high density corridors

Bengaluru

design standards manual

Bruhat Bengaluru Mahanagara Palike

DIRECTORATE OF URBAN LAND TRANSPORT
UDD, Government of Karnataka
shaping the way cities move

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INTENT OF THE MANUAL

There is an absence of a unified guiding document for high density corridor design due to which many cities lack the necessary standards for it, which is a problem as these are the major connecting road netork of the city. High density corridors are arterial roads with a high movement of vehicles and pedestrians.

Hence, there is a need for a document that provides standard guidelines for the design of HDC across the various cities of India, to make roads safer, inclusive and accessible.

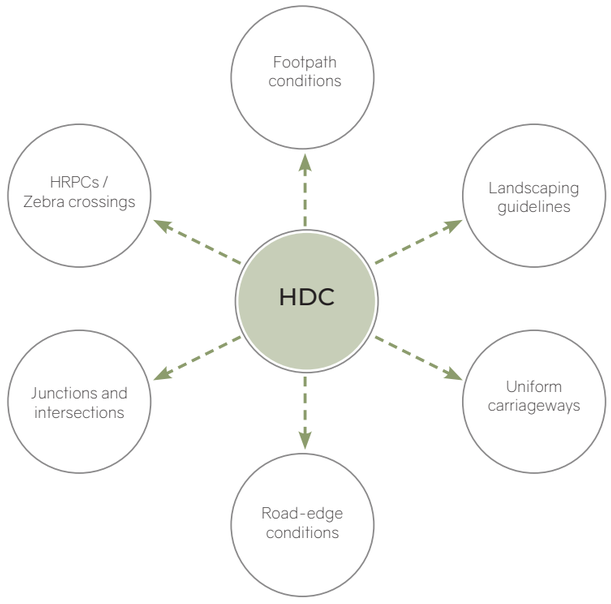
Who could make use of the Manual?

The manual can be used by various agencies that intend to work on redesign of High Density Corridors. This can also be used for educational purposes and increase public awareness regarding the design of HDC.

This manual also includes details which can be included in any other street design. It also supports the design concept for the PMC and contractors in understanding the details.

Purpose of the Manual

The manual provides the standards that can be used to understand the road edge conditions, carriageway, footpath conditions, junction, intersection details and landscaping that can be applied for the arterial roads which fall under High Density Corridor Scheme. The manual contains recommendations on different aspects of street design such as: uniform width for the existing roads, crossroad intersections, footpaths, bicycle path standards and a detailed explanation.



Method followed in Preparation of the Manual

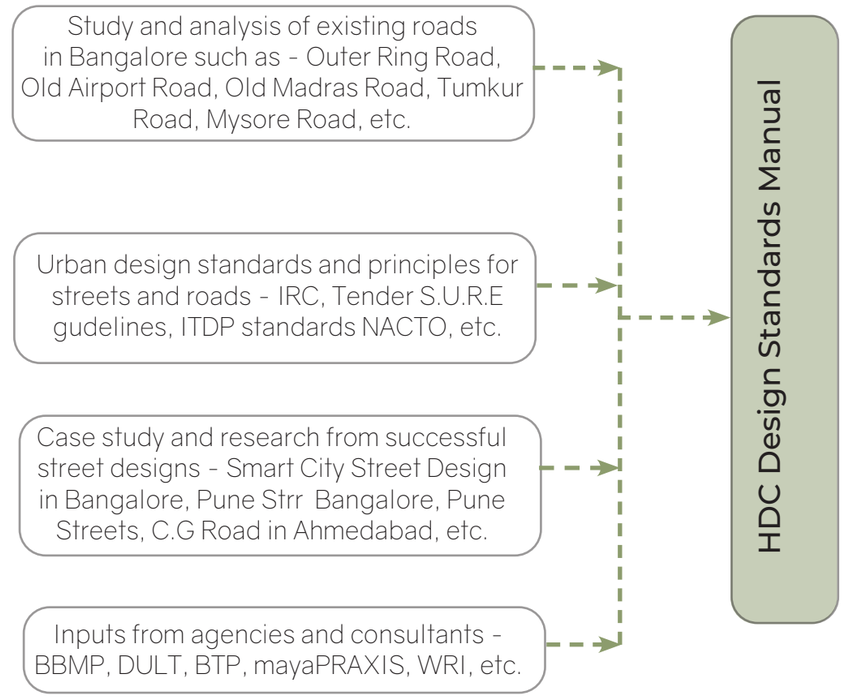


Figure 1. Method followed in Preparation of the Manual

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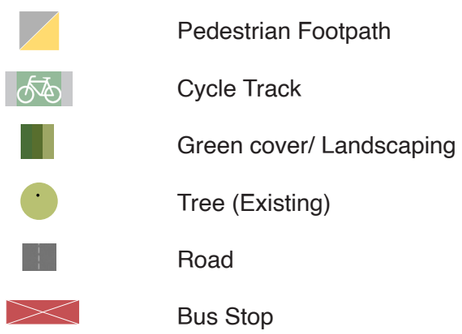
Standard Abbreviations

BBMP	Bruhat Bengaluru Mahanagara Palike
BMRCL	Bangalore Metro Rail Corporation Ltd.
DULT	Directorate of Urban Land Transport
FOB	Foot over Bridge
HDC	High Density Corridor
HRPC	High Raised Pedestrian Crossing
IPT	Intermediate Public Transport (auto rickshaws, cabs, etc.)
ROW	Right of Way

Legends Used



01 INTRODUCTION

1.1. About the Project

The rapid expansion of Bengaluru has led to the development of various important road networks that connect different parts of the city, state and national highways. However, these networks often experience traffic congestion, road crashes/ accidents and other issues. The lack of pedestrian infrastructure forces people to walk on the carriageway, making them vulnerable to road crashes/ accidents.

Hence, the Government of Karnataka has decided to hand over 9 High Density Corridors (HDC) in the city of Bengaluru to the Bruhat Bengaluru Mahanagara Palike (BBMP) to develop and enhance their design based on the ever-increasing needs of the city. This includes streetscape improvements like creating dedicated footpaths, cycle lanes, bus bays, and landscaping, as well as road safety elements such as protected crossings, median refuges, kerb extensions, pedestrian signals, informational signage and redesigned intersections.

The High Density Corridor project intends to alleviate and improve the travel experience for pedestrians, cyclists, and motorists on the arterial roads. The project also aims to increase and strengthen the urban greenery in these dense corridors for a better and greener Bengaluru.

The 9 roads come under 3 different packages, and are taken up by two different consultants.

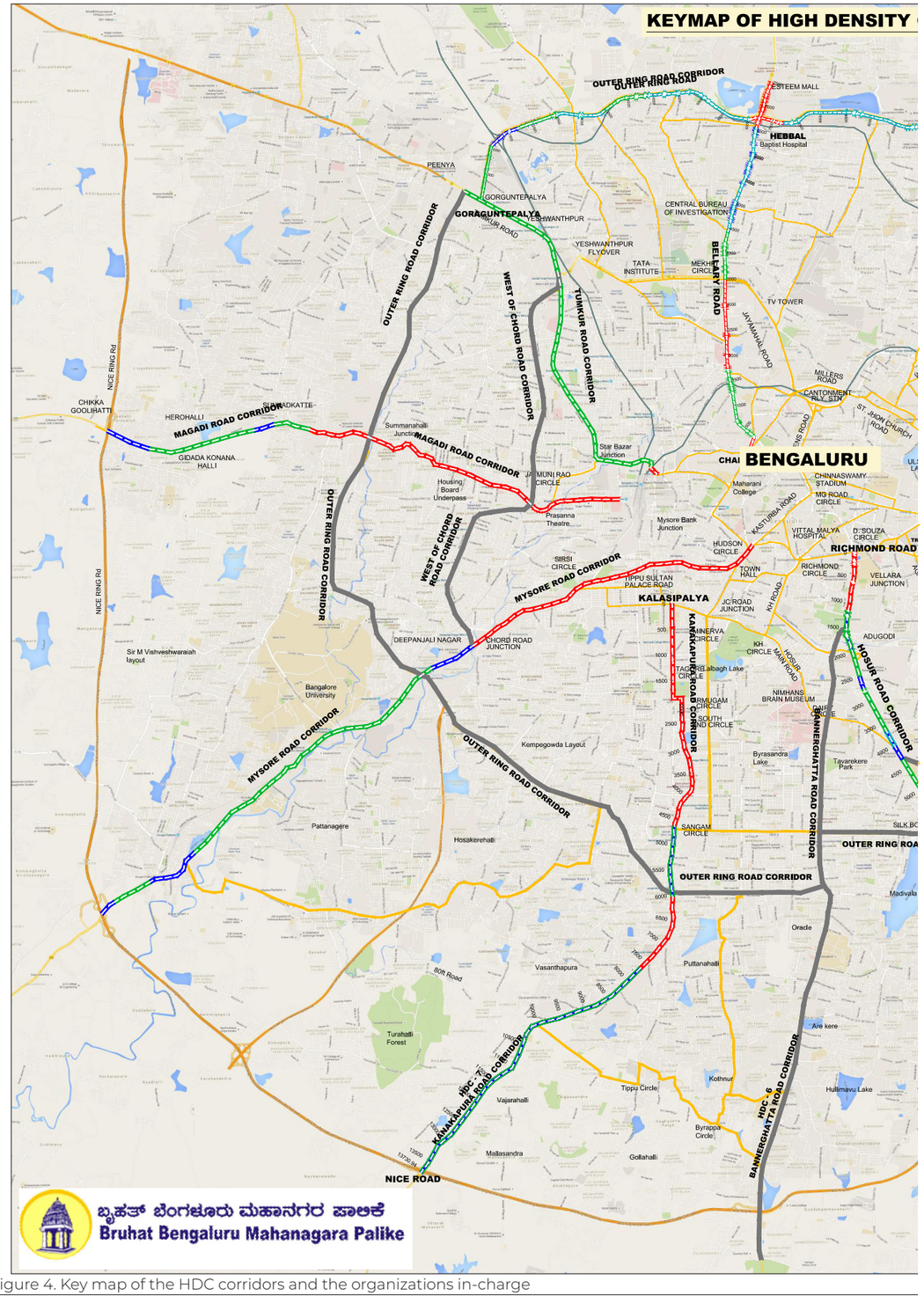
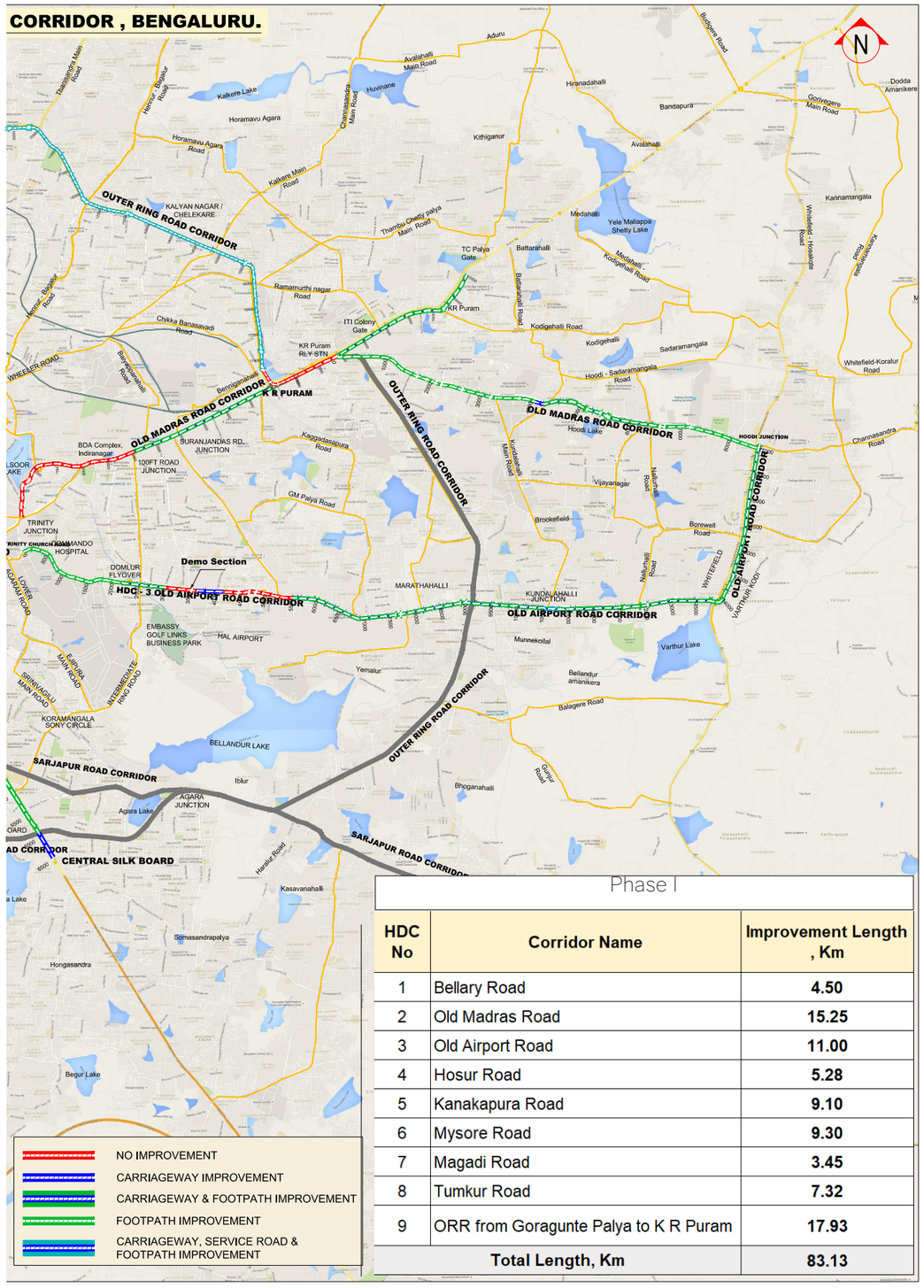


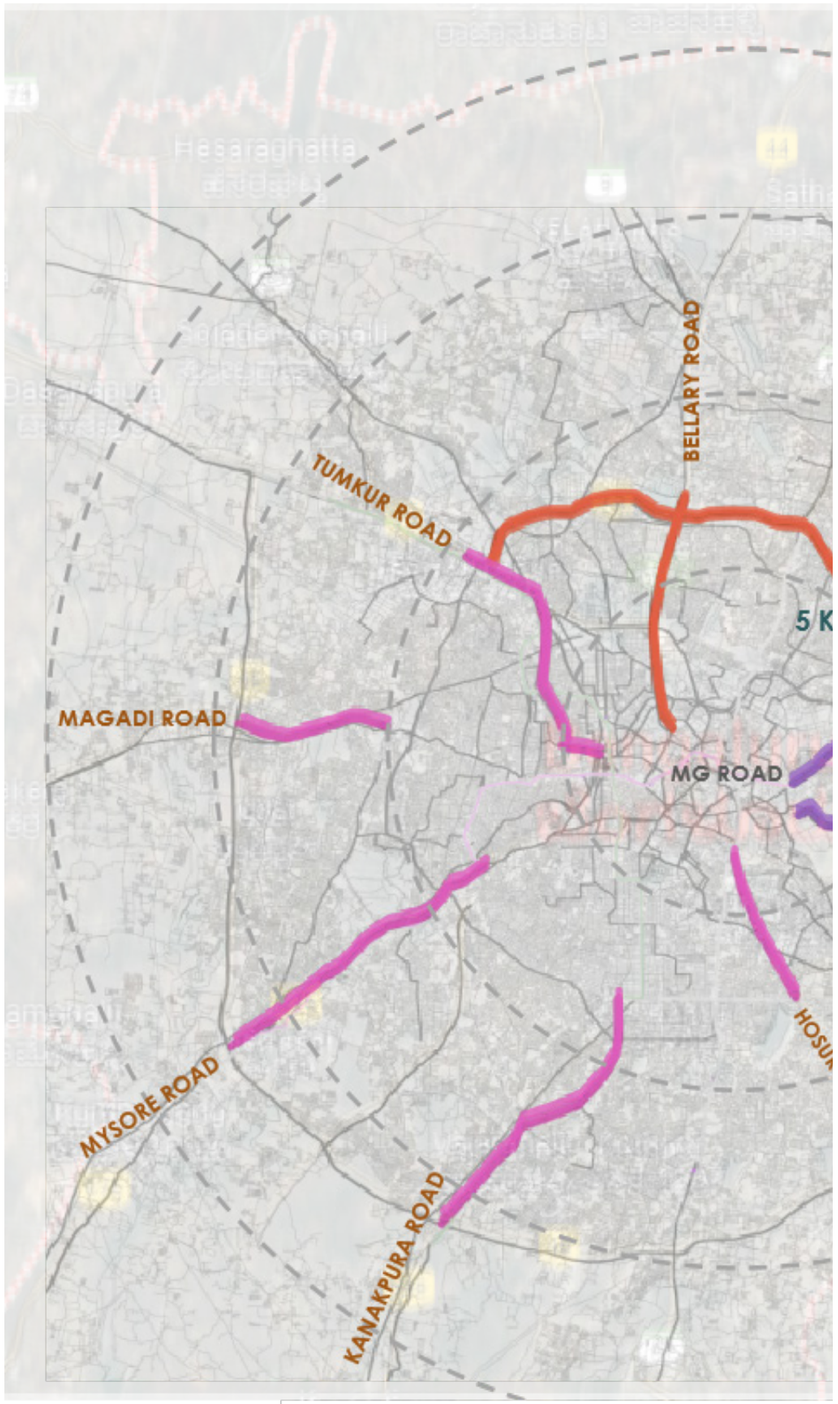
Figure 4. Key map of the HDC corridors and the organizations in-charge

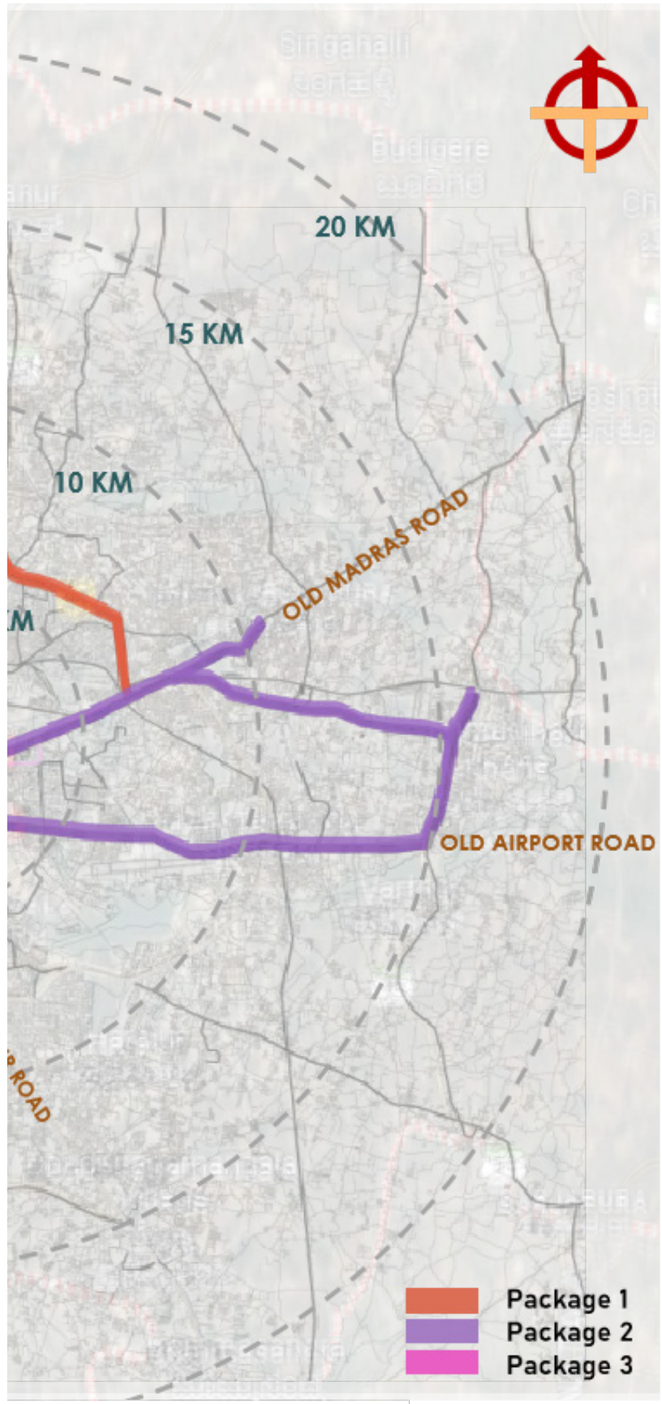


Phase I

HDC No	Corridor Name	Improvement Length , Km
1	Bellary Road	4.50
2	Old Madras Road	15.25
3	Old Airport Road	11.00
4	Hosur Road	5.28
5	Kanakapura Road	9.10
6	Mysore Road	9.30
7	Magadi Road	3.45
8	Tumkur Road	7.32
9	ORR from Goragunte Palya to K R Puram	17.93
	Total Length, Km	**83.13**

The 9 roads come under 3 different packages, and are taken up by two different consultants.





PACKAGE 1

Bellary Road

Outer Ring Road- from Goragunte Palya To KR Puram

PACKAGE 2

Old Madras Road- Part 1

Old Madras Road- Part 2

Old Airport Road

PACKAGE 3

Hosur Road

Kanakapura Road

Mysore Road

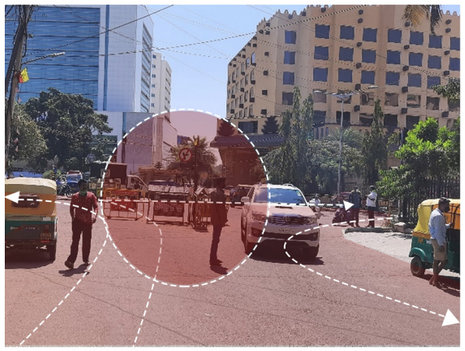
Magadi Road

Tumkur Road

1.2. Issues Identified

The **uneven carriageways** cause bottlenecks in traffic movement. The uneven carriageway also takes away essential space from the pedestrian footpath.

The **haphazard parking** causes footpaths to be occupied, posing an inconvenience to the pedestrian movement on the dedicated footpath.



The **blind turns into the main road** and **uncontrolled traffic movement** poses threat to pedestrians crossing the road.

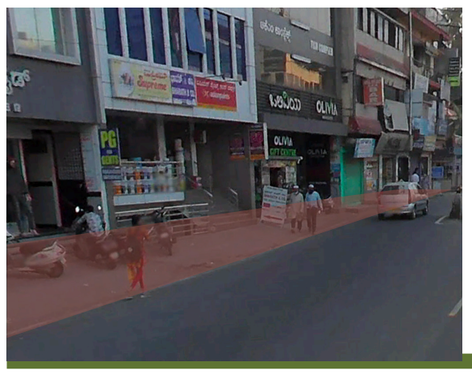
Presence of **multiple obstructions** along footpaths like billboards, Foot Over Bridges (FOB), etc.

Lack of **universally accessible ramps between footpath and road**

There is little space for pedestrian movement on footpaths due to presence of **services and utilities**

Lack of mid-block crossings increases jaywalking, accidents, and pedestrian inconvenience.

Source: Bangalore Mirror



There are **no signages** for pedestrians, cyclists, etc.

Speeding vehicles reduce reaction time, increasing accident severity and fatalities.

1.3. Opportunities Recognized in Existing Conditions

Sufficient **Right Of Way (RoW)** is available to streamline traffic movement into lanes.

Uniform carriageways enable cohesive, efficient, and safer street design integration.

Connecting roads are smaller; with the right turning radii they can facilitate safe traffic movement.

Provision for **public transport services** could be made at required junctions.

Improving the existing **shared mobility services** could encourage the public to use them more often, and reduce the usage of private vehicles.

Figure 8. T-B: Shared mobility, trees for shading, road-facing landscape

Large **trees** existing both at the median and footpaths provide shade to the street and help balance the air pollution.

Existing road-facing **landscape** maintained by private establishments.

1.4. Goals and Objectives of the HDC Project

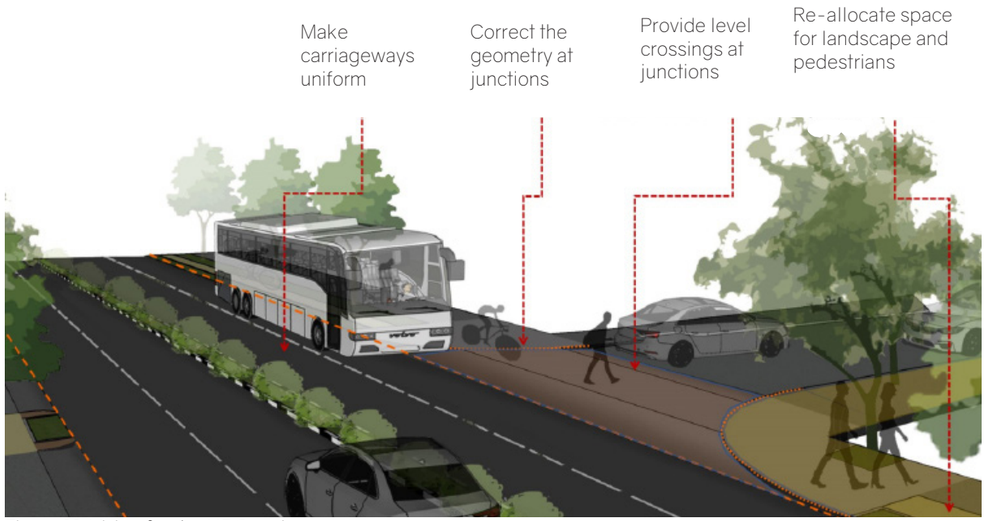


Figure 10. Vision for the HDC project

The objective of the High Density Corridor Project is to equip all the arterial roads of Bengaluru to move a high density of people and vehicles alike in a safe, efficient and sustainable manner.

Elements of a High Density Corridor

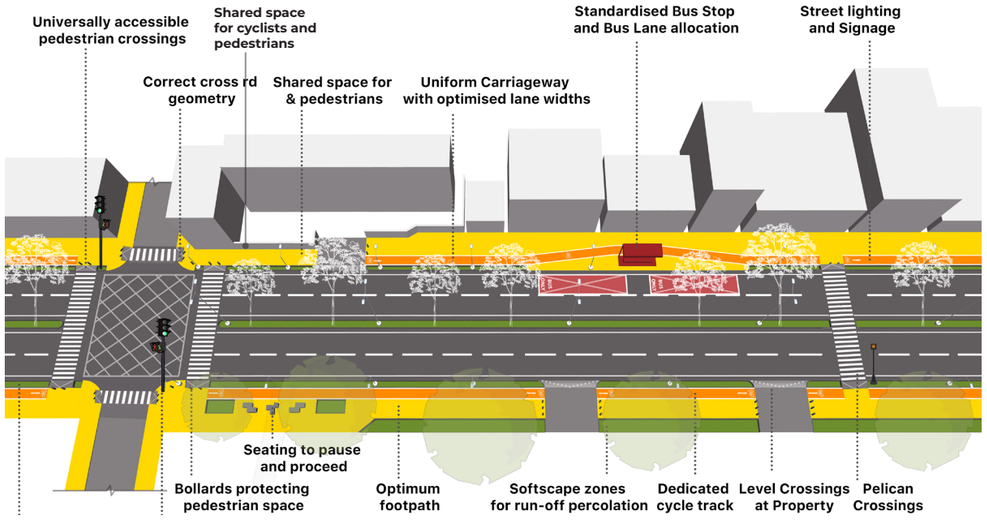


Figure 11. Elements of a High Density Corridor

Primary Objectives of HDC:

1. Efficient and safe

- Making the carriageways uniform as per standard 4-lane or 6-lane widths.
- Correcting geometry at junctions, islands, and cross roads.
- Providing level crossings at all junctions and entrances for universal accessibility, and slowing down traffic to allow pedestrians and cyclists to cross safely.

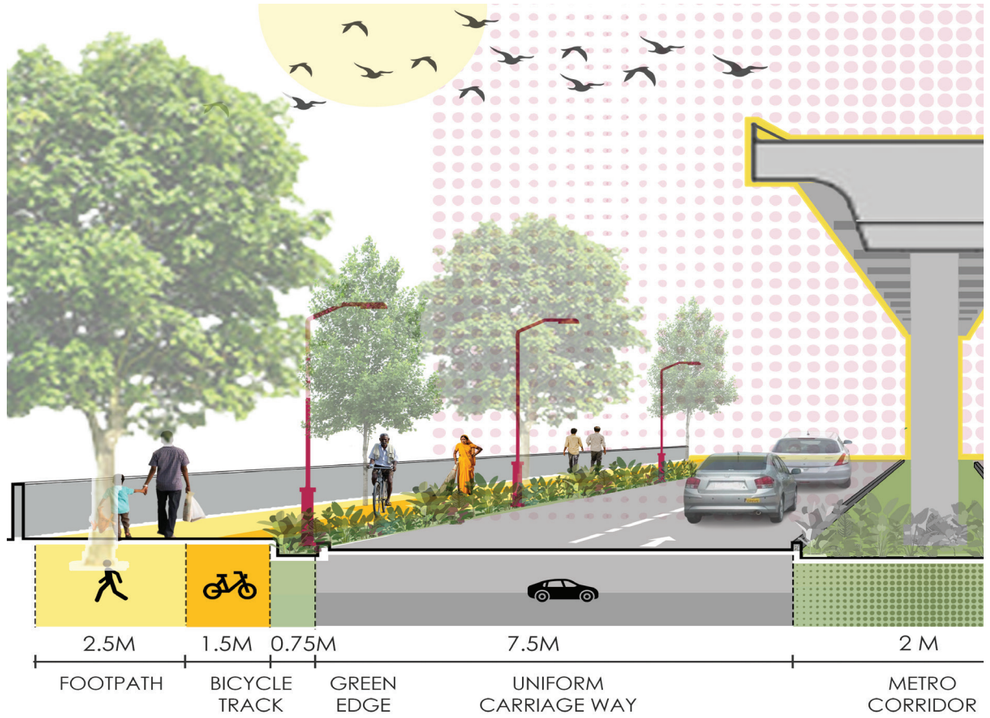
2. Universally accessible

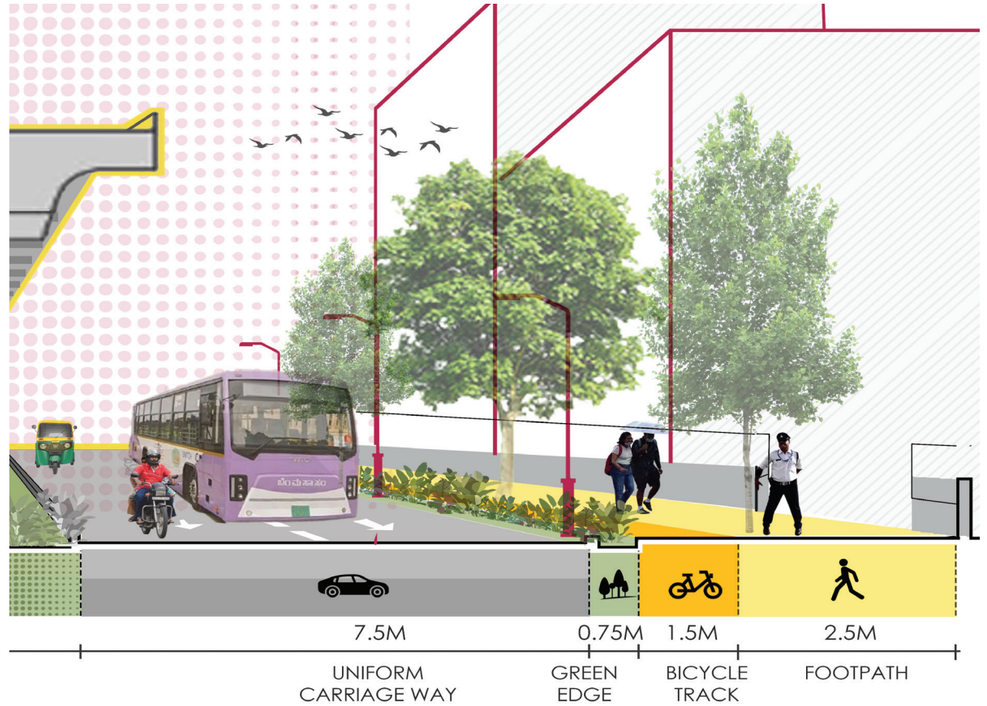
- Universal Accessibility that includes wheelchair accessibility, visually impaired accessibility, safe accessibility for people of all age groups, etc.
- Providing elements of urban street landscape

3. Multi-modal

- Re-allocating the residual space achieved by making the carriageway uniform towards landscape, pedestrians and cyclists.
- Provision for public transport services like bus lanes, bus stops, IPT parking, etc.

1.4. Goals and Objectives of the HDC Project





INCLUSIVITY	ACCESSIBLITY	SAFI
All user groups should be able to move safely, smoothly and conveniently.	Universal accessibility is essential. Proper ramps, tactile paving etc to be provided.	Foster a and in environ both w and dr experie

ETY	MULTI MODAL	GREEN COVER
secure viting ment for alking riving ences.	Promote walkability and cycling by facilitating last mile connectivity.	Aim for better user experience by increasing green cover and softscape.

Figure 13. Sectional Render of a Typical HDC Street

02 DESIGN PRINCIPLES FOR HDC

2.1 Reviewing Existing Conditions
2.2 Proposed Typical Street Plan and Section
2.3 Elements and Organisation of Right of Way (ROW)
2.4 Designing Inclusive Street
2.5 Proposed Design as per Suggested Design Principles

2.1. Reviewing Existing Conditions

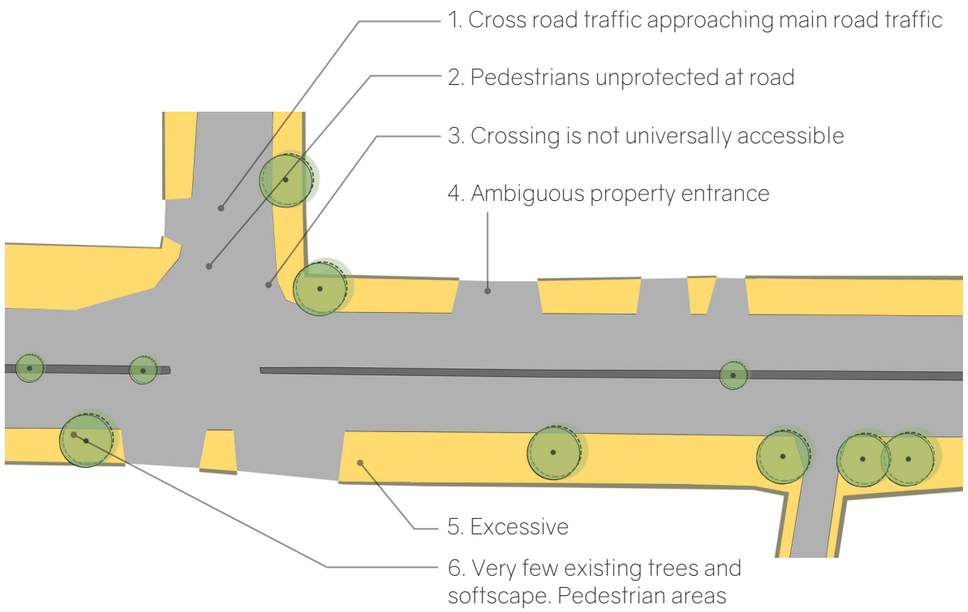


Figure 14. Existing conditions

2.2. Proposed Typical Street Plan and Section

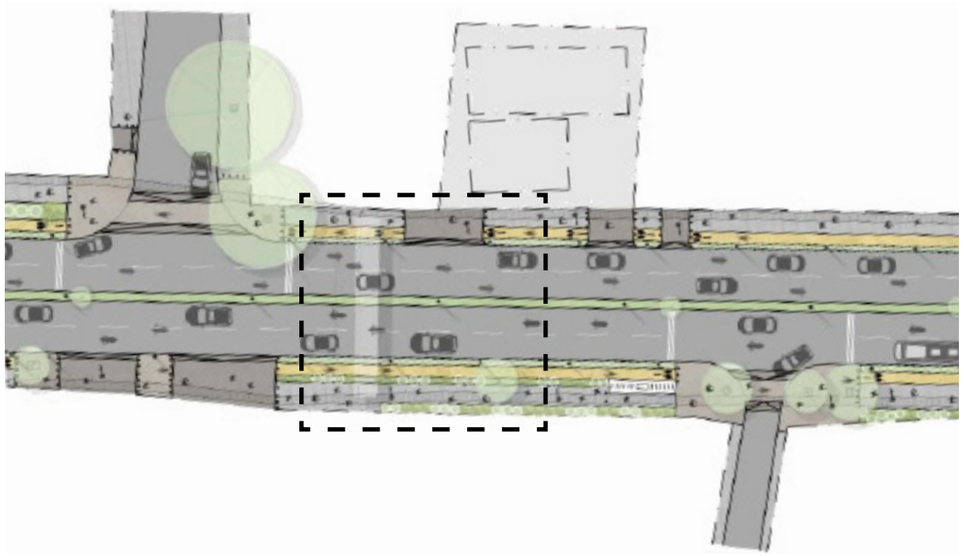


Figure 15. Typical street plan

Roads:

- All carriageways will have uniform two / four / six - lanes with uniform widths as specified. Uniform carriageway prevents bottlenecking, and facilitates smooth and uniform movement of vehicles.
- The median of the carriageway will also be redesigned with allocation of space for softscape and railings to restrict the movement and prevent unsafe crossing.

Sidewalks:

- Space gained is re-allocated for landscaping, with footpaths of minimum 1.8 M and cycle tracks of 1.5 M width.
- Pedestrians and cylists are given safe, uniform and universally accessible spaces and crossings.
- Softscape is increased, allowing for better percolation of rainwater to recharge ground water.

Junctions:

- The junctions will have standard turning radius.
- The incoming traffic from the cross road slows down at the zera crossing or high raised pedestrian crossing (HRPC) where appropriate the junction island geometry will be improved/ modified

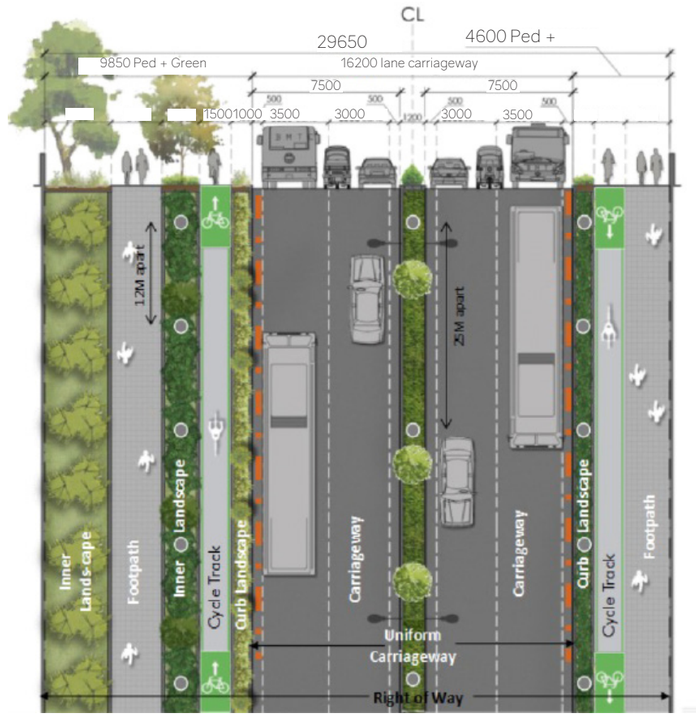


Figure 16. Typical street section

2.3. Elements and Organization of Right of Way (RoW)

The schematic image shows the different components of the proposed designs. In addition to uniform carriageways with 4 or 6 lanes, the following will be included:

- Comfortable footpaths for pedestrians with a minimum width of 1800MM. (Source: IRC: 103-2012, 6.1.3 (Pg:6))
- Cycle tracks with a minimum width of 1500MM.
- Level crossings at footpath level at all property entrances and junctions.
- Access ramps to private properties.
- Bollards, green buffer and other barriers to restrict and regulate vehicular entry.
- Landscaping such as trees and green strips.
- Street furniture such as benches, recycling and waste receptacles.
- Street lighting consisting of low-level lighting for pedestrian areas and high-masts/appropriate lighting for the carriageways.
- Signage such as direction signs, location signs showing street names and numbering, information signs including restrictions, warnings, updates, etc.

Figure 17. View of a typical street with all components

2.4. Designing Inclusive Street

2.4.1. Providing HRPCs, zebra crossings and leveling the ramps of property entrances to footpath

HRPC also helps facilitate easy movement for people and cyclists as it is at the same level as the footpath.

At junctions with traffic signals, zebra crossings will be provided

The property entrances will ramp-up to flush to the level of footpath.

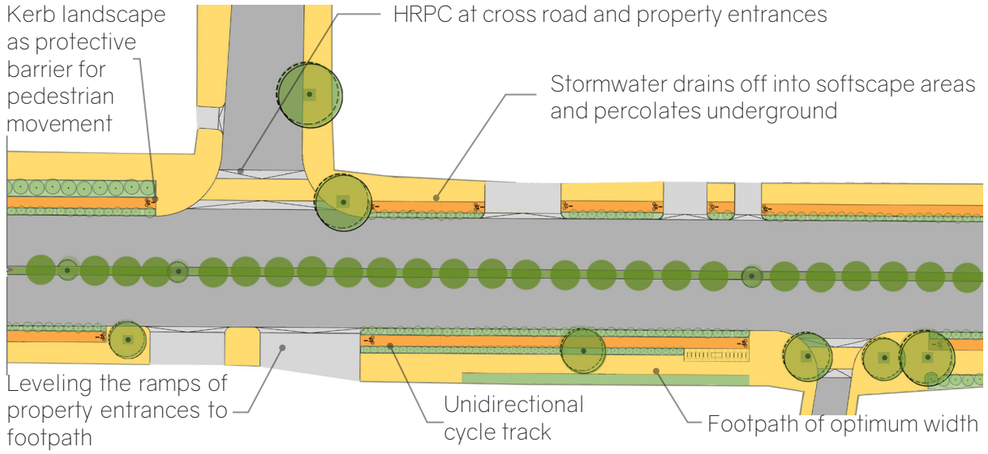


Figure 18. Landscaped areas, pedestrian and cyclist space, land level crossing

2.4.2. Universal Accessibility Elements

2.4.2.1. Wheelchair Accessibility

Ramps are provided at the junctions of property entrances. Here the footpath ramp slopes down to the road level.

For purpose of wheelchair accessibility the width between one set of the bollards on the footpath will be at 1100 MM c/c (center to center).

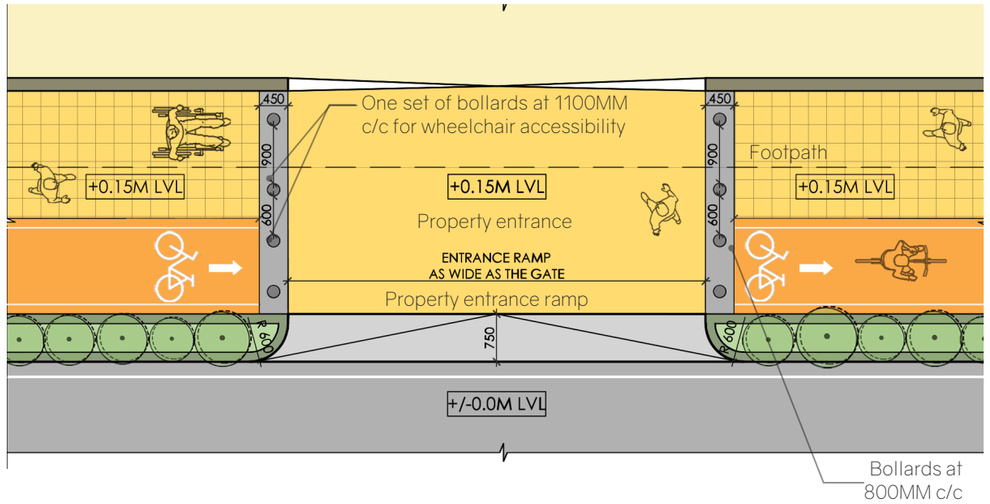


Figure 19. Bollard spacing and ramps at property entrance for universal accessibility

2.4.2.2. Visually Impaired Accessibility

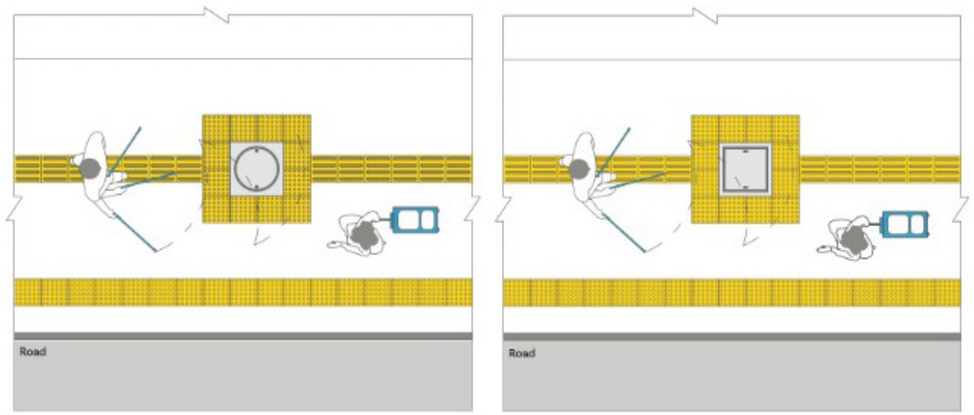


Figure 20. Tactile paving around drain covers, *Harmonized guidelines and standards for Universal Accessibility Design in India 2021*

2.5 Proposed Design as per Suggested Design Principles

Existing Street View Before Pheonix Market City, White-

After Pro-

03 DESIGN GUIDELINES

3.1. Uniform Carriageway Widths

3.1.1. Carriageway width for a 4-lane road

The two-way vehicular cariageway in a four lane road will have two carriageways of width 7.5M with a seperating median. The outer lane will have a width of 3.5M to accomodate larger vehicles such as buses, while the inner lane will have a width of 3M. A shy-away zone on either side of each carriageway will be 0.5M.

With these dimensions, a 4-lane road will be (15 M + median width) wide.
(Source: IRC 86-2018, 5.4)

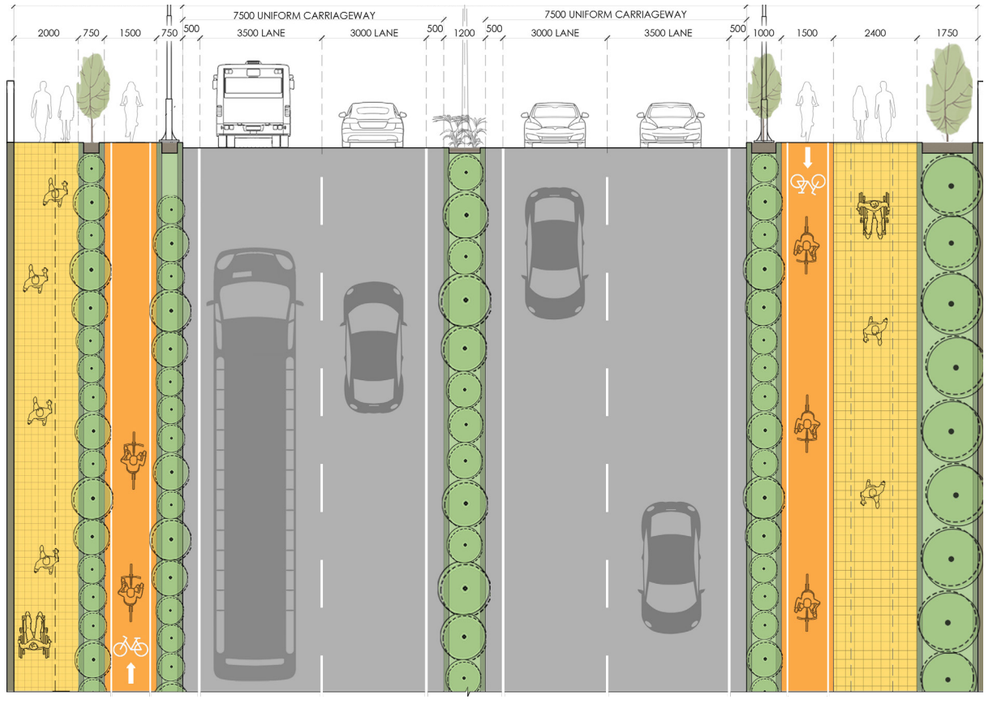


Figure 21. Diagram indicating a 4-lane road of uniform 7.5 M

3.1.2. Carriageway width for a 6-lane road

Vehicular carriageway in a six lane road shall have an average wdith is 10.5 M each seprated by a median. Two lanes will have a uniform width of 3 M. The peripheral/ left most lane will be treated as a bus lane, and will have a consistent width of 3.5 M. Shyness along both sides of carriageway will be 0.5 M. Thus, the total width of the carriageway is 10.5 M.

With these dimensions, a 6-lane road will be (21 m + median width) wide.

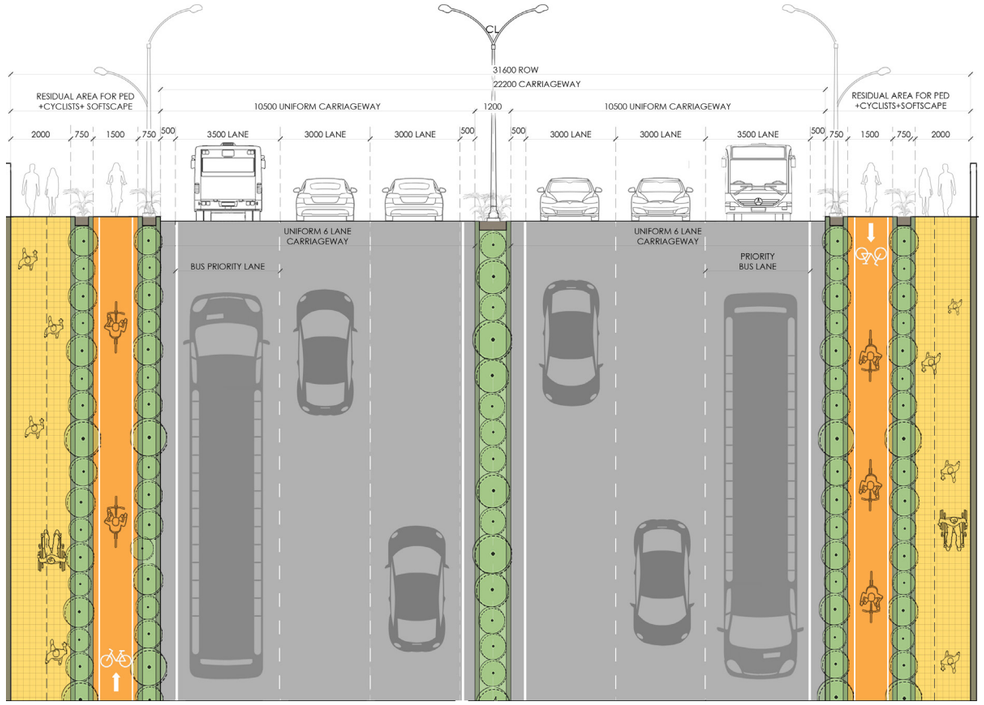


Figure 22. Diagram indicating a 6-lane road of uniform 10.5 M

3.1.3. Carriageway width for service road

The one-way service road will have a uniform total width of 6 M or 7 M depending on the road conditions, with two lanes of 2.75 M or 3 M respectively. Shyness along both sides of carriageway will be 0.25 M.

Residual space towards property side will be used for softscape, cycle track and footpath.
(Source: IRC 86-2018, 5.9)

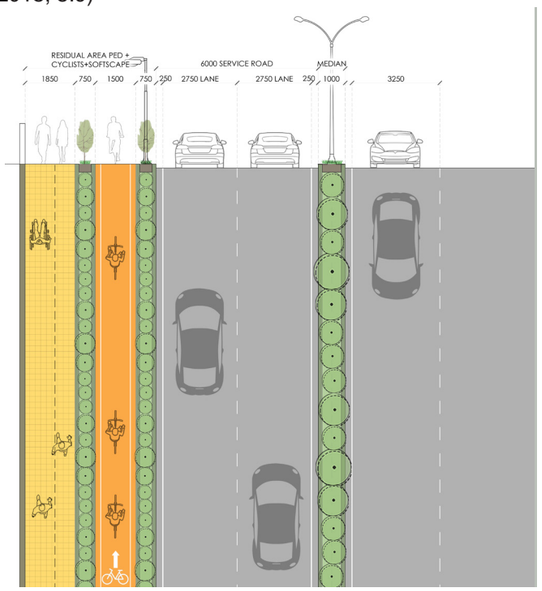


Figure 24. Diagram indicating a service road (on the left) with uniform 6M cariageway

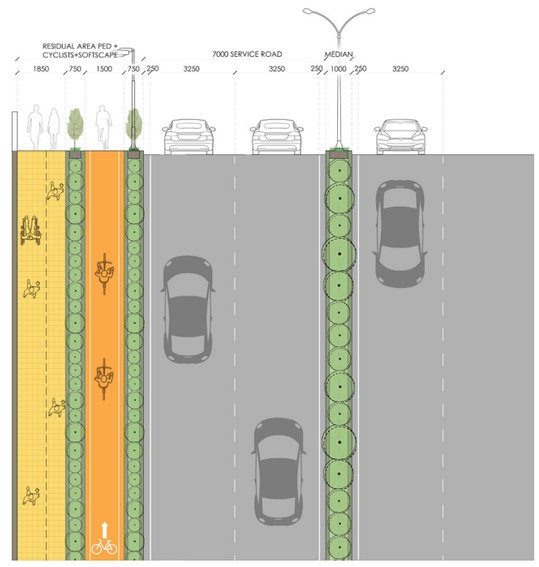


Figure 23. Diagram indicating a service road with uniform 7M carriageway

3.1.4. Median Design for Carriageway

Urban roads with four lanes or more should generally have medians, considering safety, traffic distribution, and roadside development. Medians can be avoided in areas with significant tidal traffic flows. Median width depends on various factors, with minimums of 1.2 m for pedestrian refuges and 4 m for right turns, preferring wider medians when possible.

(Source: IRC 86-2018, 5.6)

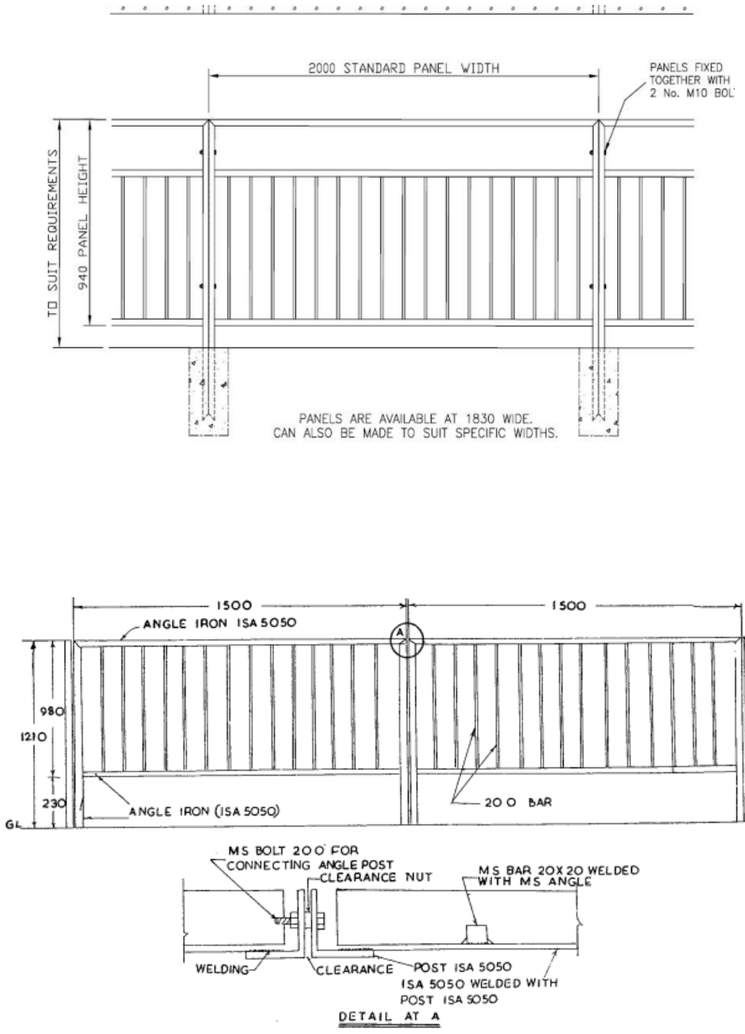


Figure 25. Cast Irn Railing design reference

Case 1: Green Median

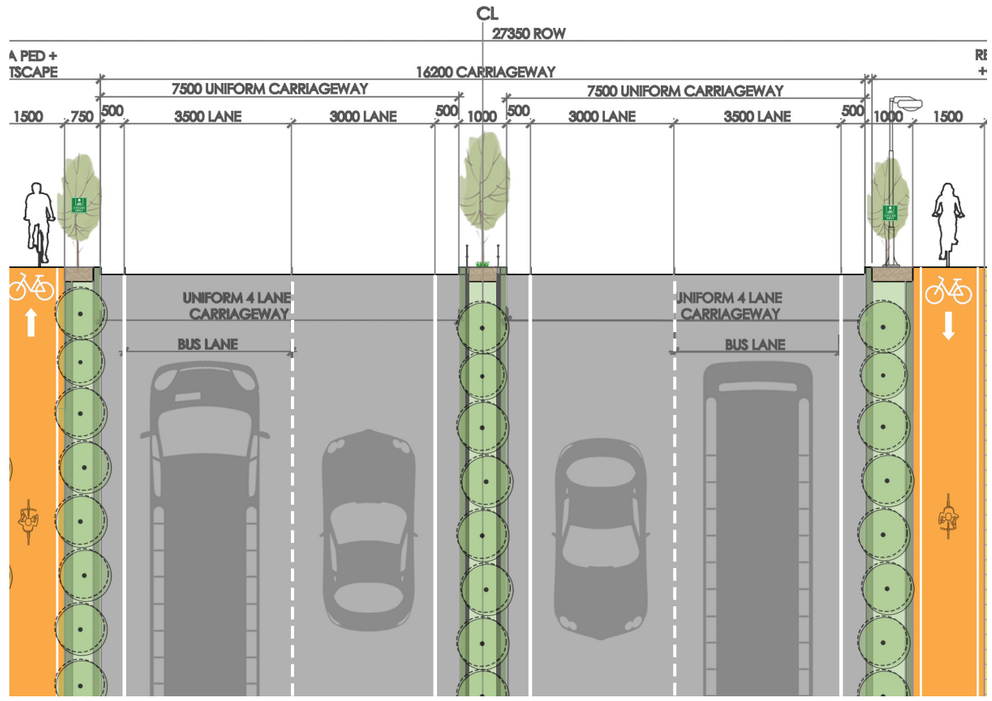


Figure 26. Median with railing design for carriageway

Case 1 : Median Curb With Railing

The median curb of width 300mm and height 200mm attached with a railing in between of height 1200mm, To prevent pedestrians from crossing at any other point other than the designated crossing midblocks.

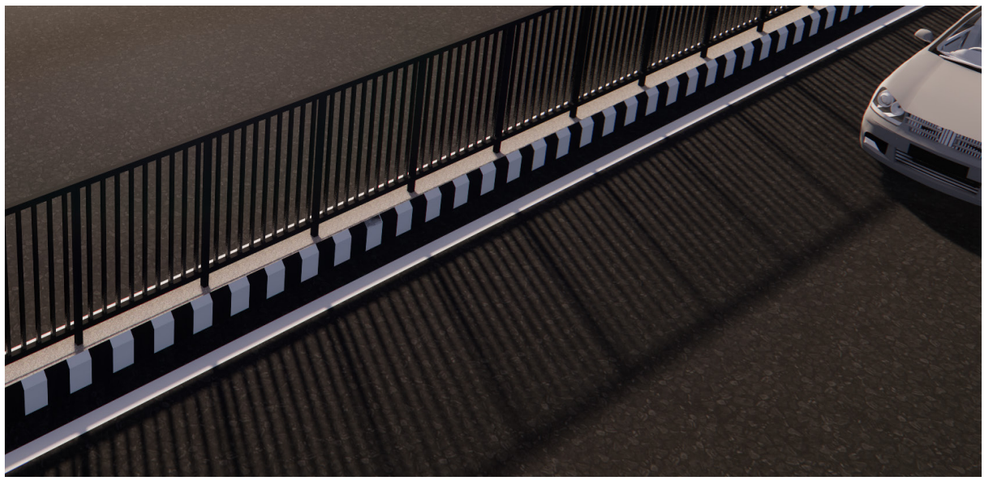


Figure 27. Media Curb with Railing

Case 2 : Median Planter with Railing

The median curb of width 300mm and height 200mm attached with a railing in between of height 1200mm and planter on either sides till the edge of the curb, To prevent pedestrians from crossing at any other point other than the designated crossing midblocks.

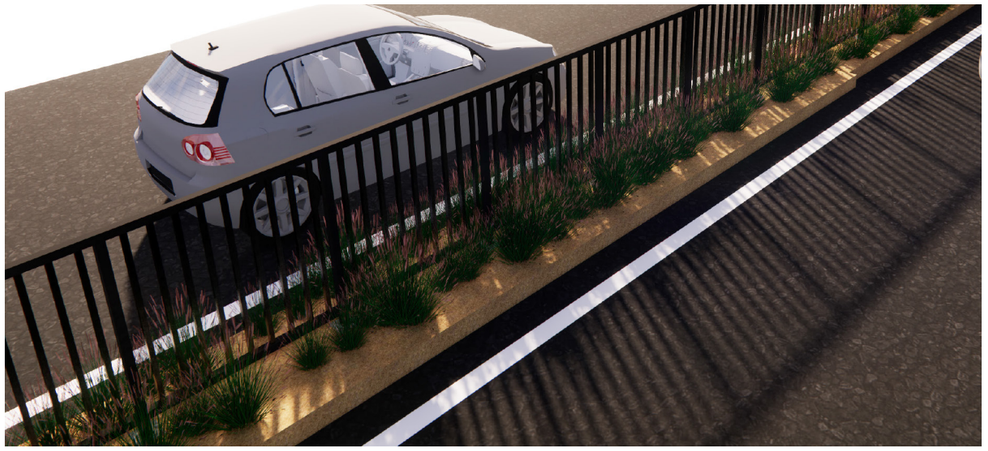


Figure 28. Median planter with Railing

Case 3 : Median Planter with railing on both sides

The median curb of width 300mm and height 200mm attached with a railing on both sides of height 900mm. Inbetween railing is fully planted. This case is impemented where median's are a width of 1200mm-2000mm To prevent pedestrians from crossing at any other point other than the designated crossing midblocks.

Figure 29. Median Planter with Railing on both sides

Case 4 : Metro Column Median Planter with railing on both sides

The median curb of width 300mm and height 450mm attached with a railing on both sides of height 600mm. Inbetween railing is fully planted. This case is impemented where medians have metro columns To prevent pedestrians from crossing at any other point other than the designated crossing midblocks.

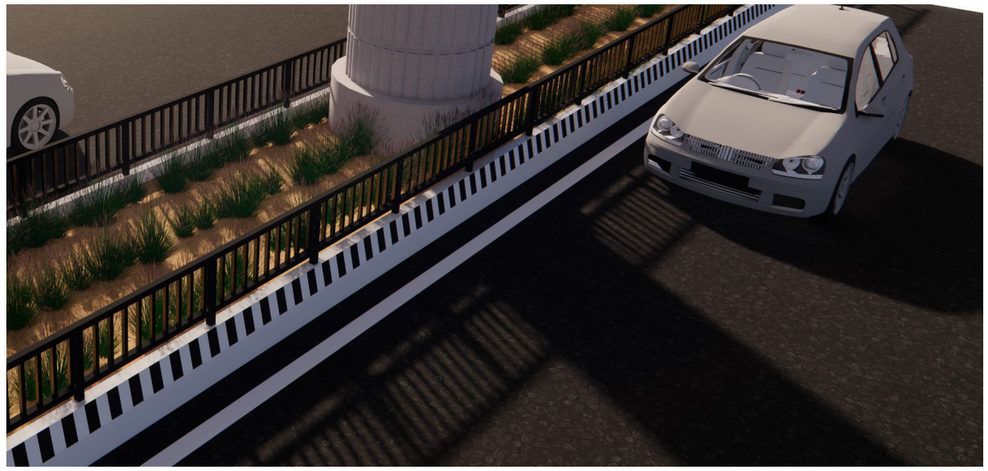
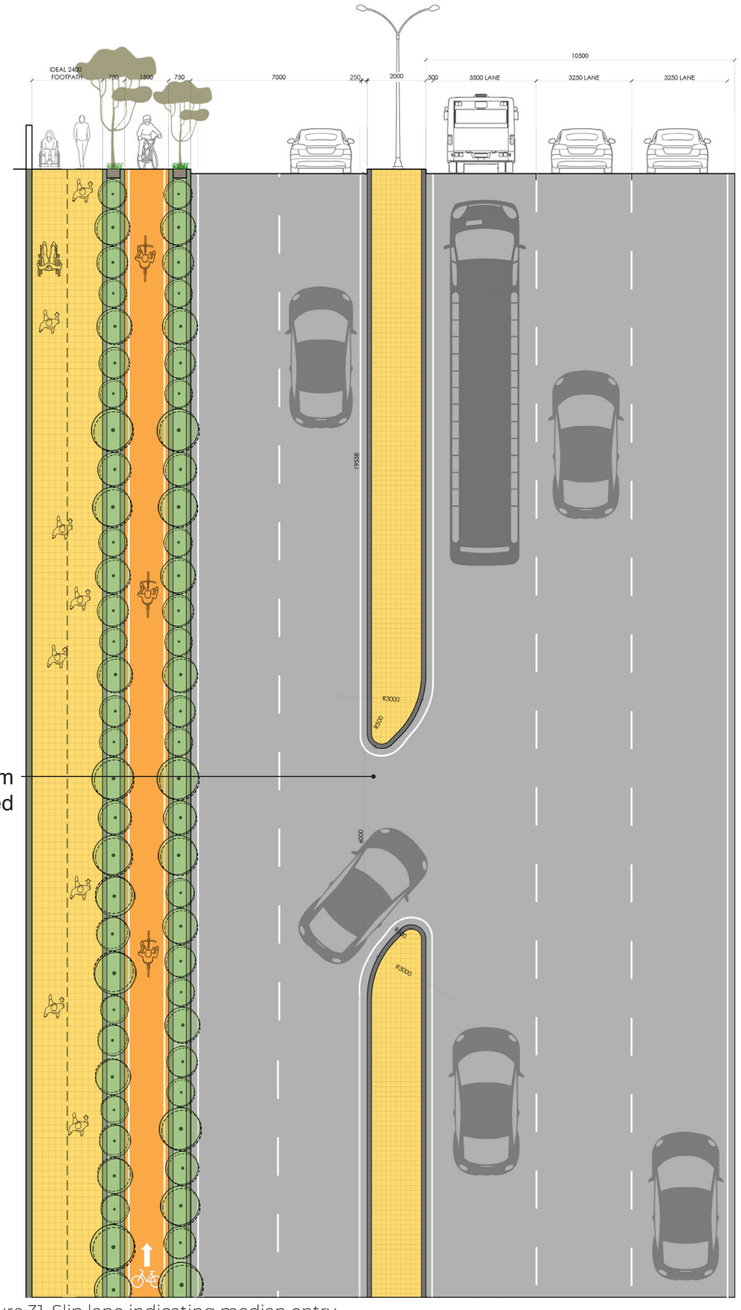


Figure 30. Metro Column Median Planter with railing on both sides

3.1.4.1 Slip Lane at service road entry & exit condition

For entries and exits from main carriageway to a one-way service road, the median geometry should be formed to facilitate smooth movement. The break in the median should be at least 6 M wide. The median kerb edge should be shaped appropriate turning radius



Note: A minimum of 40m distance is to be provided before/ after the junction

Figure 31. Slip lane indicating median entry

The entries and exits from main carriageway to a one-way service road, should be designed with separate slip lanes to facilitate smooth movement.

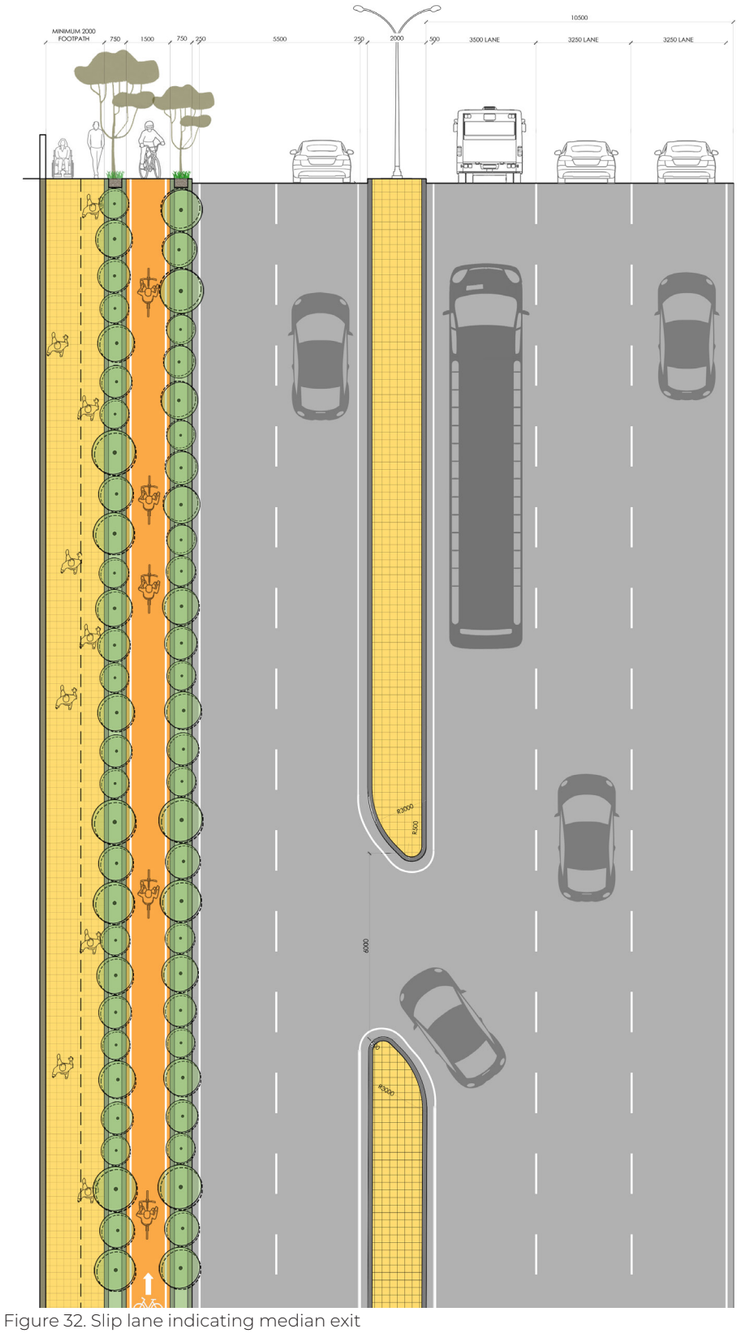


Figure 32. Slip lane indicating median exit

3.1.5. Underpass Crossing Conditions

Case 1 : Vehicular Underpass

Vehicular entry beneath a flyover is a vital urban transport link, designed for smooth traffic flow and city connectivity. These entry points, carefully planned to minimize congestion, play a crucial role in optimizing traffic management.

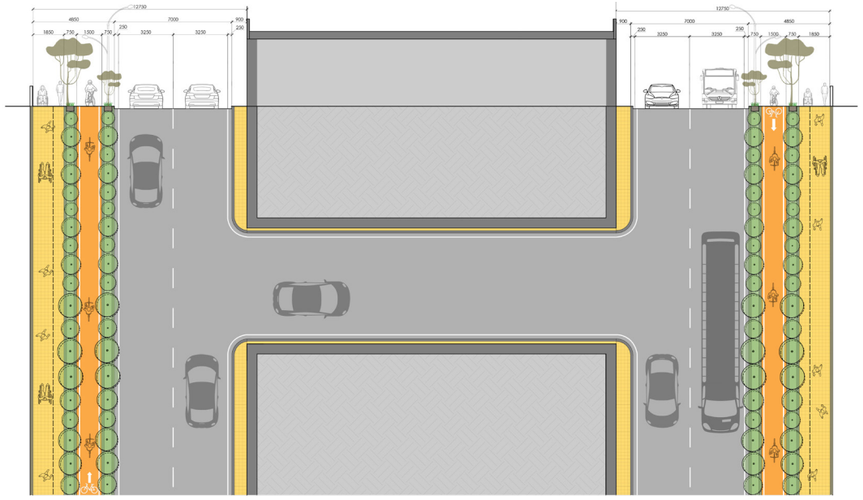


Figure 33. Vehicular Underpass

(Source: IRC 54-1974, 7 (July, 2011 reprint))

Case 2 : Pedestrian Crossing

Pedestrian crossings are provided beneath the flyover, to facilitate easy and safe crossing between the two roads adjacent to the flyover. It is designed to be universally accessible.

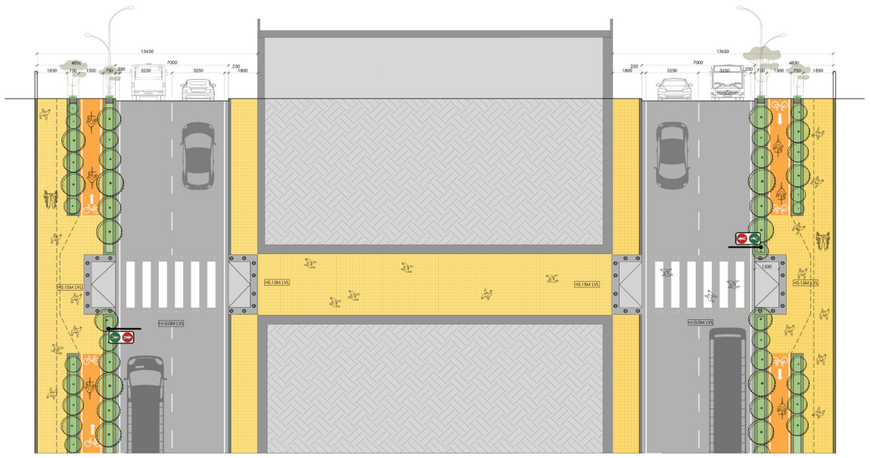


Figure 34. Pedestrian Underpass

Cycle track marking on footpath to be added

Case 3 : Vehicular & Pedestrian Crossing

Integrating both vehicular and pedestrian crossing beneath the flyover, for smooth traffic flow and pedestrian connectivity. A dedicated pedestrian footpath of minimum 1800 MM must be provided to faciliate ease of their movement at crossings.

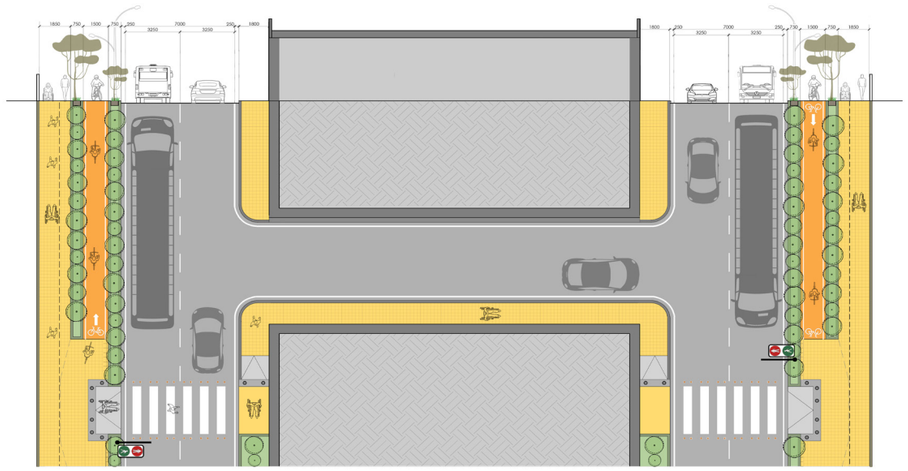


Figure 35. Vehicular and Pedestrian Underpass

(Source: IRC 103-2012, 6.1.3 (Pg:6)

3.2. Junction Geometry

3.2.1. Turning radius at junctions and cross roads

The turning radii at the junctions and cross roads varies based on the width of the cross road. The wider cross roads with width more than 6 M will have a turning radius of 4.5 M at the cross-road junction. Based on the available footpath widths at these cross-road junctions, there are three possible conditions for designing safe crossings, with either a zebra crossing with access ramps and bollards, or a High Raised Pedestrian Crossing (HRPC) to ensure pedestrian safety.

(Source: IRC SP 41-1994, 4.6

Case 1: Turning Radius of 4.5 m for cross road width above 6M

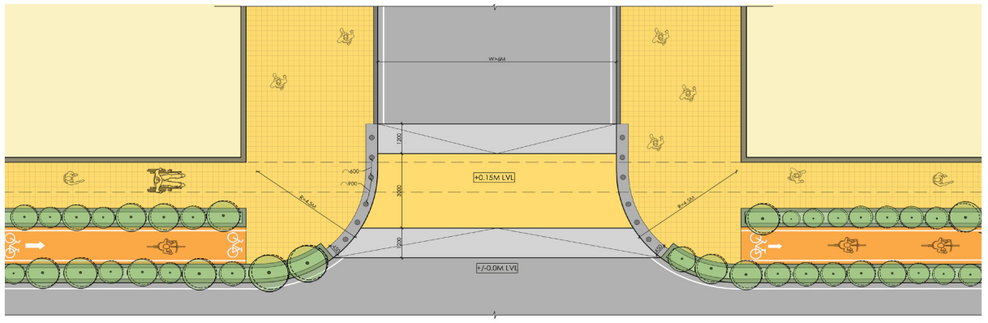


Figure 36. HRPC diagram indicating 4.5m turning radius for cross road width above 6 M

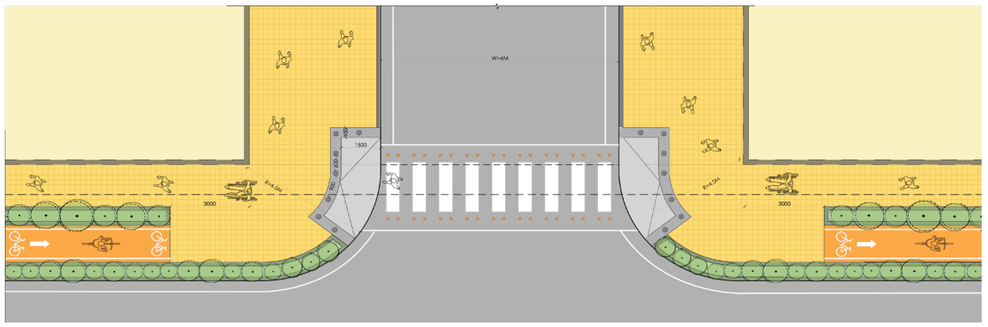


Figure 37. Zebra crossing diagram indicating 4.5m turning radius for cross road width above 6 M condition 1: Where greater footpath width is available

Note: In each case, the edge plantation shall not be taller than 0.6m to ensure clear visibility

Case 2 : The turning radius of medium-width cross road with width more 4.5 M and less than or equal to 6 M, would be 3 M at the junction.

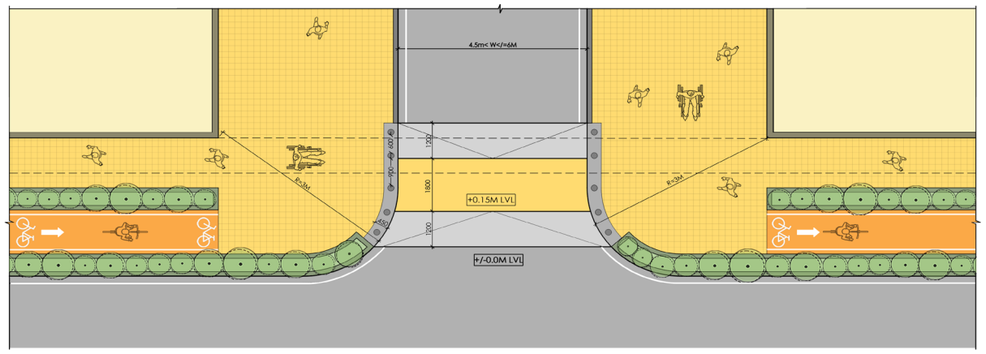


Figure 38. Diagram indicating 3 M turning radius for cross road width above 4.5 M but below or equal to 6 M with HRPC

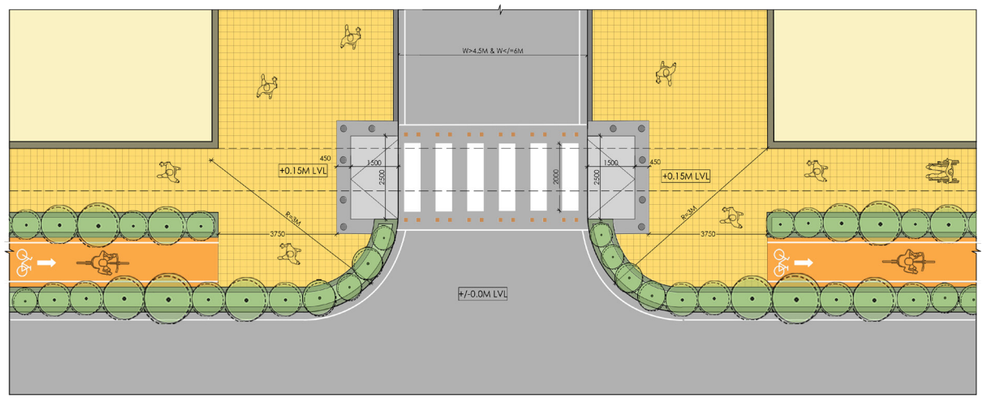


Figure 39. Diagram indicating 3 M turning radius for cross road width above 4.5 M but below or equal to 6 M with Zebra Crossing

Note: Footpath continuity should be maintained throughout the roads having widths equal to or less than 6m. Raised crossing also act as a pause point before merging to the main carriageway.

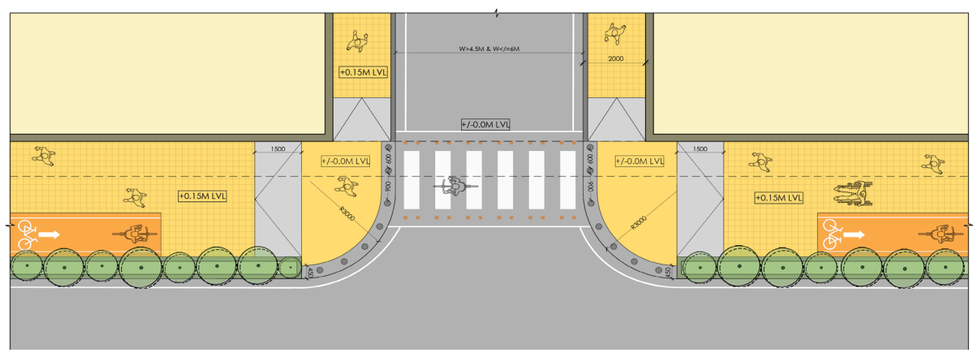


Figure 40. Zebra crossing diagram indicating 4.5m turning radius for cross road width above 6 M condition 2: Where the footpath width is less

To be completed Later

The turning radius of the cross road of width less than or equal to 4.5 meters, will be 0.9 meters.

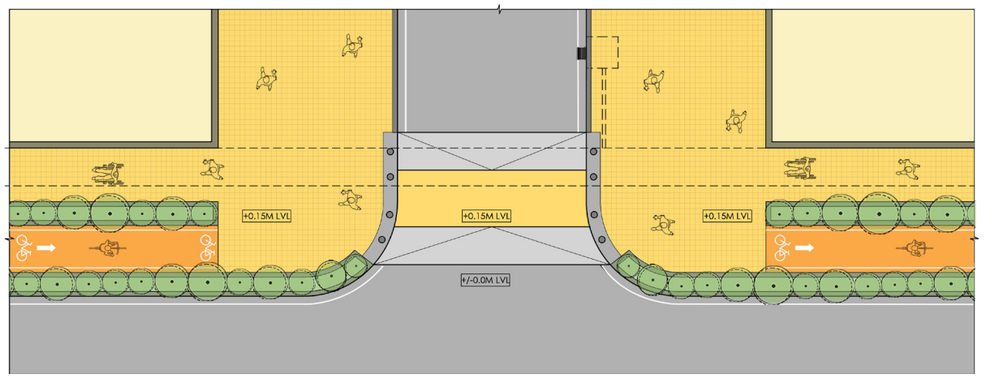


Figure 41. Diagram indicating 0.9 M turning radius for cross road width less than or equal to 4.5 M indicating drain

3.2.2. Intersection geometry

3.2.2.1. Intersections with Traffic Signals

Geometry at all intersections is modified with appropriate lane widths, turning radii, safe crossing for pedestrians with HRPCs at crossroads and signaled junctions. Zebra crossings are to be provided at the intersections with traffic signals. Access ramp from footpath level to the carriageway level is to be given for universal accessibility. (Source: IRC 99-2018, Pg: 12)

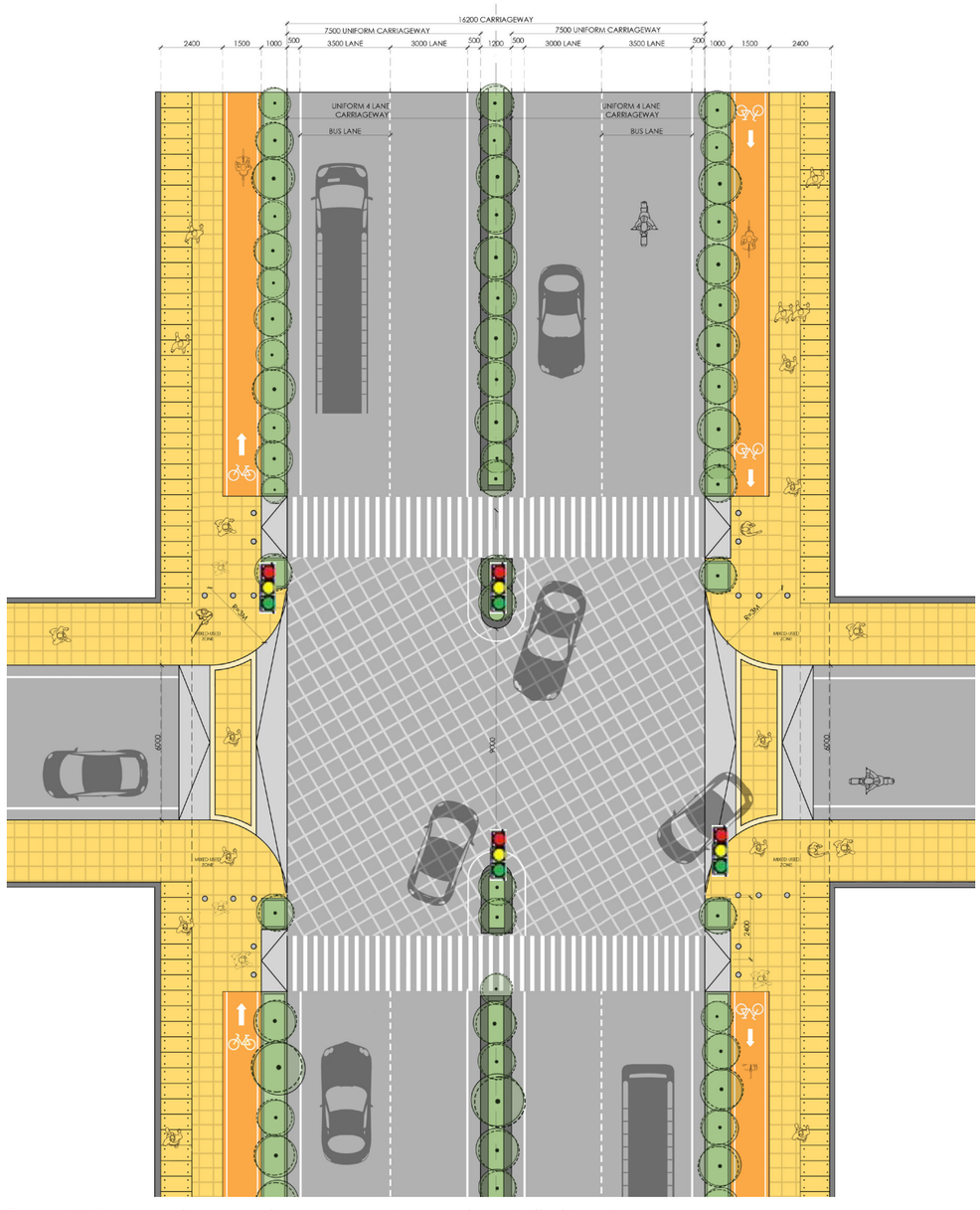


Figure 42. Diagram showing zebra crossings at a signal-controlled junction

Another option with HRPC can be done for junction detail

3.2.2.2. Intersections without traffic signals

Preferably, all the intersections should have traffic signals. In case the traffic signals cannot be installed, then the HRPC should be provided at such intersections.

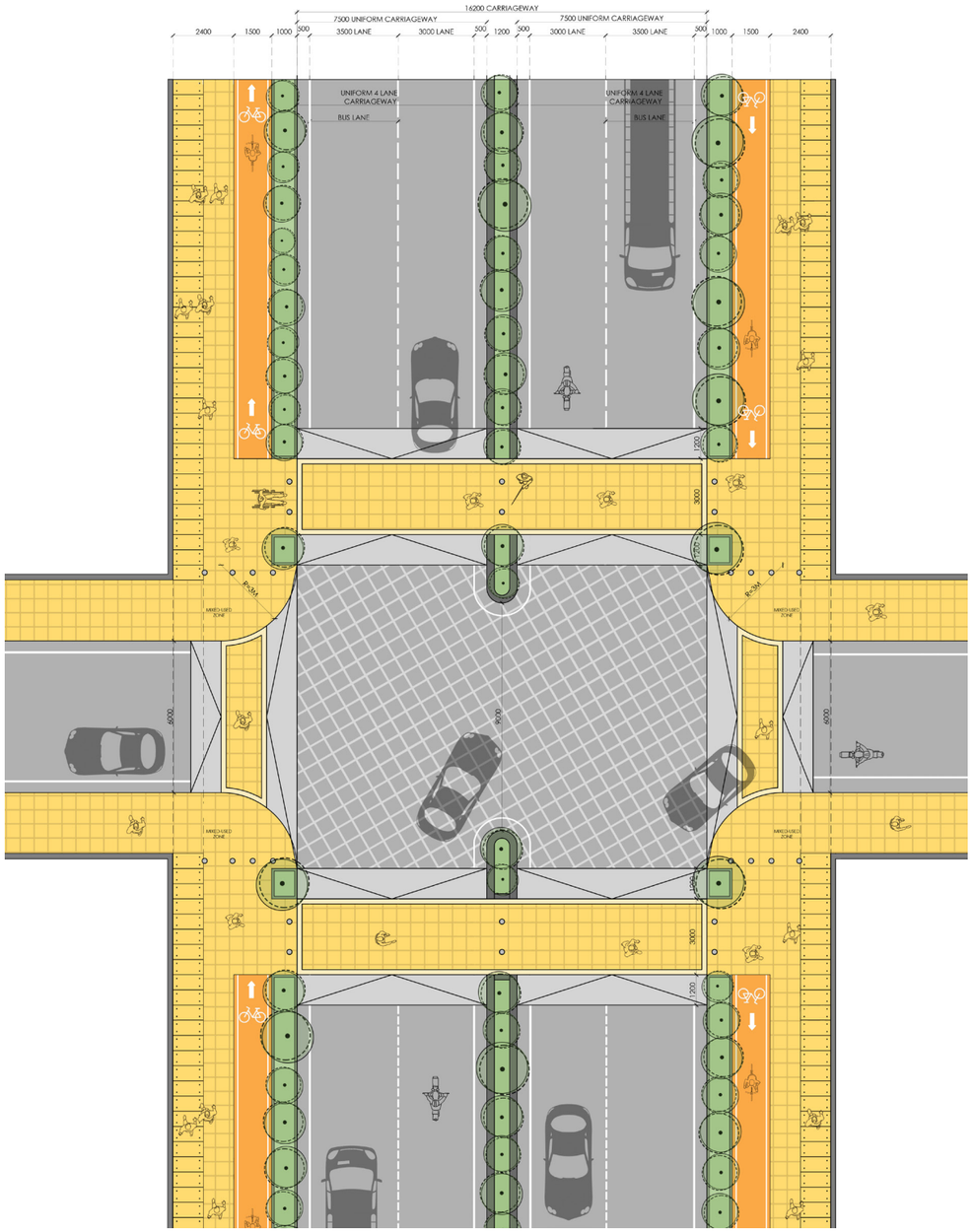


Figure 43. Diagram showing HRPCs at a signal-free junction

3.2.2.2. Signalised Junction Crossroad

Preferably, all the intersections should have traffic signals. All junctions should also have PELICON Crossing.

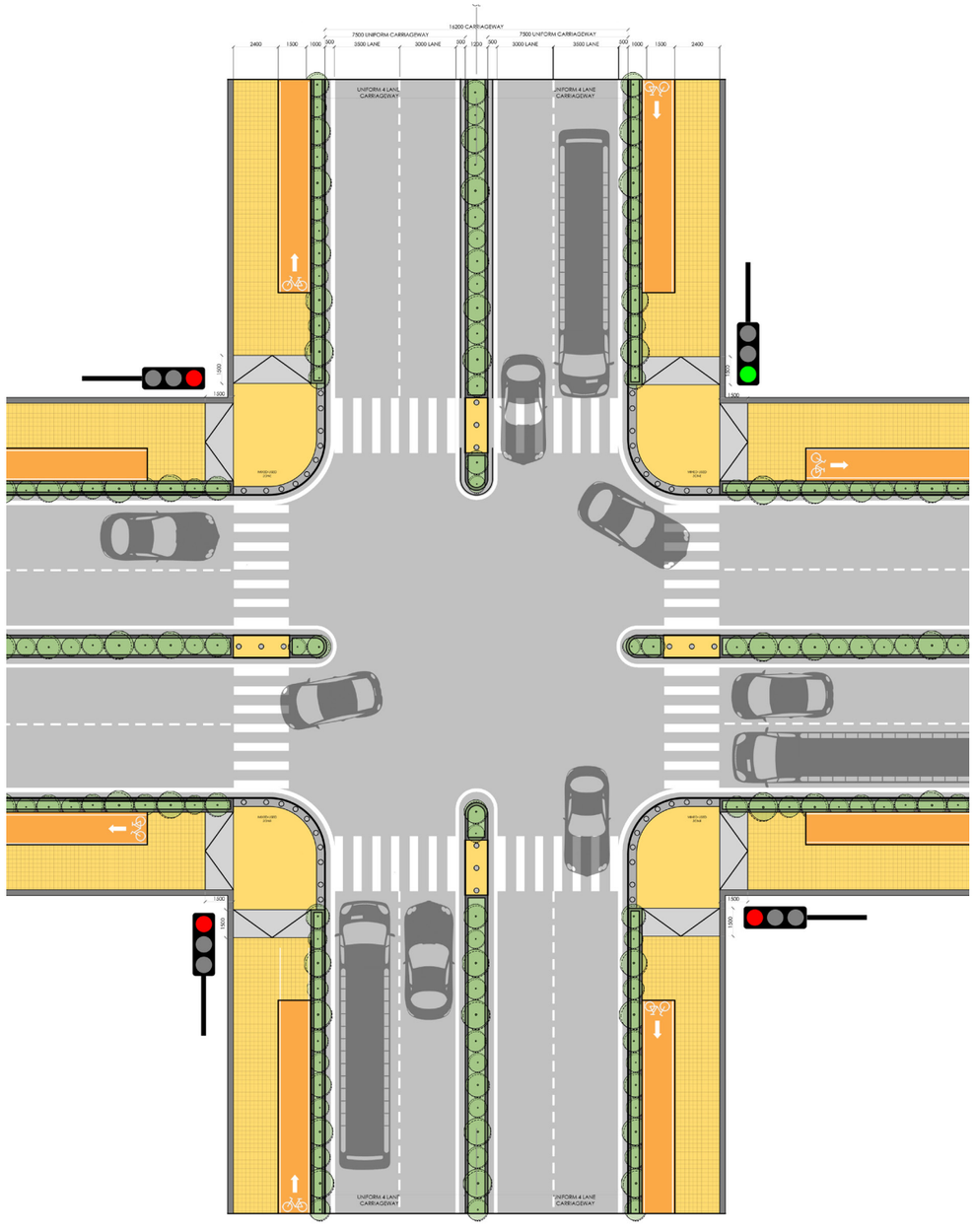


Figure 44. Diagram showing HRPCs at a signal-free junction

3.2.3. Island geometry

At the junctions with undefined island geometry, the issues identified are,

- At some parts the carriageways are wider than required and at other parts the carriageway is inadequate. The lane widths are also not uniform, leading to bottlenecking.
- Safety concerns for pedestrians as they are not protected at the crossing.
- The zebra crossings are not universally accessible.
- Lack of continuous, well maintained footpaths, and hence no dedicated space for pedestrians.
- The property entrances are ambiguous, obstructing the movement of the pedestrians.

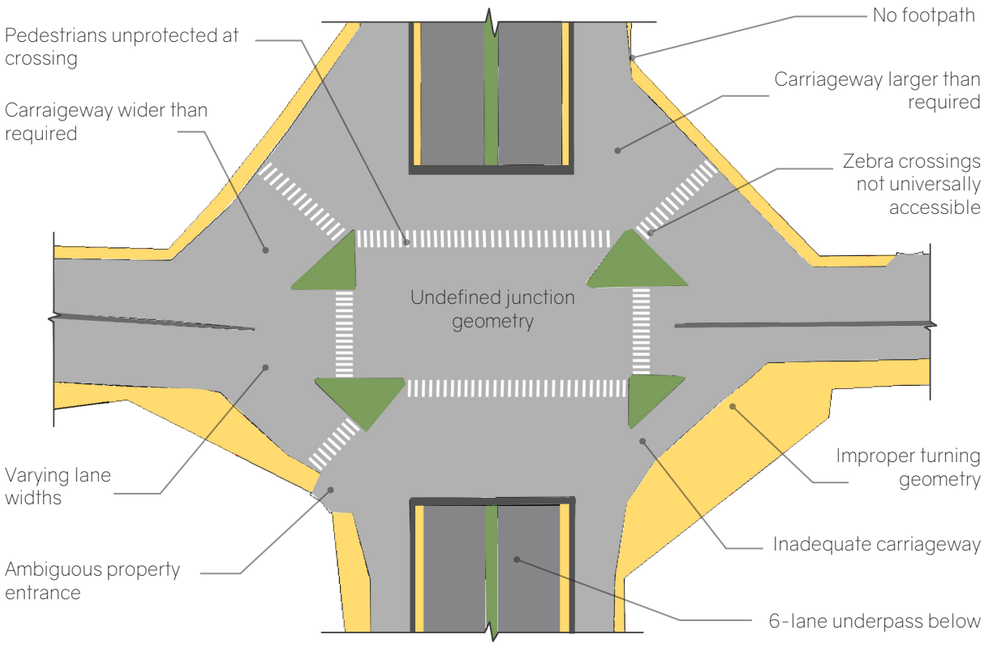


Figure 45. Diagram showing issues with existing condition at Mekhri Circle, Bellary Road

The modified/formed junctions island geometry will have,

- Uniform carriageway of 2-lane width throughout, which aids in uniform movement of traffic.
- Corrected turning radius.
- Kerb landscape is provided especially at the turnings as a protective barrier for cyclists and pedestrians.
- At free left turns, HRPC is provided as a safety measure for pedestrians crossing
- The zebra crossings at junction with signals are universally accessible.
- Safe crossing for pedestrians, with islands to stream line traffic movement. The islands are also space created for public art and sculpture to personalize each junction.
- The property entrances will ramp-up to flush to the level of footpath.
- U-turns are also permitted at the junctions.
- Where there are 6 lane under passes, the peripheral lane next to the footpath will be the bus priority lane.

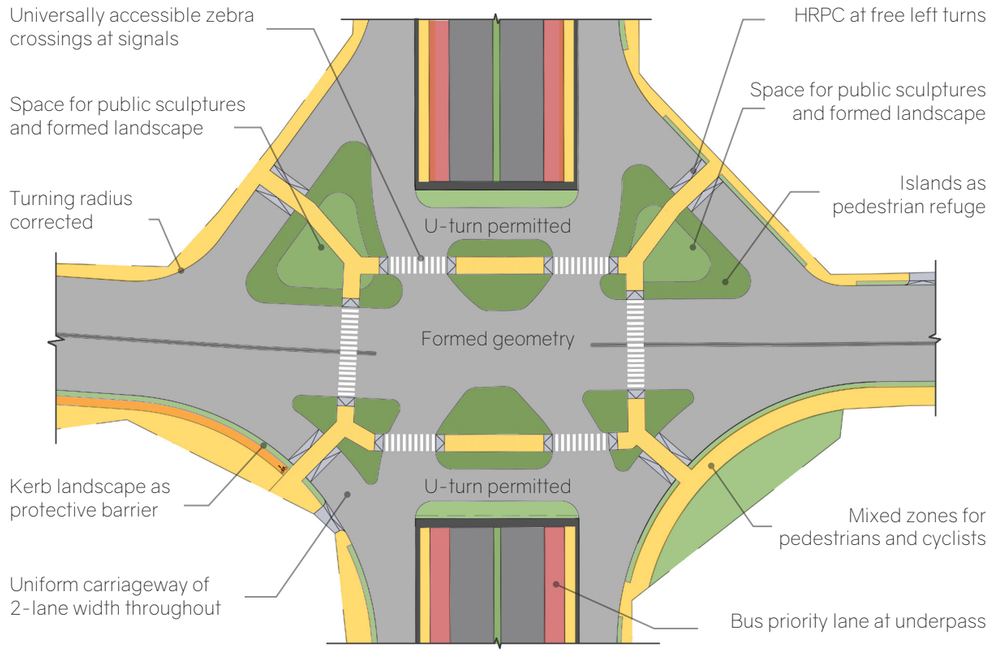


Figure 46. Diagram showing modified condition at Mekhri Circle, Bellary Road

Design to be updated

3.2.4. Roundabout geometry

While ideally traffic signals are to be provided at the major road intersections, there are conditions where a signal may not be possible/required. In such cases, providing a roundabout/circle helps to regulate the traffic flow.

The geometry of the roundabout is derived from the geometry of the intersecting roads. The carriageway around the roundabout should be 9M wide (edge of island to edge of kerb). A roundabout typically has a raised circular island of not more than 4M diameter (depending upon the width of the carriageway approaching the circle) at the center. The central island can be designed as a sculptural placemaking element or a planter with signage. The median near the roundabout should be designed to be wider, so that the vehicles have to go around the central island to make an U-turn. Pedestrian crossings (zebra or HRPC) are to be provided, with a part of the median forming a pedestrian refuge.

If there is enough area at the intersection, additional islands could be provided to accommodate free left turns.

(Source: IRC 65-2017)

Figure 47. Roundabout

Design to be updated

3.2.5. Complex Junction

A well-designed round about incorporates a seamless integration of through and through traffic movement, free left turn, U-turn facility, optimizing traffic flow and safety. The junction layout ensures efficient navigation for all vehicular users within the round about for their respective directions. This design minimizes congestion and enhances overall traffic management. It further enables well-connected crossings for pedestrians and cyclists with integrated refuge islands. The strategic placement of signages and lane marking for enhanced driver awareness.

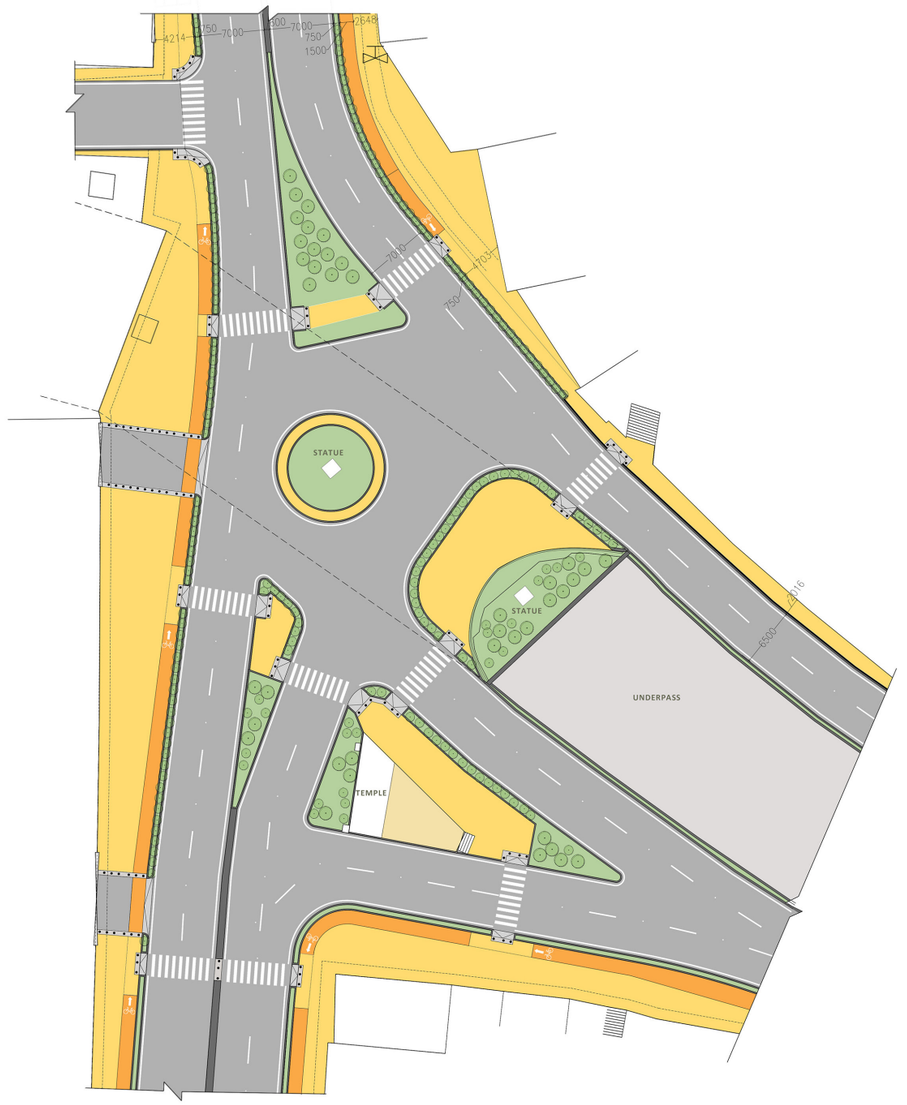
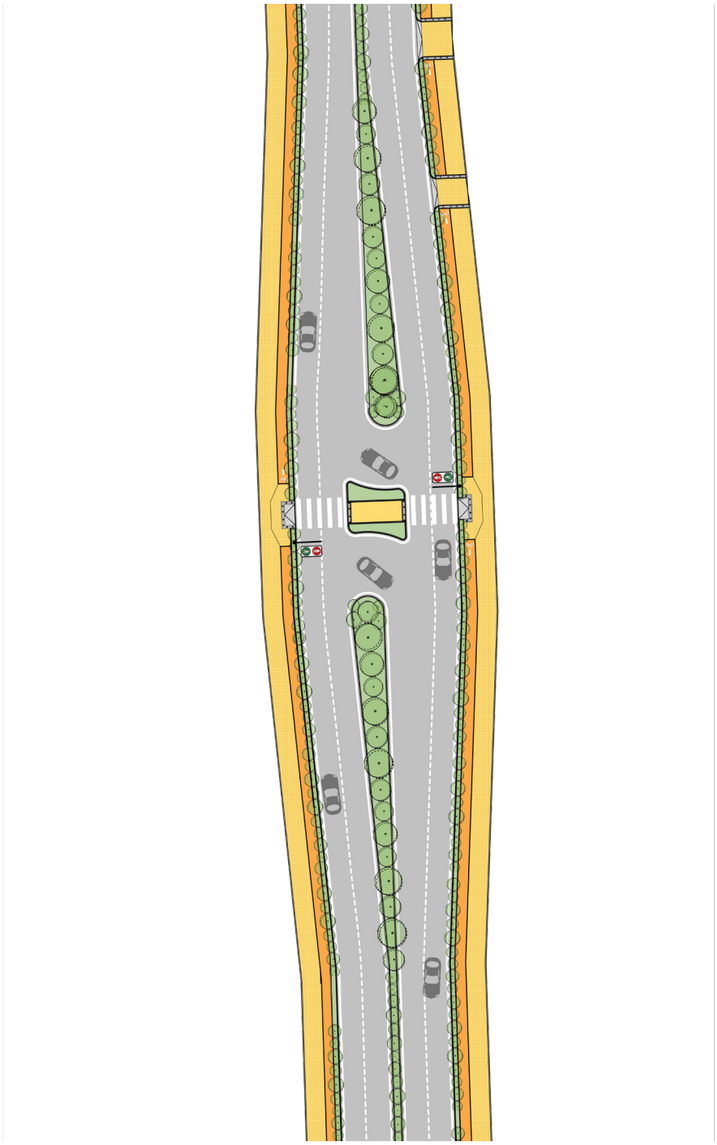


Figure 48. Diagram showing Complex Junction (ex: Tumkur Road)

3.2.5. Tear Drop u-turn

A well-designed round about incorporates a seamless integration of through and through traffic movement, free left turn, U-turn facility, optimizing traffic flow and sa



3.2.6. Synchronised Junction

Synchronized junctions utilize intelligent traffic control systems to coordinate signal timings, optimizing traffic flow across intersections. By harmonizing signal phases and adjusting timing dynamically based on real-time traffic conditions, these junctions reduce congestion, enhance efficiency, and contribute to a smoother, more synchronized urban transportation network. It further enables well-connected crossings for pedestrians and cyclists. Minimum median opening is provided.

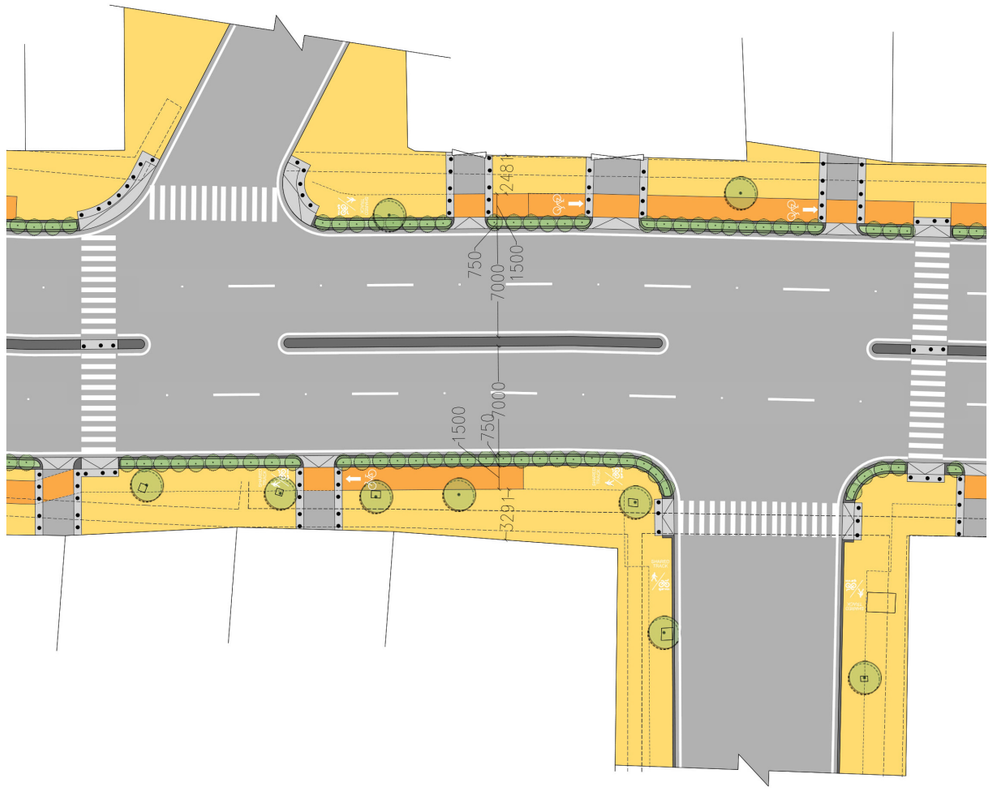


Figure 49. Diagram showing Synchronised Junction (ex: Tumkur Road)

Design to be updated

3.3. Inclusive Street Design

3.3.1. Safe crossing for pedestrians

3.3.1.1. Pedestrian Refuge

In order to facilitate safe crossing for pedestrians at a junction, the median is to be designed with a protective head that extends beyond the zebra crossing, making a safe pedestrian refuge in the median. Pedestrian refuge islands act as a pause point for pedestrians before finishing crossing a road. It comprises of a break in the median that acts as an island/safe space for people to stand.

The refuge island should be as wide as the crossing (zebra or HRPC, depending on the site conditions) and should have bollards placed in-between to prevent two-wheelers from using the pedestrian space.

The protective head should extend beyond the pedestrian refuge island by a minimum of 600MM, preferably 1000MM if possible.

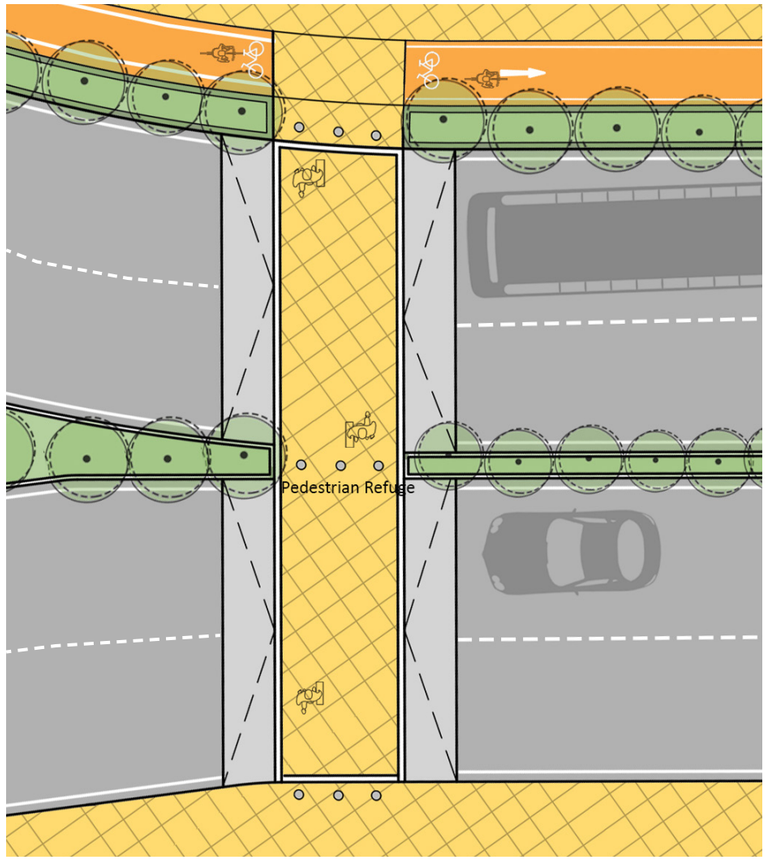


Figure 50. Pedestrian refugee island detail at crossing

3.3.1.2. Midblock Crossing

Pedestrian Light Control (PELICON) – is designed to enhance pedestrian safety on busy roads where there are no designated signals. Positioned away from junctions, it allows pedestrians to cross safely by stopping vehicular traffic with traffic lights and providing a clear path. Users activate the crossing by pressing a button, prompting the signal change. The PELICON crossing incorporates pedestrian-friendly features, such as a flashing green man indicating the end of crossing time. Mid-block crossings are usually provided every 400 M - 800 M distance depending on the road requirements.

Standard: It is suggested to add a typology of HRPC midblock crossing along with speed calming measures such as rumble strips/ material change to provide safety for pedestrians.

(Source: IRC 86-2018, Pg: 9)

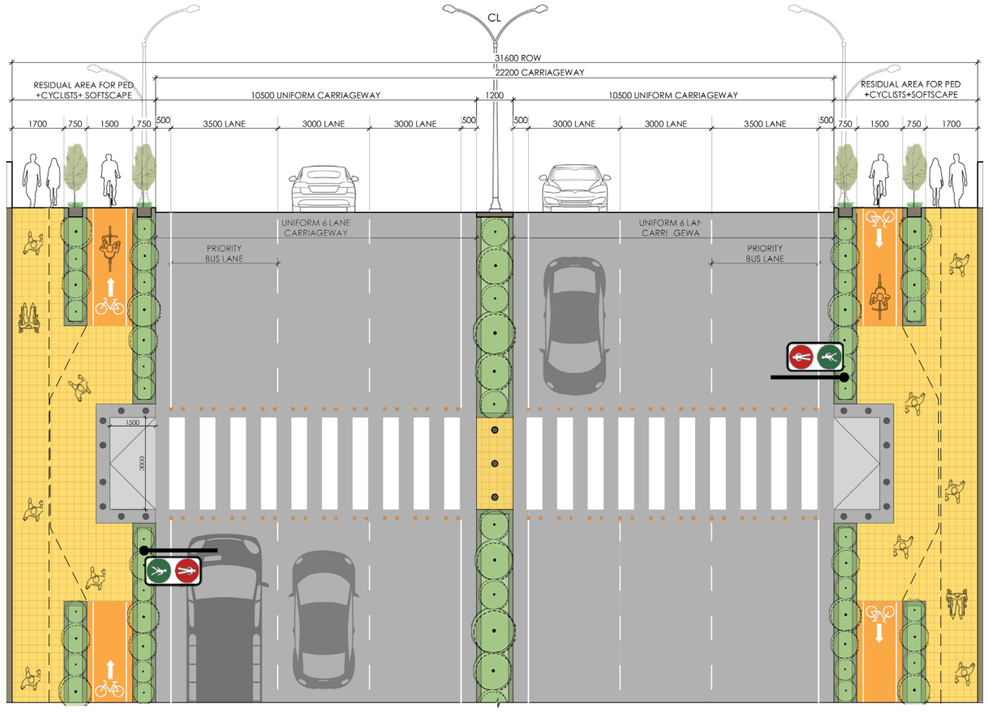


Figure 51. Mid-block pelican pedestrian crossing condition 1

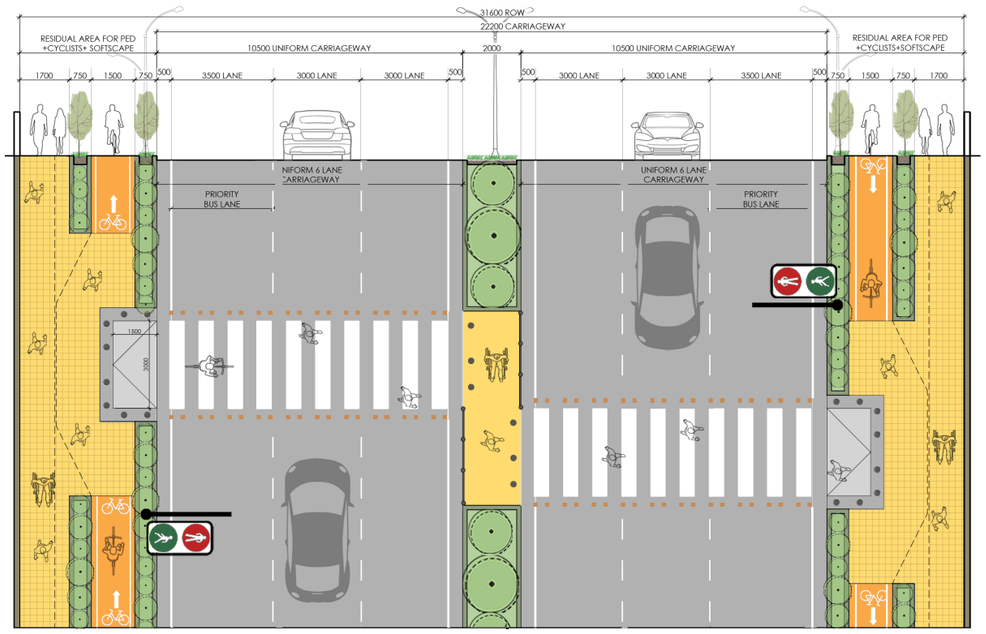


Figure 52. Mid-block pelican pedestrian crossing condition 2

Figure 53. Pelicon traffic light refrences

3.3.1.2. HRPC at cross road junctions

HRPC will be provided at all the junction where the crossroad connects with the main road. The HRPC for larger crossroad with width more than 6M and less than 7M. The HRPC is to be 3000MM wide or equal to the width of the main road (whichever is larger), with 1200MM ramp-up to HRPC from the roads on both the sides of it abutted by bollards along the footpath edges.

(Source: IRC 99-2018)

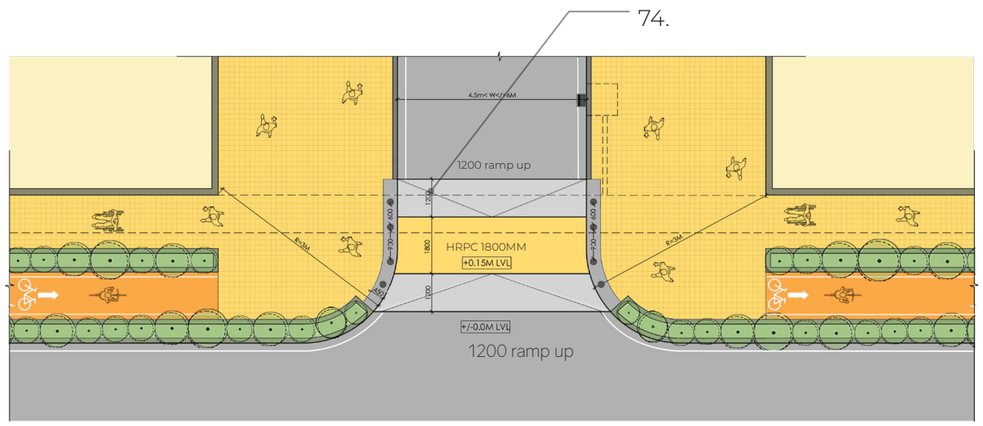


Figure 54. Diagram indicating 3 M turning radius for cross road junction with HRPC

If the crossroad width is less than 3m, a minimum HRPC 1800MM wide is to be provided, with 1200MM ramp-up to the HRPC.

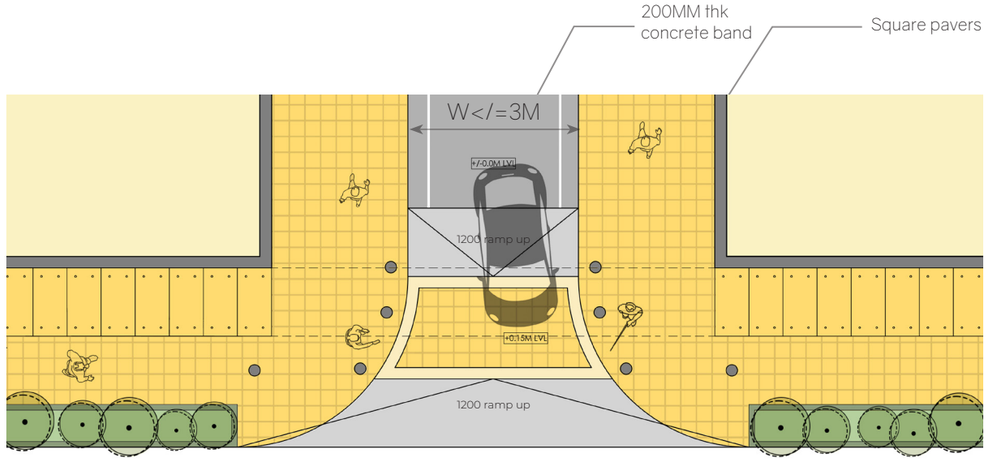


Figure 55. Diagram indicating minimum 1.8M wide HRPC at cross road junction of road width < 3M

Design to be replaced

3.3.1.3. Zebra Crossing at cross road junctions with traffic signals

At junctions with traffic signal, zebra crossings will be provided for safe crossing of pedestrians.

Access ramps are to be provided, where the footpath steps down to the road level at the zebra crossing. The gradient of a kerb access ramp should not be steeper than 1:10 and the width should not be less than 900MM. Warning blocks should be installed at the end of the kerb ramp to aid people with visual impairments. (Refer to: IRC 103-2012 6.2.3 (Pg:14-15) for details on access ramp design)

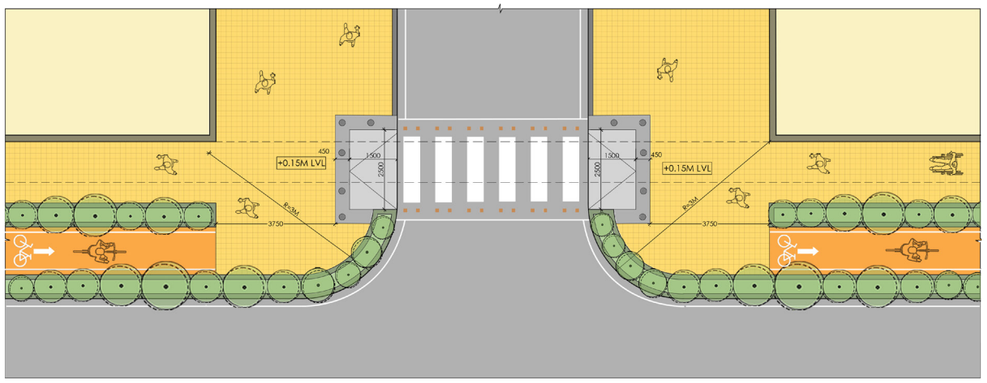


Figure 57. Diagram indicating typical cross road junction with zebra crossing

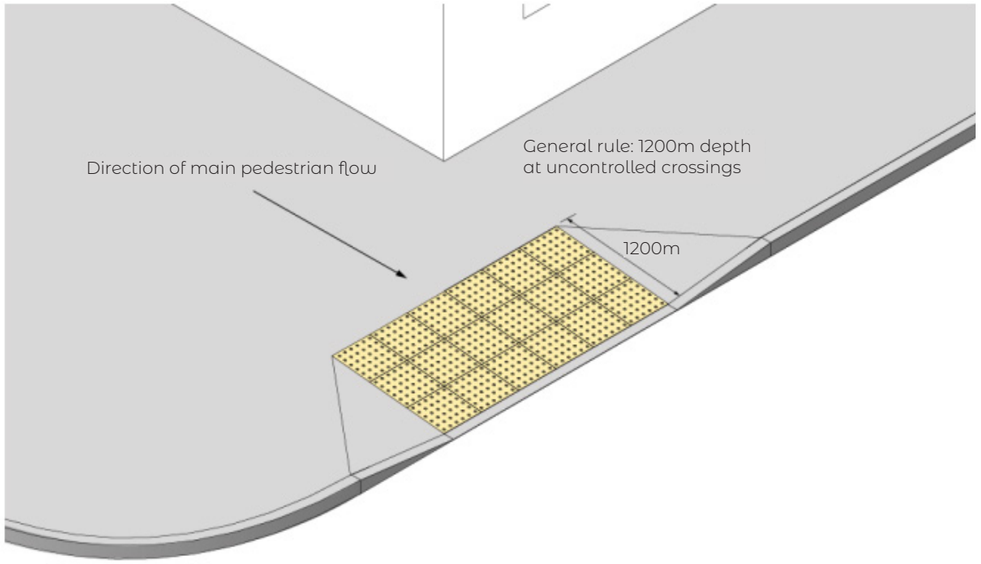


Figure 58. Warning blocks should be installed at the kerb ramp to aid people with visual impairments

3.3.1.4. Ramps at property entrance

The property entrances will ramp-up flushing to the level of footpath. This allows people on the sidewalk to continue walking across the property entrance and aids universal accessibility. The vehicular ramp to the property entrance will be in 1:8 slope, and will be aligned to flush to the edge of the kerb landscape.

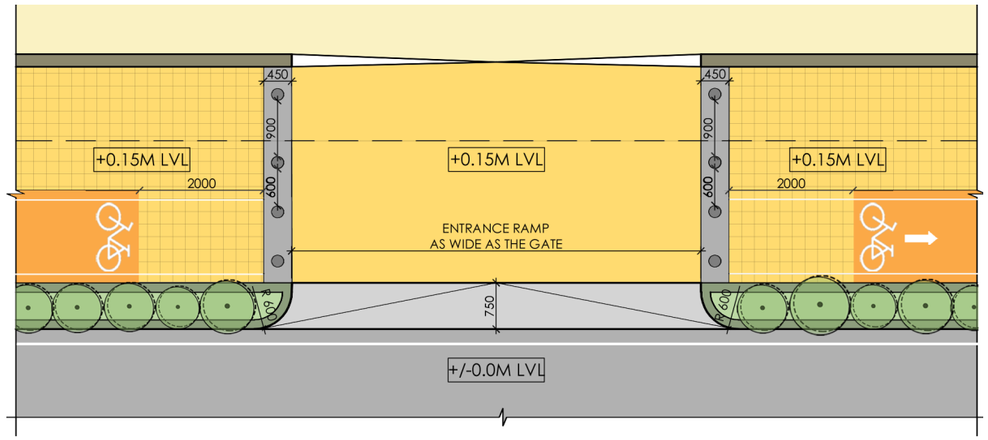


Figure 59. Diagram indicating vehicular ramp in 1:8 slope at property entrance

3.3.2. Petrol Bunk Proerty Entry & Exit

The Petrol bunk property entrances will ramp-up flushing to the level of footpath. This allows people on the sidewalk to continue walking across the property entrance and aids universal accessibility. The vehicular ramp to the property entrance will be in 750mm, and will be aligned to flush to the edge of the kerb landscape.
Both the entry and exit will have a turning radius of 9000mm in their respective sides to have a smooth turning of vehicles into the property during entry & exit of th vehicles.

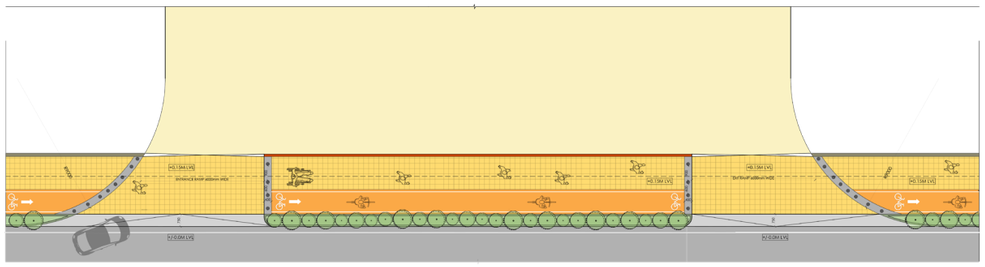


Figure 60. Petrol Bunk Property Entry & Exit with Dimensions

3.3.2. Property Entrance Condition without Boundary wall

Some property entrance's with huge setback might not have a defined boundary wall defining the edge of the property.
In such cases, to restrict onstreet parking of vehicles at such property edge conditions there are two types of measures, using Bollards or 150mmx450mm Ledge wall which will help in defining the property boundary and entrace

Case 1: Restricting onstreet Parking using Bollards to define property edge

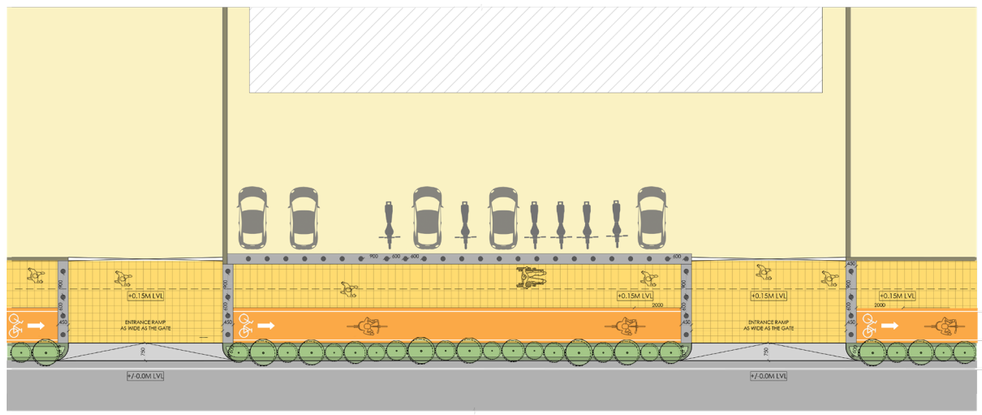


Figure 63. Restricting onstreet parking using bollards to define property edge

Case 2: Restricting onstreet Parking using Ledge wall to define property edge

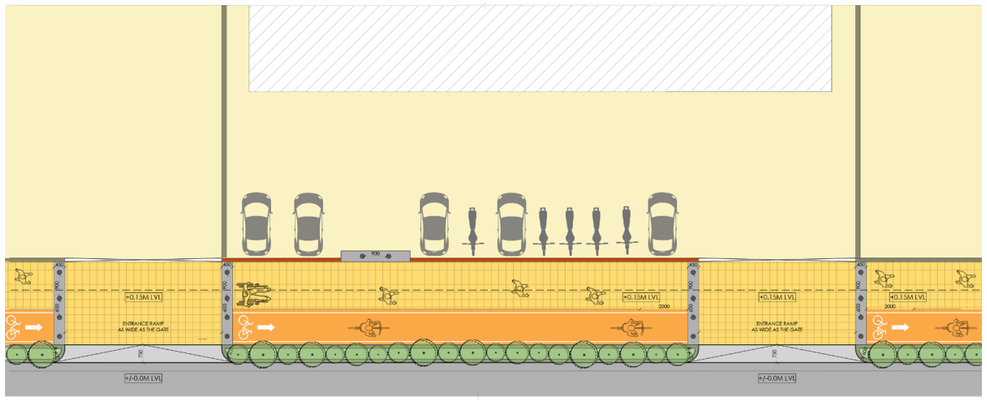


Figure 64. Restricting onstreet parking using Ledge wall to define property edge

3.3.2. Footpath widths

The ideal footpath width is 2.4 M, excluding the cycle lane and the softscape. The minimum footpath width required is 1.8 M. The maximum footpath width requirement is 3M. In cases of widths greater than 3M, the remaining space of the sidewalk is proposed to be used as Multi-utility zones. These zones shall accommodate softscaping, seaters and leisure spaces to enhance the social character of the pedestrian walkways.

(Refer to: IRC 103-2012 6.2.3 (Pg:6) for minimum clear walking zone width)

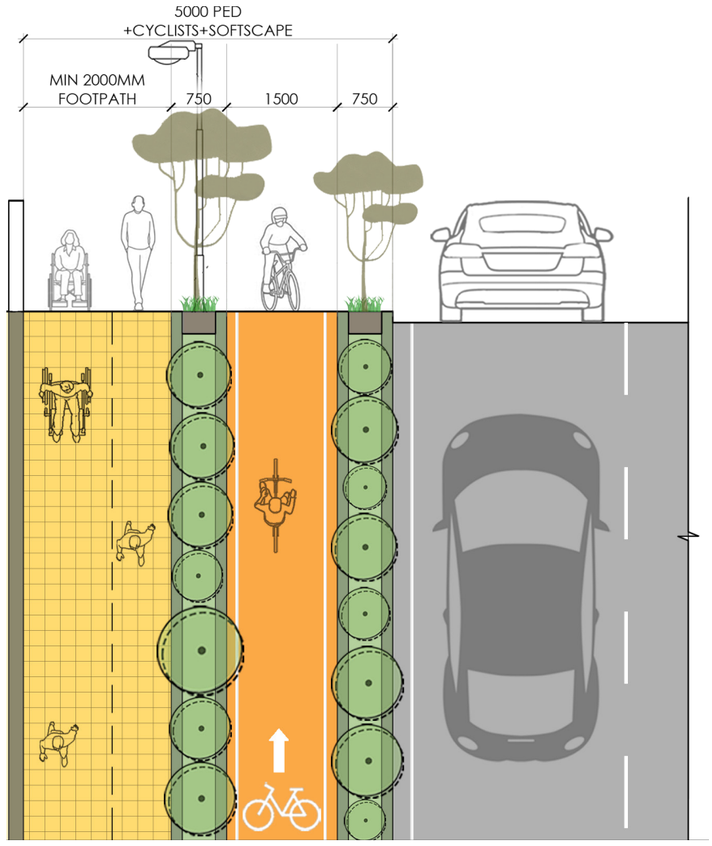


Figure 65. Ideal footpath width requirement of 2.4M

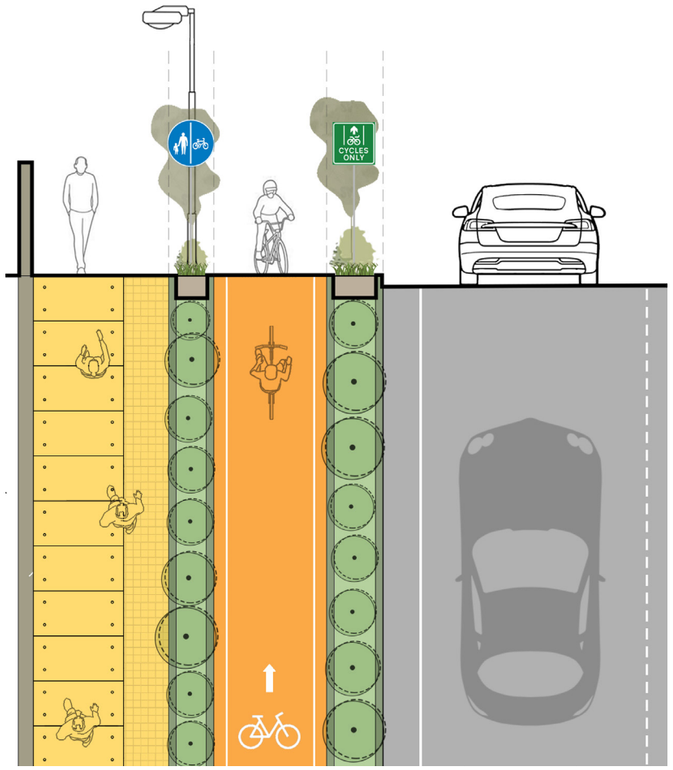


Figure 66. Minimum footpath width requirement of 1.8M

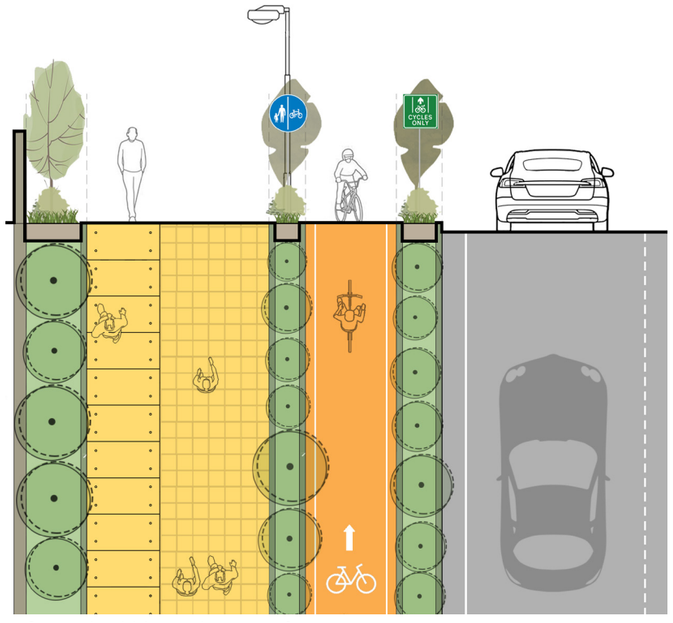


Figure 67. Maximum footpath width requirement of 3M

3.3.3. Footpath paver detail

The footpath paver blocks are to be bound and held in place by concrete bands at every 15m along the footpath, in order to prevent the pavers from settling and coming loose/chipping off easily. Concrete bands 500MM wide are to be given every 15 M.

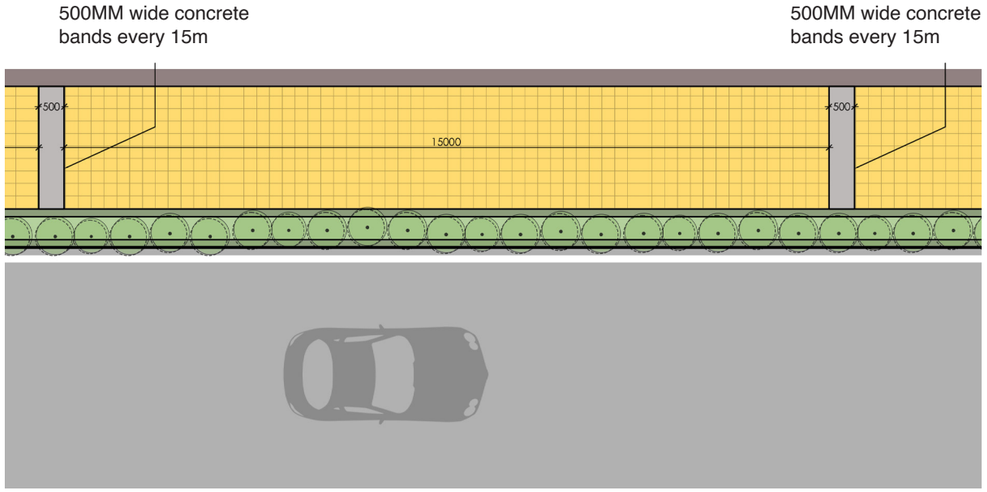


Figure 68. Concrete band detail for footpath

3.3.4. Kerb landscape

Kerb landscape, or green hedging, is provided at the edge of the kerb as a protective barrier between vehicles on the carriageway and pedestrians on the footpath. It protects cyclists from the carriageway. Signage and street lighting can also be incorporated into the planter space. A minimum of 750MM for a planter, and typically should be 1000MM wide. The planter is designed to be flushed to the footpath level itself.

When width of the kerb landscape is changing from 1000MM to 750MM due to site constraints, it must be tapered at a ratio of 1:4 accordingly.

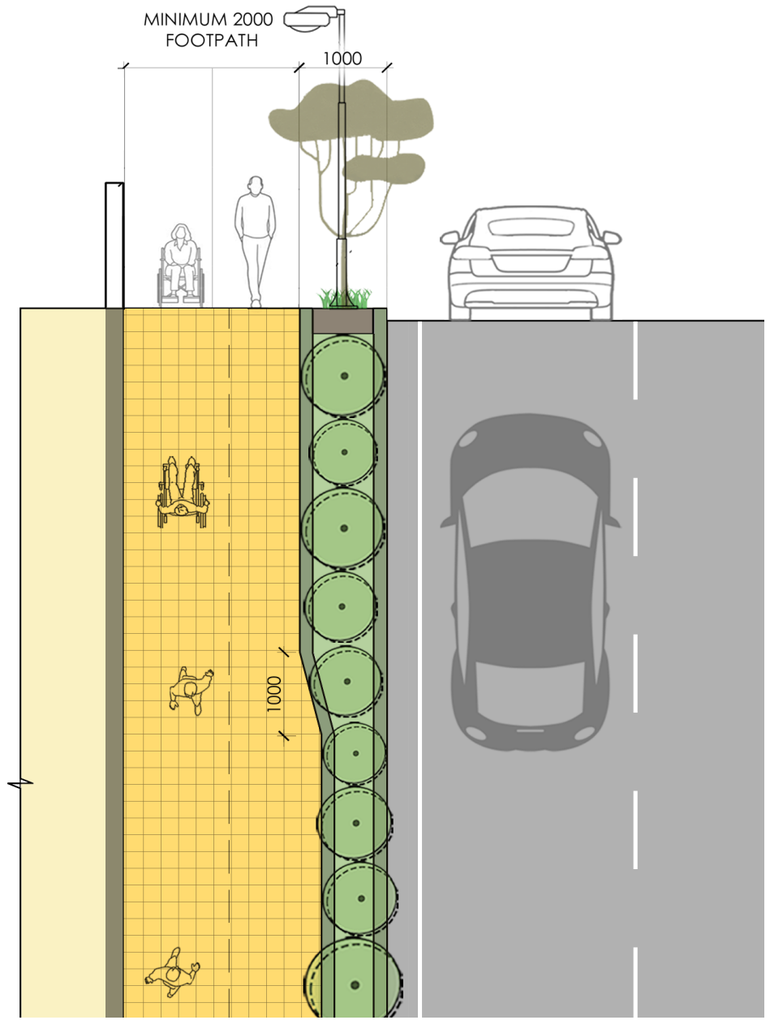


Figure 69. Tapering of kerb landscape

In conditions where excess footpath (min. 2000mm) is available, green edging can be provided on both sides of the cycle track.

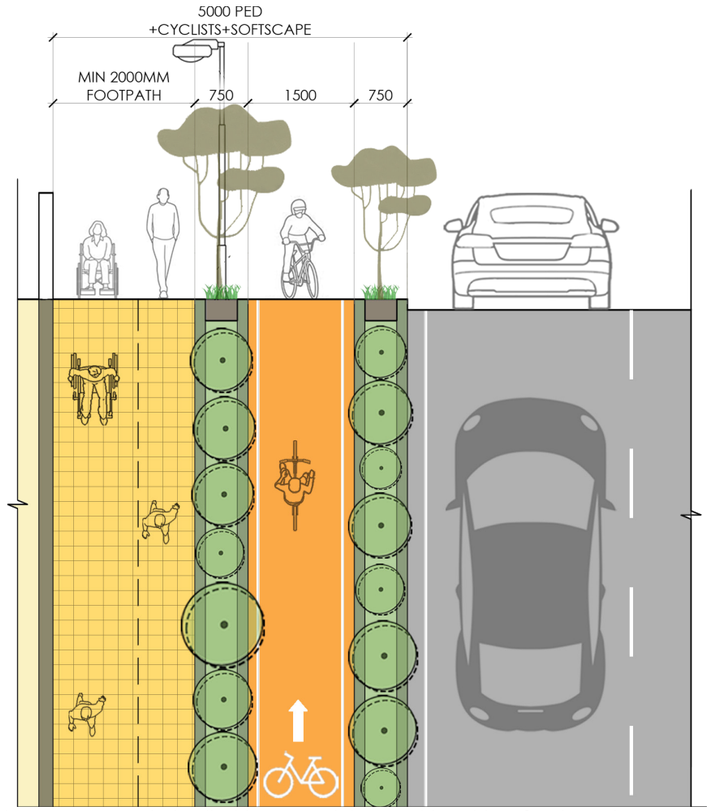
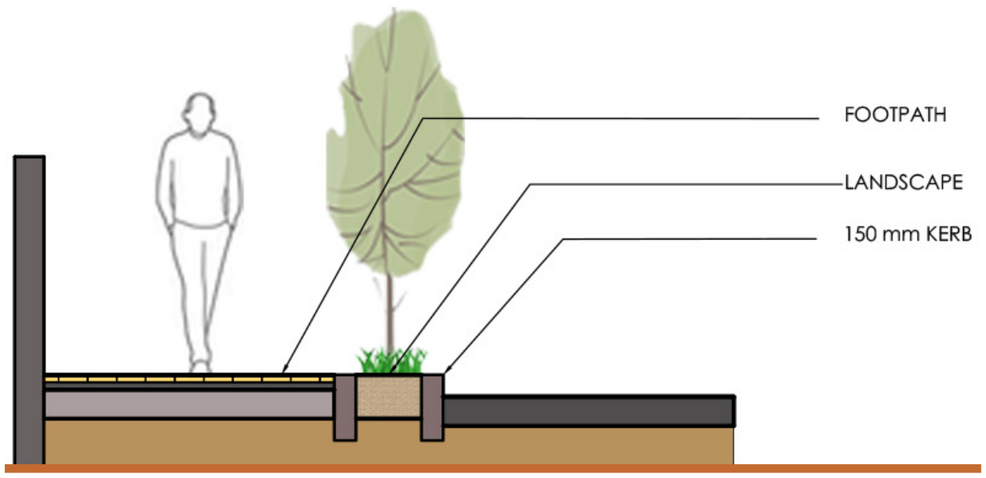


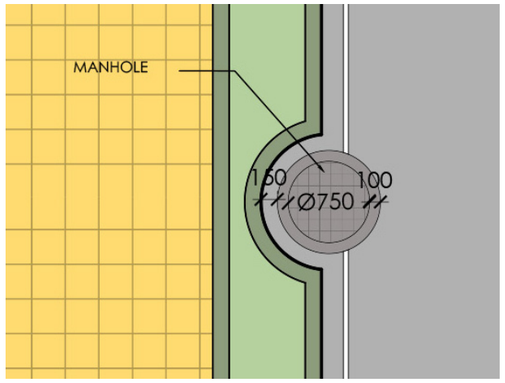
Figure 70. Footpath detail with green edging on either sides of cycle track

A typical street section shows the kerb landscape aligned to the level of the footpath (150MM wide x 150MM high kerb stone).

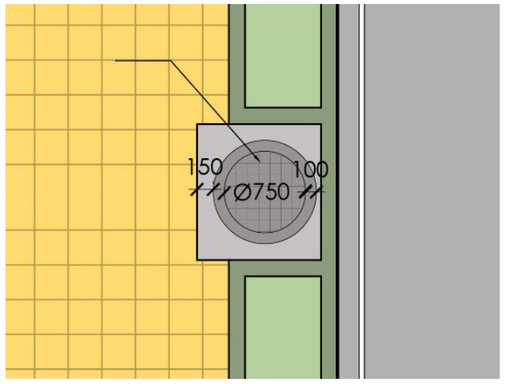


In conditions where a manhole is abutting the carriageway, the kerb landscape cannot be continued. Depending on the positioning of the manhole, three conditions are depicted in the figures below.

Manhole at carriageway level, and kerb landscape to bend around the manhole:



Manhole at footpath level and kerb landscape to terminate at the manhole:



Manhole at footpath level and kerb landscape to bend around the manhole if the footpath (min.2000mm)/cycle track (min. 1500mm) is wide enough and space is available:

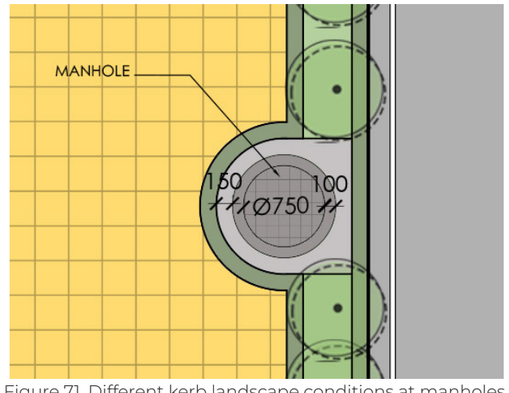


Figure 71. Different kerb landscape conditions at manholes

3.3.5. Cycle Track Design

3.3.5.1. Cycle Track Widths and Signage

A unidirectional cycle track of 1.5 M width will run largely along the kerb landscape at a level of +0.15 M from the road, unless local conditions dictate otherwise. The cycle track re-routes behind the bus shelter.

In case of excess width (4.5m to 6m) in pedestrian footpaths, a bi-directional cycle track of 3 M width (1.5 + 1.5 M) will run along the median landscape at +/-0.00 M level on the carriageway.

Trin-Trin Signage

The cycle symbol is to be stamped in white within a green box, and will be located at the beginning and end of each stretch of the cycle track.

The green box will be 3m long and 1.5m wide and will have a white border as indicated in the diagram. After every 100m of the continuous cycle track, an additional stamp will be introduced.

Cycle tracks running along a bus stop will be stamped at mid-length as indicated. The cycle lane is to be marked by a continuous green line all along its length on both sides.

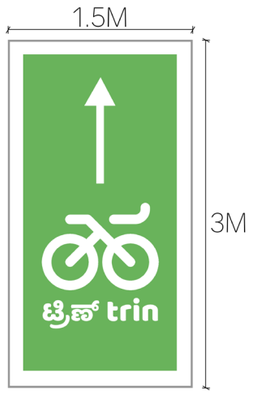


Figure 72. Cycle track stamp as per DULT TrinTrin Brand Manual

Figure 73. Cycle track marking along a typical road stretch

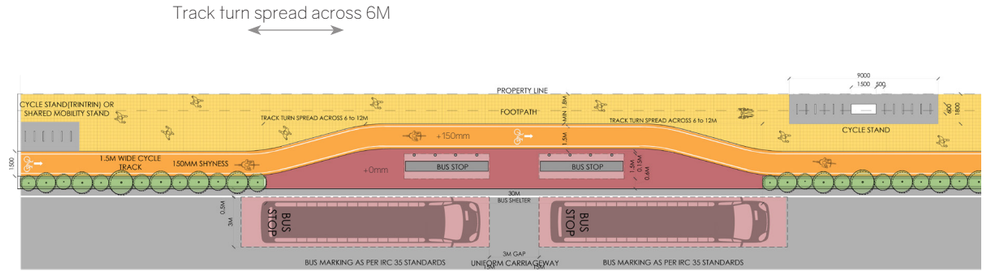


Figure 74. Detailed uni-directional cycle track marking along the road

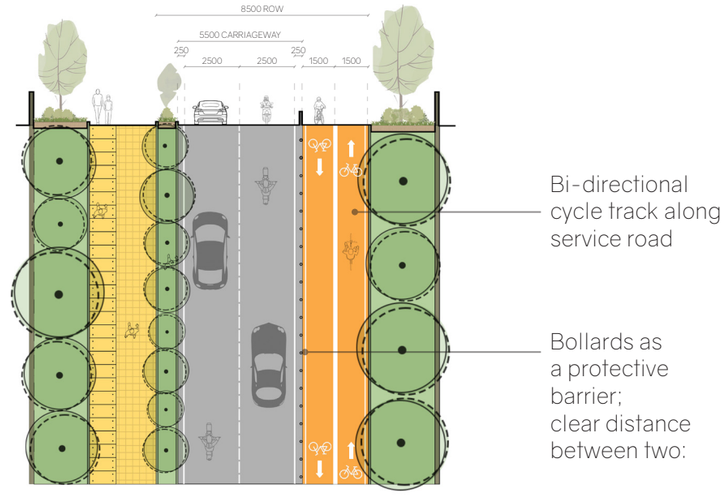


Figure 75. Detailed bi-directional cycle track marking along the road

Figure 76. Standard cycle track design and marking

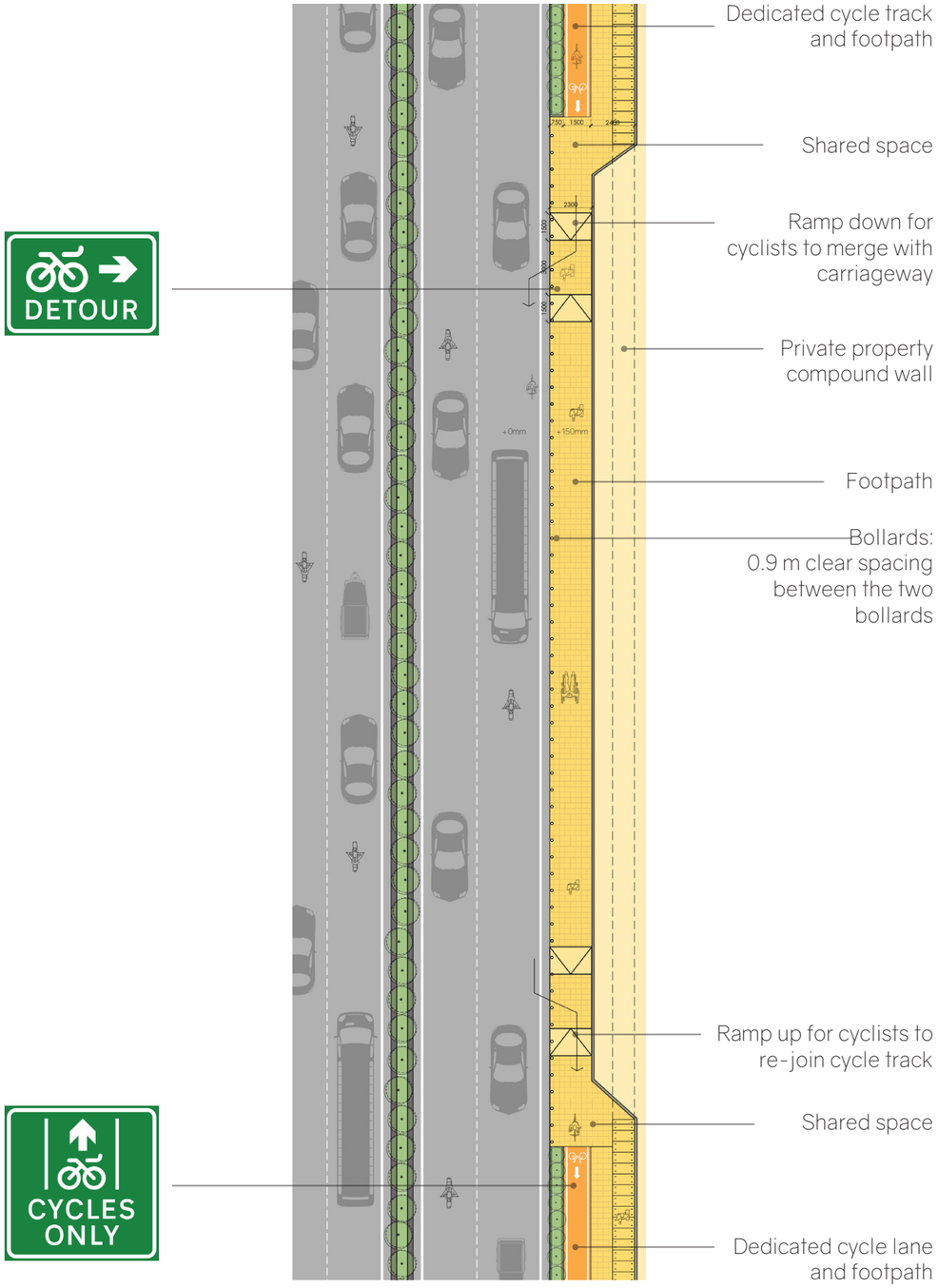


Figure 77. Detour for cyclists

In case of shortage in side walkway due to extended property compound walls, ramps are provided to easen deviation (entry and exit) for cyclists onto the road from the cycle track. Signages shall be provided indicating the same to alight moving traffic and cyclists about the deviation.

3.3.5.2. Cycle Tracks through Commuter Parks

In certain stretches of the arterial roads, linear parks are to be designated as “commuter parks”. Such parks can be used as both a walking and cycling path along with existing seating and placemaking elements of the park.

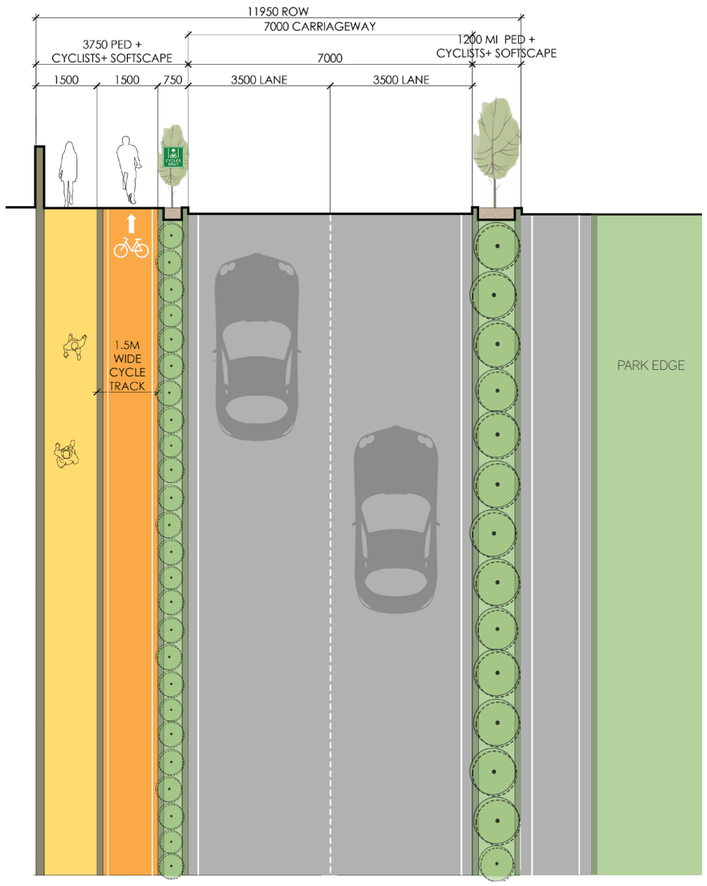


Figure 78. Green median separating service road from the main carriageway (Condition Primarily found on the Outer Ring Road)

A green median separates the service lane from the park, providing a safe, aesthetically pleasing commuter corridor for walking and cycling, promoting healthier, sustainable transportation options and reducing traffic congestion.

Reason: This commuter park typology enhances safety by separating pedestrians and cyclists from traffic, reduces noise and air pollution, and encourages active transportation. It provides aesthetic and environmental benefits through green spaces, promotes community well-being, and alleviates congestion on main roads, supporting a sustainable urban infrastructure.

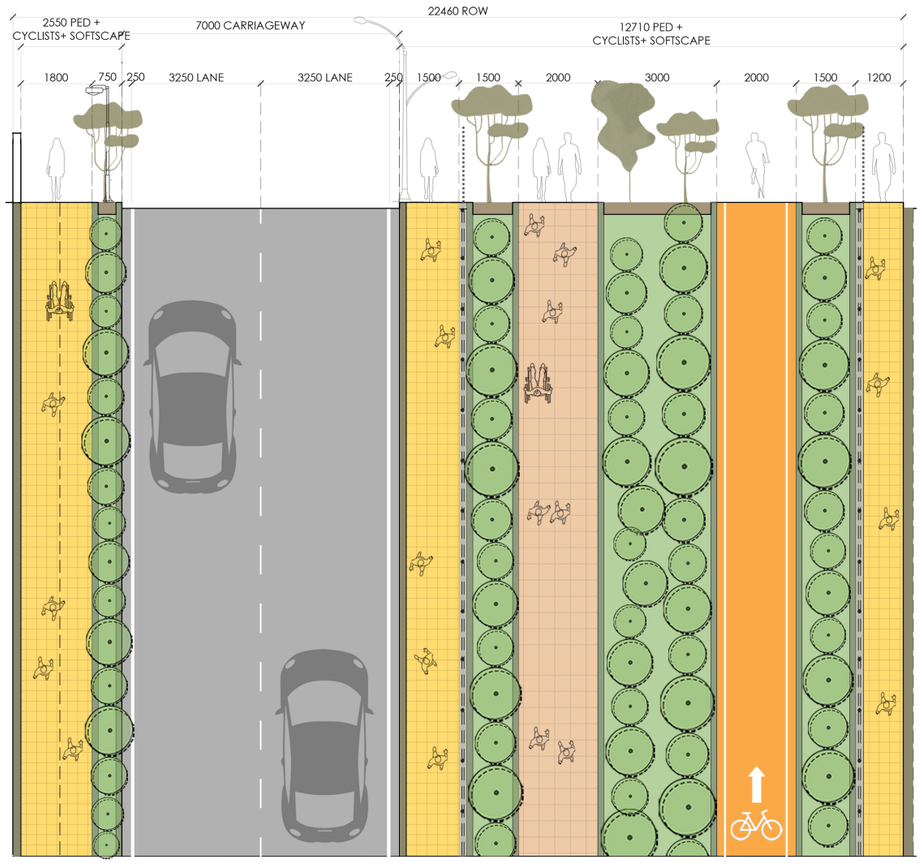


Figure 79. Bicycle track through commuter park condition 1

In this case, a green commuter park features a central bicycle track running parallel to its green edges and an adjacent footpath, which borders the nearby road. The bicycle track provides a dedicated lane for cyclists, promoting safe and efficient commuting. The green edges consist of landscaped areas with trees, shrubs, and grass, enhancing the park’s aesthetic appeal and providing a natural barrier between the track and the footpath.

Reason: Uses of such a park include providing a scenic and safe commuting route for cyclists and pedestrians, encouraging physical activity, and offering a tranquil space for relaxation.

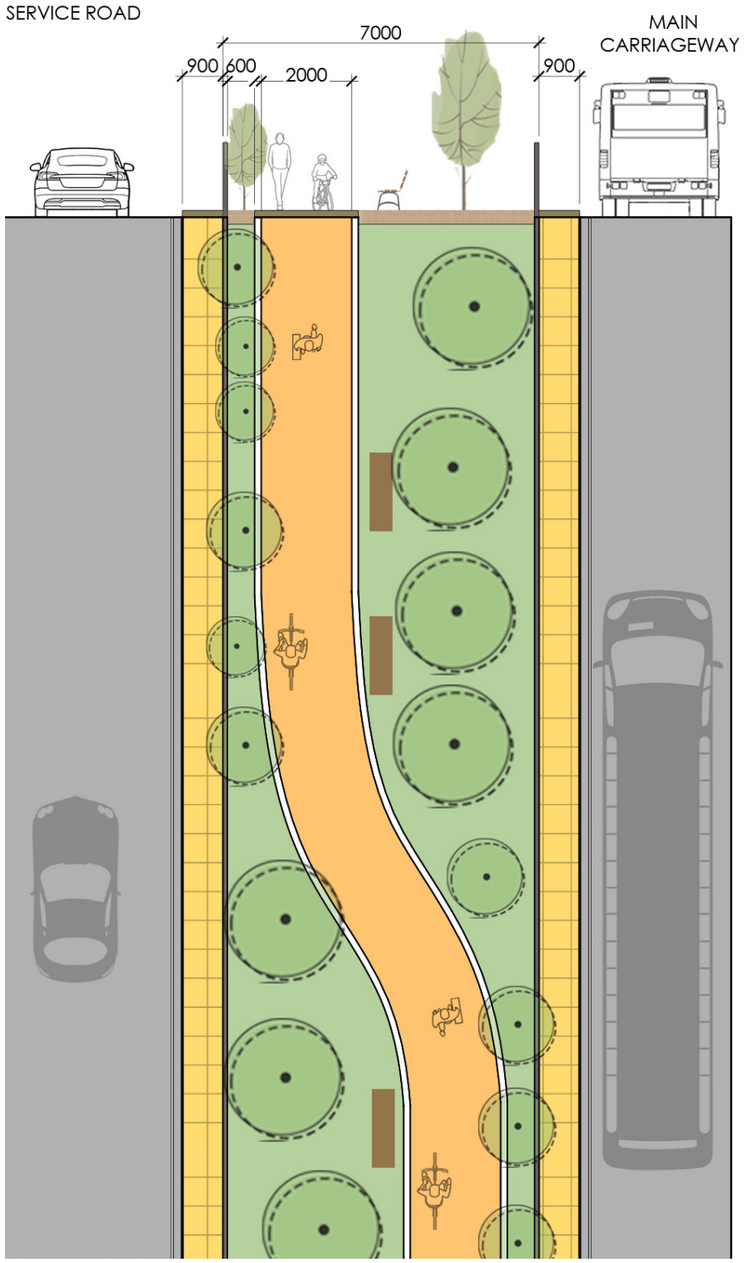


Figure 80. Bicycle track through commuter park condition 2

In this scenario, an organically winding bicycle track meanders through a 7m wide green commuter park. This central bicycle track offers a scenic and safe route for cyclists, encouraging daily commutes and recreational rides.

Reason: The design supports sustainable urban mobility by reducing reliance on motor vehicles, thereby decreasing traffic congestion and pollution.

CASE 1: Pathway between the park

CASE 2: Pathway Diverting from one edge to the other edge

CASE 3: Pathway Diverting from one edge to the other edge

3.3.6. Mixed Zone or Shared Space

For all obstructions to pedestrian movement such as existing trees, foot over bridges (FOBs) or if there is limited sidewalk space near bus-stops, a mixed zone or shared space of appropriate length is to be defined. In this shared space, cyclists must slow down and priority will be given for pedestrians to safely walk across.

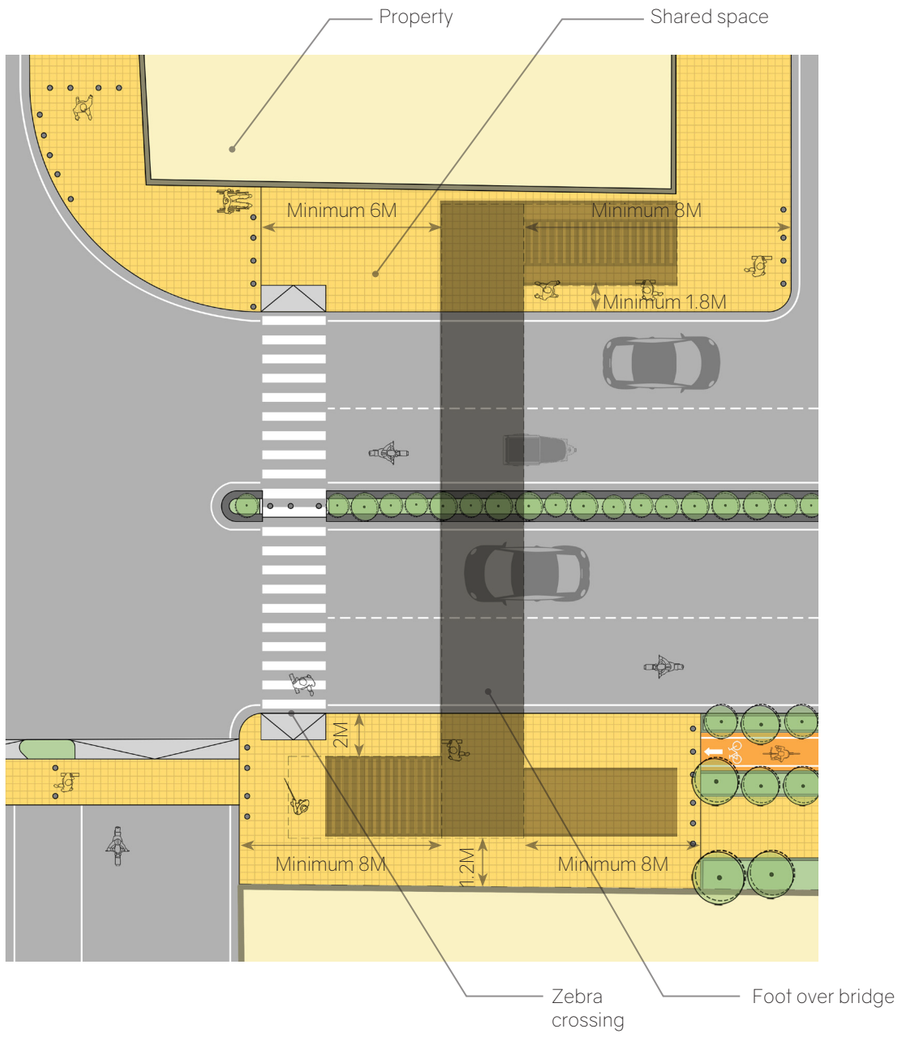


Figure 81. Response to existing foot over bridge

Source: IRC 103-2012 6.1.3 (Pg:6)

3.3.7. Subway Crossing

A subway, or underpass, is a pedestrian crossing that is grade-separated, traversing beneath a road. This design aims to completely segregate pedestrians and cyclists from motor traffic, enhancing safety by providing a dedicated subterranean passage for those on foot or bike, separate from vehicular activity. Zebra crossings should be provided to allow pedestrians to safely cross the service road to reach the carriageway median to take the subway.

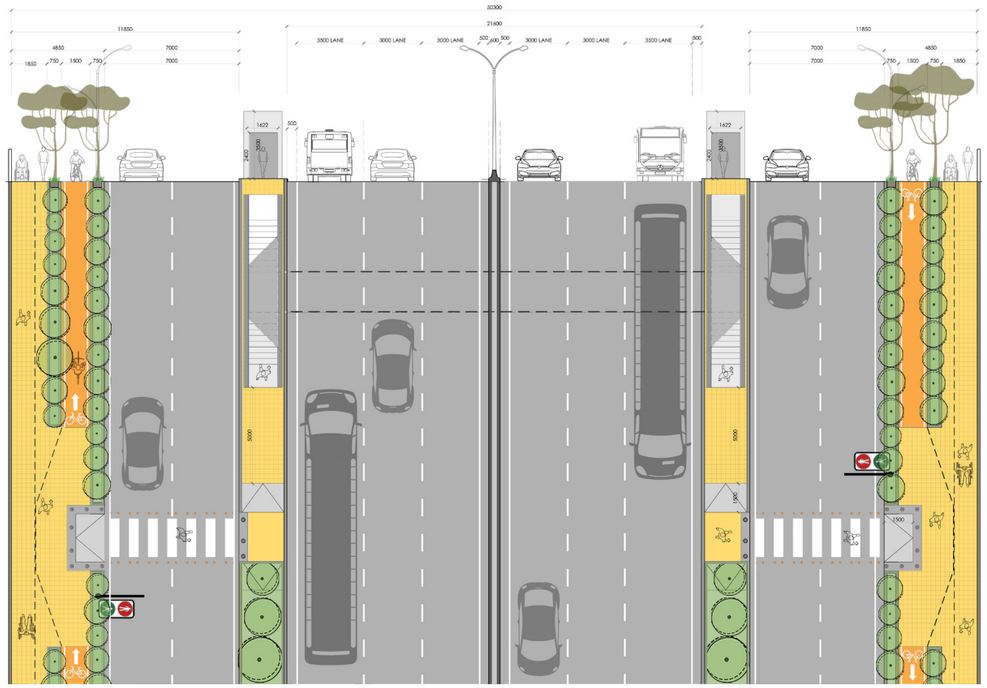


Figure 82. Pedestrian Subway Crossing

Drawing to be added

3.3.8. Last-mile connectivity (shared mobility and IPT parking)

The “last-mile” connection is a strip of road made primarily for public transportation. In this context, it is the drop-off area for shared mobility and IPT like hired-cycles (Example: Yulu). auto-rikshaws, cabs, etc.

The parking could be near bus-stops or IPT parking bay with width 3.5M with 0.25M shyness on either side, may be provided along the stretch of the road, where appropriate.

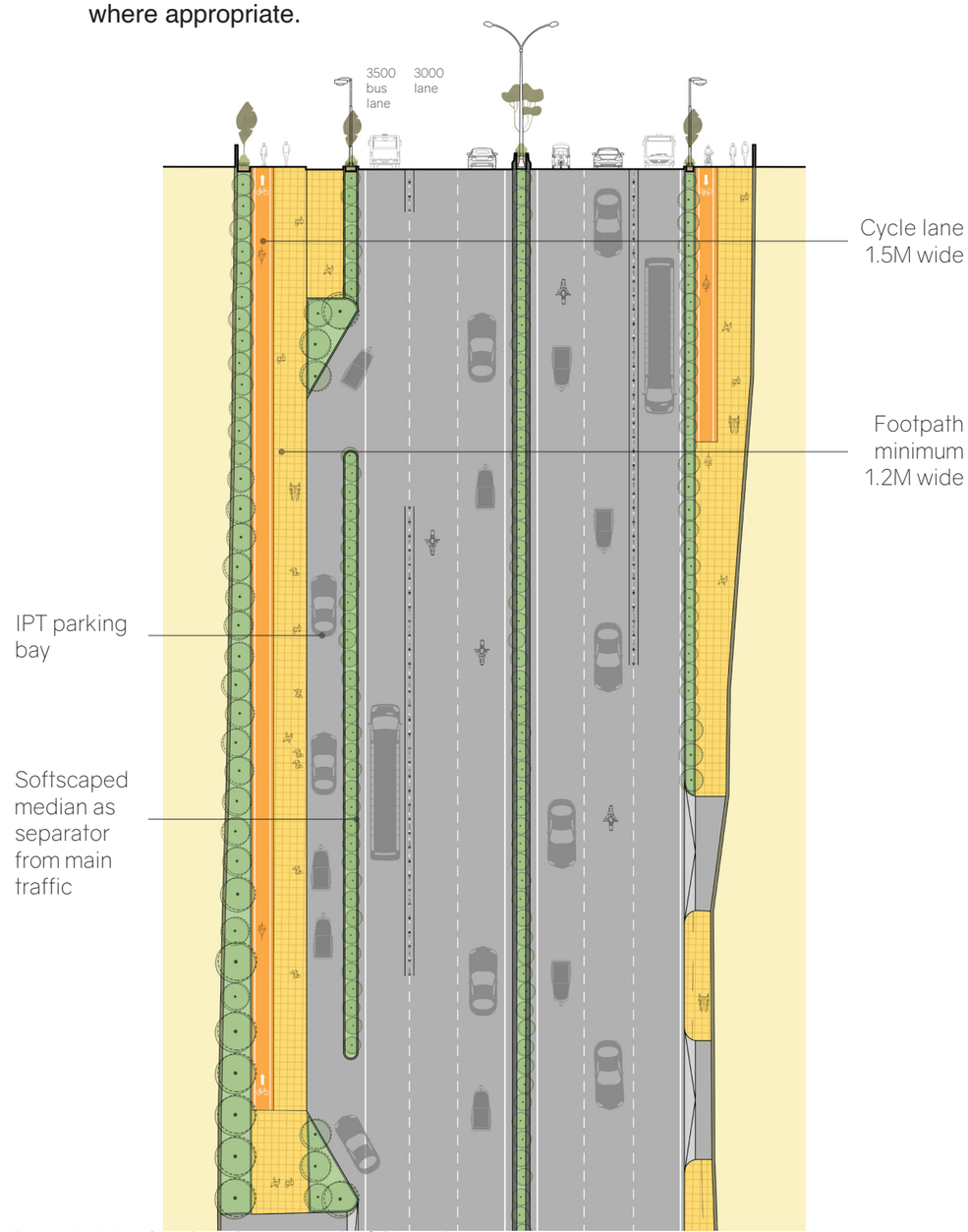


Figure 83. IPT parking bay along a stretch of the road

3.4. Elements of Urban Street Landscape

3.4.1. Street Hardscape Design and Recommended Standards

3.4.1.1. Bollards

The bollards are placed at the break in sidewalk at cross road junctions and property entrances, to restrict the entry of motorised vehicles.

The bollards are spaced at 800MM from centre to centre, and one set of bollards on the peripheral side are spaced at 1100MM from centre to centre for wheelchair accessibility.

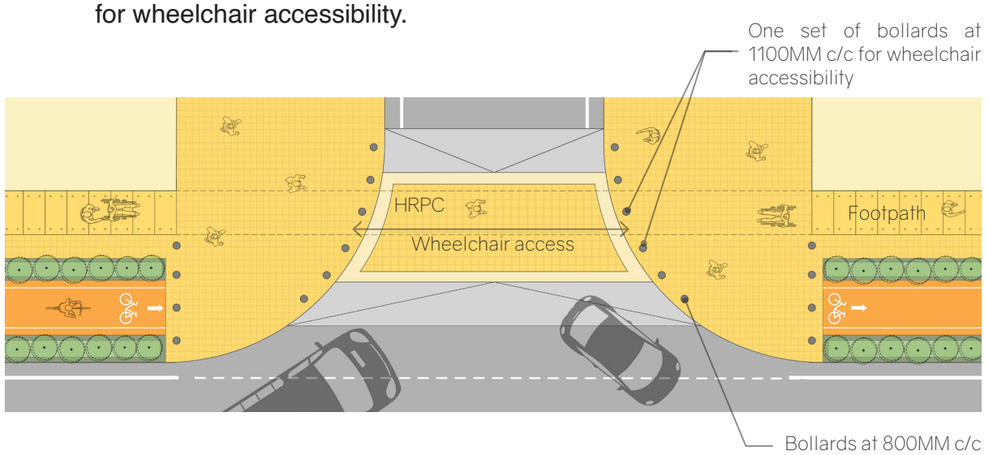


Figure 84. Bollard spacing and placement at cross road junction

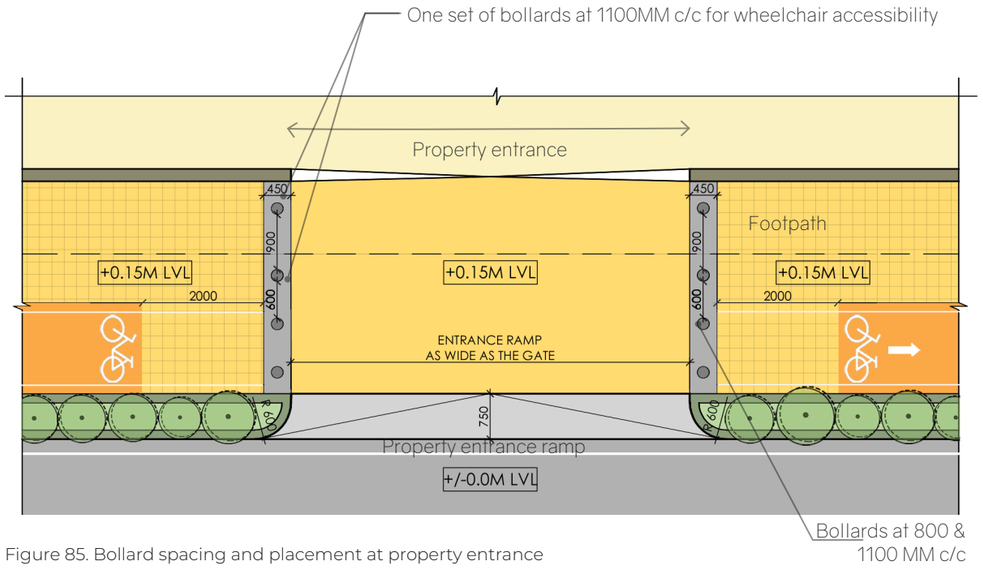


Figure 85. Bollard spacing and placement at property entrance

3.4.1.2. Seaters

Seaters are an integral part of street furniture as it allows pedestrians to pause and proceed.
The seaters will be modular, with each precast concrete seater module unit of dimension 600MM x 600MM x 450MM (length x breadth x height). These modules could be arranged in three types as represented in the figure below. The seater modules to be topped with 40 MM thick granite.

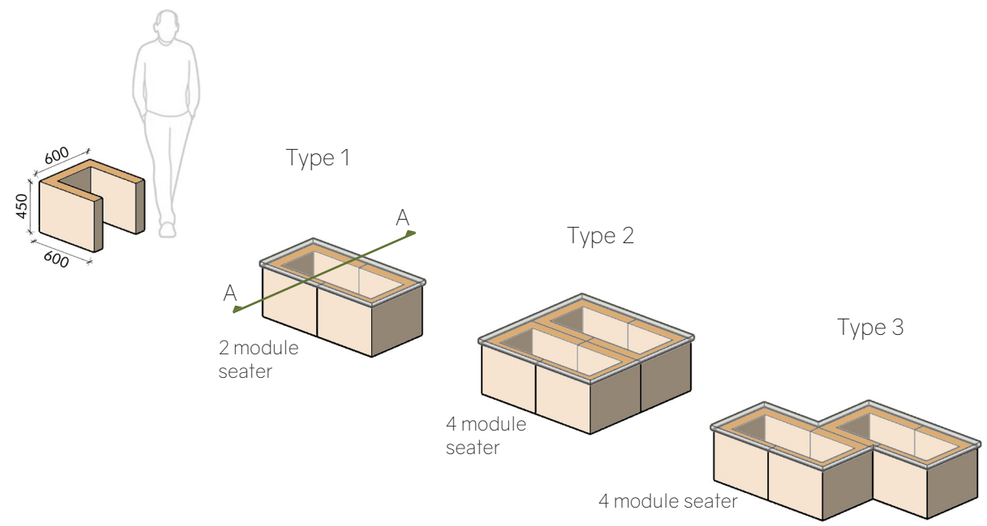


Figure 86. Precast concrete seater module and combinations

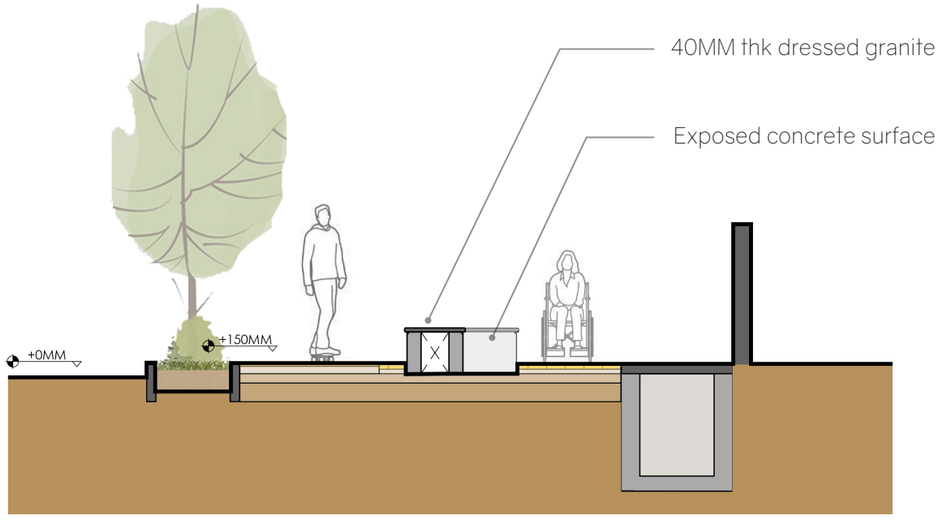


Figure 87. Section indicating seater between cycle track and footpath

The seaters have been designed into 4 different clusters depending upon location and available space on the side walk and can be placed to complement the footpath geometry. The 4 clusters are as follows:

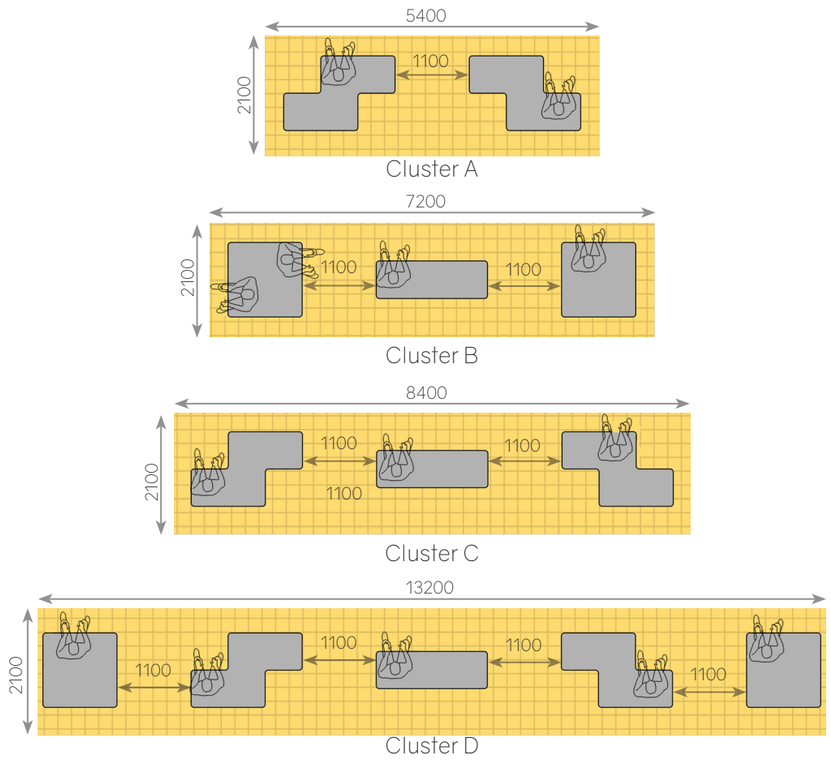


Figure 88. Four seater clusters developed

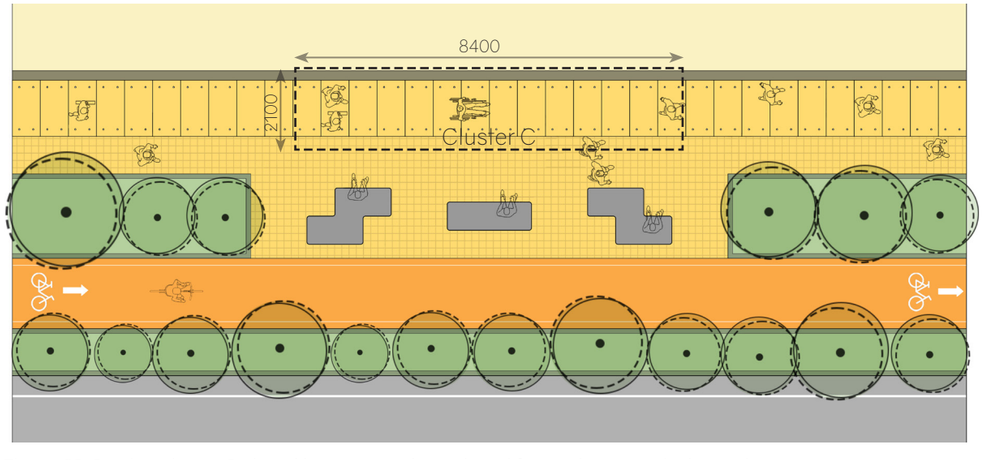


Figure 89. Seating cluster C placed between cycle track and footpath on a typical stretch

3.4.1.3. Placement of Underground utilities and wall units

All the urban utilities are placed as,

A - On the ground utilities like Transformer units to be placed at the periphery of the footpath along compound walls.

B - All the underground utilities to be finished in level with footpath surface.

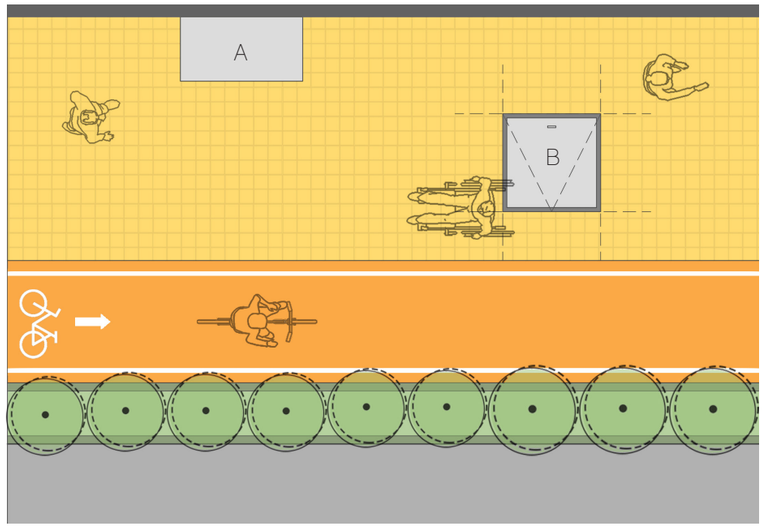


Figure 90. Diagram indicating desired placement of underground utilities and service units

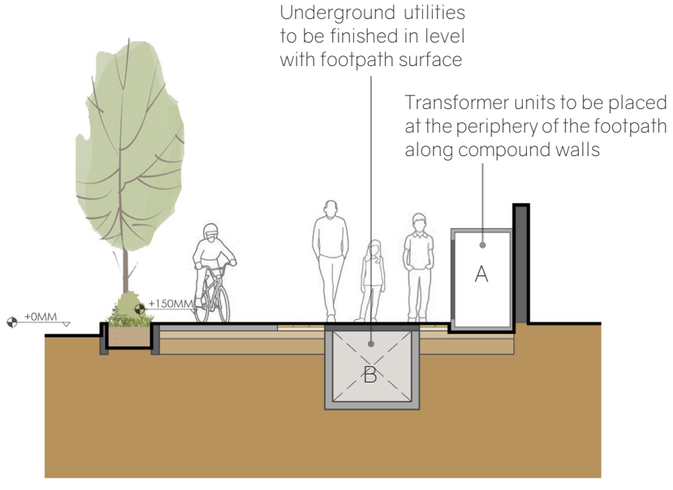


Figure 91. Section indicating desired positioning of service utilities

04 LIGHTING

4.1 Street Lighting

4.1. Street Lighting

4.1.1. Street Lighting

The Indian Roads Congress (IRC) emphasizes adequate and uniform illumination, glare control, high color rendering, energy efficiency, appropriate pole height and spacing, regular maintenance, environmental considerations, and enhanced safety and security. These guidelines ensure effective, efficient, and sustainable street lighting to improve visibility and reduce accidents and crime.

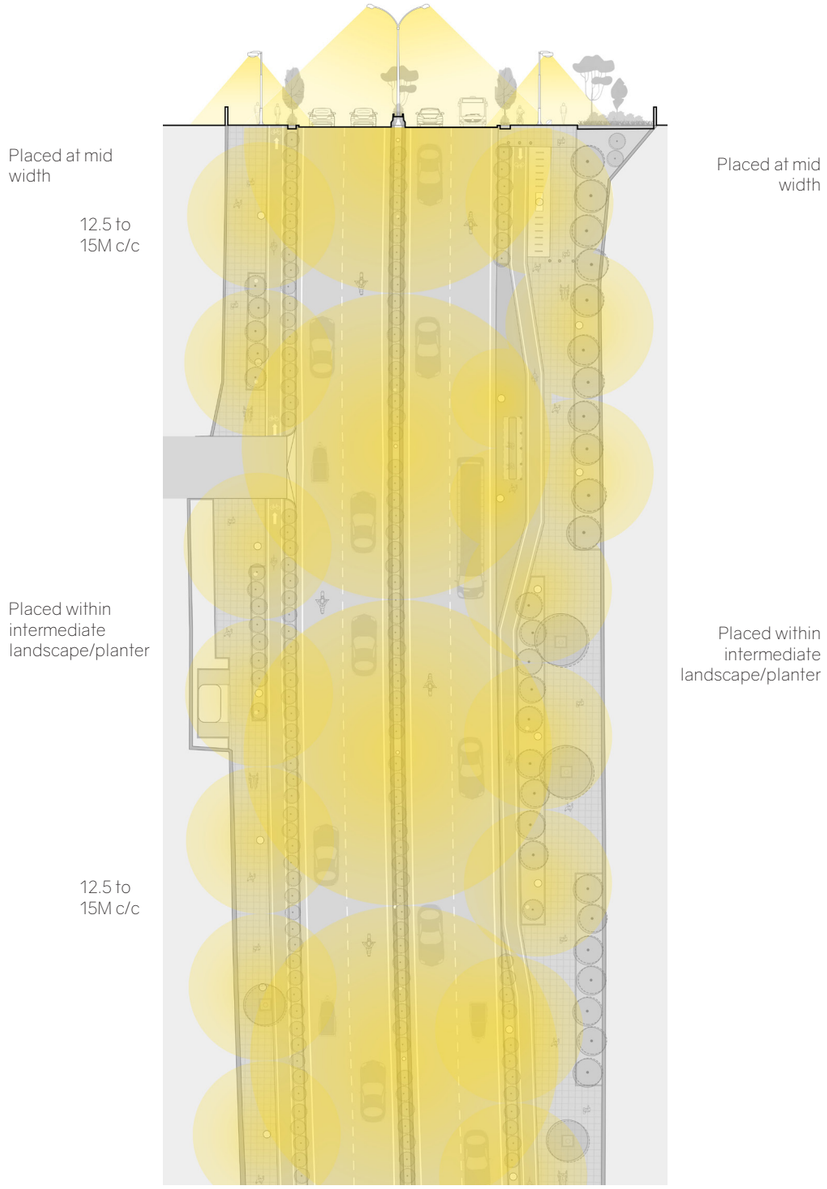


Figure 93. Carriageway lighting at median and pedestrian zone lighting at sidewalk for widths more than 4M

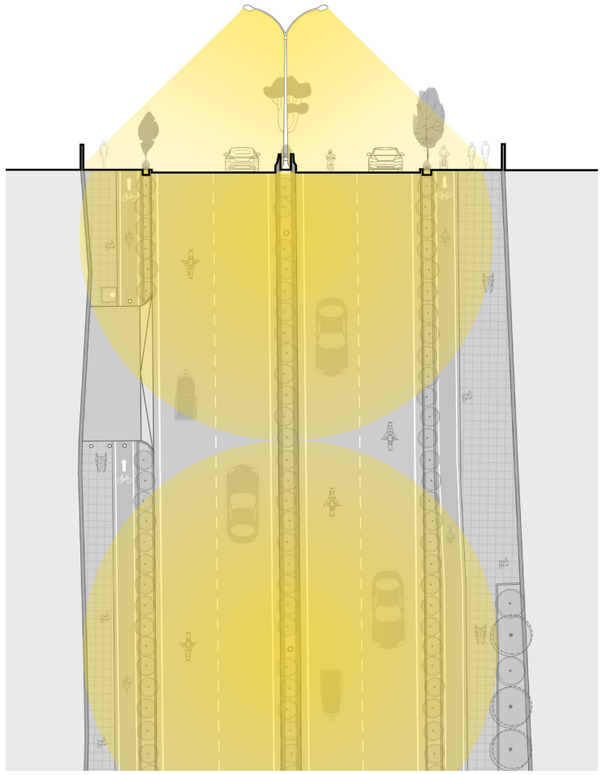


Figure 94. Lighting for pedestrian zone below 4M width at medians

05 WAYFINDING AND SIGNAGES

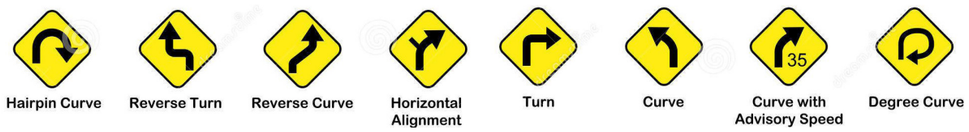
2.1 Reviewing Existing Conditions
2.2 Proposed Typical Street Plan and Section
2.3 Elements and Organisation of Right of Way (ROW)
2.4 Designing Inclusive Street
2.5 Proposed Design as per Suggested Design Principles

5.4.1.7. Signage

Street and road safety signages are crucial for regulating traffic, guiding drivers, and protecting pedestrians. Key types of street and road safety signs include:

1. Regulatory Signs: Indicate traffic laws and regulations that must be obeyed, such as speed limits, stop signs, and no parking zones. These signs are typically rectangular or circular, using red, white, and black colors.

2. Warning Signs: Alert drivers to potential hazards or changes in road conditions ahead, such as sharp turns, pedestrian crossings, or animal crossings. These signs are usually diamond-shaped with a yellow background and black symbols or text.



3. Guide Signs: Provide directional and distance information to help drivers navigate, such as street names, exit signs, and mile markers. These signs often use green backgrounds with white text and symbols.

4. Construction and Maintenance Signs: Warn drivers about road work, detours, and temporary changes in road conditions. These signs are typically orange with black text or symbols.

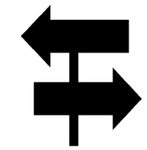
5. Informational Signs: Offer general information, such as rest area locations, gas stations, and points of interest. These signs can vary in color but commonly use blue or brown backgrounds with white text.

Source: IRC: 67-2012 Code of Practice for Road Signs (Third Revision)

5.4.1.8. Wayfinding

1. Directional Signage:

- **Directional Arrows:** Use clear, easily recognizable arrows to show directions at intersections, junctions, and along pathways. These arrows guide users towards their destinations, reducing confusion and enhancing flow.



2. Amenity Indicators:

- **Facilities Signage:** Provide signs that direct users to essential amenities such as toilets, water fountains, and rest areas. These signs should be strategically placed at entrances, exits, and along routes, ensuring amenities are easily found.

3. Transitional Areas and Decision Points:

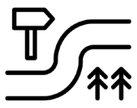
- **Junctions and Crossroads:** Install clear, prominent signage at transitional areas like junctions and decision points. These signs should provide information on the various route options, helping users make informed choices about their path.
- **Landmarks and Nodes:** Utilize landmarks and nodes (major points of interest) in the design to serve as reference points. Signage at these locations should be comprehensive, offering detailed guidance to various destinations.

4. Vehicular Wayfinding:

- **Traffic Signs:** Implement well-placed traffic signs that guide drivers through complex road networks. This includes signs for lane changes, exits, parking areas, and key landmarks.
- **Speed and Safety:** Ensure signs for speed limits and safety warnings are highly visible and positioned for maximum effectiveness to promote safe driving.

5. Pedestrian Wayfinding:

- **Walking Routes:** Design clear and continuous pedestrian pathways with signs that provide direction and distance information. This helps pedestrians plan their routes efficiently.
- **Crosswalks and Sidewalks:** Mark crosswalks and sidewalks with signs indicating pedestrian priority areas, improving safety and navigability for foot traffic.



5.4.1.9. Tactile Signages

1. Braille and Raised Letter Signs:

- **Street Name Signs:** Install signs with braille and raised letters at intersections to provide street name information. These signs should be placed at a height that is accessible for touch reading.
- **Building Numbers:** Ensure that building numbers are marked with braille and raised letters near entrances to help visually impaired individuals identify specific locations.

Figure 96. Street signs designed in Braille at a height that is accessible for touch reading

2. Directional Signages:

- **Wayfinding Maps:** Place tactile maps at strategic points like transit stations or public parks. These maps should include braille, raised print, and high-contrast colors to help visually impaired users understand the layout of the area.
- **Directional Arrows:** Use tactile directional arrows on signposts to indicate the direction of key destinations such as restrooms, exits, and service counters.

Figure 97. Tactile maps and Braille directions indicating locations and directions

3. Hazard Warnings:

- **Obstacles and Overhead Hazards:** Mark obstacles such as bollards or low-hanging branches with tactile warning signs. These signs can have raised symbols or textures to alert visually impaired pedestrians of potential hazards.
- **Elevator Controls:** Equip elevator panels with braille and tactile buttons, ensuring that floor numbers and emergency buttons are accessible to all users.

Figure 98. Elevator Controls in Braille (Necessary in Case of Emergency)

5.4.1.9. Dustbins

Separate dustbins should be provided for wet and dry waste.

The dustbins can be located at regular intervals on the street and closer along commercial sections, at FOBs, at bus shelters, at seaters and pedestrian crossings.

Figure 99. Dustbins for segregation

1. High Pedestrian Traffic Areas:

- Commercial Zones: In areas with high pedestrian traffic, such as commercial streets, shopping districts, and tourist attractions, dustbins should be placed approximately every 50 to 100 meters. This ensures convenient access and encourages proper waste disposal.
- Public Transportation Stops: Dustbins should be placed near bus stops, train stations, and other public transportation hubs to manage the increased waste generated by commuters.

2. Residential Areas:

- Sidewalks and Parks: In residential neighborhoods, dustbins can be spaced approximately every 100 to 200 meters. This spacing is sufficient to manage regular household waste and litter from pedestrians without causing unsightly overcrowding of bins.

3. Public Parks and Recreational Areas:

- Walking Trails and Picnic Areas: Dustbins should be placed at entrances, exits, and along walking trails, especially near picnic areas, benches, and playgrounds. The spacing can vary from 50 to 150 meters depending on the expected usage and size of the park.

4. Event Spaces and Large Gatherings:

- Temporary Placement: For events and festivals, additional temporary dustbins should be provided to handle increased waste. The placement should be denser, with bins every 20 to 50 meters, to ensure easy access and prevent littering.

06 PARKING DESIGN STANDARDS

6.1 Cycle Standards for Karnataka as per DULT (Trin-Trin Brand)

6.1.1. About the Trin-Trin Brand

- Trin-Trin is a brand created by DULT as part of its efforts to popularize cycling as a mainstream mode of commute in cities across Karnataka.

- A bold call and a new movement to make cycling the lifestyle statement and
- preferred choice of transport for everyone everywhere in urban Karnataka.

- Sustainable + Healthy + Joyful + Social + New Age

6.1.2. Cycle Parking Stand (as per DULT design and standards)

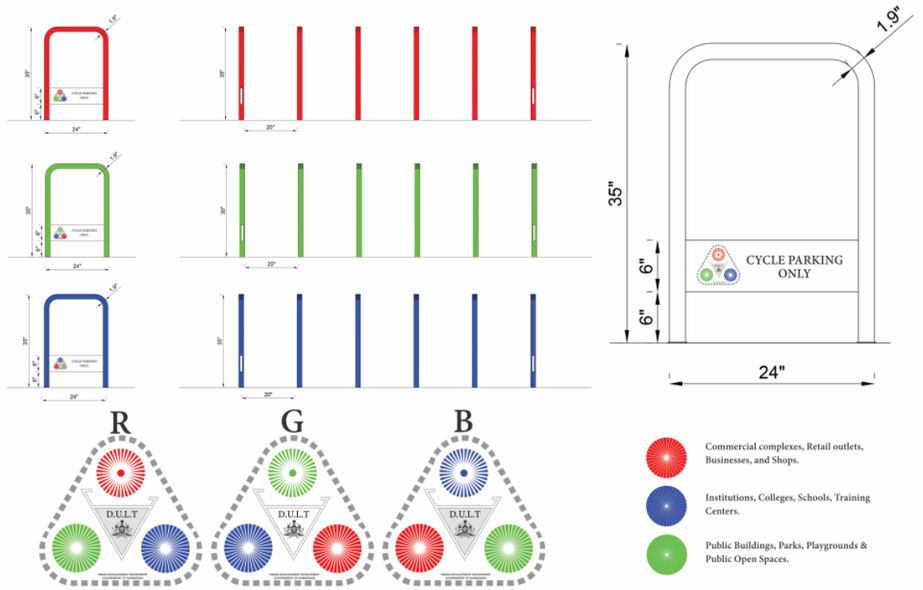


Figure 101. Cycle Parking Stand (as per DULT design and standards; DULT CycleStandDesign)

Figure 102. Cycle stand examples already implementedfrom already existing Indian Brands: Zulu and MyByk

6.1.3. Logo Design and Dimensioning (Specific Standards)

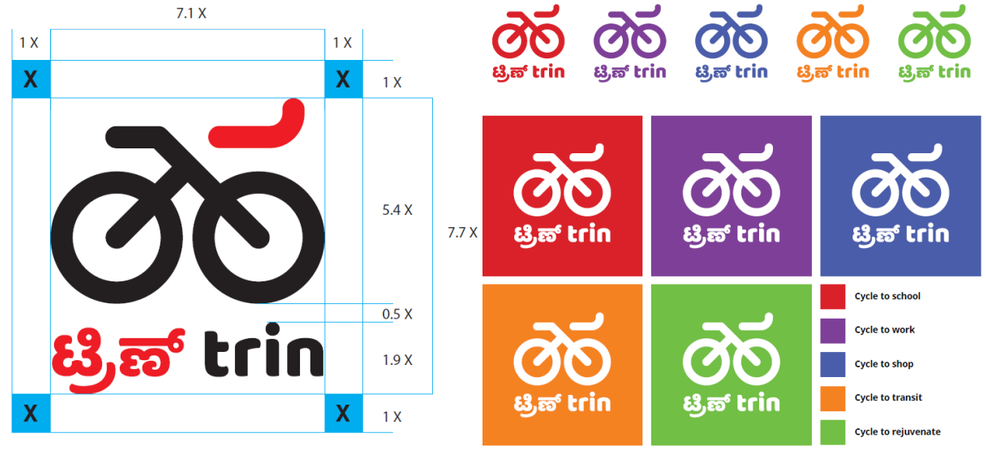


Figure 103. Logo Design and Dimension Standards on Cycling Track

6.2 Bus Stop Standards

1. Bus Stop with Dedicated Half Bus Bay

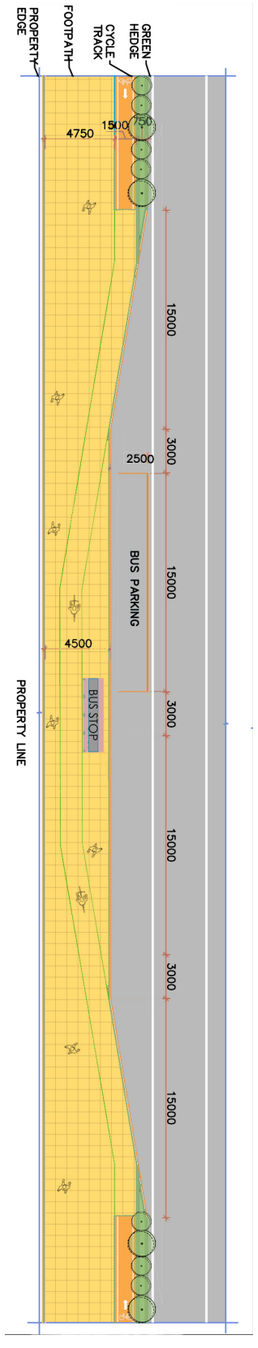


Figure 104. Bus stop with dedicated half bus bay

Location:

Half bus bays should be located at least 75-100 meters away from intersections and other high-traffic areas to ensure the safety and smooth flow of traffic.

Tapers:

- Entry Taper: Ratio 1:6 for a smooth pull in
- Exit Taper: Same ratio as entry taper

2. Bus Stop with Dedicated Full Bus Bay

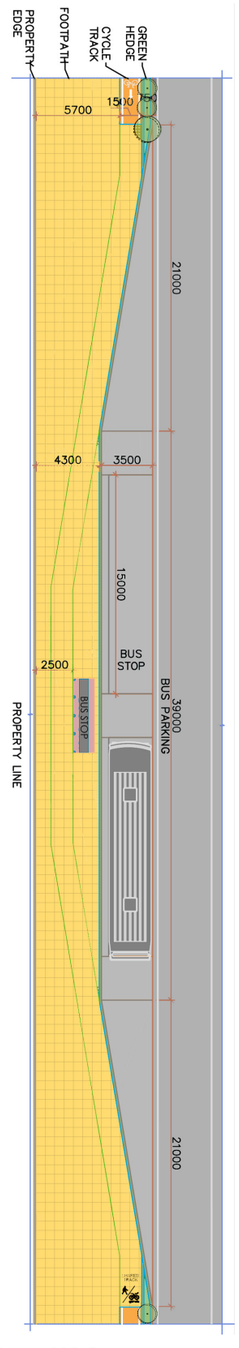


Figure 105. Bus stop with dedicated half bus bay

Location:

Half bus bays should be located at least 100-150 meters away from intersections and other high-traffic areas to ensure the safety and smooth flow of traffic.

Tapers:

- Entry Taper: Ratio 1:8 for a smooth pull in
- Exit Taper: Ratio 1:6

Figure 106. Bus stop with dedicated full bus bay for two buses (Front View)

Figure 107. Bus stop with dedicated full bus bay for two buses (Rear View)

6.3. 4-Wheeler Parking Bay Standards

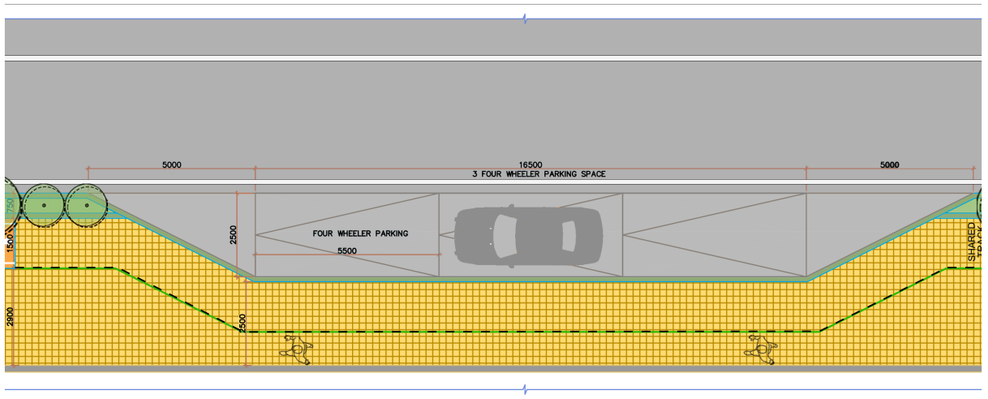


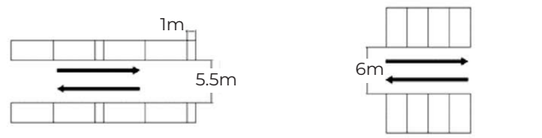
Figure 110. Dedicated 4-wheeler Parallel Parking Bay

1. Parallel Parking:

Length: 6.0 meters
Width: 2.5 meters

2. Perpendicular Parking:

Length: 5.0 meters
Width: 2.5 meters



1. Parallel Parking 2. Perpendicular Parking

Source: IRC:SP:12-2015

Figure 111. Dedicated 4-wheeler Parallel Parking Bay

6.4. 2-Wheeler Parking Bay Standards

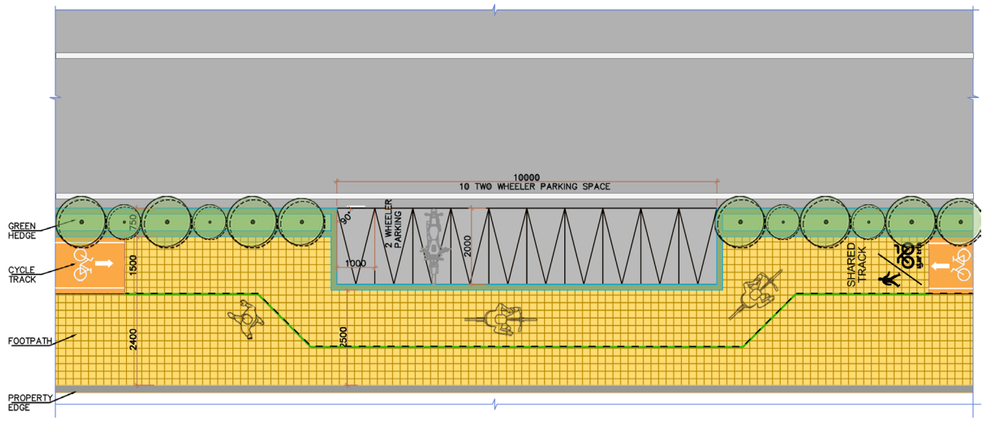


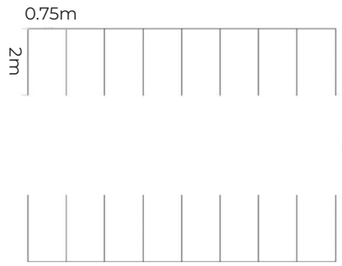
Figure 112. Dedicated 2-wheeler Perpendicular Parking Bay

1. Parallel Parking:

Length: 2.0 meters
Width: 0.75 meters

2. Perpendicular Parking:

Length: 2.0 meters
Width: 0.75 meters



Source: IRC:SP:12-2015

Figure 113. Dedicated 2-wheeler Perpendicular Parking Bay

6.5 Auto Stand Standards

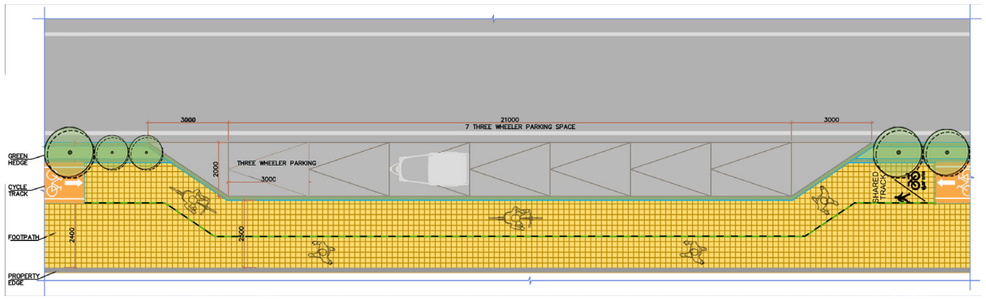


Figure 118. Dedicated Auto Parallel Parking Bay

1. Parallel Parking:

Length: 3.0 meters
Width: 2.0 meters

2. Perpendicular Parking:

Length: 3.0 meters
Width: 2.5 meters

Source: IRC:SP:12-2015

Figure 119. Dedicated Auto Parallel Parking Bay

6.6 Truck Parking Bay Standards

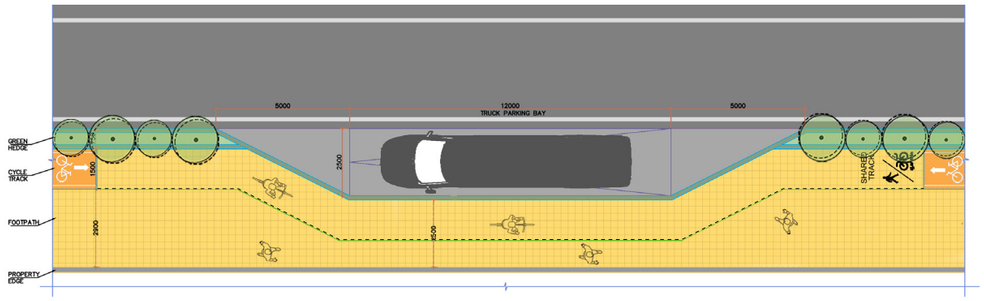


Figure 120. Dedicated Truck Perpendicular Parking Bay

1. Parallel Parking:

Length: 12.0 meters
Width: 3.5 meters

2. Perpendicular Parking:

Length: 12.0 meters
Width: 3.5 meters

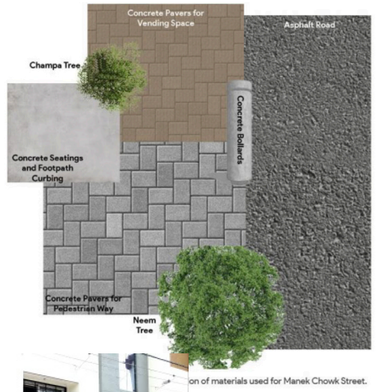
Source: IRC:SP:12-2015

Figure 121. Dedicated Truck Perpendicular Parking Bay

07 MATERIAL PALETTE, FINISH STANDARDSANDSPECIFICATIONS

6.1 Proposed Material Palette for HDC

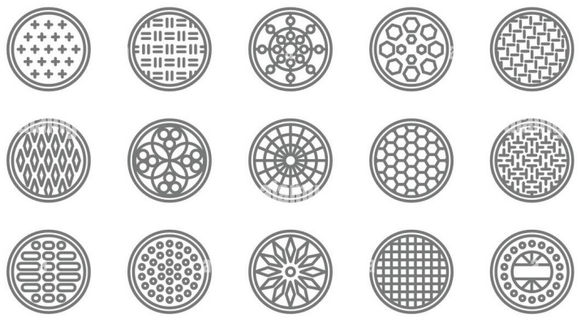
Bollards
Chambers - MS
Cycle Track
Fence
Granite
Kerb
Lane Marking
Ledge Wall
Pavers
Railing
Road
Tactile



on of materials used for Manek Chowk Street.

6.1.1 Bollards

6.1.2MSChambers



6.1.3 Green Painted Cycle Track

6.1.4 Cast Iron Fencing

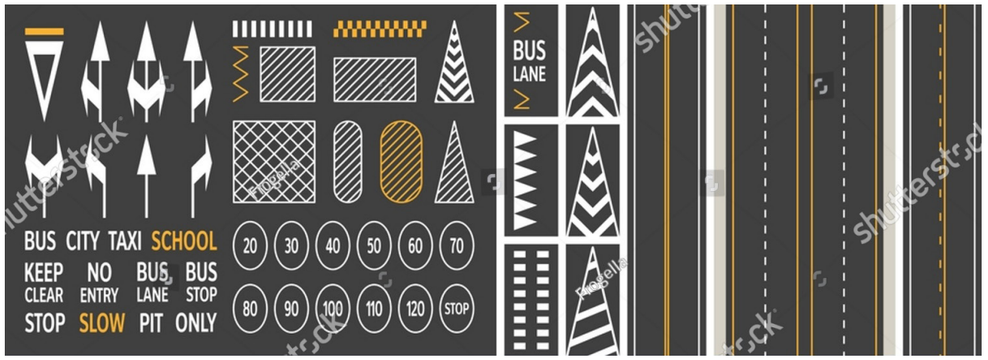
6.1.5 Footpath Textures

Brush Concrete

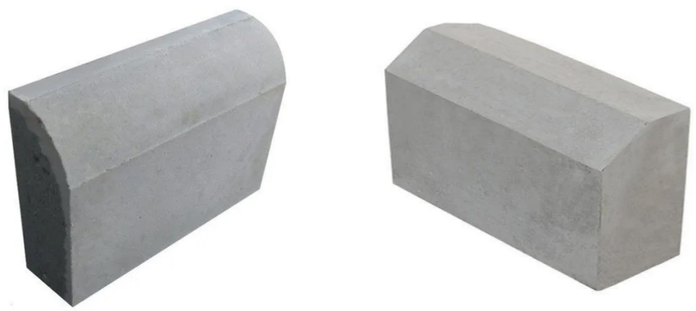
Concrete Paver Blocks

6.1.6 Parking Lot - Red and Grey Interlocking Concrete Paver Blocks

6.1.8 Lane Markings



6.1.7 Concrete Kerb Blocks



The carriageway will be clearly defined with kerbs.

The Concrete Kerb blocks of 600x300x150MM dimensions will be used. There are no raised kerbs at property entrances and zebra-crossing.

Figure 127. Detail of Kerb
Source: Om Concrete Products

6.1.8. Tactile Pavings

Tactile tiles are provided on the footpath, with directional tactile tiles to guide the visually impaired and warning tiles to warn them about any potential safety concerns.

Warning tiles are provided at turnings, around any obstructions, and at level differences (at kerb ramps, etc.)

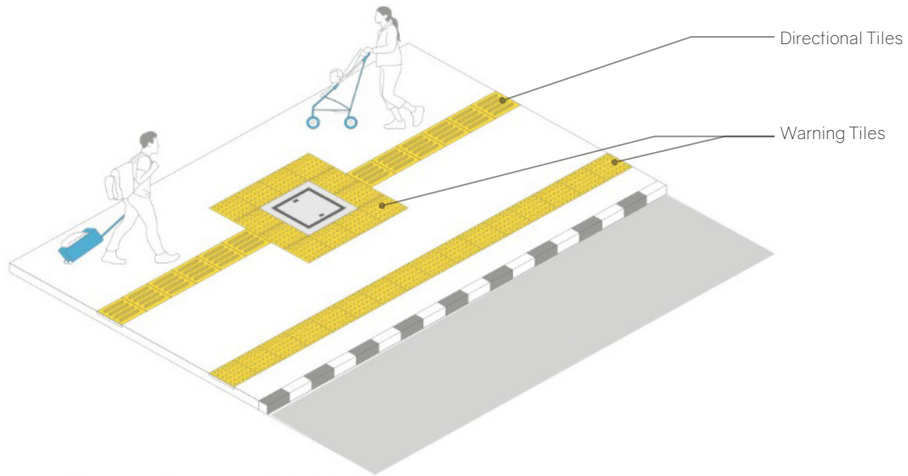


Figure 3.17 Tactile pavers around drain cover

Figure 126. Surface Detail of Tactile pavers, *Harmonized guidelines and standards for Universal Accessibility Design in India 2021*

08 LANDSCAPE

2.1 Reviewing Existing Conditions
2.2 Proposed Typical Street Plan and Section
2.3 Elements and Organisation of Right of Way (ROW)
2.4 Designing Inclusive Street
2.5 Proposed Design as per Suggested Design Principles

6.1.1. Street softscape design

Softscape blends concrete roadways with surroundings and improves environmental quality. Planting native species in roadside landscaping is crucial, as native perennials withstand urban conditions and support local ecosystems. Roadside trees trap dust, reduce runoff, and enhance micro-climates. They provide shade, food, and shelter, encourage urban wildlife, enhance biodiversity, and reduce noise pollution.

Structuring the Street Plantation:
Streets spaces are long and can add up to significant lengths. In order to avoid monotony and repetition, there is a need to structure the planting scheme and identify factors which will bring in vibrancy with variation based on the structure of the street.

Note:
In any case, the plantation height shall not exceed 600mm within 20m of the junction to avoid blind spots.

Figure 128. Structure of street plantation

- Plants for Nodes: Nodal plants can have different themes or have a unique identity based on location.
- Plants for Medians: These plants have to be compact, form a hedge, must be hardy and easy to maintain.
- Plants for Sidewalks: These plants can be ornate, easy growing and can be either sun-loving or semi-shade loving as per the street conditions.

Generally, across the above three categories, all plant species selected are to be erect-growing and not lateral-spreading, must not be thorny or have sharp stem projections, can take trimming to form hedges where needed, leave behind less leaf litter, should not make the road or pavement slippery, and should have leaves in all seasons.

Source: IRC: 119-2018 and 21-2009 (Details on Tree Planting at Junctions)

5.4.2.1. Plants for nodes

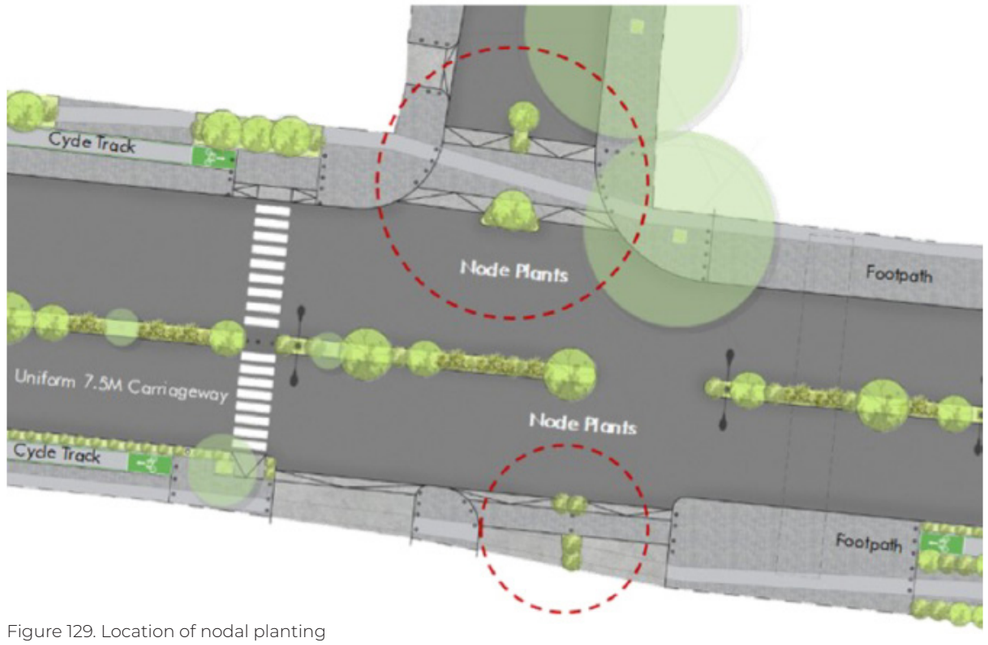


Figure 129. Location of nodal planting

- Can have a thematic link to the place
- Can highlight the spot to give identity
- Seasonal with registerable plant grouping
- Color contrast, special form and composition
- Specimen plants & full ready plants which are easy to grow and maintain

Lagerstroemia speciosa

- Crepe-myrtle, pride of India
- 20-30m tall
- Flowers bloom annually

Alpinia speciosa

- Shell ginger
- 3m long stems

Bamboo grass

- Perennial, evergreen
- Fast-growing
- Densely tufted

Figure 130. Plant palette for nodes

Manihot esculenta

- Bitter cassava, tapioca plant
- Bushy herb or shrub with elongated tubers

Pennisetum

- Fountaingrass, pearl millet
- Annual or perennial grasses
- Dense, narrow bristles

Dianella grass

- Flax lily
- Ideal for mass planting

Plumeria pudica

- White frangipani, champa, arali
- Small tree, 4m high maximum
- Very little sideways growth

Mussanda white

- Dhobi tree
- Shrub grows up to 3m high
- Lateral growth upto 3m

Ixora chinesis

- Flowers throughout the year
- Generally less than 1m tall
- Medicinal uses

Figure 131. Plant palette for nodes

5.4.2.2. Plants for medians

Figure 132. Location and variation of landscape on median

- Hardy, tolerate smoke and pollution
- Easy to grow and maintain
- Compact and can be grown to form hedge
- Locally available
- Safe, not thorny

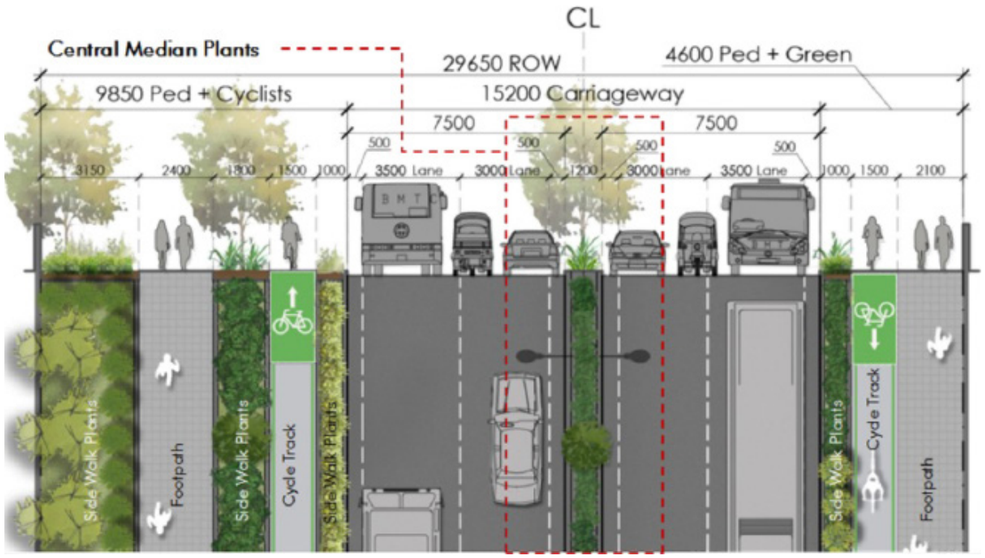


Figure 133. Layering of median plants in section

Duranta repens

- Sprawling shrub
- 4m tall
- Toxic leaves

Cassia biflora

- Suitable for group planting

Asystasia gangetica

- Chinese violet
- 600MM-1000MM high maximum

Hamelia patens

- Firebush, hummingbird bush
- Small tree
- Orange-red flowers

Hymenocallis littoralis

- Beach lily
- 60-70cm high
- Large white flowers

Pandanus plant

- Palm-like fragrant leaves
- Broad canopy
- Less than 1m high

Caesalpinia pulcherrima

- Peacock flower, gulmohar
- Shrub 3-5m tall

Turnera ulmifolia

- West Indian holly
- Shrub grows up to1m high

Rhoeo compacta

- Dense, fast growing plants
- Generally less than 50cm tall

Figure 134. Plant palette for medians

5.4.2.3. Plants for sidewalks

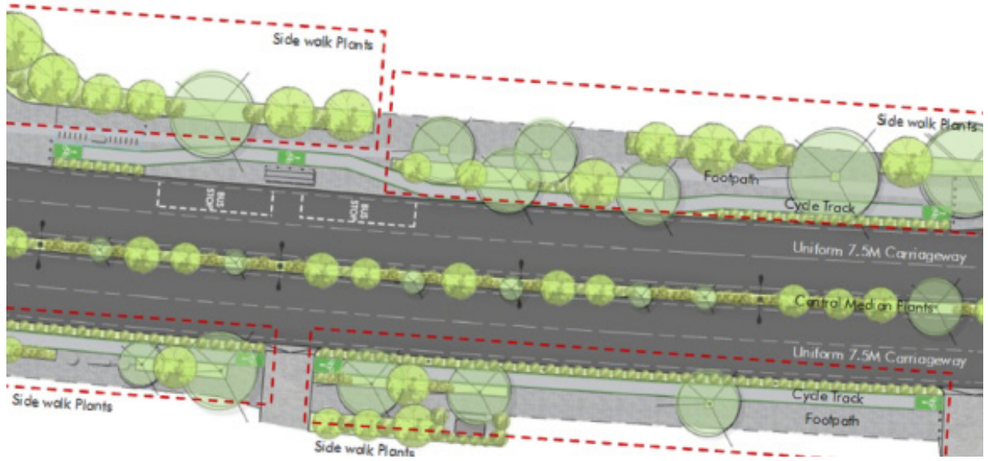


Figure 135. Location and variation of sidewalk plantation

- Hardy, tolerates smoke and pollution
- Can be ornate, flowering or leaf-colour based with multi-layered planting
- Easy to grow and maintain
- Locally available
- Both sun loving and semi shade as per conditions
- Can create thematic walk for pedestrians
- Safe, not thorny

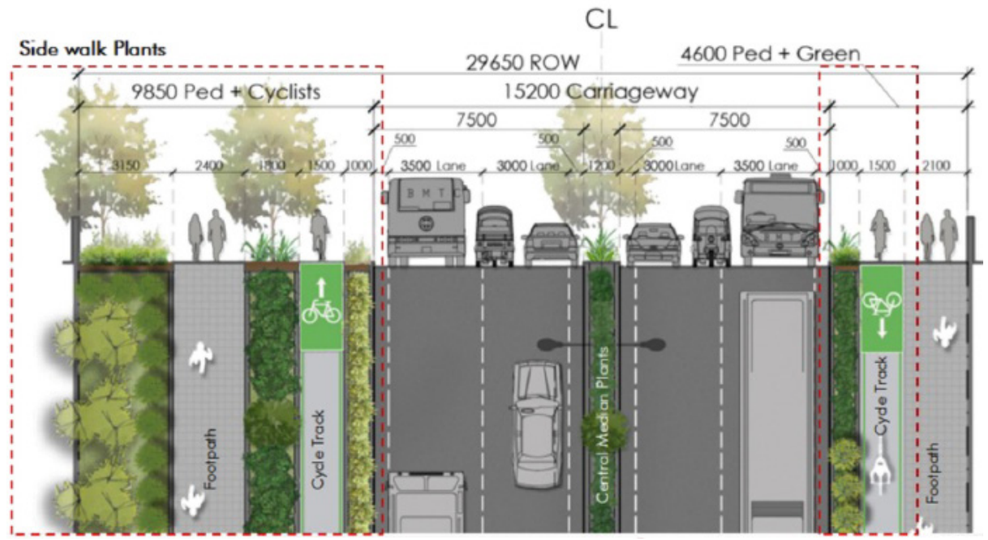


Figure 136. Layering of sidewalk plants in section

Thevetia neriifolia

- Kaner in Hindi
- Tropical shrub
- 10-20ft tall

Tabernaemontana

- Crepe jasmine, carnation of India
- 1.5-2m tall
-Blooms in spring

Lantana camara

- Range of flower colours
- CoMMon hedge plant
- 2m tall

Tecoma gaudichaudi

- 2-4m high
- 2-4m spread
- Fast-growing, good for shading

Plumbago

- Leadwort
- 0.5-2m high

Wedelia trilobata

- Creeping oxeye, Singapore daisy
- Sunflower family
- Ground cover plant

Nerium

- Oleander
- Clusters of flowers
- 2-6m tall

Allamanda cathartica

- Golden trumpet
- Shrub grows up to 1m high

Spider lily

- Dense, fast growing plants
- Generally less than 50cm tall

Figure 137. Plant palette for sun-loving sidewalk plants

Acalypha wilkins

- Copperleaf
-- 3m tall
- Max 2m width

Jacobina species

- Flamingo flower
- 24-28 inches tall
- Perennial shrub

Zebrina pendula

- Creeping plant, inch plant
- Patterned leaves
- Good for groundcover

Pseuderanthemum

- Yellow-veined eranthemum
- Evergreen shrub
- Fast-growing

Sansevieria

- Snake plant
- Hardy, easy to grow

Wedelia trilobata

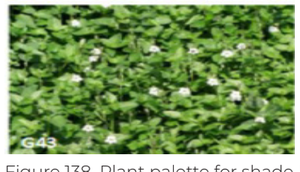
- Creeping oxeye, Singapore daisy
- Sunflower family
- Ground cover plant

Giant lily

- Himalayan lily
-Largest in the lily species
- 2-3.5m tall

Codiaeum yellow

- Croton
- Shrub grows up to 3m
- Maximum width 1.8m



Asystasia gangetica

- Chinese violet
- 600MM-1000MM high maximum

Figure 138. Plant palette for shade-loving sidewalk plants

5.4.2.4. Treatment of existing trees

Trees will need to be protected using either gratings or planter walls depending on the specific conditions of the trees around them. The protection used will have to be large enough to allow the tree roots to grow while still allowing groundwater to percolate into the soil.

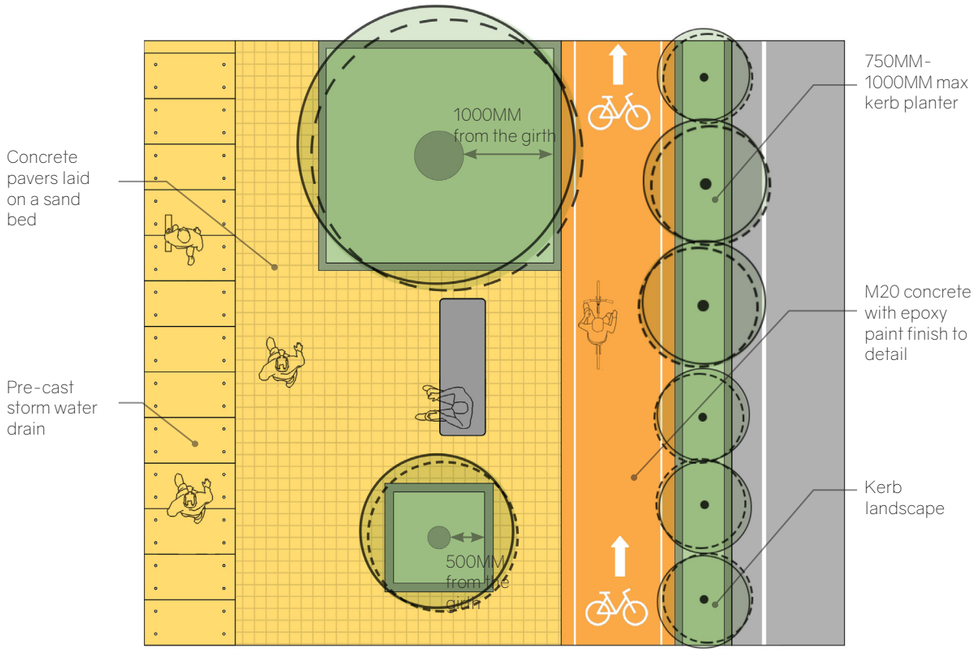


Figure 139. Diagram showing tree cut out in plan according to tree girth

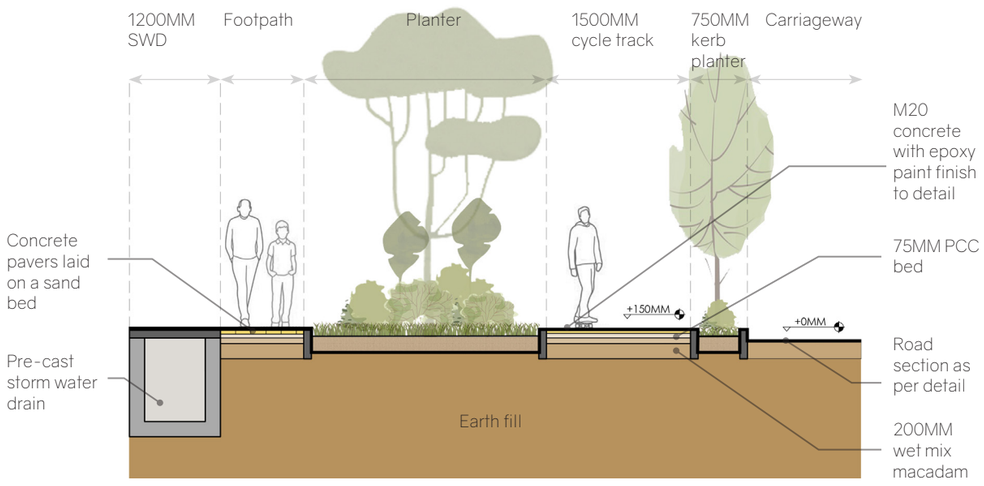


Figure 140. Diagram showing tree cut out and finish in section

5.4.2.5. New trees

Planting of street trees on a hard surface is unlike planting a young tree in a garden, park or field. Before planting a tree on the street, the location of street signage, traffic lights, road junctions, CCTV cameras, parking spaces and underground services as well as the requirements of pedestrians, cyclists and wheelchair users must be taken into account.

Specifications:
- A large tree pit: Larger the tree pit, the better. Tree pit to be a minimum of 1m long, 1m wide and 0.75 to 1m deep.
- Good quality soil with high nutrient content to provide a source of food for the tree. Root barriers to protect underground pipes, cables, paving and adjacent buildings wherever necessary.
- A good drainage layer of crushed stone at the base of the tree pit to help prevent water-logging, which will starve the roots of oxygen.
- A tree guard and underground stakes to hold the tree in position making it less vulnerable to vandalism, accidental car damage and strong winds.
- A modular system installed in the ground alongside aeration and irrigation pipes to provide support, avoid damage to the pavement and prevent soil compaction, to ensure that water, oxygen and nutrients can find their way to the tree roots.

Tree selection:
- Tree habit should be erect, compact and have a moderate canopy.
- The stem should not develop lateral buttress or roots at surface, which could affect the paving.It should not have soft wood or thorns which are hazardous.
- It should have minimal leaf litter, and not shed flower and fruits which could make the roads slippery.
- It should be good mix of evergreen, seasonal flowering and bird attracting typologies. It should require minimal maintenance and be fast-growing.

Michelia champaca

- Champak
- Fl0wering tree
- 30-50m tall
- 180-190cm diameter

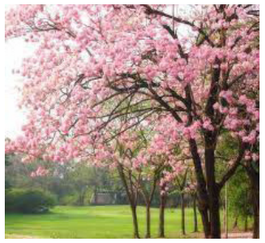
Alstonia scholaris

- Indian pulai, blackboard tree
- 25-40m tall
- Spread/canopy width: 10m
- 1m trunk diameter

Figure 141. Plant palette for new trees

Bauhinia variegata

- Kachnar, orchid tree
- 20-40ft tall
- Crown width 10-20ft wide



Tabebuia rosea

- Trumpet tree
- Up to 35m tall
- Deciduous tree
- 1m trunk diameter

Millingtonia hortensis

- Tree jasmine, Indian cork tree
- 18-25m tall
- 7-11m spread

Podocarpus

- Conifer trees
- 25-40m tall
- Fast-growing

Lagerstroemia speciosa

- Crepe-myrtle, pride of India
- Small-medium size
- 20-30m tall
- Flowers bloom annually

Peltophorum ferrugineum

- Copperpod
- Maximum 35m tall
- 9-12m crown width
- 1m trunk diameter

Figure 142. Plant palette for new trees

5.4.2.6. Planting and maintenance guidelines

- Trenching to be done to the required depth. Pit to be cleared of debris, any leftover vegetation like grass, weeds, or unwanted roots. All serviceable materials to be removed and stacked, rest disposed of appropriately. The trenched area needs to be filled and neatly leveled with the right mixture of soil as mentioned below.

- Pit specifications
  - Tree pit: For a tree sapling of 4-5' height, pit size of 2.5' x 2.5' x2.5' is required, depending on the soil condition.
  - Large shrubs pit: For shrubs of 1.5' height, pit size of 1.5'x1.5'x1.5' is required.
  - Medium shrubs pit: For shrubs of 1' height, pit size of 1'x1'x1' is required.
  - Ground cover pit: For ground cover of 0.5' height, pit size of 0.5'x0.5'x0.5' is required.

- Planting media:
Uniform mixture of 50% of excavated soil with 25% of good quality garden top soil and 25% of FYM or compost enriched with bio-fertilizers/ coco peat and 25% by volume of plant nutrients in 2:1:1 ratio.

Proper management of roadside softscape ensures public safety, improves the urban environment and makes the city more livable. Maintenance shall include, but is not limited to:
- Watering as per need using tankers
- De-weeding of plant bed fortnightly
- Application of fertilizers and pesticides on a monthly basis
- Hedge trimming to be done on a monthly basis.

- Replacement: The number of trees requiring replacement is determined based on continuous monitoring of the trees planted.
  - All dead, dying, or diseased plants should be removed and disposed of appropriately.
  - One tree must be planted for each tree removed.
  - If a fruit tree is to be replaced, two fruit trees should be planted for every tree removed.
  - Replacement tree must be of deciduous (minimum 2.5m in height) or evergreen species (minimum 1.75m in height).

- Mulching: All tree pits and individual shrub pits should be mulched with appropriate material.
  - Organic mulch, such as shredded bark or pine straw, helps conserve moisture and keeps weeds at bay.
  - To prevent rot, mulch must not be piled up against the tree trunk.
  - Having grass grow under trees is beneficial. It acts as a cover crop or natural mulch; hence, more water will be retained in the soil.

- Pruning: It usually involves the removal of smaller and lower branches of trees and shrubs.

- Branches should be cut clearly and as close as possible to the main stem.

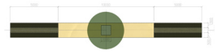
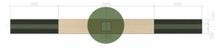
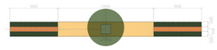
- The Wmain objective of pruning is to add value to the trees, and it is mostly undertaken at the end of the dry season to serve the following purposes:

- To increase light reaching shrubs
- To check on the spread of pests and diseases
- To promote straight stem growth
- To improve growth rate of trees and the quality of stem
- To reduce competition between adjacent trees
- To control plant size and shape
- To keep shrubby evergreens well-proportioned and dense
- To remove unwanted branches, waterspouts, suckers, and undesirable fruiting structures that detract from plant appearance
- To minimize shading

- Pruning can be a major source of firewood and wood for other purposes. Pruned branches can also be used as mulch between tree rows.

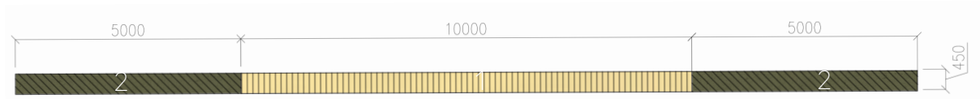
- The best practice for pruning is up to two-thirds of the tree height. It must be done once every month for trees and shrubs.

8. Proposed Plantation Matrix Based on Certain Conditions

Types of Plantations	(Location) Context	Normal Median	Metro Median
 Light Formal	Institutions - Hospitals, Schools, Religious, etc.	Shadow Formal	
 Light Organic	Near Parks, Green Open Spaces, Residences, Hotels, etc.		
 Shadow Formal	Institutions - Hospitals, Schools, Religious, etc. (>50% is shaded)		
 Shadow Organic	Near Parks, Green Open Spaces, Residences, Hotels, etc. (>50% is shaded)		

8.1.1 Plantation Template 1 (Light Formal)

Case 1: Single Green Edge

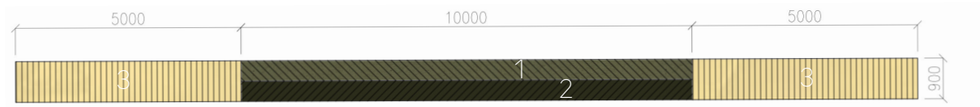


(Dimensions in mm)

Characterstics

- Minimum footpath width of 1.8m
- Minimum cycle track width of 1.5m
- Two different species of plantations at 10m intervals each.

Case 2: Double Green Edge

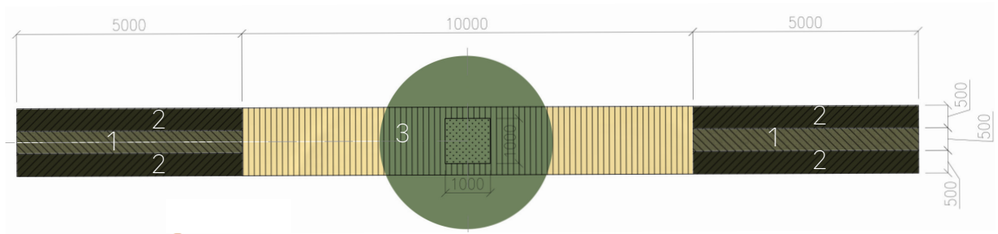


(Dimensions in mm)

Characterstics

- Minimum footpath width of 2 - 2.5m
- Minimum cycle track width of 1.5m
- Three different species (1 & 2 in one 10m stretch) and (3 in another 10m stretch).

Case 3: Triple Green Edge



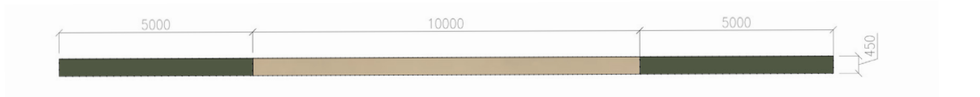
(Dimensions in mm)

Characterstics

- Minimum footpath width of 2.5 - 3m
- Minimum cycle track width of 1.5m
- Three different species (1,2 in one 10m stretch) and (3 in another 10m stretch with proposed 1000mm x 1000mm tree planter box in the middle).

8.1.2 Plantation Template 2 (Shaded Formal)

Case 1: Single Green Edge

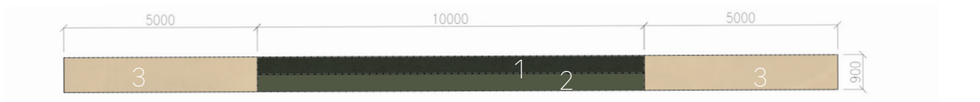


(Dimensions in mm)

Characterstics

- Minimum footpath width of 1.8m
- Minimum cycle track width of 1.5m
- Two different species of plantations at 10m intervals each.

Case 2: Double Green Edge

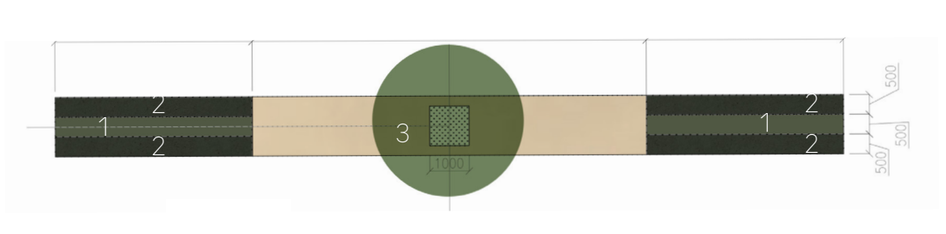


(Dimensions in mm)

Characterstics

- Minimum footpath width of 2 - 2.5m
- Minimum cycle track width of 1.5m
- Three different species (1 & 2 in one 10m stretch) and (3 in another 10m stretch).

Case 3: Triple Green Edge



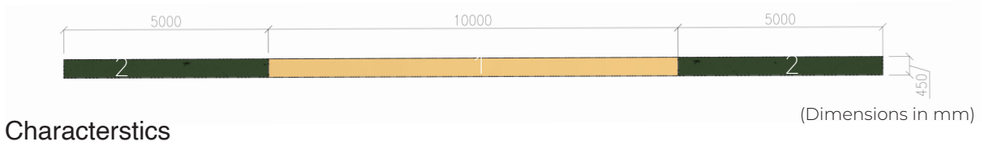
(Dimensions in mm)

Characterstics

- Minimum footpath width of 2.5 - 3m
- Minimum cycle track width of 1.5m
- Three different species (1,2 in one 10m stretch) and (3 in another 10m stretch with proposed 1000mm x 1000mm tree planter box in the middle).

8.1.3 Plantation Template 3 (Light Organic)

Case 1: Single Green Edge

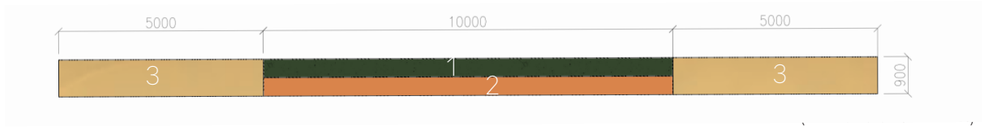


(Dimensions in mm)

Characterstics

- Minimum footpath width of 1.8m
- Minimum cycle track width of 1.5m
- Two different species of plantations at 10m intervals each.

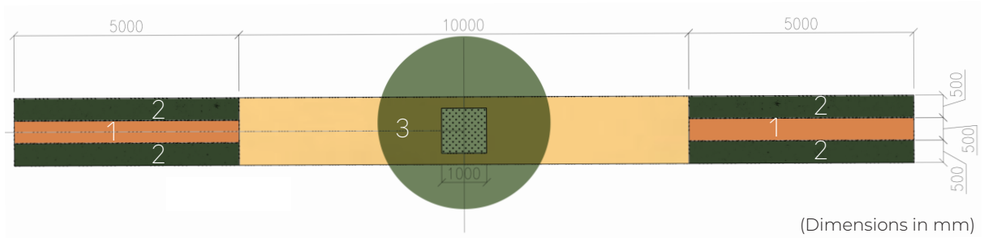
Case 2: Double Green Edge



Characterstics

- Minimum footpath width of 2 - 2.5m
- Minimum cycle track width of 1.5m
- Three different species (1 & 2 in one 10m stretch) and (3 in another 10m stretch).

Case 3: Triple Green Edge



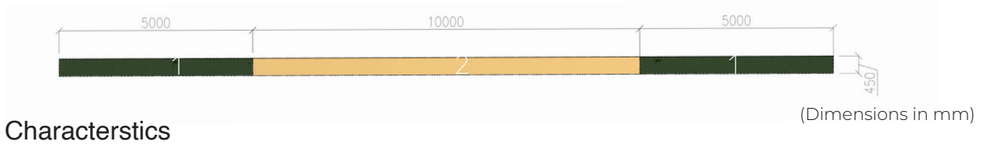
(Dimensions in mm)

Characterstics

- Minimum footpath width of 2.5 - 3m
- Minimum cycle track width of 1.5m
- Three different species (1,2 in one 10m stretch) and (3 in another 10m stretch with proposed 1000mm x 1000mm tree planter box in the middle).

8.1.4 Plantation Template 2 (Shaded Organic)

Case 1: Single Green Edge

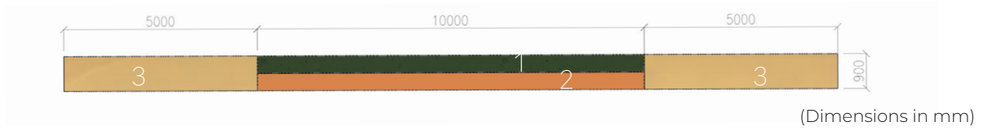


(Dimensions in mm)

Characterstics

- Minimum footpath width of 1.8m
- Minimum cycle track width of 1.5m
- Two different species of plantations at 10m intervals each.

Case 2: Double Green Edge

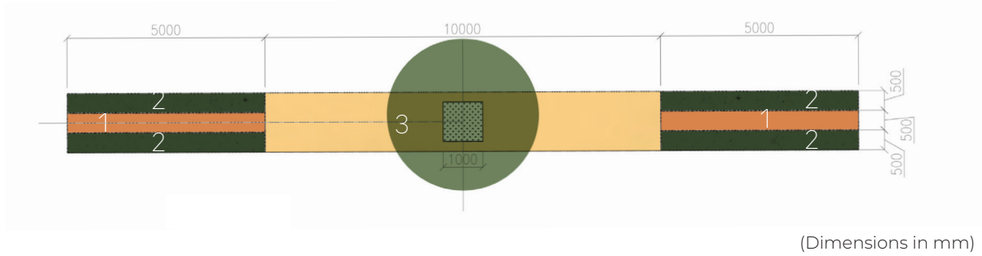


(Dimensions in mm)

Characterstics

- Minimum footpath width of 2 - 2.5m
- Minimum cycle track width of 1.5m
- Three different species (1 & 2 in one 10m stretch) and (3 in another 10m stretch).

Case 3: Triple Green Edge



(Dimensions in mm)

Characterstics

- Minimum footpath width of 2.5 - 3m
- Minimum cycle track width of 1.5m
- Three different species (1,2 in one 10m stretch) and (3 in another 10m stretch with proposed 1000mm x 1000mm tree planter box in the middle).

09 CONCLUSION

The rapid growth of Bengaluru necessitates improvements in its road networks to address traffic congestion and safety issues. To this end, the Government of Karnataka has tasked the Bruhat Bengaluru Mahanagara Palike (BBMP) with upgrading and maintaining 9 High Density Corridors (HDC) in the city. This manual serves as a comprehensive guide for these upgrades, focusing on the following key aspects:

1. Streetscape Improvements: Creation of dedicated footpaths, cycle lanes, bus bays, and landscaping to enhance mobility and safety.

2. Road Safety Elements: Integration of protected crossings, median refuges, kerb extensions, pedestrian signals, informational signage, and redesigned intersections to improve road safety.

3. Design Principles: Uniform carriageways, corrected junction geometries, space reallocation, level pedestrian crossings, and universal accessibility.

4. Urban Street Landscape: Detailed standards for street hardscapes (bollards, seating, dustbins, lighting, signage) and softscapes (plant selection and green cover specifications).

5. Target Audience: The manual is intended for agencies, professionals, and educational institutions involved in high-density corridor projects.

By implementing these guidelines, the HDC project aims to create safer, more accessible, and efficient streets, setting a benchmark for urban development in Bengaluru.

10 REFERENCES