TOYOTA ROAD IMPROVEMENT PROJECT (TRIP)

NATIONAL HIGHWAY - 5

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KARACHI

TOYOTA

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Executive Summary

National Highway (N-5) is a dominant and lengthy highway in Pakistan connecting Karachi with Thatta, Hyderabad, Punjab, and Peshawar. Additionally, it serves as a connecting route for Baluchistan province and the southern part of Sindh. It covers a total length of 1819 km.

For Toyota Road Improvement Project, approximately 13.5 km segment of the N-5 highway is considered. It starts from the Kalaboard bus stop and ends at Port Qasim Chowrangi. The part of highway considered for the study is of utmost importance due to the presence of industries and significant landmarks. The commercial and industrial land use on the N-5 shows that a diversified proportion of vehicle mix can be observed in this segment consisting of motorcycles, cars, pick-up vans and a significant proportion of heavy vehicles.

Various data collection methods were employed to identify the road defects and arising road safety concerns on the N-5 highway. These included travel time survey, traffic count survey, road inventory survey, and collecting accident data from the Sindh traffic police. A survey was conducted to determine travel time using the test car method and Google live traffic data. This survey helped to obtain the congested segments on the selected route with maximum travel times. The morning peak was observed from Kalaboard to Toyota Roundabout, with the maximum and minimum travel time as 58 and 17 minutes respectively. While the evening peak was observed from Toyota Roundabout to Kalaboard the maximum and minimum travel time as 66 and 17 minutes respectively.

The primary objectives of the traffic count survey were to determine the current traffic volume of through traffic on the selected road segment. For this purpose, five locations were selected for traffic video count survey including Kalaboard, Malir 15, Gulistan Society bus stop, Quaidabad-Landhi bus stop, and Toyota motor office. The maximum volume for both directions was obtained at Kalaboard.

Additionally, a road inventory survey was conducted to collect data on the current geometric conditions of the road. A mosaic image was obtained from it which provided a geometric alignment for the road. In addition to it, a visual inspection was also

conducted along the route at each 100-meter chainage. From which fundamental geometric parameters of the road including lane width, geometry, flyovers, u-turns, intersections, roundabout, signals etc was observed.

The data collected helped the team to conduct detail evaluation for identifying problems on the entire road. In addition to major road defects like potholes, and ditches few geometric defects were also identified. These defects included wrong placement of U-turns, sudden and abrupt left turn near flyovers, uneven width of median throughout the road, major intersections connecting at 90-degree angle with the road, inadequate height of Toyota roundabout, presence of pedestrian bridge column in the fast lane, encroachment and parking near bus stops, traffic police barrier present in between the road, and interruption of through traffic due to movement of heavy vehicles near Manzil pump intersection. The entire data was used to perform traffic modelling for evaluating existing travel time which was obtained as 51 minutes from Malir 15 to Toyota Roundabout while 46 minute for opposite direction.

Due to significant wrong way movement on the U-turns of Malir 15 and Malir Court, it is proposed to provide one wider U-turn in between both current U-turns. All the minor intersections were modified by provision of proper chamfered island design to allow gradual merging of vehicles on the main road. It would decrease the force merging behaviour. The diameter of Toyota roundabout is also proposed to increase by 54% as the current diameter is not adequate for smooth movement of heavy vehicles. All encroachments, and parking must be removed from the road specially on the bus stops. Furthermore, all bus stops must be provided with properly chamfered bus stopping areas to improve lane efficiency. The medians must have a even width throughout the road. Some other suggested improvements includes provision of height restriction pole for manzil pump flyover, and signal for manzil pump intersection.

In conclusion, the one of the main recommendations suggested for the N-5 road section after detailed study

- ***is converting the road into the category of 'Urban Arterial'.***

Due to the mixed land-use type including residential, commercial, and industrial the diversity in the use of travel modes is significant. In addition to it, there are many uncontrolled intersections present on the road section which does not provide a

concrete explanation to be part of the Highway. So, the entire road section from Kalaboard to Toyota Roundabout must be designed considering the parameters of an urban arterial. For example, proper service roads, median, chamfered U-turns, Bus stops, and parking spaces must be ensured on the road segment.

Table 1 Problems at Critical Locations and their solutions

LOCATIONS	COORDINATES	PROBLEMS IDENTIFIED	SOLUTIONS PROPOSED
• Kalaboard Bus Stop • Quaidabad Bus Stop • Jafco Plaza • Qasim Textile Mill • Cattle Colony	• 24°52'56.54"N, 67°10'56.37"E • 24°51'19.48"N, 67°12'42.41"E • 24°51'17.55"N, 67°13'22.81"E • 24°51'12.73"N, 67°14'48.96"E • 24°49'40.48"N, 67°17'9.39"E	• Column present in fast lane (orientation of column is different in each type) • Encroachment • No proper bus stop	• Chamfered Median • Hawkers and Stalls Removed • Chamfered area for Bus Stop • On Road Parking Removed
Malir 15, Malir Court U-turn	24°52'24.22"N, 67°11'43.64"E	• Traffic congestion present on the u-turn • Wrongway movements	• Protected U-turn must be designed
Qomi Shahrah Bridge over Malir River	24°52'6.74"N, 67°22'31.13"E	Inadequate height of New Jersy Barrier	• install Fibre Glass sheets to separate the traffic in both directions • install barriers that are at least 3.5 feet high

Malir 15 Flyover	24°52'43.57"N, 67°11'18.62"E	• Force merging and diverging of vehicles at the end and start of flyovers respectively	• Extend the flyover's edge to allow gradual merging and diverging of vehicles at start and end point
Intersections • Razzaqabad • Manzil Pump	• 24°51'51.70"N, 67°17'32.89"E • 24°51'17.07"N, 67°13'44.78"E	• Intersections at 90° direct opening on the highway	• Must provide a proper gradual merging of vehicles in all intersections
• Razaqabad U-Turn	• 24°51'51.99"N, 67°17'33.41"E	• Sudden increase in median width near U-turn	• signage indicating the presence of an abrupt median • Cut the median and provide studs near the U-turn
• Toyota Roundabout	• 24°51'58.62"N, 67°18'0.88"E	• Diameter not adequate for maneuvering HGVs	• Redesigning after Detailed Study

Chapter 1: Introduction

1.1 Study Area

The starting section of approximately 13.5 km of this highway considered for this study is present in Karachi as shown in Figure 1. It starts from the Kalaboard bus stop and ends at Port Qasim Chowrangi.

Figure 1 Selected Road Section Karachi from Nehal Hospital to Port Qasim Chowrangi

1.2 Surrounding Landuse

The part of highway considered for the study is of utmost importance due to the presence of industries and significant landmarks as follows:

1. Abbott Laboratories
2. Dawlance Private Ltd.
3. Gul Ahmed Textile Mills
4. Artistic Fabric Mills
5. Atlas Autos (Private) Limited
6. Orient Textile Mills
7. Mekotex (Pvt.) Limited
8. Lucky Textile Mills
9. National Textile Mills Limited
10. Popular Fabric (Private) Limited
11. Soorty Denim Mills
12. Hamsons Industries

Some other landmarks present in this particular section are prisons, courts, hospitals, shops, restaurants, and motor companies as follows:

1. Toyota Port Qasim Motors

2. Daeewo Motors Pvt Ltd
3. The Court Industrial Park
4. FAST National University Karachi Campus
5. NLC Freight Terminal Landhi
6. Juvenile Prison Malir District
7. District and Sessions Courts Malir Karachi

1.3 Traffic Mix

The traffic mix along this road is distinctly categorized into two main groups: light vehicles, comprising motorcycles and cars, and heavy vehicles, including trucks and buses. Due to the substantial industrial presence in the area, a significant number of trucks are commonly found traversing this route. However, it is noteworthy that within the category of light vehicles, motorcycles are the most prevalent. This situation presents a notable road safety concern as motorcycles, being the predominant light vehicle, share the same corridor with heavy trucks. The coexistence of these two critical types of vehicles poses heightened risks and challenges for road safety management along this stretch of the highway.

1.4 Elements Affecting Safety

The detailed characteristics and features of the N5 highway which are affecting road safety are presented in Table 2.

Table 2 Road Features and Elements

Parameters	Details
Road Carriageway	The number of lanes maximum is 4 but due to encroachment functional lanes are 3 or 2 on some sections of the road. Furthermore, the distribution of lanes is uneven in each direction. The direction of Kalaboard to Toyota Roundabout has more lanes than Toyota Roundabout to Kalaboard.
Geometry	The Median has uneven along the highway with sudden increase and decrease in width. Furthermore, the height of the new jersey barrier is also not adequate on a few sections of the road
Parking Spaces	Most of the service road as well as a few sections of highway is used for parking vehicles

Bridge	Malir River
Pedestrian Bridges	Fifteen bridges found on the road segment
Flyovers	Three Flyovers namely Malir 15, Quaidabad-Landhi, Manzil Pump
U-Turns	Six U-turns
Intersections	Five Major and Seven Minor Intersections
Roundabout	One at Toyota Chowrangi named as Toyota Roundabout
Road Markings	Faded Lane Markings
Traffic Signage	Less amount of traffic signage
Signals	None
Landuse Type	Mixed Landuse Type with a significant percentage of Industrial area. Residential, Commercial

1.5 Types of Solutions

1.5.1 Short term

The term "short term" is used in this context to emphasize actions that can be implemented quickly to address immediate concerns. In the case of road defects, such as potholes, cracks, or damaged signs, prompt repairs are necessary to prevent accidents, injuries, and further deterioration of the infrastructure. These short-term solutions focus on addressing the most pressing issues to ensure the continued safety and usability of the road network in the immediate future. They are typically temporary fixes meant to provide immediate relief while more extensive repairs or long-term solutions are planned and executed.

1.5.2 Medium Term

In the context of road maintenance and infrastructure management, "medium term" refers to solutions and actions that are implemented over a somewhat longer timeframe compared to short-term measures but are still relatively prompt and actionable. Medium-term solutions typically involve more comprehensive repairs and upgrades that address underlying issues and contribute to the overall improvement and sustainability of the road network. This may include activities such as resurfacing worn-out pavement, repairing or reconstructing damaged sections of the road, upgrading drainage systems, or replacing outdated infrastructure components. While medium-

term solutions may require more time, resources, and planning compared to short-term fixes, they are essential for addressing persistent issues, improving road conditions, and extending the lifespan of the infrastructure. These measures are crucial for ensuring the continued functionality, safety, and efficiency of the road network over an intermediate period.

1.5.3 Long Term

In the context of road maintenance and infrastructure management, "long term" refers to solutions and strategies that are implemented over an extended period, typically spanning years or even decades. Long-term solutions focus on addressing fundamental challenges and improving the overall resilience, sustainability, and efficiency of the road network. These solutions often involve significant investments in infrastructure upgrades, comprehensive planning, and the implementation of proactive maintenance programs. Long-term measures may include activities such as redesigning road layouts for better traffic flow, implementing advanced materials and construction techniques for enhanced durability, integrating smart technologies for real-time monitoring and management, and establishing sustainable funding mechanisms for ongoing maintenance and improvements. While long-term solutions require substantial resources, coordination, and commitment, they are essential for ensuring the long-term viability and effectiveness of the road network, enhancing safety, reducing environmental impacts, and supporting economic growth and development.

Chapter 2 Critical Sites and their Solution

2.1 Razaqabad Median

Medians are provided to divide the carriageways to separate the traffic flow in each direction. The road of N5 has many defects. First, a lot of segments on the road are not provided with a median instead new jersey barriers are used for separating the traffic. Second, the segments where medians are provided have not been properly designed. As shown in Figure 2, there is a sudden increase in the width of the median near 'Razaqabad'. One issue that may arise is confusion or uncertainty among drivers about which lane to stay in. The uneven or inconsistent pattern lead to unexpected lane changes, sudden braking, and other unsafe driving behaviours that increase the risk of accidents and traffic congestion in particular segments.

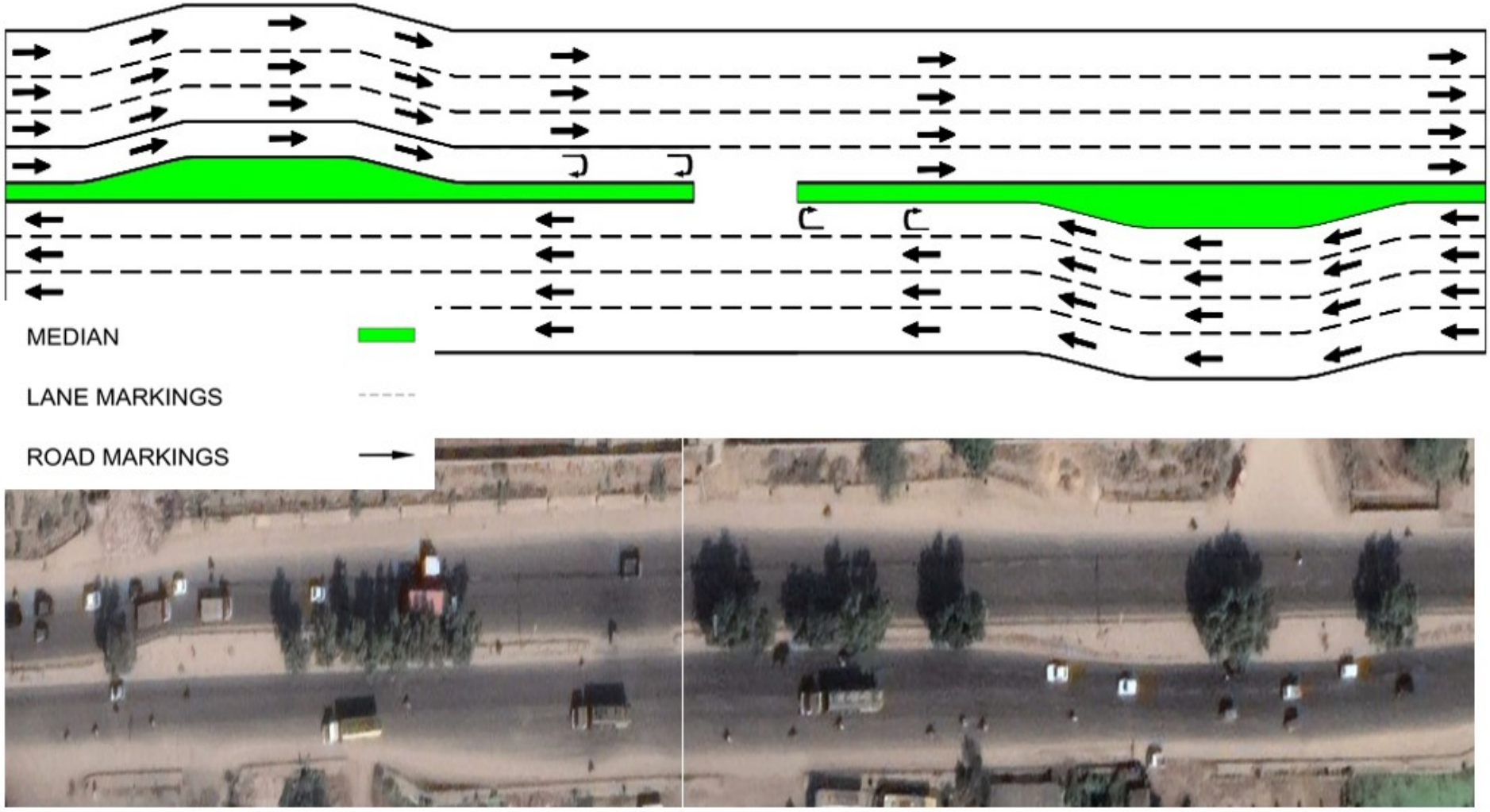


Figure 2 Road Section near Razaqabad U-turn

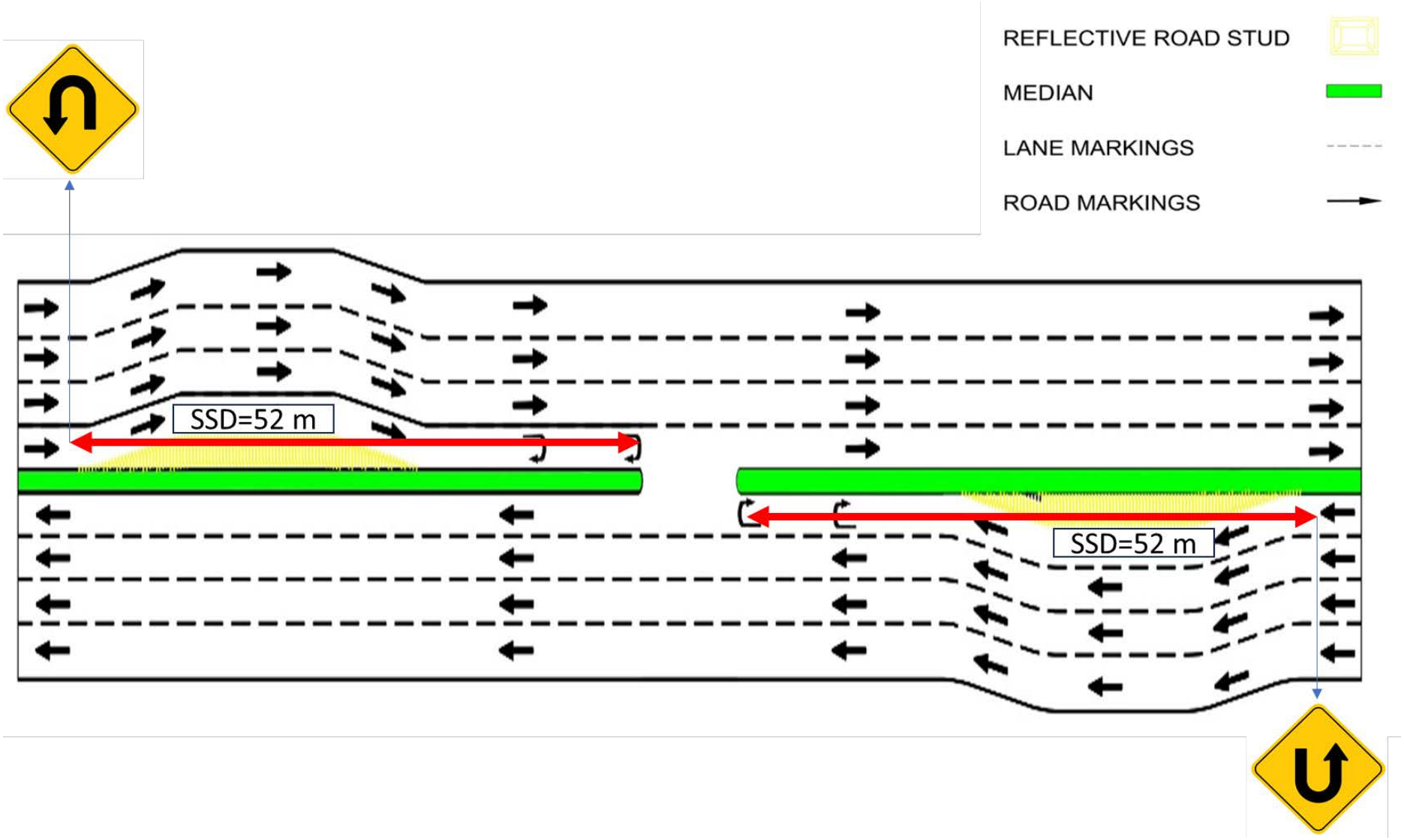


Figure 3 Proposed solution of extruding median

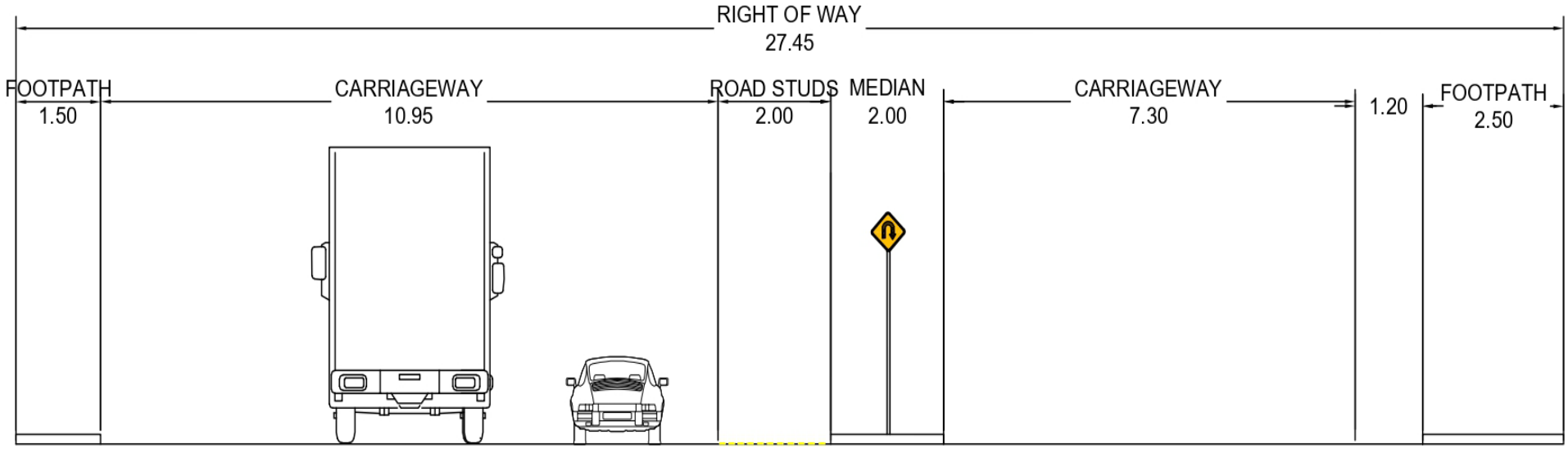


Figure 4 Proposed solution of extruding median (cross-section)

2.1.1 Action Plan:

The action plan has been divided into short-, medium-, and long-term solutions.

Short Term: Implement signage indicating the presence of an abrupt curve along with proper lighting, and trim trees to ensure improved visibility and safety for drivers.

Medium Term: Installation of road safety studs on flushed median.

Long Term: Implementing proper chamfering of the median will help enhance safety and facilitate smoother traffic flow along the road.

2.2 Pedestrian Bridge Extruding On Fast Lane

Pedestrian bridges are typically elevated structures designed to provide a safe and convenient passage for pedestrians over busy roads. The columns of these pedestrian bridge are protruding into the fast lane, causing a sudden narrowing of the lane width and posing a safety hazard.

2.2.1 Location:

These pedestrian bridges are located at the following locations on NH-5.

- Kalaboard
- Quaidabad
- Qasim Textile Mill
- Cattle Colony

2.2.2 Action Plan:

Short term: The short-term solution for the pedestrian bridge extruding onto the fast lane involves installing proper cat eyes and yellow markings for the road edge, along with fluorescent paint or sheeting, as well as road narrow ahead signage.

Medium term: Not applicable

Long term: The long-term solution for the pedestrian bridge extruding onto the fast lane is to implement chamfered medians.

2.2.3 Safe Sight Distance

The Safe Sight distance calculated from ASHTO is approximately 52.15 meters and it indicates that the chamfering and placemnent of road studs must be done. It is also reccomanded that there must be provision of a traffic signage indicating the presence of curved chamfer inorder to provide the driver adequate distance for taking the decision.

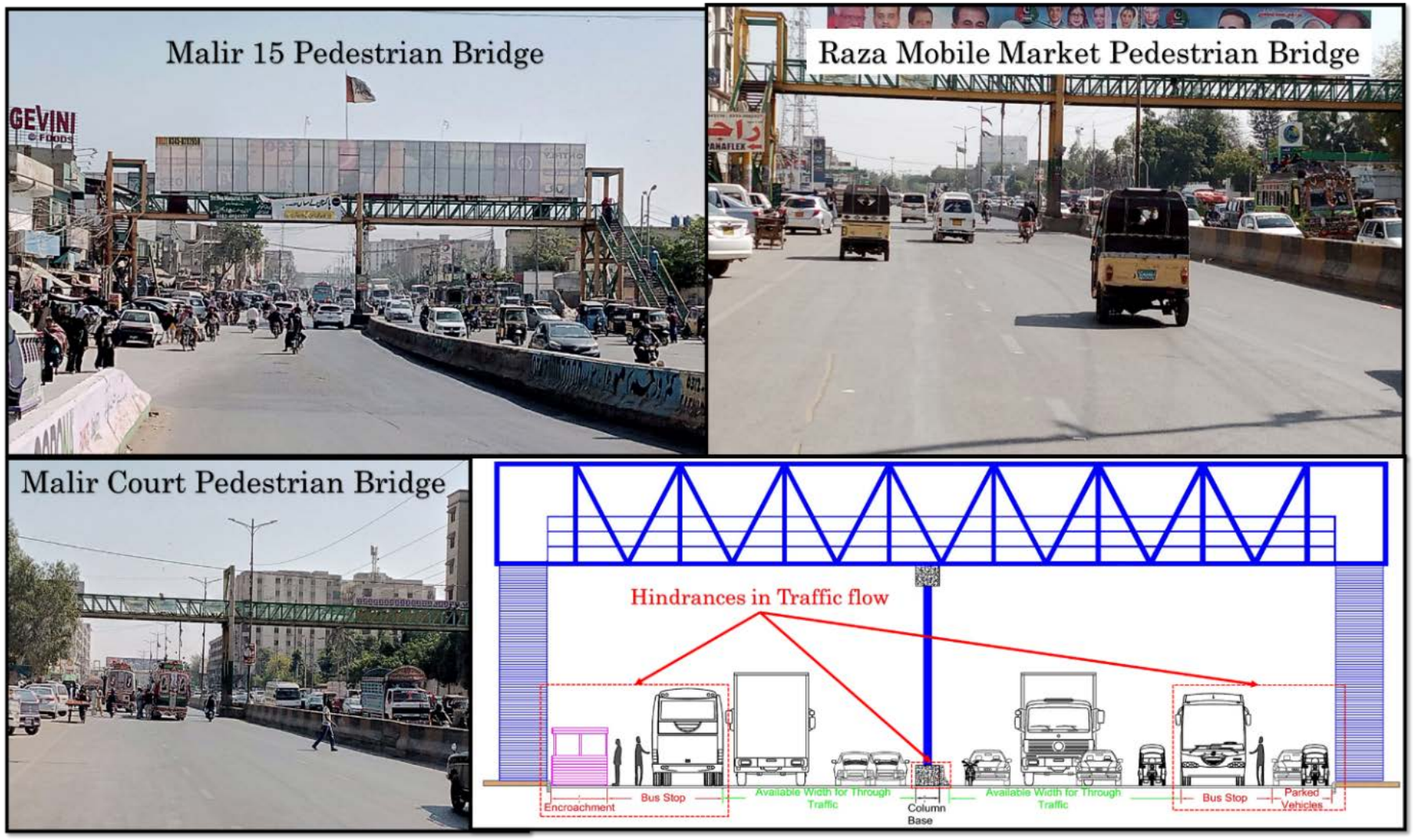
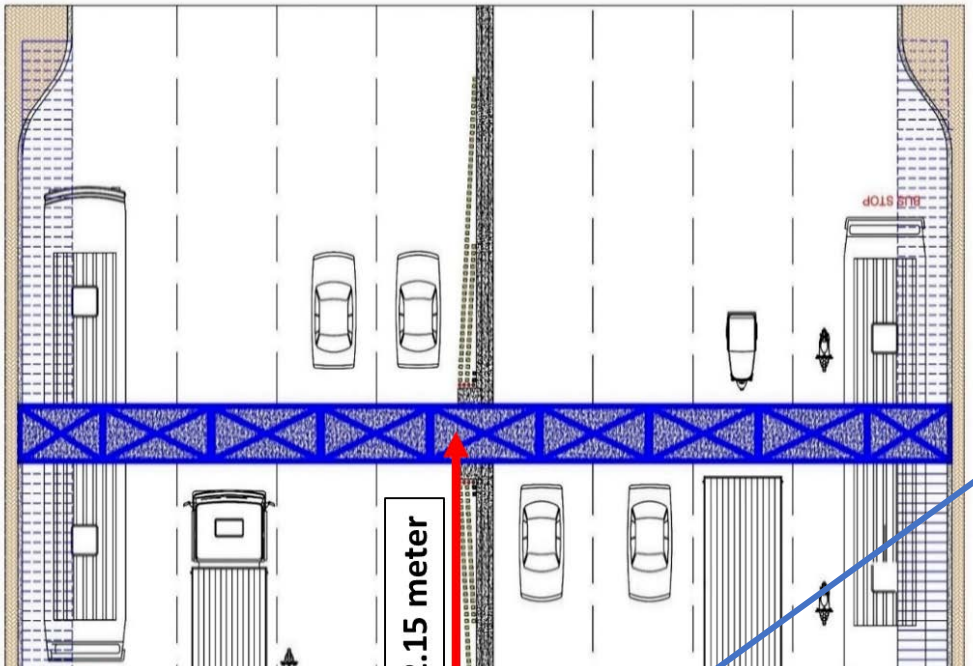


Figure 5 Pedestrian Bridge extruding on fast lane



Signage

Figure 6 Proposed Solution for extruding pier of pedestrian bridge

2.3 Manzil Pump Flyover

The traffic police at the Manzil Pump flyover have placed a barrier at the beginning of the flyover during daytime as shown in Figure 6. The intention behind this blocking is to prevent heavy traffic from entering. However, this barrier also causes congestion as vehicles to have to slow down and wait for their turn to pass through the barrier.

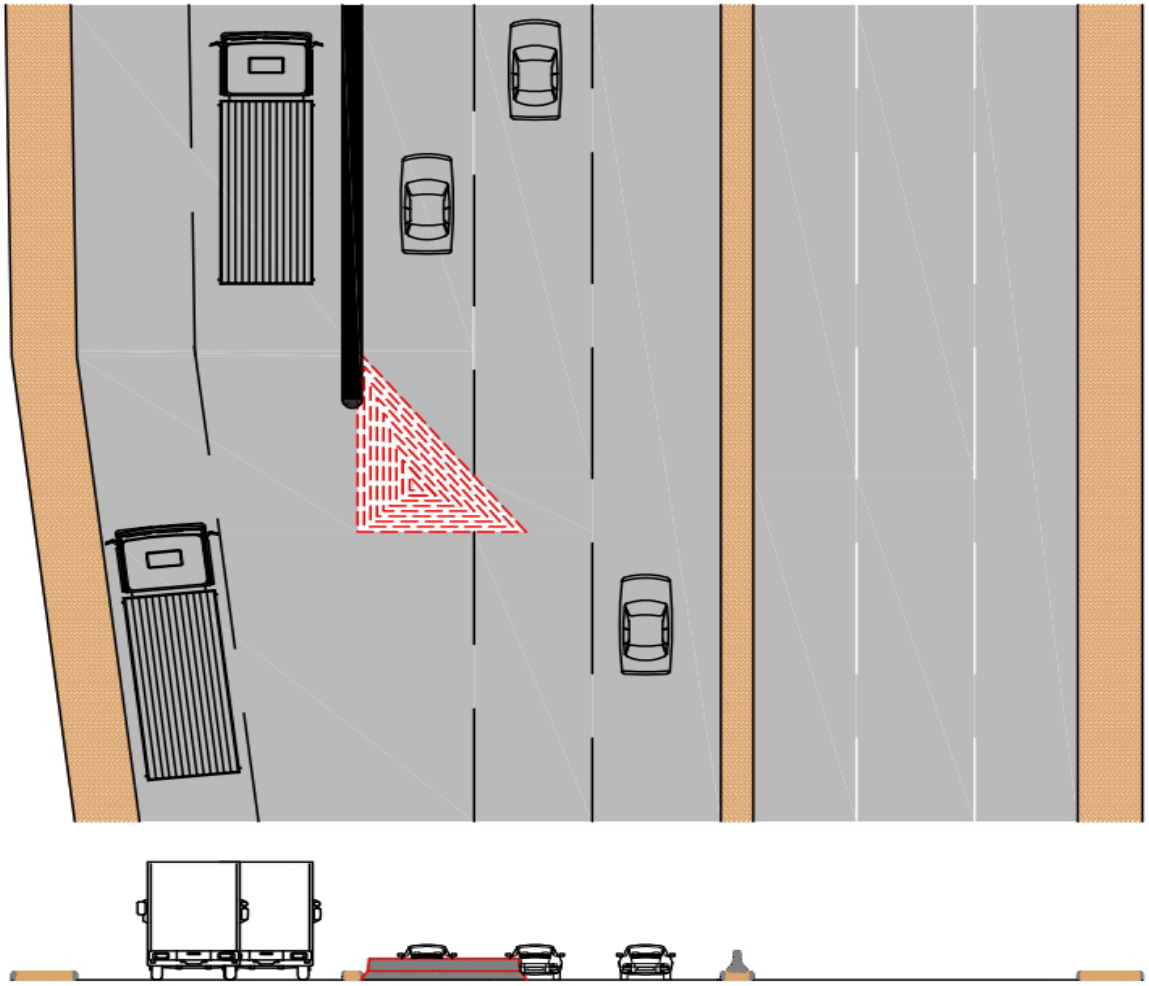


Figure 7 Manzil pump flyover

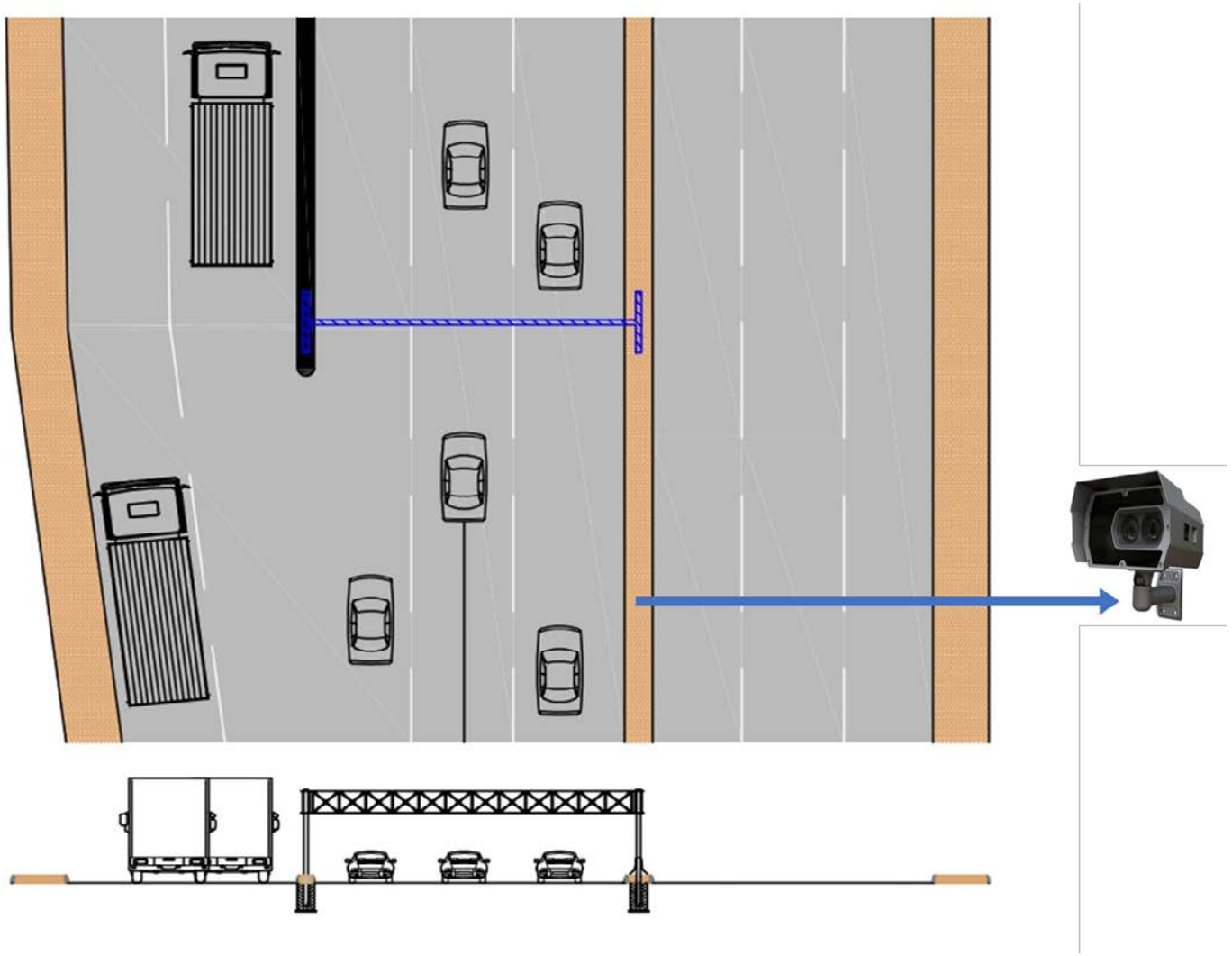


Figure 8 Proposed Solution for Police Barricade

2.3.1 Action Plan:

Short term: To install traffic surveillance cameras functioning based on ITS.

Medium term: The medium-term solution of the issue is to place a Movable Vehicle Height restriction pole in order to prevent heavy traffic from entering during day time.

Long term: Not applicable.

2.4 Inadequate Height New Jersy Barrier:

New Jersey barriers are concrete barriers used on highways and other roads to separate traffic, prevent crossover accidents, and provide protection in the event of a crash. An inadequate height of a New Jersey barrier refers to a barrier that is not high enough to provide sufficient protection for vehicles or to prevent crossover accidents. The effects of these New Jersey barriers can be severe. Their inadequate height increased the risk of crossover accidents, which can be catastrophic for drivers and passengers involved in the crash.

2.4.1 Location:

The New Jersey barriers which are intended to separate opposing traffic streams, have been found to have an inadequate height of approximately 2 feet at the following Location.

- Malir River Bridge
- Quaidabad-Landhi Flyover

2.4.2 Action Plan:

Short term: The medium-term solution for inadequate height New Jersey barriers is to install fibre sheets on the barrier to separate both directional traffic.

Medium term: The long-term solution for inadequate height New Jersey barriers is to install barriers that are at least 3.5 feet high.

Long term: Maintainace of entire bridge which includes repairing of expansion joints and slabs etc.

Figure 9 Height of New Jersey Barrier at Malir River Bridge

2.5 Malir 15 And Malir Court U-Turns:

More than just a simple U-turn, it resembles a significant incision on the highway, designated for vehicle turnarounds, thereby presenting notable challenges for users of the fast lane. This disruption in traffic flow leads to congestion and delays for commuters traveling along the road segment. Such congestion not only hampers travel times but also fuels frustration among drivers, further amplifying the overall risks to road safety.

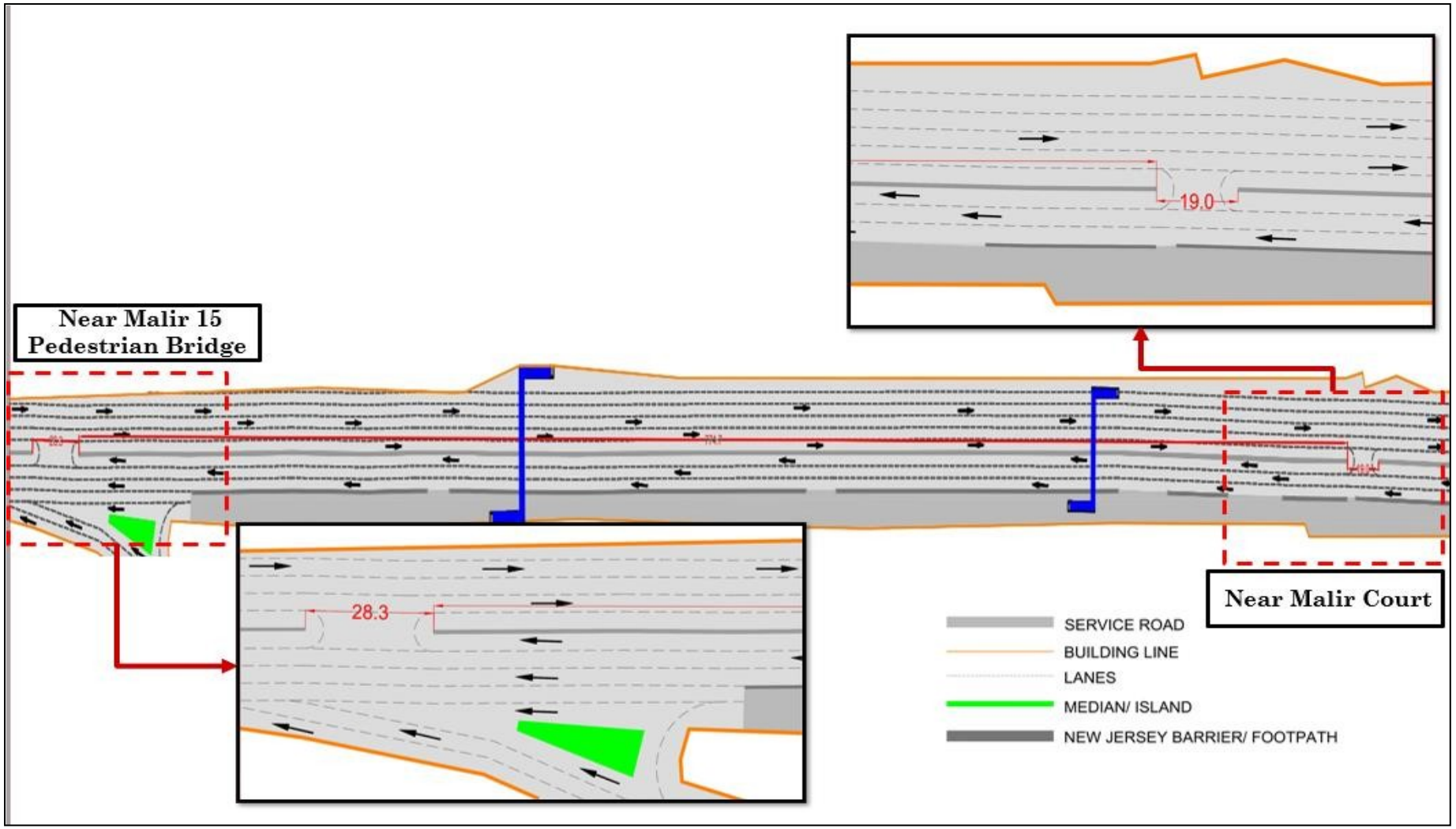


Figure 10 Existing U-turns present on Malir 15

2.5.1 Action Plan:

The action plan has been divided into short-, medium-, and long-term solutions.

Short Term: The first U-turn on National Highway 5 will be temporarily closed for one to two weeks to assess its impact on traffic flow and safety.

Medium Term: Install a U-turn midway along the segment to facilitate safe vehicle turnaround.

Long Term: Implement a protected U-turn zone between the two existing turns to ensure safer and more efficient traffic flow

2.6 TOYOTA ROUNDABOUT

One primary issue arises from the correlation between roundabout size and the turning radius required to navigate it: smaller roundabouts demand tighter turns, posing challenges for heavy vehicles that need more space to maneuver safely and efficiently. Heavy vehicles, in particular, encounter difficulties negotiating small-diameter roundabouts due to the necessity for wider turning paths. Consequently, these vehicles may encroach into other lanes, posing hazards to both themselves and other road users, leading to delays, congestion, and heightened accident risks. Additionally, the Toyota roundabout's abnormal median further exacerbates the situation by reducing the vehicle's turning radius, thereby contributing to congestion at the roundabout.

Chapter 3: Road Safety Audit

3.1 Road Defects per Kilometer

3.1.1 Kalaboard to Toyota Roundabout

3.1.1.1 Chainage 0+000 to 1+000:

Type of Defect	Number of Defect
Damaged pavement	1
Encroachment	1

Defects Identified: Damaged Pavement

Action Plan:

The action plan has been divided based on short-term, medium-term, and long-term solutions.

Short term: The short-term solution for potholes is to fill them.

Medium term: Not applicable

Long term: The long-term solution for potholes is to perform surfacing or overlay of the road surface.

Defects Identified: Encroachment

Action Plan:

Short term: Immediate removal of encroachments through enforcement actions, such as Police challan or eviction notices, to clear the affected areas.

Medium term: Not applicable

Long term: Not applicable.

3.1.1.2 Chainage 1+000 to 2+000:

Type of Defect	Number of Defect
Pothole/Ditches	2

Defects Identified: Pothole/Ditches

Action Plan:

The action plan has been divided based on short-term, medium-term, and long-term solutions.

Short term: The short-term solution for potholes is to fill them.

Medium term: Not applicable

Long term: The long-term solution for potholes is to perform surfacing or overlay of the road surface.

3.1.1.3 Chainage 2+000 to 3+000:

Type of Defect	Number of Defect
Inadequate Height of NJ barriers	1

Defects Identified: Inadequate Height of NJ barriers

Action Plan:

Short term: Not applicable.

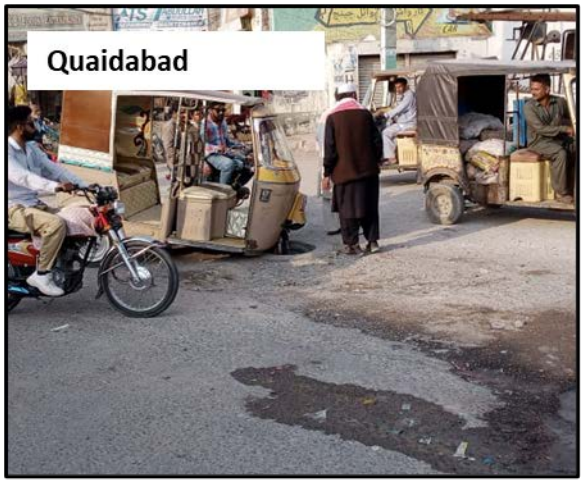
Medium term: The medium-term solution for inadequate height New Jersey barriers is to install metal sheets on the barrier to separate both directional traffic

Long term: The long-term solution for inadequate height New Jersey barriers is to install barriers that are at least 3.5 feet high.

3.1.1.4 Chainage 3+000 to 4+000:

Type of Defect	Number of Defect
Pothole/Ditches	2

Defects Identified: Pothole/ Ditches



Action Plan:

The action plan has been divided based on short-term, medium-term, and long-term solutions.

Short term: The short-term solution for potholes is to fill them.

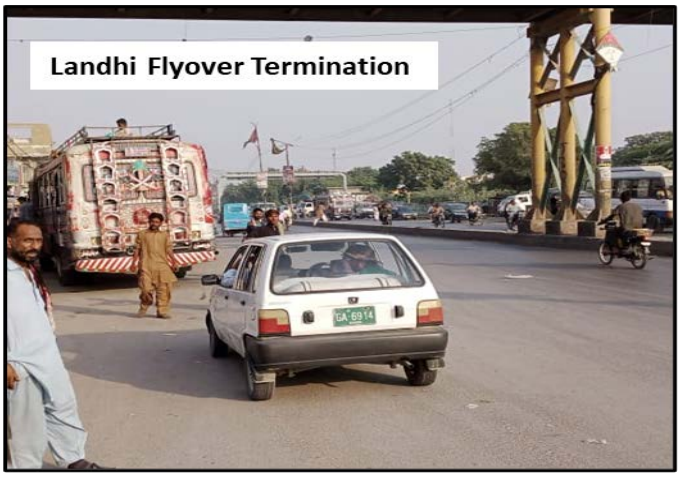
Medium term: Not applicable

Long term: The long-term solution for potholes is to perform surfacing or overlay of the road surface.

3.1.1.5 Chainage 4+000 to 5+000:

Type of Defect	Number of Defect
Illegal Parking	1

Defects Identified: Illegal Parking



Action Plan:

Short term: Police challan.

Medium term: Not applicable

Long term: Providing proper parking for vehicle.

3.1.1.6 Chainage 5+000 to 6+000:

Type of Defect	Number of Defect
Illegal Parking	1

Defects Identified: Illegal Parking/

Action Plan:

Short term: Police challan.

Medium term: Not applicable

Long term: Providing proper parking for vehicle.

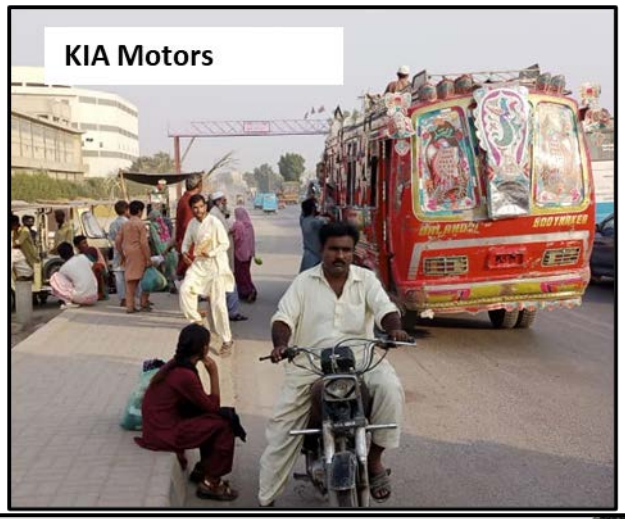
3.1.1.7 Chainage 6+000 to 7+000:

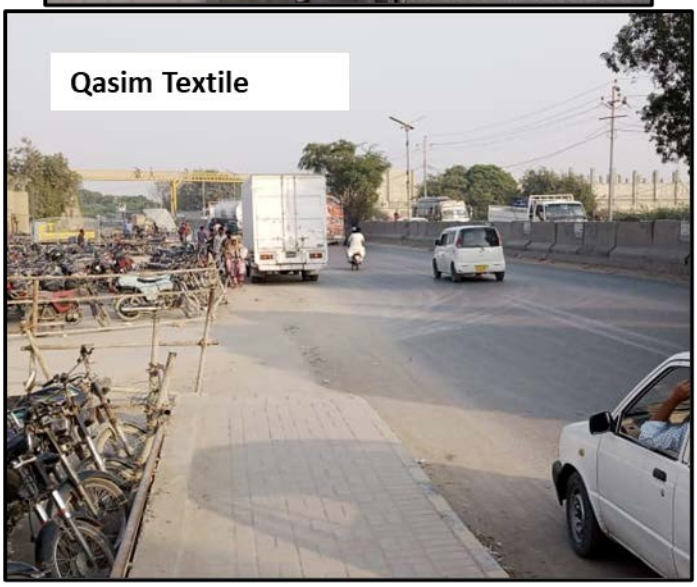
No defect observed

3.1.1.8 Chainage 7+000 to 8+000:

Type of Defect	Number of Defect
Illegal Parking	2

Defects Identified: Illegal Parking/Encroachment





Action Plan:

Short term: Police challan.

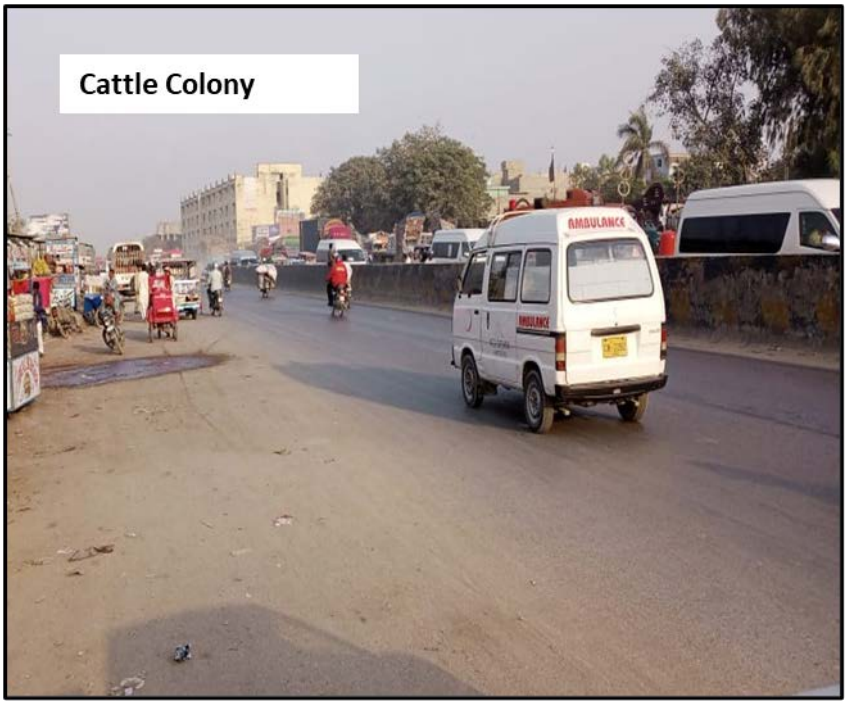
Medium term: Not applicable

Long term: Providing proper parking for vehicle.

3.1.1.9 Chainage 8+000 to 9+000:

Type of Defect	Number of Defect
Encroachment	1

Defects Identified: Encroachment



Action Plan:

Short term: Immediate removal of encroachments through enforcement actions, such as Police challan or eviction notices, to clear the affected areas.

Medium term: Not applicable

Long term: Not applicable.

3.1.1.10 Chainage 9+000 to 10+000:

No defects observed

3.1.1.11 Chainage 10+000 to 11+000:

Type of Defect	Number of Defect
Encroachment	1
Wrongway Movement	1

Pedestrian Bridge with gaurdrails	1

Defects Identified: Encroachment

Action Plan:

Short term: Immediate removal of encroachments through enforcement actions, such as Police challan or eviction notices, to clear the affected areas.

Medium term: Not applicable

Long term: Not applicable.

Defects Identified: Wrongway Movement

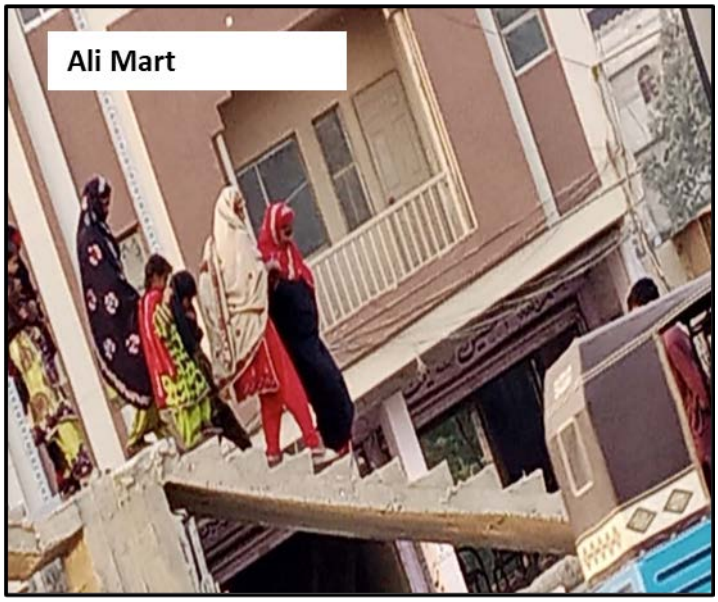
Action Plan:

Short term: Strong Enforcement.

Medium term: The medium-term solution for wrong-way movement is to place U-turns at important locations.

Long term: The long-term solution for wrong-way movement is the construction of service roads along NH5.

Defects Identified: Pedestrain bridge without gaurdrails



Action Plan:

Short term: Provide guardrails to the padestrian.

Medium term: Not applicable

Long term: Not applicable.

3.1.1.12 Chainage 11+000 to 12+000:

Type of Defect	Number of Defect
Broken Pole	7

Defects Identified: Broken Poles

Action Plan:

Short term: The short-term solution for broken poles is to install proper cat eyes and yellow markings to separate the median from the road, ensuring vehicles are distant from the median.

Medium term: Not applicable

Long term: Pole should be shifted from median to footpath.

3.1.1.13 Chainage 12+000 to 13+480:

No defects found

3.1.2 Toyota Roundabout to Kalaboard

3.1.2.1 Chainage 0+000 to 6+000

No defects found

3.1.2.2 Chainage 6+000 to 8+000

Type of Defect	Number of Defect
Pothole/Ditches	1

Defects Identified: Pothole/Ditch

Action Plan:

The action plan has been divided based on short-term, medium-term, and long-term solutions.

Short term: The short-term solution for potholes is to fill them.

Medium term: Not applicable

Long term: The long-term solution for potholes is to perform surfacing or overlay of the road surface.

3.1.2.3 Chainage 8+000 to 13+480

Type of Defect	Number of Defect
Pothole/Ditches	2

Defects Identified: Pothole/Ditch

Action Plan:

The action plan has been divided based on short-term, medium-term, and long-term solutions.

Short term: The short-term solution for potholes is to fill them.

Medium term: Not applicable

Long term: The long-term solution for potholes is to perform surfacing or overlay of the road surface.

3.2 Road defect Table

Figure 13 represents the defects of the National Highway with respect to the chainage. From Kalaboard to the Toyota roundabout, the highway is divided into 25 stations. Out of 25 segments, only 40% of the locations were having all lanes completely functional. In the other 60% of the locations, the corner lanes are either encroached or not in suitable condition, reducing the route segment's capacity, which in turn causes traffic congestion. No signage can be seen throughout the route. Signage provides critical safety information, such as warning signs for road conditions, speed limit signs, U-turns, and stop signs. This helps to ensure that drivers are aware of potential dangers on the road and can take appropriate action to avoid any mishap. The pavement is not marked except for the locations near the Toyota roundabout, and a few locations show some traces of faded pavement marking. Pavement marking helps drivers and pedestrians be aware of their respective lanes and directions of travel, reducing the likelihood of

accidents and congestion. Crosswalks and other pavement markings can provide important tactile cues that help pedestrians to navigate the roadway more safely and confidently. Traffic calming devices are not present where it is necessary to install them for better traffic flow. Potholes and open manholes are present at more than half of the total route segment, and some potholes are deteriorated severely and formed ditches. These potholes, open manholes, and ditches are hazardous for drivers because they can cause the vehicle to lose control, especially at high speeds. Potholes can damage the vehicle's tires, wheels, and suspension, leading to costly repairs and potentially dangerous accidents. They can also cause drivers to swerve suddenly, potentially colliding with other vehicles or pedestrians.

From Toyota Port Qasim motors to Kalaboard, the highway is divided into 13 segments for close analysis of the route. No signage, calming devices, pedestrian crossing, or pavement marking can be seen throughout the route. All these factors are of significant importance in assessing the reliability of the road. Potholes and ditches are also present at some locations. The existing road condition is not adequate as fallen poles are observed at different locations. A fallen pole can obstruct the roadway, limiting the available space for vehicles to maneuver and creating a dangerous situation for drivers. Fallen poles can also damage vehicles or cause serious accidents if drivers are unable to avoid them or swerve to miss them.

S.NO	Location	Station	Lanes		Geometry/ Alignment	Signage	Marking	Calming	Pedestrian Crossing	Road Defects					
			Functional	Actual						Pothole	Ditch	Manhole	Encroachment	Rut	Other
KALABOARD TO TOYOTA ROUNDABOUT															
1	Kalaboard	00+000	2.5	4	Straight	×	FADED	×	✓	✓	✓	×	✓	×	×
2	Malir 15 Bridge	00+400	3	3	Point Of Commencement Of Bridge	×	×	×	×	✓	✓	×	×	×	×
3	Malir 15 Bridge	01+000	3	3	Mid Block	×	×	×	×	✓	✓	×	×	×	×
4	Malir 15 Bridge	01+240	2	2	Point Of Termination Of Bridge	×	×	×	✓	✓	✓	×	✓	×	×
5	Main Road (Malir Court)	01+840	2	3	Mid Block	×	×	×	×	✓	✓	×	×	×	×
6	Main Road (Malir Court)	02+040	3	4	Mid Block	×	×	×	✓	✓	✓	✓	✓	×	×
7	Raza Mobile Pedestrian (200m)	02+240	3	4	Mid Block	×	×	×	✓	✓	✓	×	✓	×	×
8	Usmania Masjid	02+590	3	4	U-turn	×	×	×	×	✓	✓	×	×	×	×
9	Qomi Shahrah Bridge	02+610	2.5	2.5	Point Of	×	×	×	×	✓	✓	×	×	×	×
10	Qomi Shahrah Bridge (1000m)	03+610	2.5	4	Point Of Termination Of Bridge	×	×	×	×	✓	✓	×	✓	×	×
11	Landhi Bridge	04+175	2.5	2.5	Point Of Commencement Of Bridge	×	×	×	×	✓	×	✓	×	✓	×
12	Landhi Bridge	04+695	3	4	Point Of Termination Of Bridge	×	×	×	✓	×	×	×	✓	×	×
13	Manzil Pump	06+120	2	4	T-Intersection	×	×	×	×	×	×	×	×	×	×
14	Orient	06+640	2	3	Mid Block	×	×	×	×	×	×	×	×	×	×
15	Islamic Kanta	07+140	3	4	Straight	×	×	×	×	×	×	×	✓	×	×
16	Lucky Textile Mill	07+340	3	4	Straight	×	×	×	×	×	✓	×	×	×	×
17	Kia Motors	07+720	3	4	Straight	×	×	×	×	×	×	×	×	×	×
18	Kassim Mill	08+060	4	4	Mid Block	×	×	×	×	×	×	×	✓	×	×
19	Malir Prisoner Jail	08+700	4	4	U-turn	×	×	×	×	×	×	×	×	×	×
20	Cattle Colony	09+200	2	4	Straight	×	×	×	×	×	×	×	✓	×	×
21	Cattle Colony (100m)	09+300	2	4	U-turn	×	×	×	×	×	×	×	✓	×	×
22	Mateen Complex	10+030	3	4	U-turn	×	FADED	×	×	×	×	×	✓	×	×
23	Afzal Motors	12+100	4	4	U-turn	×	✓	×	×	×	×	×	×	×	×
24	Atlas Honda	12+770	4	4	Straight	×	✓	×	×	×	×	×	✓	×	×
25	Toyota Roundabout	13+330	4	4	Roundabout	×	✓	×	×	×	✓	×	×	✓	×
TOYOTA ROUNDABOUT TO KALABOARD															
26	Toyota Port Qasim Motors	00+450	4	4	Straight	×	✓	×	×	×	×	×	×	×	FALLEN POLE
27	Raja Poultry Farm	00+760	4	4	Straight	×	×	×	×	×	×	×	×	×	FALLEN POLE
28	Usmania Masjid	01+570	3	4	Straight	×	×	×	×	✓	✓	×	×	×	FALLEN POLE
29	MA Autos	02+910	2	3	Straight	×	×	×	×	×	×	×	×	×	FALLEN POLE
30	Shayan Qasim Iron Store	03+510	2	3	Straight	×	×	×	×	×	×	×	×	×	FALLEN POLE
28	Hasan Mart	03+740	3	4	U-turn	×	×	×	×	×	×	×	×	×	FALLEN POLE
29	Fast University	04+060	3	4	Straight	×	×	×	×	×	×	×	✓	×	DEBRIS
32	Malir Jail	05+120	4	4	U-turn	×	×	×	×	×	×	×	×	×	STUDS
30	Islamic Kanta	05+860	3	3	Mid Block	×	×	×	×	✓	✓	×	×	×	×
33	Landhi Bridge	08+300	4	4	Point Of Commencement Of Bridge	×	×	×	×	×	✓	×	×	×	×
34	Qomi Shahrah Bridge	09+350	2.5	2.5	Point Of	×	×	×	×	×	×	×	×	×	BOTTLE NECK
35	Malir Court	11+350	2	4	Straight	×	×	×	×	×	×	×	✓	×	×
36	Kalaboard	13+480	4	4	Straight	×	×	×	×	✓	✓	×	×	×	×

Figure 11 Detail Defects of National Highway 5 with respect to chainage

3.3 Road Defect Map

A "Road Defect Map" is a visual representation of road conditions, highlighting areas with various types of defects such as potholes, cracks, pavement deterioration, and other issues. This map provides valuable information for transportation authorities, road maintenance teams, and the general public to identify areas in need of repair or improvement. By pinpointing specific locations and types of defects, the Road Defect Map helps prioritize maintenance efforts and allocate resources efficiently to address road infrastructure challenges. It is characterized with respect to the number of defects found on the road segment which is divided into one kilometer of road section.

3.3.1 Major defective Road Segment:

Major defective sections have been observed on National Highway – 5, indicating the presence of road defects along segments divided into 1.0 kilometers. Several sections are affected, including the segment from the termination of the Malir 15 flyover to the inception of the Malir River bridge, the stretch from Manzil Pump to KIA Motors Port Qasim, and the portion from Court Industrial Park to the Toyota Roundabout.

3.3.2 Minor defective Road Segment:

Minor defective sections have been observed on National Highway – 5, indicating the presence of road defects along segments divided into 1.0 kilometers. Several sections are affected, including the segment from the inception of the Landhi Flyover to Manzil Pump and from KIA Motors Port Qasim to Cattle Colony.

3.3.3 Critical Road Segment:

Critically defective sections have been observed on National Highway – 5, indicating the presence of road defects along segments divided into 1.0 kilometers. Several sections are affected, including the segment from the inception of the Kalaboard to termination of Malir 15 flyover, Raza mobile mall to inception of Landhi flyover, FAST University to Court Industrial Park.

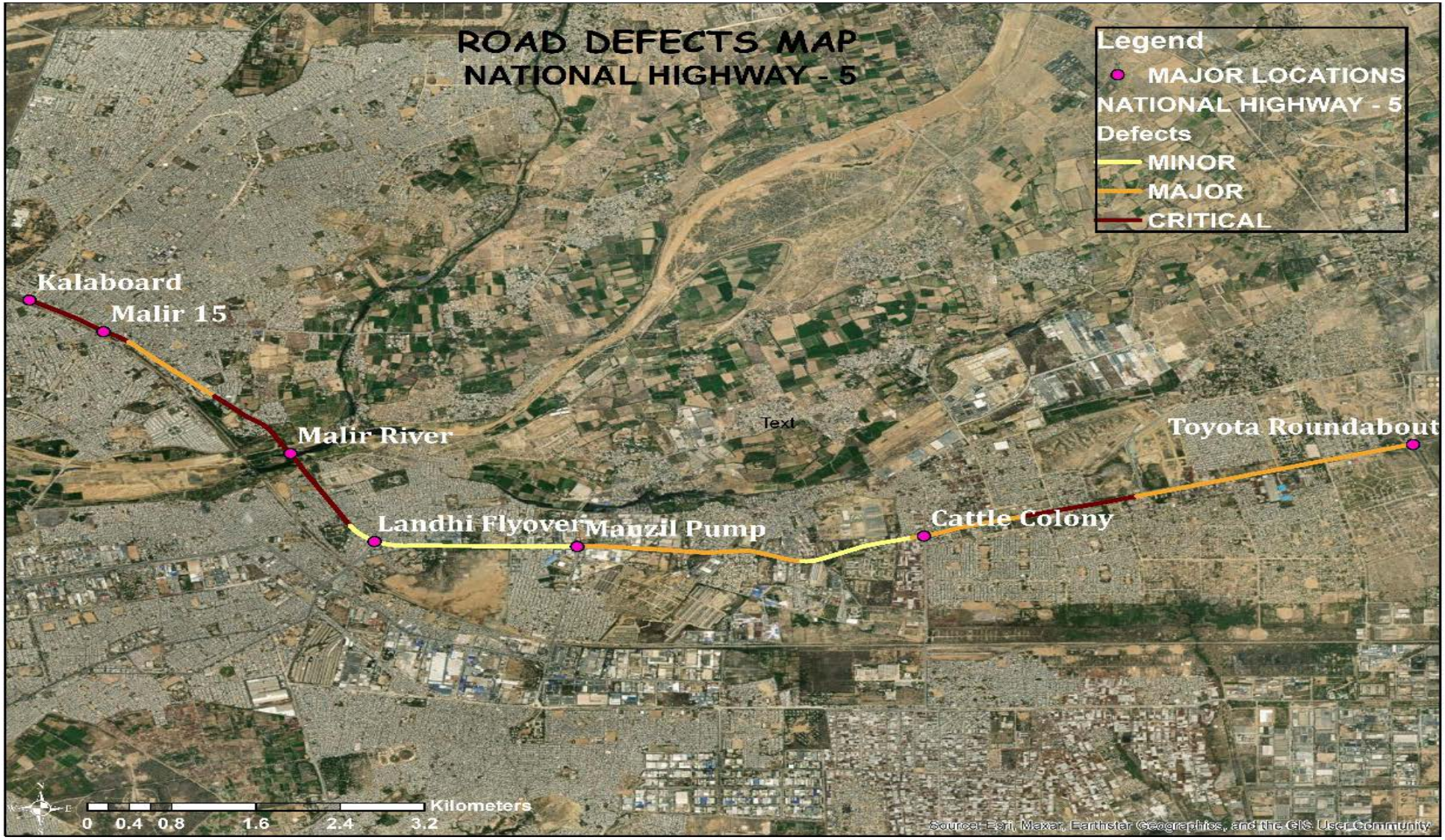


Figure 12 Road Defect Map

Chapter 4 Traffic Analysis

4.1 Classified Volume Count:

Traffic count survey is conducted on major corridors which provides the midblock or through traffic volumes and at intersections, it provides the delays and capacity. The main objectives of the traffic count survey are to obtain the existing traffic volume on the major corridors, to analyze the existing traffic condition, to calibrate the existing Origin Destination matrices, and to obtain the turning movement of vehicles at major intersections and squares.

This survey was conducted on Thursday, December 22, 2022, from 6 am in the morning to 8 pm in the evening. The obtained data were analyzed for two peak periods with each having 3 hours of traffic data i.e. morning period (7:00 am to 10:00 am) and the evening period (5:00 pm to 8:00 pm). For this project, traffic cameras were used to obtain the data for traffic volumes, and speed of the road. Only through movement was critically observed to determine the congestion points, volume, and speed of the road. Five pedestrian bridges were selected to mount the camera including Kalaboard, Malir 15, Gulistan Society bus stop, Quaidabad-Landhi bus stop, and Toyota motor office. These locations were selected based on the analysis performed in the travel time survey. The vehicles are divided into seven categories including cars, motorcycles, rickshaws, pickup vans, buses, minibuses, and trucks.

Table 3 represents the Classified Traffic volume count of 5 different locations during morning and evening peaks towards Toyota and away from Toyota, respectively.

Table 3 Classified Traffic Count

Location	Direction	Motorcycle	Car	Rickshaw	Pickup	Minibus	Bus	Truck	Total
Kalaboard	Morning Peak	8621	2758	2758	862	1034	862	172	17067
	Evening Peak	9632	4180	1454	909	909	545	363	18173
Malir 15	Morning Peak	10485	3732	533	1066	355	178	355	17772
	Evening Peak	11303	897	3229	1076	1076	179	179	17941
Gulistan Society Bus Stop	Morning Peak	8654	2270	567	709	1135	426	426	14187
	Evening Peak	7823	3157	549	824	1098	275	137	13725
Quaidabad-	Morning	9460	915	2594	915	1068	153	153	15258

Landhi Bus stop	Peak								
	Evening Peak	4484	2760	1495	575	1150	460	575	11498
Toyota Motor Office	Morning Peak	9459	915	2594	915	1068	153	153	15257
	Evening Peak	3679	2989	1725	805	920	460	1035	11498

4.2 Traffic Modelling:

Traffic modelling is performed to evaluate and predict the existing and proposed scenarios for the road of N5 highway. 3D models of traffic flow are used to evaluate the existing travel time and compare it with the travel time after proposed solutions. This process of traffic modelling is a highly effective method for evaluating the impact of various transportation infrastructure options and identifying the transportation system's expected future performance.

4.2.1 Existing Travel Time

Table 4 illustrates the travel time from Kalaboard to Toyota Roundabout, divided into four segments for a detailed analysis of travel time for each segment. Initially, the travel time under free flow conditions was calculated, and then the current travel time was determined using Vissum software. The difference between the current travel time is 3.4, 4.6, 4.6, and 4 times more than their respective free-flow speeds for segments 1, 2, 3, and 4, respectively. This table indicates that the current travel time deviates by an average of 4.125 times more than the free-flow time from Kalaboard to Toyota Roundabout.

Table 4 also represents the travel time from Toyota Roundabout to Kalaboard, and this route is also divided into four segments, each with the same free flow speed. The current travel time is then calculated, which averages 3.7 times more than the free-flow speed, with a current travel time of 2.9, 4, 2.8, and 5.2 times more than their respective free-flow speeds for each segment.

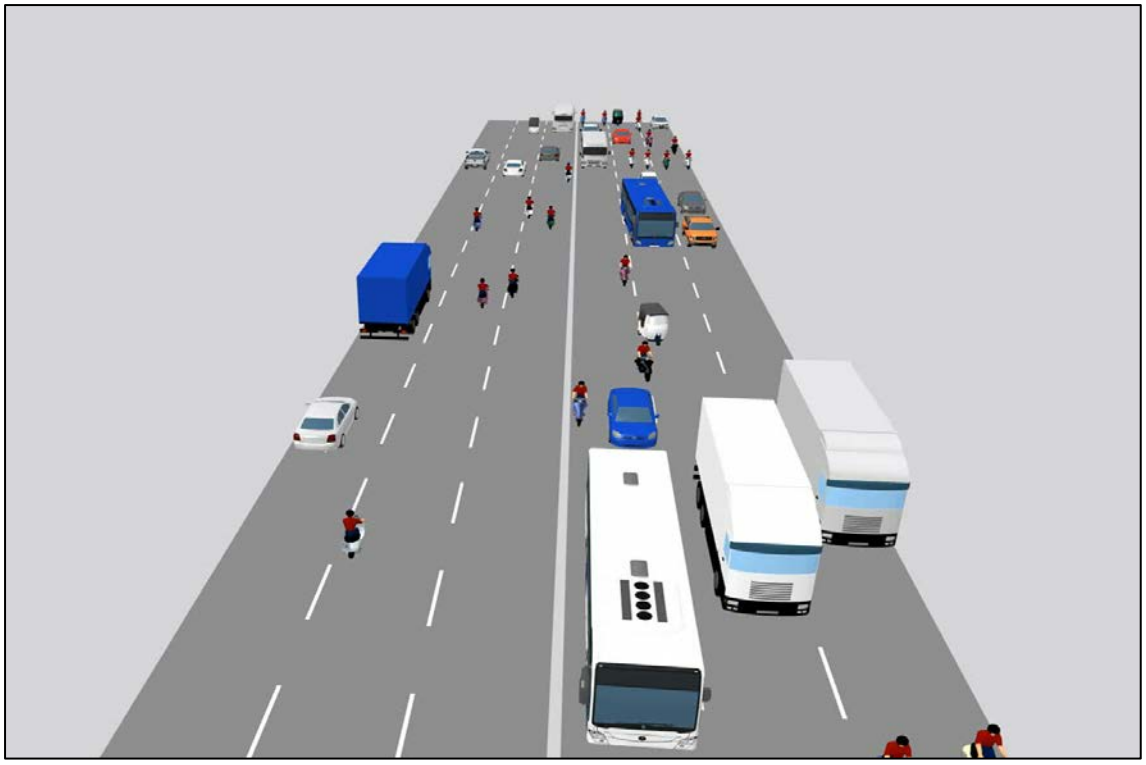


Figure 13 National Highway 3D traffic model

Table 4 Existing Travel Time obtained from Traffic Modelling

	From	To	Distance (km)	Posted Speed Limit (kmph)	Free Flow Travel Time (min)	Current Travel Time (min)
Kalaboard to Toyota Roundabout						
Segment 1	Malir 15	Gulistan Society Bus Stop	2.472	60	2.472	8.26
Segment 2	Gulistan Society Bus Stop	Quaidabad Landhi Bus Stop	1.03	60	1.03	4.733
Segment 3	Quaidabad Landhi Bus Stop	Malir Jail	4.478	60	4.478	20.76
Segment 4	Abdullah Goth	Toyota Roundabout	4.478	60	4.478	17.7
Toyota Roundabout to Kalaboard						
Segment 4	Toyota Roundabout	Abdullah Goth	4.478	60	4.478	12.96
Segment 3	Malir Jail	Quaidabad Landhi Bus Stop	4.478	60	4.478	18
Segment 2	Quaidabad Landhi Bus Stop	Gulistan Society Bus Stop	1.03	60	1.03	2.9
Segment 1	Gulistan Society Bus Stop	Malir 15	2.472	60	2.472	12.85

4.2.2 Improved Travel Time

Table 5 presents the results of traffic modelling after implementing the proposed solution. It compares the current and travel times after implementing the proposed solution. The results indicate an average reduction of 25% in travel time across all four route segments from Kalaboard to Toyota roundabout. And for the segment from Toyota Roundabout to Kalaboard, the overall average reduction in travel time is 30%. The table provides quantitative evidence that the proposed solution effectively reduces travel time and improves traffic flow along the route. Further analysis and evaluation may be necessary to determine the proposed solution's long-term impact and identify any potential limitations or challenges that may arise.

Table 5 Proposed Traffic Modelling (Travel Time Reduction)

	From	To	Distance (km)	Current Travel Time (min)	Travel Time After Proposed Solutions (min)	Percentage of Travel Time Reduced
Kalaboard to Toyota Roundabout						
Segment 1	Malir 15	Gulistan Society Bus Stop	2.472	8.26	7.26	12%
Segment 2	Gulistan Society Bus Stop	Quaidabad Landhi Bus Stop	1.03	4.733	2.33	50%
Segment 3	Quaidabad Landhi Bus Stop	Malir Jail	4.478	20.76	17.3	15%
Segment 4	Abdullah Goth	Toyota Roundabout	4.478	17.7	13.5	24%
Toyota Roundabout to Kalaboard						
Segment 4	Toyota Roundabout	Abdullah Goth	4.478	12.96	11.31	13%
Segment 3	Malir Jail	Quaidabad Landhi Bus Stop	4.478	18	10.73	80%
Segment 2	Quaidabad Landhi Bus Stop	Gulistan Society Bus Stop	1.03	2.9	2.36	18%
Segment 1	Gulistan Society Bus Stop	Malir 15	2.472	12.85	11.7	9%

4.3 Congested Segments:

The bottleneck and congested segment on the national highway refer to a specific area where the flow of traffic is restricted or slowed down significantly, leading to congestion and delays. In such areas, vehicles may be forced to slow down or come to a complete

stop, leading to a buildup of vehicles and delays in travel time. The bottleneck and congestion can cause frustration among drivers and may also increase the risk of accidents. Efforts to alleviate such congestion often involve infrastructure improvements, traffic management strategies, and enforcement of traffic regulations. Following is the most congested segment found on National Highway starting from inception of Malir River bridge to termination of Landhi flyover.

Figure 14 Congested Road Segment

Chapter 5: Conclusions

5.1 Most Critical Safety Issues:

A comprehensive approach to addressing safety concerns on NH5 involves a systematic and integrated strategy aimed at reducing accidents and enhancing the overall safety of the highway. Infrastructure development plays a pivotal role, focusing on the construction and maintenance of various elements such as service roads, pedestrian bridges, and proper signage. Service roads provide alternative routes for local traffic, alleviating congestion on the main highway and reducing the likelihood of accidents. Pedestrian bridges offer safe crossings for foot traffic, separating pedestrians from vehicular flow and minimizing the risk of pedestrian-vehicle collisions. Additionally, clear and visible signage helps guide drivers, enhancing navigation and reducing the likelihood of wrong-way movement or other traffic infractions. Traffic management measures are also critical components of a comprehensive safety strategy. Implementing speed calming devices, such as speed bumps or rumble strips, helps control vehicle speeds and promote safer driving behaviors. Strategically placed U-turns and marked pedestrian crossings further contribute to managing traffic flow and enhancing pedestrian safety. Moreover, the enforcement of regulations through rigorous monitoring and penalties for violations is essential for ensuring compliance with traffic laws and maintaining order on the highway. This includes measures to deter reckless driving behaviors, such as speeding or driving under the influence, which pose significant risks to road users. In addition to infrastructure and traffic management, public awareness and education campaigns are vital for fostering a culture of safety among road users. These initiatives aim to inform and educate drivers, pedestrians, and other stakeholders about safe driving practices, the importance of following traffic rules, and measures to enhance overall safety on NH5. By raising awareness and promoting responsible behavior, these campaigns help reduce the incidence of accidents and promote a shared commitment to road safety. Overall, a comprehensive approach to safety on NH5 requires a coordinated effort across multiple fronts, including infrastructure development, traffic management, enforcement of regulations, and public awareness initiatives. By addressing these key areas in a holistic manner,

authorities can effectively mitigate risks, reduce accidents, and create a safer environment for all road users.

5.2 Recommendations:

The recommendations suggested for the N-5 road section after detailed study are as follow.

- Convert the section of N-5 from Malir (Nehal Hospital) to Toyota Roundabout into an 'Urban Arterial'.
- Implement features like proper service roads, median, chamfered U-turns, bus stops, and parking spaces.
- Remove encroachments and illegal parking.
- Provide pedestrian bridge at MDA Flats/Ghora Chowk.
- Amend existing road facilities.
- Modify existing intersections.
- Install traffic signals.

5.3 Benefits Of Implementing Solution:

Implementing comprehensive solutions to address safety concerns on NH5 yields a multitude of benefits for both road users and the transportation infrastructure. By constructing service roads and pedestrian bridges, along with implementing traffic management measures like speed calming devices, the frequency and severity of accidents can be notably reduced. These infrastructure improvements not only enhance safety but also contribute to smoother traffic flow, reducing congestion and delays. Moreover, the provision of pedestrian-friendly infrastructure promotes safer crossings for foot traffic, mitigating the risk of accidents involving pedestrians. Strict enforcement of regulations further ensures compliance with traffic laws, fostering a safer environment on the highway. Additionally, by encouraging sustainable transportation modes and minimizing disruptions to traffic flow, these solutions offer economic benefits by reducing the costs associated with accidents and enhancing overall productivity. Overall, the implementation of comprehensive safety solutions on NH5 improves safety, efficiency, and sustainability, benefiting both road users and the broader community.

5.4 Post Crash Response:

As the National Highway segment is about 14 km long, whenever a serious accident happens on it, the case is sent to Jinnah Hospital, which is about 26 km away from the location, without providing any first aid.

Recommendation:

- Activate 100 bed Pakistan Steel Mill Trauma Centre.
- Private hospitals should be obligated to provide treatment and first aid to patients.