

Study on Effectiveness of Road Signs and Pavement Markings on Compliance & User Behavior on Rural Roads in India



International Conference on New Technologies



National Rural Infrastructure
Development Agency

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Issues

Built on voluntary land donation, minimal land acquisition.

Single-Lane to Two-lane variability. Also, presence of Intermediate lane roads

Geometric inconsistencies
– Alignment, Curves,
Merging areas.

Signage and road markings are missing, Below par quality,

No consistent policy of signage- interpretations vary.

Safety of roadusers is compromised, lack of awareness.

Opportunity

Study the road user's behaviour in a scientific manner, never been done in India.

Increased awareness of what signage means and what message they convey

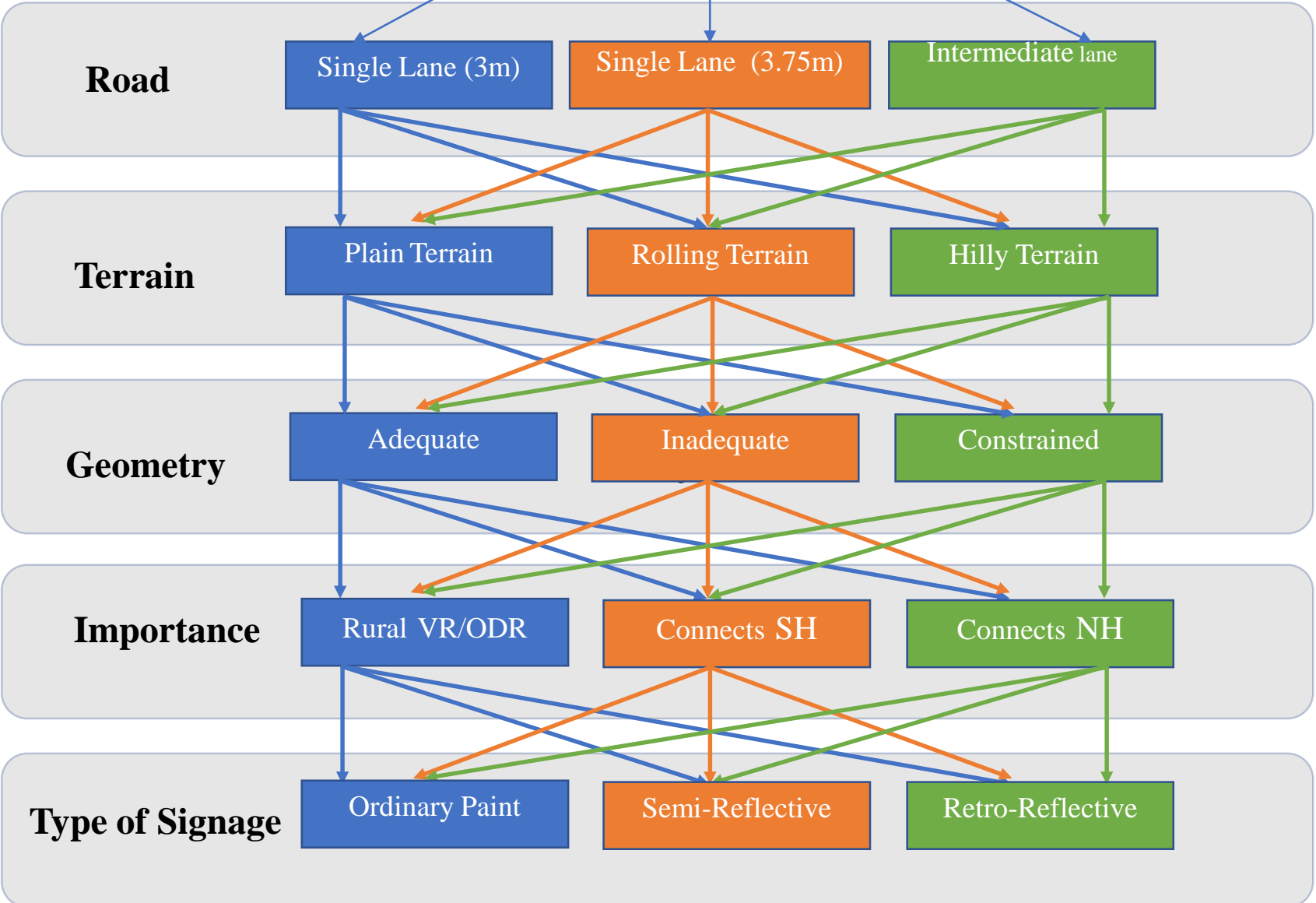
Importance of Retro reflectivity.

How change of sheeting can change the perception of the people in the way they look at road signage.

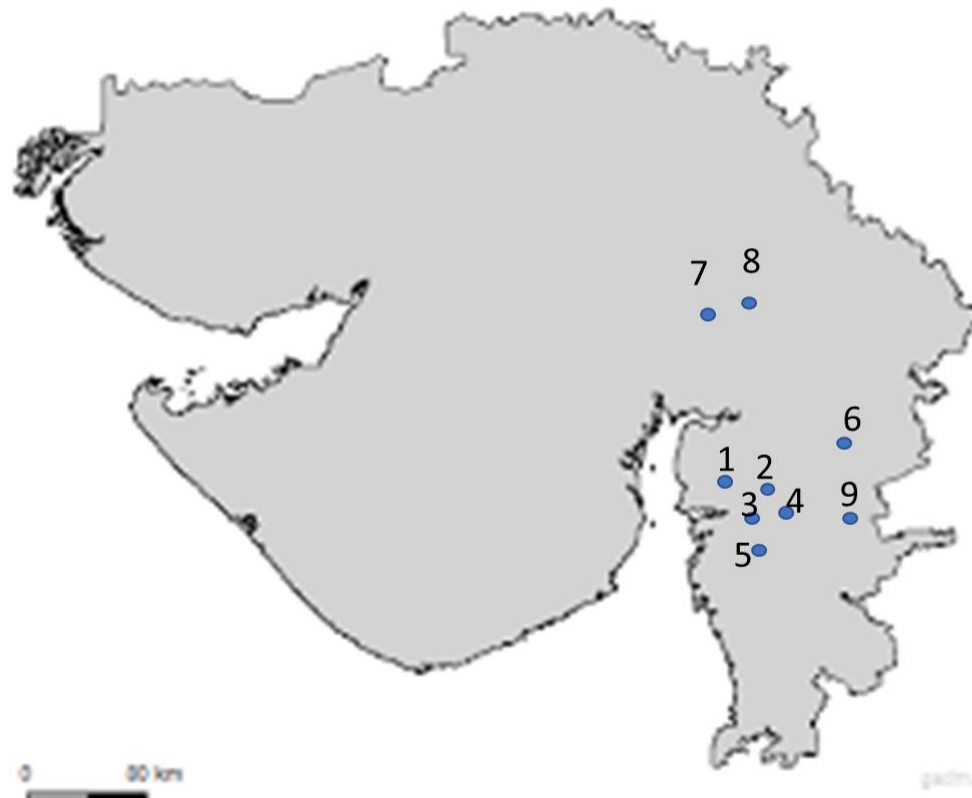
Capturing the change in latent behaviour.

Forming a uniform policy for signage on rural roads.

Selection of Road Stretches



Selected Stretches



1. Saniya Kande
2. Ten Barasadi
3. Mahuwar Chinnam
4. Maroli Posrawada
5. Palsana Baleshwar
6. Kunda Silotmal
7. Khadakiya Simel
8. Por Untiya Road
9. Asura Masjid Road

Road Stretches and Critical Sections

SL	Road Name	Terrain	Carriageway	Stretch length	Critical Sections
1	Saniya Kande Road	Plain	>3.75 m	1.10 km	5
2	Ten Badasari Road	Plain	>3.75 m	1.40 km	2
3	Maroli Posrawada Road	Plain	5.50 m	4.00 km	5
4	Palsana- Baleshwar Road	Plain	5.50 m	3.00 km	5
5	Muhwar- Chhinam Road	Rolling	5.50 m	15 km	1
6	Kunda Silotmad Road	Hilly	>3.75 m	8.00 km	3
7	Kharkiya Simel Road	Hilly	3.75 m	6.60 km	3
8	Por Untiya Road	Rolling	3.75 m	2.50 km	3
9	Asura Mashjid Road	Rolling	3.75 m	13 km	1

Details of Critical Sections

SL	Location	Critical Locations	Locations/Features				
1.	Saniya Kande	5	Curve- 3	Built-up-0	Intersection- 2	School 0	Others 0
2.	Ten Barasadi	5	Curve -3	Built-up-2	Intersection	School	Others
3.	Maroli Posrawada	3	Curve-1	Built-up -1	Intersection	School-1	Others
4.	Palsana- Baleshwar	3	Curve-3	Built-up-1	Intersection	School-1	Others
5.	Mahuwar- Chinnam	1	Curve	Built-up-1	Intersection	School	Others
6.	Kunda Silotmal	4	Curve-2	Built-up	Intersection-1	School	Others-1
7.	Por-Untiya Road	2	Curve-2	Built-up	Intersection	School	Others
8.	Khadakiya-Simel	3	Curve-1	Built-up-1	Intersection-1	School	Others
9.	Asura Masjid Road	1	Curve	Built-up	Intersection-1	School	Others

Type of data collected through various Surveys

-
1. Classified Volume counts
 2. Spot speeds
 3. Signage Placements and Road Markings
 4. Test runs by probe vehicle in Day & Night Conditions to assess the Road Conditions, Driving Behaviour and for Visibility of Signage at night.
 5. Retro-reflectivity of the Signage to be measured for performance.
 6. Public Perceptions of the Signage to be undertaken for “Before” condition assessment.

Classified Volume Counts

- **Categories**

- Cycle
- Two-wheeler (2W)
- Three-wheeler (3W)
- Four-Wheeler (4W)
- LCV
- Tractor
- Truck (HCV)
- Bus
- Other (Pedestrian, Bullock cart etc.)



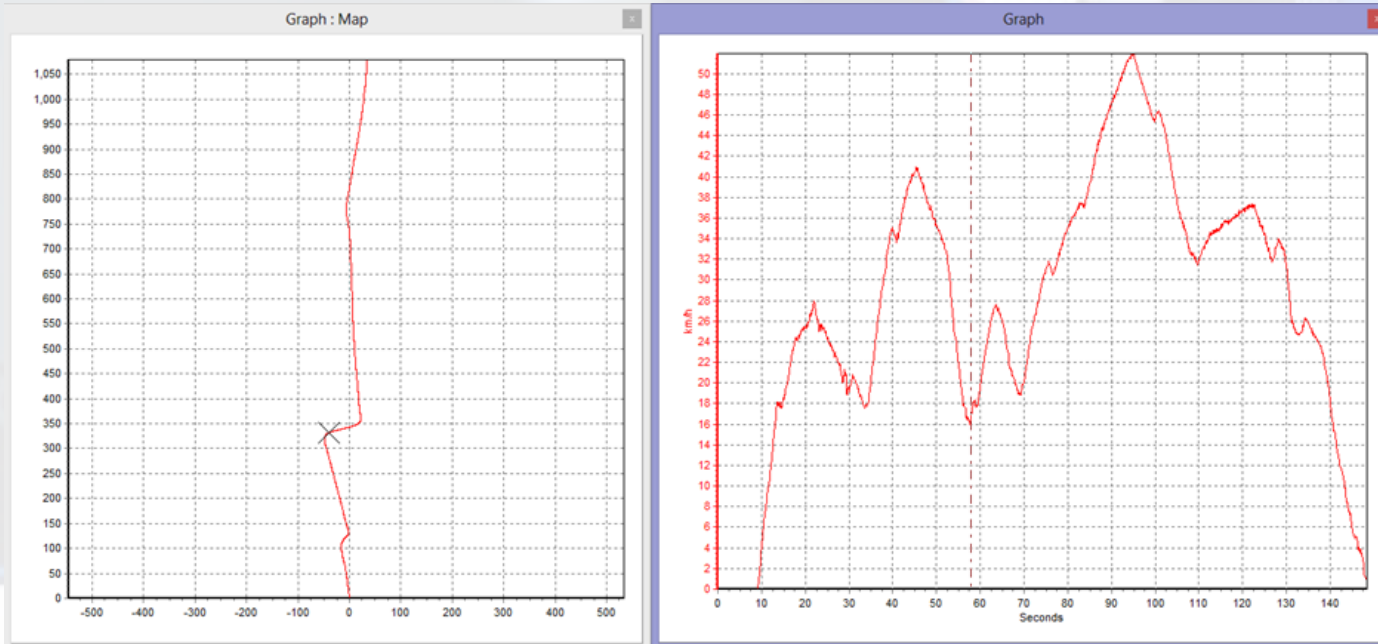


Signage Condition and Placement Survey

- Condition of Existing Signage – Broken, Missing etc.
- Placement of Existing Signage- Misplaced, Misleading etc.

V-Box Data Collection

- Speed Profiles of different road users
- Accurate estimate of behaviour at curves and other critical sections





Measurement of Retro reflectivity

- Retro reflectivity values against various entrance angles gives the performance measure of the signage.
- Compared to IRC 67 Tables, it indicates the effectiveness of the sign





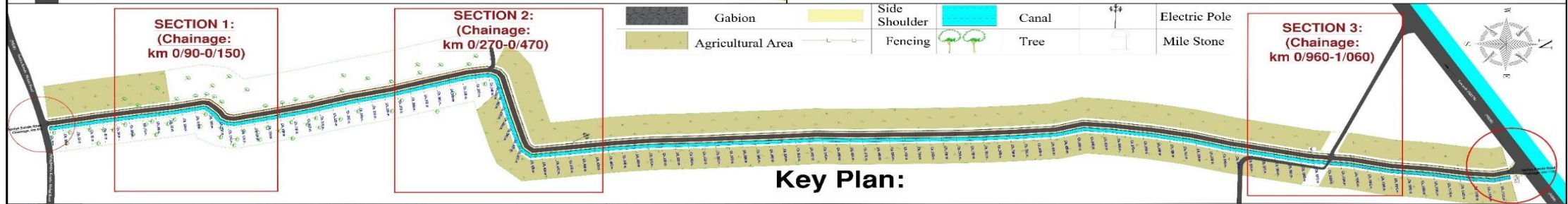
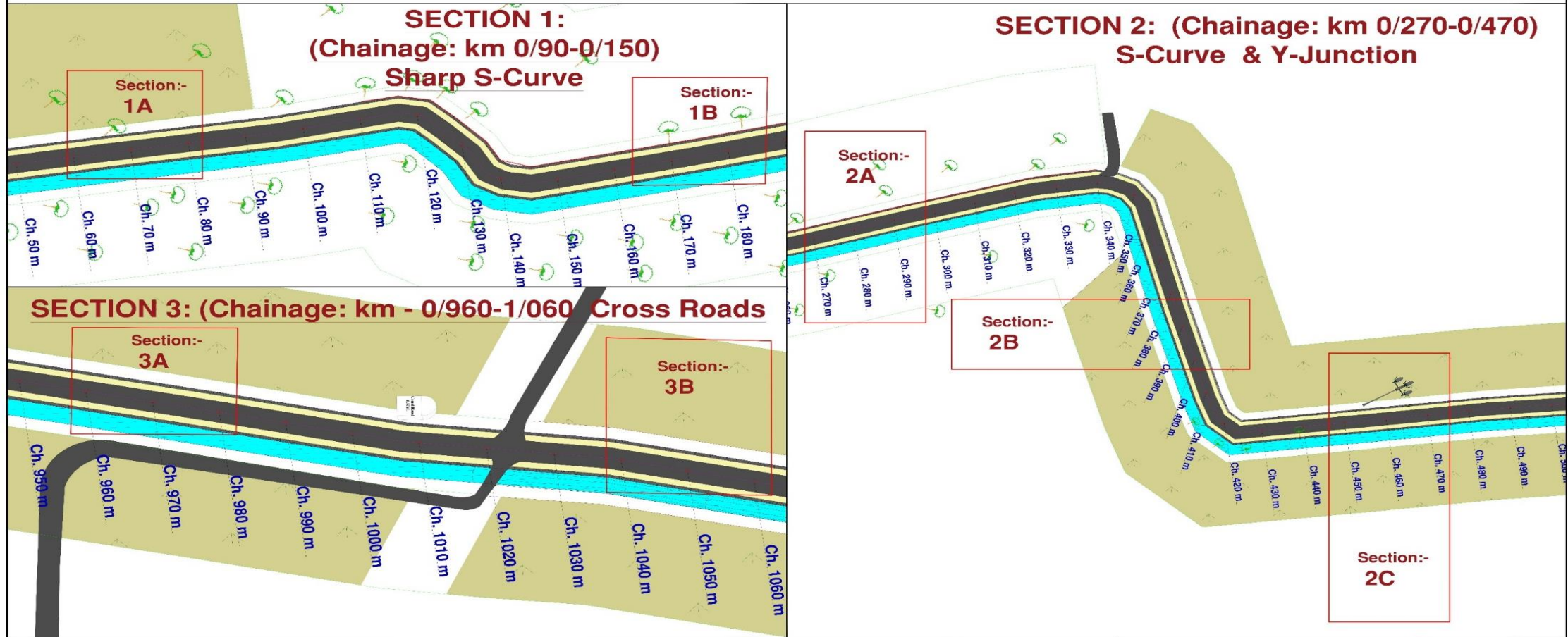
User Perception and Awareness of Signages

- Getting to understand the Knowledge of road users about traffic signage.
- Indicates the level of engagement required.
- Perception is helpful in Before and After cases.

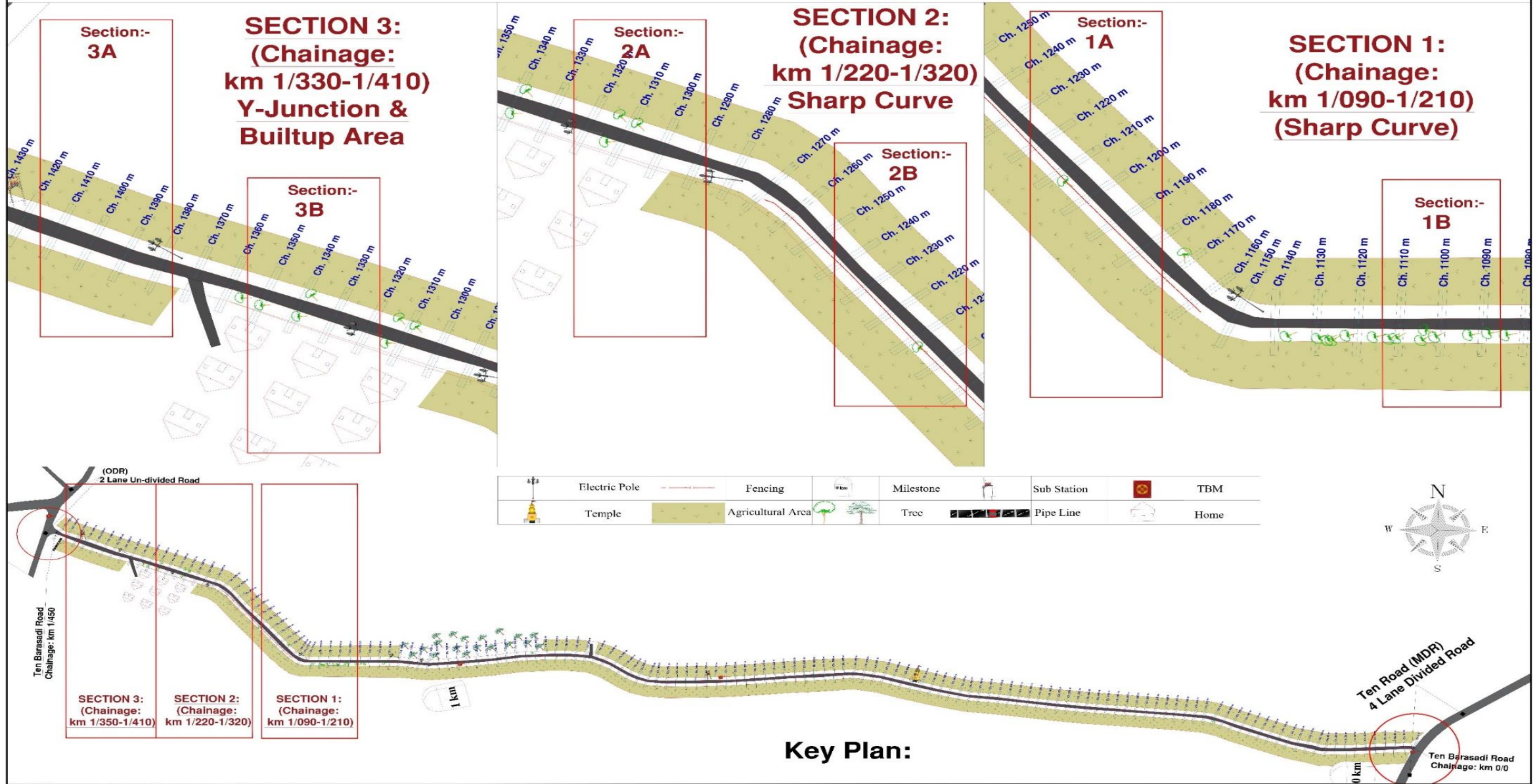
- Awareness Camps were conducted at site for the road users.

Identification of Critical Sections

SANIYA-KANDE ROAD [Chainage: Km 0.0-1.157]:CRITICAL SECTIONS



TEN-BARASADI ROAD [Chainage: Km 0.0-1.4]:CRITICAL SECTIONS

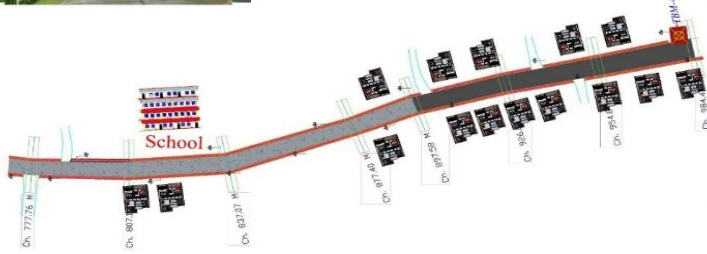


Key Plan:

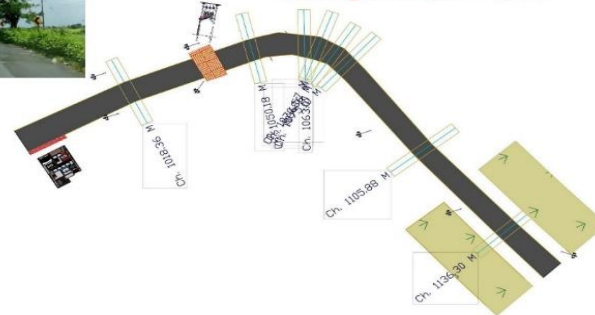
Mahuwar Chhinam Road Critical Sections Chainage: Km 0/000 – 3/600



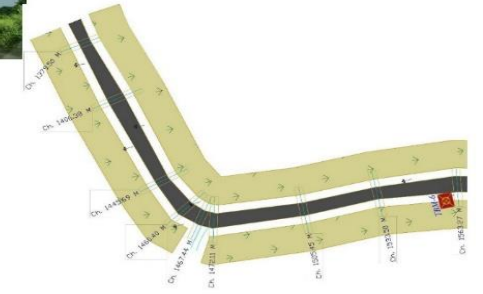
Section: 1 (School)
Chainage: Km 0/750 – 0/850



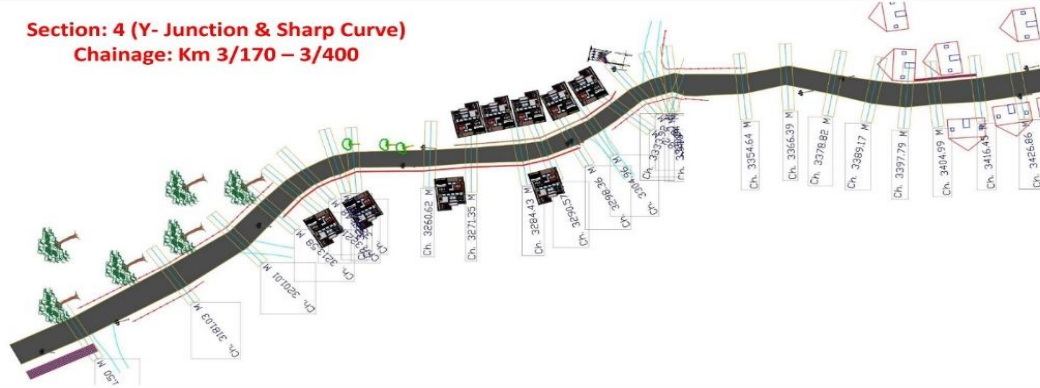
Section: 2 (Sharp Curve)
Chainage: Km 1/00 – 1/140



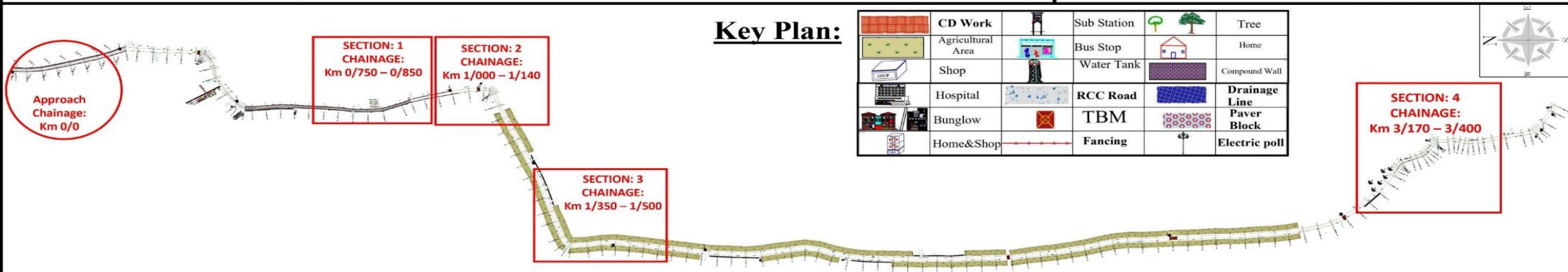
Section: 3 (Sharp Curve)
Chainage: Km 1/350 – 1/1500



Section: 4 (Y- Junction & Sharp Curve)
Chainage: Km 3/170 – 3/400

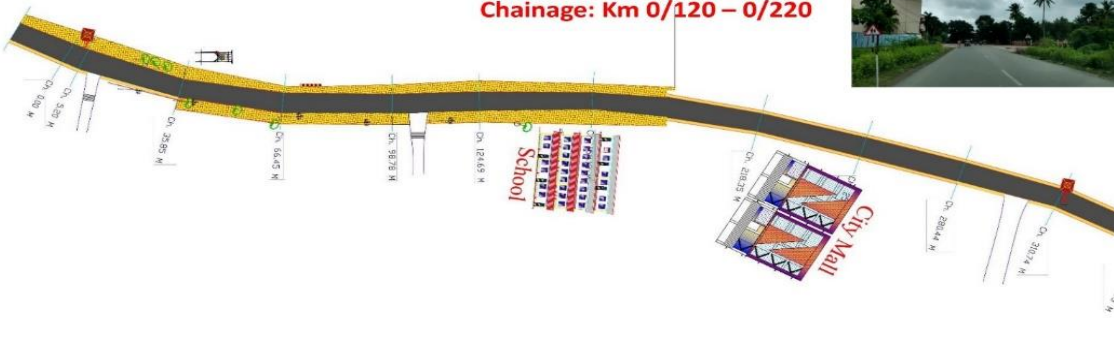


Approach Chainage: Km 0/0

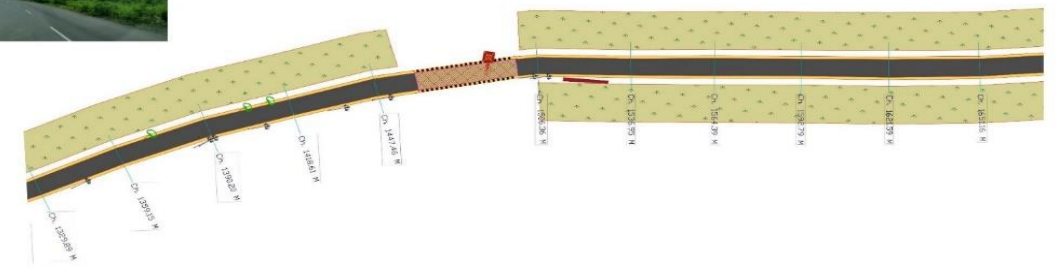


Palsana Baleshwar Road Critical Sections (Chainage: Km 0/00 – 2/056)

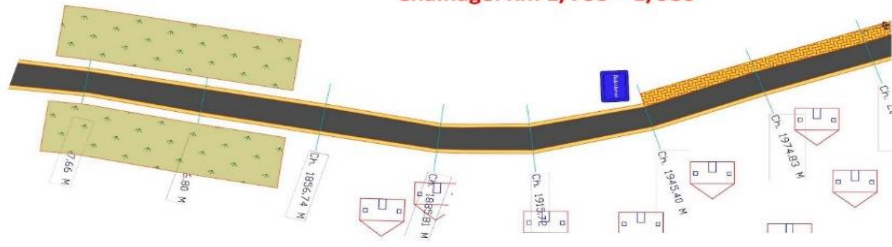
Section: 1 (School)
Chainage: Km 0/120 – 0/220



Section: 2 (Curve)
Chainage: Km 1/390 – 1/550



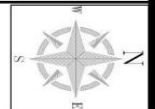
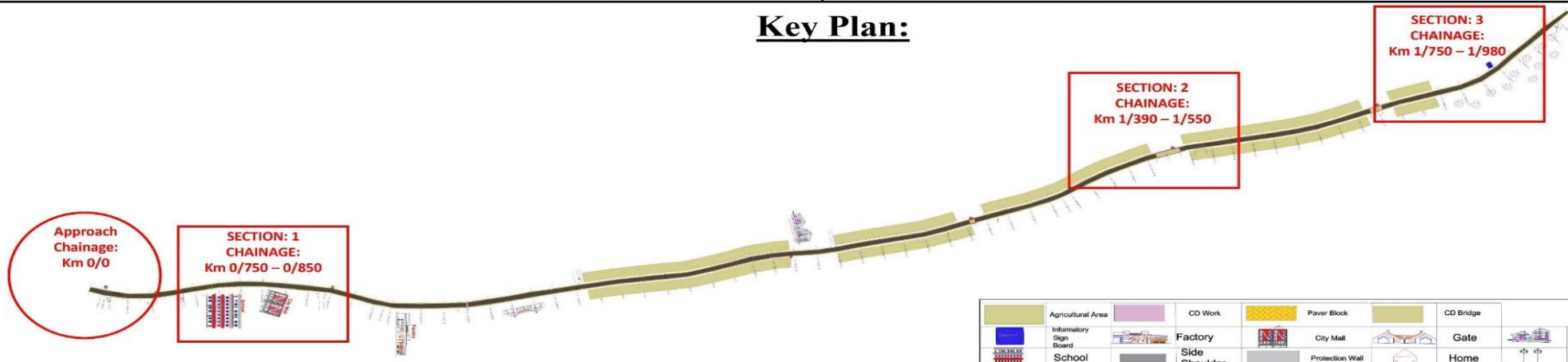
Section: 3 (Curve)
Chainage: Km 1/750 – 1/980



Approach Chainage: Km 0/0

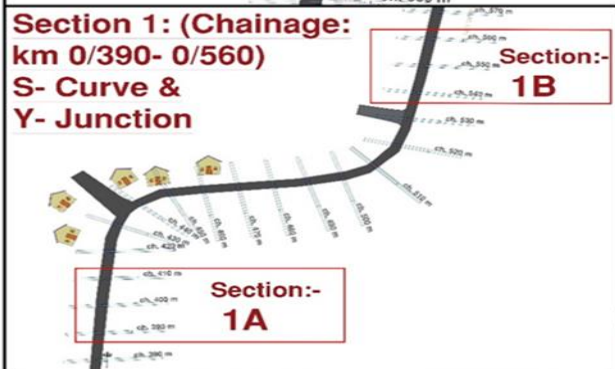
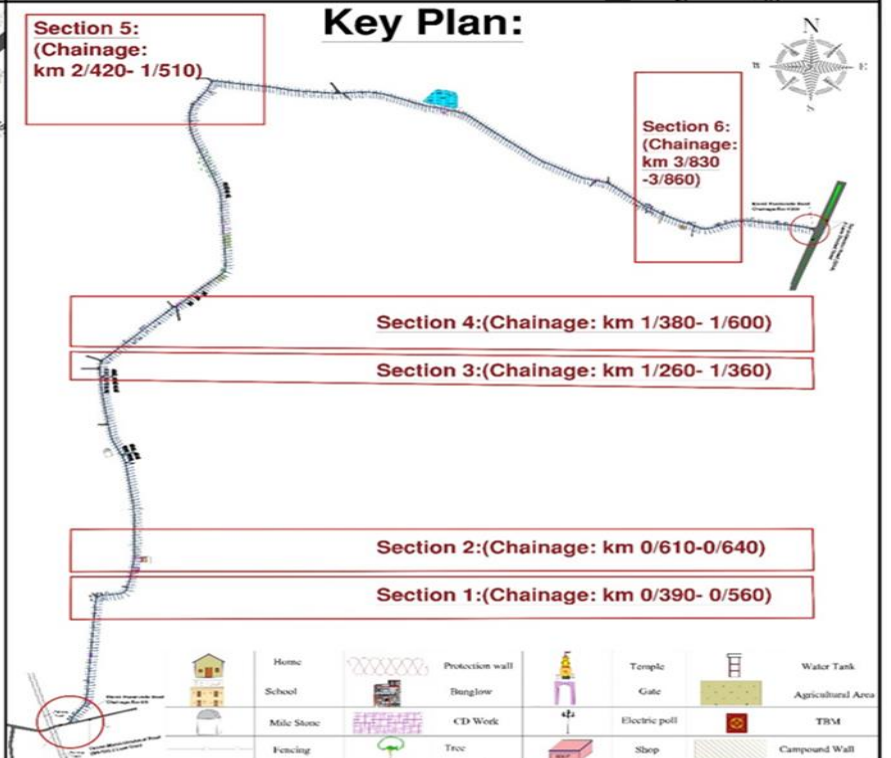
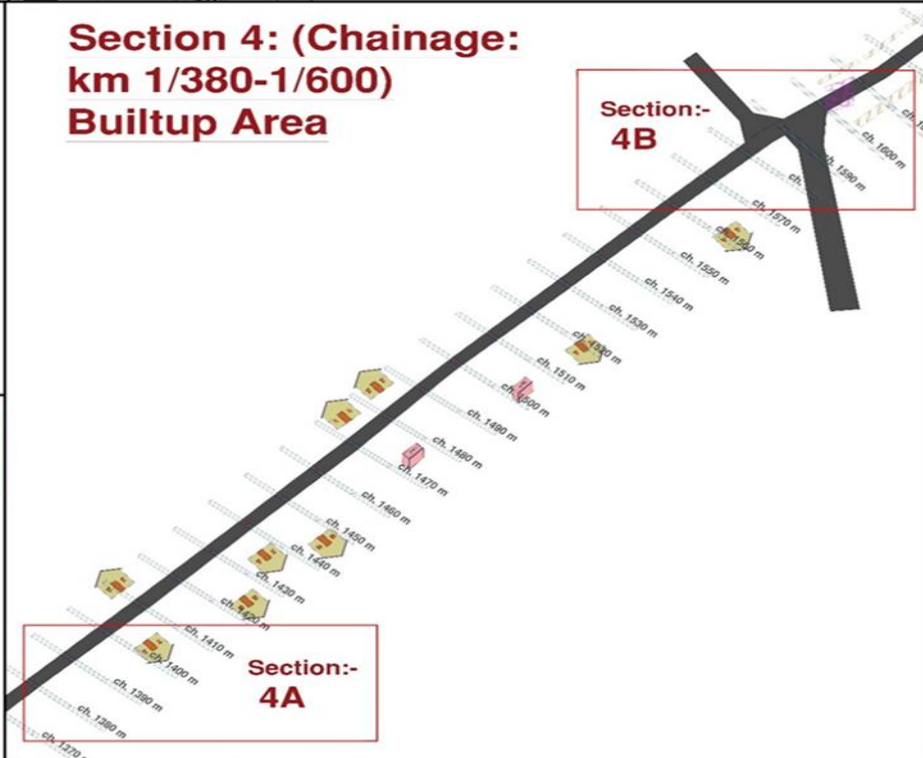
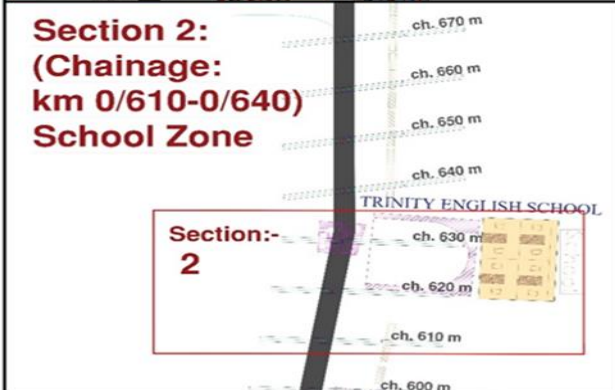
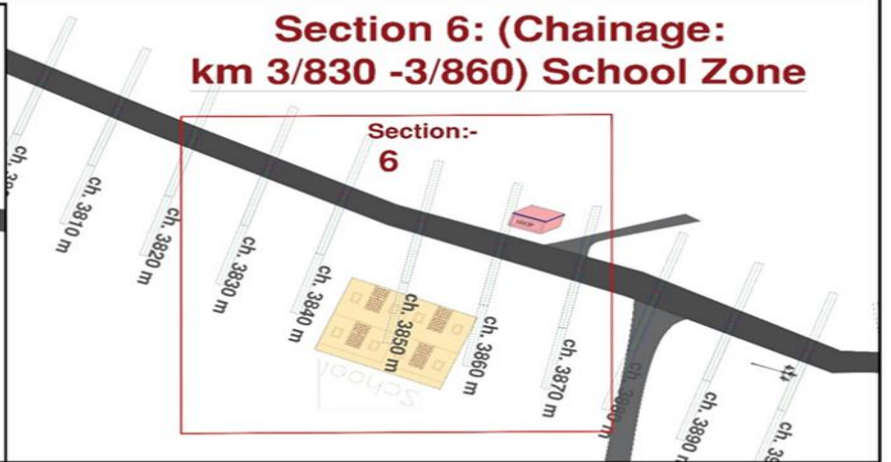
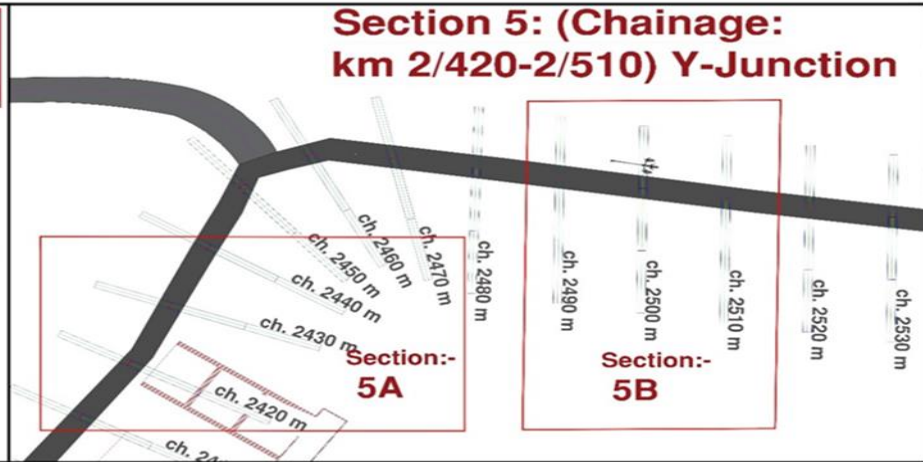
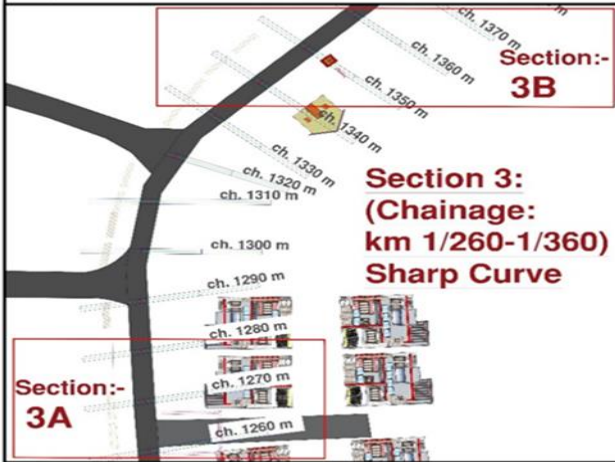


Key Plan:



Agricultural Area	CD Work	Paver Block	CD Bridge
Informal Sign Board	Factory	City Mall	Gate
School	Side Shoulder	Protection Wall	Home
		Electric pole	TBM
			Fencing

MAROLI-PONSRA-WADA ROAD [Chainage: Km 0.0-4.2]:CRITICAL SECTIONS



KUNDA- SILOTMAL ROAD [Chainage: Km 0.0-8.0]:CRITICAL SECTIONS

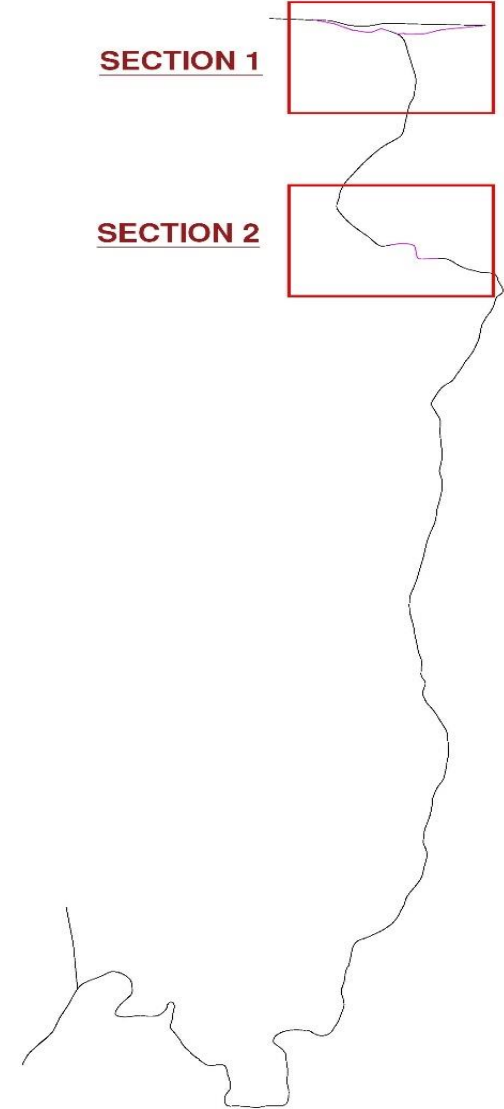
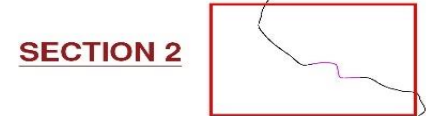
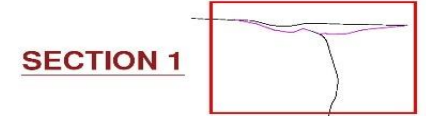


**SECTION 1: (Chainage: km 0/0)
Y- Junction**



SECTION 2: (Chainage: km 1/450-1/600) Reverse Curve

Key Plan:



CONSULTANT:
Sardar Vallabhbhai National Institute of Technology, Surat
P.G. Section in Transportation Engg. & Planning
Civil Engineering Department



CLIENT:
3M

PROJECT TITLE:
Consultancy Services for Effectiveness of Road Signs and Pavement Marking on Compliance & User Behaviour

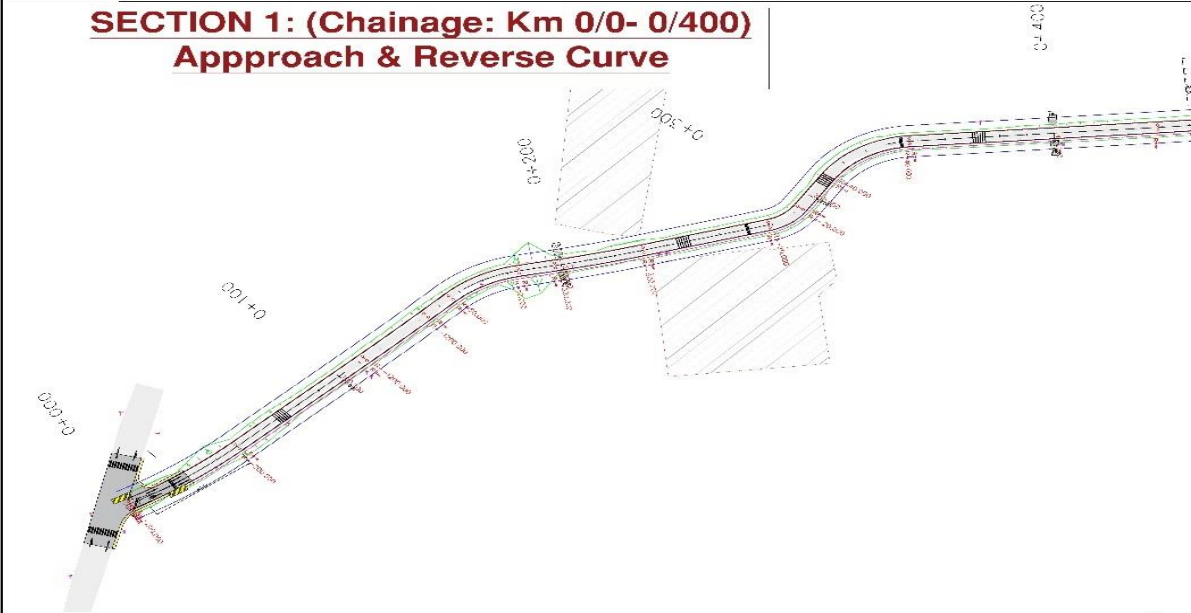
DRAWING NAME:
Kunda Silotmal Road Critical Sections_
Chainage: km 0/0 - 8.0

Drawing No.: 01
Rev. Drawing: R-00

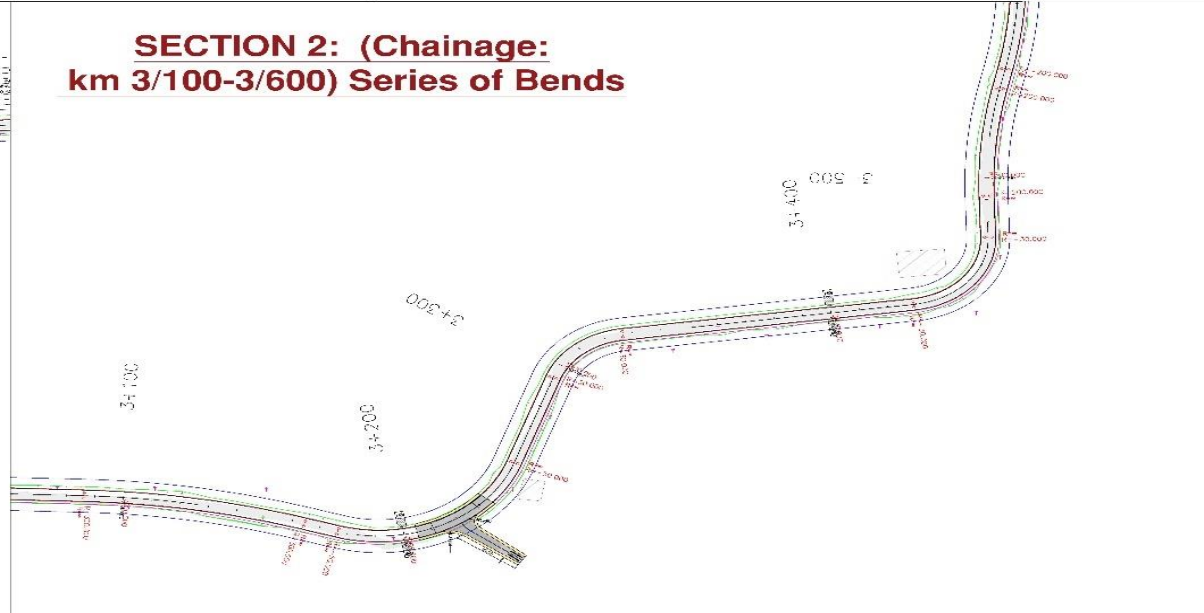
Date:
11-02-2021

POR-UNTIYA ROAD [Chainage: Km 0.0-10.5]:CRITICAL SECTIONS

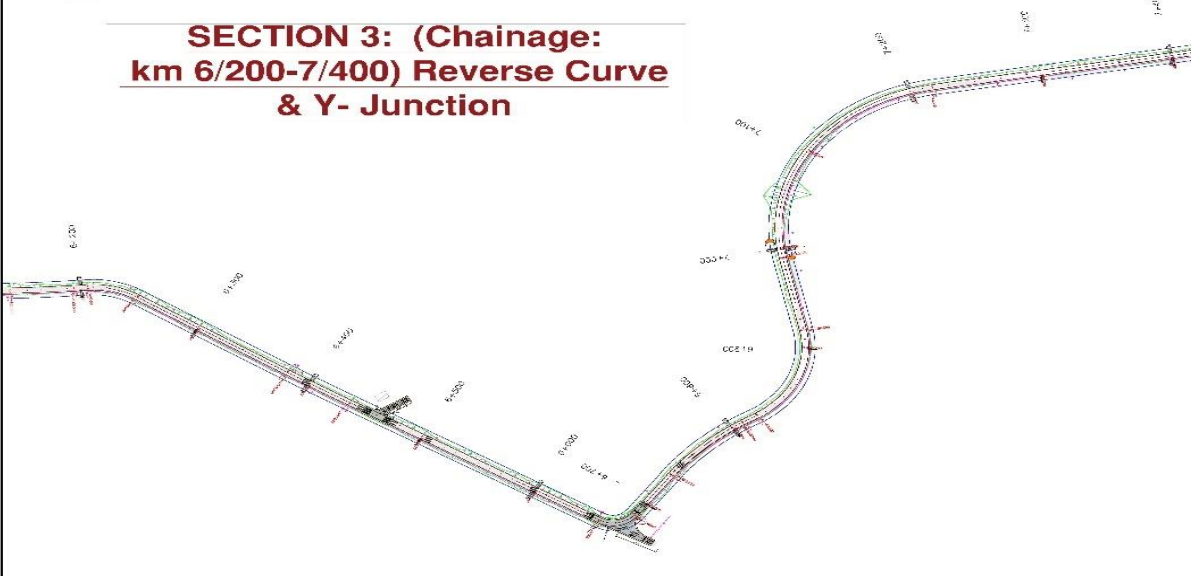
SECTION 1: (Chainage: Km 0/0- 0/400) Approach & Reverse Curve



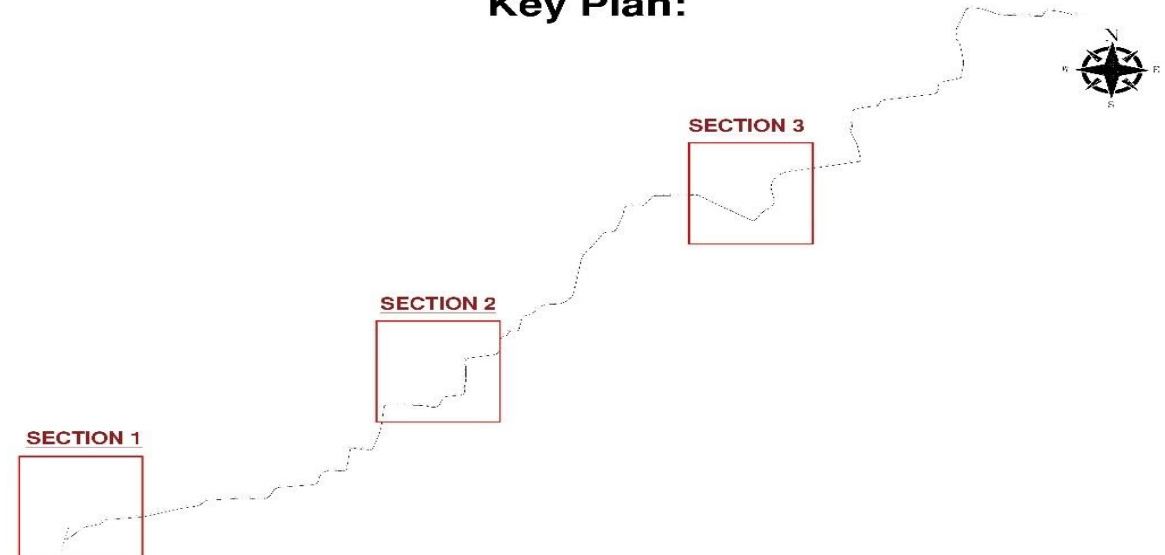
SECTION 2: (Chainage: km 3/100-3/600) Series of Bends



SECTION 3: (Chainage: km 6/200-7/400) Reverse Curve & Y- Junction



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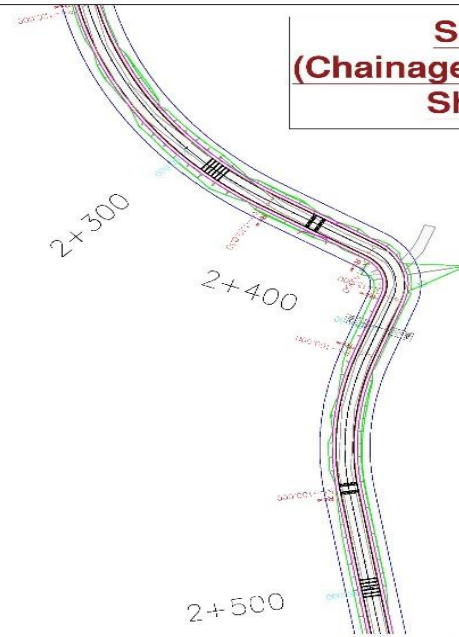
DRAWING NAME:
Por Untiya Road Critical Sections
Chainage: Km 0+ 0/0 - 10.5

Drawing No.: 01
Rev. Drawing: R-00

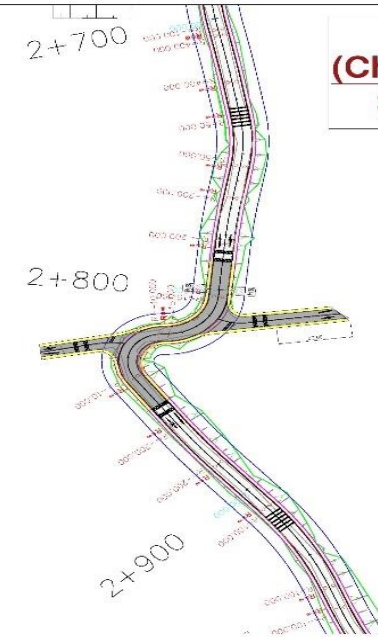
Date:
11-02-2021

KHADAKIYA-SIMEL ROAD [Chainage: Km 0.0-9.79]:CRITICAL SECTIONS

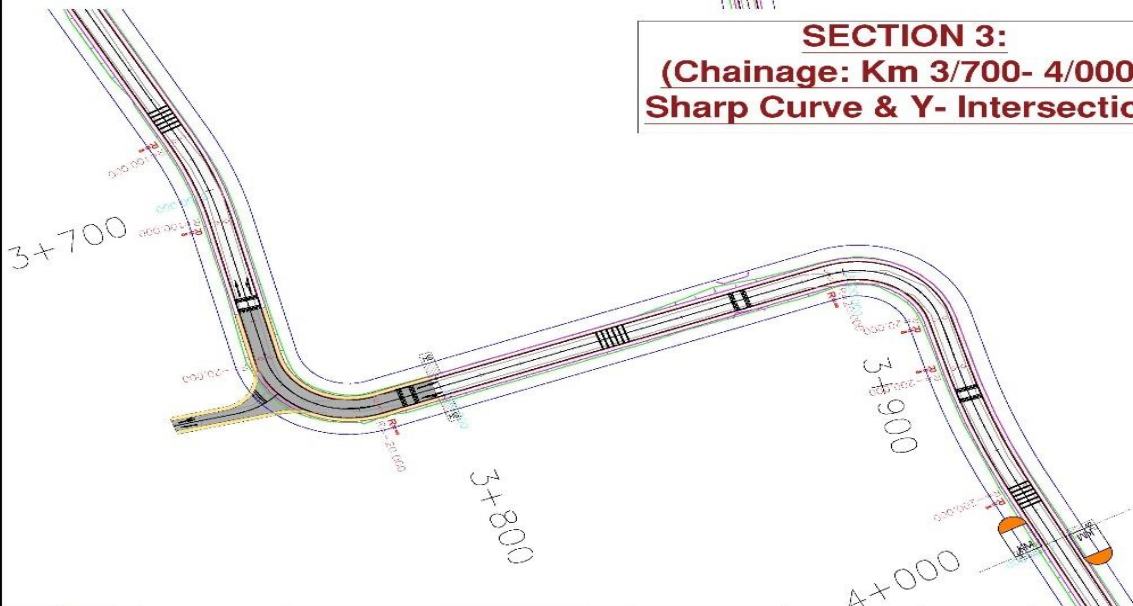
SECTION 1:
(Chainage: Km 2/200- 2/500)
Sharp Curve



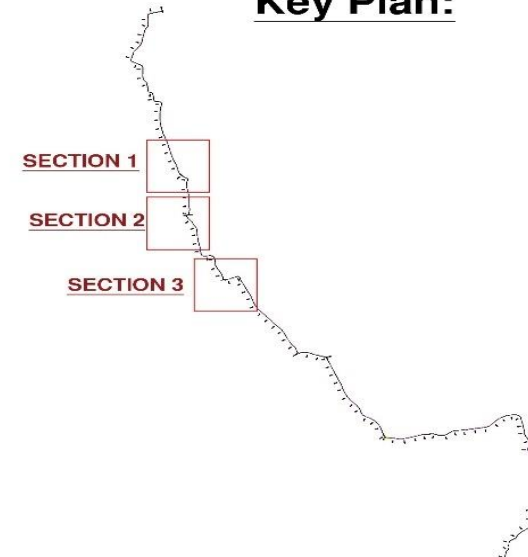
SECTION 2:
(Chainage: Km 2/700- 2/900)
Staggered Intersection



SECTION 3:
(Chainage: Km 3/700- 4/000)
Sharp Curve & Y- Intersection



Key Plan:



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DRAWING NAME:
Por Untiya Road Critical Sections
Chainage: Km 0+ 0/0 - 10.5

Drawing No.: 01
Rev. Drawing: R-00

Date:
11-02-2021



Post-Installation Surveys and Results



Installation of Signage

- Each stretch was analysed separately
- BOQs were prepared after identification of treatment for individual critical sections.
- Traffic Signs were installed by 3M Partner with SVNIT supervision at 7 locations.
- 2 locations were dropped due to capacity augmentation works in progress.



Implementation of Road Signs



Spot Speeds Surveys

- The Surveys were conducted after the installations of new improved 3M signages at Site.
- Significant drop in speeds were observed, showing improved compliance.
- Critical sections such as Curves, School Zones and Built-up Sections were prominent and visibility improved after at night.
- Speeds dropped from 4 to 32 percent across sections and vehicle classes.



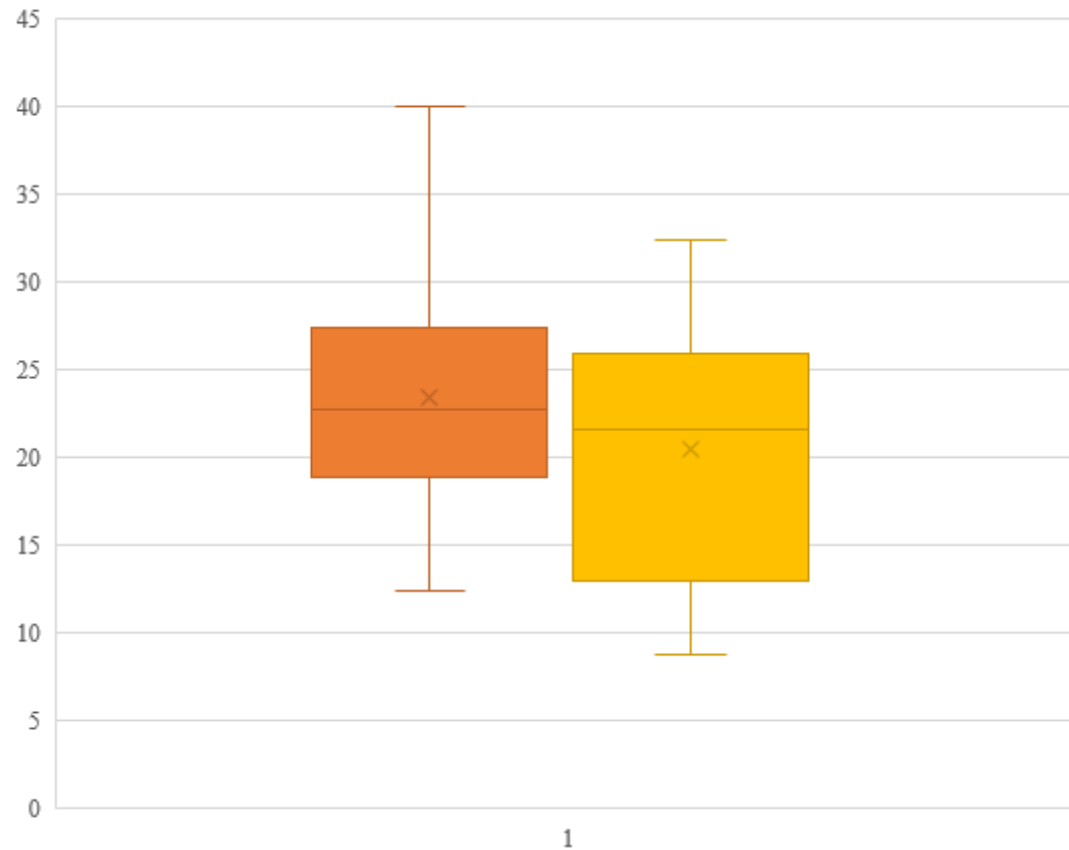
Speed Profiles- Before & After Improvement

SL	Site	Min. Speed		Max. Speed		Average Speed		85 th Percentile Speed		% Over speeding	
		B	A	B	A	B	A	B	A	B	A
1	Saniya Kande	12.6	10.8	47.4	36.5	26.5	19.7	31.9	25.3	14.3	9.8
2	Ten Barasadi	5.6	9.7	53.6	41.2	28.5	21.3	35.8	25	21	12
3	Mahuwar Chinnam	7.7	10	54	47	29.4	21	36.2	24.8	44.90	5.4
4	Palsana Baleshwar	7.3	11.1	59.6	63.6	24.2	30.8	30.6	36.8	13.9	7.1
5	Maroli Posrawada	9.7	7.6	50.5	38.3	28	19.6	34.7	20.2	18.5	9.5
6	Kunda Silotmal	8.9	9.5	32.7	28.5	21.5	21.4	26.3	25.5	42.5	42.7
7	Por Untiya	12.1	8.8	46.9	36.7	24.4	21.4	29.9	26.4	41.9	45.2

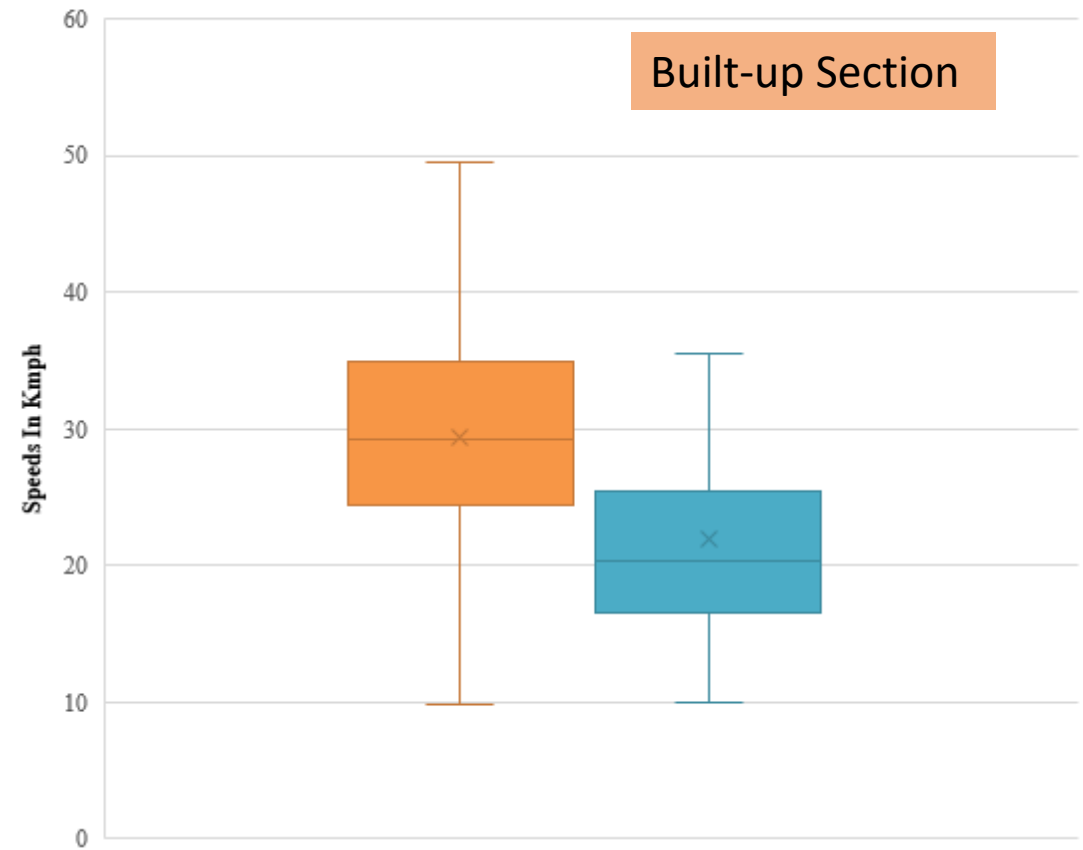
**All speeds in Kilometres per hour*

Treatment Effects

Section 1A Saniya

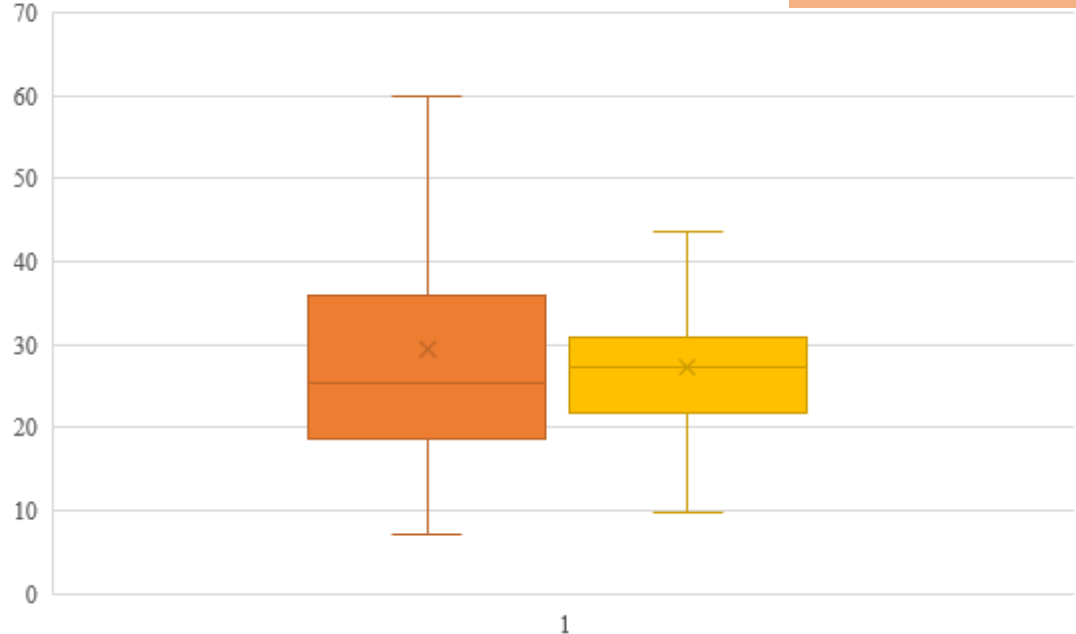


Mahuwar Chinnam

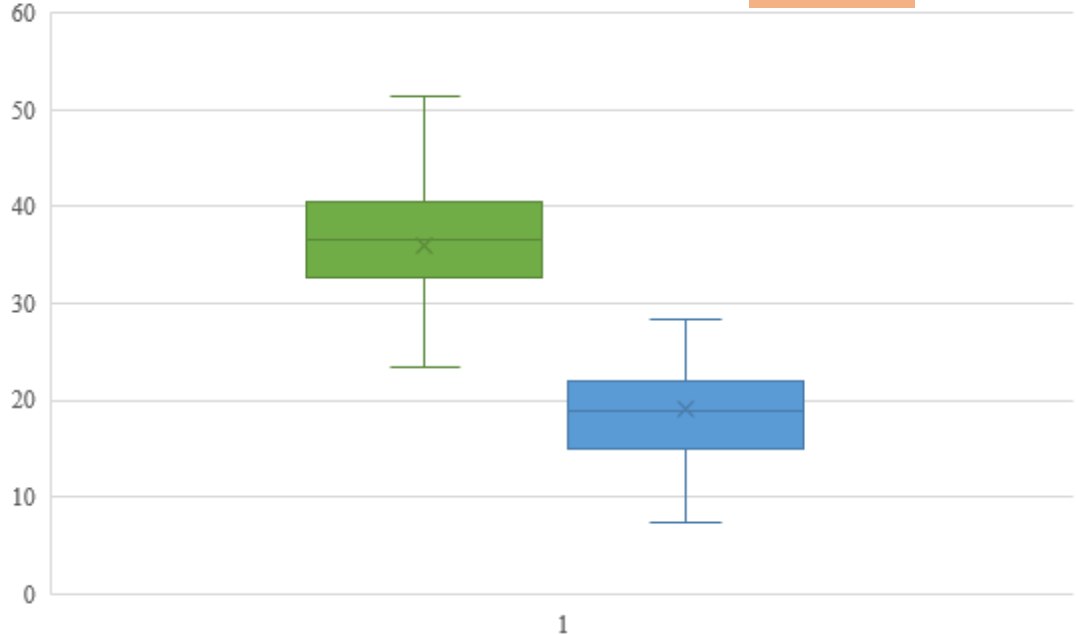


Speeds Before and After Implementation

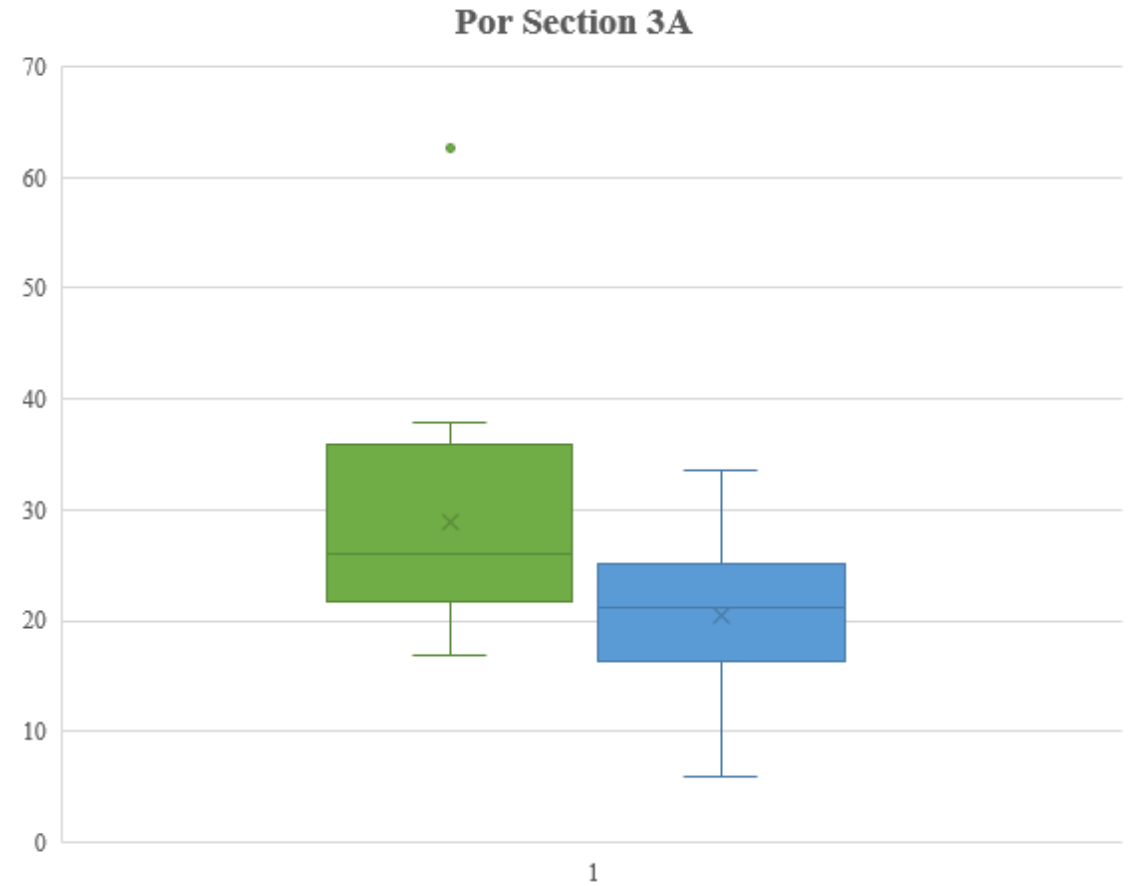
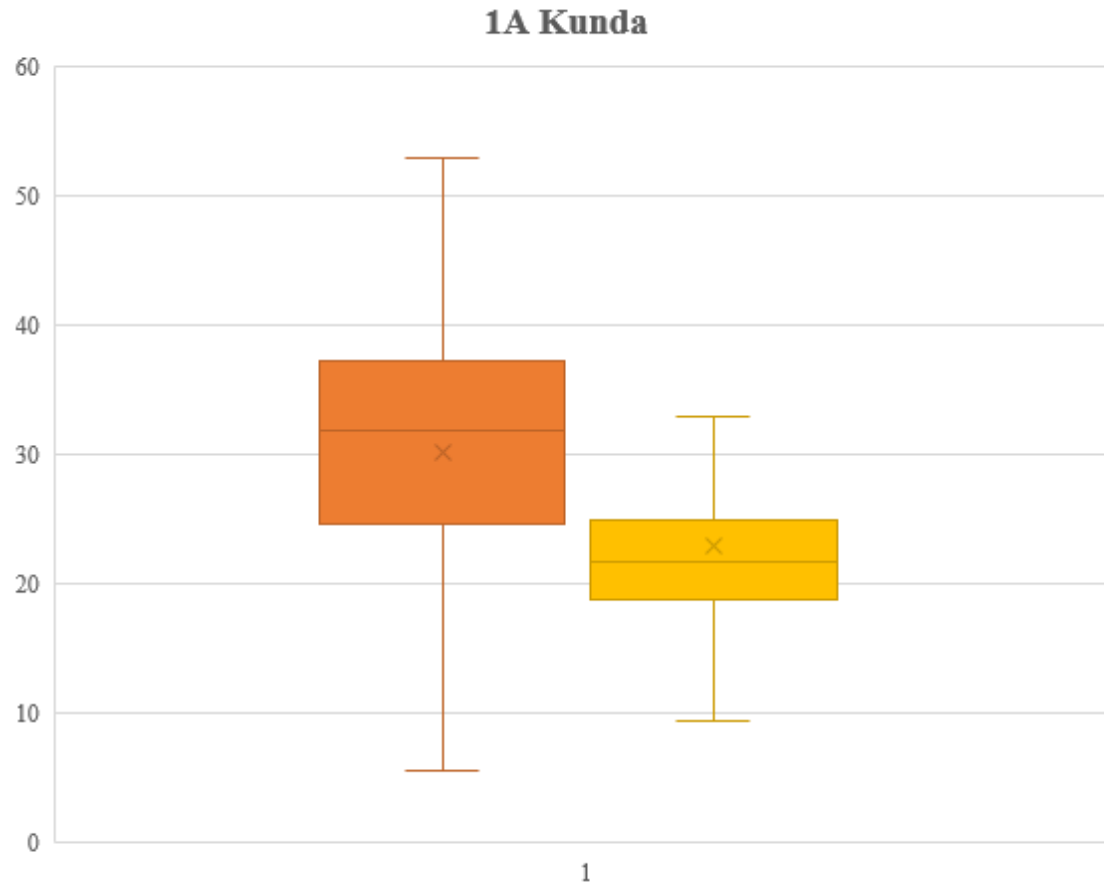
Section 1: Palsana Baleshwar School Zone



Section 4 Maroli Curve



Speeds Before and After Implementation



Before and After Implementation



User Perception Surveys

Road Users Reported Improved Perception about :

- A) Delineation of Road at night
- B) Feeling secured at night
- C) Sense of Safety
- D) Delineation of Road hazards
- E) Visibility of edge lines and carriageway

Testing of Installed Retroreflective Signs vs Locally Installed Signs

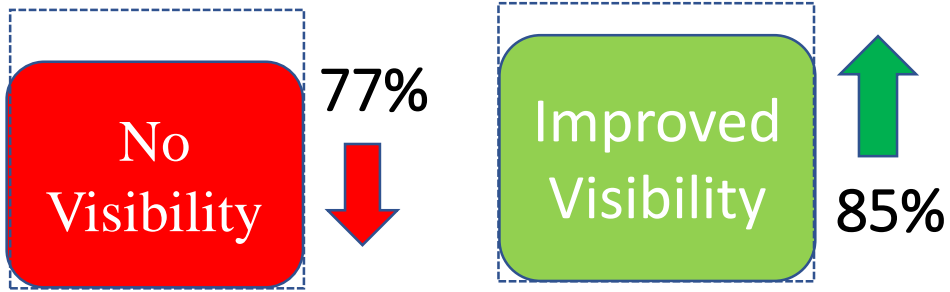
Retro-Reflectivity Test Report-Type I (Already Installed Sign Board)

S.No	Sign Board	Color	Entrance Angle	Observation Angle (Degree)	Actual Ra (Cd/Lux/Sqm) Value at Site				Minimum Requirement Ra (Cd/Lux/Sqm) as per IRC
					R1	R2	R3	Average	
1		White	-4	0.2	0	0	0	0.0	70
				0.5	0	0	0	0.0	30
			30	0.2	2.8	2.8	2.8	2.8	30
				0.5	2.8	2.8	2.8	2.8	15
2		Blue	-4	0.2	0	0	0	0.0	4
				0.5	0	0	0	0.0	1.7
			30	0.2	7.7	7.7	8.1	7.8	2
				0.5	4.5	4.7	4.4	4.5	0.8



Key changes in User Perception

i. Night Visibility



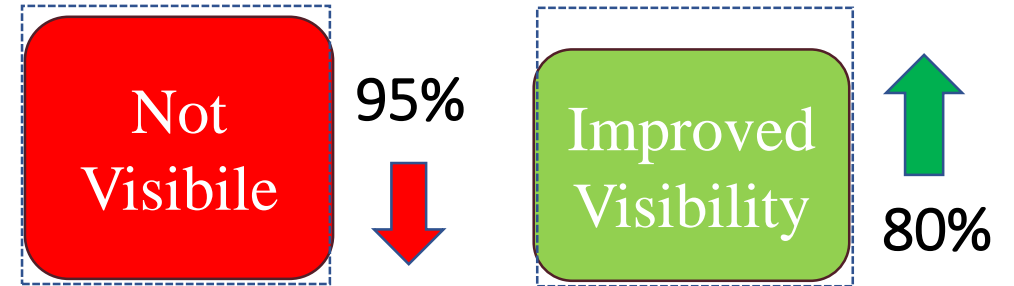
Before After

ii. Identification of Traffic Signs



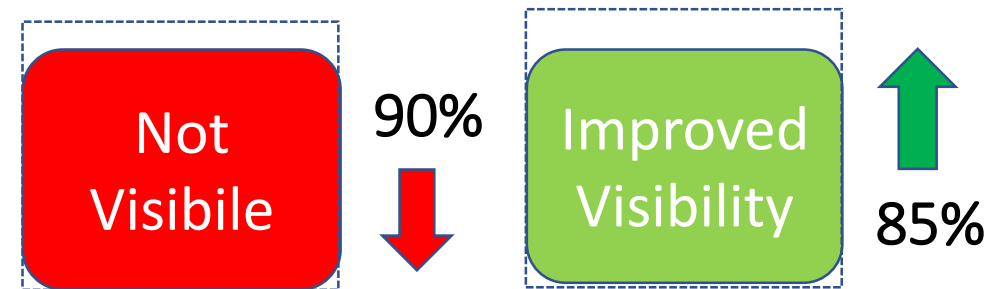
Before After

iii. Night Visibility of Traffic Signs



Before After

iv. Edge Line Visibility at Night



Conclusion

- The study concludes the following:
 - Rural roads lack geometric consistencies, the curves are deficient, and built-up sections are not treated, leading to crashes.
 - There is a lack of awareness among road users about the utility of traffic signs and their relation to safety. The road user survey revealed that the drivers could not recognize basic traffic signs despite having a valid driver's license.
 - The identified critical sections were subjected to speed checks, as speeding was directly related to aggressive behaviour. Aggressive behaviour is directly related to crashes.

- After installing retro-reflective signages, speeding decreased significantly to 4-32 percent at all road stretches.
- The average speeds at the road stretch dropped between 15% to 55% across the sections after implementing traffic signs and road furniture.
- Testing the retro-reflectivity of signage showed that the signage from retro-reflective sheeting met all the criteria set by IRC 67:2012. In contrast, local authorities' signs installed from non-tested sheeting failed the criteria for minimum retro-reflectivity.

- After installing retro-reflective signage, road users reported significant improvement in night visibility, decision making, and edge delineation.
- The pre-installed sample board tested failed to meet the minimum reflectivity criteria of Class-A sheeting, which is the minimum grade, retro-reflective sheeting required for Rural Road. Many boards were painted or of vinyl, thereby not fulfilling their purpose of guiding road users at night. Henceforth it is recommended to have a quality check viz warranty certificate, test certificate, on-field testing as mentioned in IRC 67.
- As a policy, all the semi-reflective boards should be replaced with retro-reflective Type-IV sheeting on all the rural road stretches. It offers no retro-reflectivity at night, a critical element of positive guidance and road user safety.







Thank you





Survey Forms





1	Gender	<input type="checkbox"/> Male <input type="checkbox"/> Female	
2	Place of Residence	<input type="checkbox"/> Rural <input type="checkbox"/> Urban	
3	Age		
4	Highest Education	<input type="checkbox"/> LTI (Left Thumb Impression) <input type="checkbox"/> Under Matriculation <input type="checkbox"/> Matriculation <input type="checkbox"/> 12 th Standard <input type="checkbox"/> Graduate <input type="checkbox"/> Post Graduate <input type="checkbox"/> Doctorate	
5	Vehicle Ownership	Vehicle Type	Age of Vehicle
		<input type="checkbox"/> Cycle	
		<input type="checkbox"/> 2-Wheeler (Non-Geared)	
		<input type="checkbox"/> 2- Wheeler (Geared)	
		<input type="checkbox"/> 3-Wheeler (Auto)	
		<input type="checkbox"/> Car	
		<input type="checkbox"/> Tractor	
	<input type="checkbox"/> Others (Specify) _____		
6	Profession		
7	Driving since		
8	Holding License Since		
9	How Frequently Do you Drive your vehicle?	<input type="checkbox"/> Daily <input type="checkbox"/> Only on Weekends <input type="checkbox"/> Once or Twice in a Week <input type="checkbox"/> Monthly <input type="checkbox"/> Rarely	
10	You primarily Use your vehicle for	<input type="checkbox"/> Daily Work Trips <input type="checkbox"/> Education Trips <input type="checkbox"/> Leisure Trips/Movies/Dining	





		<input type="checkbox"/> Long Drives <input type="checkbox"/> Intercity Trips	
11	Driving Zones	<input type="checkbox"/> Within Village (Less than 3 km) <input type="checkbox"/> Inter-Rural (More than 5 Km) <input type="checkbox"/> Rural to Outskirts <input type="checkbox"/> Rural to City CBD <input type="checkbox"/> Rural to State Highways <input type="checkbox"/> Rural to National Highways/Expressways	
12	Involved in an Accident?	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/> More than Once <input type="checkbox"/> Once
13	Involved in an Accident WITH?	<input type="checkbox"/> Single Vehicle Accident (Hitting a stationary Object/ Animals) <input type="checkbox"/> 2-Wheeler (Non-Geared) <input type="checkbox"/> 2- Wheeler (Geared) <input type="checkbox"/> 3-Wheeler (Auto) <input type="checkbox"/> Small Car (Sedan) <input type="checkbox"/> Big-Car (SUV) <input type="checkbox"/> LCV <input type="checkbox"/> HCV <input type="checkbox"/> BUS	
14	Do you See Road Signs?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Sometimes	
15	Do you Understand Road Signs?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
16	RATE the Issues with Road Signages (Top 5)	<input type="checkbox"/> I don't understand the meanings <input type="checkbox"/> Not Visible <input type="checkbox"/> Not Visible due to vegetation <input type="checkbox"/> Board Damaged <input type="checkbox"/> Not Visible at night <input type="checkbox"/> Not placed where needed <input type="checkbox"/> I am a regular user and hence I don't need to see boards <input type="checkbox"/> I drive my own way; signage isn't helpful for me.	




1		<input type="checkbox"/> Compulsory Keep Left <input type="checkbox"/> Obstacle on the Left <input type="checkbox"/> Road turning Left <input type="checkbox"/> Accident on the Left
2		<input type="checkbox"/> Hairpin Bend on Left <input type="checkbox"/> Left-hand Curve ahead <input type="checkbox"/> Look Left <input type="checkbox"/> Do Not turn Left
3		<input type="checkbox"/> Running Children ahead <input type="checkbox"/> Do Not hold Hands <input type="checkbox"/> Do Not Cross <input type="checkbox"/> School Zone Ahead
4		<input type="checkbox"/> Do-Not Give Way <input type="checkbox"/> Allow Overtaking <input type="checkbox"/> Give Way to Pedestrians <input type="checkbox"/> Give-way to Major Traffic <input type="checkbox"/> Movement

5		<input type="checkbox"/> Do-Not Cross the Road <input type="checkbox"/> Cross with Caution <input type="checkbox"/> Pedestrian Crossing <input type="checkbox"/> Accident Zone
6		<input type="checkbox"/> Right Reverse Bend <input type="checkbox"/> Hill Climb Ahead <input type="checkbox"/> Left Reverse Bend <input type="checkbox"/> Sharp Curve Ahead
7		<ul style="list-style-type: none"> • 4 Bends Ahead • Hill Climb Ahead • Series of Bends ahead • Steep Climb Ahead
8		<input type="checkbox"/> Road Hump Ahead <input type="checkbox"/> Elevated Road <input type="checkbox"/> Do Not Stop <input type="checkbox"/> Left Turn Ahead

9		<ul style="list-style-type: none"> <input type="checkbox"/> Hazard on the Left <input type="checkbox"/> Hazard on the Right <input type="checkbox"/> Keep Right <input type="checkbox"/> Deep Excavation
10		<ul style="list-style-type: none"> <input type="checkbox"/> Do Not Stop <input type="checkbox"/> Look and Go <input type="checkbox"/> STOP Completely <input type="checkbox"/> Speed Up
11		<ul style="list-style-type: none"> <input type="checkbox"/> Right Turning Chevron <input type="checkbox"/> Exit on Left <input type="checkbox"/> STOP Completely <input type="checkbox"/> Left Turning Chevron
12		<ul style="list-style-type: none"> <input type="checkbox"/> Road For Cattle only <input type="checkbox"/> Cattle Crossing <input type="checkbox"/> Milk Dairy Ahead <input type="checkbox"/> Cow Shed Ahead

13		<ul style="list-style-type: none"> <input type="checkbox"/> Road Fencing <input type="checkbox"/> Road Block <input type="checkbox"/> Rail-Road Crossing <input type="checkbox"/> Agriculture Stock
14		<ul style="list-style-type: none"> <input type="checkbox"/> 4-Arm Intersection <input type="checkbox"/> Side Road Left <input type="checkbox"/> Turn Left <input type="checkbox"/> Side Road on Right
15		<ul style="list-style-type: none"> <input type="checkbox"/> No Entry <input type="checkbox"/> Cross road <input type="checkbox"/> No parking <input type="checkbox"/> No stopping
16		<ul style="list-style-type: none"> <input type="checkbox"/> U-Turn ahead <input type="checkbox"/> Hair-pin Bend <input type="checkbox"/> Turn Left <input type="checkbox"/> No U-Turn

17		<input type="checkbox"/> Height Restriction <input type="checkbox"/> Flooded Road <input type="checkbox"/> No-Entry <input type="checkbox"/> NO Overtaking
18		<input type="checkbox"/> No Exit <input type="checkbox"/> One- Way Road <input type="checkbox"/> No-Stopping <input type="checkbox"/> NO Overtaking
19		<input type="checkbox"/> No -Entry No-Exit <input type="checkbox"/> One- Way Road <input type="checkbox"/> Priority to Oncoming <input type="checkbox"/> Traffic <input type="checkbox"/> NO Overtaking
20		<input type="checkbox"/> NO Overtaking <input type="checkbox"/> One- Way Road <input type="checkbox"/> No-Entry <input type="checkbox"/> No-Parking on-Right

21		<input type="checkbox"/> Max. Speed 30 kmph <input type="checkbox"/> Maintain 30 kmph <input type="checkbox"/> Speed Limit 30 kmph <input type="checkbox"/> Minimum Speed 30 Kmph
22		<input type="checkbox"/> Max. Speed 30 kmph <input type="checkbox"/> Maintain 30 kmph <input type="checkbox"/> Speed Limit 30 kmph <input type="checkbox"/> Minimum Speed 30 Kmph
23		<input type="checkbox"/> Keep Right <input type="checkbox"/> Overtaking Permitted <input type="checkbox"/> No-Overtaking <input type="checkbox"/> Parking Permitted