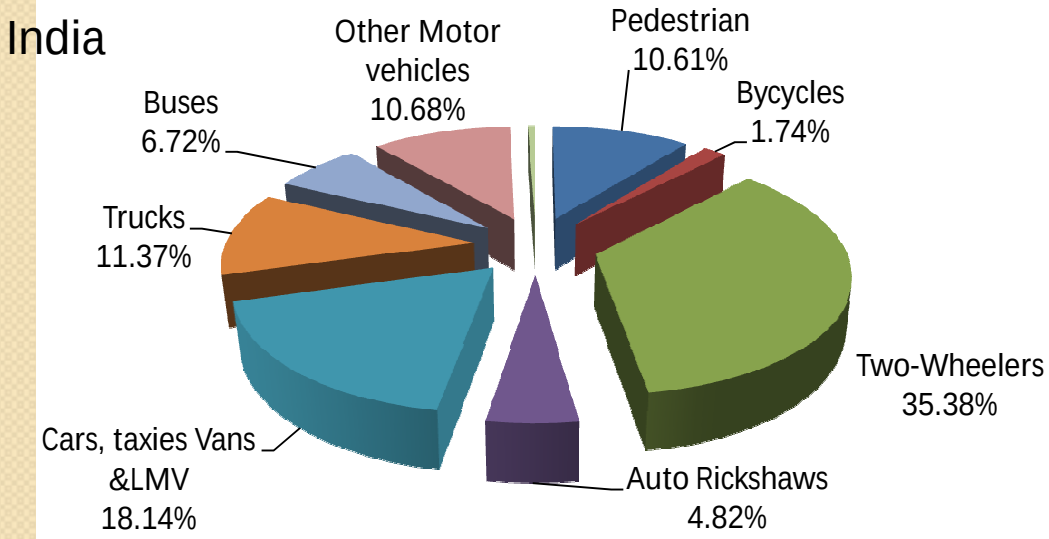


80,717 deaths in top 6 states

53 % of total deaths

Share of Urban & Rural (India)

Years	Total Killed		Total Injured	
	Urban	Rural	Urban	Rural
2016	57,840	92,945	2,16,813	2,63,839
2015	56,978	89,155	2,31,894	2,69,529
2014	56,663	83,008	2,26,415	2,62,985
2013	52,603	84,969	2,22,883	2,63,593
2012	53,127	85,131	2,23,933	2,66,450
Avg. Share	38.91%	61.09%	45.82%	54.18%



VRUs Share 52.55%

Some stats about Global road crashes

- About 1.25 million people die each year across the world as a result of road traffic crashes
- Road traffic injuries are the leading cause of death among young people, aged 15–29 years
- 90 % of the world's fatalities on the roads occur in low- and middle-income countries

Some stats about road accidents

In India -

- India has a road network of about 5.4 million kms, which is the second largest in the world
- About .15 million people died in Road Crashes in the year 2016
- NHs and SHs constitutes only for 5% of total road length but they account for about 63% of the total road accidents
- Vulnerable road users share about 44% of the total road accidental death
- Yearly it consumes a total share of 3% of the country's Gross Domestic product (GDP)

What is Road Safety Audit ?

- A formal check
- Systematic, evidence-based
- Auditors are experienced road safety engineers
- Auditors are independent of the designers
- Safety recommendations are set out in an Audit Report
- Final decision rests with the Project Manager / Client like OWD.

Why do Road Safety audit?

- Experience has shown that new roads are not always as safe as they should be.
- This is often because potential safety problems often overlooked when the road is designed.
- It is much easier to change a design than have to change the road once it is built.

Steps in an Audit Procedure

- **Ordering an audit**
- **Studying the plans - inspecting the site**
- **Holding a commencement meeting with the highway design team**
- **Undertaking the audit**
- **Writing the Road Safety Audit Report**

What does the report contain?

Observation

Problems observed and its location

Reasons for concern

The safety concerns will be narrated, supported with pictures to appreciate the gravity of the issue

Recommendations

The Audit would recommend road safety engineering measures for each observed problem

Priority

The Audit will also set priority levels, the urgency with which each recommendation has to be compiled with such as “Essential”, “Highly Desirable” and “Desirable”.

When should schemes be audited ?

Ideally at:

- feasibility study stage
- preliminary design stage
- detailed design stage
- Construction Stage
- Pre-opening
- Existing Road: Operation and Maintenance Stage

Coverage of Audit

1. General
2. Cross Section
3. Alignment
4. Interchanges
5. Junctions
6. Provision of Vulnerable Road Users
7. Road Signs, Markings & Lightings as per Standards
8. Provision for Roadside communities
9. Roadside hazard

Typical Coverage in Design Stage Audit

Detailed Design -- Geometry of Horizontal and Vertical Alignment, Alignment, Road Signing, Lane markings, signing, delineation, lighting, intersection details, clearances to roadside objects, provision for road user groups with special requirements *(i.e. pedestrians, cyclists, people with disabilities),* drainage, poles and other roadside objects, landscaping, adequacy of embankment slopes and guard fencing.

Typical Design Stage Audit of Alignment

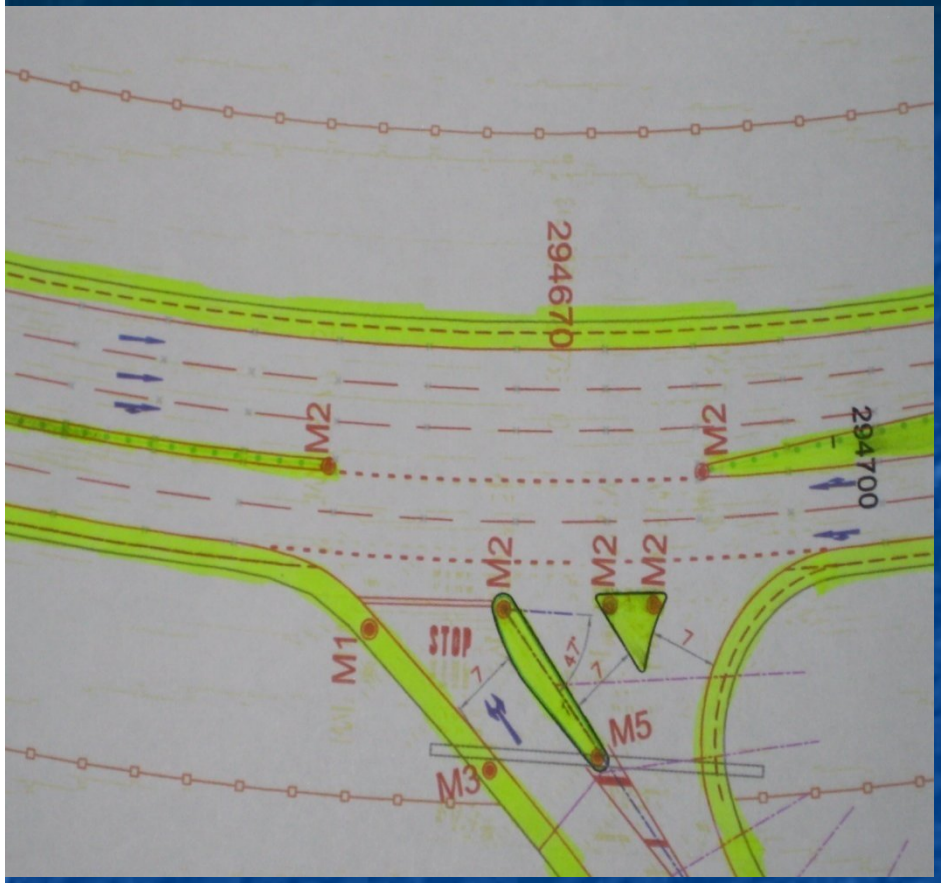
DESIGN ISSUES	N/A	Yes	No	Comments
Geometry of Horizontal and Vertical Alignment				
a. Does the horizontal and vertical design combination of the road provide a suitable alignment?				
b. Do the combinations of horizontal and vertical design elements conform to design practice?				
c. Is the design would cause a driver to misread the road characteristics? (e.g. visual illusions, confusing delineation of lines of trees, poles, etc.)				
d. Does the alignment selected ensure speed consistency?				
e. Is Sight Distance criteria met?				

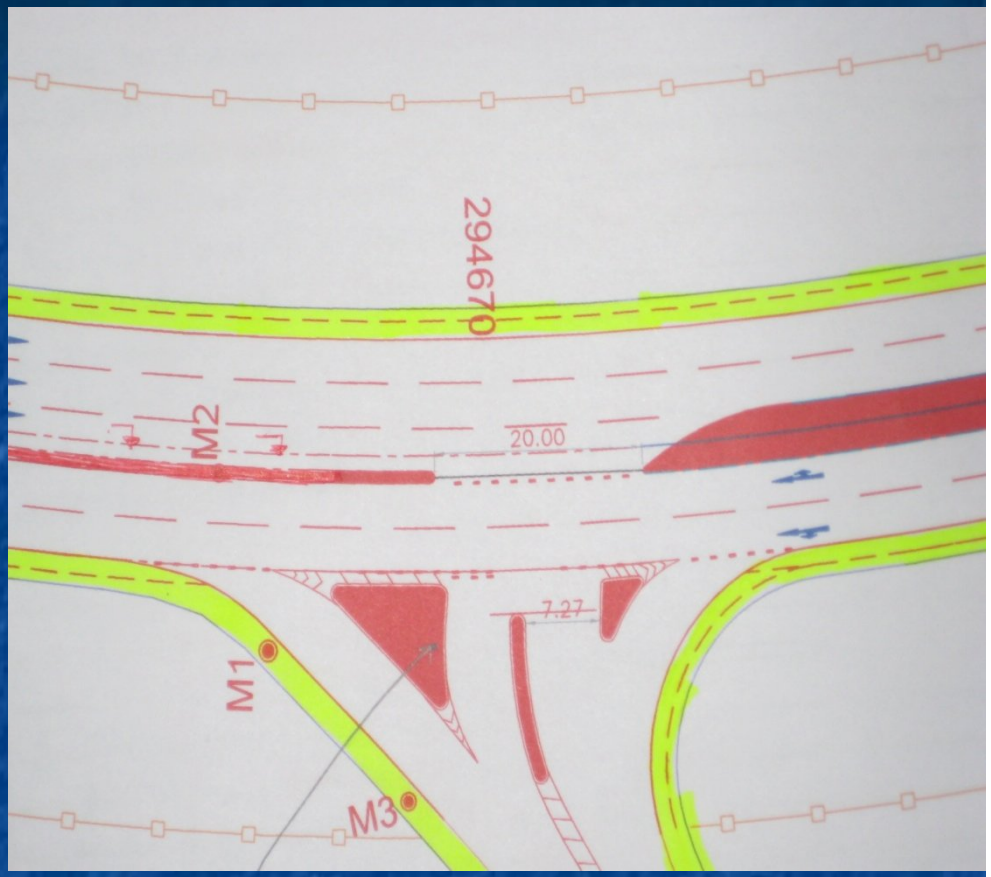
Typical Design Stage Audit of Alignment *(Contd..)*

DESIGN ISSUES	N/A	Yes	No	Comments
Typical Cross Sections **a.** Are the lane widths, shoulders, medians and other cross section features in accordance with standard design and adequate for the function of the road? **b.** Is the width of traffic lanes and roadway suitable in relation to: - alignment? - traffic? - speed environment? - combinations of speed and traffic volume?				

Design Audit of Intersections

At-grade Junctions

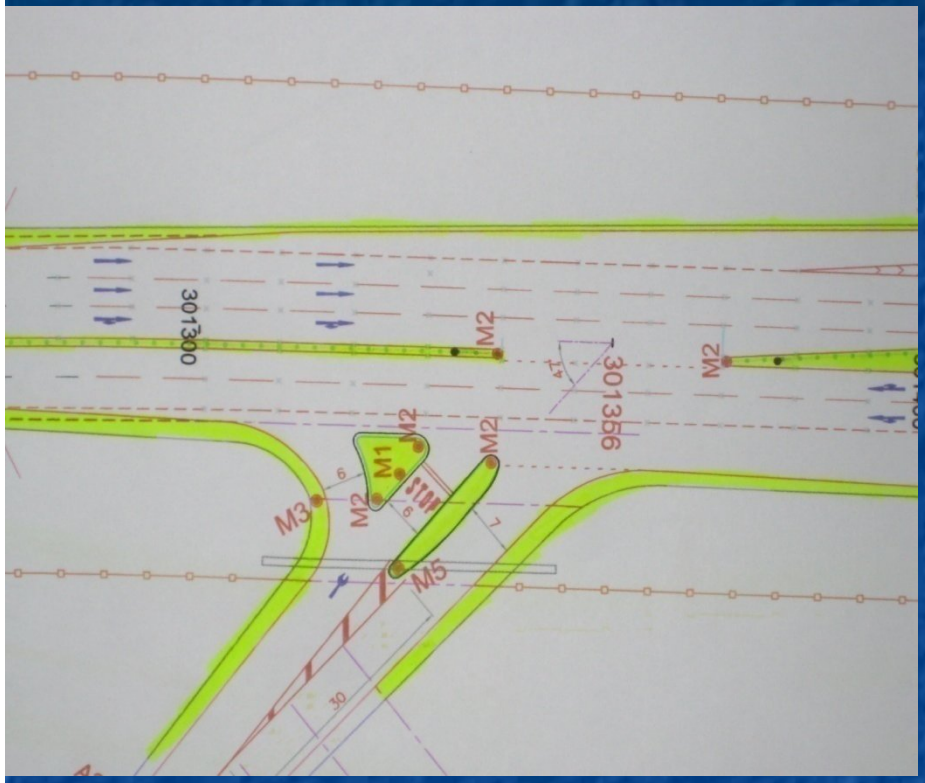


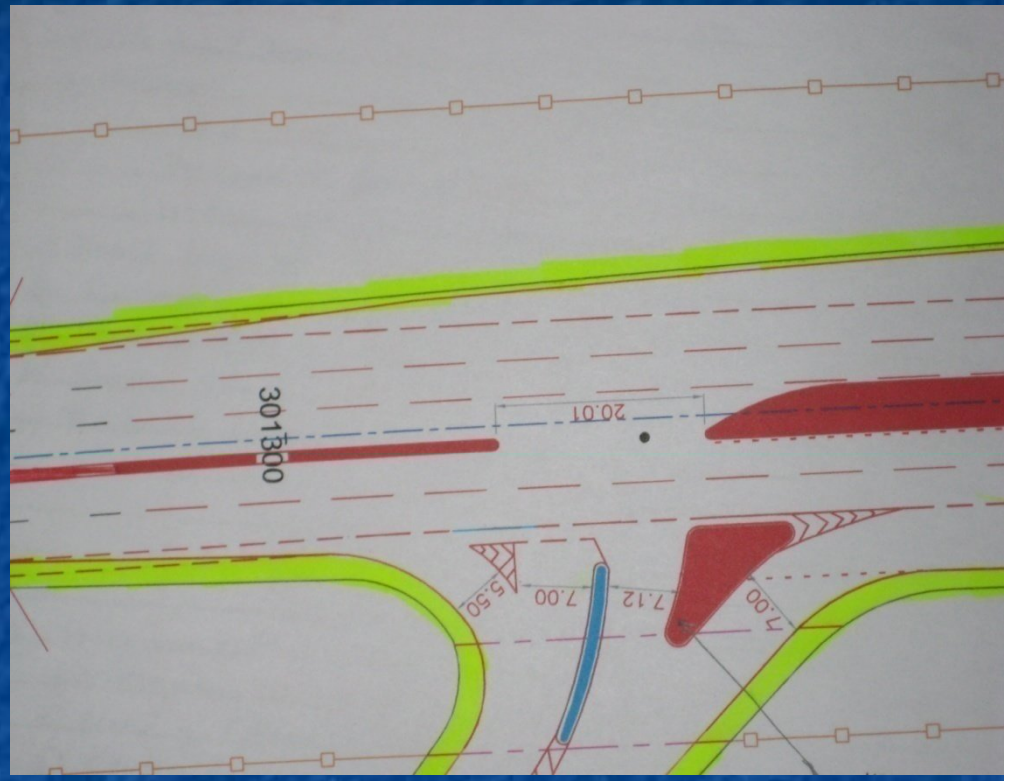


Current Layout *(Potential safety Problems)*

Possible Revised Layout (red ink shows the alteration to reduce the safety risk)

At-grade Junctions

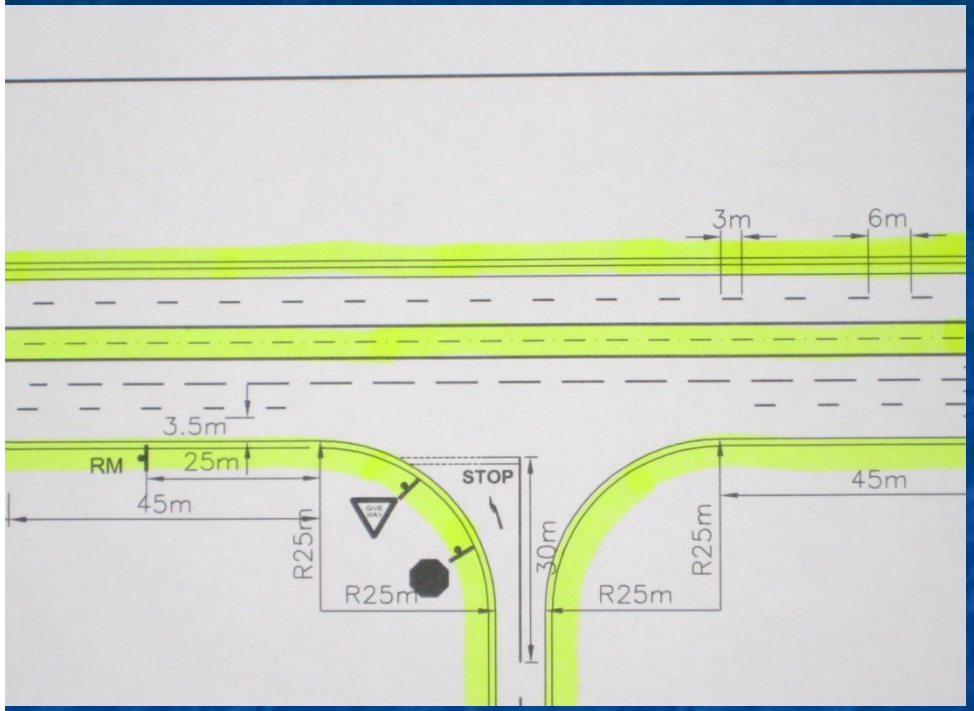




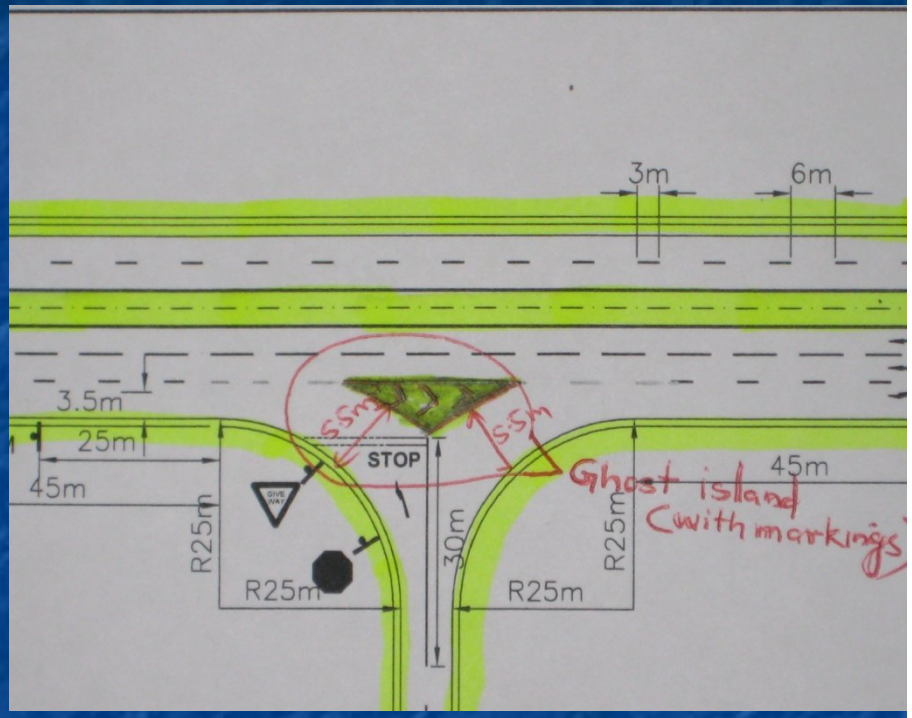
Current Layout
(Potential safety Problems)

Possible Revised Layout
(red ink shows the alteration to reduce the safety risk)

Minor Junctions



Minor Junction without Ghost Island



Minor Junction with Ghost Island

Unregulated Access

Reasons for concern:

- The side road traffic from towns/villages joining the high speed corridor in an unregulated manner is highly unsafe.
- If they are not controlled before entering into the main road, each access point could become a blackspot. .

Unregulated Access

Recommendations: Essential

(i) The speed of the side road traffic should be curtailed before it enters the main road with a provision of road hump of 3.7m chord length in the side road. The hump should be provided for all side roads, where it joins NH directly without through a service road.

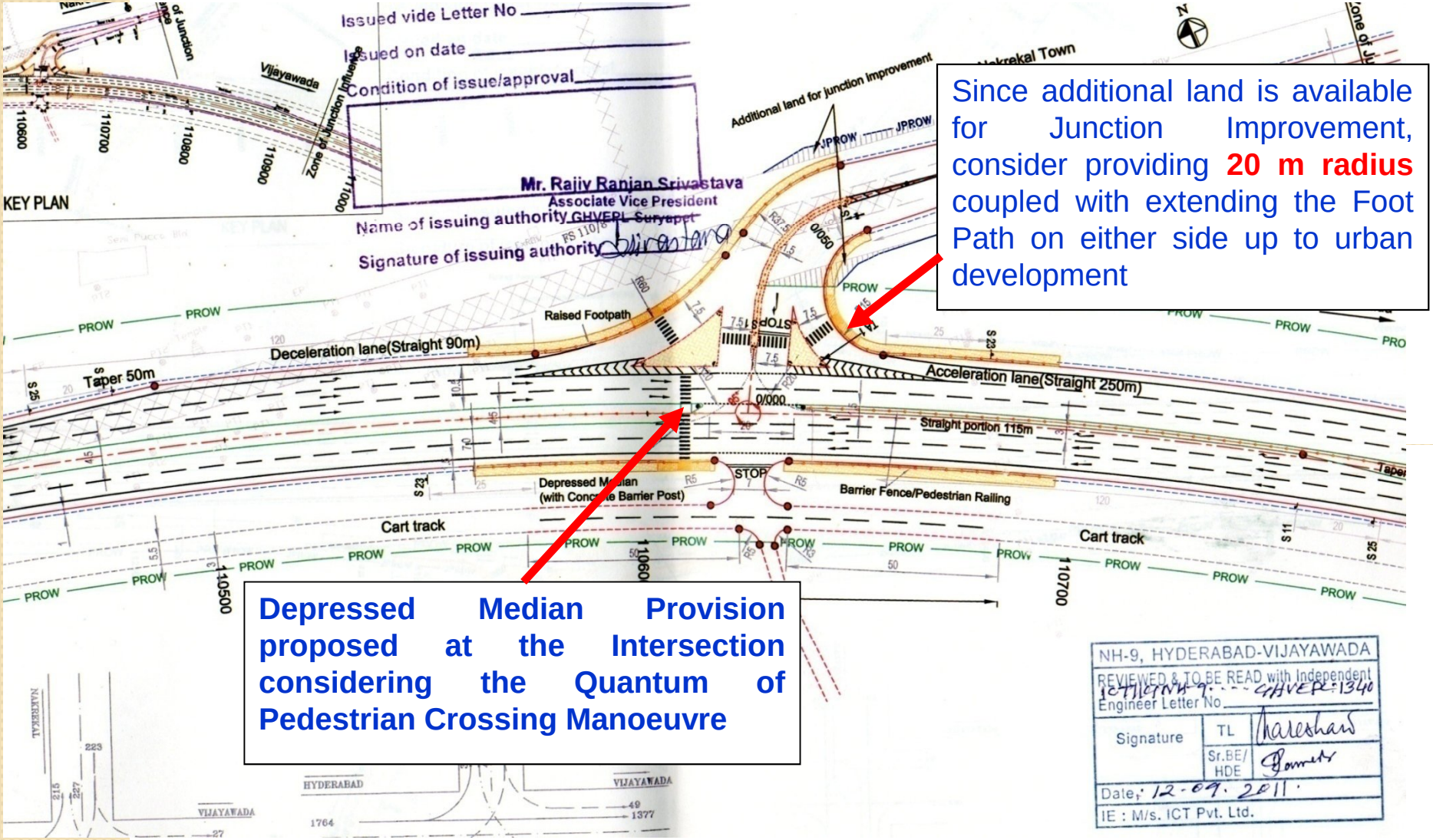
(ii) Hump shall be placed around 12m to 15m away from the edge line of the main road so that a vehicle approaching the main road shall mount the hump and then wait to see an opportunity to enter into main stream. Similarly, vehicles exiting from main road can fully leave *(full length of vehicle)* from traffic way of main carriageway and then mount the hump in order to avoid any possible rear end collision.

Highly Desirable

(iii) Install hump warning signs in advance and informatory sign at the location of hump. All signs should be installed at the side road only. Also, properly mark the hump as per IRC.

(iv) Mark Stop marking and Install stop sign at 2-4m away from stop marking to establish the control.

Typical Detailed Design Stage RSAs (Contd…)

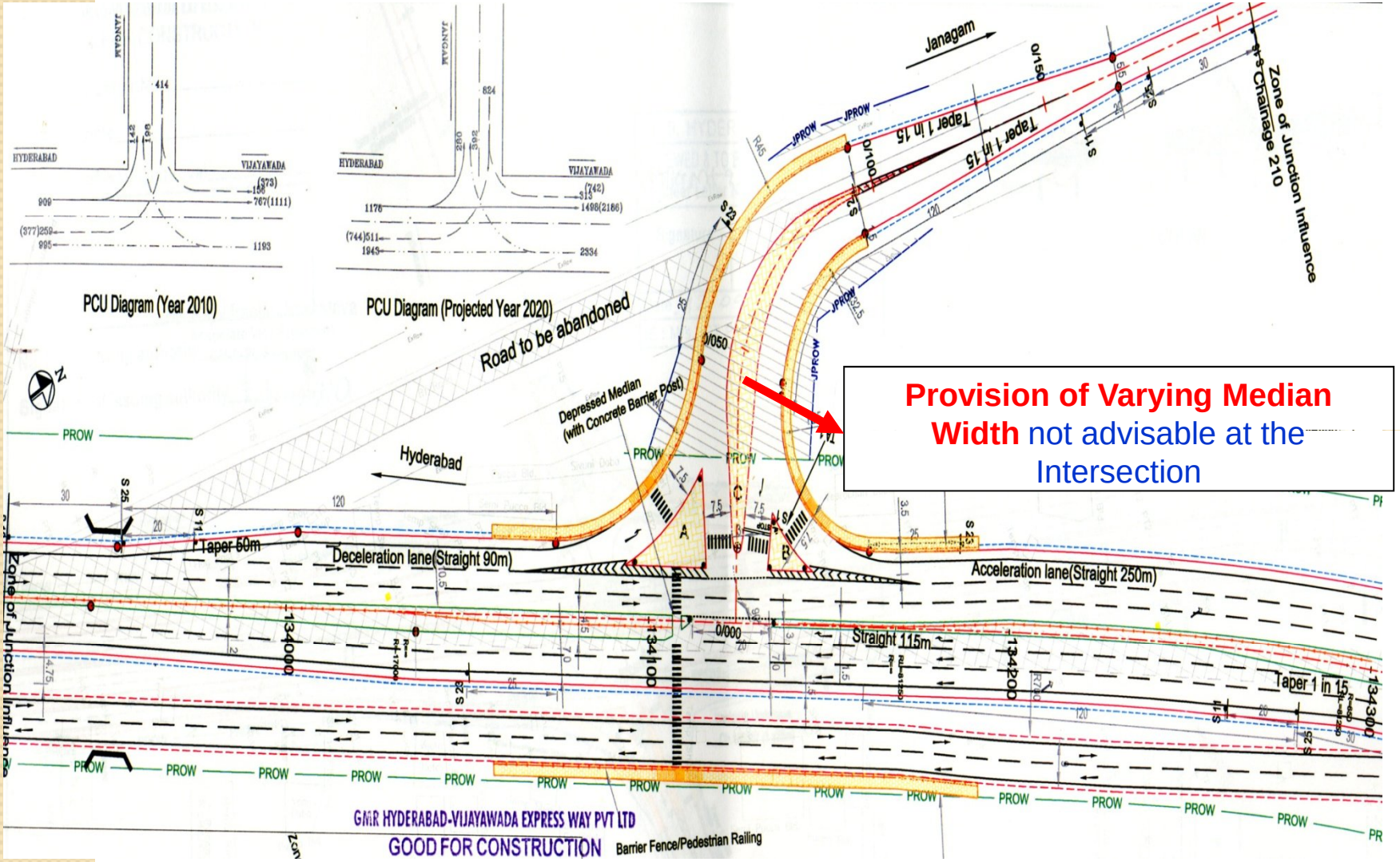


Since additional land is available for Junction Improvement, consider providing **20 m radius** coupled with extending the Foot Path on either side up to urban development

Depressed Median Provision proposed at the Intersection considering the Quantum of Pedestrian Crossing Manoeuvre

Major Intersection leading to Suryapet Town at Km 133/450 on NH-9

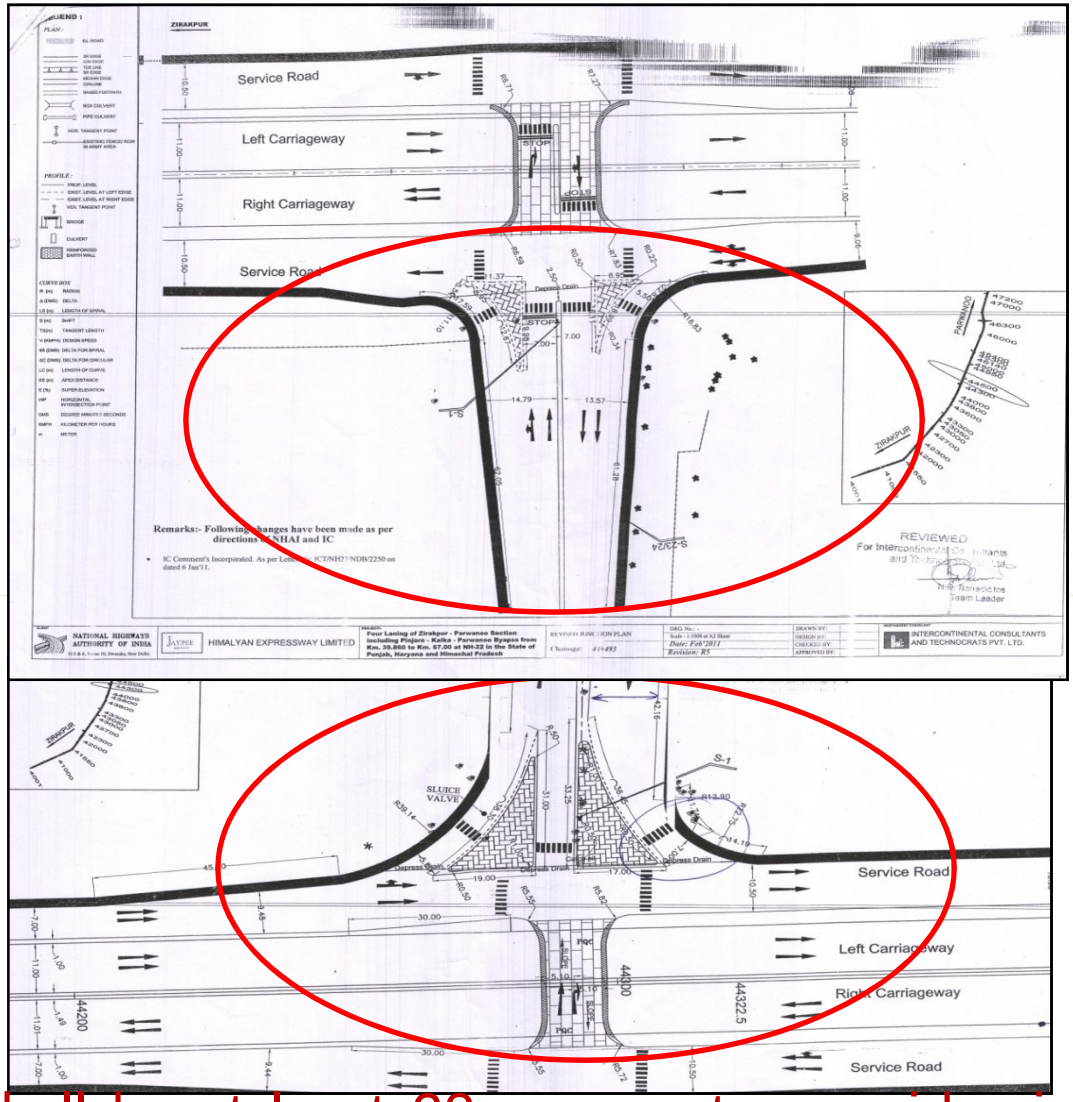
Typical Detailed Design Stage RSAs (Contd…)



Major Intersection leading to Janagam Town at Km 133/950 on NH-9

Narrow span of the vehicular underpass on NH-21

- Narrow vehicular underpass of 15.16m width for existing six lane divided carriageway road (30m ROW) is meeting the project road.

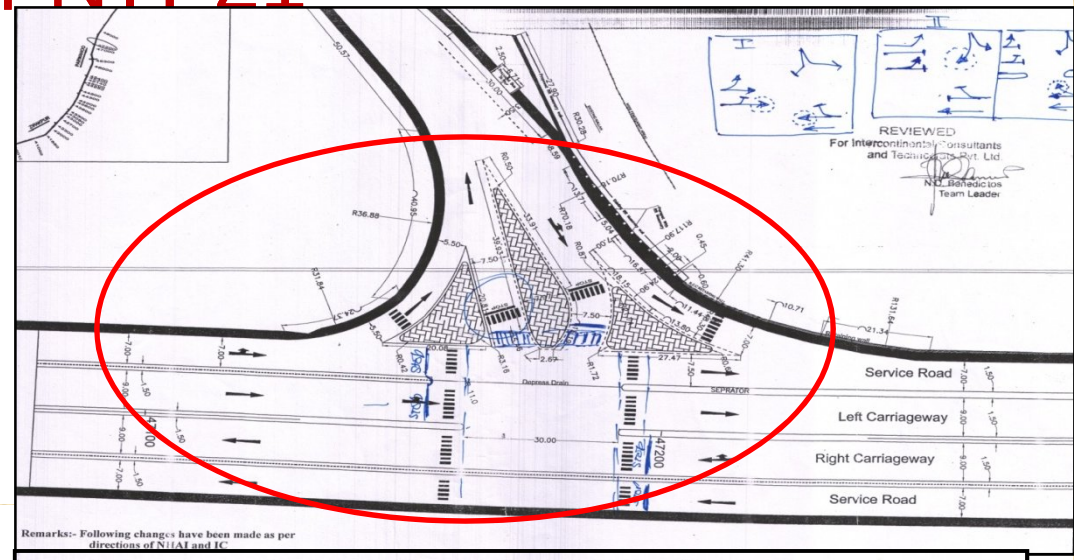


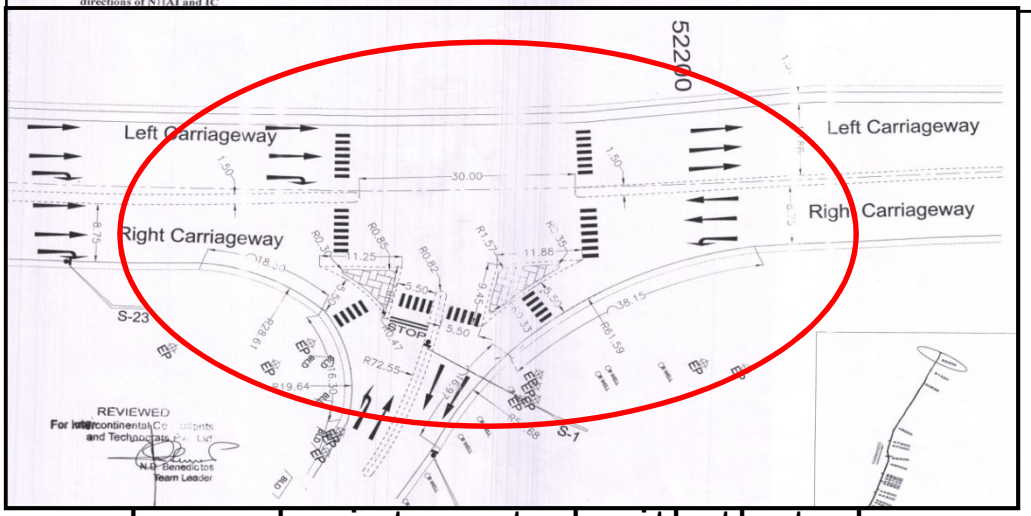
Recommendations

- Span of the underpass shall be at least 28m so as to provide six lane divided carriageway or with 2.5m side walk and 2.0m median to take care of future traffic.

Pedestrian Crossing Facilities at Intersections on NH-21

- Stop line and Pedestrian Zebra crossing not provided properly
- Pedestrian desire line of crossing across the approach roads is not followed appropriately and is not integrated with stop line and zebra crossing markings etc. leading to a situation where pedestrians will try to cross at unauthorized places and put themselves to risk.



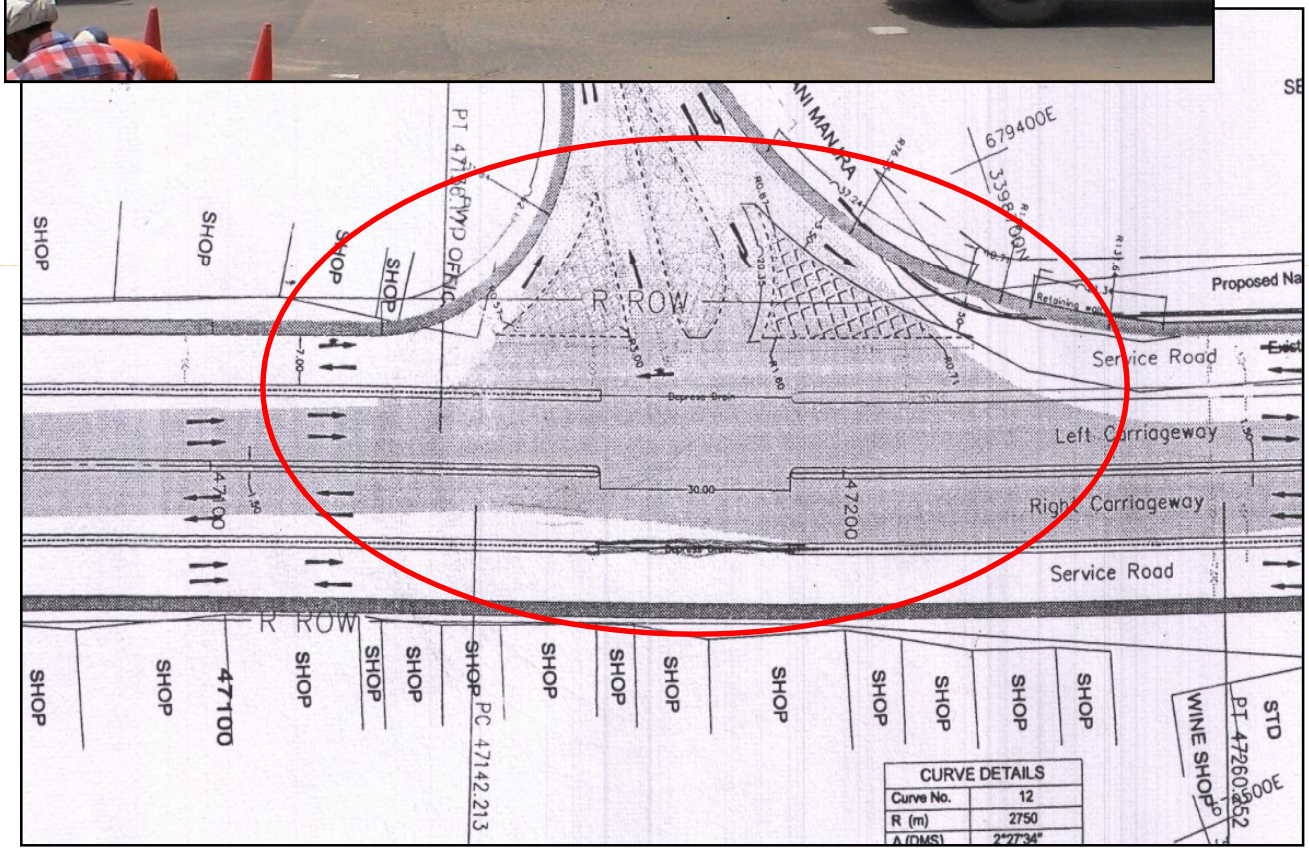


Recommendations

- Straight movement along the slip roads can be integrated with that along the main road and extra conflicts may be avoided. Proper pedestrian management / circulation plan integrating with signal phasing be provided.

Too many conflicts at Intersections on NH-21

- Too many conflicts created by joining of service lane at the junctions.



Recommendations

- **Merge service road with main road at least 50 - 75 m before the intersection influence area and allow only left turn of service road traffic at intersections.**

Pedestrian crossing Facilities at Intersections

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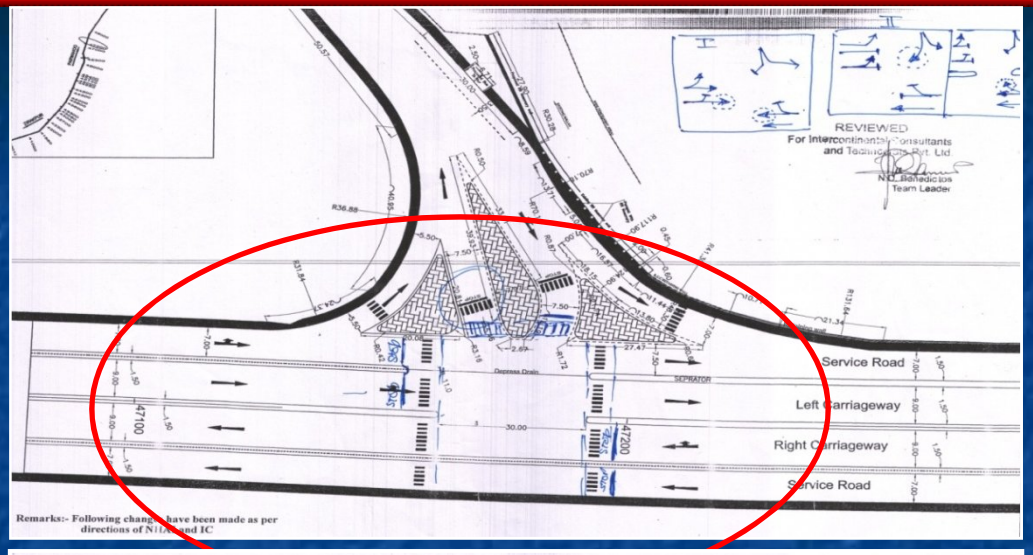

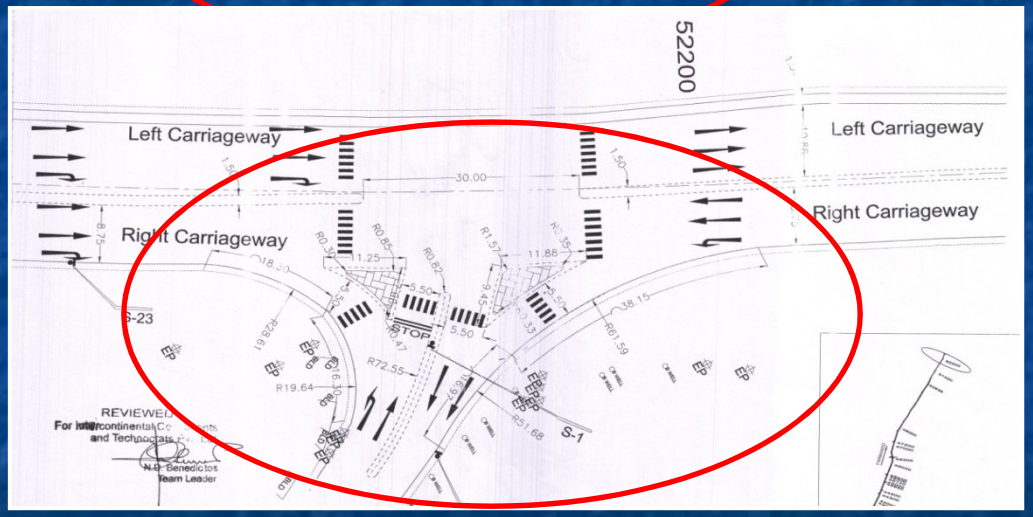

Recommendations

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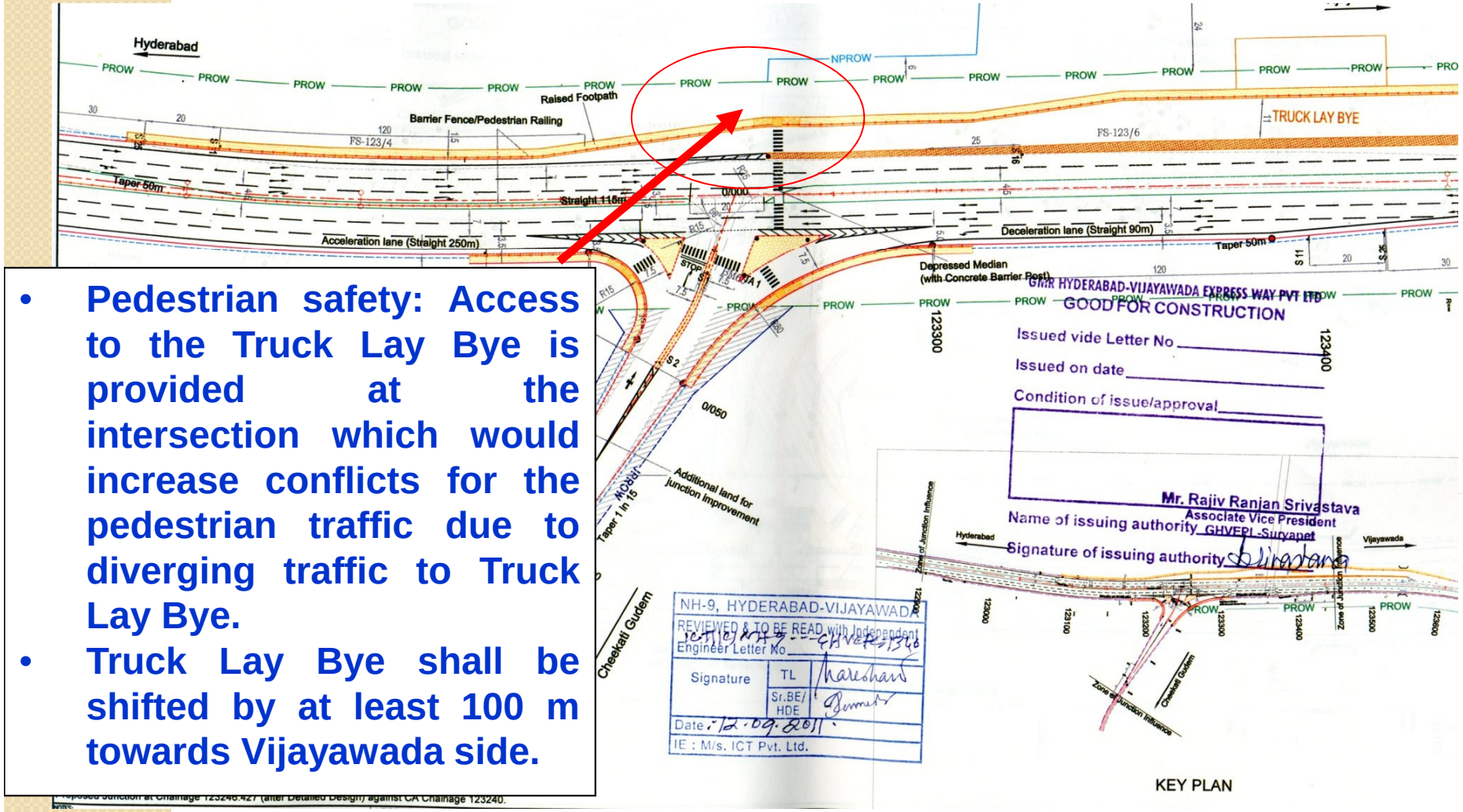
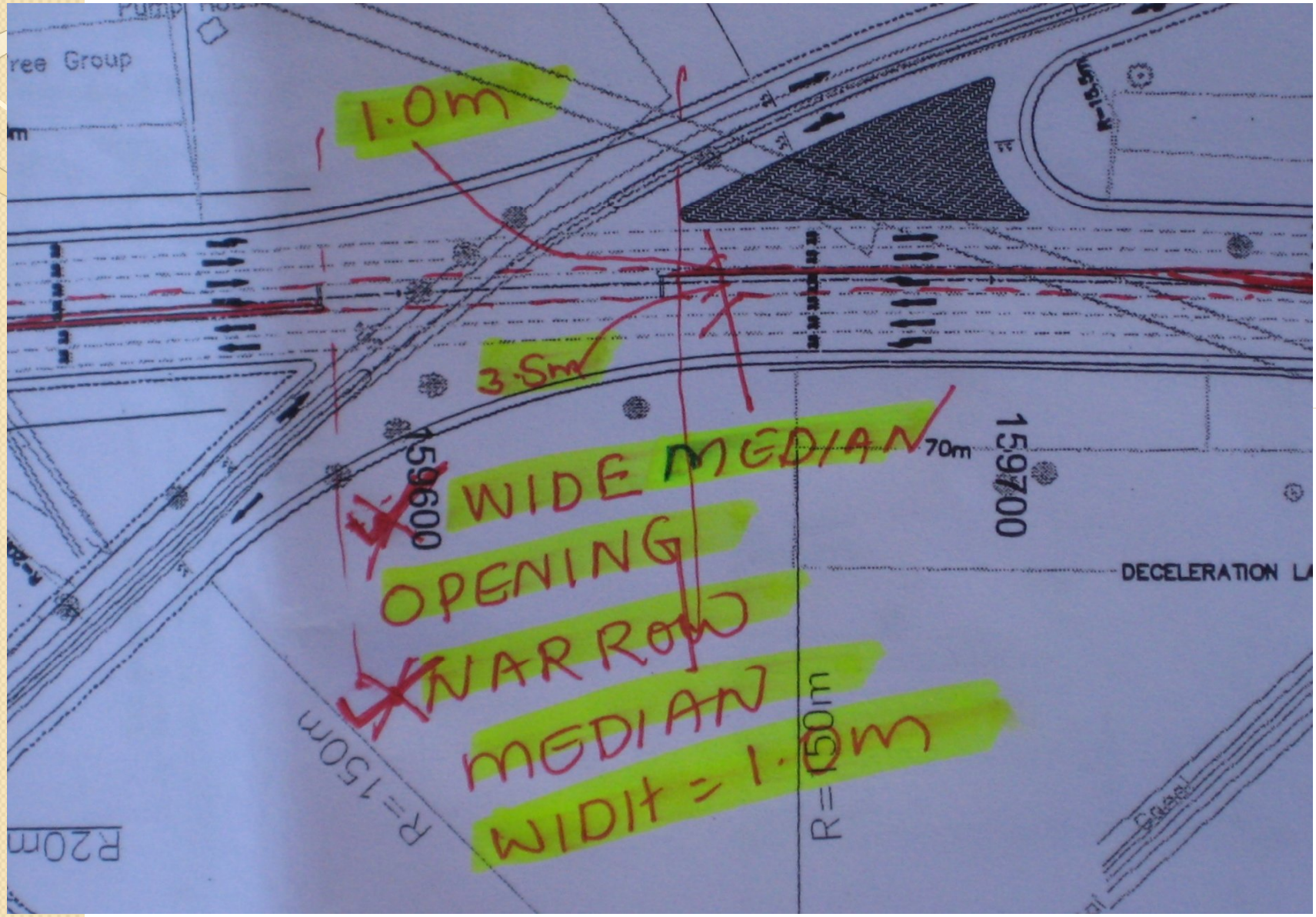
Typical Detailed Design Stage RSAs (Contd…)



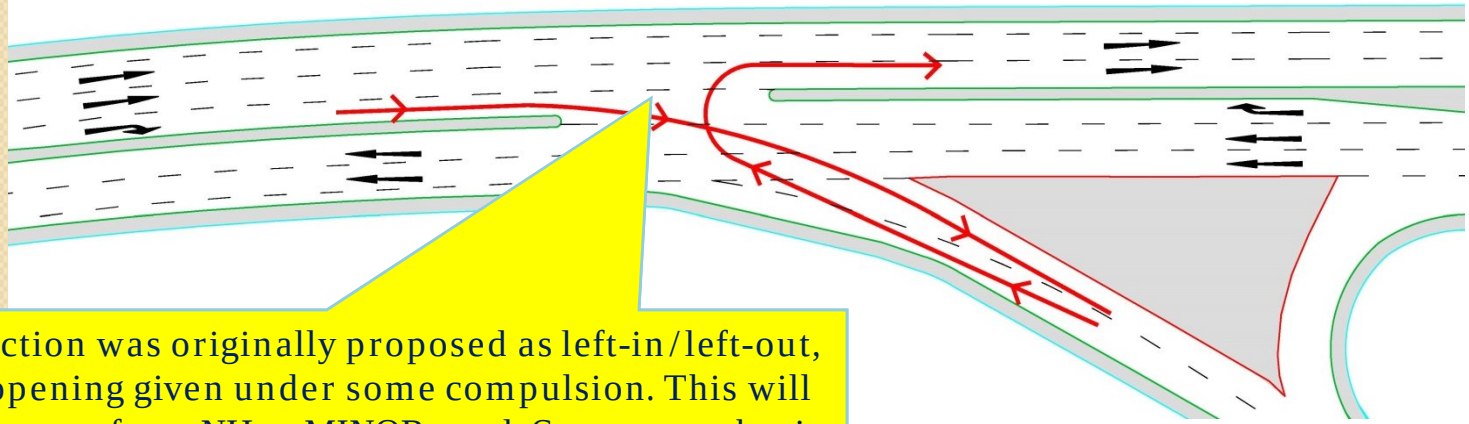
- **Pedestrian safety: Access to the Truck Lay Bye is provided at the intersection which would increase conflicts for the pedestrian traffic due to diverging traffic to Truck Lay Bye.**
- **Truck Lay Bye shall be shifted by at least 100 m towards Vijayawada side.**

Minor Intersection leading to Cheekati Gudem Village at Km 123/240 on NH-9

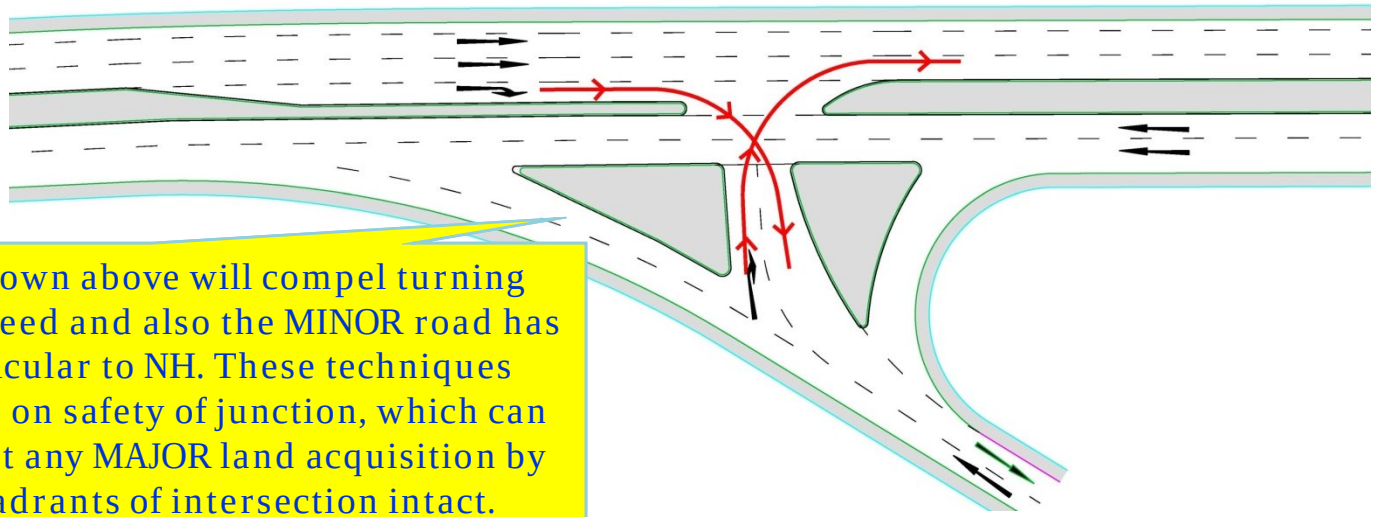
Need for the Installation of OHM and Issue of Median Opening more than 20 m wherein Median width is only 1m



DESIGN ISSUES

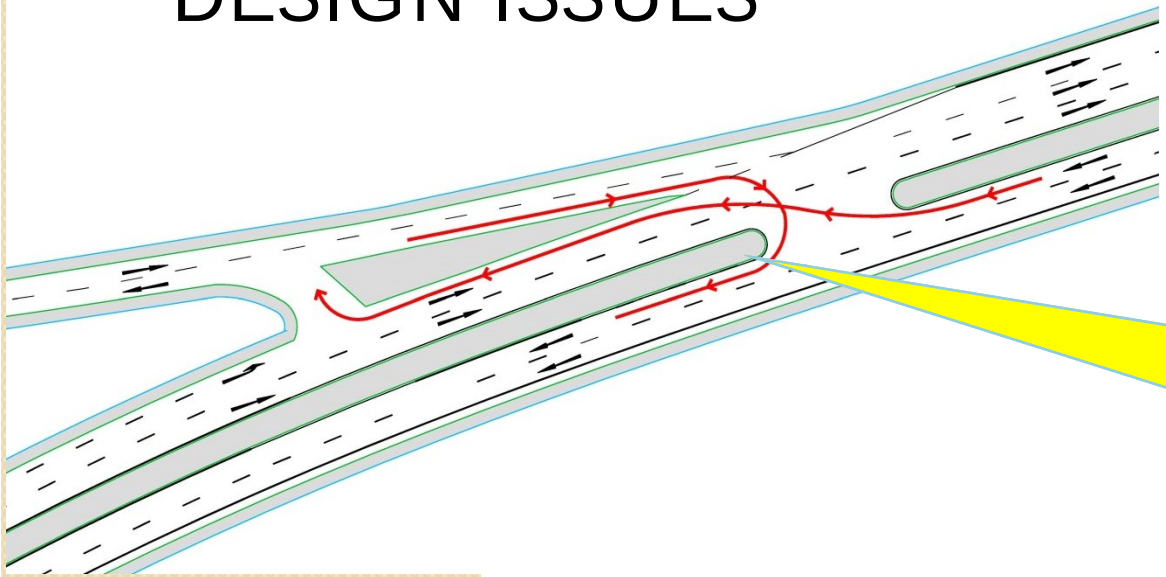


Safety Issues: The junction was originally proposed as left-in/left-out, but later-on median opening given under some compulsion. This will cause high speed movement from NH to MINOR road. Contrary to basic safety principle that turning traffic would endanger themselves of making movements with zero sight distance.

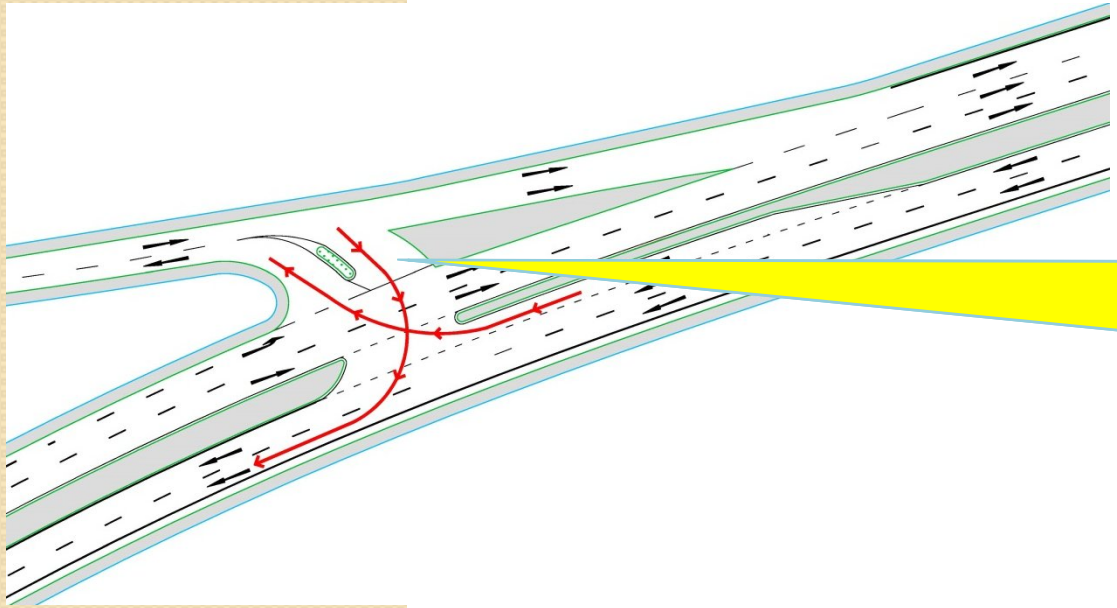


Suggestions: Layout shown above will compel turning traffic to turn at lower speed and also the MINOR road has been aligned perpendicular to NH. These techniques would have great impact on safety of junction, which can be accomplished without any MAJOR land acquisition by keeping the three quadrants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

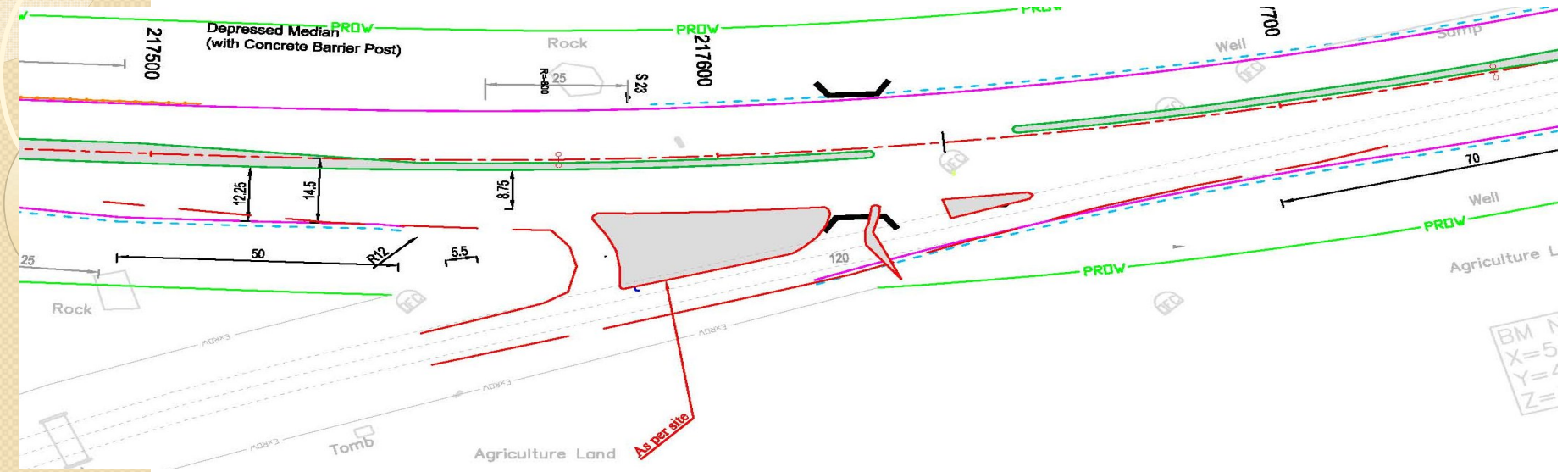
DESIGN ISSUES

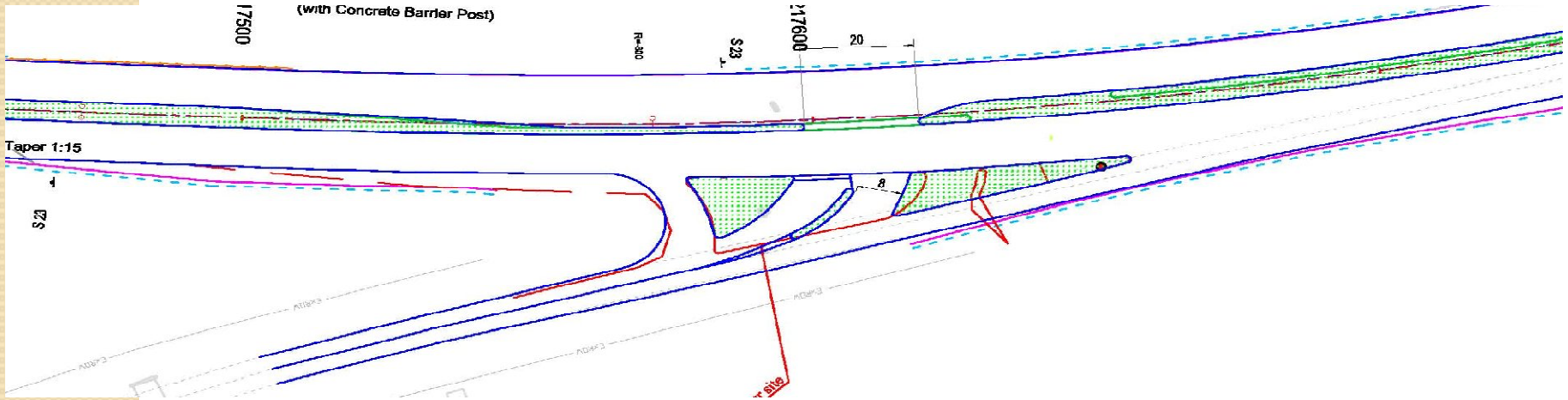


Safety Issues: A median opening has been provided eccentrically without considering the side road on left hand side of NH, which would cause highly unsafe contra-flow and reckless driving.

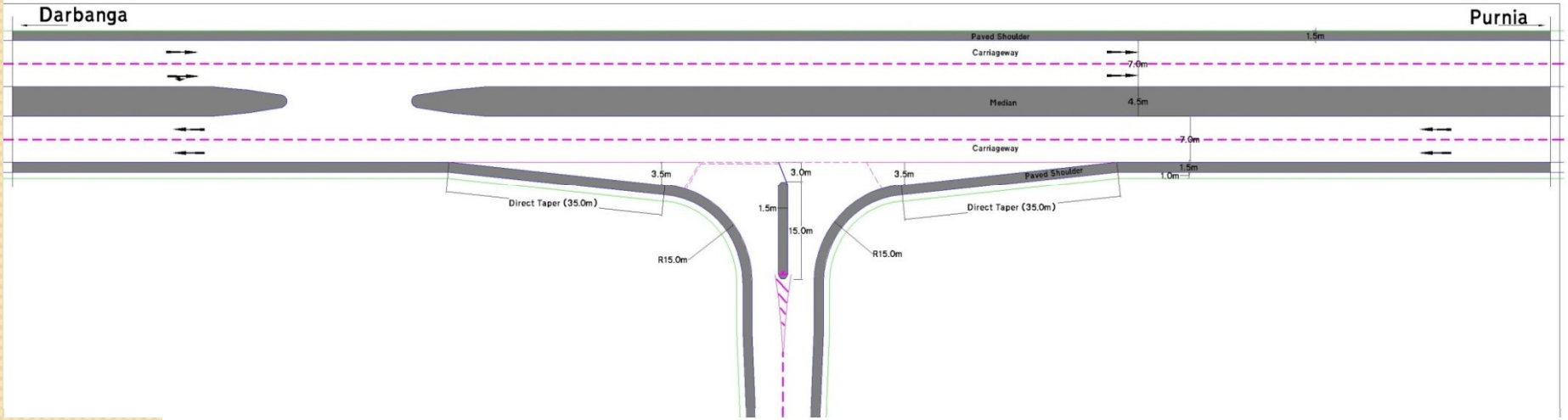


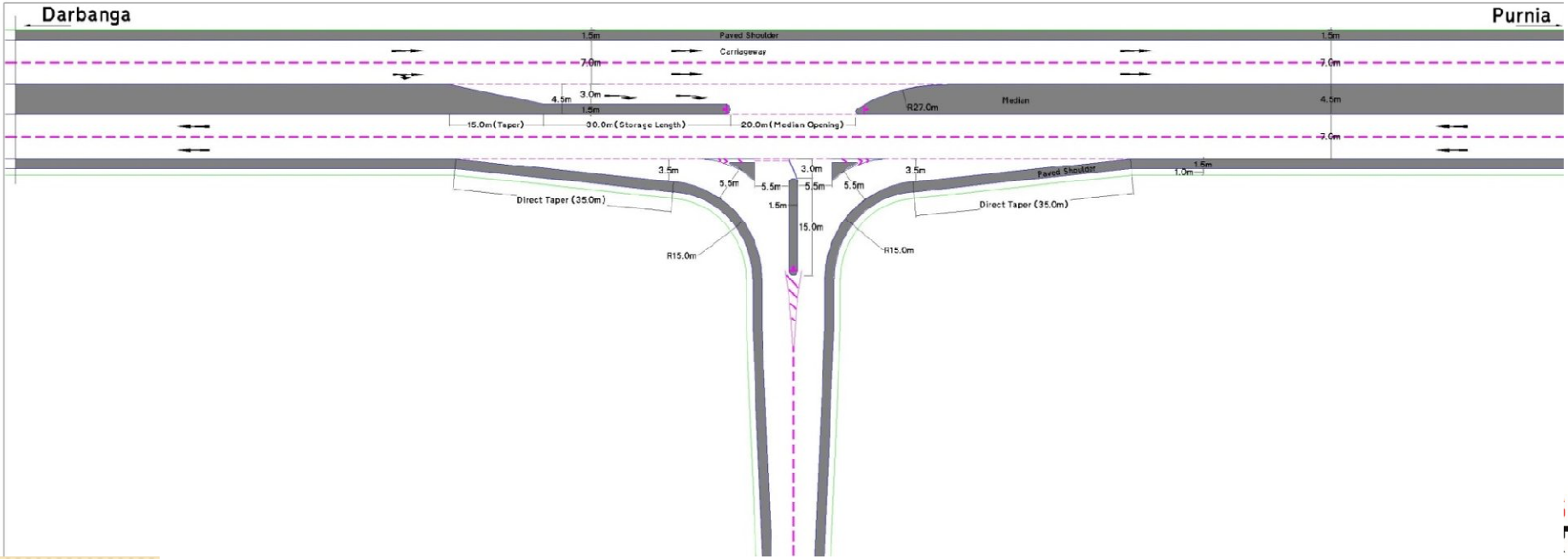
Suggestions: Without requiring further land, there is enough room to provide a safe layout as shown above, wherein storage lane has been created and side road brought to nearly perpendicular.


Depressed Median
(with Concrete Barrier Post)
PROW
PROW
217500
217600
Rock
Well
Sump
12.25
14.5
8.75
50
R12
5.5
120
70
Well
PROW
PROW
Rock
Tomb
Agriculture Land
As per site

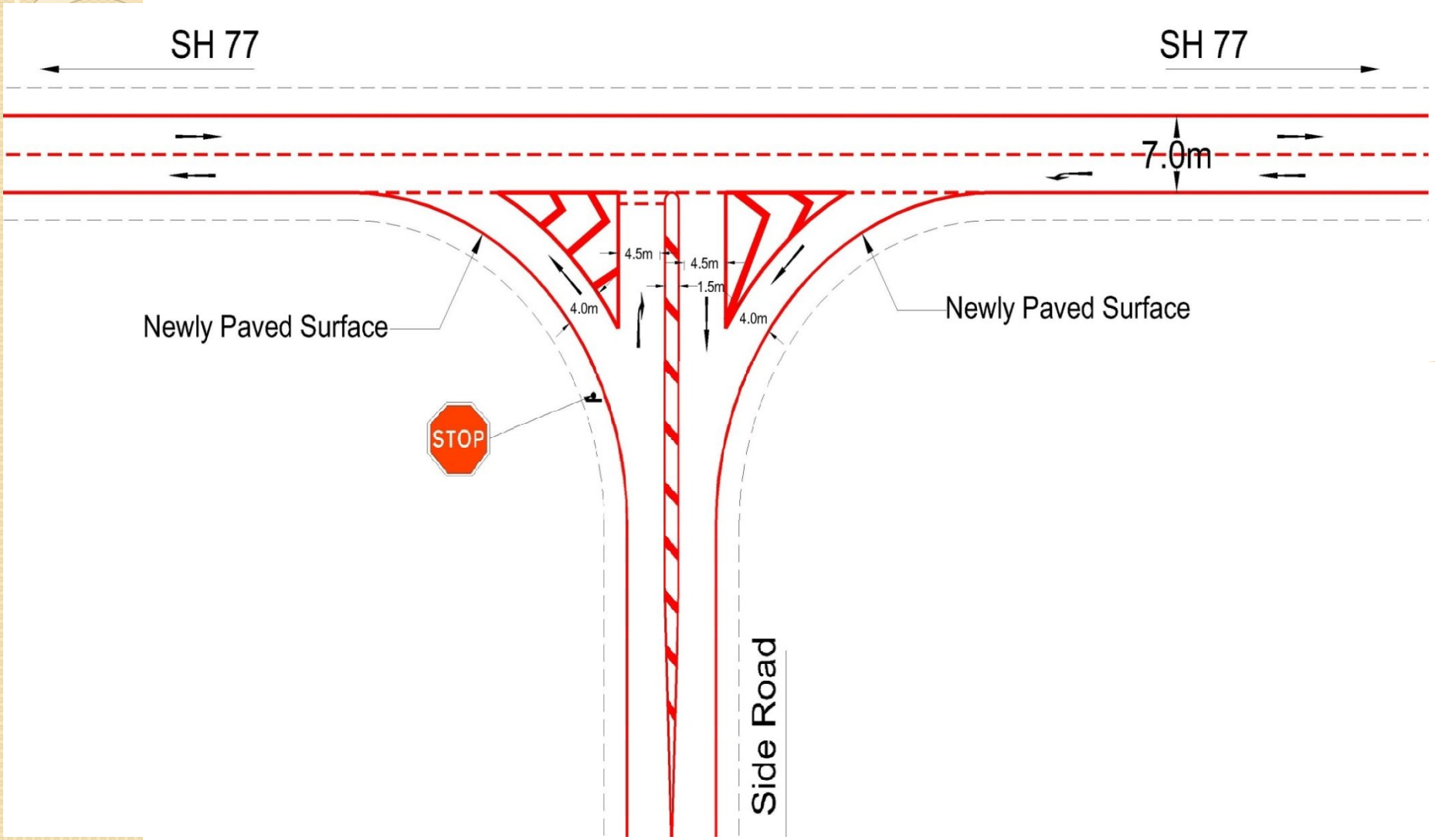

(with Concrete Barrier Post)
217500
217600
20
Taper 1:15
S23
As per site

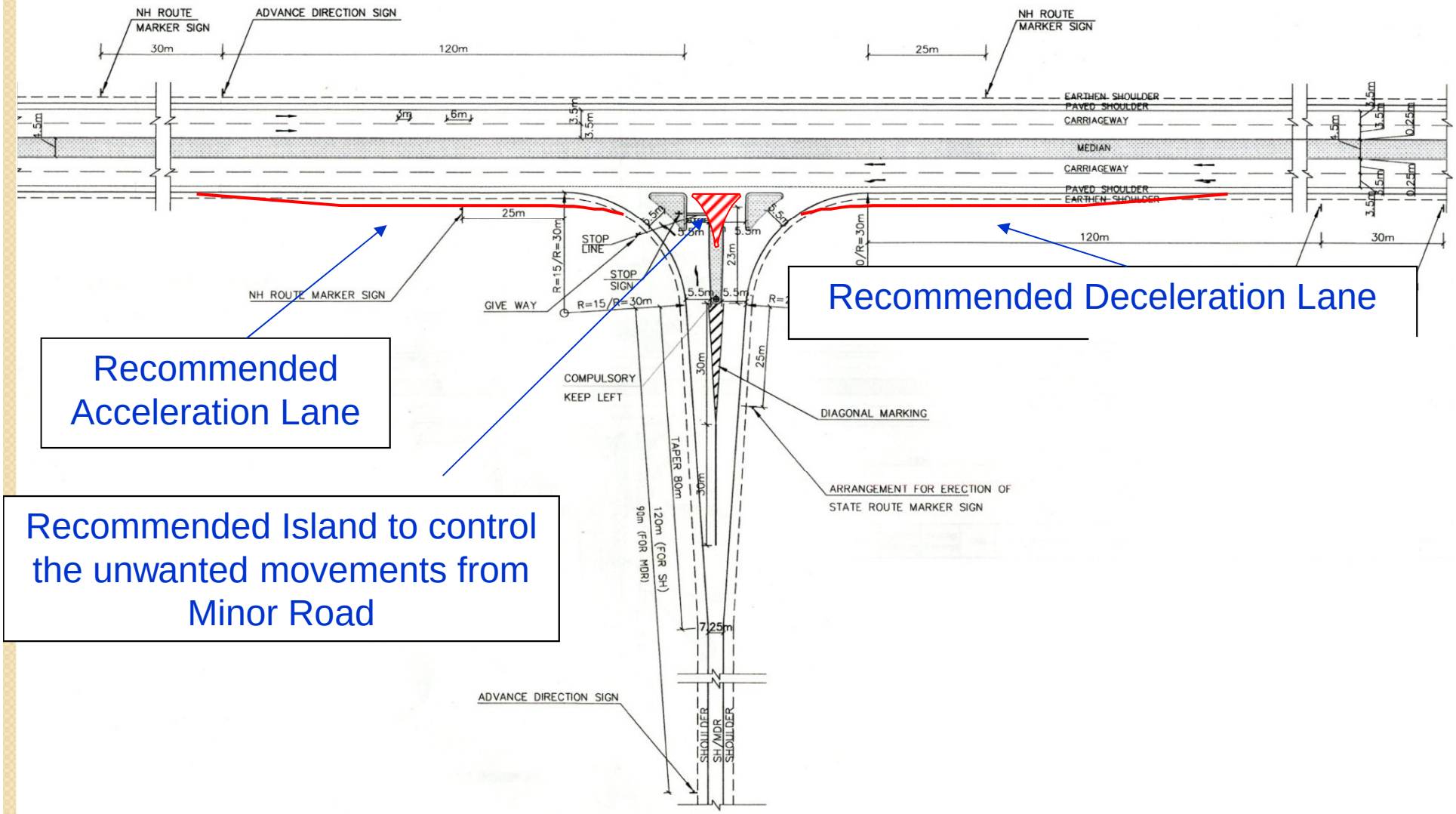
Safety issues at a Typical Intersection on a NH can be addressed more efficiently during Design Stage RSA





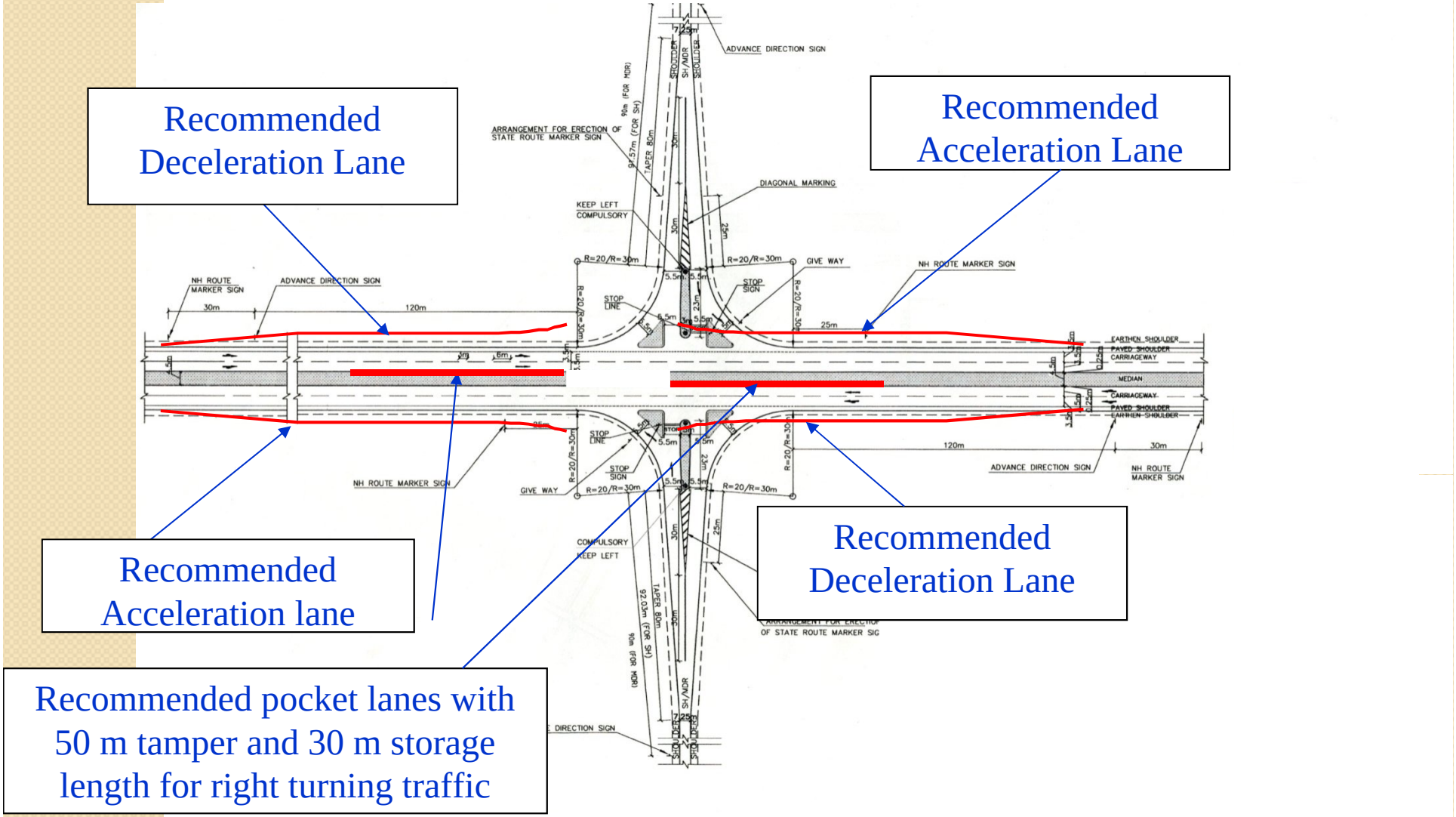
Safety issues at a Typical Intersection on a SH can be addressed more efficiently during Design Stage RSA





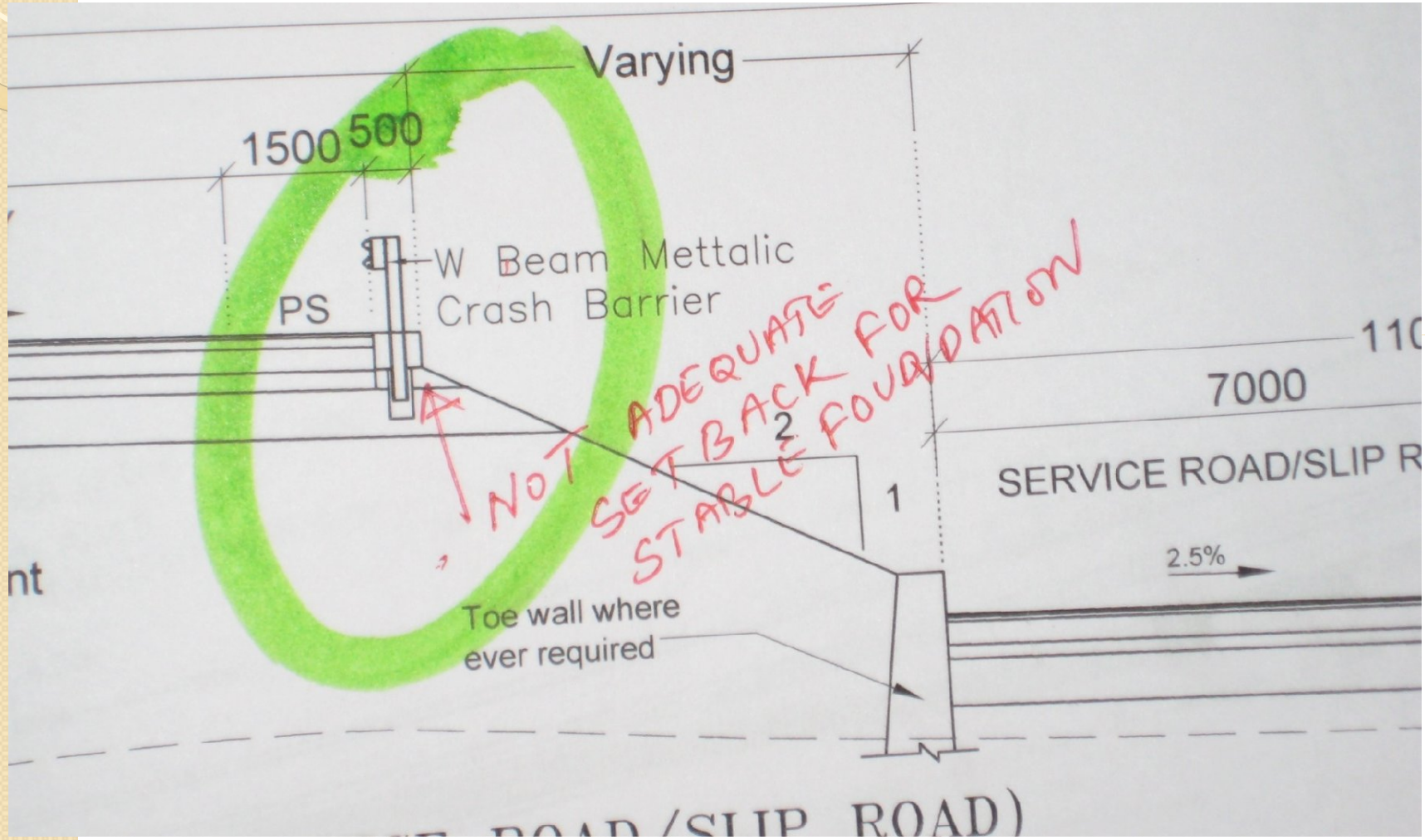
Recommended Conceptual Design for a Typical Minor Junction (T-Type)

Typical Detailed Design Stage RSAs (Contd…)

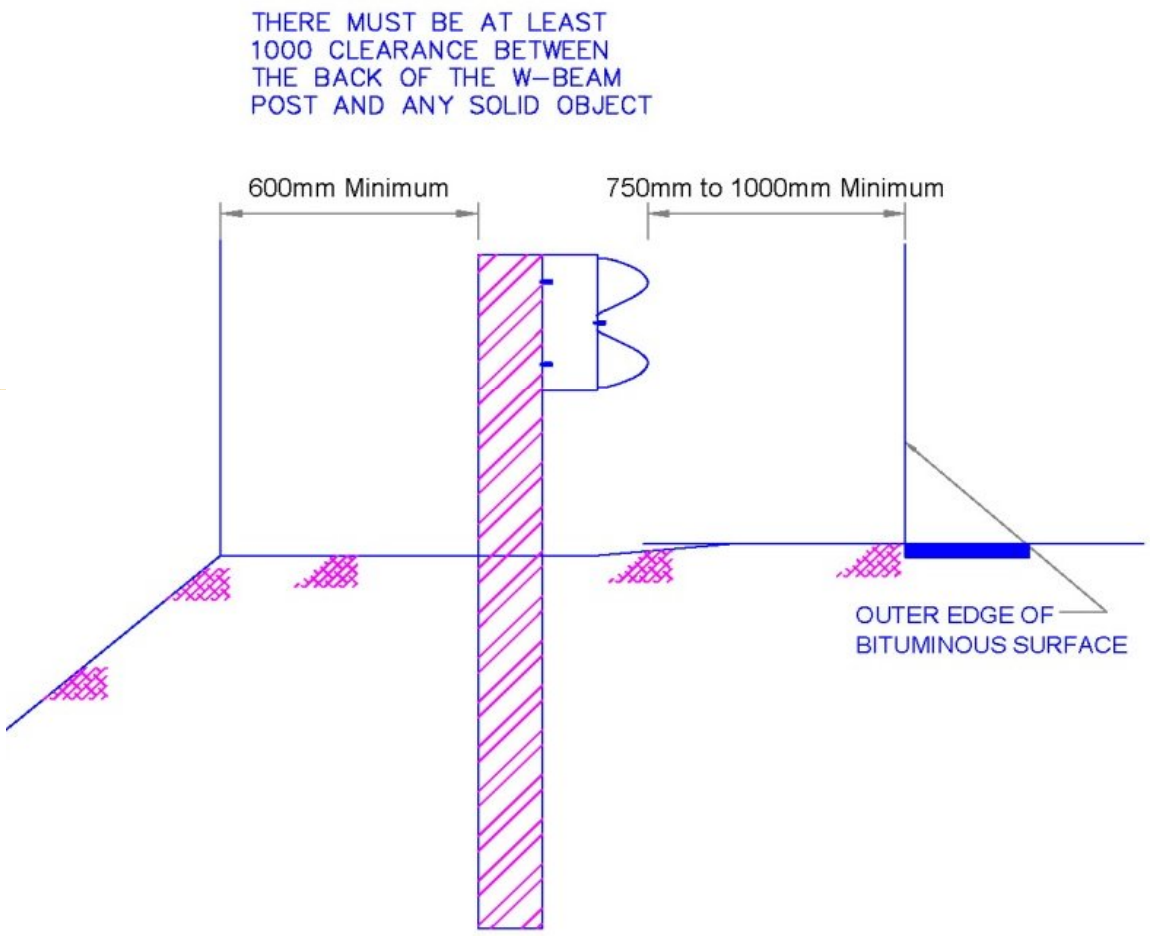


Recommended Conceptual Design for a Typical Four arm Intersection with Median

Safety issues on Crash Barrier Installation can be addressed more efficiently during Design Stage RSA



Crash Restraint System



W-BEAM ON SHOULDER / EMBANKMENT SIDE

Function of Signs

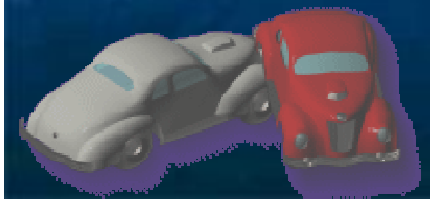
- Warn - of hazards
- Inform - of direction to take
- Direct - drivers as to what they must do

Includes upright signs, overhead signs, traffic signals, road markings, road studs, roadside marker posts.

Road Signs

Priorities for Road Signing

- Gateway
- Junction Signings
- Bend Signs
- School signs
- Median ahead, keep left signs
- One-way systems



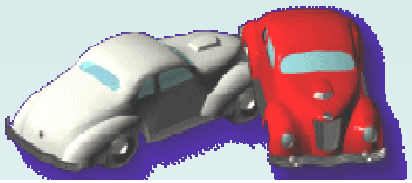
Size and Siting of Informatory Signs

	Advance Direction Signs (ADS)				Direction Signs Reassurance Signs Place Identification Signs	
1	2	3	4	5	6	7
85th percentile	"x" height (mm)	Minimum clear visibility to the sign (m)	ONE sign: distance from junction (m)	TWO signs: distance between 1st and 2nd sign (m)	"x" height (mm)	Minimum clear visibility to the sign (m)
Up to 50 km/h	75 (60)	45	45		60 (50)	35
50 - 65 km/h	100 (75)	60	90	50	75 (60)	45
65 - 80 km/h	125 (100)	80	90 - 150	70	100 (75)	60
80 - 90 km/h	**150 (125)**	**90**	**150 - 225**	**100**	**125 (100)**	**75**
Over 90 km/h	200 (150)	115	225 - 300	100	150 (125)	105

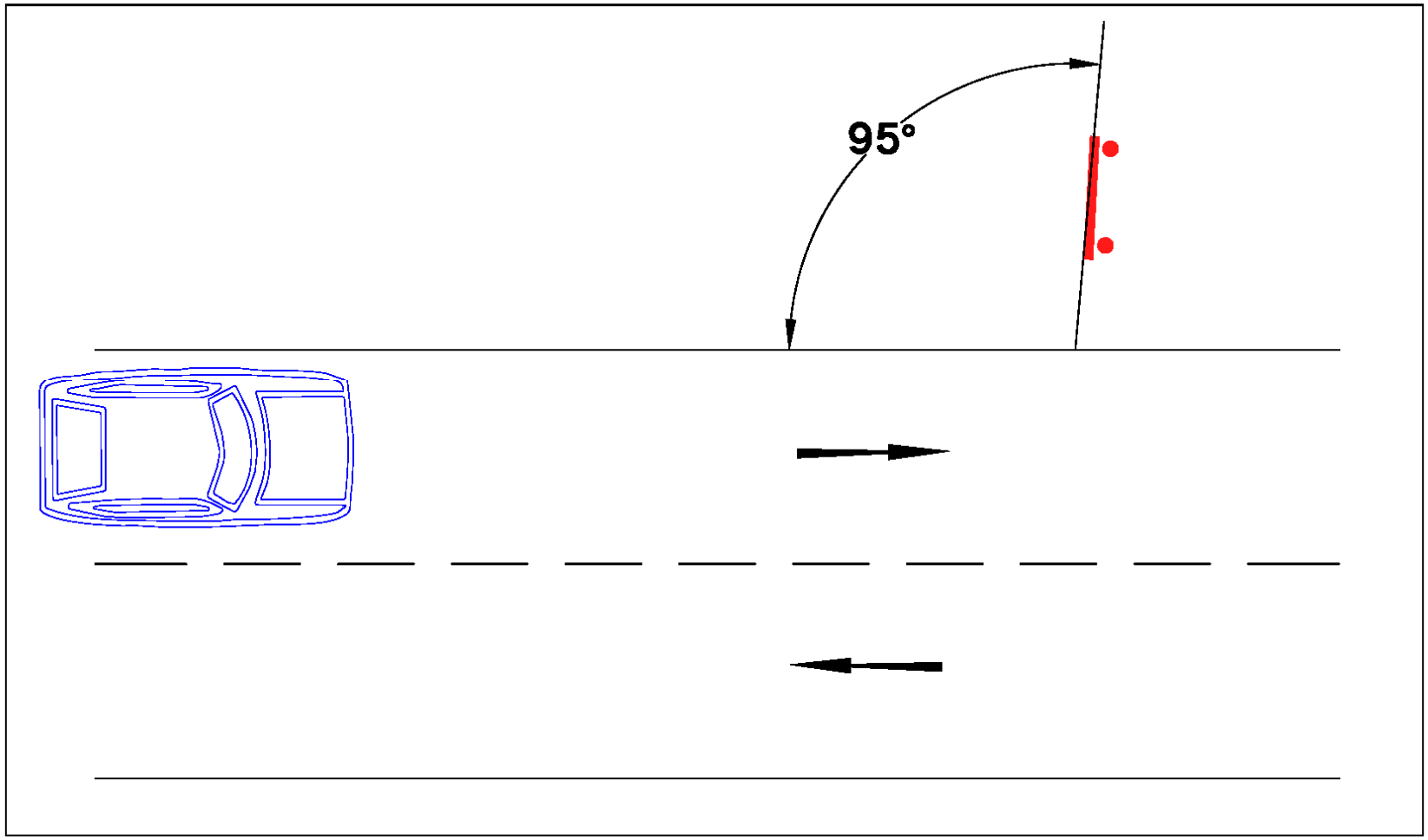
Size and Siting of Mandatory and Warning Signs

Mandatory / Regulatory Signs	**Diameter of sign (mm)**
Signs attached to traffic signal heads	300
Sites where space is limited (e.g. on narrow traffic islands)	450
Traffic speeds up to 50 km/h	600
Traffic speeds between 50 km/h and 65 km/h – STANDARD SIZE	750
Traffic speeds above 65 km/h	900
Sites where additional emphasis is required – because of a bad accident record	900

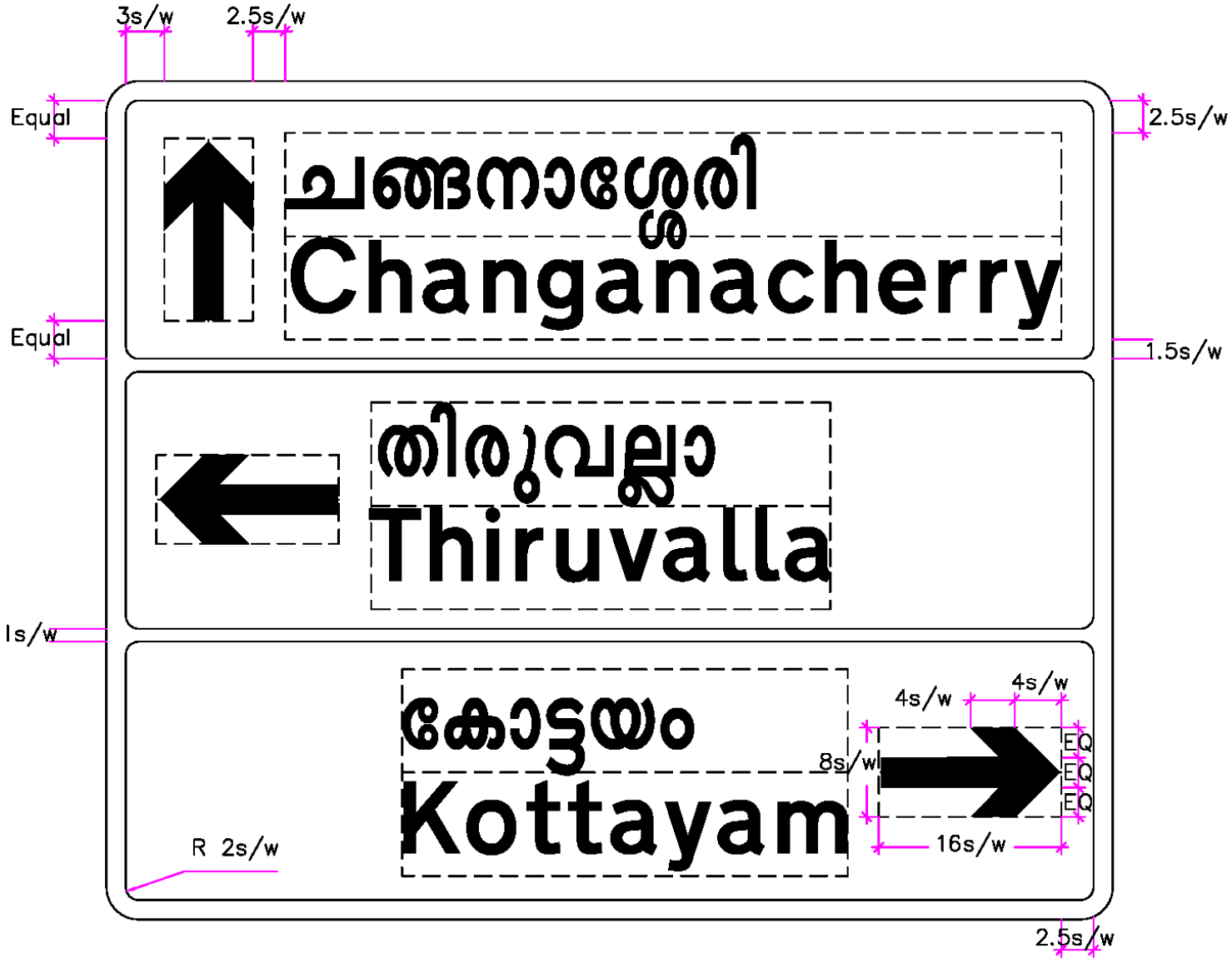
Cautionary/Warning Sign	**Length of triangle side (mm)**	**Distance of sign from hazard (m)**
Traffic speeds up to 50 km/h	700	45
Traffic speeds between 50 km/h and 65 km/h – STANDARD SIZE	900	90
Traffic speeds above 65 km/h	1000	120
Sites where additional emphasis is required – because of very high speeds and / or a bad accident record	1340	200



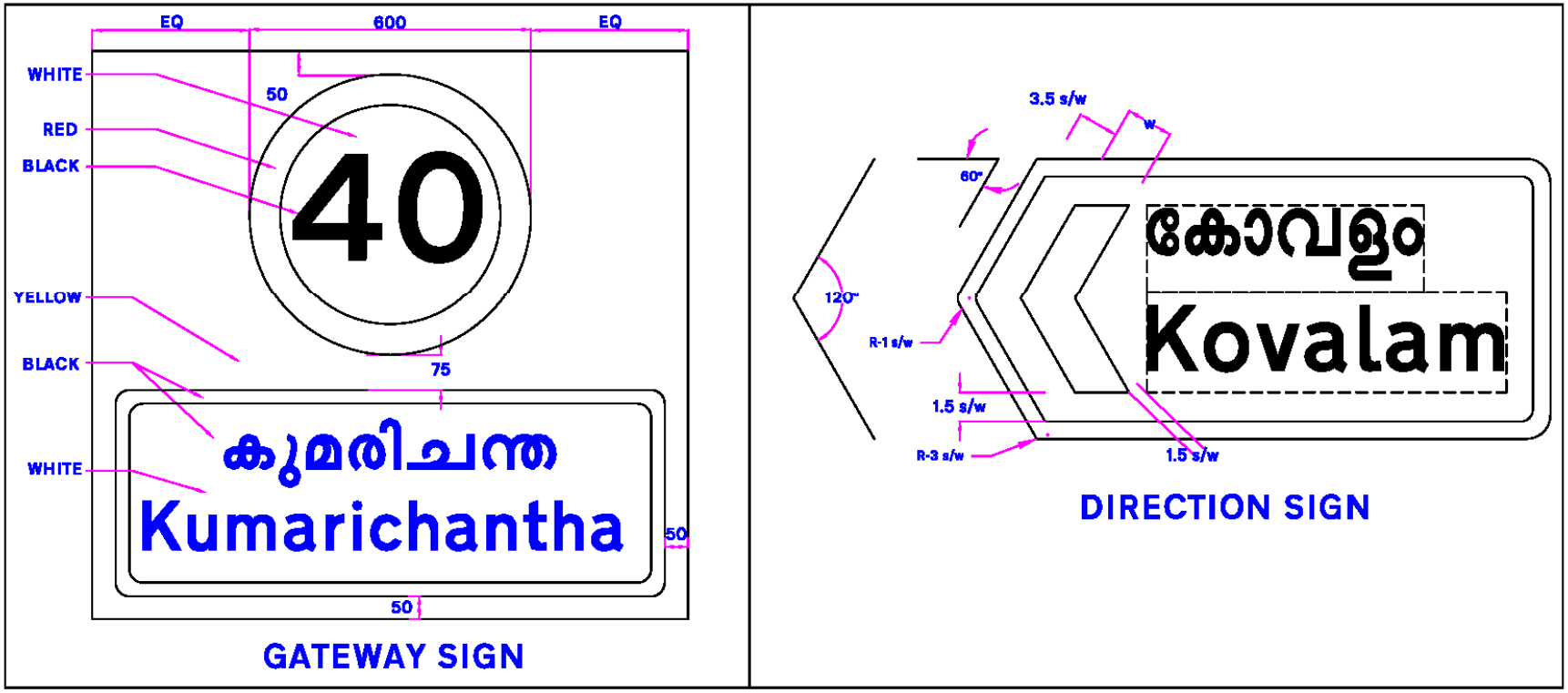
Orientation of Signs

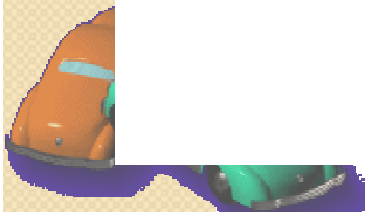


Typical Design of Stack Type ADS

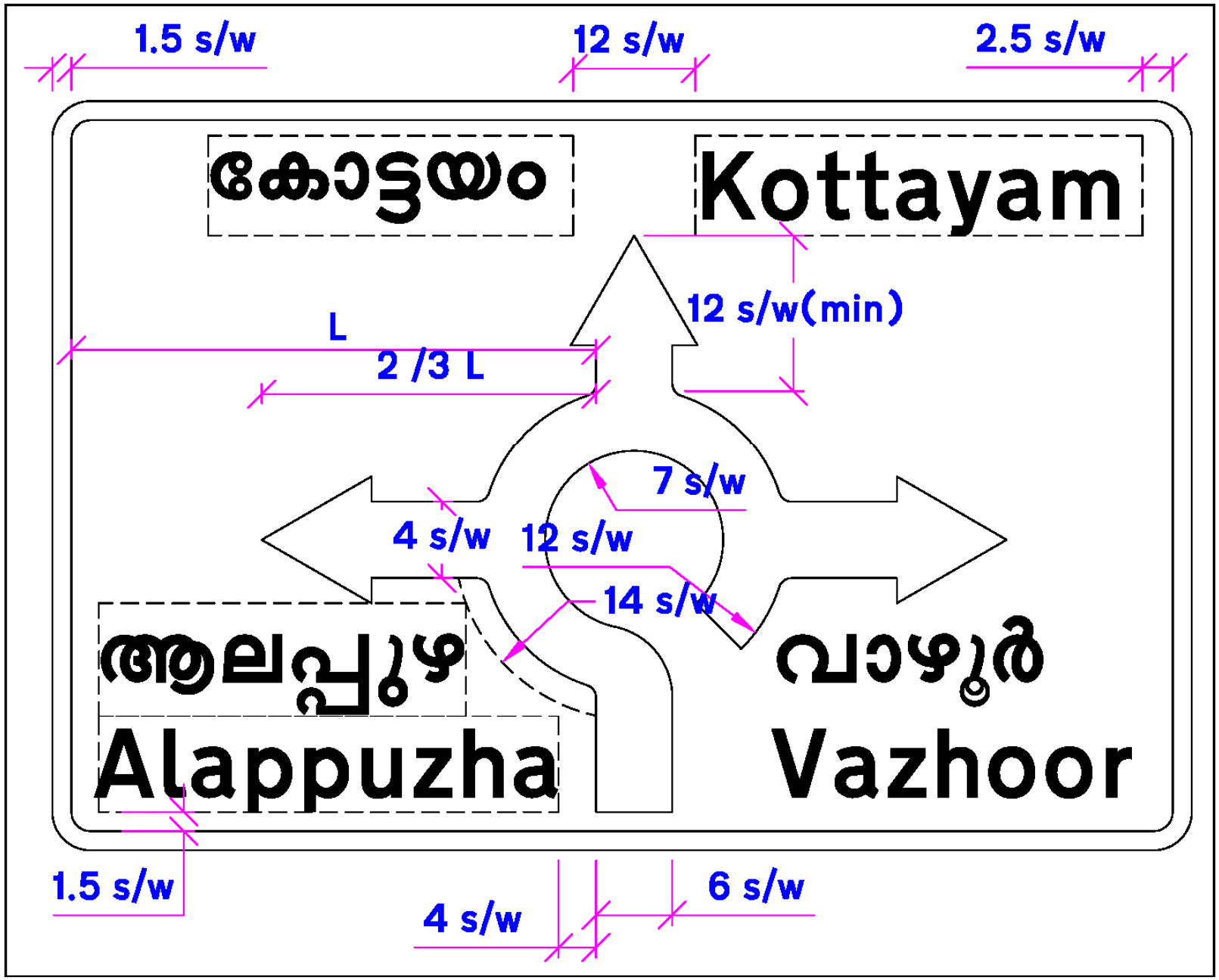


Typical Design of Gateway & Direction Sign

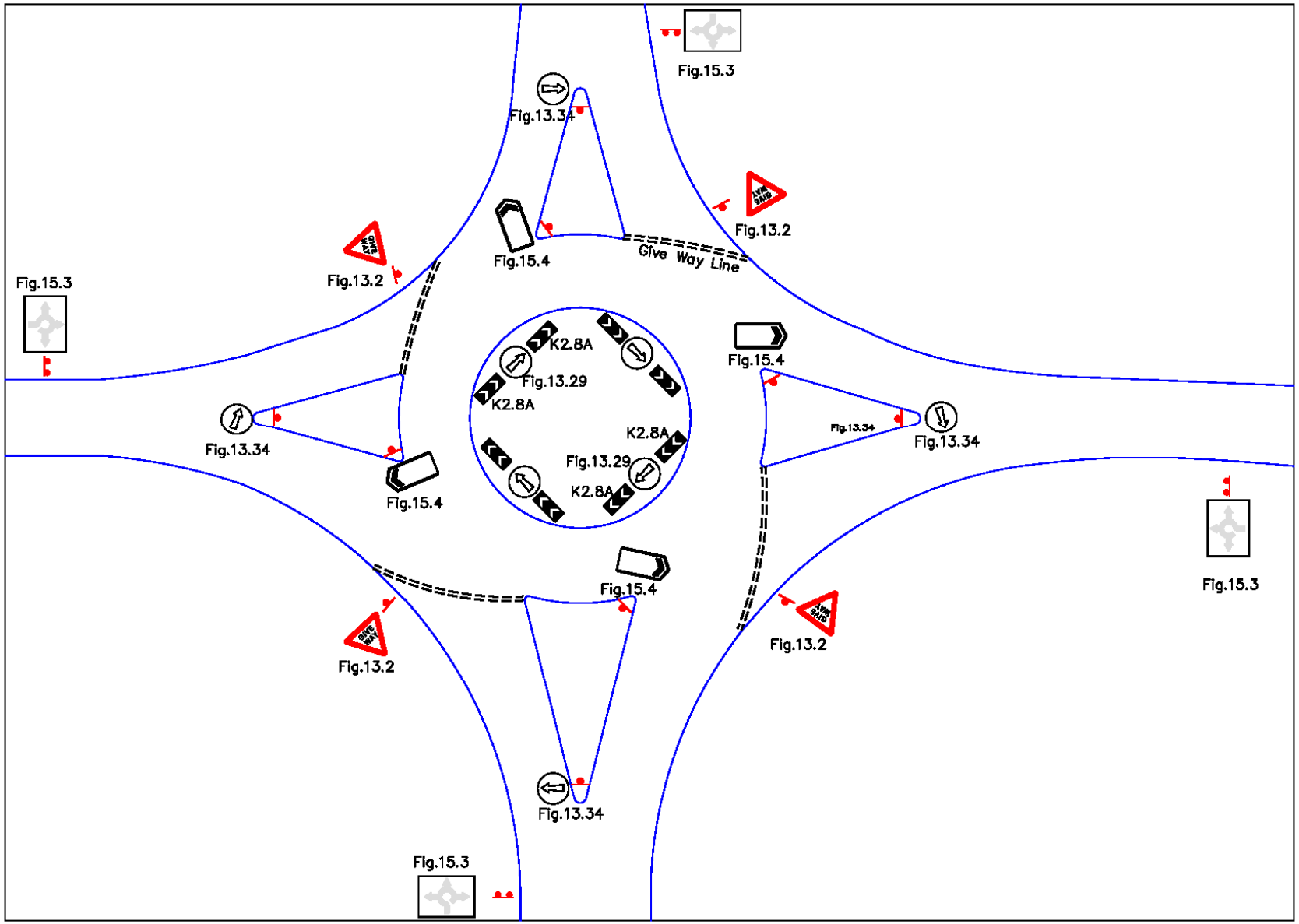




Typical Design of Map Type ADS



Typical Junction Signing



Design Audit of Interchanges

Design Audit of Eastern Peripheral Expressway *(EPE)*

Reasons for concern:

Any possible queuing in toll booth might be tailed to main road and might cause rear end collision with vehicle plying through ramp-1

Recommendations *(Highly Desirable)*

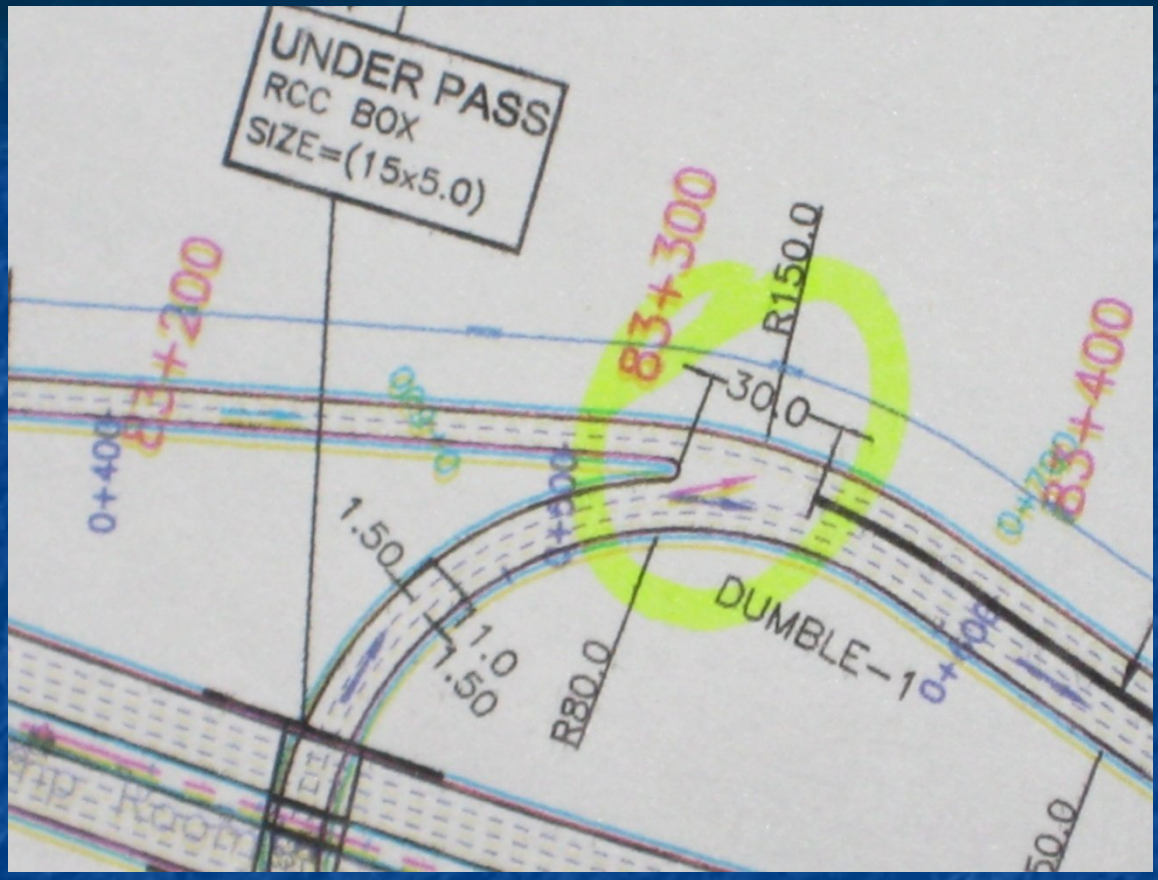
Redesign loop-1 as shown above, so that toll booth could be relocated further ahead to have adequate queuing length in the connector road itself.

*** Eastern Peripheral Expressway**

Interchanges *(Design Audit of EPE – Contd..)*

Reasons for concern:

Short weaving length



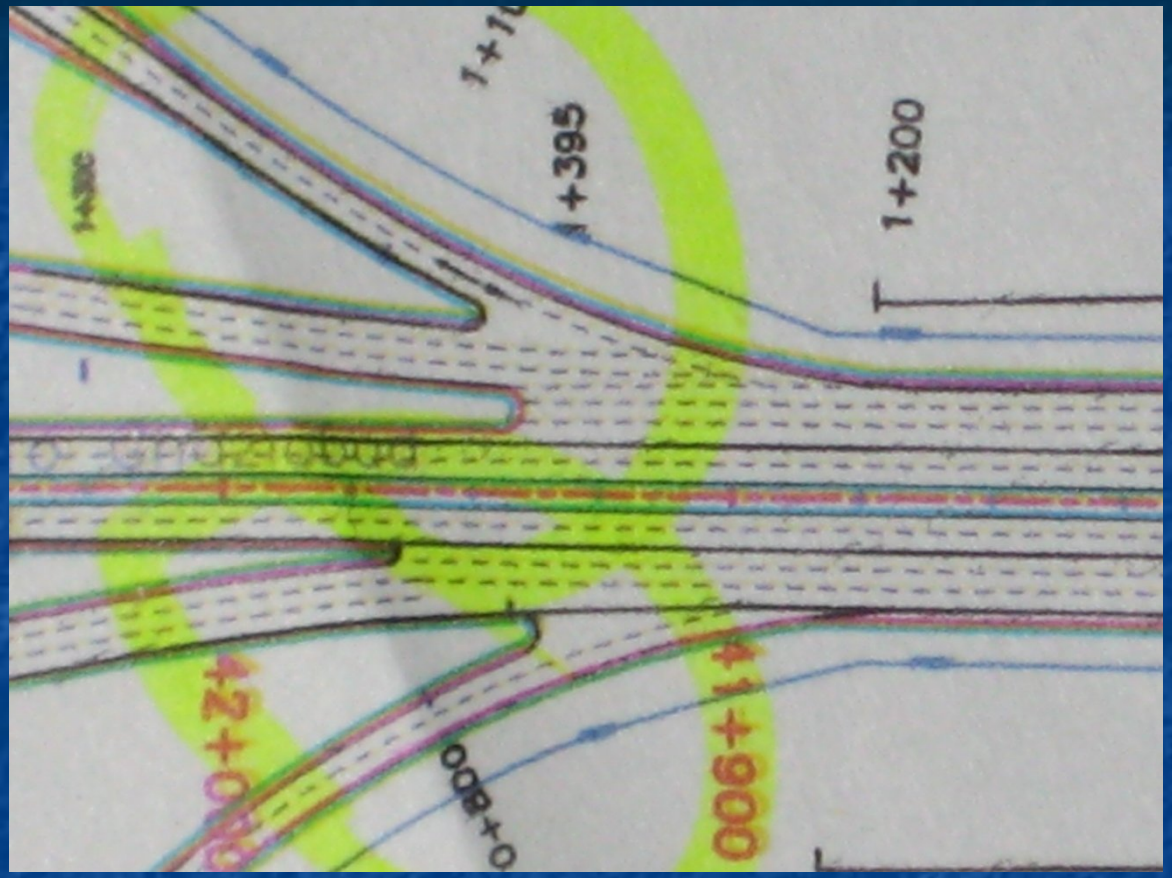
Recommendations *(Essential)*

Increase the weaving/ merging length to facilitate safe weaving.

Interchanges *(Design Audit of EPE – Contd..)*

Reasons for concern:

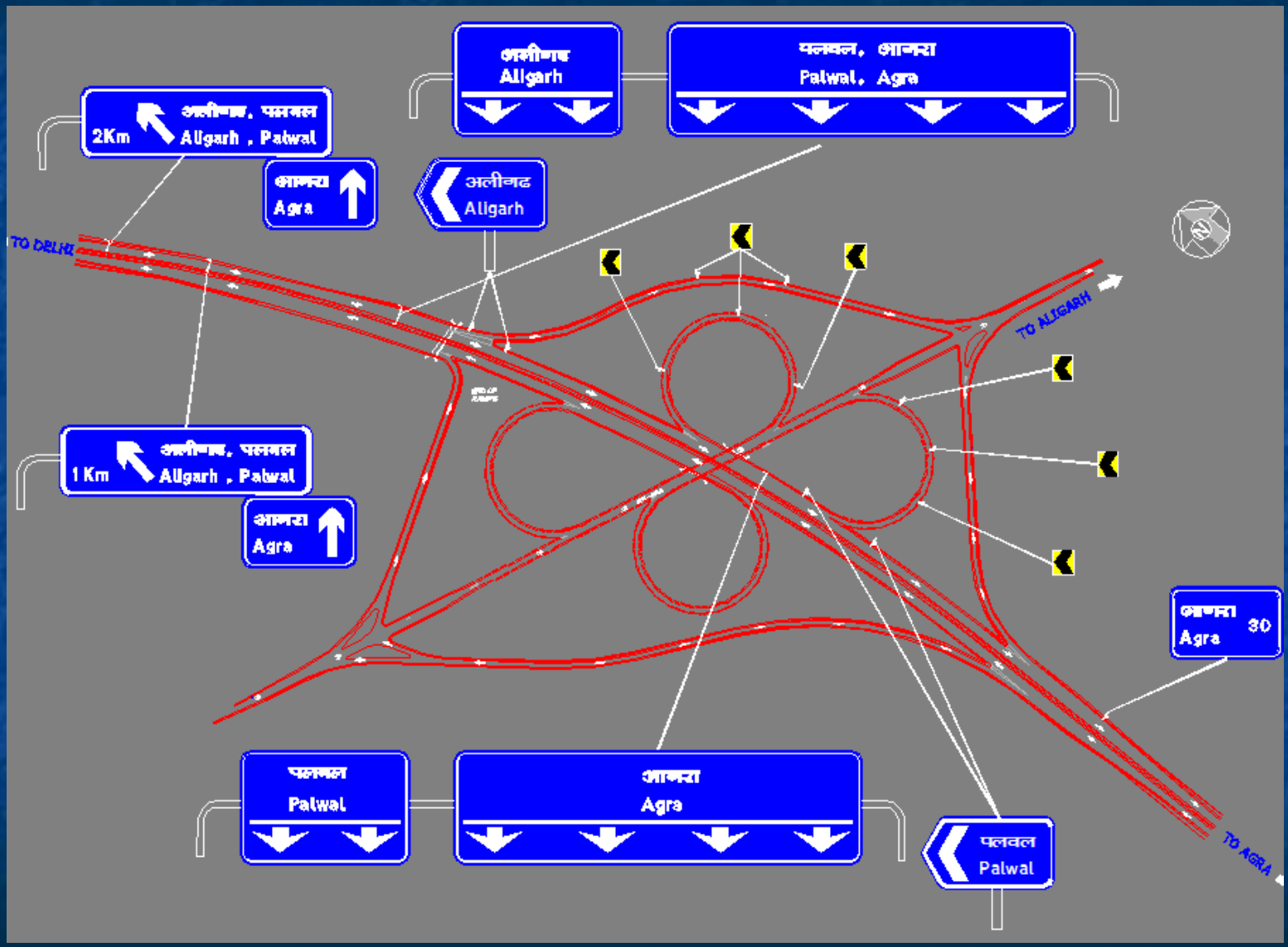
Two successive diverging/merging at short interval will be confusing and might lead to accident.



Recommendations *(Highly Desirable)*

Provide adequate distance between two diverging/ merging for safe operation

TYPICAL SIGNAGE FOR AN INTERCHANGE




Thank you