

# Design Stage RSA Case Studies

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FICCI Safety Manager Award (2017)

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# Brief Introduction



- ❑ **Sudershan K. Popli** , Master in Transport Planning from School of Planning & Architecture, New Delhi. He has **36 years experience** in the field of Transport Planning, Traffic Engineering, Highway Design, Black Spot Management and Safety Engineering. **Presently, Working as Advisor (Road Safety), NHAI** and contributed towards development of **Safety Audit Mobile App**, Model Safe Road, DPR Safety Audit, etc. Awarded by FICCI Safety Manager Award (2017), NHAI Safety Appreciation Award (2018) and RITES Safety Expert Award (2019)
- ❑ **Worked as Team Leader** on design and Safety projects funded by MoRTH, NHAI, NHIDCL, PWDs and International Lending Agencies viz. **WB/ADB/AfDB/ITEC and BOT, DBFOT, Annuity, EPC projects**. As **Road Safety Auditor cum TL completed audit of 10,000 lane km Audit** at Feasibility, DPR, Construction stage, Pre opening audit and O & M stage of Expressways, 8 laning/6 laning/4/2 laning highways.
- ❑ **Life Fellow of Indian Roads Congress, Life Fellow of Institution of Engineers, Fellow of Institute of Town Planners, Life Member of Institute of Urban Transport**. As Member of Indian Roads Congress H 1 Committee-Transport Planning and Traffic Engineering and H 7 Committee-Road Safety and Design, **contributed revision of IRC codes 8,9,32,35,39,46,62, 67,79,80,108,131 and IRC SP 30, 55, 85, 88**. **Delivered around 1000 lectures on Safety Engineering, Audits Safe Practices during design & construction**.
- ❑ **Published and presented 35 nos. papers** on Traffic Studies, Traffic Calming, Design of Highways, Safety Audit, Asset Management, Intelligent Transport Systems, ,GIS and Social Impacts of Highways. Trained
- ❑ **Countries Worked: India, Botswana, Guyana, Kenya, Nepal, Myanmar, Nigeria**

# DPR Stage Safety Audit

**Inception Report**

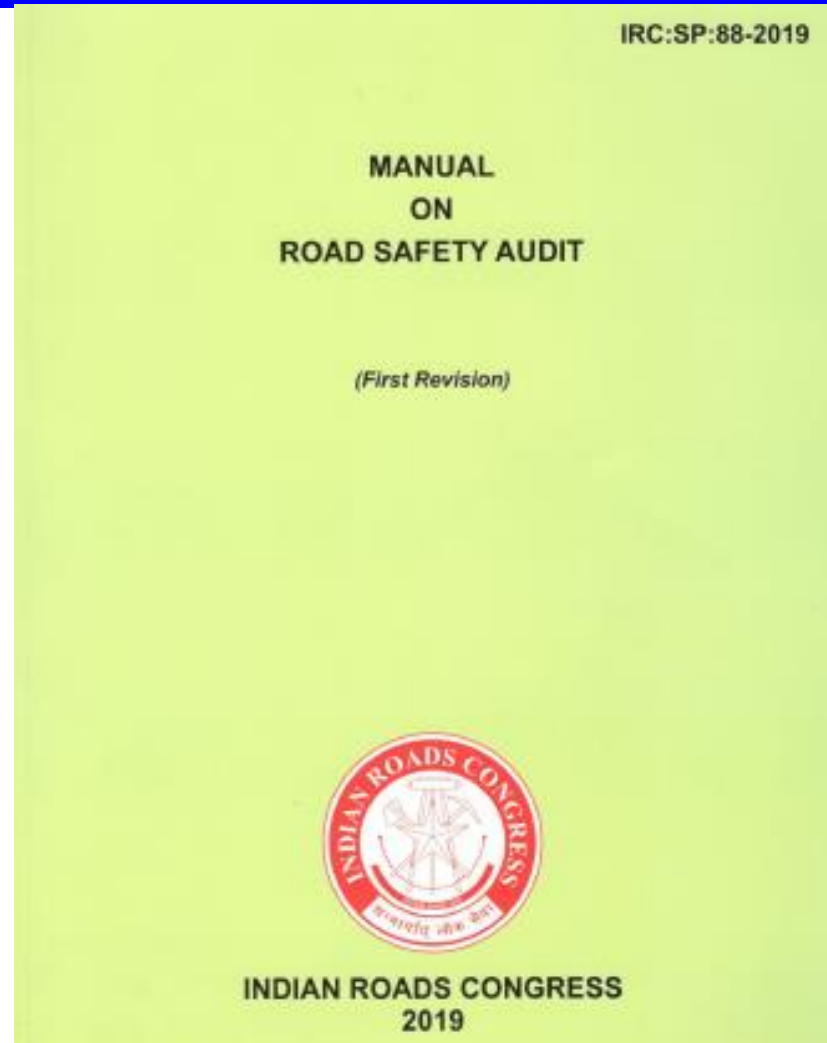
**Crash Analysis and Road Safety Inspection Report (Existing) and Development of Short Term Countermeasures, Cost Estimate & BOQ**

**Draft Feasibility Report**

**Draft Detailed Project Report**

**Technical Schedules**

# Manual for RSA: IRC SP 88-2019



# IRC Reference Codes for Audit

- IRC 73 Geometric Design Standards for Rural (Non Urban Highways)
- IRC 86 Geometric Design Standards for Urban Roads
- IRC 35 Code of Practice for Road Marking
- IRC:38: Guidelines for Design of Horizontal Curves for Highways and Design Tables
- IRC 65 Guidelines For Planning & Design of Roundabouts
- IRC 67 Code of Practice for Road Signs
- IRC: 80 Type Design for Pick-up Bus Stops on Rural (Non Urban) Highways
- IRC 99 Guidelines for Traffic Calming Measures in Urban & Rural Areas
- IRC 103 Guidelines for Pedestrian Facilities
- IRC 119 Guidelines for Traffic Safety Barriers
- IRC SP 73 Manual of Specifications & Standards for 2-Laning of Highway
- IRC SP 84 Manual of Specifications & Standards for 4-Laning of Highway
- IRC SP 87 Manual of Specifications & Standards for 6-Laning of Highway
- IRC SP 23 Vertical Curves for Highways
- IRC SP 41 Guidelines for Design of At Grade Intersections in Rural and Urban Areas
- IRC SP 55 Guidelines for Traffic Management for Work zones
- IRC SP 85 Guidelines VMS
- IRC SP 88 Manual for Road Safety Audit



# **Road Safety Audit Checklists**

# Types of Audit Checklists

- Checklist for Planning/Feasibility Stage
- Checklist for Detailed Design Stage
- Checklist for Construction Stage
- Checklist for Pre-opening Stage
- Checklist for Audit of Existing Roads
- Checklist for rural roads with low design speeds and low volumes of traffic

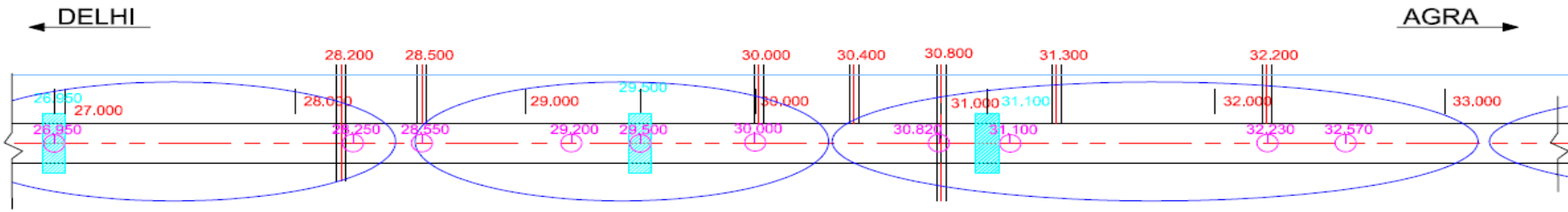
# List of Safety Drawings to be Audited

- Plan & Profile of Project Highway with HAR & VAR Report for main highway and Service Road
- Typical Layout and Details of Median Opening Locations
- Typical Cross Sections with their applicability chainage wise
- Detailed Layout Drawings of Intersections/Interchanges
- GADs of all Major & Minor Bridges; Flyovers/VUP/PUP/ROB
- Typical Layout Plan and details of Toll Plaza showing Traffic Aid Post, Medical Aid Post, Weigh Batcher, Public Toilet facilities, etc; Truck Lay bye; Bus Bays & Bus Shelter, Rest Areas
- Road Furniture Plan showing details of traffic signage and pavement Markings
- Details of Highway Drainage, Slope Protection Works,
- Details of Protection Works- Fencing/Metal Crash Barrier/Rigid Barrier, etc
- Details of Highway Lighting and their location specific positions
- Advanced Traffic Management (ATMS)



# **Safety Audit Report**

# Traffic Circulation Plan for Access Control Highway



- 7 nos. MO with Cross Roads
- 4 nos. MO Closed
- Proposed 3 nos. Grade Separated Intersection
- Expected Congestion on SR and Intersections



# Integration of Existing Road with Project facility

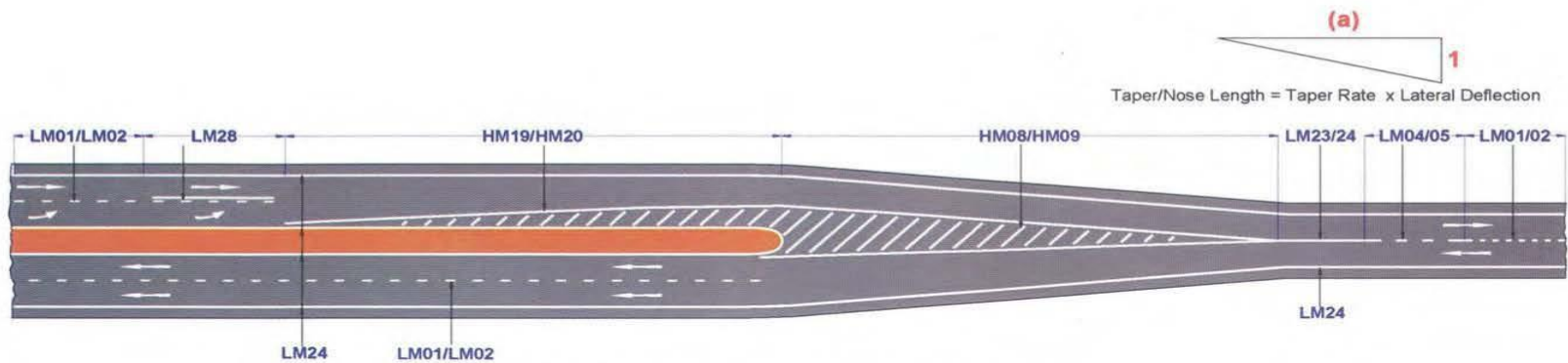
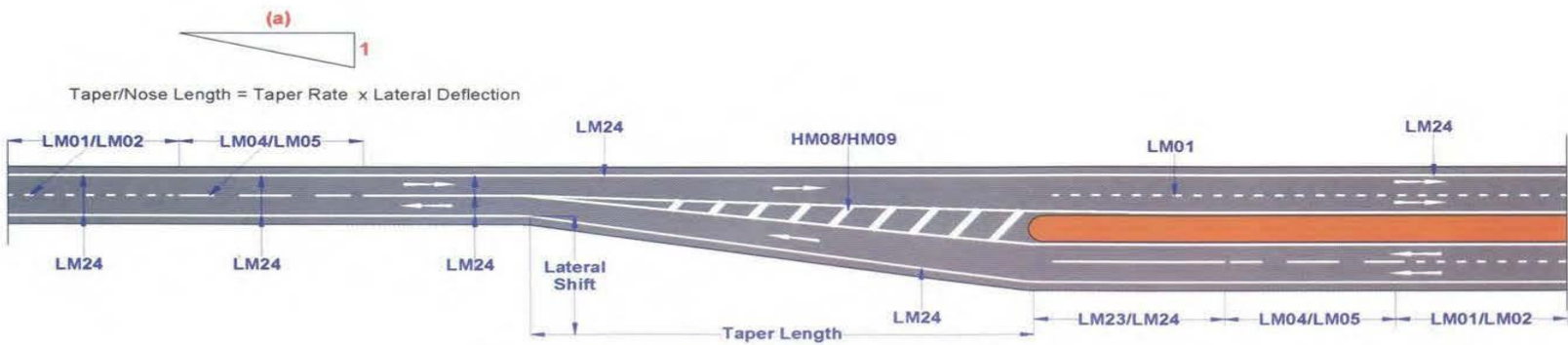


Fig. 7.5 Four Lane to Two Lane Transition (Concentric)



Lane Transition (Eccentric)

Table 7.2 Taper Rate of Diagonal/Chevron Marking

| Speed (kmph)  | Désirable Minimum Taper | Absolute Minimum Taper |
|---------------|-------------------------|------------------------|
| < 50 kmph     | 1:35                    | 1:20                   |
| 51 to 65 kmph | 1:40                    | 1:25                   |
| 66 to 80 kmph | 1:45                    | 1:30                   |
| > 80 kmph     | 1:50                    | 1:40                   |



# **AUDIT OF ROAD ALIGNMENT DESIGN**

# Design Considerations

- Minimum Vs liberal standards
- Stage Construction Vs Full Construction

## Issues

- Horizontal & Vertical Geometry is difficult to change at later stage
- Difficult to rebuild Retaining Walls, Breast Walls, etc
- Difficult to rebuild drainage structures

# Geometric Design

**Design of Vertical Alignment with Intermediate Sight Distance**

**Summit Curves are designed for ISD**

**Valley Curves are designed for Head Light Sight Distance i.e. SSD and not for ISD.  
(Clause No. 2.9.5 IRC: SP:84-2019/ IRC: SP:87-2019)**

**In case Speed limit signs fixed for 100 kmph, the valley curves may cause rear end accidents**

**Proposed Summit & Valley Curves shall be designed for ISD**



# Sharp Horizontal Curve



# Vertical Curve length inadequate



# Poor Vertical Design Leads to Drainage Issues



## Lack of Coordination Horizontal & Vertical Alignment





# **AUDIT OF PROPOSED CROSS-SECTION**

# Cross Section: Flush and Depressed

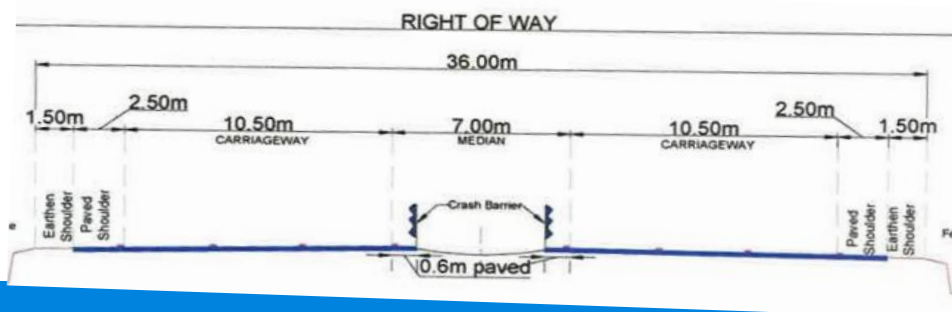
Flush and Depressed median shall be provided with 0.6m paved edge strip towards median side

In case MCB is to be fixed on median side then slope in front of MCB shall be 1:10 and MCB shall be 0.7m to 1m away from the outer edge of the paved strip

It is observed 0.5m edge strip is provided in place of 0.6m for Flush Median and MCB Beam installed in line of the outer edge of the paved strip

IRC SP 99: Provide Paved shoulder at the edge of the carriageway, shyness on the median side, earthen shoulders on either side

It is proposed 1m wide earthen shoulder with 150/200 mm thick Granular Material on median side in case of flush median also as in Expressways.



# Risks Identification During Site Inspection



# Roadway Restrictions Impacts

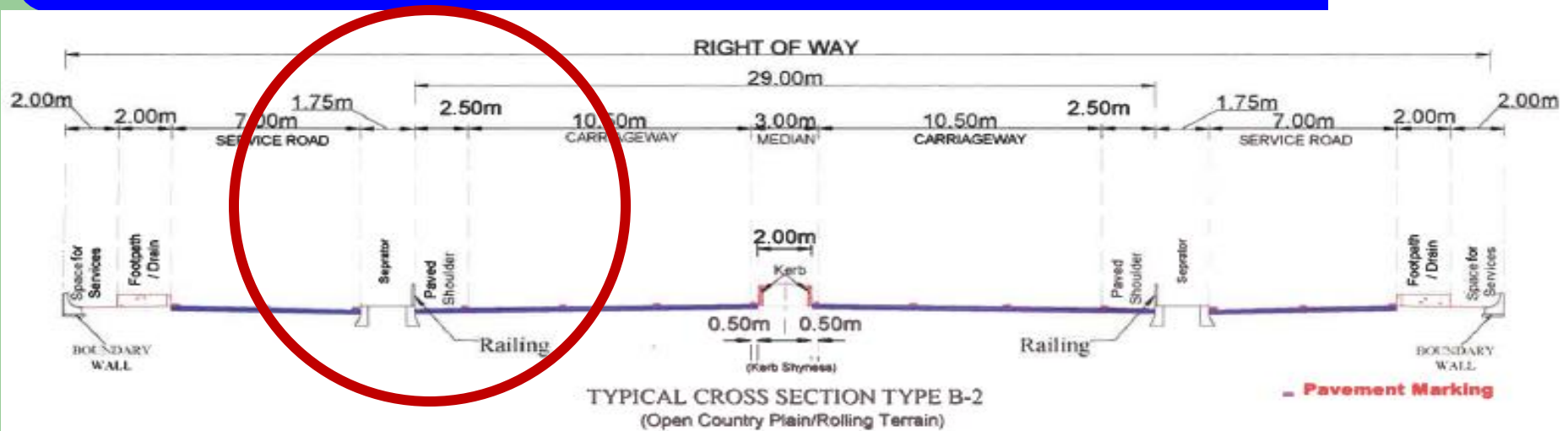


**RCC Crash Barrier Hit by Vehicle**

# Road Mitigation Measures Implemented



# Main Carriageway and Service Road



# Split Carriageway without Safety Barrier



# Set Back Distance on Curves



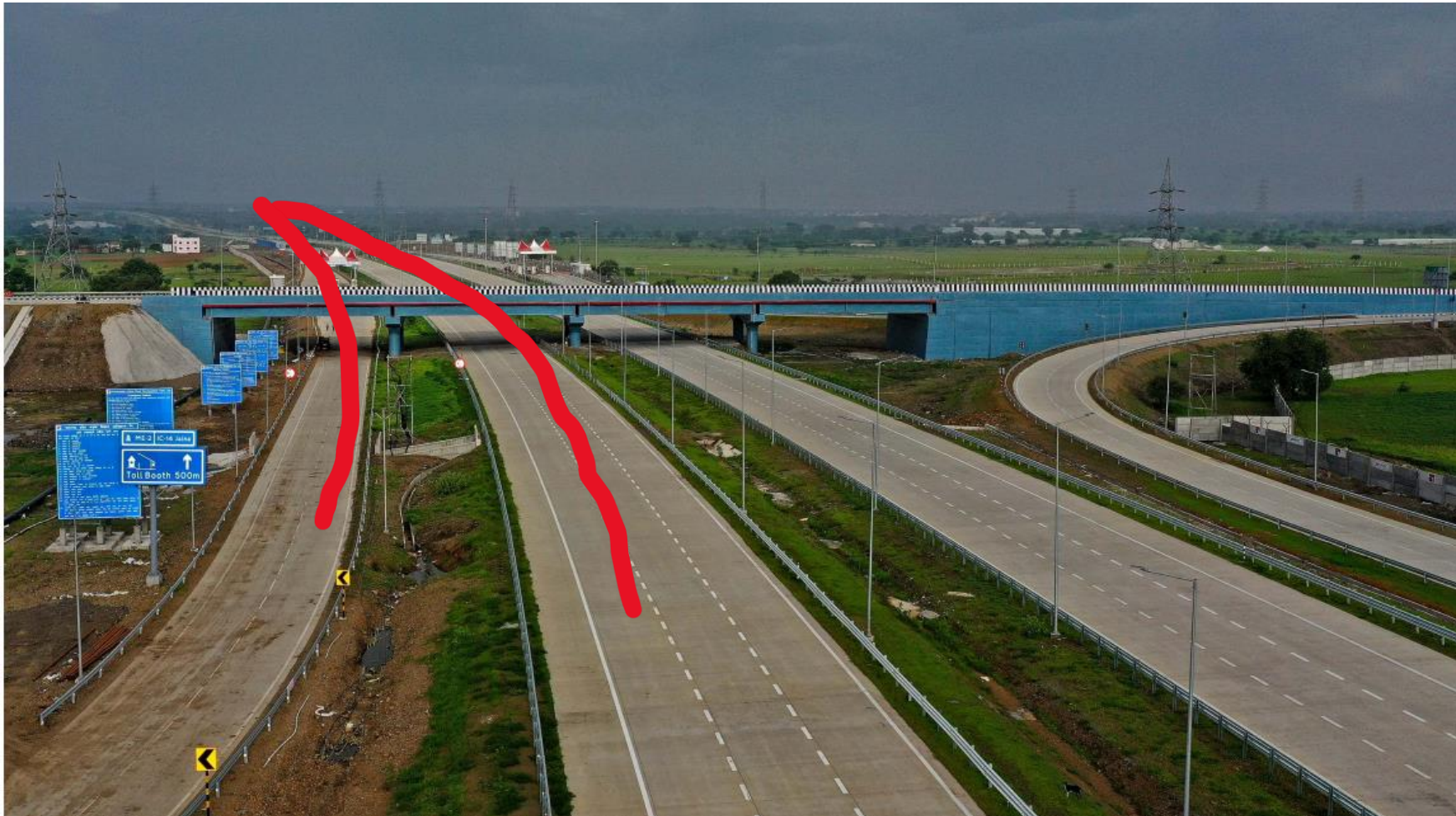
# Unsafe Embankment Slope



## **Partly RE wall (6m high) and partly Embankment Slopes proposed to provide Metal Crash Barrier**



# Unsafe Entry/Exit on Horizontal Curve



# Unsafe Merging/Demerging on Start/End



# Unsafe Exit/Entry



# Unsafe Exit/Entry



# Safe Exit/Entry as per IRC SP 84/87

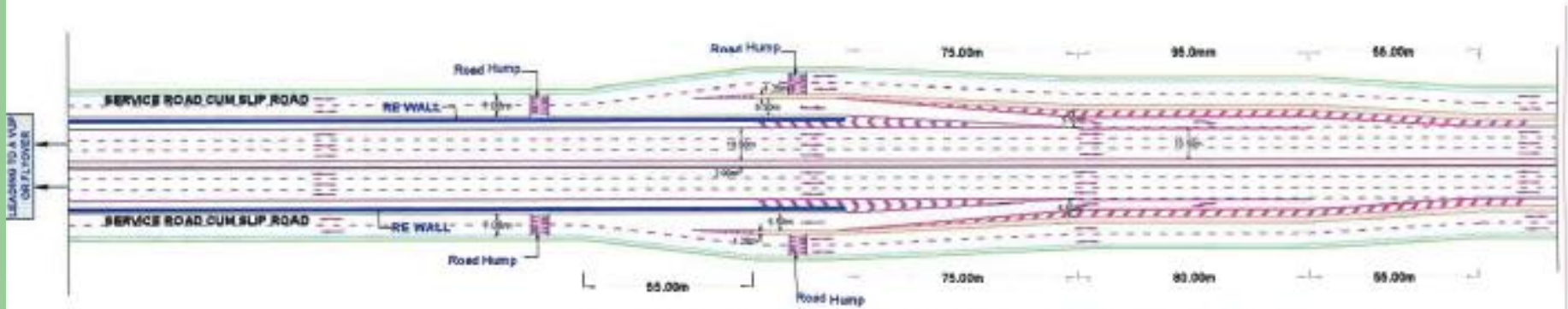


Fig. 2.1F Entry/Exit Arrangement with a Service Road cum Slip Road (Speed Reduction by Road Hump)

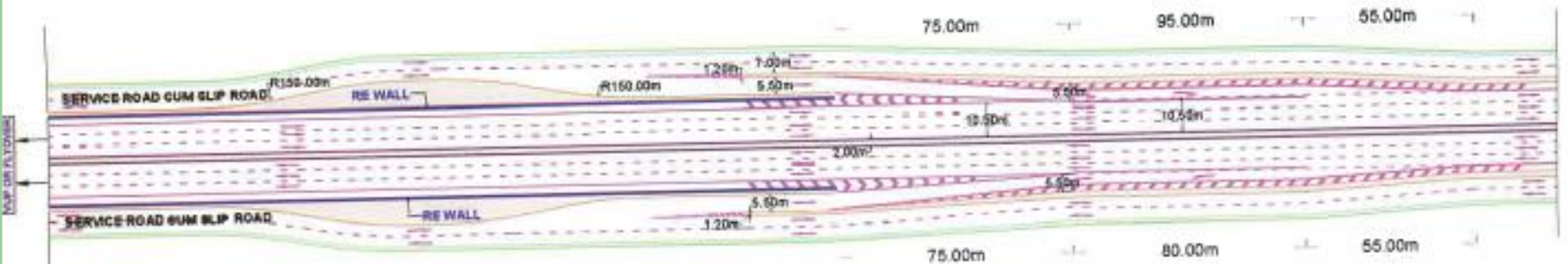


Fig. 2.1E Entry/Exit Arrangement with a Service Road cum Slip Road (Speed Reduction by Deflection)



# **AUDIT OF INTERSECTION AT-GRADE and GRADE SEPERATED**

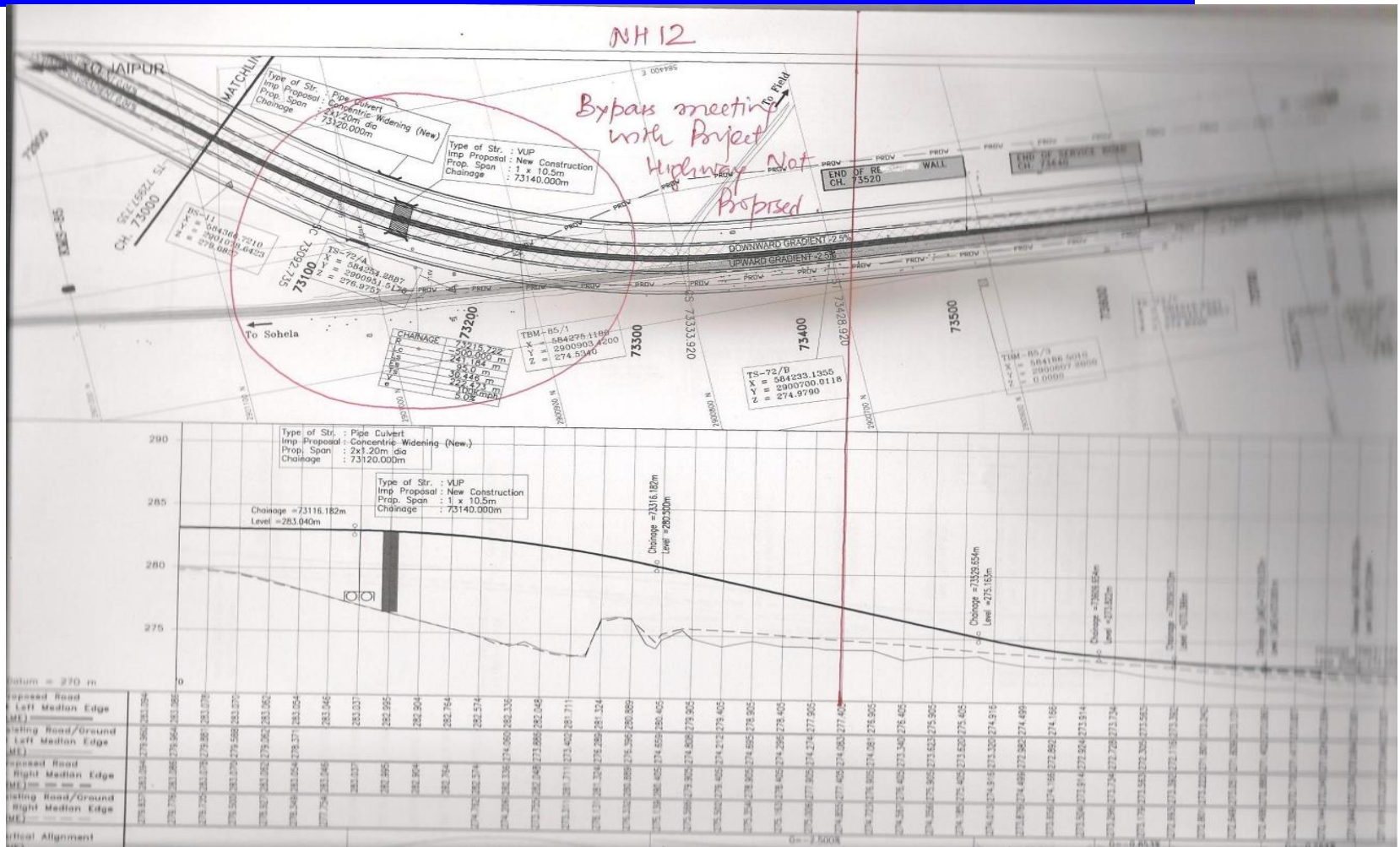
# Cross Roads in Steep Gradient



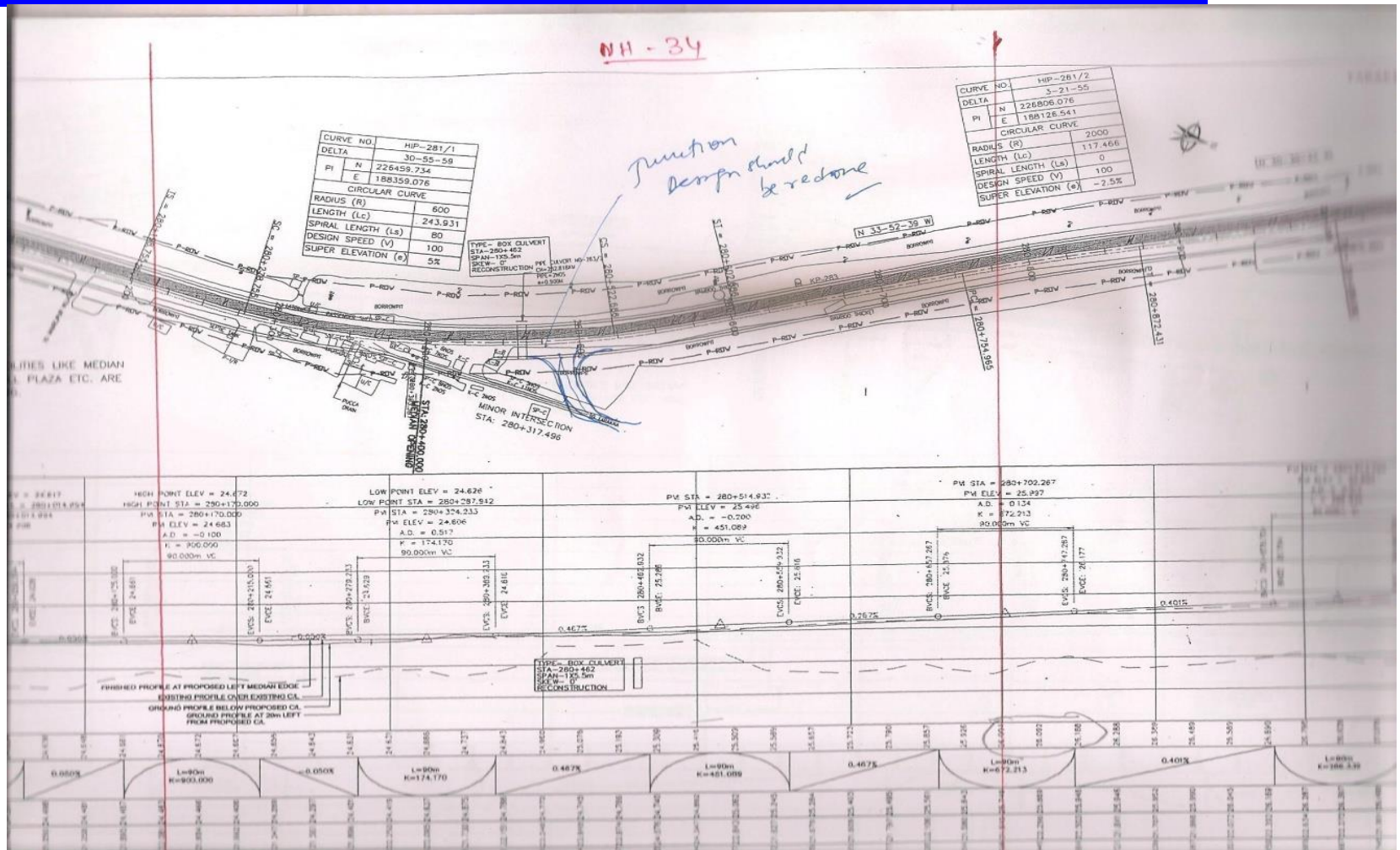
# Unsafe Cross Road Intersection



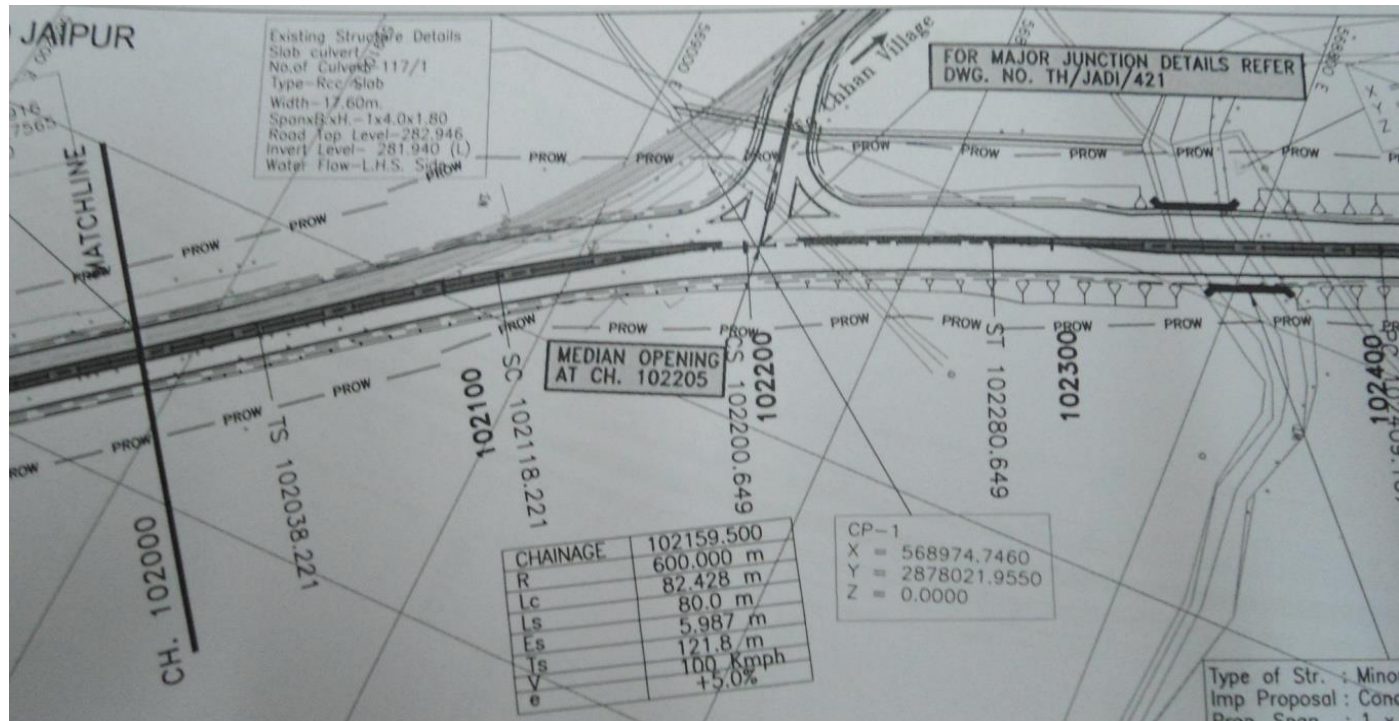
# Non Development of Intersection



# Improper Angle of Cross Road Joining Main Road

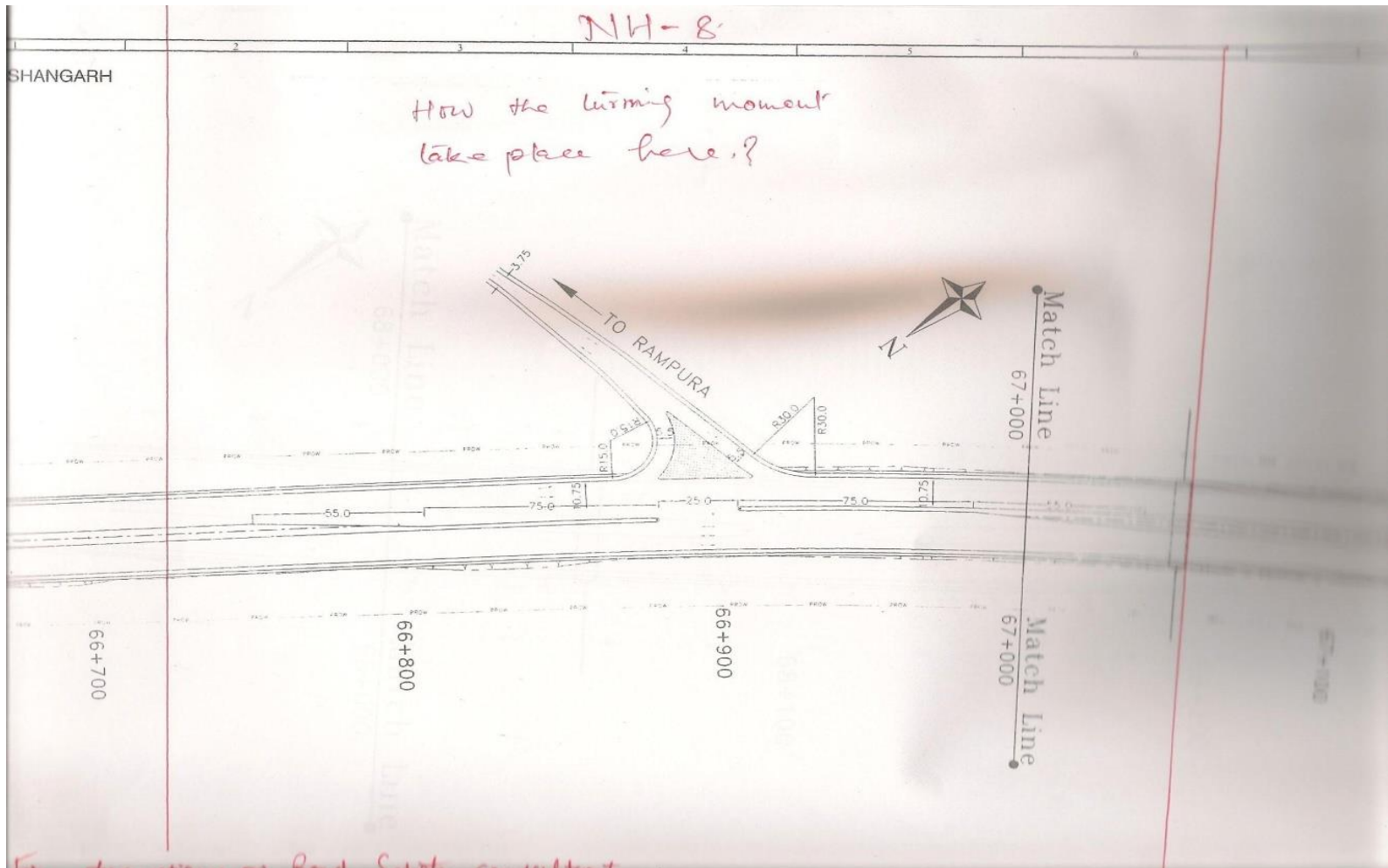


# Junction without Accl/Decl Lanes

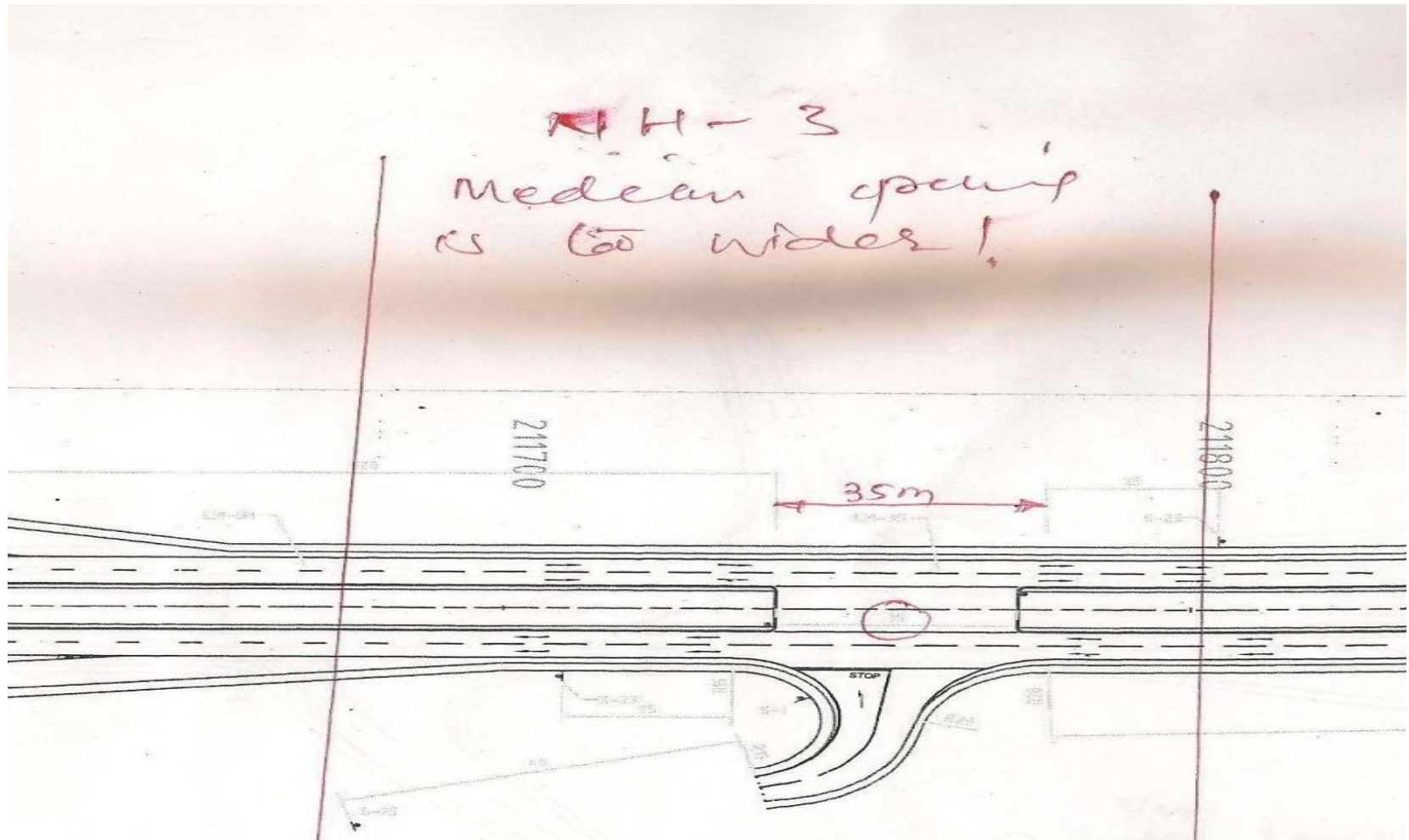


- Sufficient length of acceleration / Deceleration length not provided. The length restricted due to Minor Bridge under construction.

# Improper Median Opening



# Large width of median opening



# Improper Median Opening Geometry



Layout for U-Turn at Site – Median Width reduced to 1.0m (Approx)

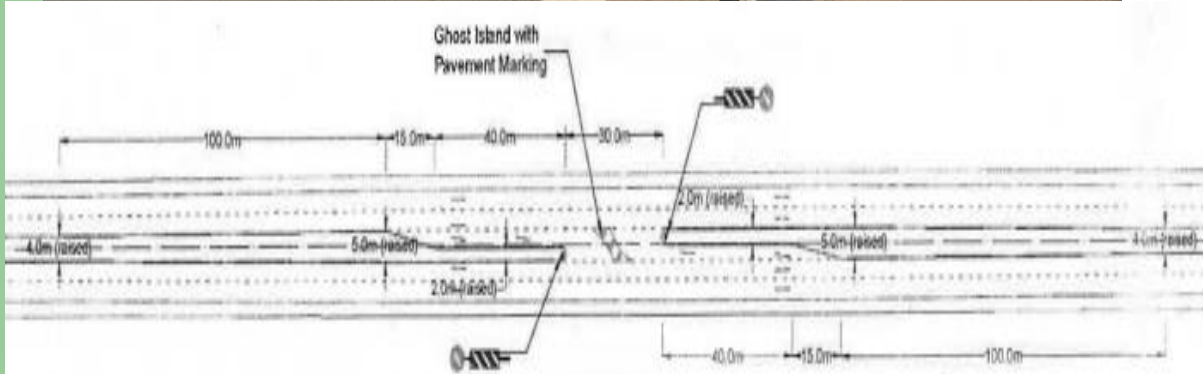


Fig 3.7 : Layout for U-turn

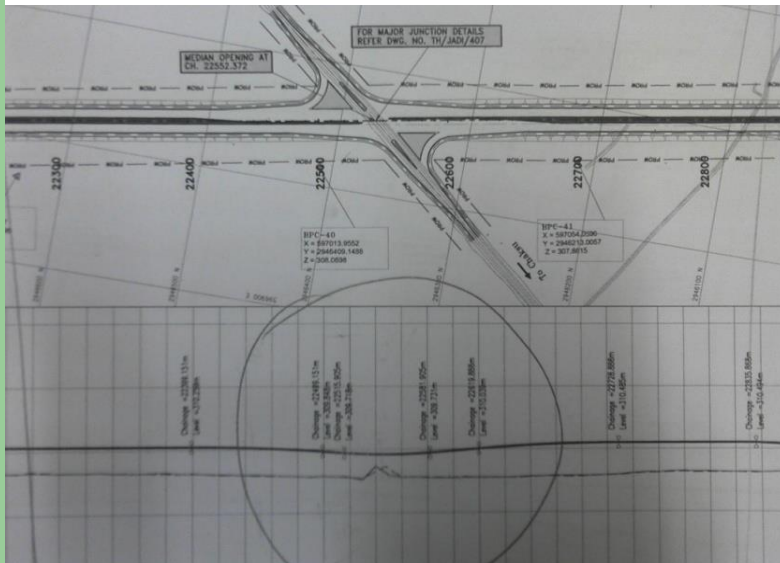
Layout for U-Turn to be provided as per IRC:SP: 84. Increase raised median width from 4m to 5m and then reduce to 2m to provide 3m storage lane

# Unsafe Median Plantation

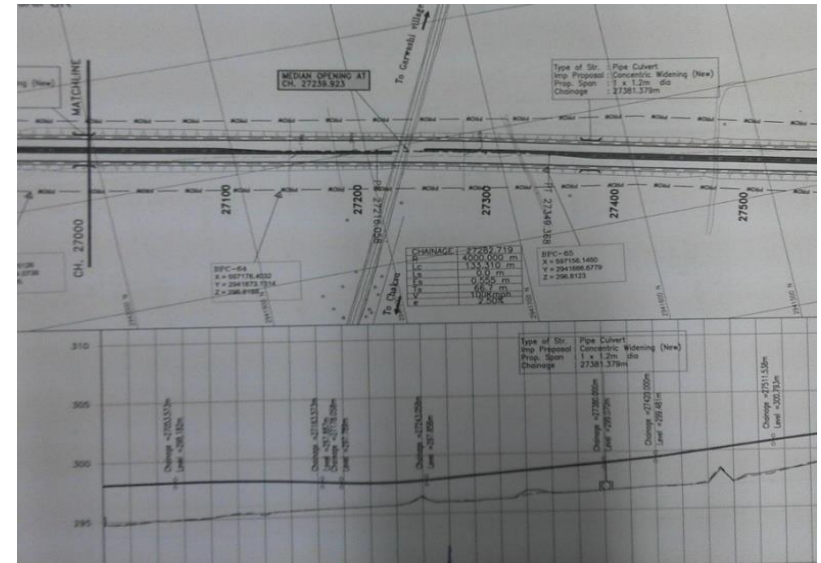


**Recommended** to avoid/restrict median plantation at median opening as per Clause A.4.3 of IRC:SP: 21

# Intersection Profile



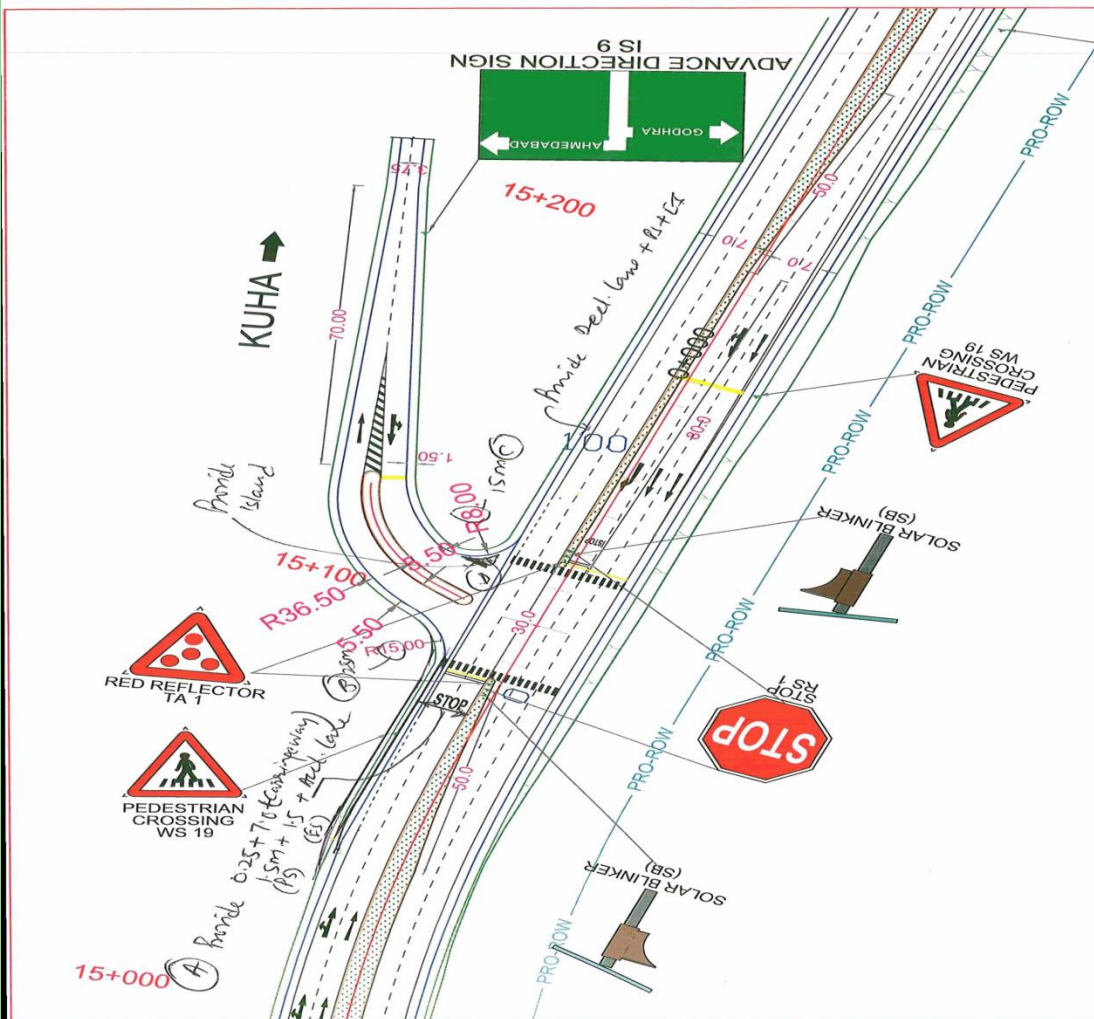
Ch. 22+552



Ch. 27+239

Junctions designed and constructed with frequent gradient change near intersection giving kink effect/sharp curve visibility

# Non Provision of Adequate Turning Radius

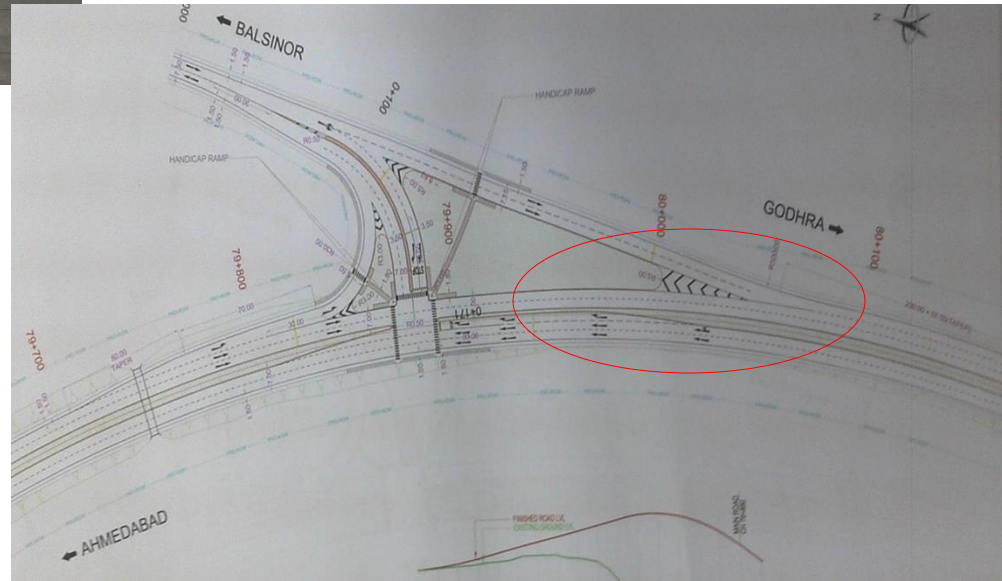


- ① Show vertical profile if command
- ② Provide (A)
- ③ Provide (B) radius 25m
- ④ Provide (C) Radius 15m
- ⑤ Provide Island on turning radius
- ⑥ Provide Acc/Decl lane as the land along project highway may not be a constraint.

## 46

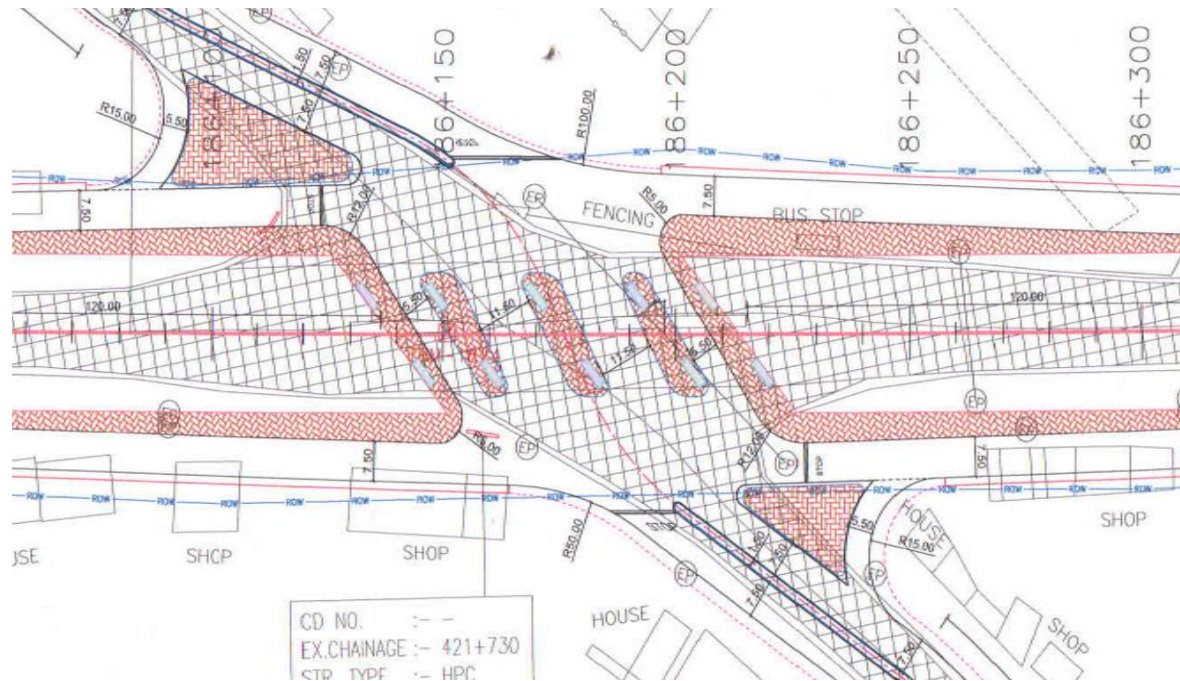


# Turning Radius and Slip Lanes



# Grade Separated Intersections

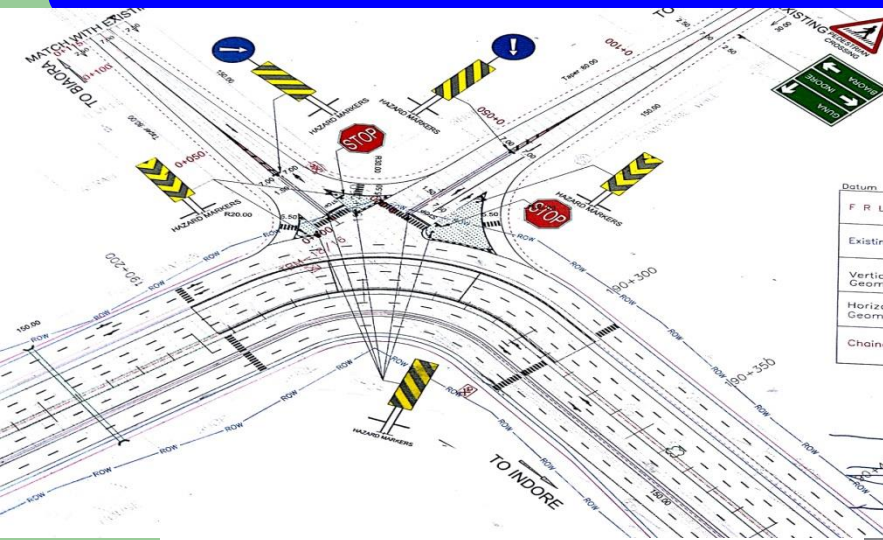
- Intersection formed below a grade separator between cross roads and service roads



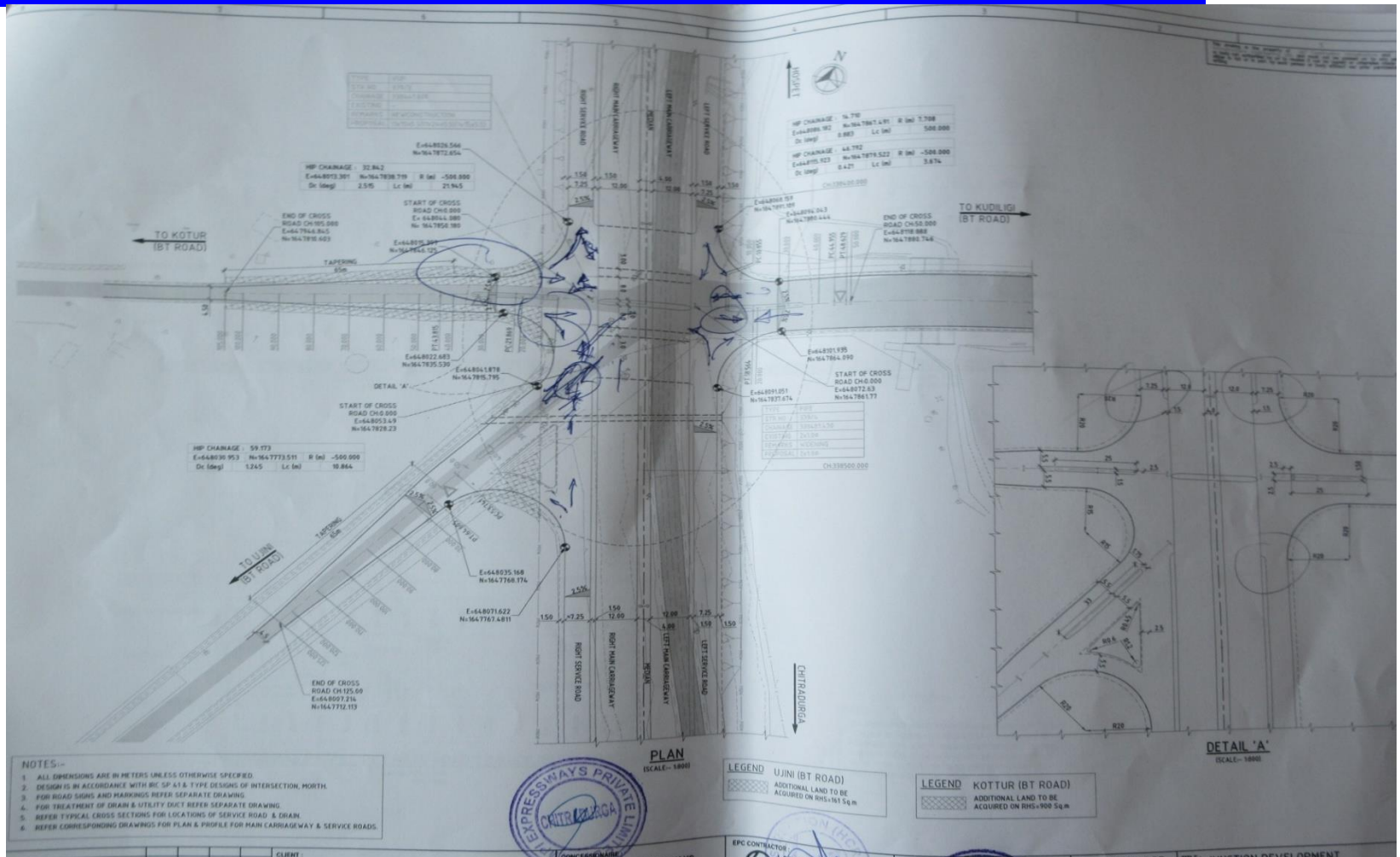
Provide Circular Piers as Rectangular Piers in Skew Grade Separated Junctions cause inadequate turning radius

# Grade Separated Intersections

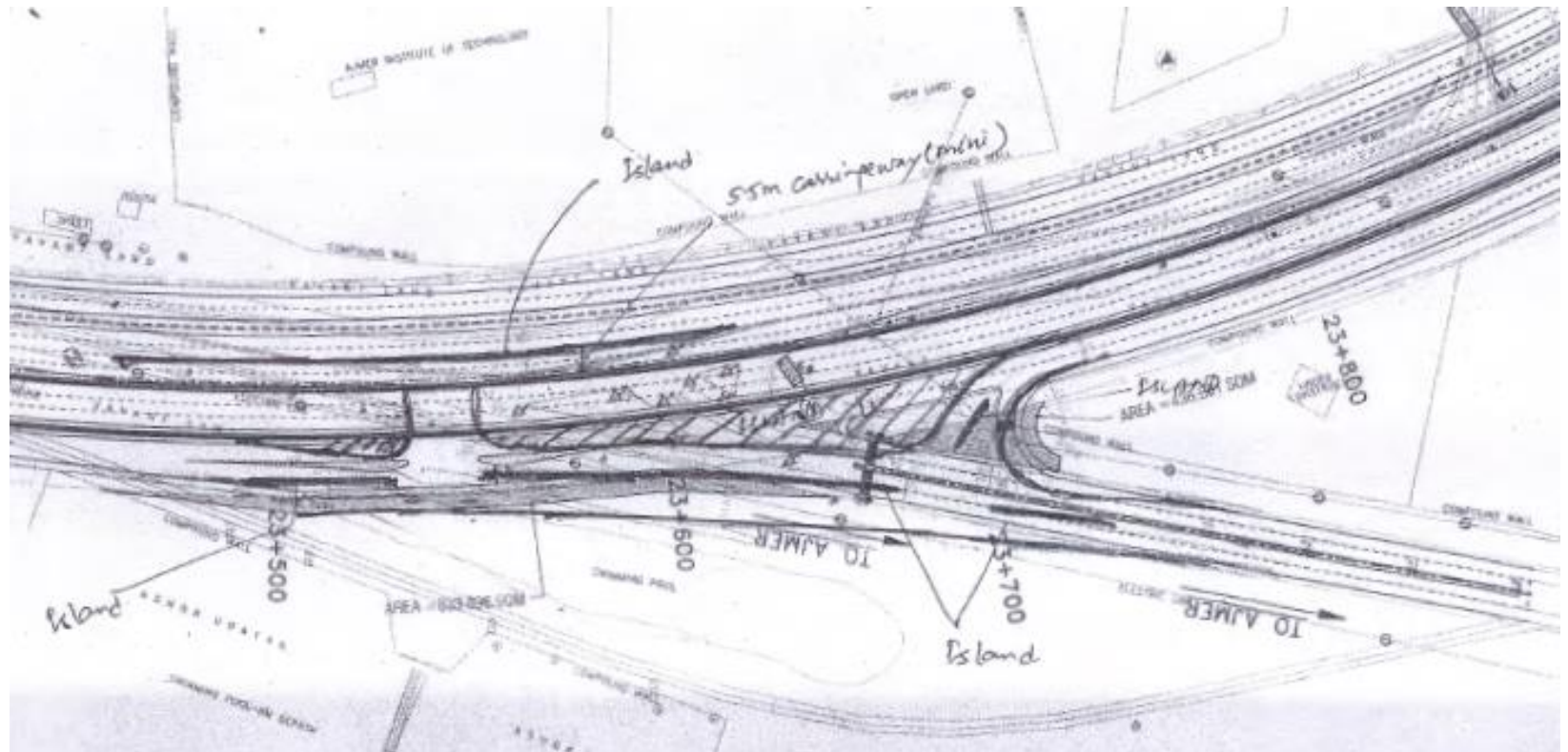
- Redesign to enhance safety



# Design of 5 legged Intersection



\_\_\_\_\_



\_\_\_\_\_



# Mitigation Measures Implemented



➤ Junction Developed, Lane marking & signage provided

# Lateral and Vertical Clearance

Finish road level in VUP/ LVUP/ SVUP shall be kept 150 mm above the ground level/service road/ cross road (whichever is higher) (Clause No. 2.10 IRC: SP:84-2019/ IRC: SP:87-2019)



# Grade Separated Structures

| Sr. No. | Design Chainage (Km) | LHS Roadway Width (m) | RHS Roadway Width (m) | Super Structure Provision in Median | Span Arrangement (m) | Minimum Vertical Clearance (m) | Skew Angle (to be specified) | Remarks |
|---------|----------------------|-----------------------|-----------------------|-------------------------------------|----------------------|--------------------------------|------------------------------|---------|
| 1       |                      | 15.1                  | 15.1                  | No                                  | 1x<br>20+1x30+1x20   | 5.5                            | 0                            |         |
| 2       |                      | 15.1                  | 15.1                  | Yes                                 | 1x20                 | 5.5                            | 16°                          |         |

1. Retaining wall/ RE wall shall be provided for full height on all structures.  
(clause No. 7.1 (iv) IRC:SP:84/87)
2. Toe wall (0.6m ht) to be provided where ROW is restricted and water bodies along the proposed highway on the sections specified in Schedule-B
3. Carriageway width tapering shall be provided 1 in 50 as per manual
4. Provide detailing of placement and specification of Railing, Fencing and electric poles, etc. (clause No. 2.17 IRC:SP:84/87)
5. RCC barrier shall start from start of valley curve and end after grade separator at end of valley curve
6. 50m long MBCB Safety barriers on structure approaches shall be provided

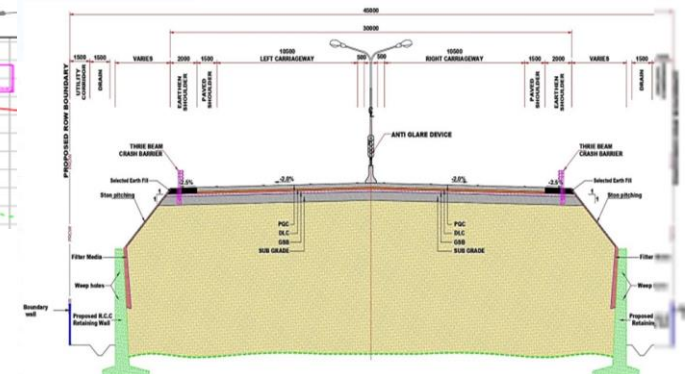
# Retaining Structure

Retaining Wall/ RE Wall shall be provided upto 7.5m height (or full height on VUP/LVUP/SVUP) on all structures refer clause No. 7.1 (iv) IRC:SP:84-2019/ IRC:SP:87-2019)

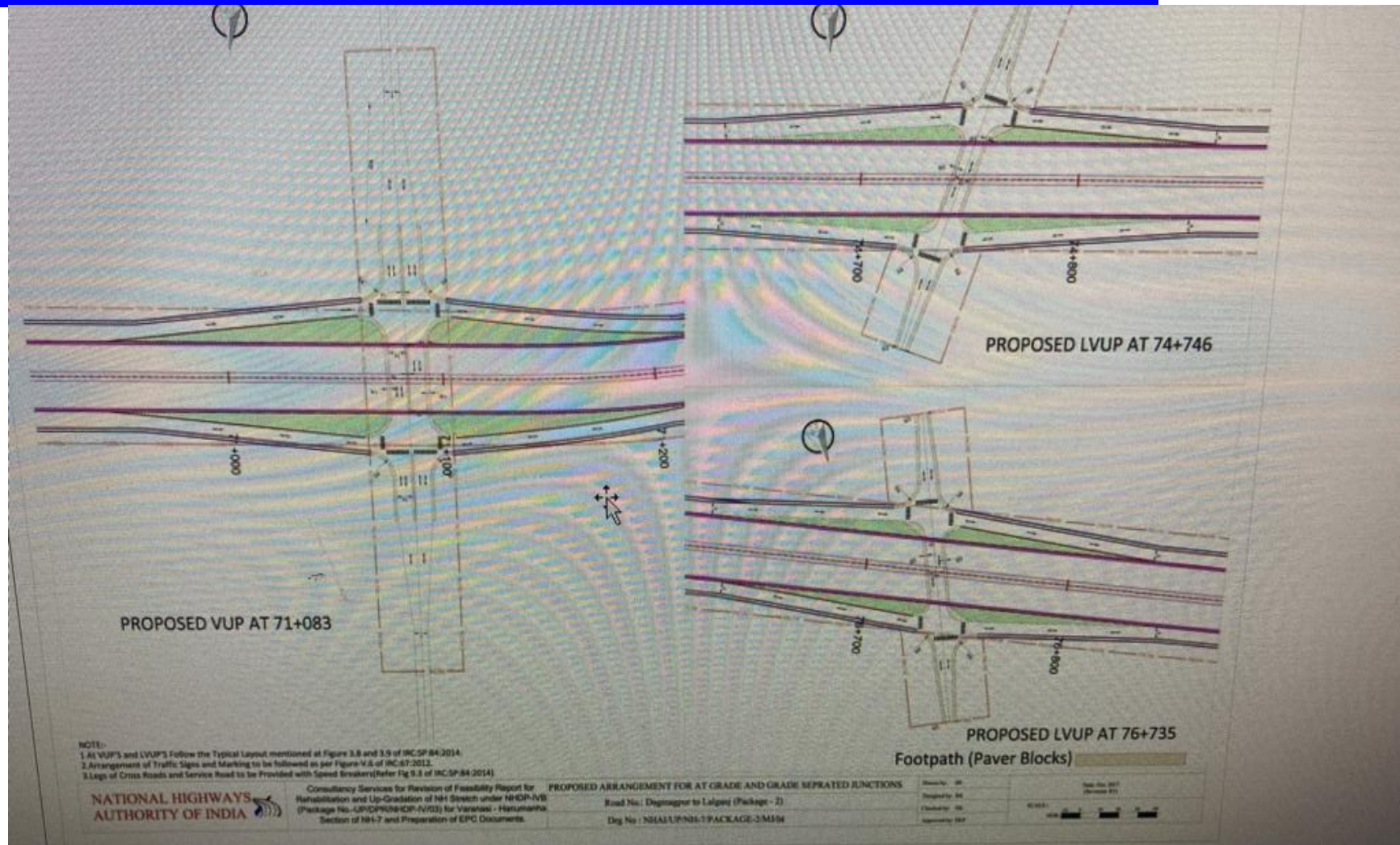


## Partial Retaining wall/ RE Not Permitted

- i. Unsafe due to MBCB Provision
- ii. Wastage of precious land
- iii. Future extension of wall to full height is difficult and cost extensive



# Grade Separated Intersections



# Grade Separated Intersections

- Slip Roads provided steep gradient before turning below Grade Separator
- Intersection without Flaring leading to blind corners



## Provide Adequate Turning Radius by flaring on Slip Roads

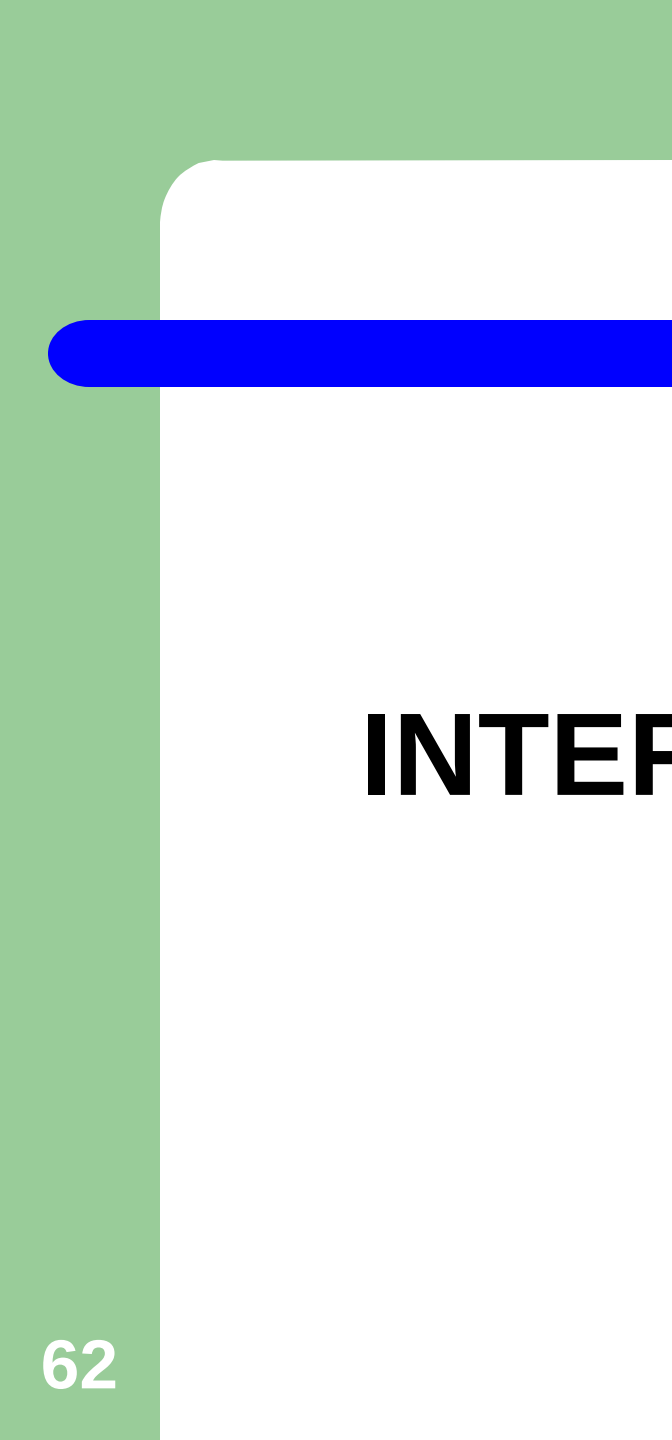


# Pedestrian Movement through Islands



# Left-in/ Left-out Intersection





# **AUDIT OF INTERCHANGE DESIGN**

# Design Standards

| Description                                           | Provisions as per Expressway Manual (IRC : SP:99-2023)                                                        |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| <b>Geometric design features and general features</b> |                                                                                                               |
| <b>Design speed</b>                                   |                                                                                                               |
| Main -line Expressway                                 | 120 kmph                                                                                                      |
| Ramps i/c loop ramps                                  | 70 kmph                                                                                                       |
| <b>Lane width</b>                                     | 3.75m (main line, ramps, laybys and auxiliary lane)                                                           |
| <b>Median</b>                                         | Only depressed or Thrie beam crash barrier flushed with the face of raised median                             |
|                                                       | Transition of 1 in 50 in case median is not uniform                                                           |
| <b>Median opening</b>                                 | Only collapsible or movable median barrier at every 5km interval for traffic management for maintenance works |
| <b>Shoulder</b>                                       | 3.0m paved shoulder                                                                                           |
|                                                       | 2.0 m earthen                                                                                                 |
|                                                       | 0.75m paved on inner side (median side)                                                                       |
| <b>Camber/Cross wall</b>                              | 2.5% bitumen surface & 2 % for cement concrete surface                                                        |

# Design Standards

|                                   |                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Embankment slope</b>           | 4H :1 V and cut slopes in 2:1                                                                                                                                                                                                                                                                                                                     |
| <b>Radius of Horizontal curve</b> | Desirable Min.-1000m & absolute min.-650m<br>Ramps-300m                                                                                                                                                                                                                                                                                           |
| <b>Length of Transition curve</b> | Main line-70m & ramps -40m                                                                                                                                                                                                                                                                                                                        |
| <b>Sight Distance</b>             | 500m                                                                                                                                                                                                                                                                                                                                              |
| <b>Vertical alignment</b>         | No change in grade within distance of 150m                                                                                                                                                                                                                                                                                                        |
|                                   | Gradient- 2%                                                                                                                                                                                                                                                                                                                                      |
|                                   | Minimum length of vertical curve-100m, min. grade change requiring vertical curve- 0.5%                                                                                                                                                                                                                                                           |
| <b>Auxiliary lanes</b>            | Lane width 3.75m and 1.0 m wide paved shoulder<br><b>200m for deceleration</b> (140m for deceleration from 120kph to 70kph & 60m for storage space for vehicle in ques for exit)<br><b>550m for acceleration</b> [240m for speed differential of entry speed (70kph) and main line speed (120kph) plus 210m additional length for gap acceptance] |
| <b>Ramps</b>                      | Lane width 3.75m and 1.0 m wide paved shoulder                                                                                                                                                                                                                                                                                                    |

# Design Standards

|                                                                                 |                                                                                                        |
|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Loop ramps                                                                      | Loop ramps can be reduces to the min. 170m                                                             |
|                                                                                 | Any merging and weaving on loop ramps shall be totally unacceptable.                                   |
| Weaving lengths                                                                 | 600m on the upstream of an exit before diverge and equal length on the downstream of entry after merge |
|                                                                                 | Nose length -75m                                                                                       |
| <b>Traffic control devices, Road safety devices and road safety furniture's</b> |                                                                                                        |

# Audit Checklist

Sightlines availability on Merging/Diverging

Layout(Dimensions) of all Components of Inetchange

Layout easily understood while approaching

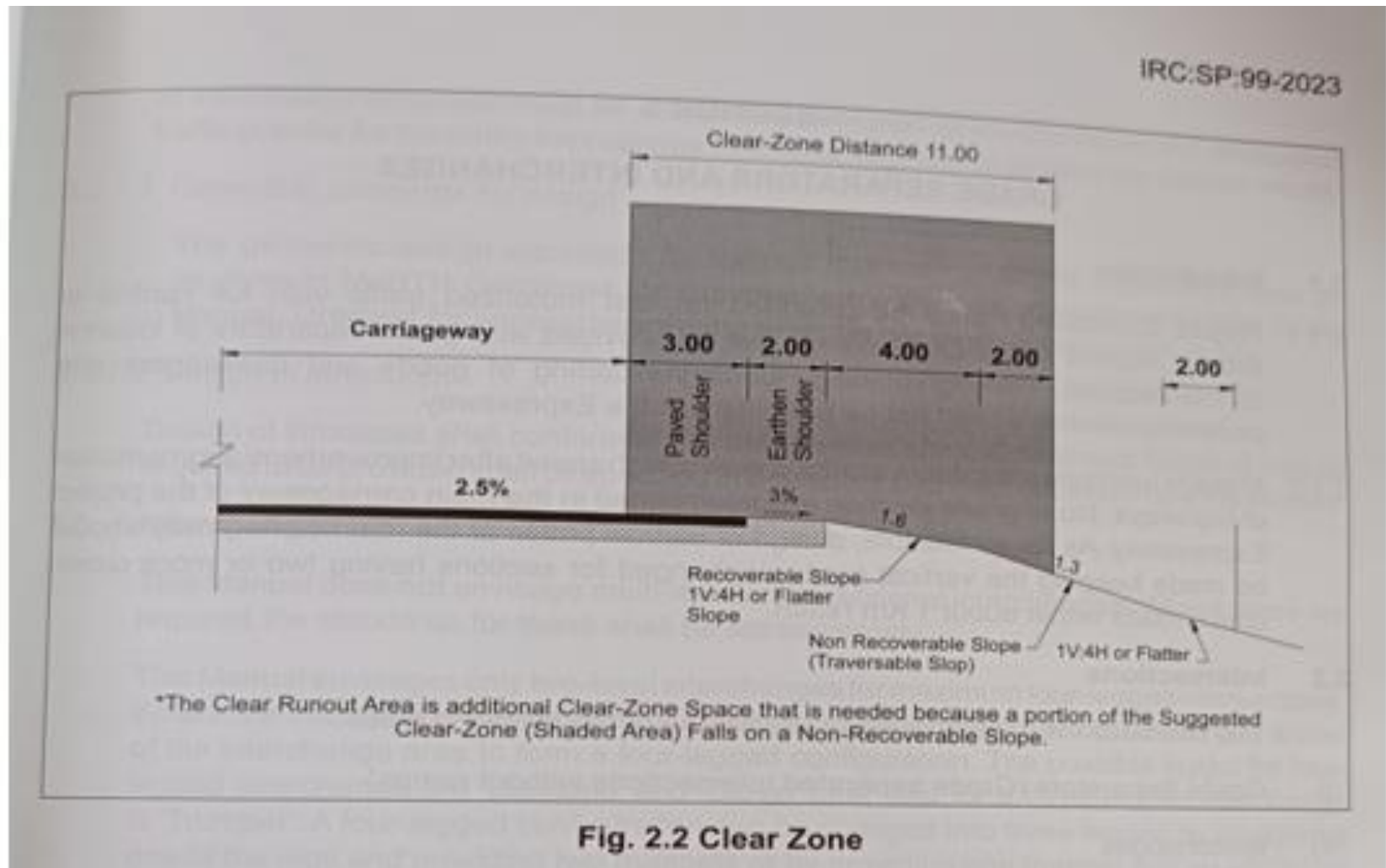
**Pavement markings** – Chevron Markings, Profile Edge Line Markings, Directional Arrows

**Signage plans** – Information Signs, Speed Limit Signs, Lane Signs, Chevron Signs, Public Utility Signs, etc.

Illumination

Roadside hazards

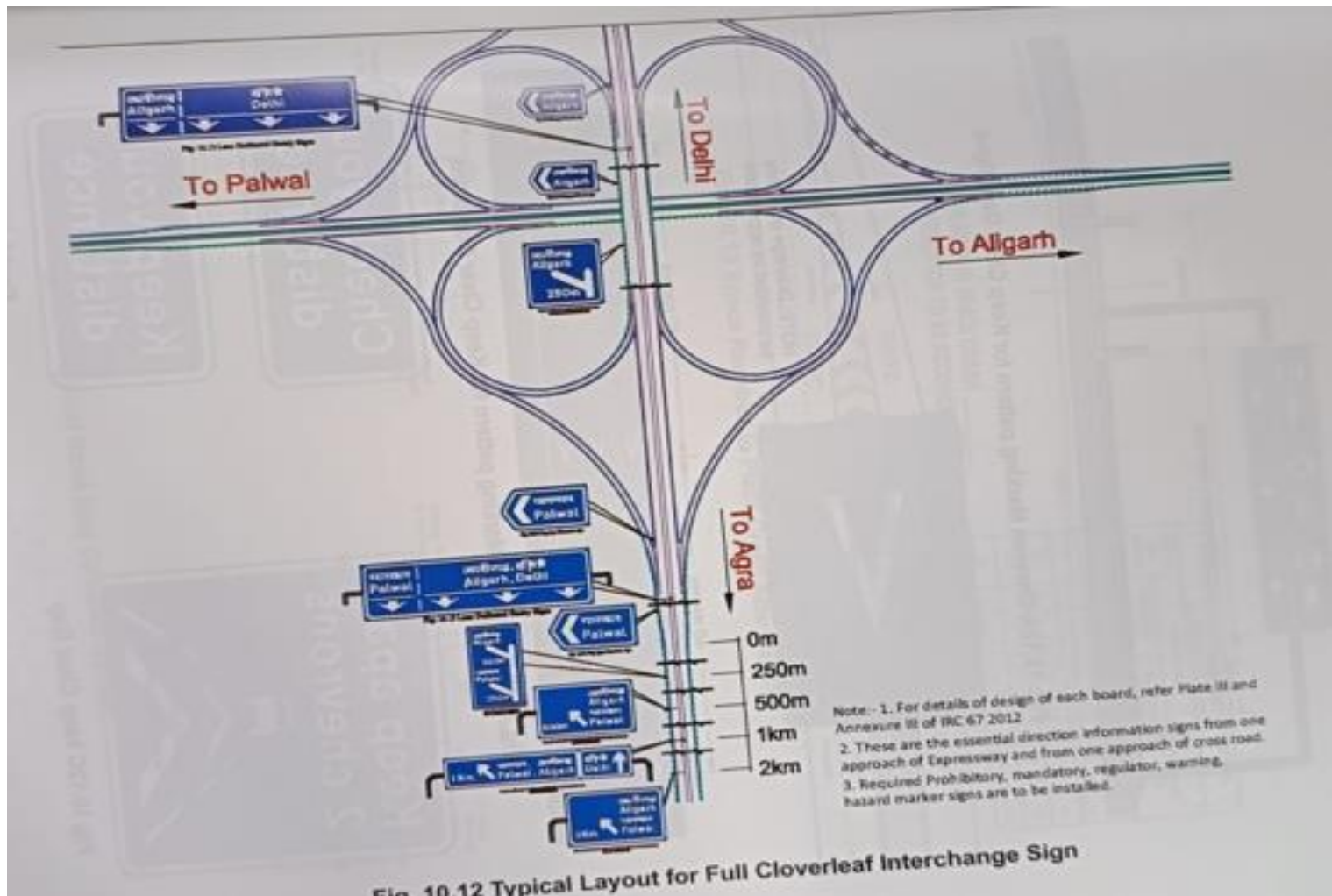
# Audit of Roadside Hazards



# Audit of Road Signs



# Audit of Road Signs



# Audit of Road Markings

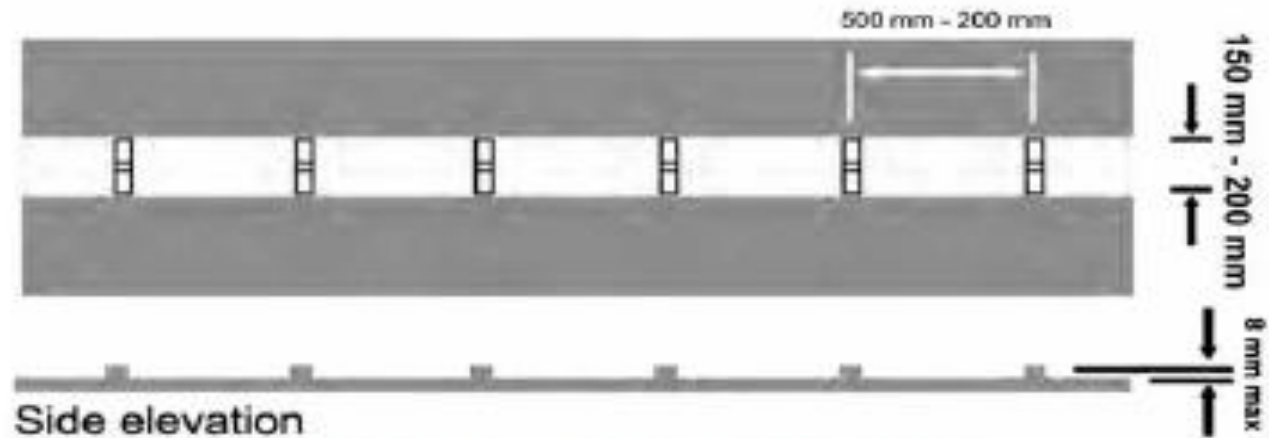


Fig. 7.4 Raised Profile Edge Lines

# Audit of Road Markings

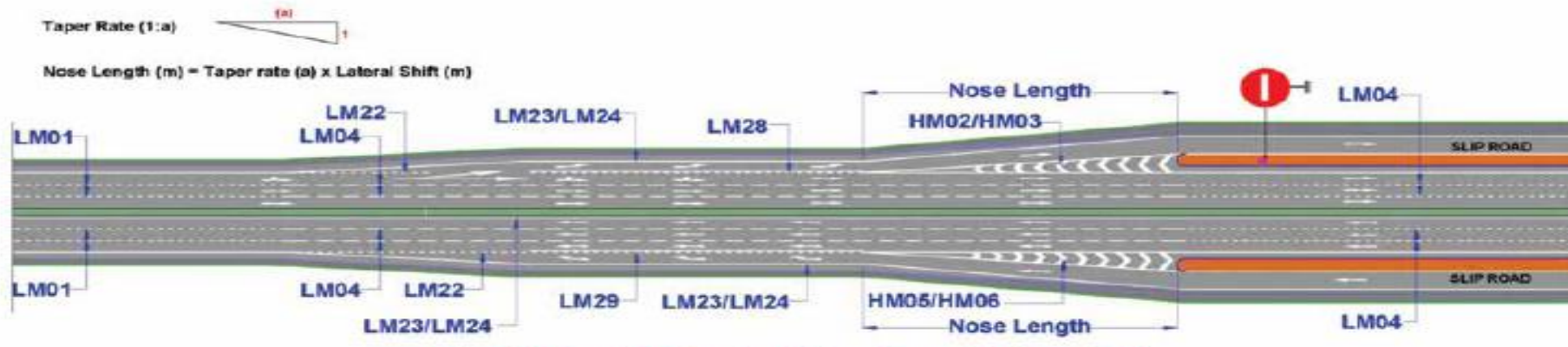


Fig. 10.1 Merging/Diverging (Without Lane Gain/Lane Drop)

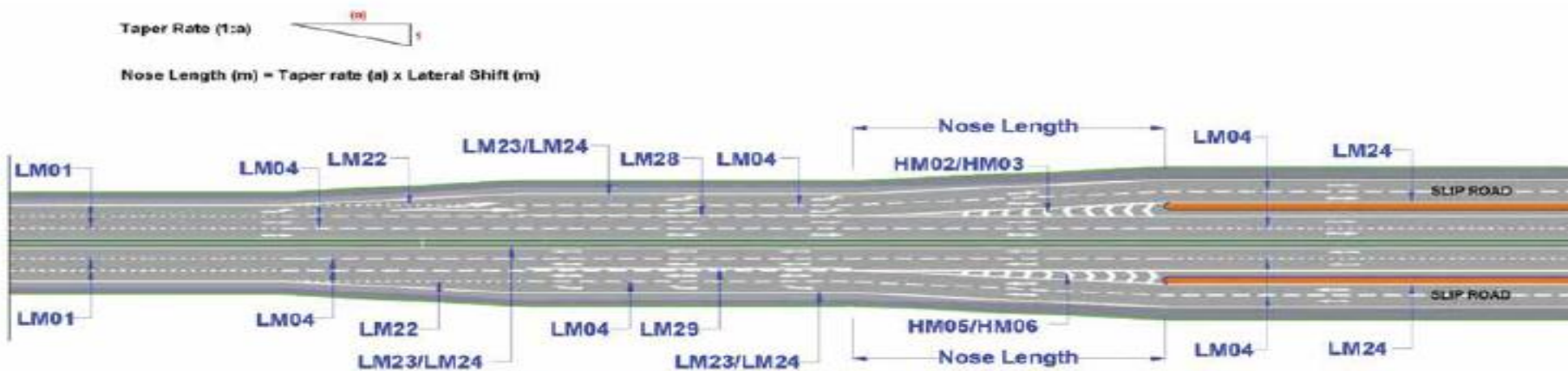


Fig. 10.2 Merging/Diverging (With Lane Gain/Lane Drop)

# Audit of Road Markings

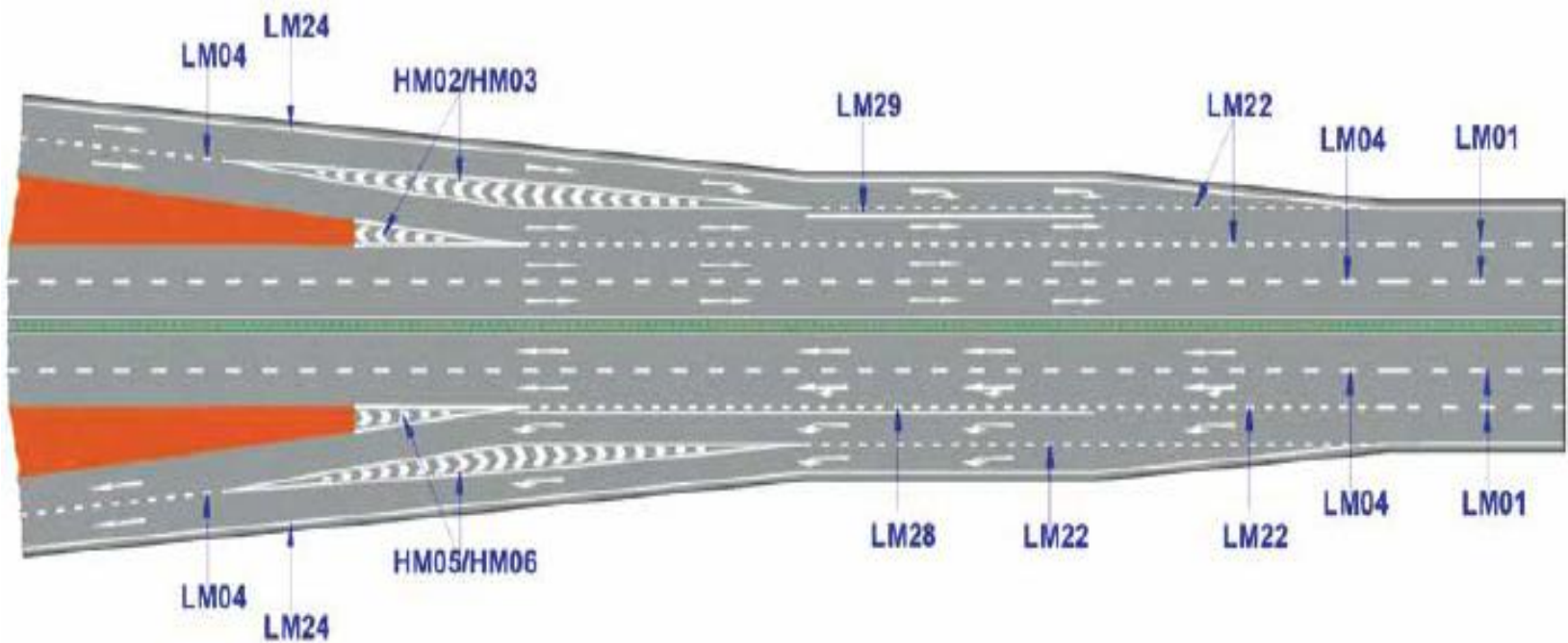


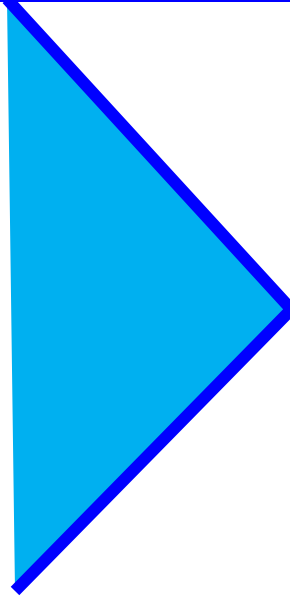
Fig. 10.3 Merging/Diverging with Ghost Island (with Lane Gain/Lane Drop)



# **AUDIT OF ROAD SIGNS PROPOSAL**

# Road Signs

- Guidance
- Warning
- Regulation



Information  
***when and where***  
it is most effective for  
influencing safe behavior

# Types of Traffic Sign

## 1. Regulatory/Mandatory sign:

The indicate prohibition on certain type of vehicle maneuver. Violation is an offence.



Prohibitory  
Regulation



Operational  
Control



Compulsory  
Direction  
Control

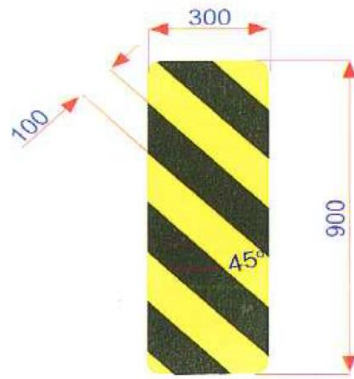
## 2. Warning Sign Warn road users on change in road conditions; helps avoid accidents.



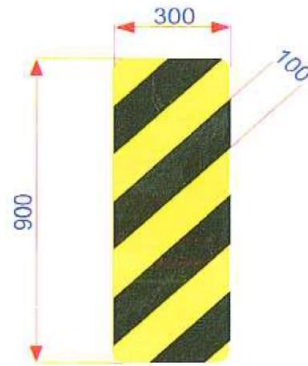
## 3. Informatory sign: Provide information to users; helps improve traffic efficiency.



# Object Hazard Marker Sign



Object Hazard ( Left )



Object Hazard ( Right )



Two Way Hazard Marker

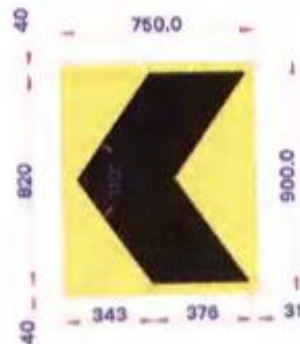
# Chevron Signs

Chevron sign provided on curved alignment of roadway to inform the driver about sharpness of the curve

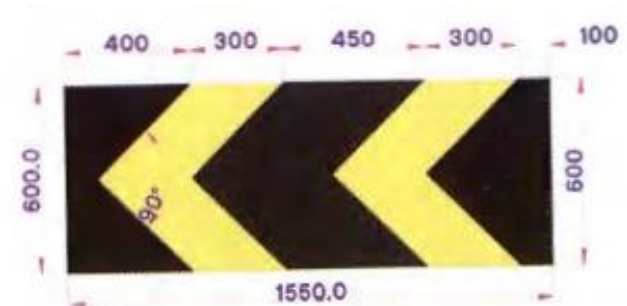
| Curve Radius | Distance Between Single Chevron (m) |              |
|--------------|-------------------------------------|--------------|
|              | On Curve                            | Before Curve |
| 50           | 15                                  | 30           |
| 100          | 20                                  | 40           |
| 200          | 30                                  | 60           |
| 300          | 45                                  | 90           |
| 400          | 60                                  | 120          |
| 401-750      | 70                                  | 150          |
| >750         | 80                                  | 160          |



Single Chevron (Normal)

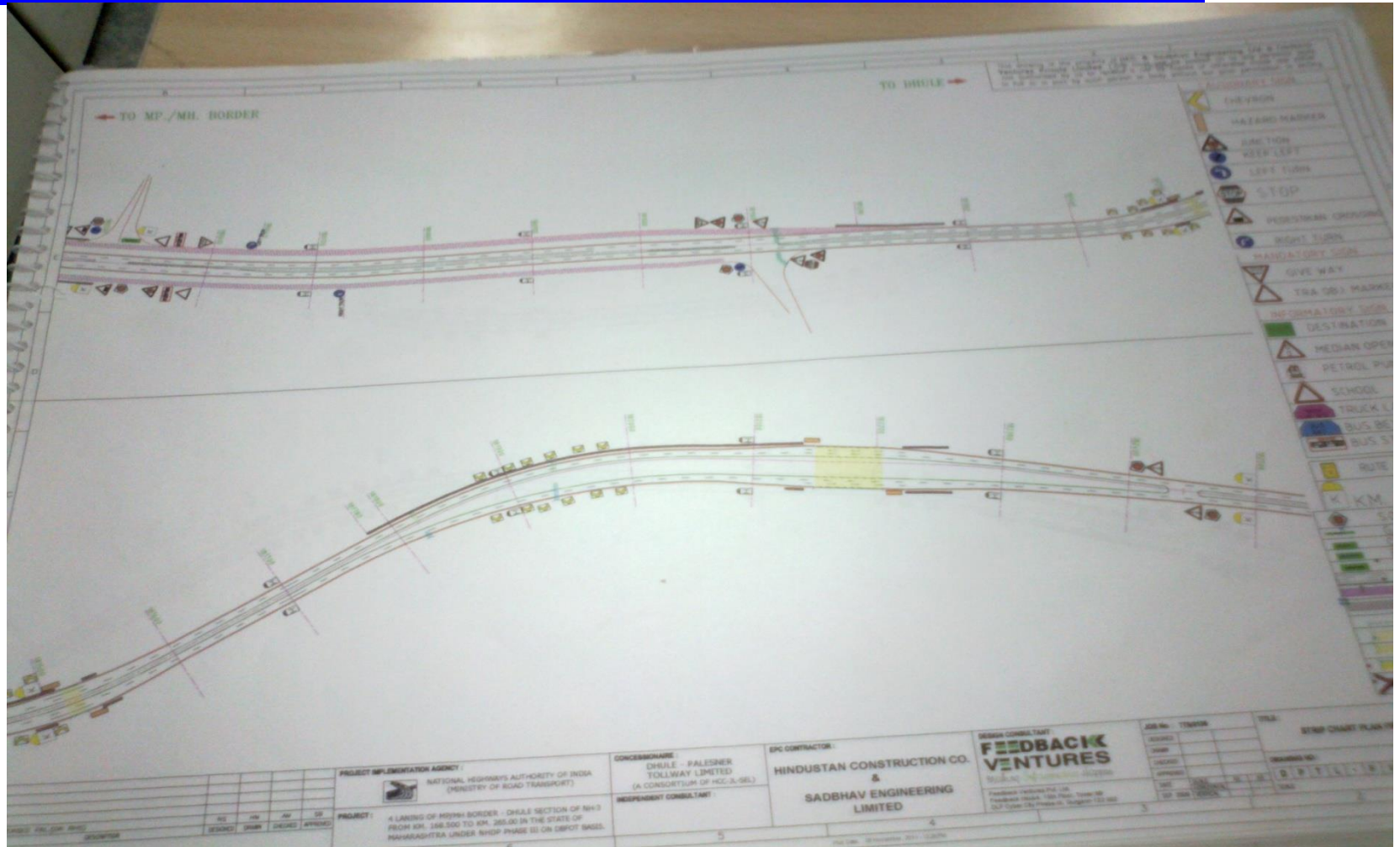


Single Chevron (Normal)

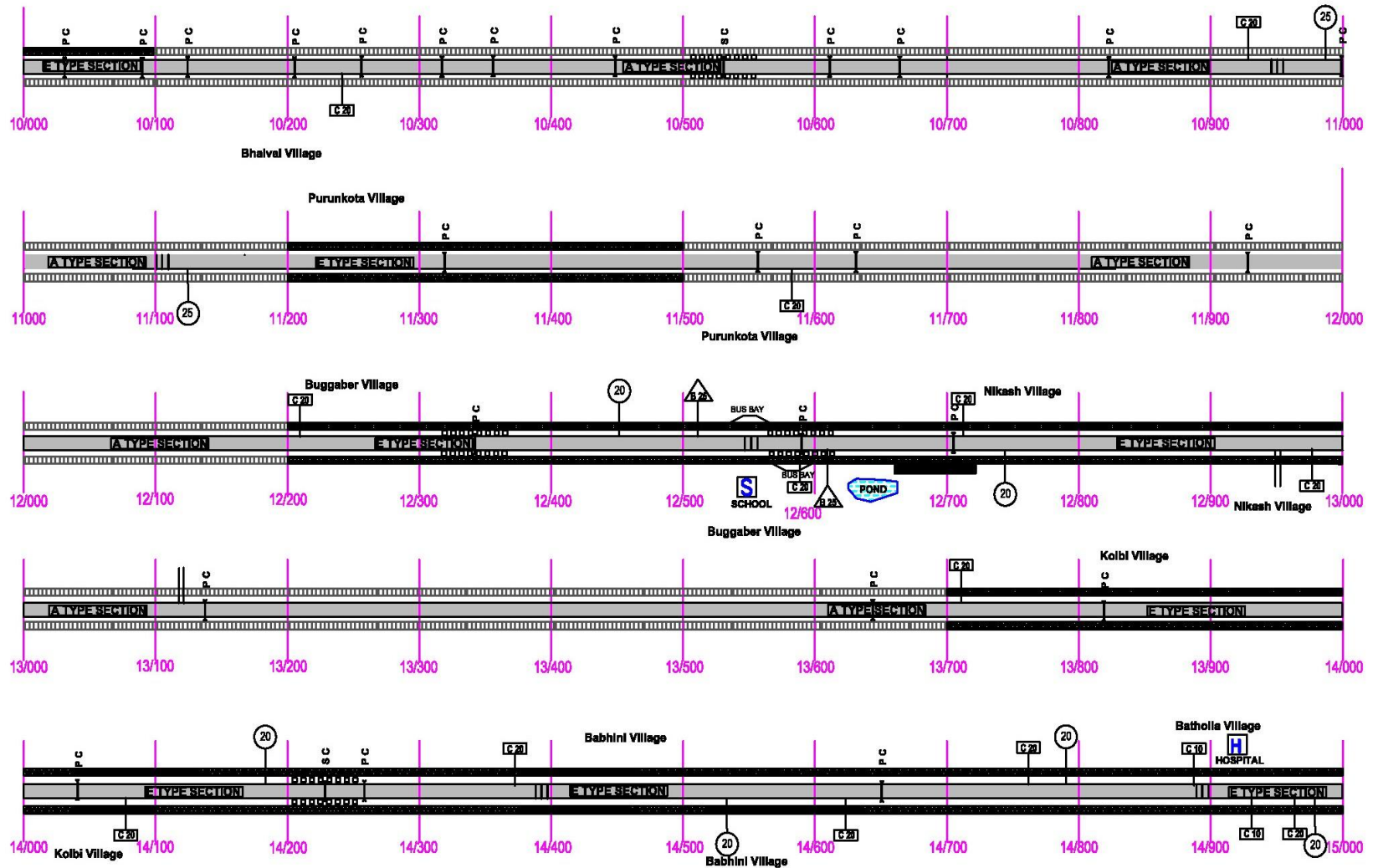


Double Chevron (Normal)

# Strip Plan Showing Signs



# Strip Plan Showing Signs



| LEGEND | P           | H        | S      | T      |              | GUARD STONE /<br>DELINEATOR | P.C<br>PIPE CULVERT | S.C<br>SLAB CULVERT | C.W<br>CAUSEWAY | B.C<br>BOX CULVERT | EXIST. BRIDGE | EARTHEN DRAIN | TRAPEZOIDAL RR<br>MASONRY DRAIN | MASONRY DRAIN (OPEN) | MASONRY DRAIN (COVERED) | STONE MASONRY<br>TOE WALL |
|--------|-------------|----------|--------|--------|--------------|-----------------------------|---------------------|---------------------|-----------------|--------------------|---------------|---------------|---------------------------------|----------------------|-------------------------|---------------------------|
|        | PETROL PUMP | HOSPITAL | SCHOOL | TEMPLE | RUMBLE STRIP | GUARD STONE /<br>DELINEATOR | P.C<br>PIPE CULVERT | S.C<br>SLAB CULVERT | C.W<br>CAUSEWAY | B.C<br>BOX CULVERT | EXIST. BRIDGE | EARTHEN DRAIN | TRAPEZOIDAL RR<br>MASONRY DRAIN | MASONRY DRAIN (OPEN) | MASONRY DRAIN (COVERED) | STONE MASONRY<br>TOE WALL |

# Enhance Readability of Signs



# Confusing Road Signs



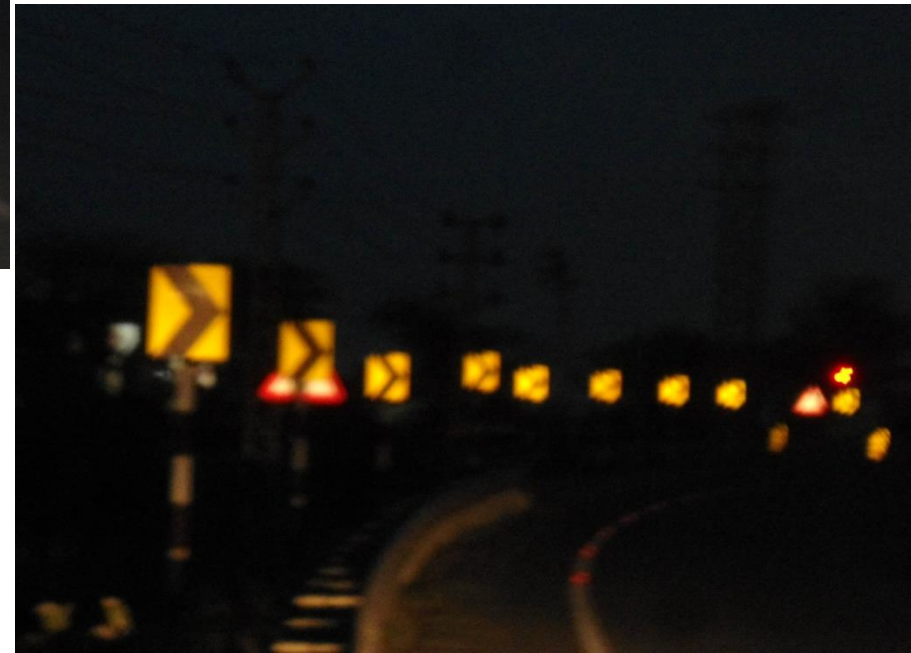
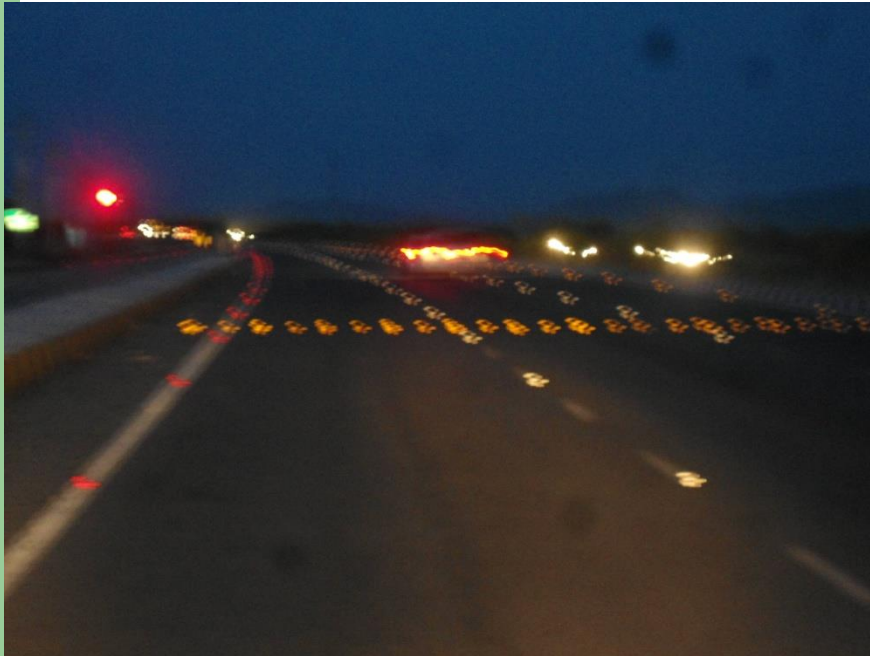
# Signage fixed on Earthen Shoulder



# Avoid Clustering of Signs



# Night Visibility on Project Highway





# **AUDIT OF PAVEMENT MARKINGS PROPOSAL**

# Classification of Road Marking

- Longitudinal Marking ( LM )
- Transverse Marking ( TM )
- Hazard Marking ( HM )
- Block Marking (BM)
- Arrow Marking ( AM)
- Directional Marking (DM)
- Facility Marking ( FM )

# Installation of Stop & Give Way Marking

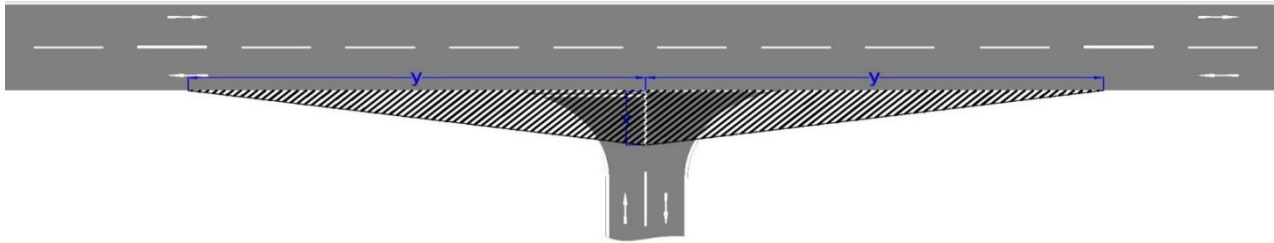


Fig 6.4 : Visibility Funnel

| Speed on Major Road | Visibility Distances on Major Road (y) | Distance measured along the centre line of minor road from edge line of major road (x) |
|---------------------|----------------------------------------|----------------------------------------------------------------------------------------|
| Upton 15kmph        | 15m                                    | x = 4.5m for medium traffic and 3.0m for lightly trafficked side road                  |
| 31- 50 kmph         | 30m                                    |                                                                                        |
| 51-65 kmph          | 45m                                    |                                                                                        |
| 66 -80 kmph         | 70m                                    |                                                                                        |
| 81- 100kmph         | 90m                                    |                                                                                        |
| > 100kmph           | 120m                                   |                                                                                        |

➤ **STOP Marking** : If the visibility funnel is not obstruction free taking like parking or stoppage of vehicles or other geometric deficiency or climatic factors, install Stop marking and Stop Sign

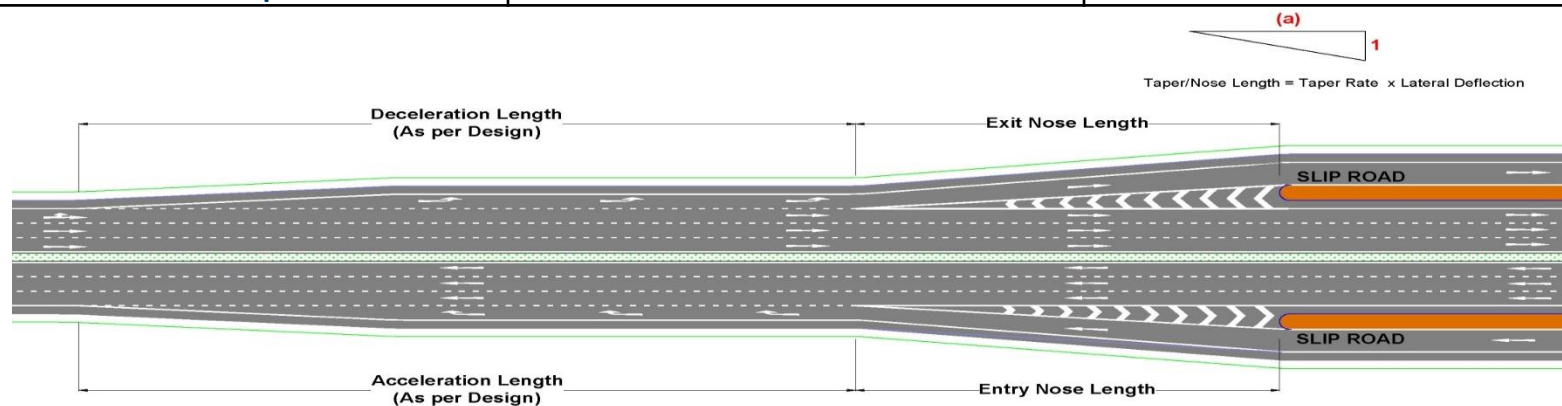
➤ **GIVE WAY Marking** : If the visibility funnel is clear enough from both directions of travel, then the Give Way marking along with Give Way sign can be considered.

# Merging & Diverging Markings

The merging and diverging at high speed situations will be critical, the length of nose length to be provided shall be the function of approach speed and the taper rate for diagonal or chevron.

**Table 7.2: Taper Rate of Diagonal/Chevrons Marking**

| Speed (kmph)  | Désirable Minimum Taper | Absolute Minimum Taper |
|---------------|-------------------------|------------------------|
| < 50 kmph     | 1:35                    | 1:20                   |
| 50 to 65 kmph | 1:40                    | 1:25                   |
| 66 to 80 kmph | 1:45                    | 1:30                   |
| >80kmph       | 1:50                    | 1:40                   |



**Fig 7.2: Nose Length at High Speed Situations**

# Lane Reduction / Narrowing Situations & Transitions

- The reduction and transition of traffic lanes are frequent and generally carried out in the case of four lane divided carriageway getting reduced to 2-lane bidirectional carriageway condition.
- In such situations, the drivers should be properly guided to transfer from 4-lane to 2-lane and vice versa. If one or more lanes are to be discontinued, the centres and the lane lines should be connected in such a way that traffic safely merged in to the reduced number of lanes.

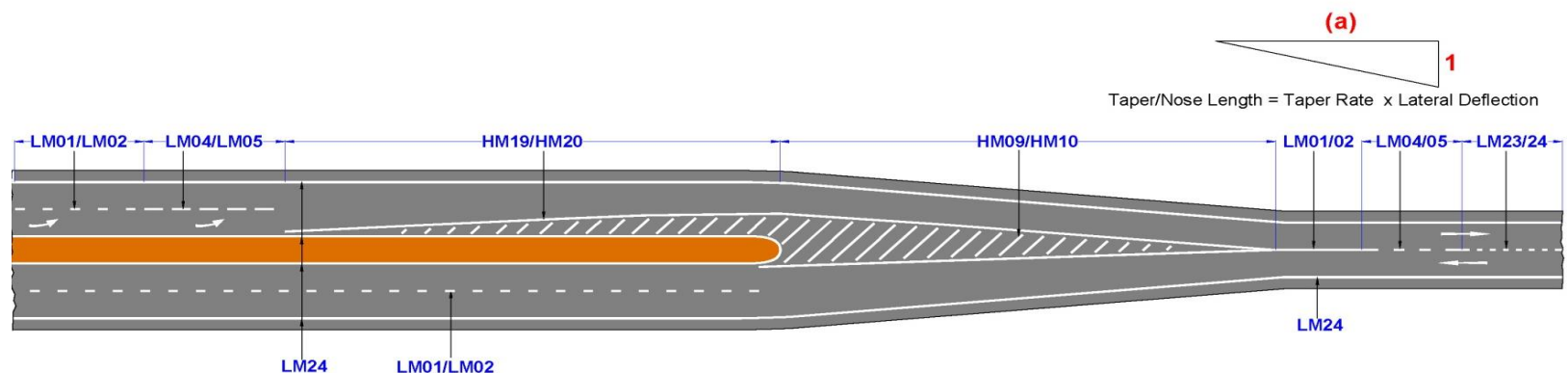


Fig 7.5: Four Lane to Two Lane Transition (Concentric)

# Pavement Marking on Project Highway



Chevron Marking on  
Dividers



Kerb Painting

# Zebra and Chevron Pavement Marking



Road Marking at  
Median Openings



Road Marking at  
Junctions

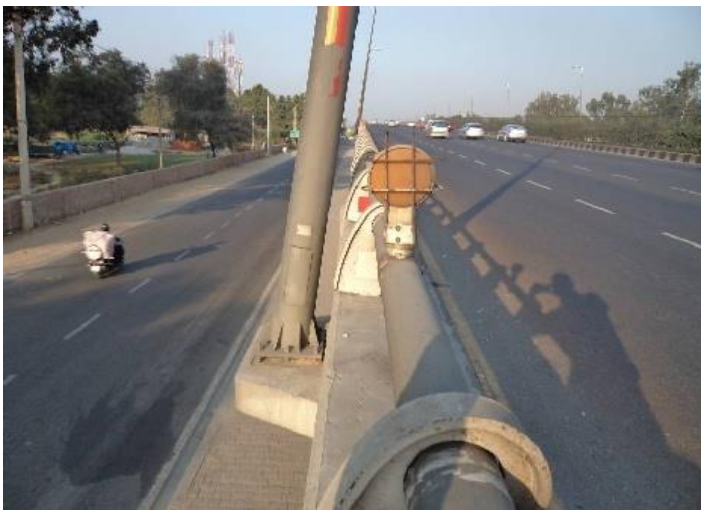
# Signs and Markings on Intersections





# **AUDIT OF LIGHTING SCHEME**

# Fixing of Lighting Poles



# Hanging Electric Wires inside VUP/PUP





# **Audit of Safety Barrier**

# Safety Barriers ?

1. Reduce Severity of Accidents
  - i. When Vehicle Lose Control
  - ii. Vehicle Runoff from the Road
2. Reduce Impacts to Occupants
3. Reduce Damage to Properties

# MoRTH Circular Jan 01,2021

## Safety Barrier Requirements

| Type of Crash barrier                                      | Terrain           | Working Width(*)                                                                                            | Containment level                                             | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Thrie Beam<br>(single sided/<br>double sided<br>on median) | Hilly             | W3 ( $W_N \leq 1.0\text{m}$ )<br>Or<br>W4 ( $W_N \leq 1.3\text{m}$ )                                        | H2 as per EN<br>1317 - part 2<br>OR<br>TL4 as per<br>MASH     | <u><b>Containment Level H2:-</b></u><br>Car of 900 kg, Speed 100 Kmph, Impact angle 20 degrees and,<br><br>Bus of 13,000Kg, speed 70 Kmph, impact angle 20 degrees<br><br><u><b>Containment Level TL4:-</b></u><br>Car of 1100 kg, Speed 100 Kmph, Impact angle 25 degrees and,<br><br>Pick up of 2270 kg, speed 100kmph, impact angle 25 degrees and,<br><br>Single unit truck 10,000kg, speed 90 kmph, impact angle 15 degrees |
|                                                            | Plain/<br>rolling | W4 ( $W_N \leq 1.3\text{m}$ )<br>Or<br>W5 ( $W_N \leq 1.7\text{m}$ )                                        |                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| W- Beam<br>(single sided/<br>double sided<br>on median)    | Hilly             | W3 ( $W_N \leq 1.0\text{m}$ )<br>Or<br>W4 ( $W_N \leq 1.3\text{m}$ )                                        | H1 as per EN<br>1317 - part 2<br><br>OR<br>TL4 as per<br>MASH | <u><b>Containment Level H1:-</b></u><br>Car of 900 kg, Speed 100 Kmph, Impact angle 20 degrees and,<br><br>Bus of 10,000Kg, speed 70 Kmph, impact angle 15 degrees<br><br><u><b>Containment Level TL4:-</b></u><br>Car of 1100 kg, Speed 100 Kmph, Impact angle 25 degrees and,<br><br>Pick up of 2270 kg, speed 100kmph, impact angle 25 degrees and,<br><br>Single unit truck 10,000kg, speed 90 kmph, impact angle 15 degrees |
|                                                            | Plain/<br>rolling | W3 ( $W_N \leq 1.0\text{m}$ )<br>Or<br>W4 ( $W_N \leq 1.3\text{m}$ )<br>Or<br>W5 ( $W_N \leq 1.7\text{m}$ ) |                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                  |

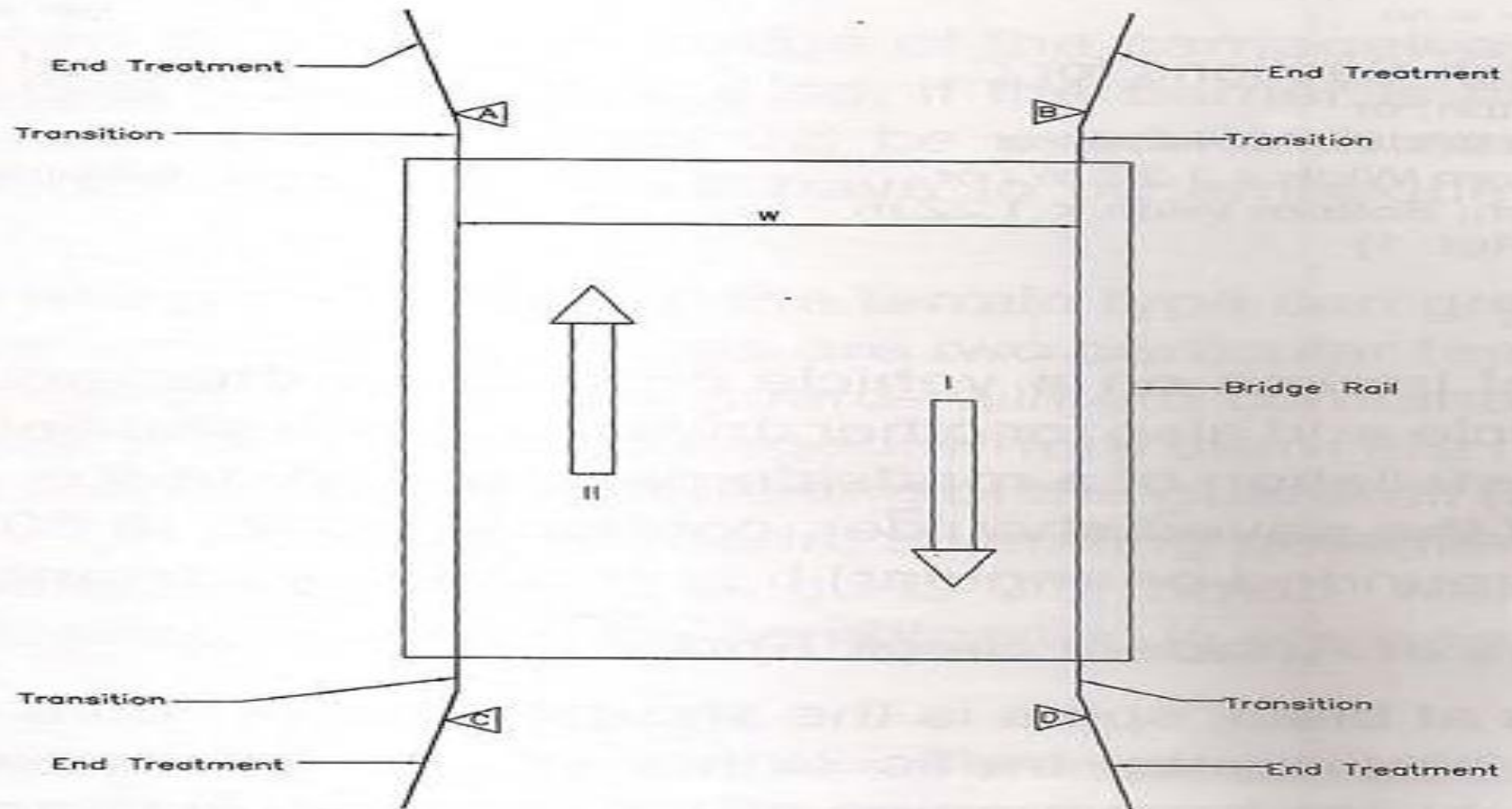
# Safety Barrier



# Insufficient Working width Beyond MBCB Post



# Barriers for Bridge Rail Ends



| Traffic Direction | Distance Between Bridge Rails - W (m)   | Approach Barrier Required At |
|-------------------|-----------------------------------------|------------------------------|
| I And II          | $\leq 2 \times \text{Clear Zone Width}$ | A,B,C,D                      |
| I And II          | $> 2 \times \text{Clear Zone Width}$    | C,B                          |
| II Only           | All Widths                              | C,D                          |
| I Only            | All Widths                              | A,B                          |

# Metal Beam Crash Barrier fixed Before Kerb



Correct Method of fixing  
Metal Crash Barrier



# Safety Barrier Required on Outer Edge of Curve



# Safety Barrier Required on Higher C/W



Provide Metal Crash Barrier on Higher Carriageway as per Clause 5.10, Fig. 23 of IRC: 119-2015

# MBCB & CCB Connection



# Unsafe Start/End of Bridges



# MBCB on Bridge and Causeway

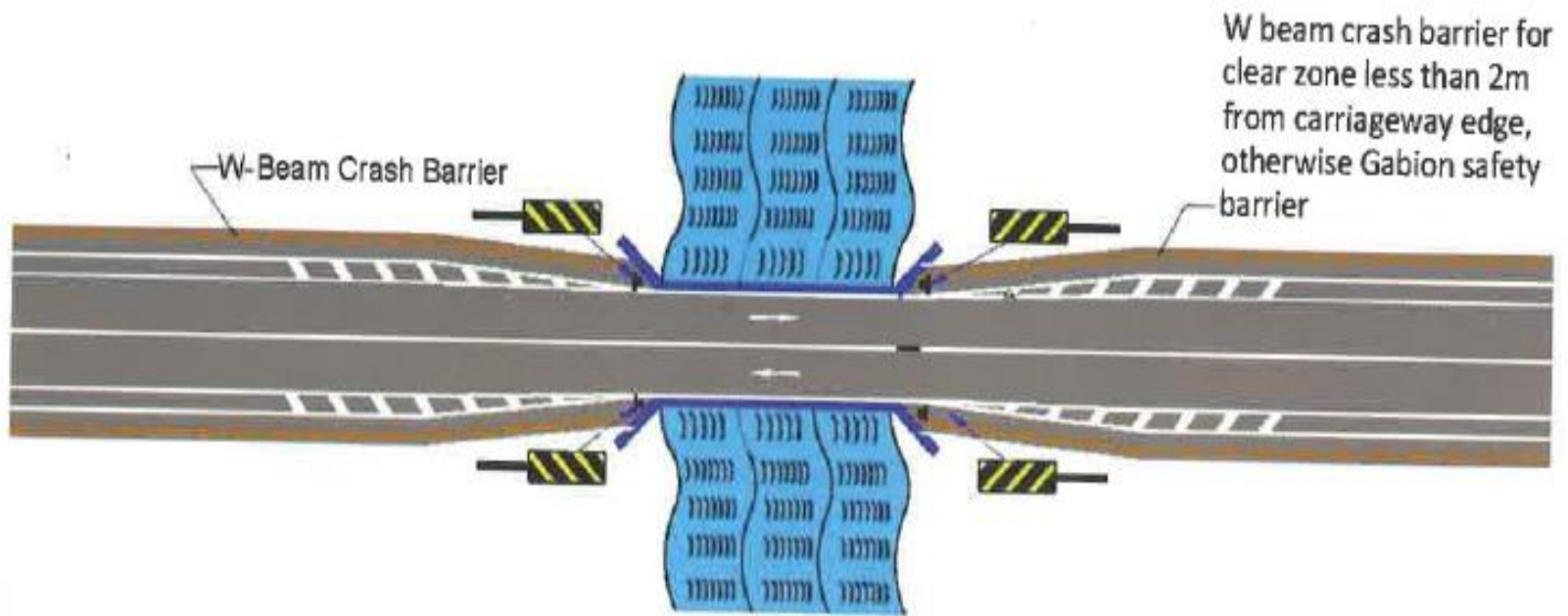


Figure 7: Safety Measures for Bridge  
with W-Beam crash Barrier

# Gabion Safety Barrier on Bridge and Causeway

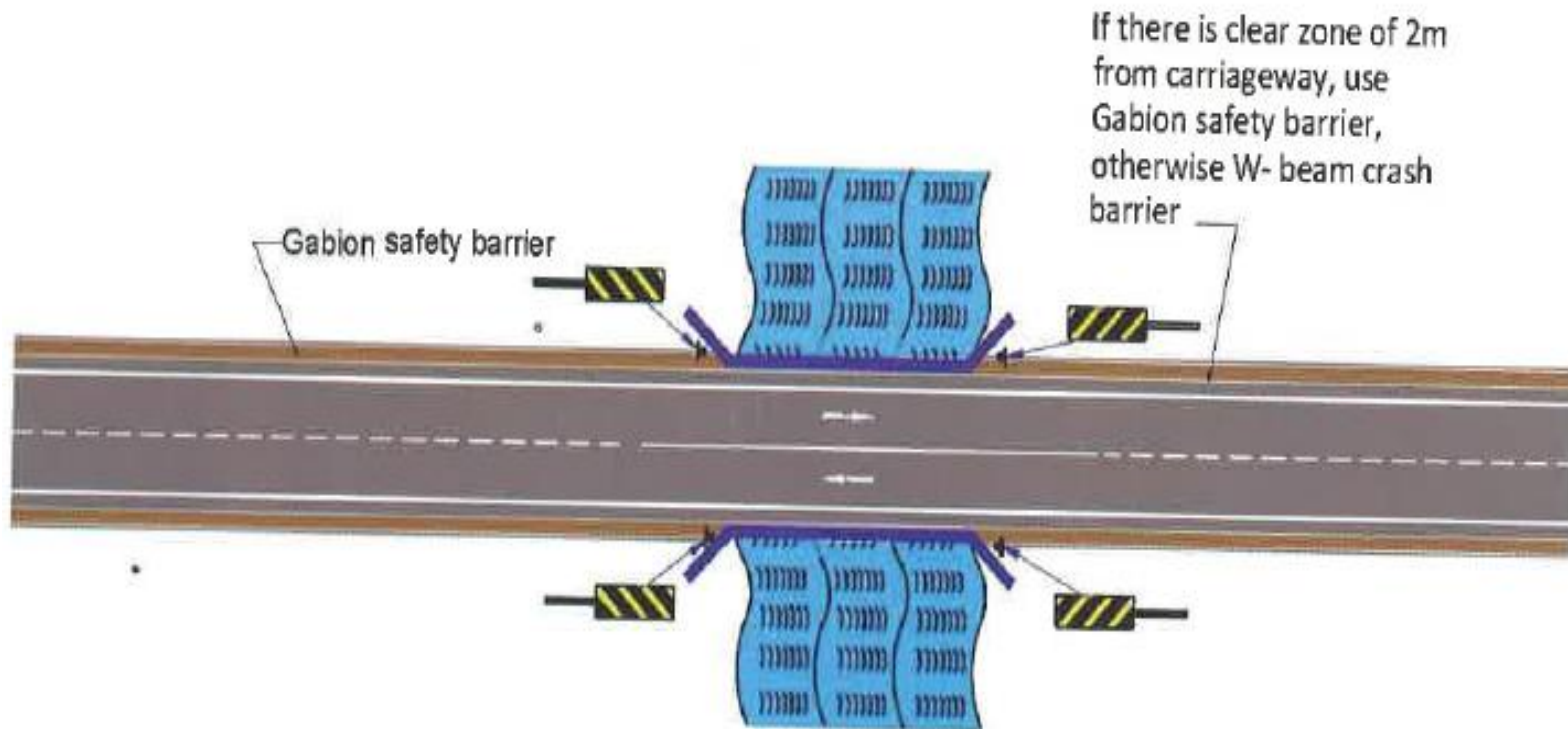


Figure 8: Safety Measures for Bridge Approach  
with Gabion safety barrier

# Parapet Provision between Bridges



# Night Visibility of Metal Crash Barrier



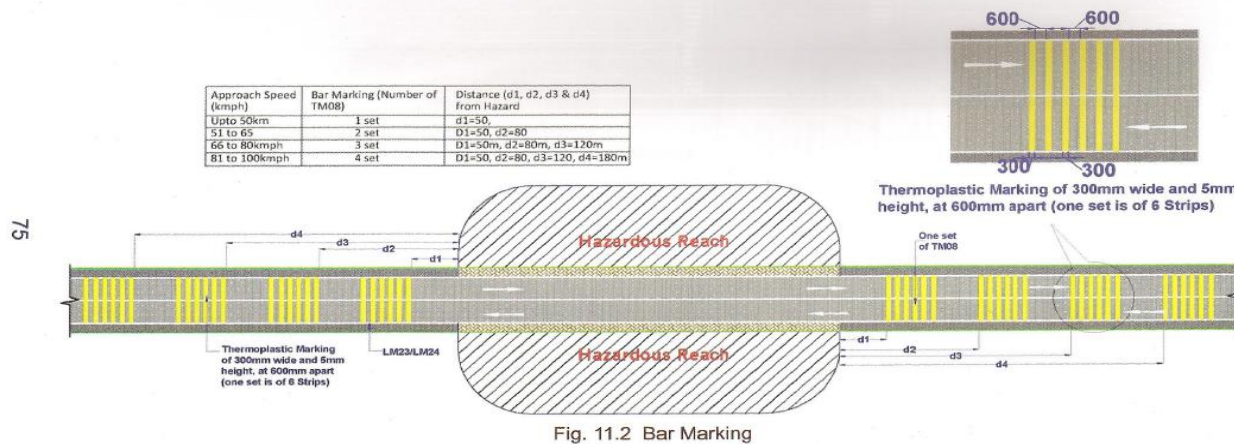
# Impact Attenuators in Gore Area





# **Traffic Calming Measures on Highways**

# Traffic Calming Measures



IRC:35-2015

Thermoplastic Bar Marking used before approaching Hazardous reach

# Traffic Calming Measures





# Miscellaneous

# Bus Bay Requirement on Interchange



# Girders Launching Safety



Girders Holding by Turnbuckles till Casting of Diaphragm



# Animals are also Road Users



**Let us Join Hands to Make our Roads Safer**



**Email: [popliskp@yahoo.co.in](mailto:popliskp@yahoo.co.in)**

**Mobile : + 91 9999 797 135**

***Thank You All***