



Low cost High Impact Road Safety Measures

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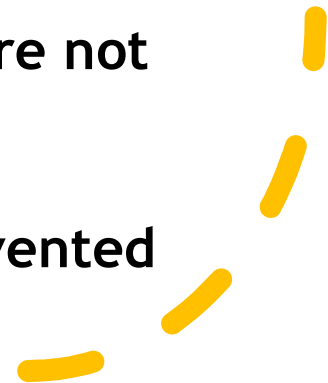
**Transportation Research and Injury Prevention Centre (TRIP Centre)
Indian Institute of Technology Delhi, New Delhi.**





Guiding Principles

- There is no fundamental difference between injuries and the occurrence of any other disease.
- Injury can be defined as a disease that results from an acute exposure of the human body to transfer of energy from the environment around it
- “Accidents” and injuries are not acts of God
- All injuries cannot be prevented

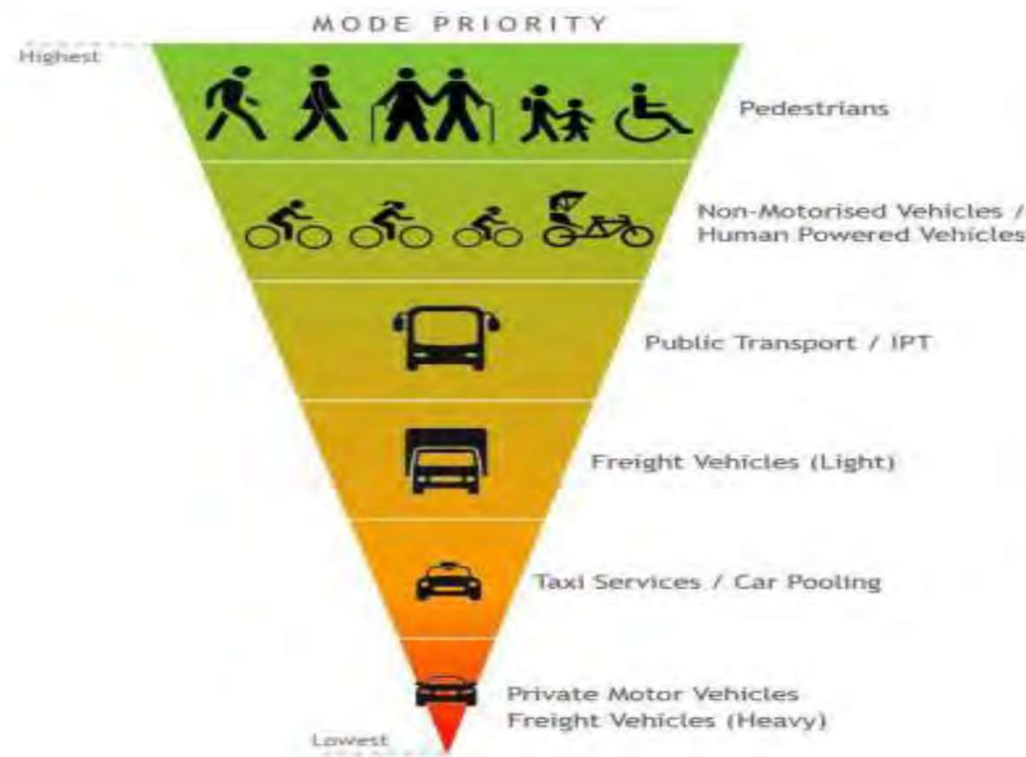




Key Principles of Safe System Approach Vision Zero

- Principle 1 : Recognition of human frailty
- Principle 2 : Acceptance of human error
- Principle 3 : Creation of a Forgiving environment and appropriate crash energy management.

Priority in urban traffic/mobility/infrastructure





LUSTRE summary (lower Urban Speed Limits in Europe, May 2023)

- Excessive or inappropriate speed is major contributory factor to road casualties. Setting and enforcing speed limits is a well established part of road safety policy.
- As per Vision Zero , a safe speed is one at which the road user can withstand a collision without suffering a death or life changing injury. (safety performance of the vehicles, infrastructure and nature of collision).
- 20mph (30km/h) is generally accepted as the safe speed for streets used by pedestrians and cyclists.



20 MPH/30KMPH Zones

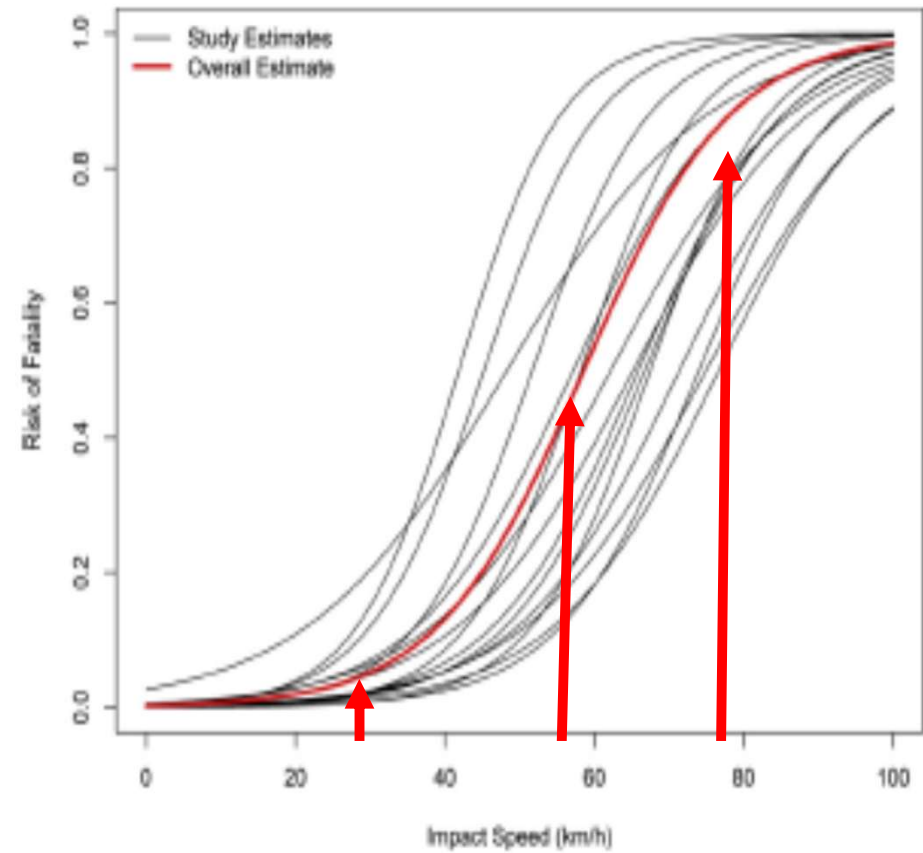
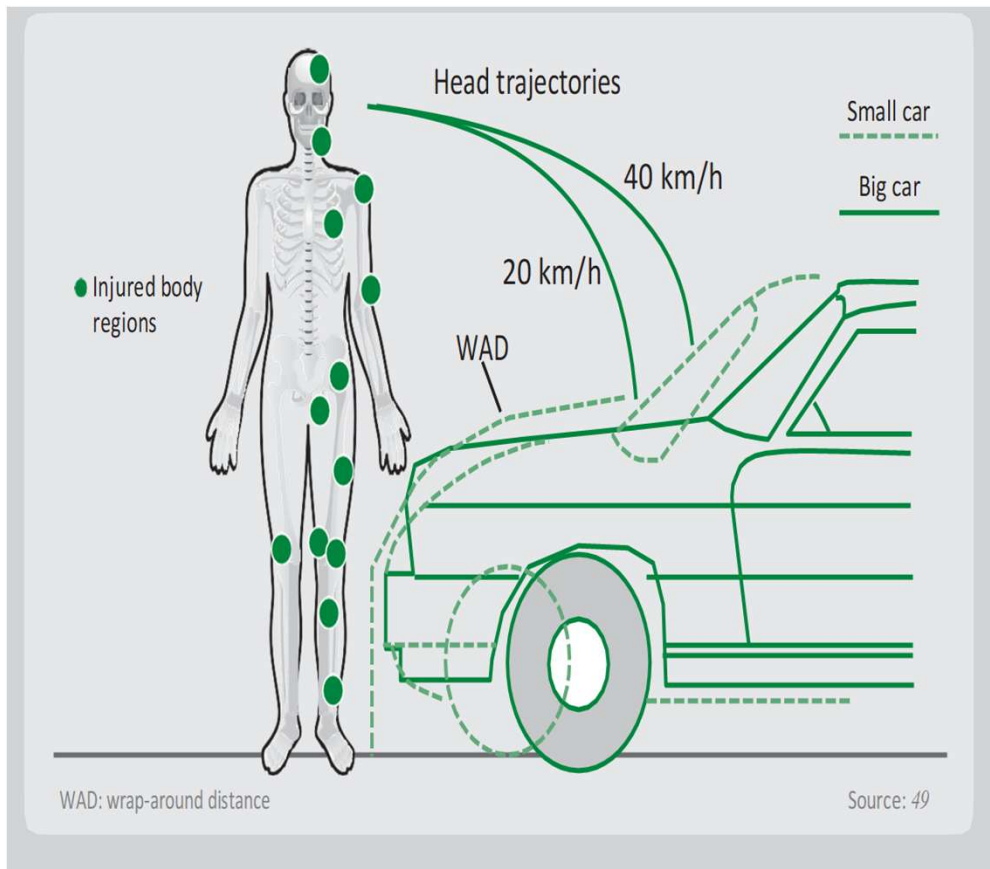
- 20mph speed limit should be self enforcing, speed humps and other traffic calming measures were installed in UK, and evaluated. Vehicles speed and casualties reduced substantially.
- Research has established that speed and casualty reductions from introducing 20mph with self enforcing physical measures are greater than 20 mph speed limits with no physical measures.



Findings from UK and 6 European countries

- 20 mph speed limit without physical measures result in modest speed reduction(1-2 mph when speed were 25 mph and 3-5 when speeds were 30mph and 11% reduction in casualties in UK
- EU registered 18% reduction in casualties when 30km/h limit was introduced.
- Complementary cycling infrastructure may have contributed to additional benefit.

Pedestrian vulnerability

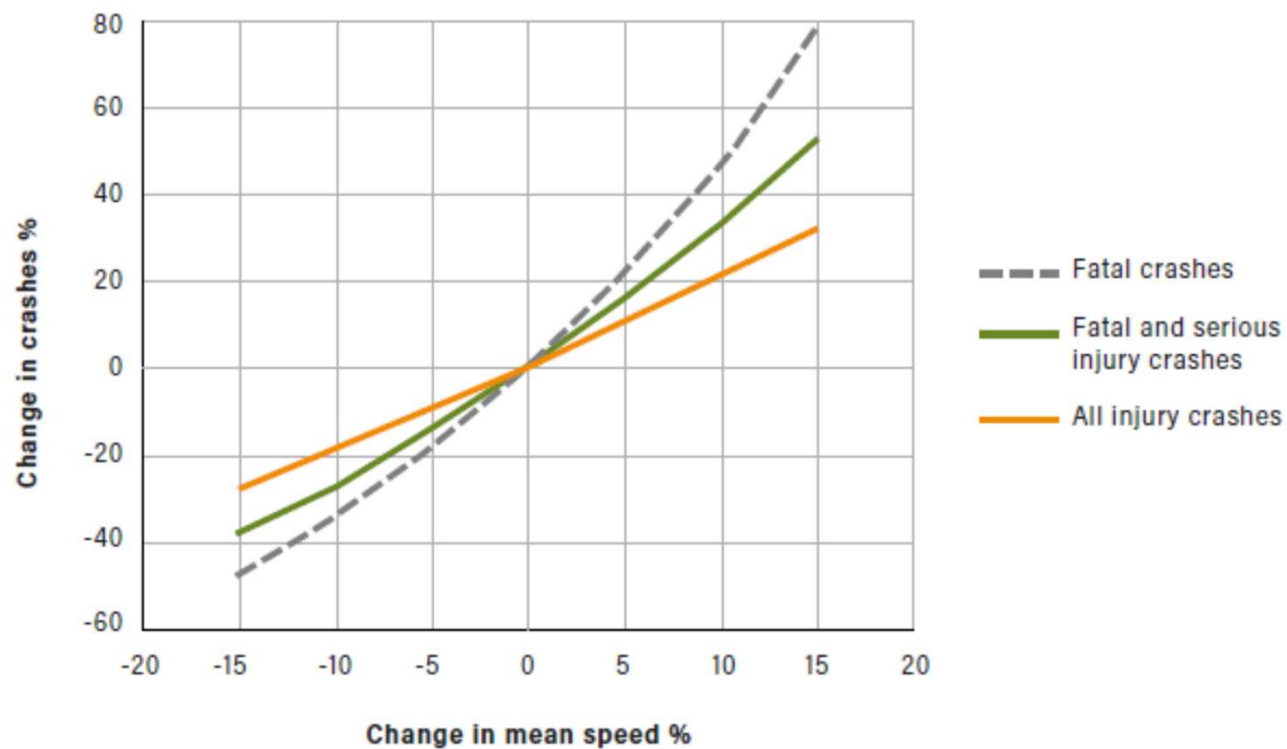




% change in mean speed and crashes

(WHO speed management manual, 2023)

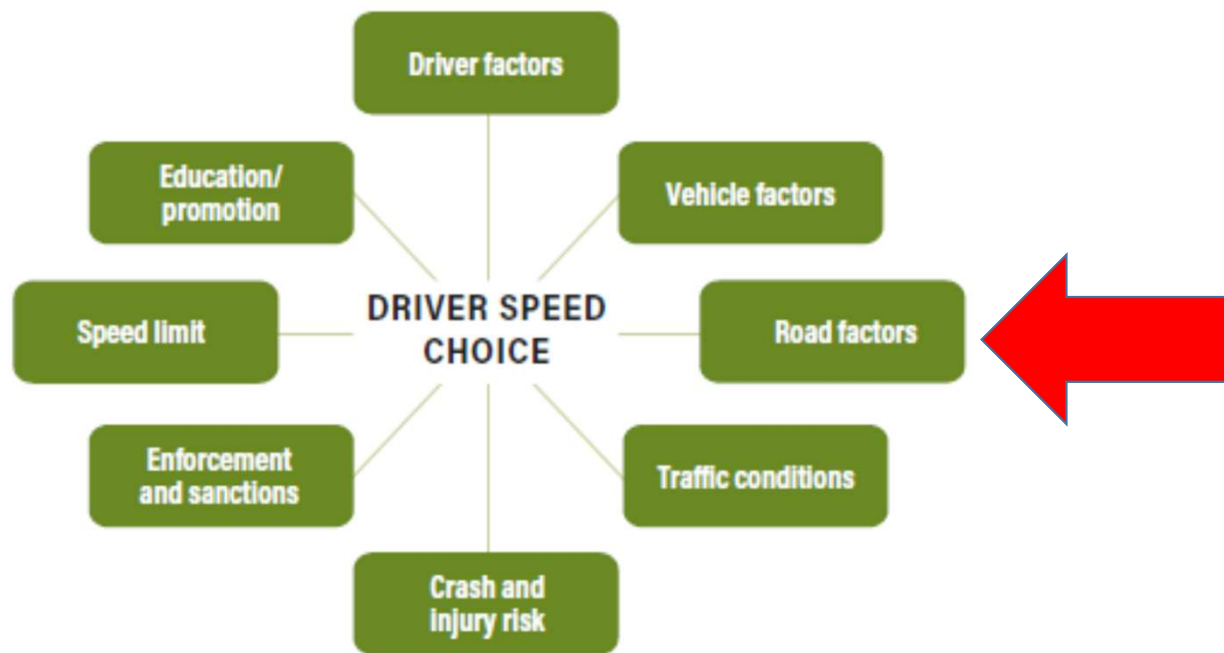
Fig. 1.2 Relationship between percentage change in mean speed and the percentage change in crashes





Risk Factors affecting speed choice

Fig. 1.5 Risk factors affecting speed choice



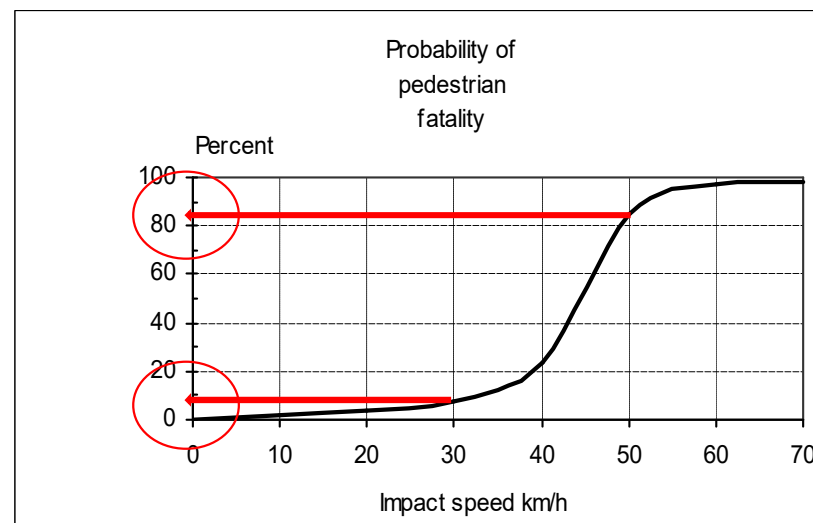
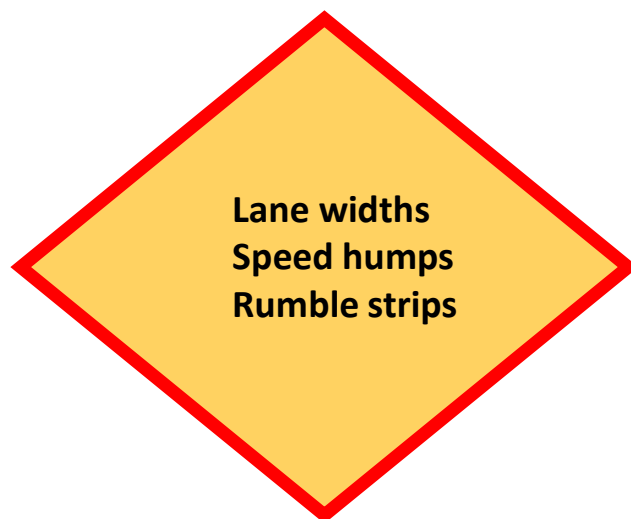
Source: (52).



Speed reduction

Urban speed limits should
not exceed 50 km/h 30km/h(2023)

local authorities should
be able to reduce speeds
where necessary.





Helmets and motorised two wheeler safety

- 30-40% fatal crash victims are two wheeler riders.
- Helmets can reduce head injury.
- Helmets are effective in low as well as high speeds.
- Helmets are essential for driver as well as riders.
- Day light head lights improves visibility and therefore reduces chances of crash.



Motorcycle helmets

Wearing a good quality motorcycle helmet can reduce the risk of death by $\pm 40\%$ and severe head injury by $>70\%$.
Strict enforcement by police improves compliance.

Most cities have less than 40% compliance





Traffic Safety around schools Safe Environment?

- Low speed limit zones near schools(20km/h)
- Introducing traffic calming techniques near school zones for better speed management and compliance.
- Making bicycling and walking options (safe routes to schools).
- Encourage bus transport instead of cars or two wheelers.



Safe Intersection design Principles

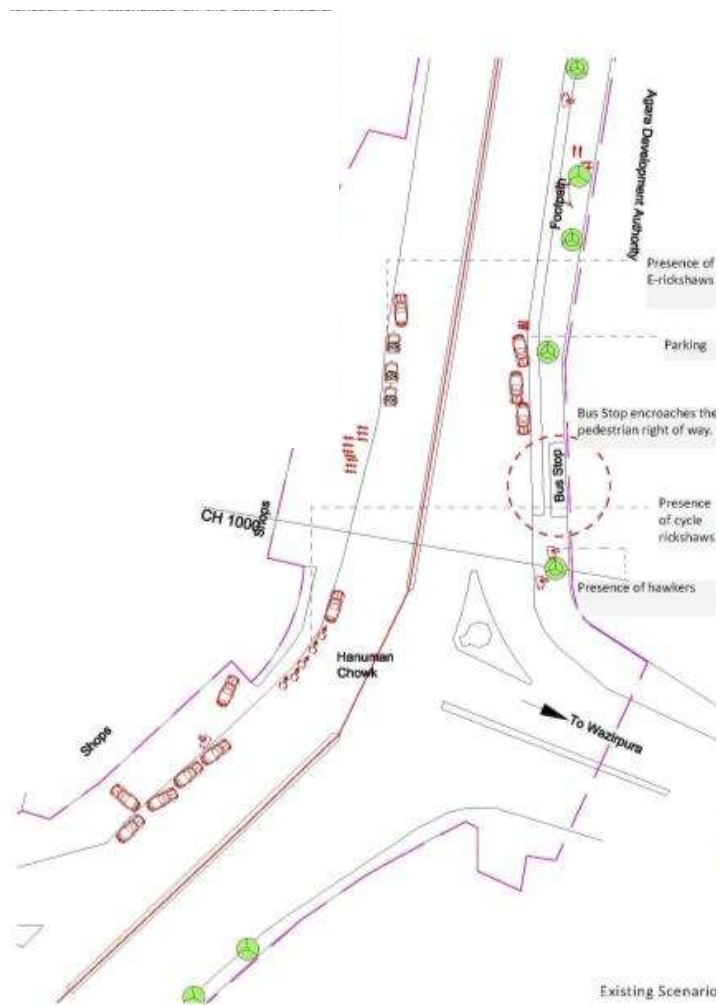
(Candappa et al., 2015):

- Principle 1 – key principle – limit travel speeds through intersections to 50 km/h)
- Principle 2 – important principle – avoid 90° impact angles,
at 70 km/h, colliding at a 90° angle generates kinetic energy of around double the maximum tolerable lateral kinetic energy of 96.5 kJ..
- Travel speeds above 50 km/h, 90° impact angles are not compatible with Safe System ideals.

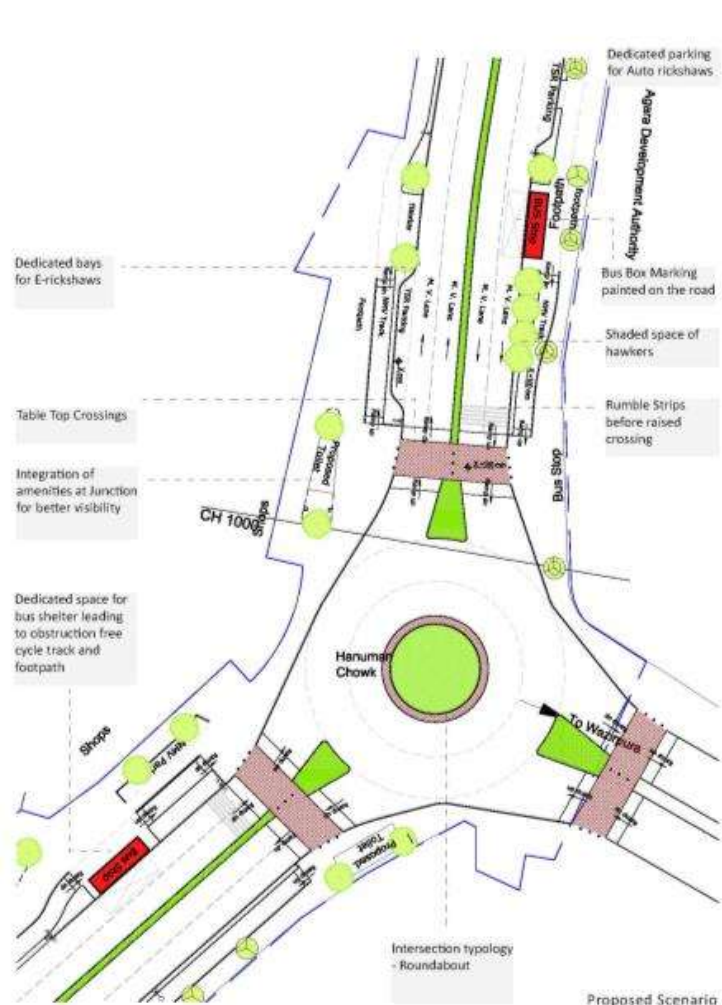


Principle 3 – important principle – physically separate vulnerable road users or provide travel speeds <30 km/h

- The absence of any vehicle protection leaves vulnerable road users open to the full force of a crash.
- Temporal separation of vulnerable road users from vehicles is less effective in meeting Safe System ideals as this still relies on road user compliance and avoidance of error.
- For this reason, temporal separation has not been defined within Principle 4 as it still leaves open the possibility of serious injury.



39



40



Safe T Junction



Name of Intersection

Lado Sarai Intersection

Latitude

28°31'24.39"N

Longitude

77°11'24.44"E

Type of Junction

T-Intersection

Signalized/ Unsignalized

Signalized

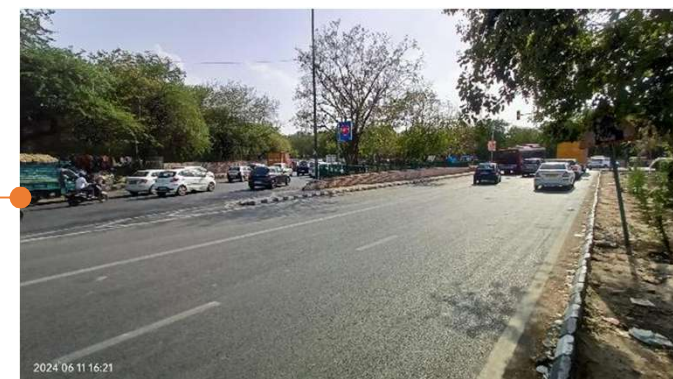
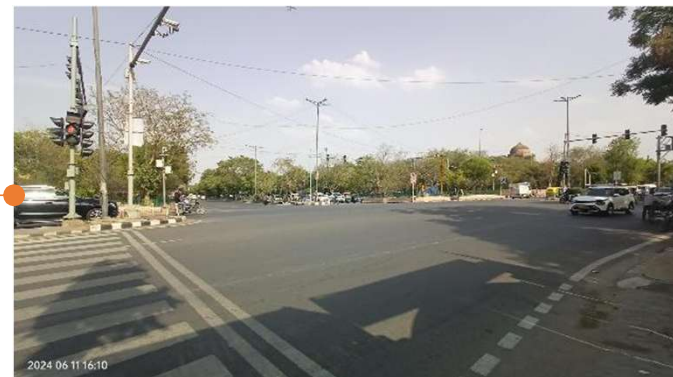
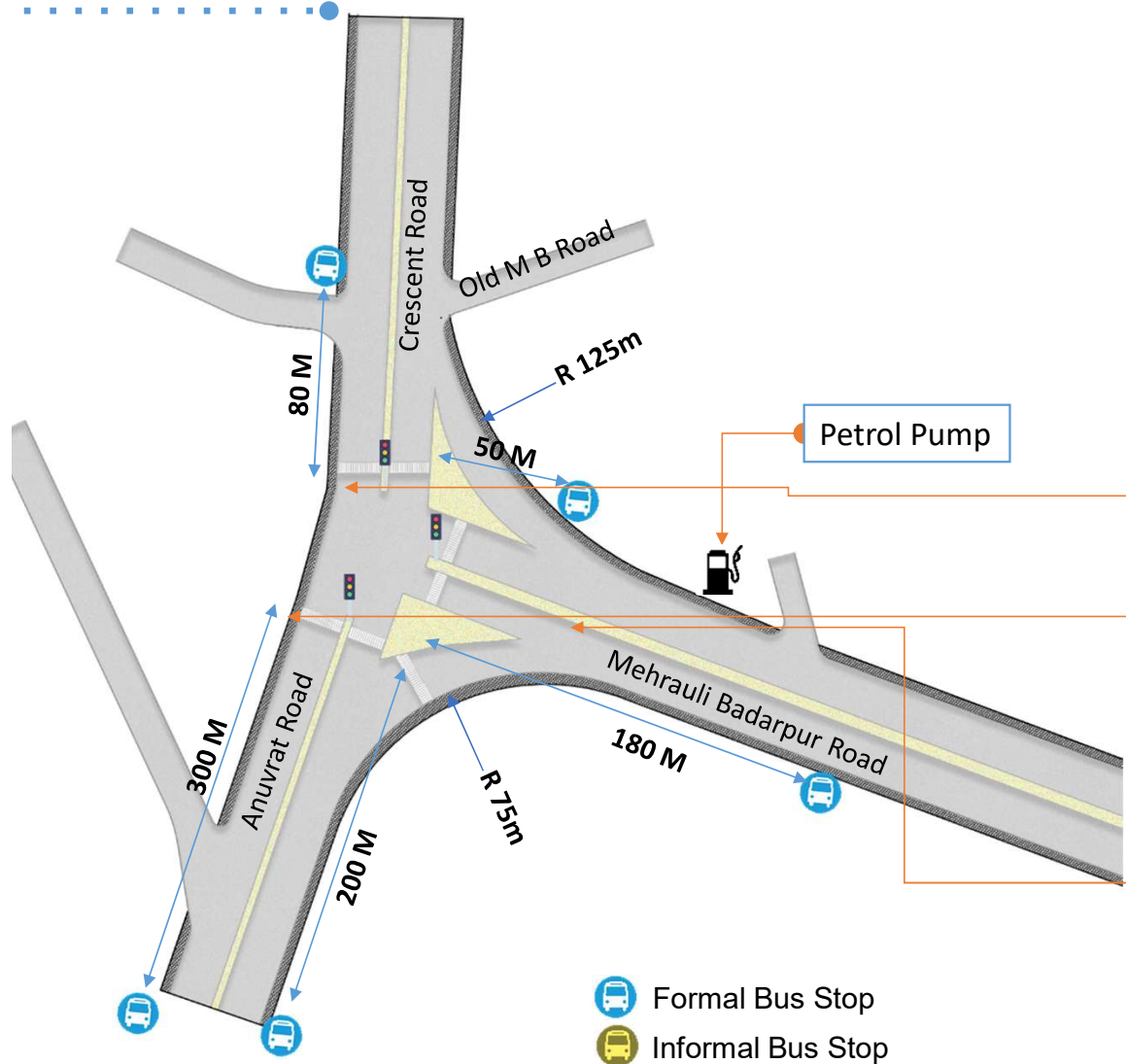
Intersecting Road Names

Mehrauli-Badarpur Road(Sub-Arterial Road)

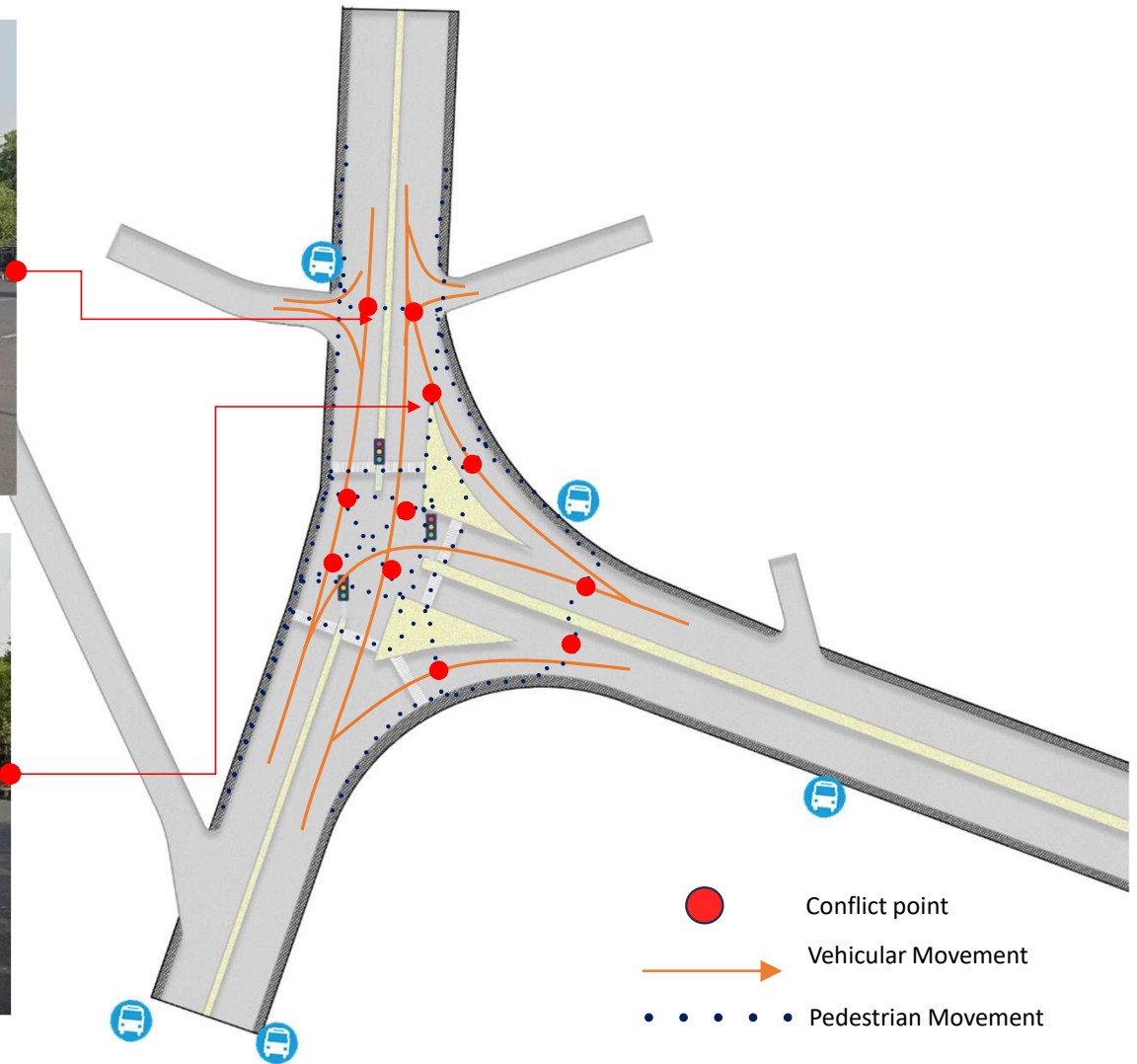
Anuwat Marg(Sub-Arterial Road)

SGA sustainable mobility solutions

Existing Scenario



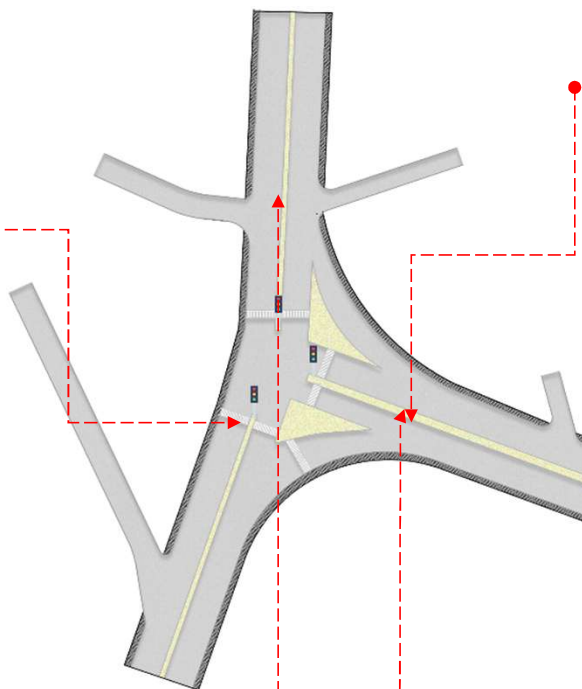
Existing Vehicular & Pedestrian Movement



Issues Identified



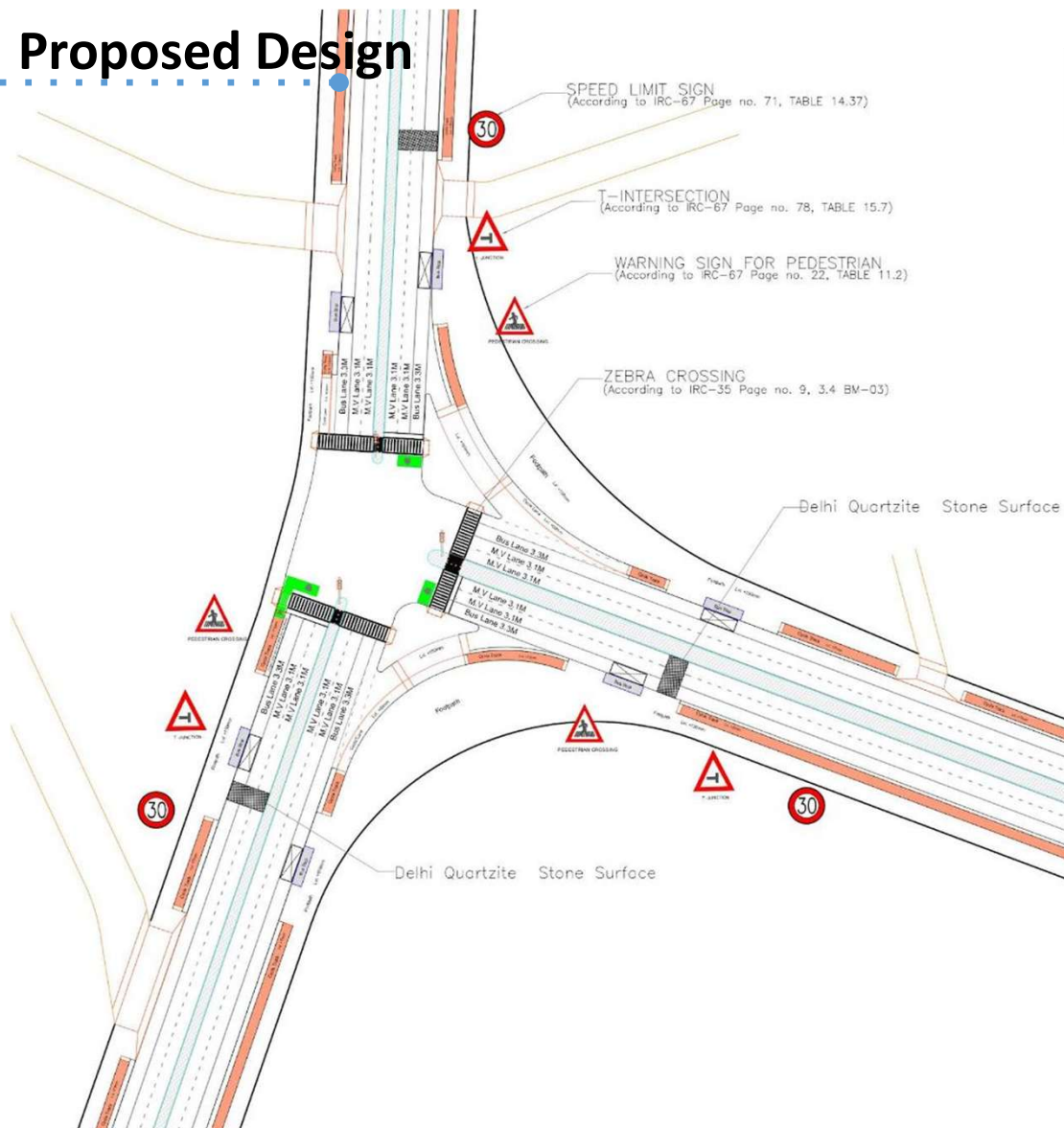
Faded road markings and signboards



Median opening due to damaged guardrail, people tends to cross the road from median which making pedestrians vulnerable



Proposed Design



The junction is redesigned for the speed of 30 km/hr to ensure the safety

Provision of raised crossing with paver block & cobbled stone to prevent speeding on free left turn

Dedicated 2.5m wide cycle track to separate the motor traffic and the cyclists (as per IRC: 11-2015)

Proposed new bus stop near (30m to 100m) the junction to reduce the pedestrian crossing movement

Corrected turning radius and geometry to reduce conflict area and vehicle speed

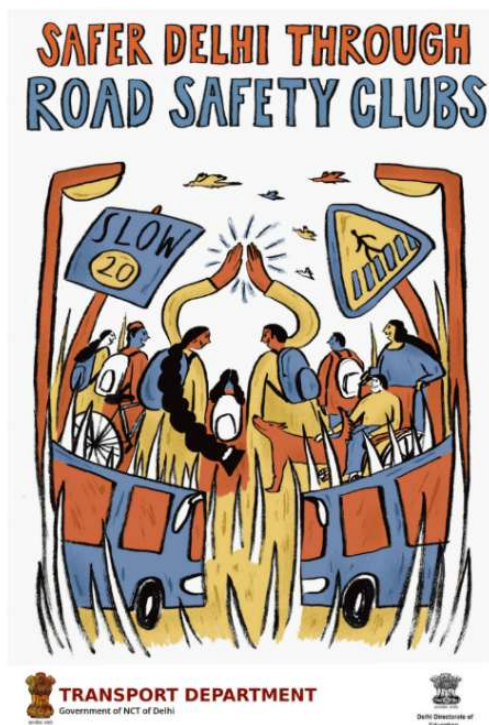
Redesigned the geometry of junction and proposed a roundabout with cobbled stone texture on surface to prevent speeding at junction

Provision of Delhi Quartzite stone surface to slow down the approaching traffic

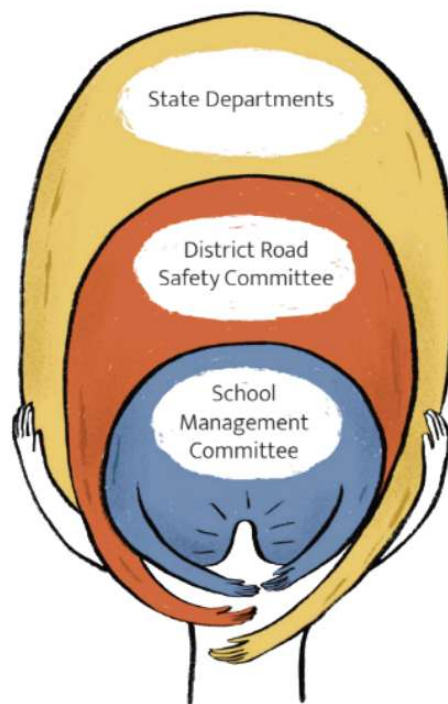
Installation of signages - Speed Limit, stop sign, pedestrian crossing and other necessary Signages.

Provision of tactile pavers and kerb ramps for the accessibility of differently abled users (as per IRC:103-2022)

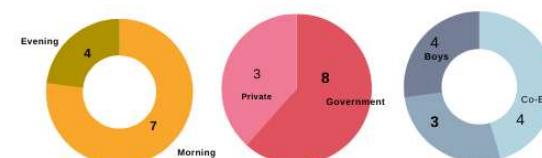
Safe School Zones



11 Safety Clubs were formed in 11 schools comprising of all school members, including students



DRSCs monitor road safety clubs initiatives and get insights to improve traffic safety support in the district



11 schools, one in every district were selected based on proximity to high risk locations

Road Safety Club Curriculum

HumanQind

1 | Orientation



2 | Collection of School Data



3 | Design Collaboration



4 | Exhibition



5 | Implementation



6 | Management



Photo: HumanQind
24

District South | DAV Vasant Kunj

Implementation by PWD



Location : DAV Vasant Kunj

250 meters of Happiness - safe school zone for all

HumanQind
Public Works Department

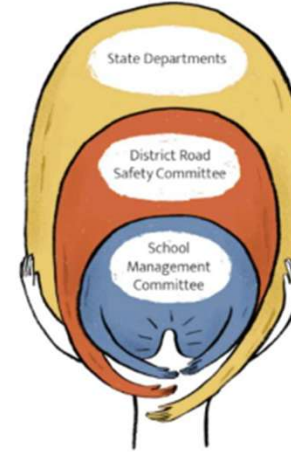


Location : DAV Vasant Kunj

Safe School Zone Initiative (2021- Present)



HumanQind



Road Safety Clubs

- **Apr 22 - Oct 22** | Via Lead Agency, DoE institutionalised road safety clubs (2500+ schools) - Constitutes all school members and students
- Road Safety Club curriculum with 6 step methodology;
- Step 1-4 : Education. Step 5- PWD/MCD. Step 6 - Traffic Police.

Model Safe School Zones

- 11 proposals ready for implementation (2023)
- One every district
- **Jul 22 - Aug 23** | Co-created by students, school road safety clubs and youth fellows (25000 students, 3000+ hrs)
- Potential impact - 25 schools – 100000 student families
- Estimated Budget - INR 70 cr

DRSC Support

- 50+ DRSC meetings across 6 districts
- Meetings with SDM, PWD, DDE
- 6/11 districts have initiated site meeting on proposal.
- **10 zones pending implementation.**
- DRSC reports

Delhi's Pilot School Zone

- District South - DAV VK - 250 meters of Happiness
- **India's first. Impact: 4 schools - 10000 students**
- Design support to PWD SRII
- 20km/h zone; IRC compliant; 40% public realm added
- International case study

Recommendations

Noorpur– (BS 107) – Type-IV

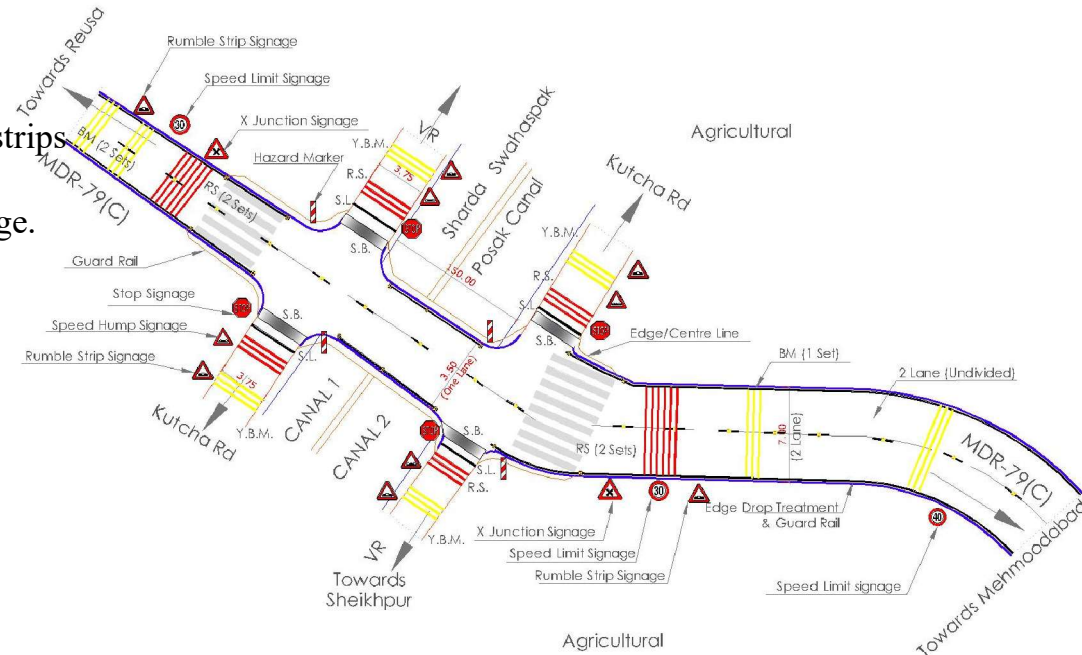
Major road (Reusa-Mehmoodabad MDR) :

Sequential application of interventions such as:

- Provide two sets (one set has 6 strips) of bar markings & rumble strips (one set has 6 strips) as per **IRC 99-2018** on both sides of the bridge.
- Provide centre line / edge line markings (**IRC:35-2015**)
- Provide hazard markers for hazardous objects (**IRC 67-2015**)
- Provide lighting for night time traffic & guardrails at the curved section.

Minor roads (Village Roads):

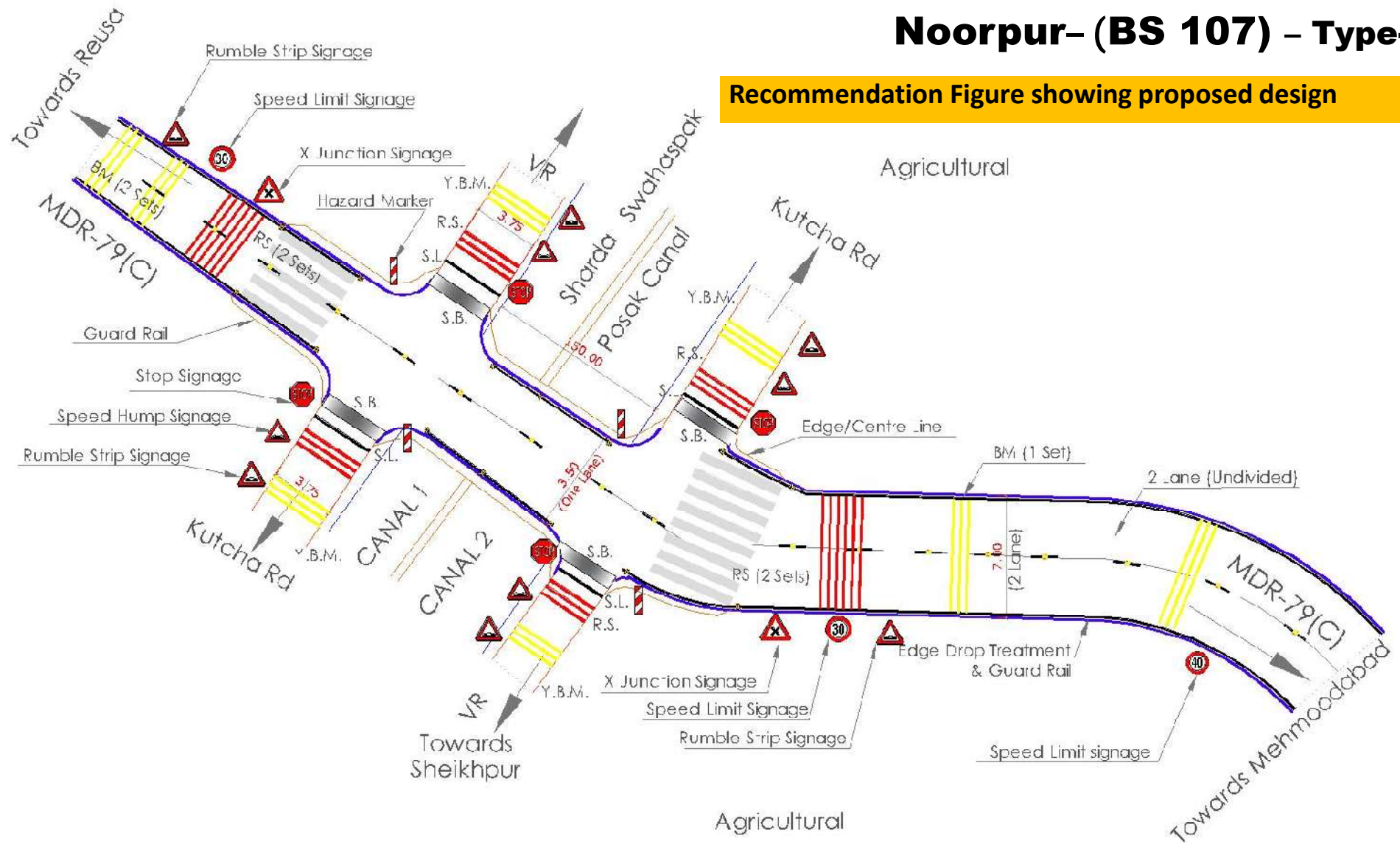
- Set of bar markings as per design speed (30 kmph) (**IRC 99-2018**)
- Rumble Strips- one set on each minor road (VR) along with its cautionary sign.
- Circular speed hump with stop line.



Recommendation Figure showing proposed design

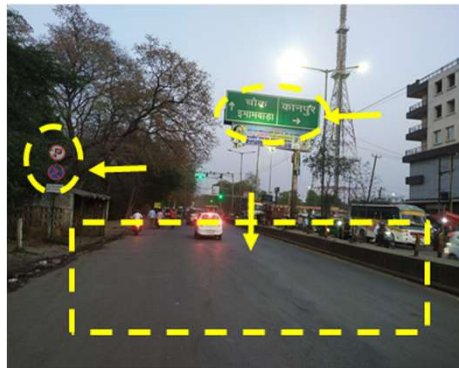
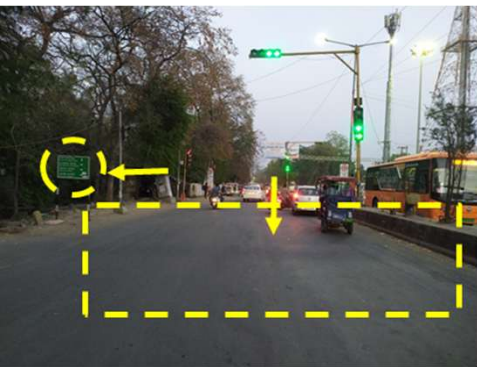
Noorpur- (BS 107) – Type-IV

Recommendation Figure showing proposed design



“T” Junction

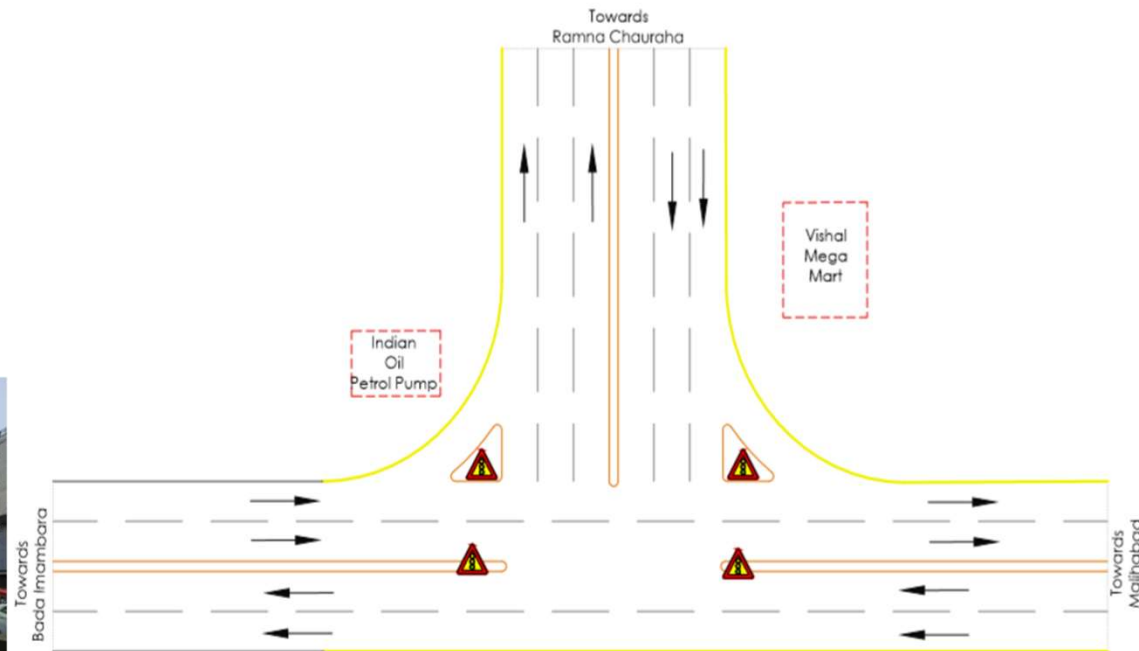
- The predominant land use in the vicinity of this blackspot is commercial, barren and residential.
- Major landmark around this blackspot is the petrol pump. Pedestrians were crossing and walking along the road.
- Buses were boarding and deboarding the passengers at informal stops.
- The shoulder was occupied by the vendor shops, M2W, M3W and other parked vehicles.



BS 40

BS Name - Dubanga

Road Category - NH



Activities Drawing showing Plan and Cross-section

“T” Junction

Major Road Recommendations Tondan Road (NH-230):

Speed control and driver alerting measures:

- Provide sets (one set has six strips) of bar markings (5 mm thick) before the Trapezoidal speed table both sides of the junction on the major road.
- Provide Trapezoidal speed tables before the junction on the Major road as per across the whole carriageway, and it should have markings as per standard.
- Edge drop shall be treated with a safety edge. For details of the safety, edge treatment.
- Provide Six-metre-wide textured patch on approach lanes of the major road after Bar marking.

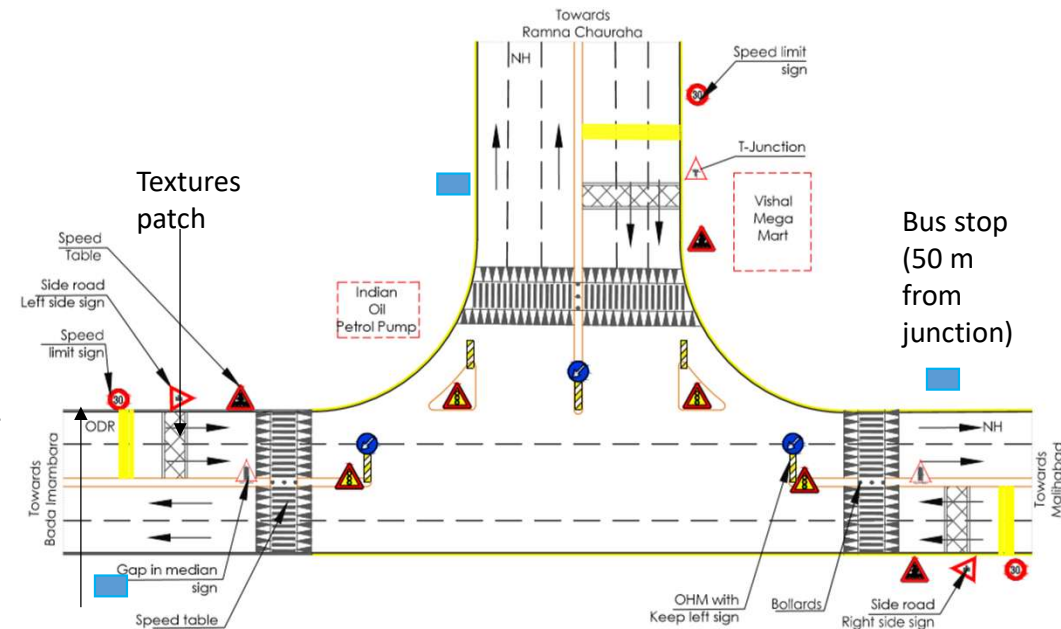
Road markings as per IRC:35-2015:

- Provide road markings.
- Hazardous roadside objects shall be highlighted with hazard makers.

Road signage's as per IRC:67-2021:

- Provide speed table and T- junction signs before the junctions of the major road.
- Provide Speed limit sign before the junctions of the major road.

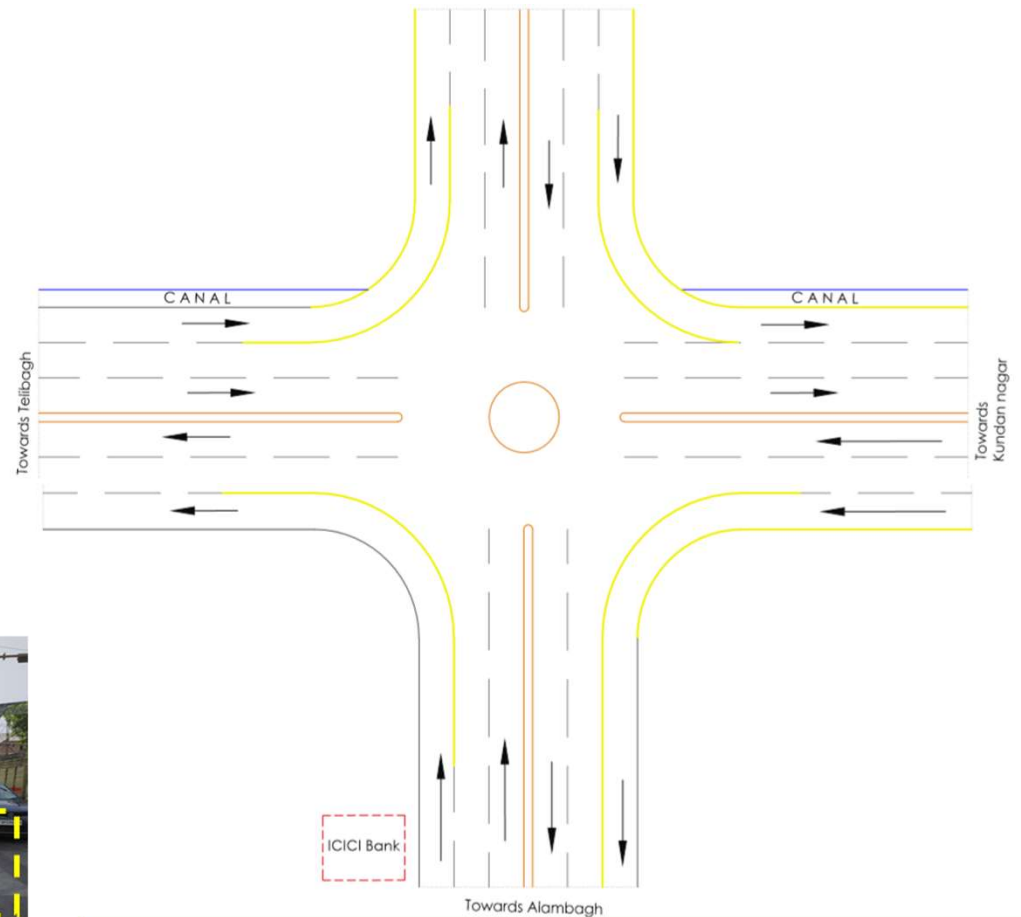
OPTION A



Recommendation Figure showing proposed design

"X" Junction

- Predominant land use in the vicinity of this blackspot is commercial and residential.
- Pedestrians were crossing and walking along the road.
- There is a canal across the road.
- Buses were boarding and deboarding the passengers at informal stops.
- Vehicles were over speeding at the location.



Activities Drawing showing Plan and Cross-section

"X" Junction

Major Road Recommendations Tondan Road (NH-230):

Speed control and driver alerting measures:

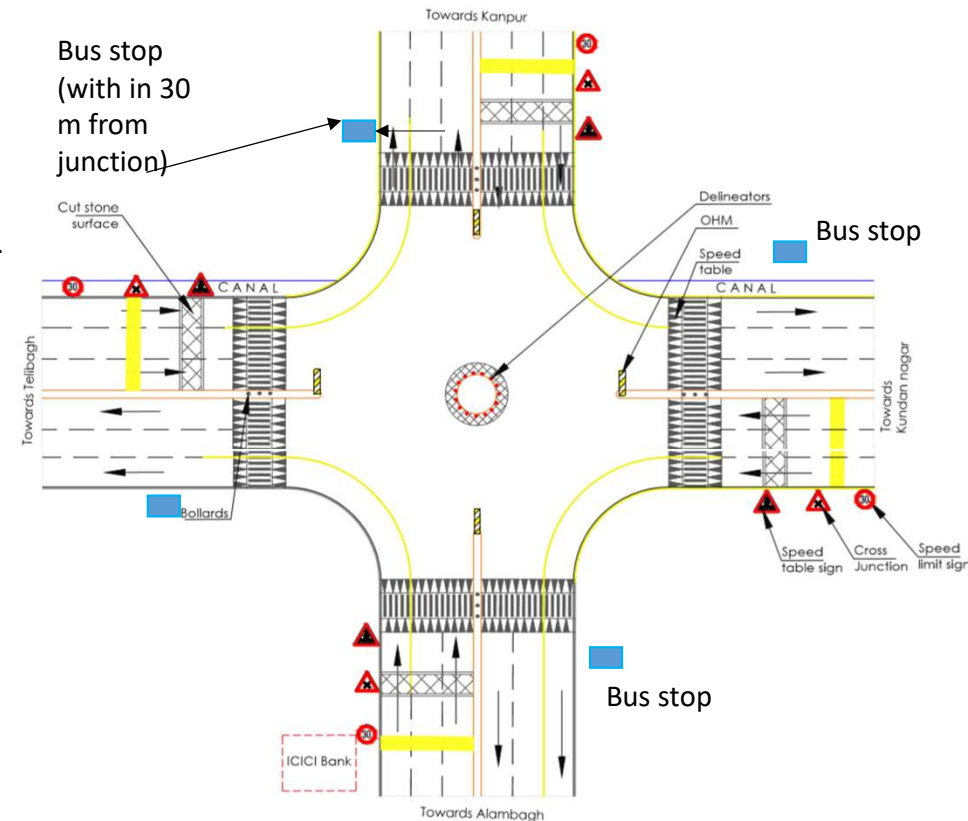
- Provide sets (one set has six strips) of bar markings (15 mm thick) before the Trapezoidal speed table both sides of the junction on the major road.
- Provide Trapezoidal speed tables before the junction on the Major road as per across the whole carriageway, and it should have markings as per standard.
- Edge drop shall be treated with a safety edge. For details of the safety, edge treatment.
- Provide Six-metre-wide textured patch on approach lanes of the major road after Bar marking.

Road markings as per IRC:35-2015:

- Provide road markings.
- Hazardous roadside objects shall be highlighted with hazard makers.

Road signage's as per IRC:67-2021:

- Provide speed table and X-Intersection signs before the junctions of the major road.
- Provide Speed limit sign before the junctions of the major road.
- Provide hazard markers for hazardous objects.



Recommendation Figure showing proposed design

“Y” Junction

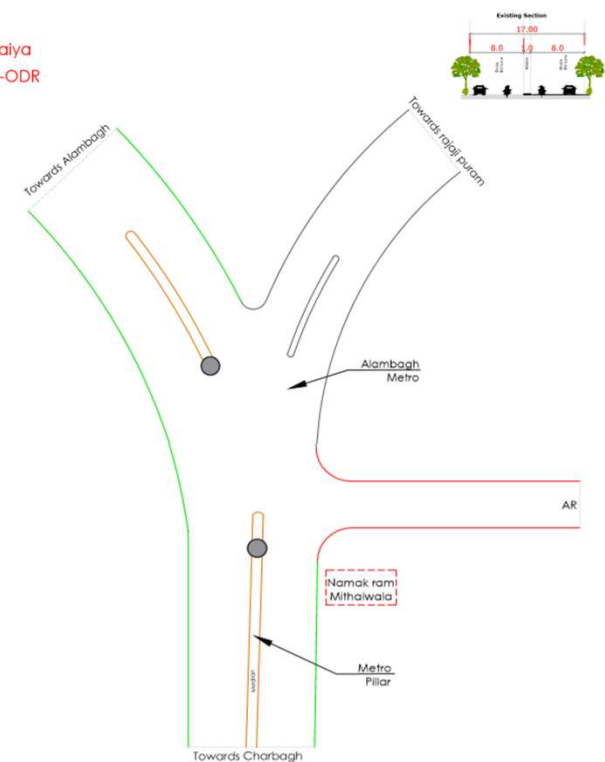
- This junction is primarily located in the urban area where the predominant land use in the vicinity of this blackspot is residential and commercial.
- Pedestrians were crossing and walking along the road.
- There is a curved section on the road.
- Buses were boarding and deboarding the passengers at informal stops.
- Temporary barricades were present at the junction for restricting the incoming vehicles to the junction from minor road and AR.
- Vehicles were over speeding at the BS location.
- Unsafe edge drop



BS 78

BS Name - Mawaiya

Road Category -ODR



Activities Drawing showing Plan and Cross-section

“Y” Junction

Major Road Recommendations Mangal Pandey Marg (ODR):

Speed control and driver alerting measures:

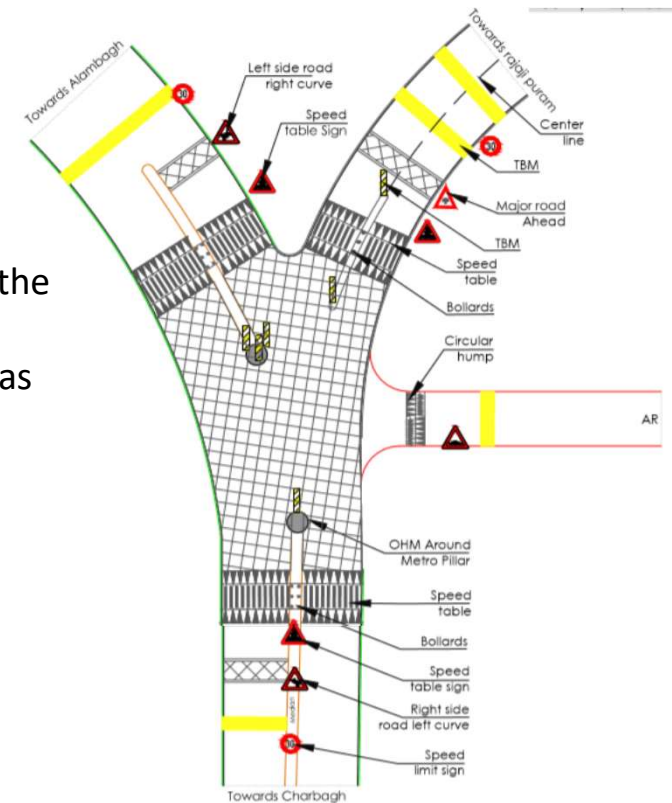
- Provide sets (one set has six strips) of bar markings (5 mm thick) before the Trapezoidal speed table both sides of the junction on the major road.
- Provide Trapezoidal speed tables before the junction on the Major road as per across the whole carriageway, and it should have markings as per standard.
- Edge drop shall be treated with a safety edge. For details of the safety, edge treatment.
- Provide Six-metre-wide textured patch on approach lanes of the major road after Bar marking.

Road markings as per IRC:35-2015:

- Provide road markings.
- Hazardous roadside objects shall be highlighted with hazard makers.

Road signage's as per IRC:67-2021:

- Provide speed table and Y- junction signs before the junctions of the major road.
- Provide Speed limit sign before the junctions of the major road.
- Provide hazard markers for hazardous objects.



Recommendation Figure showing proposed design

Staggered junction

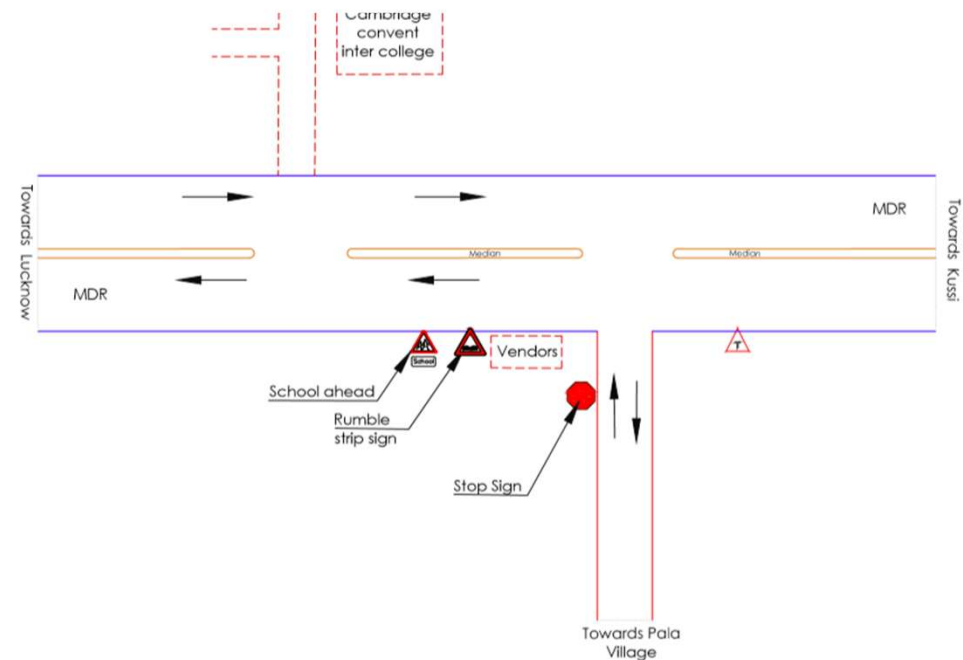
- The BS-323 Behati Area is primarily located in the urban area where the predominant land use in the vicinity of this blackspot is residential, commercial and agricultural.
- Pedestrians were crossing and walking along the road.
- The shoulder was occupied by the vendor shops, M2W, M3W and other parked vehicles.
- Buses were boarding and deboarding the passengers at informal stops.
- Vehicles were over speeding at the BS location.



BS 323

BS Name - Behati Area

Road Category - MDR



Activities Drawing showing Plan and Cross-section

Staggered junction

Major Road Recommendations Kursi Road (MDR-77C):

Speed control and driver alerting measures:

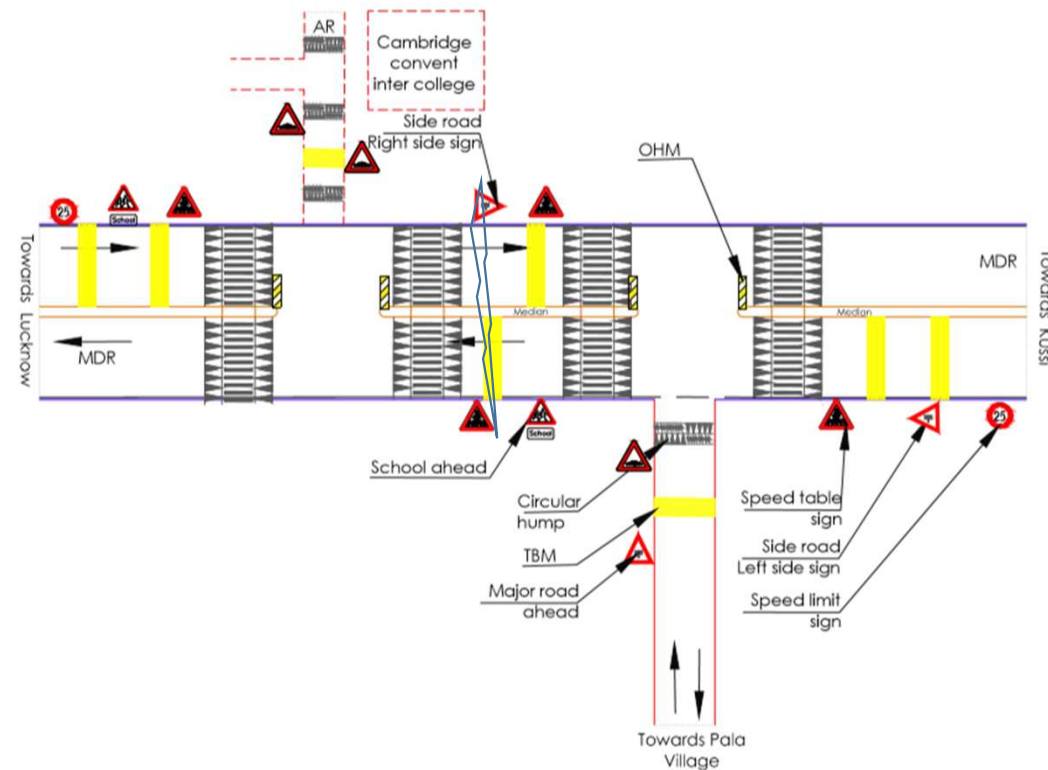
- Provide sets (one set has six strips) of bar markings (5 mm thick) before the Trapezoidal speed table both sides of the junction on the major road.
- Provide Trapezoidal speed tables before the junction on the Major road as per across the whole carriageway, and it should have markings as per standard.
- Edge drop shall be treated with a safety edge. For details of the safety, edge treatment.

Road markings as per IRC:35-2015:

- Provide road markings.
- Hazardous roadside objects shall be highlighted with hazard makers.

Road signage's as per IRC:67-2021:

- Provide speed table and T- junction signs before the junctions of the major road.
- Provide Speed limit sign before the junctions of the major road.
- Provide hazard markers for hazardous objects.



Recommendation Figure showing proposed design

Effectiveness of Measures for improving pedestrian safety

Key measures	Examples of interventions	Effectiveness		
		Proven	Promising	Insufficient evidence
	Provide sidewalks	Yes		
	Install and/or upgrade traffic and pedestrian signals		Yes	
Reduce pedestrian exposure to vehicular traffic	Construct pedestrian refuge islands and raised medians	Yes		
	Construct enhanced marked crossings		Yes	
	Provide vehicle restriction/diversion measures		Yes	
	Install overpasses/underpasses			Yes
	Improve mass transit route design	Yes		
	Reduce traffic volumes by switching journeys from the car to public transport, walk and cycle for distances and purposes where these options work well	Yes		

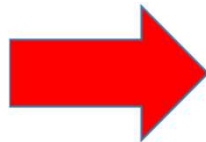
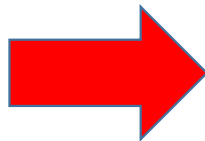
Effectiveness of Measures to improve Pedestrian Safety

	Reduce speed limit	Yes		
	Implement area-wide lower speed limit programmes, for example, 30km/hr	Yes		
Reduce Vehicle Speeds	Implement road-narrowing measures		Yes	
	Implement speed management measures at road sections		Yes	
	Install speed management measures at intersections	Yes		
	Provide school route improvements		Yes	
	Provide crossing enhancements		Yes	
	Implement lighting/crossing illumination measures		Yes	
Improve sight distance and/or visibility between motor vehicles and pedestrians	Reduce or eliminate obstruction by physical objects including parked vehicles		Yes	
	Install signals to alert motorists that pedestrians are crossing			Yes
	Improve visibility of pedestrians		Yes	



Speed management best practices

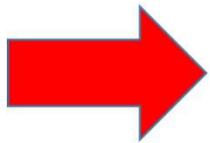
(WHO, Speed Management, 2023)



Intervention	Proven	Promising	Insufficient evidence	Ineffective	Potentially harmful
<i>Establishing speed limits appropriate to the road users (see Section 2.2.1)</i>					
Setting speed limits for new and existing roads based on Safe System principles	✓				
Implementation of 30 km/h zones	✓				
Setting speed limits based on the 85th percentile					✓
<i>Building or modifying roads to include features that reduce speed (see Section 2.2.2)</i>					
Increasing travel speed without improving quality of infrastructure					✓
Speed humps and chicanes	✓				
Lane narrowing	✓				
Refuge islands and kerb extensions	✓				
Footpaths and cycling lanes	✓				
Raised pedestrian crossings	✓				
Pedestrian bridges					✓
Pedestrian fencing			✓		
Raised intersections	✓				
Roundabouts	✓				
Gateway treatment at entrances to towns and villages	✓				



Speed management best practices(WHO,2022)



<i>Enforcing speed limits (see Section 2.2.3)</i>			
Manual speed enforcement	✓		
Automated speed enforcement	✓		
Point-to-point enforcement ("section control")	✓		
<i>Using in-vehicle technologies (see Section 2.2.4)</i>			
Speed limiters (SL)		✓	
Intelligent speed adaptation (ISA)		✓	
Autonomous emergency braking (AEB)		✓	
<i>Raising awareness about the dangers of speeding (see Section 2.2.5)</i>			
Stand-alone public campaigns (TV, newspapers)			✓
Public campaigns supporting enforcement initiatives	✓		
School-based education on speeding		✓	
Driver skills training			✓

B/C ratios for various safety measures

