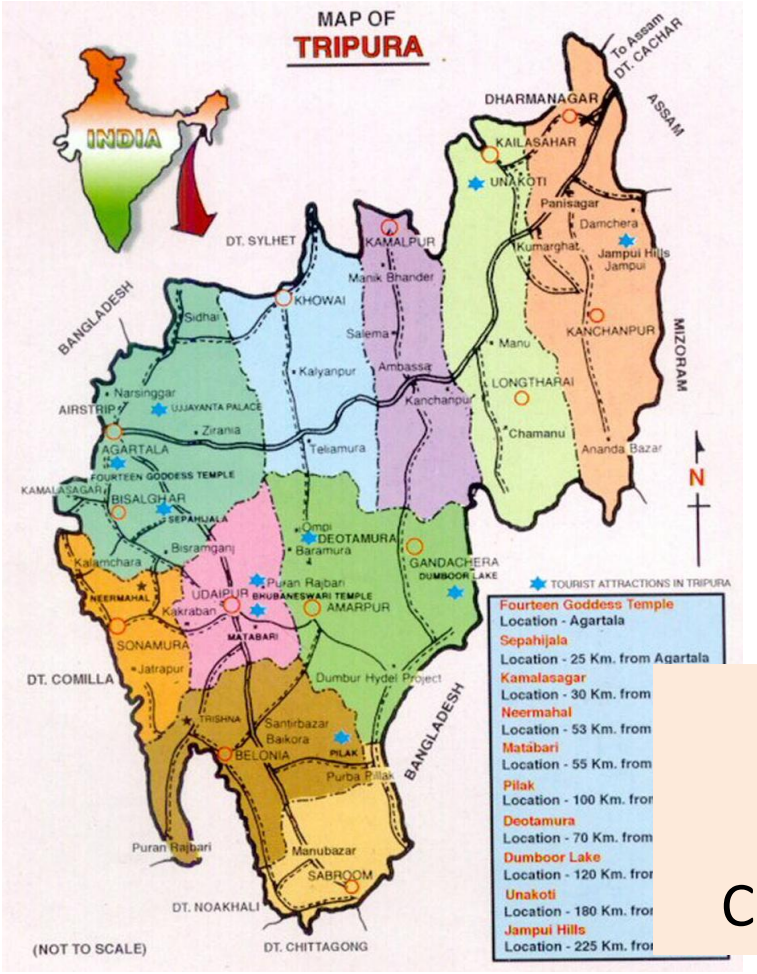
Road Safety Audit of 20 Km Stretch from Lichubagan Tri Junction to Mohanpur Intersection, Tripura



Dr. A. Mohan Rao

Principal Scientist

Central Road Research Institute, New Delhi

Objectives and Scope of the Study

- To conduct Road Safety Audit (RSA) on the 20 Km road stretch from Lichubagan Tri Junction to Mohanpur.
- To understand the **traffic characteristics** and **road crash scenario** through the conduct of relevant traffic studies and critical data analysis of the traffic flow, road crashes and **assessment of speed characteristics** on the identified stretches in study area.

The scope of the study covers the following:

- To analyze the secondary data relating to the traffic volume / spot speed studies, road crash data and assessment of speed profile characteristics.
- To conduct the traffic studies and analysis of the traffic flow data.
- Identification of problems being faced by different categories of road users during post-operational phase.
- To study the Black Spots based on the FIR data/ road crash data provided by the client.
- To prepare the action plan aimed at mitigating the black spots.

Meetings and Reconnaissance Visit

Deputy Secretary , Mr. Sustanta Das PWD, Agartala

EE, Mr. Kamal Sengupta PWD, Mohanpur Division

SP, Traffic Police Agartala Mr. Rati Ranjan Das

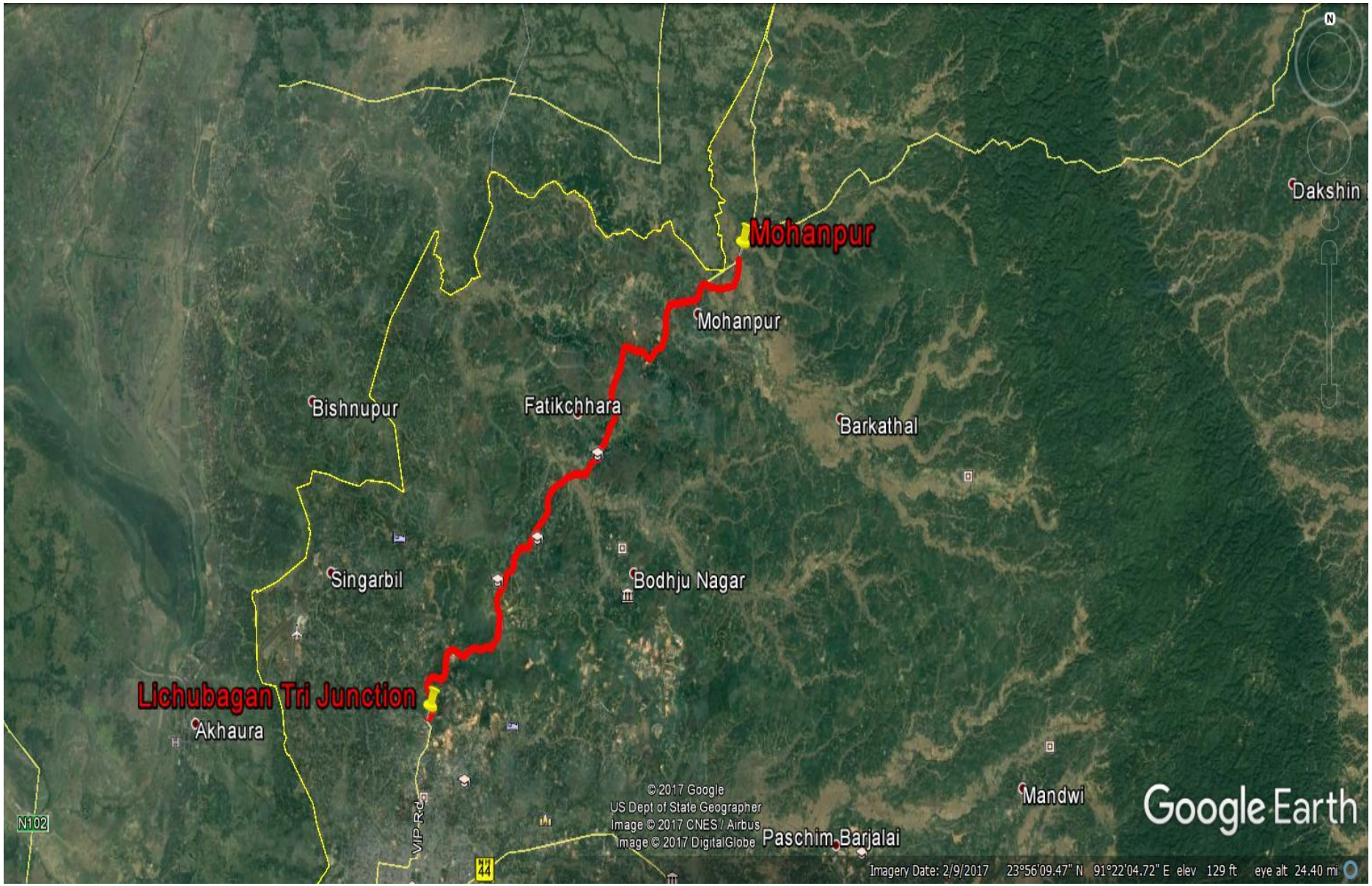
Chief Engineer, Mr. Somesh Ch. Das, PWD Agartala

Meetings and Reconnaissance Visit contd…

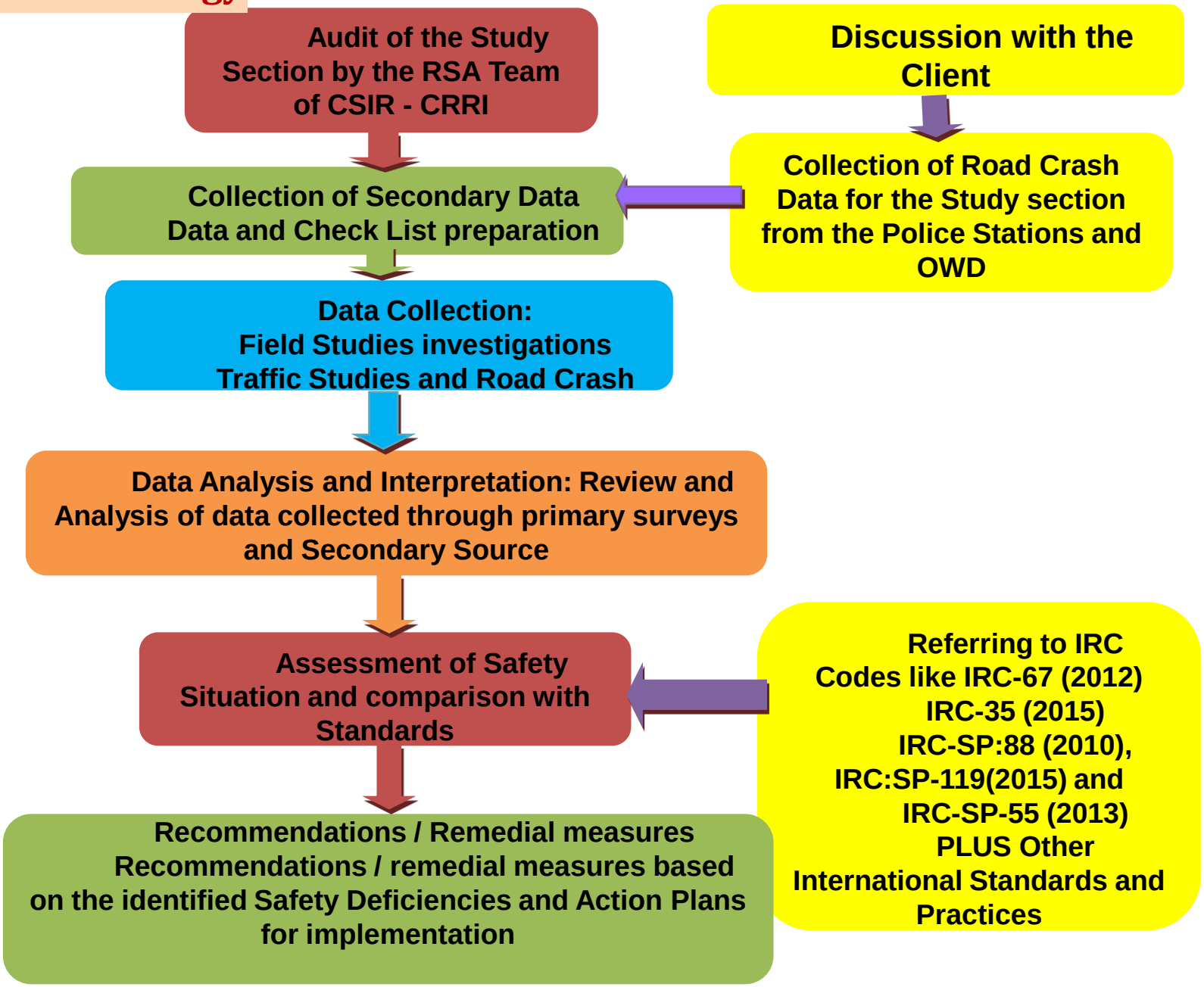
CSIR - CRRI Study Team and PWD Officials during RSA

Discussion with Traffic Police, Agartala during RSA on Project Corridor

Geographical Location of Lichubagan Tri Junction to Mohanpur Intersection



Study Methodology

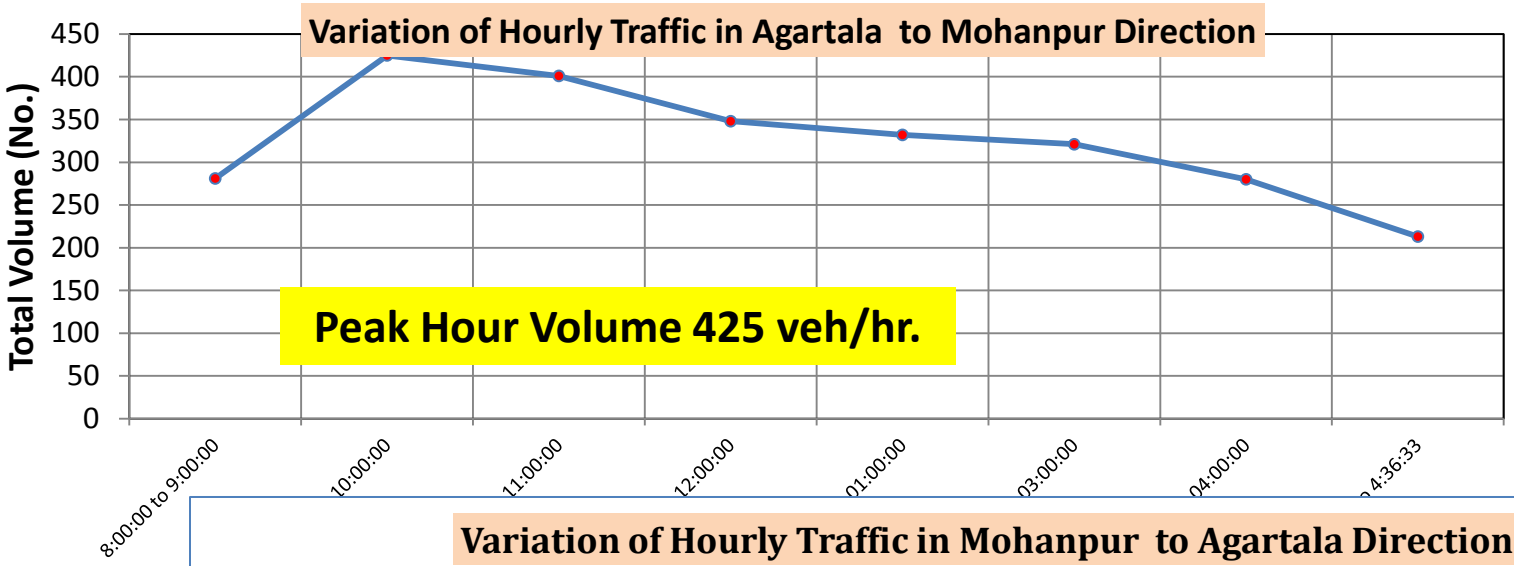


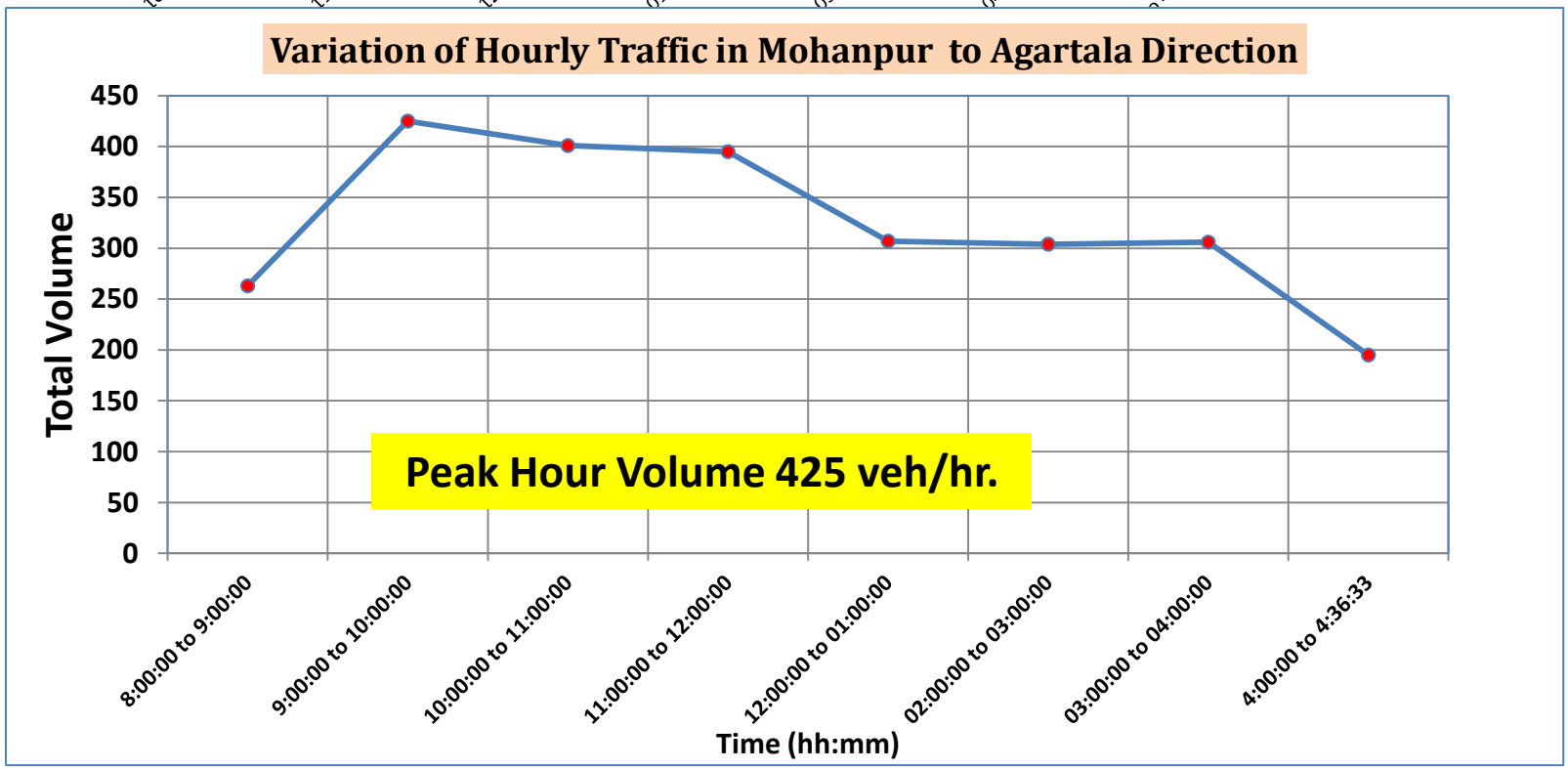
Traffic surveys

- **Classified Volume Counts**
- **Spot Speed Survey**
- **Speed and Delay Studies**

Type of Survey	Location	Survey Direction	Location Chainage (Km)	Date and Time of Survey
Classified Traffic Volume Count	CVC-1	Agartala to Mohanpur	1.0 Km	26.4.17; 08.00 am to 04.30 pm
	CVC-2	Mohanpur to Agartala	1.0 Km	26.4.17; 08.00 am to 04.30 pm
	CVC-3	Agartala to Mohanpur	12.0 Km	27.4.17; 10.00 am to 05.30 pm
	CVC-4	Mohanpur to Agartala	12.0 Km	27.4.17; 10.00 am to 05.30 pm
Spot Speed Survey	SS-1	Agartala to Mohanpur	1.7 Km	27-04-2017 (09.20 am)
	SS-2	Mohanpur to Agartala	1.7 Km	27-04-2017 (09.20)
	SS-3	Agartala to Mohanpur	3.3 Km	26-04-2017 (10.00 am)
	SS-4	Mohanpur to Agartala	3.3 Km	26-04-2017 (11.00 am)
	SS-5	Agartala to Mohanpur	6.7 Km	27-04-2017 (11.00 am)
	SS-6	Mohanpur to Agartala	6.7 Km	27-04-2017 (11.00 am)
	SS-7	Agartala to Mohanpur	9.7 Km	26-04-2017 (10.00 am)
	SS-8	Mohanpur to Agartala	9.7 Km	26-04-2017 (11.00 am)
	SS-9	Agartala to Mohanpur	10.7 Km	26-04-2017 (10.00 am)
	SS-10	Mohanpur to Agartala	10.7 Km	26-04-2017
	SS-11	Agartala to Mohanpur	1.0 Km	08.00 am to 04.30 pm
	SS-12	Mohanpur to Agartala	1.0 Km	08.00 am to 04.30 pm
	SS-13	Agartala to Mohanpur	12.0 Km	10.00 am to 05.30 pm
	SS-14	Mohanpur to Agartala	12.0 Km	10.00 am to 05.30 pm
Speed and Delay	SD	Both Directions	-	26 & 27-04-2017

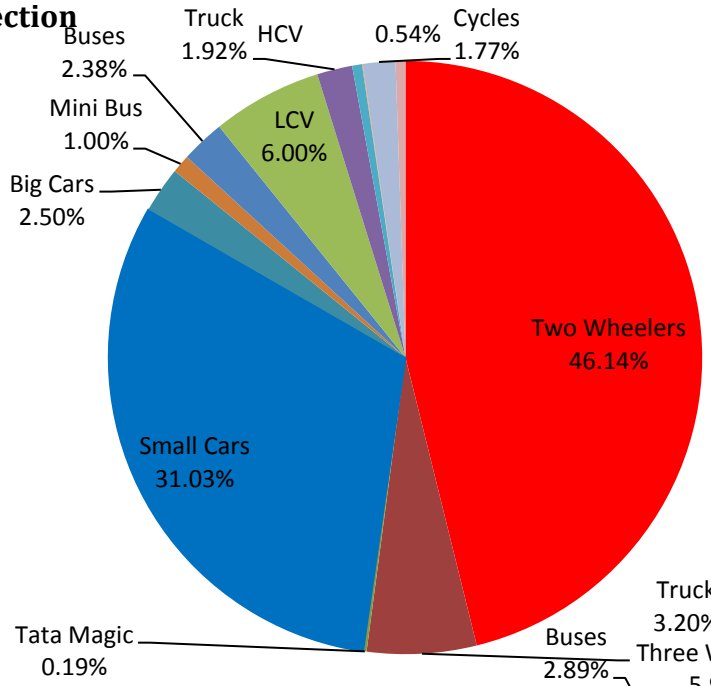
Traffic Volume @BSF Camp at km 1/0



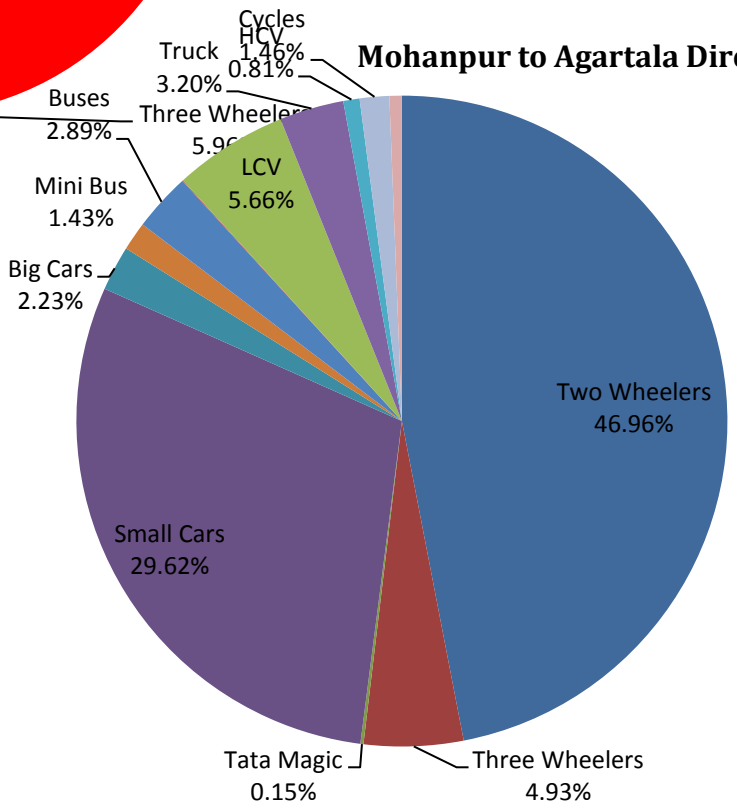


Traffic Composition @BSF Camp at km 1/0

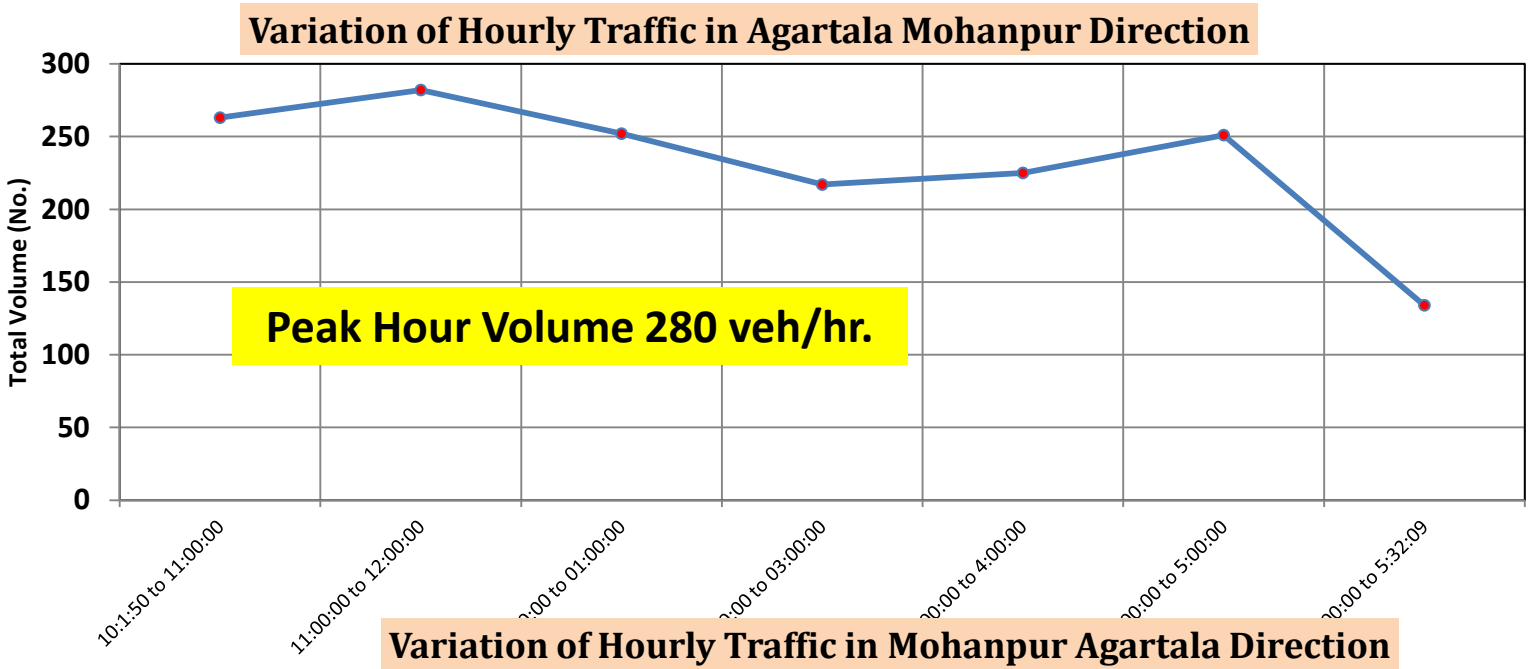
Agartala to Mohanpur Direction

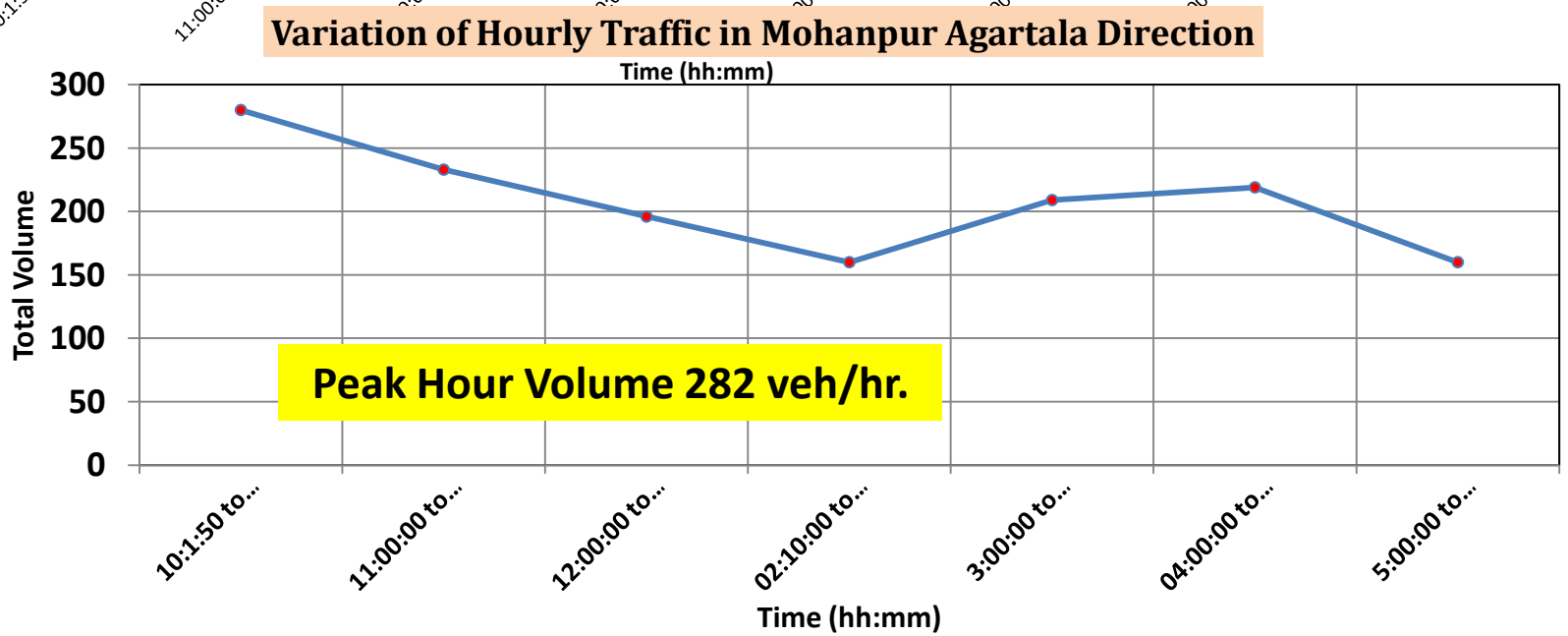


Mohanpur to Agartala Direction

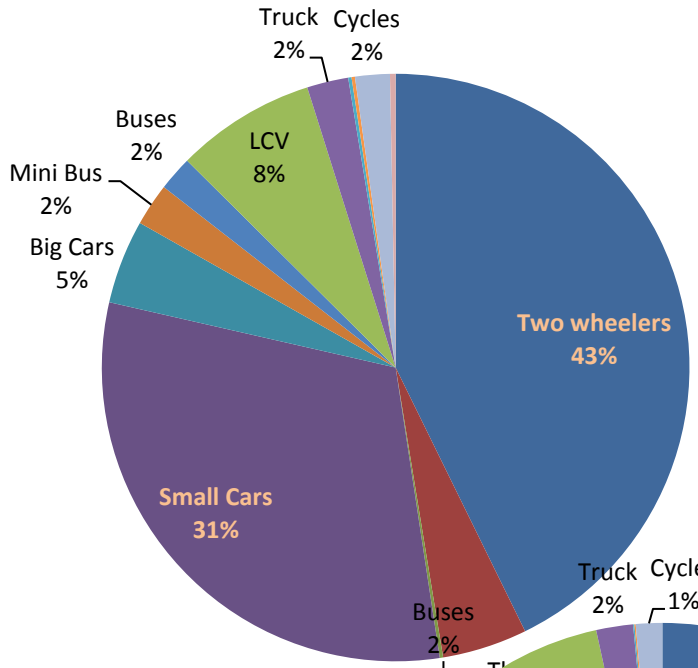


Traffic Volume @ Tea Garden at Km 12

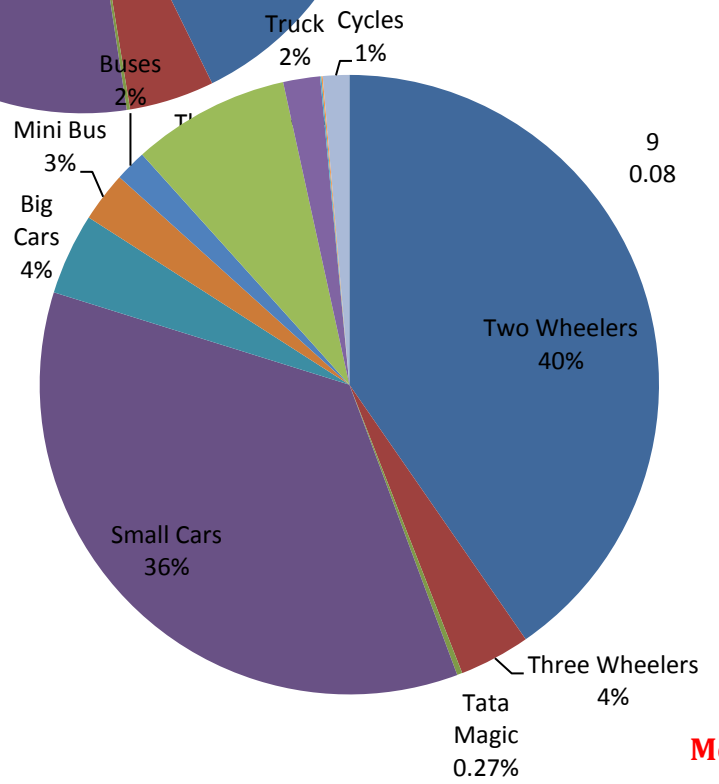




Traffic Composition @ Tea Garden at Km 12



Agartala to Mohanpur Direction



Mohanpur to Agartala Direction

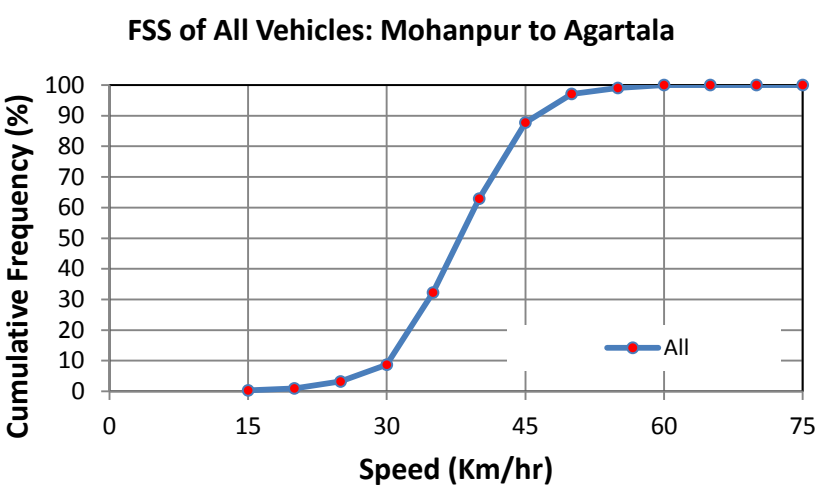
Summary of Speeds on Agartala to Mohanpur Direction

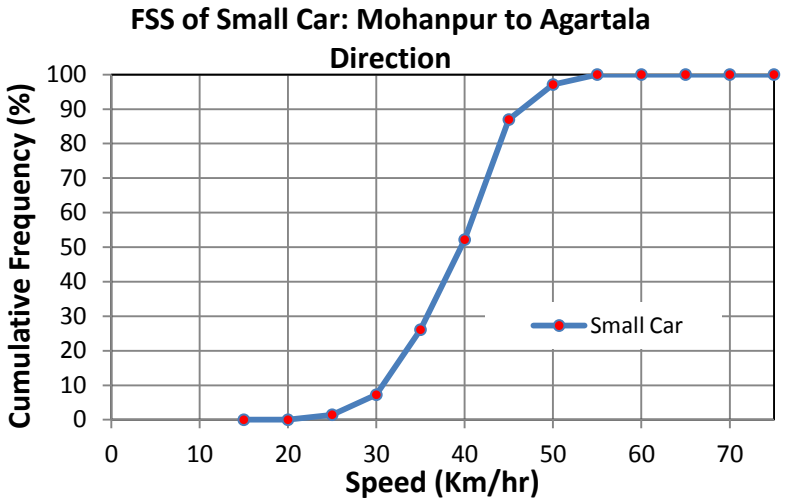
Agartala to Mohanpur Direction	Percentile Speed	All Vehicles	Small Car	Big Car	Bus	MB	3/4 Autos	Two Wheeler	LCV	MCV	H CV
BSF @ about 1 Km	15	38	42	45	38	41	33	37	36	30	36
	50	47	52	54	45	49	39	45	44	30	41
	85	**59**	**62**	**61**	**55**	**53**	45	**57**	**55**	30	**54**
Chainage @ 1.7 Km	15	30	31	31	29	30	31	31	32		28
	50	37	38	40	35	39	34	39	36		31
	85	44	47	48	40	44	39	45	39		39
Chainage @ 3.3 Km	15	34	39	30	36	37	33	35	31	27	33
	50	42	46	43	40	45	36	42	40	28	36
	85	50	**56**	**55**	46	**51**	42	49	45	31	48
Chainage @ 6.7 Km	15	30	33	38	29	34	26	30	35	21	31
	50	36	38	41	32	37	32	35	37	22	39
	85	44	44	46	38	43	38	46	42	23	42
Chainage @ 9.7 Km	15	30	33	38	30	35	26	30	26		29
	50	38	40	41	36	41	28	36	33		31
	85	46	49	**62**	38	47	32	44	39		40
Chainage @ 10.7 Km	15	28	35	39	30	37	26	30	24		26
	50	38	44	44	32	42	35	38	31		36
	85	47	**54**	46	34	47	40	45	43		44
Tea Garden @ about 12 Km	15	38	42	39	35	41	33	36	42	55	44
	50	47	52	45	43	49	37	45	52	57	53
	85	**59**	**62**	**59**	**52**	**60**	45	**56**	**60**	**58**	**60**

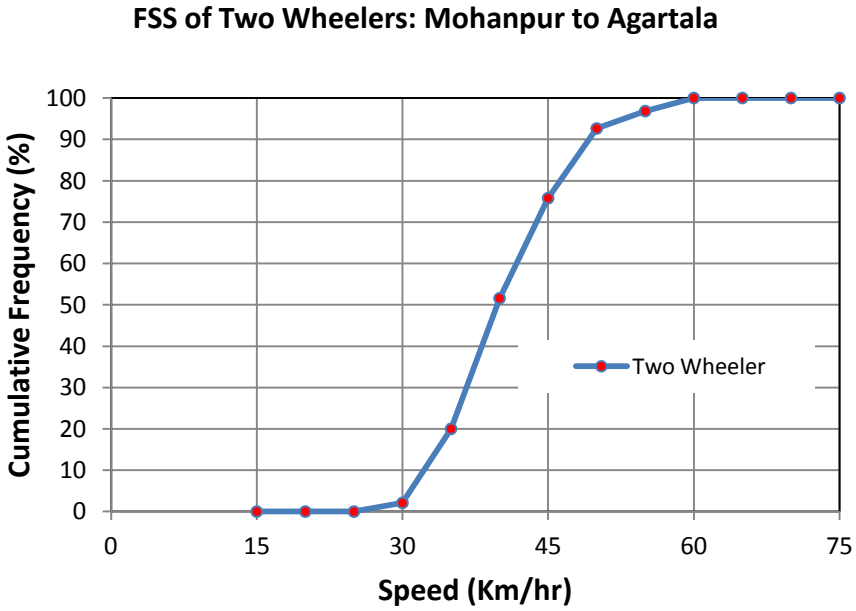
Summary of Observed Speeds on Mohanpur to Agartala Direction

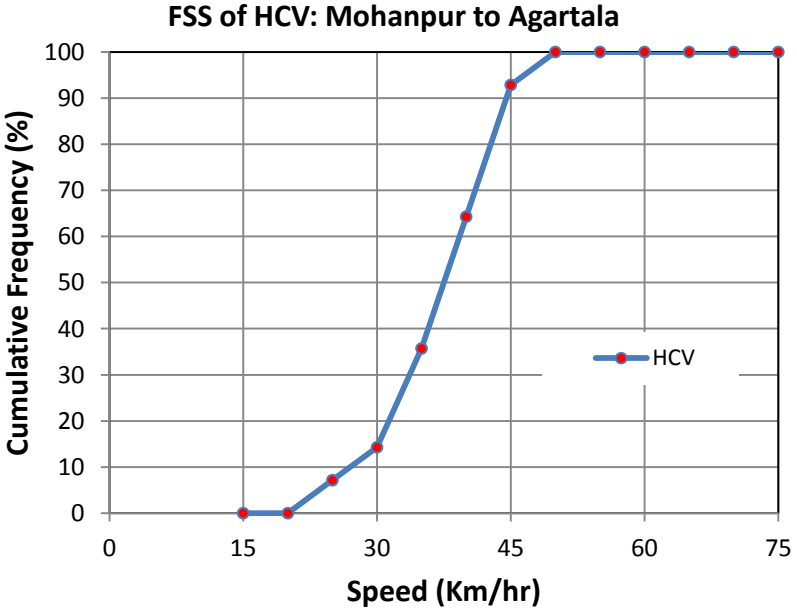
Mohanpur to Agartala Direction	Percentile Speed	Summary of Spot Speeds										
		All Vehicles	Small Car	Big Car	Bus	MB	Three Wheeler	Two Wheeler	LCV	MCV	HCV	4A
BSF @ about 1 Km	15	32	37	37	26	31	28	33	30	29	27	
	50	41	46	45	35	39	33	42	37	34	35	
	85	51	55	51	41	41	41	51	47	44	43	
Chainage @ 1.7Km	15	32	33	34	33	34	28	34	28	21	32	31
	50	39	40	41	38	39	33	40	33	29	37	35
	85	45	45	46	41	42	39	48	37	36	42	40
Chainage @ 3.3 Km	15	35	38	35	36	40	33	34	36		34	38
	50	42	50	42	42	44	37	41	37		39	45
	85	51	57	48	46	50	42	51	41		43	49
Chainage @ 6.7 Km	15	33	33	38	29	35	31	33	33	38	35	31
	50	40	41	43	40	42	37	40	45	38	39	41
	85	47	50	51	45	48	42	46	46	38	46	45
Chainage @ 9.7 Km	15	30	34	33	31	31	29	29			28	27
	50	37	41	41	36	36	31	37			36	34
	85	46	49	48	42	43	34	46			38	39
Chainage @ 10.7 Km	15	33	42	40	30	34	29	33	35		35	26
	50	38	44	44	32	39	36	37	43		38	34
	85	47	52	47	38	46	40	44	48		43	40
Tea Garden @ about 12 Km	15	32	32	30	27	40	28	32	38		35	26
	50	41	43	35	33	48	33	41	45		42	35
	85	52	53	41	39	56	41	51	53		55	41

Percentile Speeds Observed on the Project Corridor

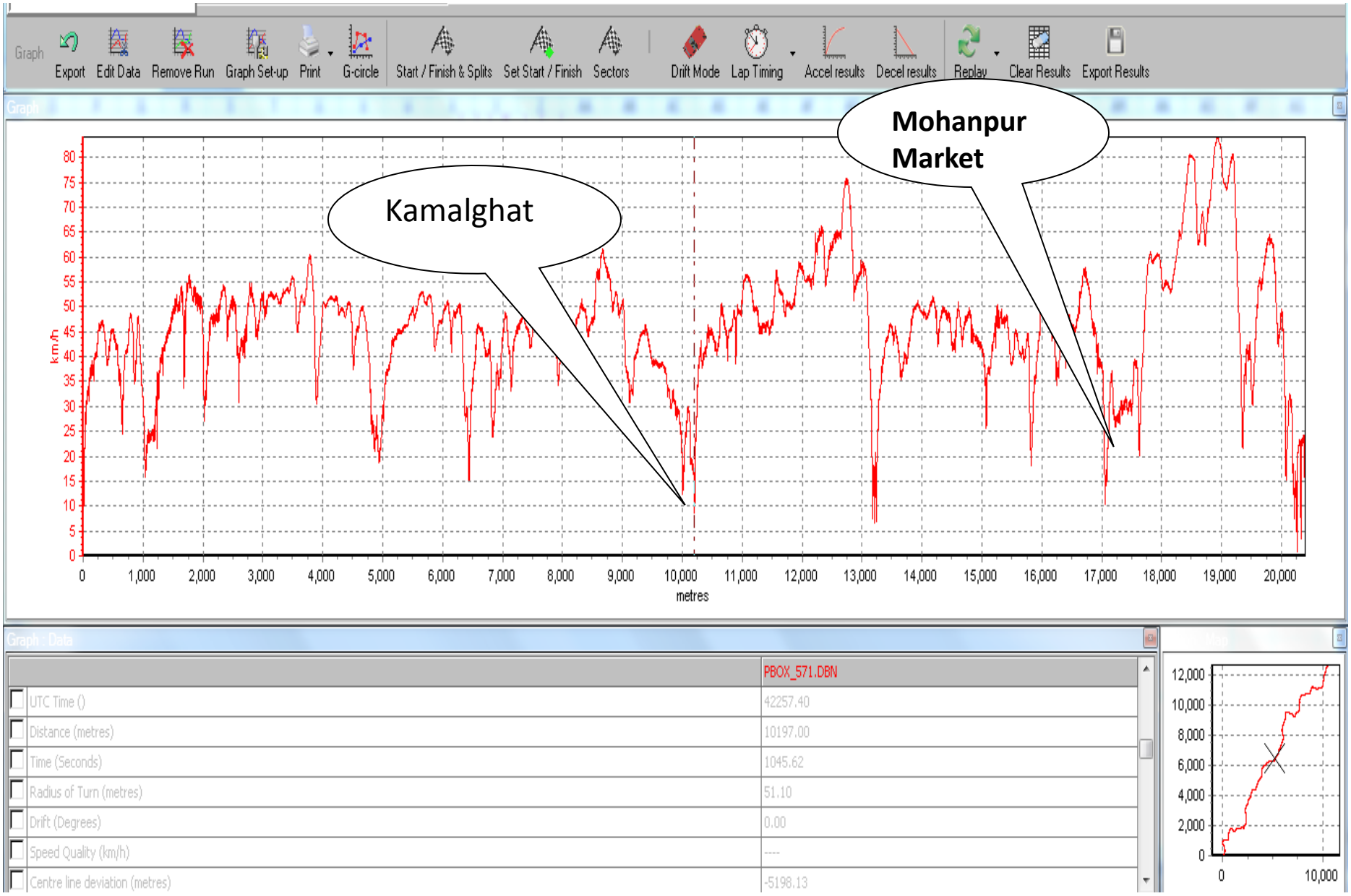




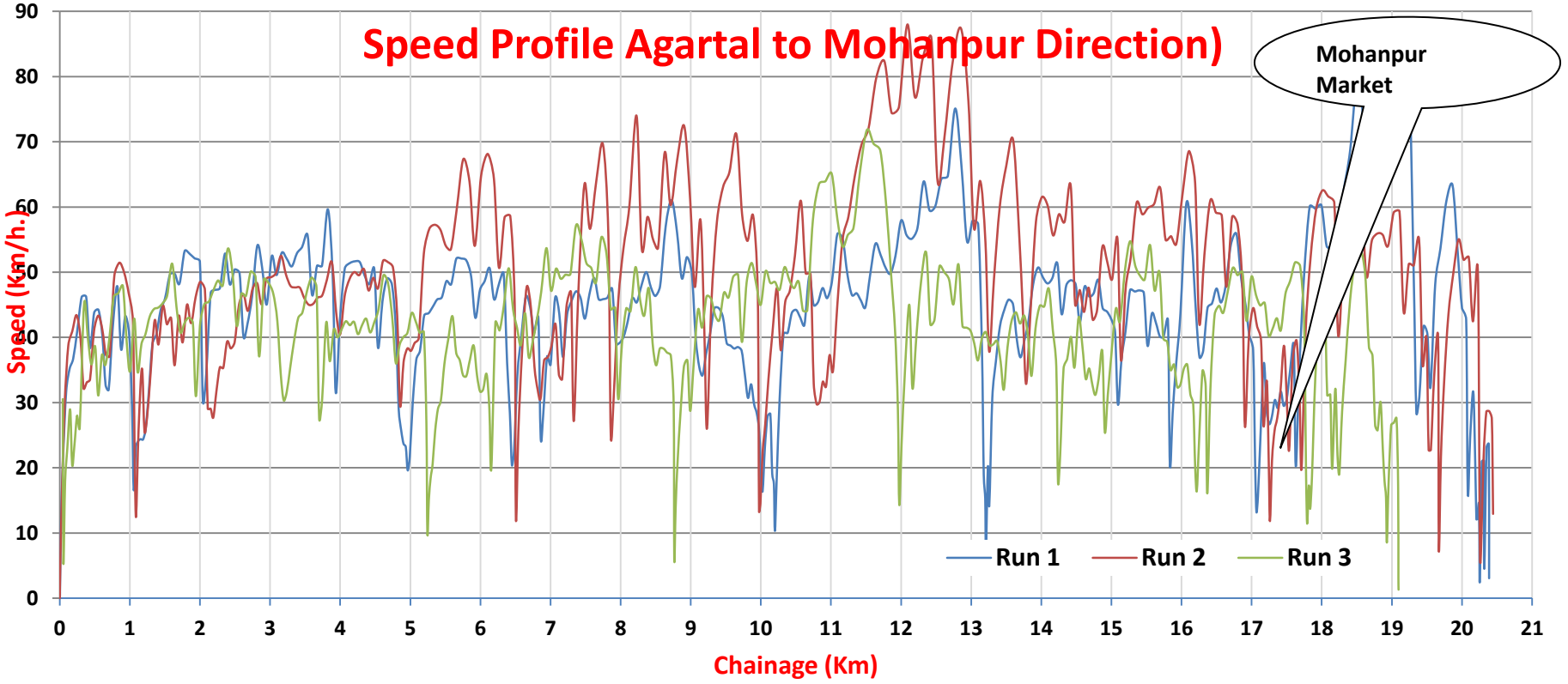




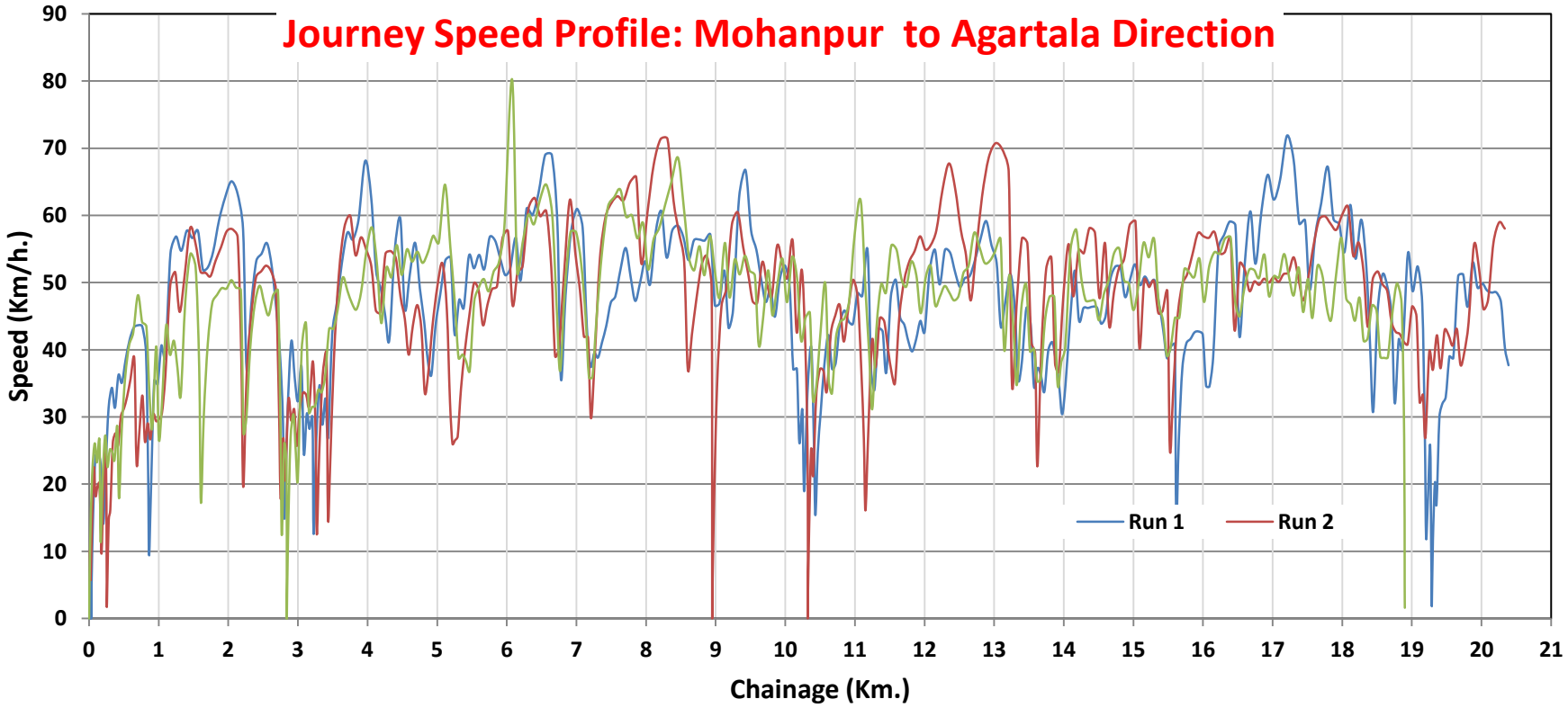
Speed Profile on the Project Corridor (GPS, Floating Car Method)



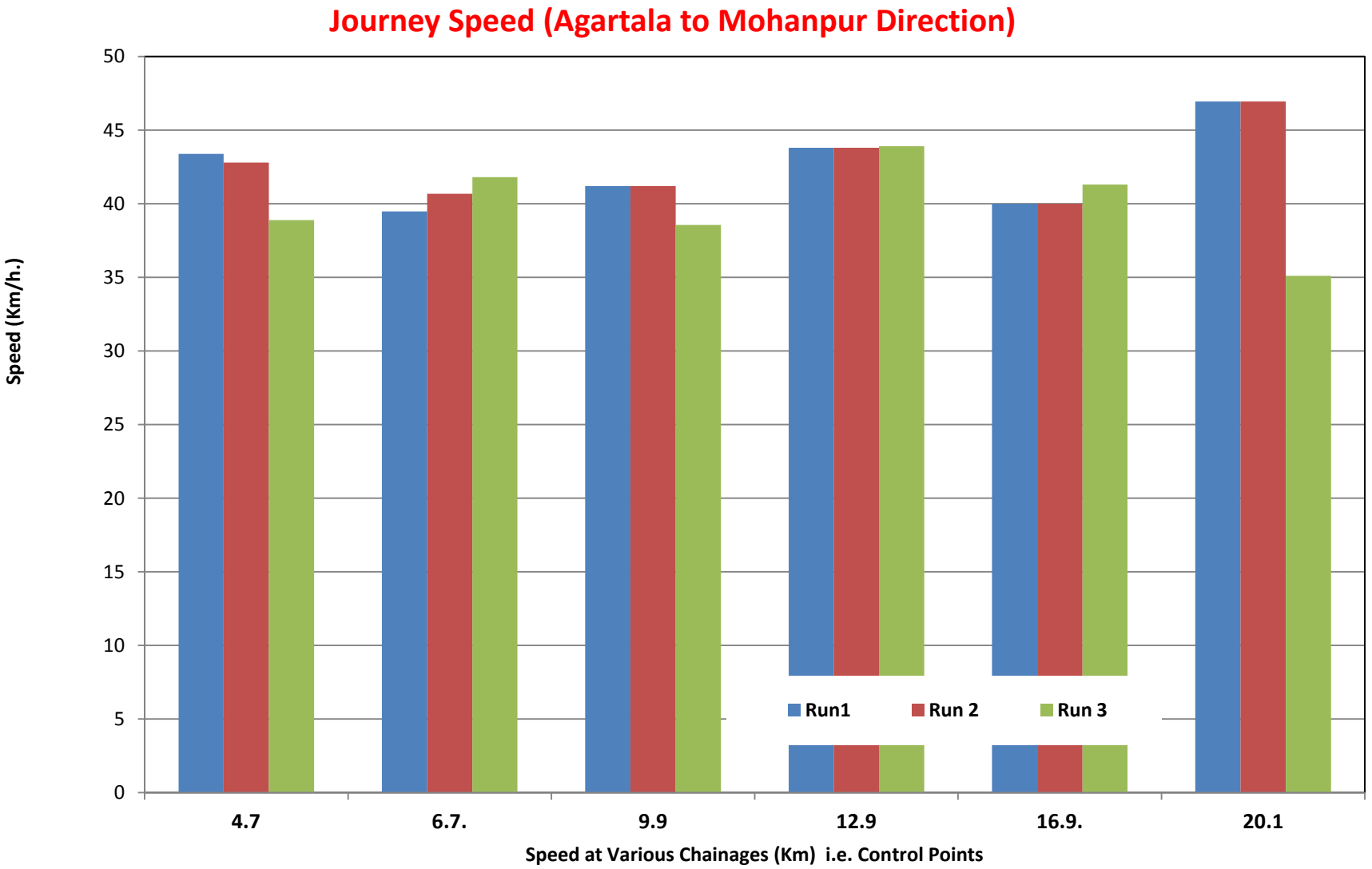
Variation in Journey Speed during different time period runs on the Project Corridor: Agartala to Mohanpur direction of travel



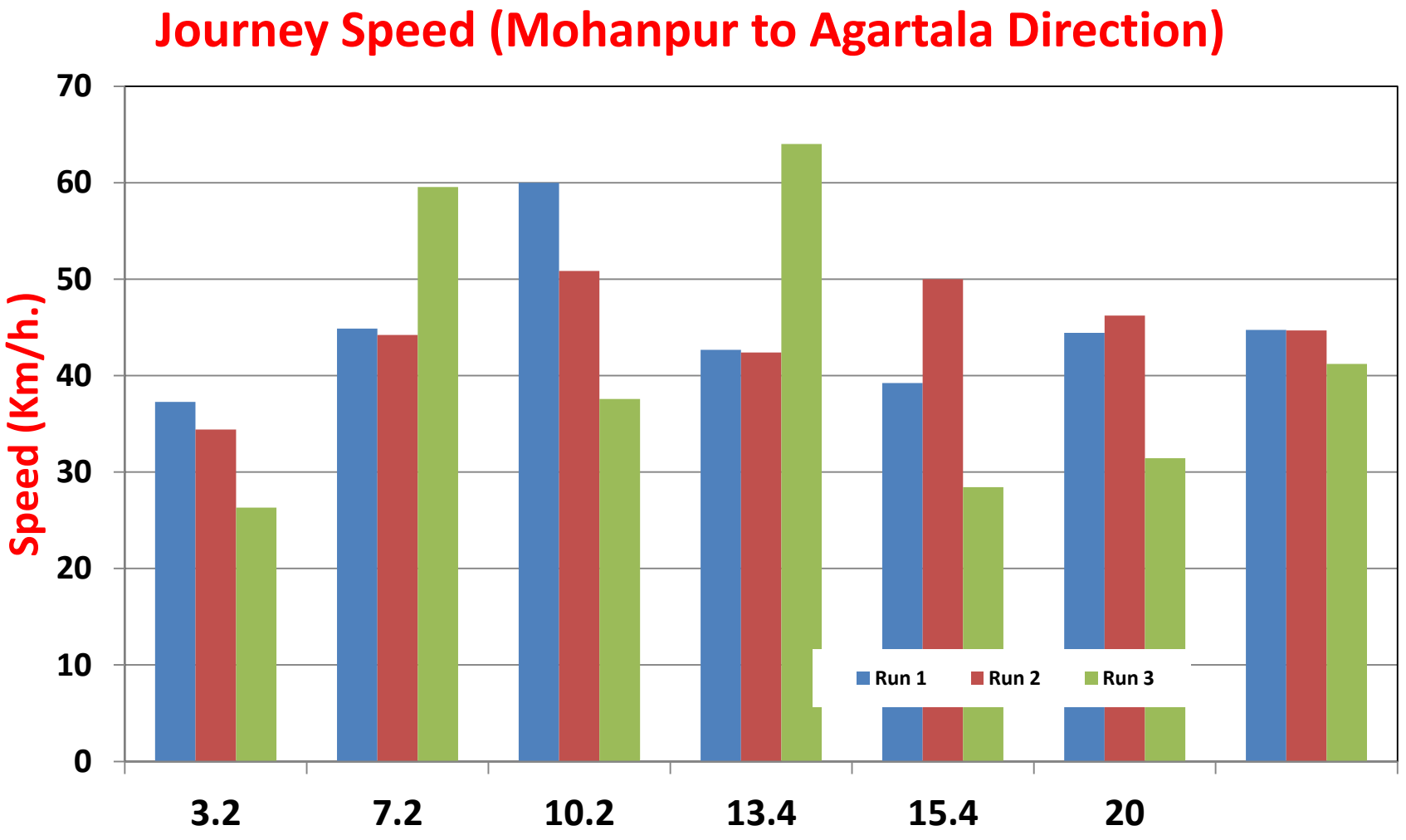
Variation in Journey Speed during different time period runs on the Project Corridor: Mohanpur to Agartala direction of travel



Variation in Journey Speed during different various runs covering different time periods on the Project Corridor: Agartala to Mohanpur direction of travel



Variation in Journey Speed during different time period runs on the Project Corridor: Mohanpur to Agartala direction of travel



Recommendation based on speed studies

- It is strongly suggested that the **speed limit** on the Project Corridor shall be pegged at **50 Kmph on the open areas**. At the same time, Speed Limit shall be reduced to **20 Kmph near schools and other vulnerable** locations wherein increased movement of pedestrians as well as crossing traffic is observed.

- *The vicinity of **isolated curves and school/college areas*** at sporadic locations and it also suggested that **soft traffic calming measures** is essentially required at this location in both the directions of travel.

- the Regulatory Sign in the form of **'Restriction End Sign'** must be provided at the end of vulnerable reach stretch followed by the posting of Speed Limit sign of 50 Kmph *(applicable for the study corridor)* within a distance of 50 m.

- **Transverse Bar Markings *(TBM)*** shall be installed *(at least 50 m before)* at all the vulnerable locations. The thickness of the markings may be increased to **8 mm** from the specified thickness of 5 mm as per IRC. 35 *(2015)* as the greater rumbling effect would facilitate in higher speed reductions.

- **All the Side Roads**, **Speed Humps** shall necessarily be provided so that the vehicles do not merge with the traffic on the main road at high speeds.

- There is an urgent need to implement strict enforcement measures on the ground to curb the speeds of traffic on the Project Corridor through deploying Speed Enforcement Cameras which can directly help in enhancing road safety.

ROAD SAFETY AUDIT FINDINGS

Alignment and Cross Section

Project Corridor having two lane undivided road of 7.5 m width

Project Corridor having two lane undivided road of 7.5 m width

Poor condition of shoulders with on either side with fully grown grass making it unusable by any form of traffic / Pedestrians

Poor condition of shoulders with on either side with fully grown grass making it unusable by any form of traffic / Pedestrians

Absence of ‘Curve Ahead’ Warning Signs and 'Chevron Signs' and trees obstructing the Sight Distance at the horizontal curves between Km. 0/000 to Km. 1/200 on RHS.

Absence of ‘Curve Ahead’ Warning Signs and 'Chevron Signs' and trees obstructing the Sight Distance at the horizontal curves between Km. 0/000 to Km. 1/200 on LHS & RHS

Pavement Edge Drops noted at many locations

Making it unusable by any form of traffic between km 0/000 to km 1/200; Absence of Edge Delineation

Making it unusable by any form of traffic between km 0/000 to km 1/200; Absence of Edge Delineation

Making it unusable by any form of traffic between km 0/000 to km 1/200; Absence of Edge Delineation

Making it unusable by any form of traffic between km 1/200 to km 1/500; Absence of Edge Delineation

Making it unusable by any form of traffic between km 8/200 to km 10/000; Absence of Edge Delineation

Making it unusable by any form of traffic between km 17/700 to km 20/000; Absence of Edge Delineation

Military establishments

Direct connection with the Project Corridor which is a safety hazard; Recommended to provide Speed Hump on the Access Road coupled with placement of concave mirror on the Project Corridor at suitable location near Km 2/500

Military establishments having direct connection with the Project Corridor without any Traffic Calming measures; Recommended to provide Speed Hump on the Access Road coupled with placement of concave mirror on the Project Corridor at suitable location near Km 13/600

Military establishments having direct connection with the Project Corridor which is a safety hazard; Recommended to provide Speed Hump on the Access Road coupled with placement of concave mirror on Project Corridor at suitable location near Km 13/600

Military establishments having direct connection with the Project Corridor which is a safety hazard; Installed concave mirror for Project Road traffic which is a good practice; To be replicated at all such direct access locations to Military as well as Commercial / Office establishments

Example of usage of Concave Mirror**; To be implemented at all such direct access locations to Military as well as Commercial / Office establishments**

Intersections and Access Roads

Intersections and Access Roads

Tri Junction with Poor Road geometrics requiring redesign conforming to IRC:.SP-41 *(1994)*

Absence of Segregation Treatment for the Through Traffic bound to Agartala from Durjaynagar at Km 0/000

Absence of Segregation Treatment for the Through Traffic bound to Agartala from Durjaynagar at Km 0/000

Major junction with Poor Road geometrics requiring redesign conforming to IRC.SP-41 *(1994)* coupled with absence of Traffic Calming Measures Minor Road Junction and Absence of Over Head Gantry / Shoulder Mounted Sign on Major Road @ Km 1/200.

Major junction with Poor Road geometrics requiring redesign conforming to IRC.SP-41 (1994) coupled with absence of Traffic Calming Measures on Minor Road Junction @ Km 17/700

Absence of Side Road Left' Warning Sign coupled with Direction Destination Sign for the Minor Road Crossing coupled with Absence of Speed Calming measures on the minor road merging with Project Corridor - Many such between Km 10/000 to Km 13/600.

Road Surface

Condition of Road Surface

Poor Drainage Mechanism having led to Pavement Distress development during rainy season leaving the road water logged between Km 0/000 to Km 1/200.

Poor Drainage Mechanism having led to Pavement Distress development during rainy season leaving the road water logged between Km 0/000 to Km 1/200.

Poor Drainage Mechanism having led to Pavement Distress development during rainy season leaving the road water logged between Km 0/000 to Km 1/200.

Pavement cracks and Patches observed on pavement between Km 2/500 to Km 5/000.

Pavement cracks observed on pavement and heavy sand deposited on pavement it may lead skidding of vehicles between Km 7/100 to Km 8/200

Pavement cracks observed on pavement between Km 17/700 to Km 20/000

Visual Aids and Crash Protection Measures

Road Signs

Non-standard, wrong location and wrong orientation of Sign board; not conforming to IRC.67 (2012) between chainage km 0/000 to km 1/200.

Non-standard directional Sign board; not conforming to IRC.67 (2012) at Km 1/200.

Absence of Side Road Left' Warning Sign coupled with Direction Destination Sign for the Minor Road Crossing coupled with Absence of Speed Calming measures on the minor road merging with Project Corridor @ Km 1/700.

Absence of Side Road Left' Warning Sign coupled with Direction Destination Sign for the Minor Road Crossing coupled with Absence of Speed Calming measures on the minor road merging with Project Corridor - Many such between Km 2/500 to Km 5/000.

Non-standard School Sign board; not conforming to IRC.67 (2012) between Km 5/000 to Km 6/300.

Non-standard School Sign board; not conforming to IRC.67 (2012) between Km 5/000 to Km 6/300.

Road Signs

Non-standard direction Sign board; not conforming to IRC.67 (2012) between Km 10/000 to Km 13/600.

Non-standard School Sign board; not conforming to IRC. 67 (2012) between Km 10/000 to Km 13/600.

Non-standard Direction Information Sign between Km 10/000 to Km 13/600

Non-standard Direction Information Sign board; not conforming to IRC.67 (2012) between Km 17/700 to Km 20/000

Encroachments

Encroachment by the abutting landuse in the village area of Project Corridor making it unusable by NMT traffic between Km 10/000 to Km 13/600. Needs Strict Enforcement

Encroachment by the abutting land use in the village area of Project Corridor making it unusable by NMT traffic between Km 10/000 to km 13/600. Needs Strict Enforcement

Encroachment by the abutting land use in the village area of Project Corridor making it unusable by NMT traffic at Km 17/700. Needs Strict Enforcement

Road side objects

Electric pole located within the Recovery Zone without Retro reflective Tapes at Km 1/200.

Electrical Pole within the Recovery Zone without Retro reflective Tapes between Km. 1/500 to Km. 1/700.

Electric pole and trees without Retro reflective Taps between Km 1/700 to Km 2/500.

Hoardings located within 10 m from edge of the carriageways which is not conforming to IRC 46 (1972) “Policy on Road Side Advertisements” between Km 8/200 to Km 10/000.

Speed Breaker

		
Non-standard Speed breaker; not conforming to IRC.67 (2012) between chainage km 2/500 to km 5/000.	Non-standard Speed Breaker; not conforming to IRC. 67 (2012) between Km 10/000 to Km 13/600.	Non-standard Speed Breaker; not conforming to IRC. 67 (2012) between Km 13/600 to Km 17/700

High Embankment

Bad conditions of shoulders forcing pedestrians and NMT to use carriageway between chainage km 5/000 to km 6/300.

High embankments it is necessary to provide Metal Beam Crash Barrier between Km 6/300 to Km 7/100.

High embankments at water body it is necessary to provide Crash Barrier between Km 6/300 to Km 7/100.

High embankments coupled with water bodies adjacent to the carriageway; To provide Crash Barrier near Km 10/000

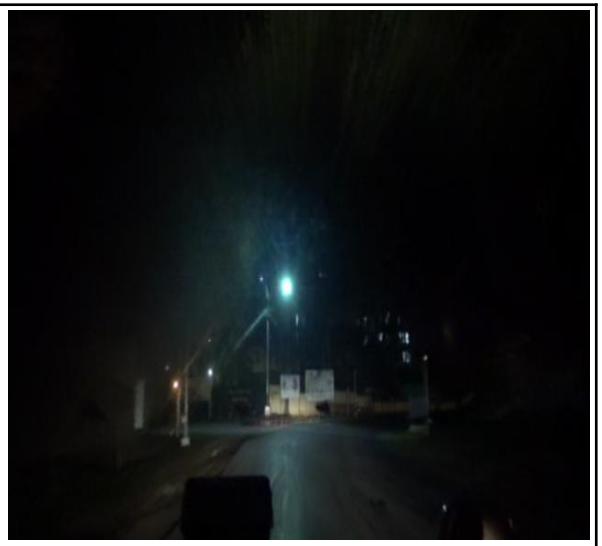
High embankments at water body approaching to bridge; Essential to provide Crash Barrier between Km 17/700 to Km 17/900

Audit During Night

Audit During Night

Speed Barricaders without retro reflective taps for better visibility during night

No retro reflective taps on trees they are not visible during night time, it is recommended to past the retro reflective tapes



No delineations and chevron signs on curves

No delineations and chevron signs on curves

No reflective taps on drums for reducing the speed

No street lights are a safety problem for pedestrians and NMT users.

ROAD CRASH BLACK SPOT ANALYSIS

Road Crash Prone Spots on the Project Corridor

S.No.	Name of the Location	Number of Fatal Accidents	Years of Fatal Accidents	Number of Other Accidents	Years of other Accidents	Total Accidents
1	**Salbagan**	1	2014	12	2014, 2015, 2016	**13**
2	**Mohanpur**	1	2013	6	2012, 2013, 2016, 2017	**7**
3	**Lembucherra**			6	2012, 2015, 2017	**6**
4	**Yubatara**	1	2012	5	2012, 2013, 2014	**6**
5	**Damdamia**	1	2012	3	2013, 2016	**4**
6	**Lichu bagan**			4	2004, 2016	**4**
7	**Sanitala**	1	2014	3	2012, 2015	**4**
8	**Adarini tea- Estate**	1	2013	2	2012, 2017	**3**
9	**Fatikcherra**	1	201	2	2012, 2013	**3**
10	**Gangagatipur**			3	2013, 2014, 2015	**3**
11	**Manipuri chow (Mohanpur)**	3	2012, 2013			**3**
12	Bhati Fatikcherra			2	2012, 2013	2
13	Tanti para	1	2015	1	2013	2
14	CRPF main gate Salbagan			1	2016	1
15	ICFAI University			1	2016	1
16	Kathaltali	1	2012			1
17	Laxmipara			1	2014	1
18	Near BLW office Lefunga			1	2013	1
19	Sepahipara			1	2012	1
20	Tarapur			1	2017	1
21	Tulsbagan			1	2015	1

Black Spots on Project Road

Accident Block Spot at Km 1/700, Horizontal curve

Accident Block Spot at Km 1/700, Horizontal curve level difference with side road

Accident Block Spot at Km 1/700, Horizontal curve with sight Distance obstructions due to trees

Accident Block Spot at Km 1/700, Horizontal curve with embankment without crash barrier

Accident Block Spot at near Km 16/000, series of Horizontal curve with sight Distance obstructions due to trees

Accident Black Spot at Km 17/700, Urban encroachments and un-authorized parking

Black Spots on Project Road

Accident Block Spot at near Km 18/000, Major Intersection without information signs it requires design of intersection

Accident Block Spot at near Km 18/000, Major Intersection without information signs it requires design of intersection

Accident Block Spot at Km 7/100, (near Lembucherra) Horizontal and vertical curve on water body with sight Distance obstructions due to trees

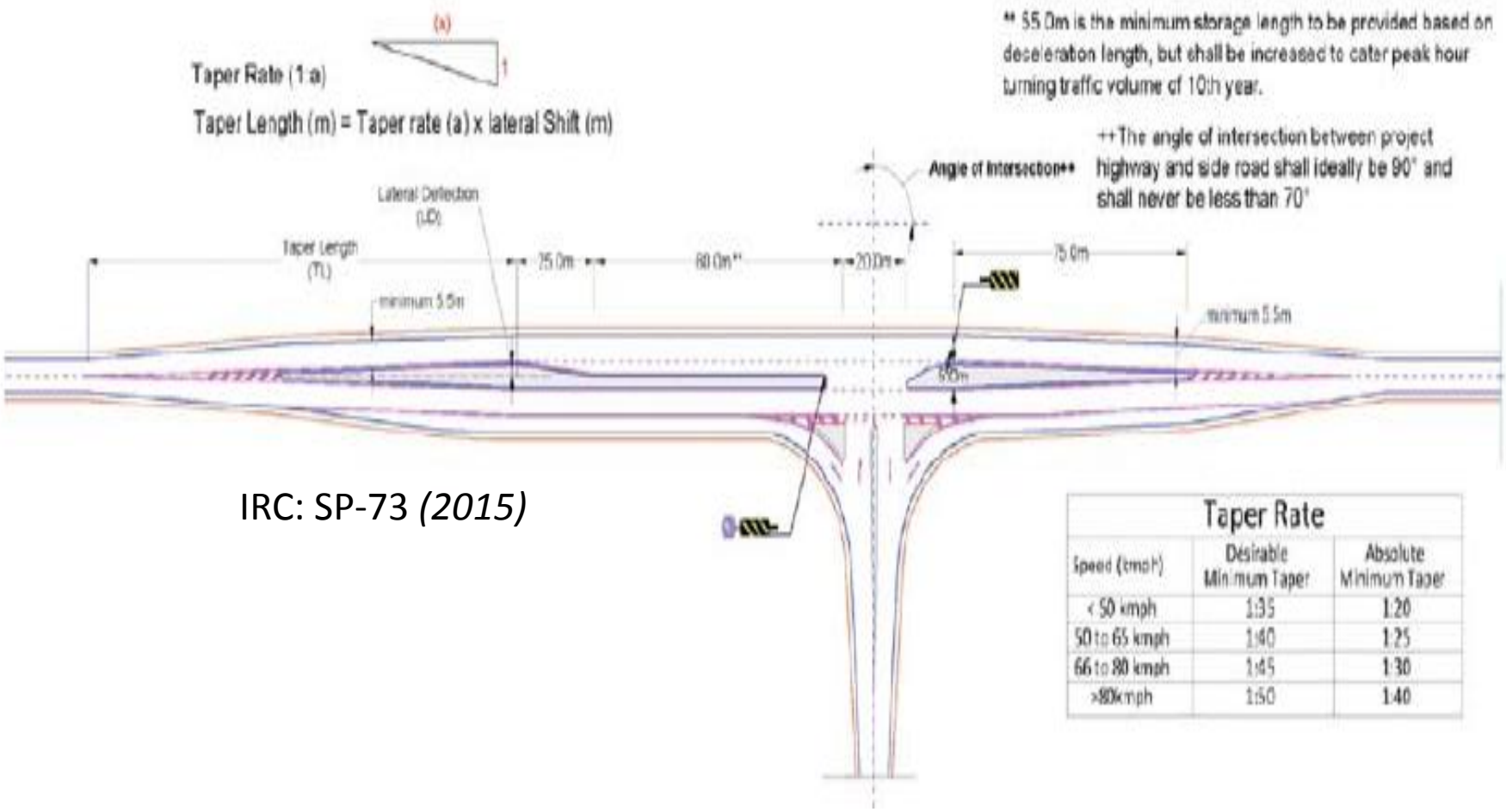
Accident Block Spot at Km 7/100, (near Lembucherra) Horizontal and vertical curve on water body curve with sight Distance obstructions due to trees

ACTION PLAN

Measures to Enhance the Safety on the Curves

Radius of the Curve *(m)*	Spacing of Delineators/ Reflectors *(m)*
15	6
35	9
55	11
75	13
90	15
120	17
150	19
180	21
210	23
240	25
270	26
300	27

Junction Improvements



IRC: SP-73 *(2015)*

Taper Rate		
Speed (mph)	Desirable 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

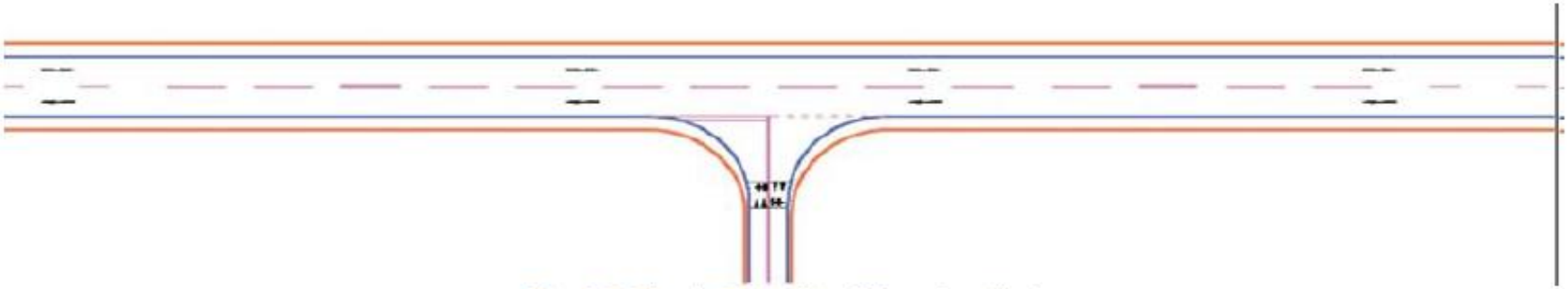


Fig. 3.5 Simple T-Junction (Minor Junction)

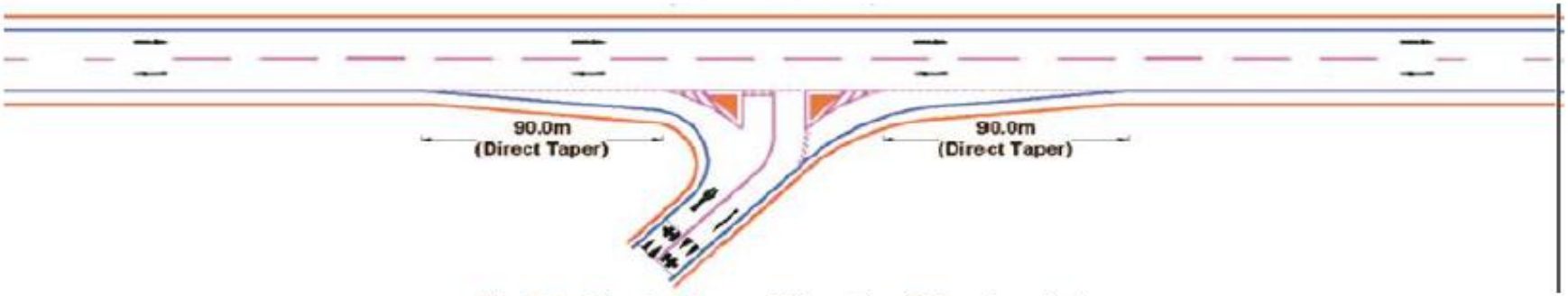
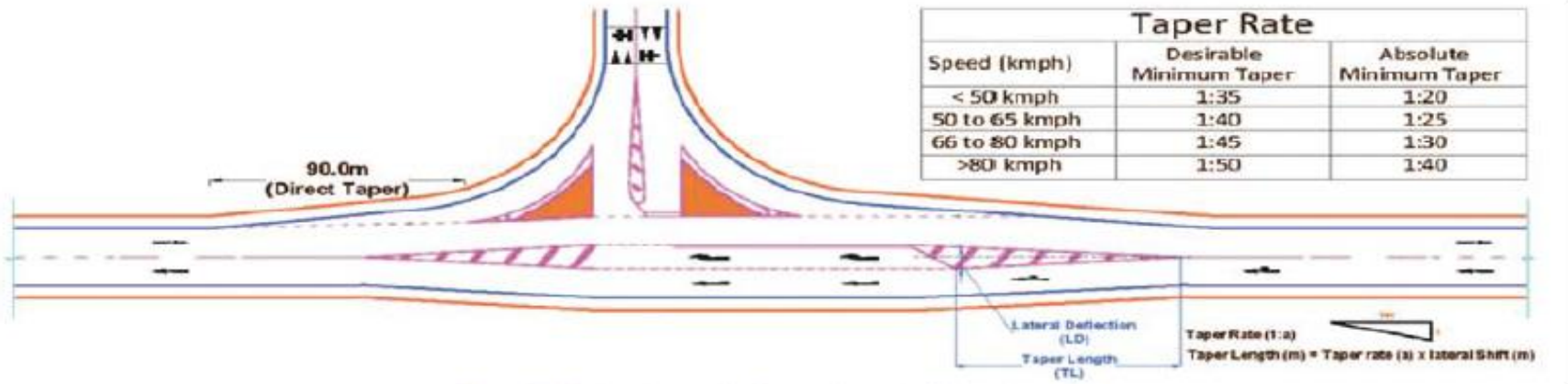


Fig. 3.6 Simple Skew or Y-Junction (Minor Junction)



Taper Rate		
Speed (kmph)	Desirable 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
>80 kmph	1:50	1:40

Fig. 3.7 T-Junction with Ghost Islands (Minor Junction)

Visual Aids to Improve the Safety of Road User

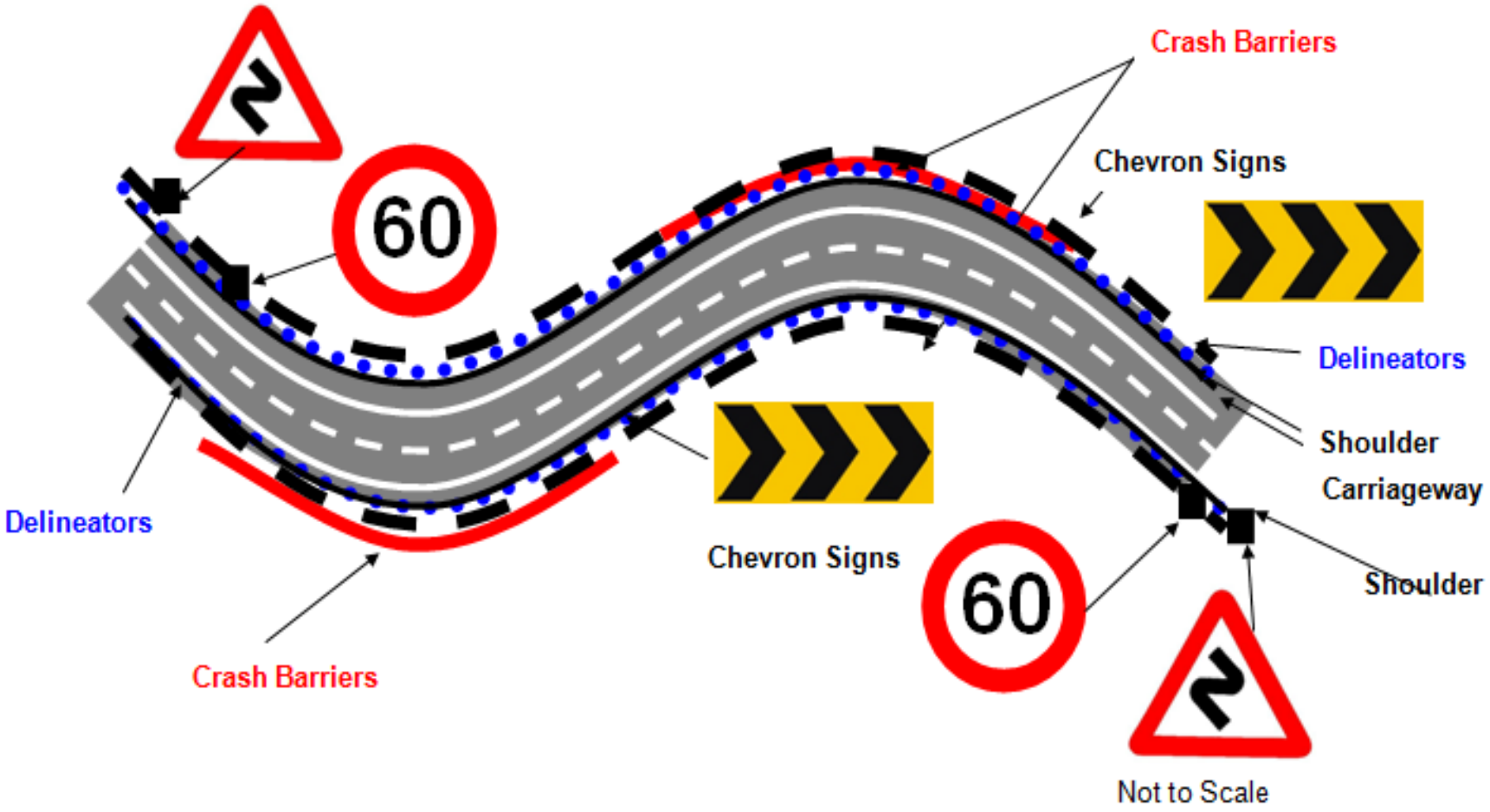


Figure :: Typical Example of Proposed Safety Features at Horizontal Curves on a Two lane

Undivided Carriageway

Treatment for Safety of Vulnerable Road Users

Approach Speed (kmph)	Bar Marking (Number of TM08)	Distance (d1, d2, d3 & d4) from Hazard
Upto 50km	1 set	d1=50,
51 to 65	2 set	D1=50, d2=80
66 to 80kmph	3 set	D1=50m, d2=80m, d3=120m
81 to 100kmph	4 set	D1=50, d2=80, d3=120, d4=180m

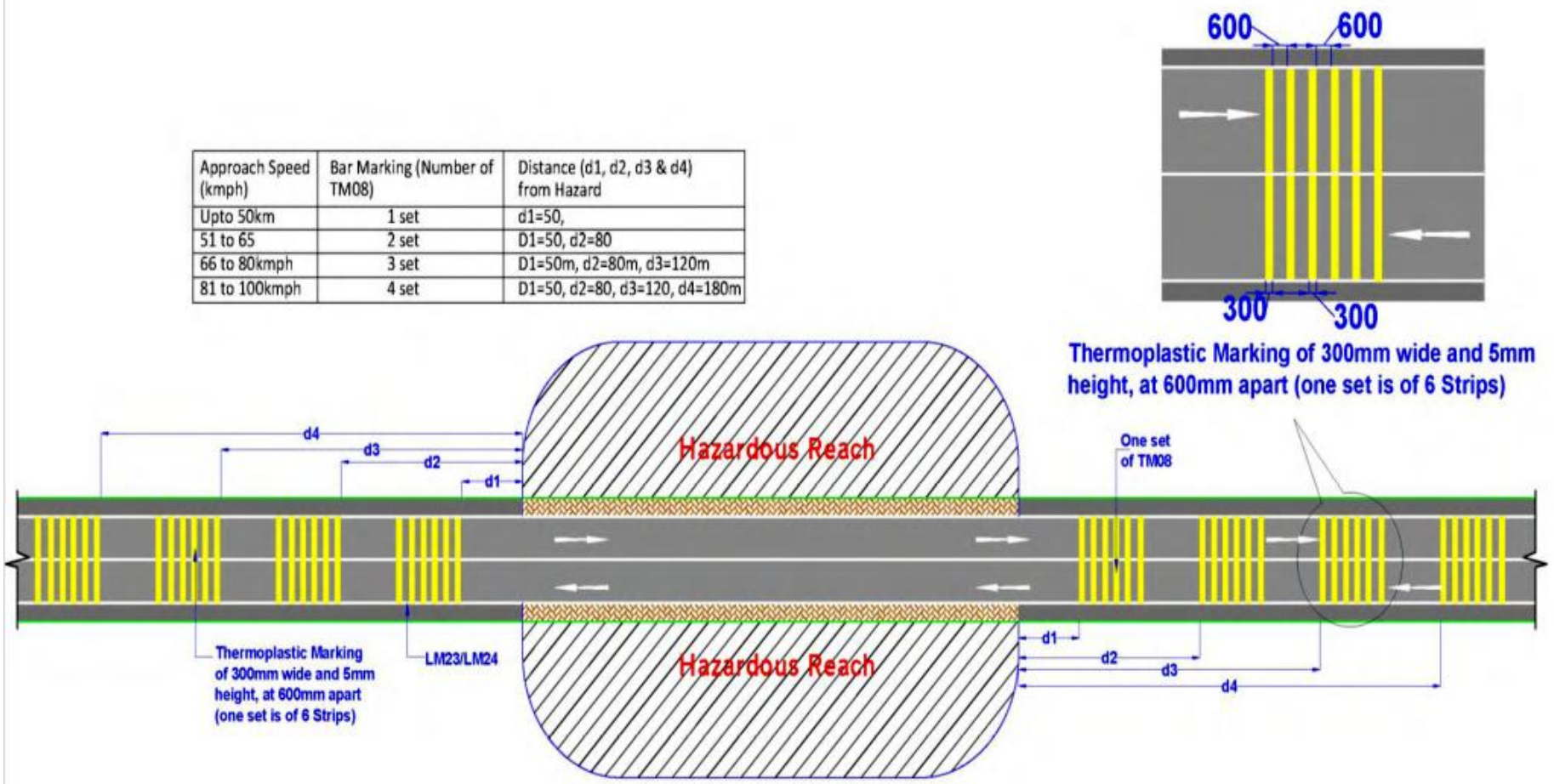


Figure :: Typical Example of Hazardous Reach Treatment with Traffic Calming using Thermoplastic Bar Markings.

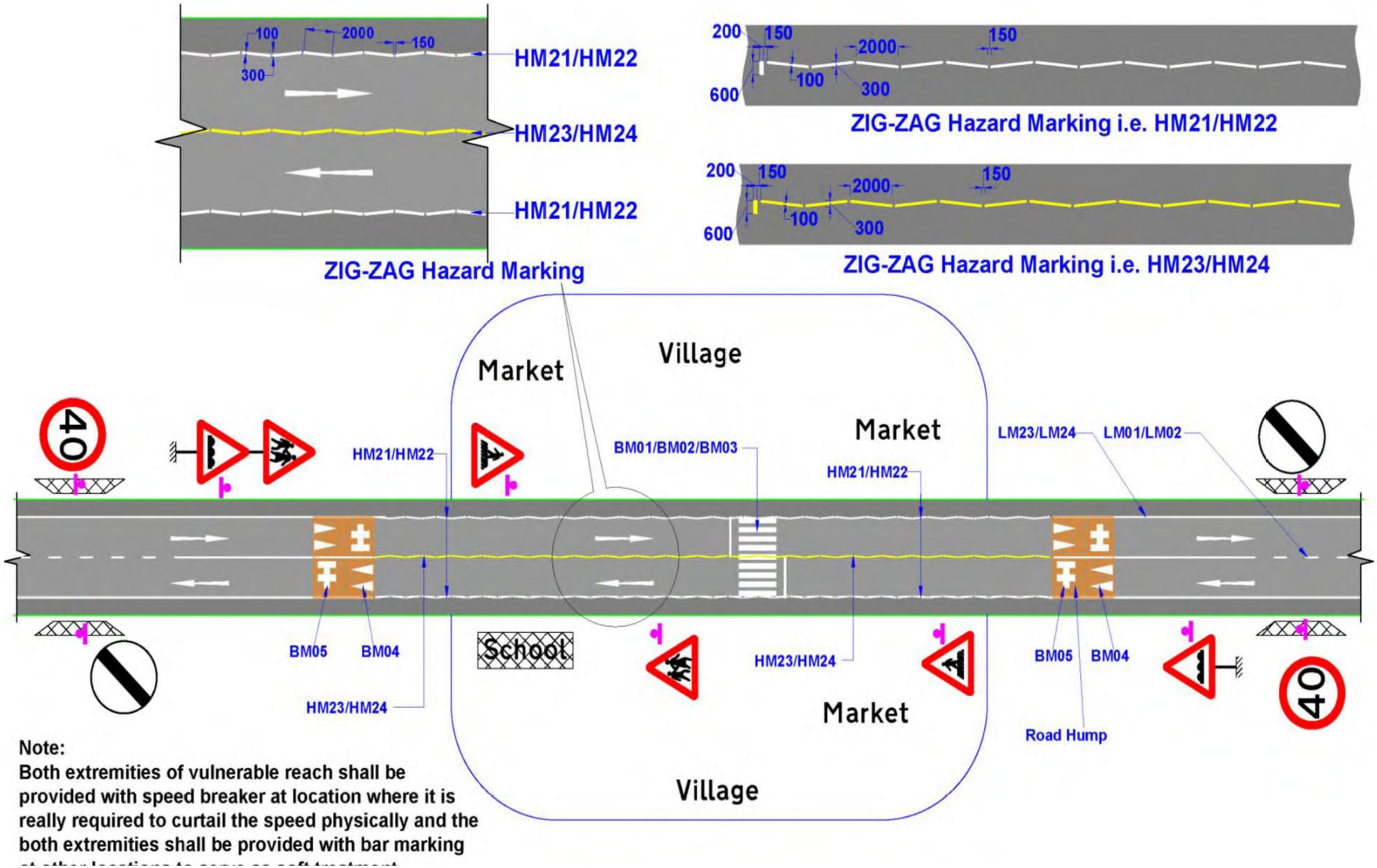


Figure :: Typical Example of Vulnerable Reach Treatment with Traffic Calming near Built-up Areas

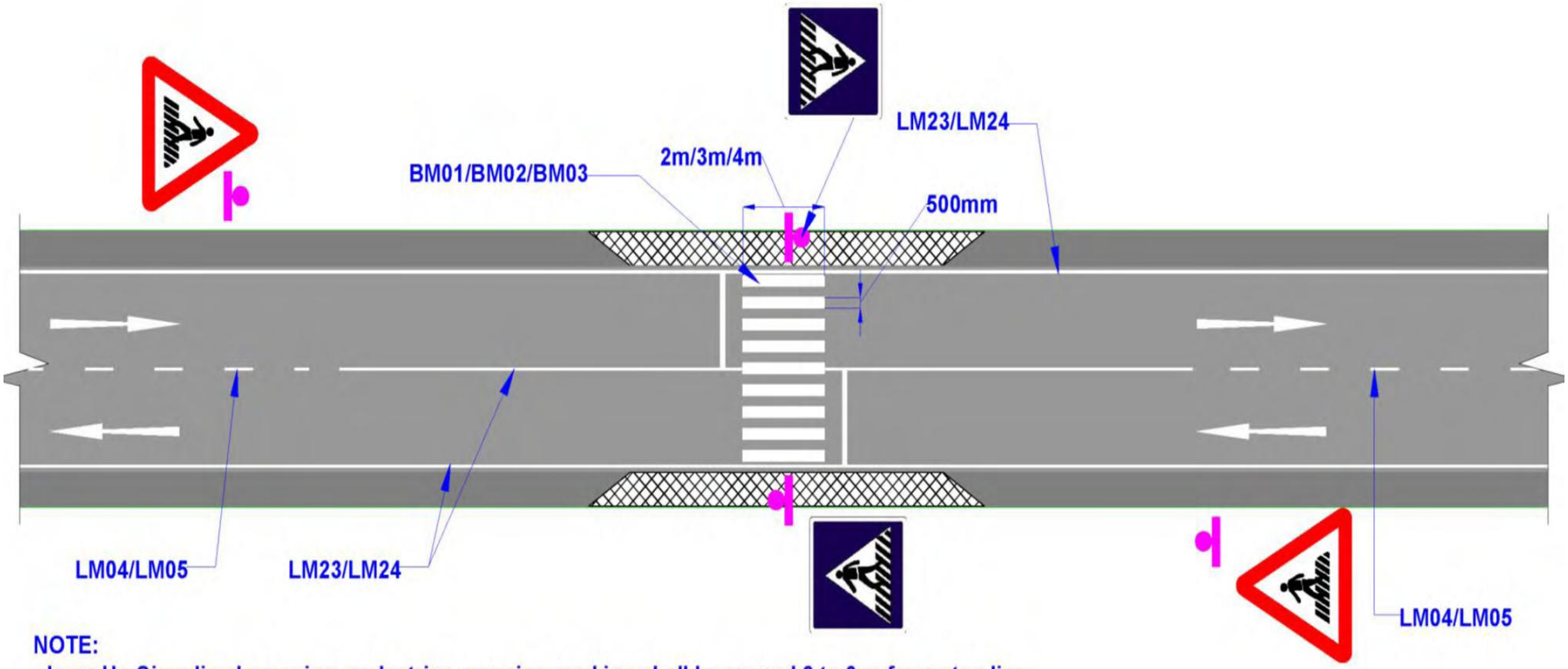


Figure :: Typical Example of provisions for stand-alone Pedestrian Crossings

Control of Encroachments at Urban Areas