GUIDELINES ON REGULATION AND CONTROL OF MIXED TRAFFIC IN URBAN AREAS

(First Revision)

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CONTENTS

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ABBREVIATIONS

BRT	Bus Rapid Transit
CS&MC	Central Sanctioning and Monitoring Committee
ECS	Equivalent Car Space
GPS	Global Positioning System
HCV	Heavy Commercial Vehicle
ICT	Information and Communication Technologies
IPT	Intermediate Public Transport
IRC	Indian Roads Congress
IT	Information Technology
ITS	Intelligent Transport Systems
LCV	Light Commercial Vehicle
MFZ	Multi-Functional Zone
MMIs	Multi-Modal Interchanges
MoHUA	Ministry of Housing and Urban Affairs
MoRTH	Ministry of Road Transport and Highways
MRT	Mass Rapid Transit
NMT	Non-Motorized Transport
NMV	Non-Motorized Vehicles
NUTP	National Urban Transport Policy
PCU	Passenger Car Unit
PMV	Personal Motor Vehicle
PT	Public Transport
RoW	Right of Way
WZTMP	Work Zones Traffic Management Plan

TERMINOLOGY

Accessibility: Facilities offered to people to reach social and economic opportunities, measured in terms of time, cost, comfort, and safety that are associated with reaching such opportunities.

Bus Rapid Transit (BRT): High quality bus based mass transit system that delivers fast, comfortable, reliable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service.

Complete streets: Streets that are designed for all users as per existing and projected local demand, including all modes of mobility as well as street vending, trees, street furniture etc.

Greenway: A strip of land set aside for recreational use of environmental protection and where vegetation is encouraged along with exclusive facilities for cycling and walking.

Mass Rapid Transit (MRT): A high quality public transport system characterized by high capacity, comfort, overall attractiveness, use of technology in passenger information system, and ensuring reliability using dedicated right of way for transit vehicles (i.e. rail tracks or bus lanes).

Non-Motorized Transport (NMT): Human powered transportation such as walking and cycling.

On-street parking: The space occupied by vehicles to park along the edge of the street or carriageway which otherwise could have been used by motorized or non-motorized traffic.

Intermediate Public Transport: The term refers to informal public transport, including vehicles like auto rickshaw, vans, tempo, jeeps, private city buses and private city mini buses that operate on a shared or per seat basis on informally organized routes operated by private sector and has intermediate stops. The service may or may not have a predefined “fare structure.” The term “Intermediate Public Transport (IPT)” means the same.

Public Transport (PT): Shared passenger vehicle which is publicly available for multiple users. The term “PT” as used in this document and other toolkits includes city buses and Mass Rapid Transit (MRT).

Parking management: A mechanism to ensure the efficient use of street space, and over time, parking fees can be implemented to manage demand.

Sustainable transport modes: The following modes are categorized as “sustainable modes” of urban transport because when compared with personal motor vehicles, they consume least amount of road space and fuel per person-km and also cost much less to build the infrastructure: walking, cycling, and public transport (including a regular bus service as well as an MRT system).

Traffic calming measures: Traffic calming measures ensure pedestrian and vehicle safety by reducing speed. Traffic calming slows down vehicles through vertical displacement, horizontal displacement, real or perceived narrowing of carriageway, material/colour changes that signal conflict point.

GUIDELINES ON REGULATION AND CONTROL OF MIXED TRAFFIC IN URBAN AREAS

1 INTRODUCTION

Urban traffic in India is mixed in character. The conflict, confusion and irritation caused by mixed traffic result in a large number of accidents. The rapid increase in population of motor vehicles and cycles, combined with increase in pedestrian traffic, has exposed the inadequacy of our street system which was originally planned mainly for slow moving vehicles and for more leisure way of life. The future will only make the matters worse, if the present trend continues. With a view to have unified approach, the IRC first brought out Guidelines in 1977 and same was used by the profession for regulation and control of mixed traffic in urban areas.

Due to recent fast urbanization and growing traffic, need was felt for the revision of IRC:70 as the traffic conditions in urban areas are heterogeneous and require planning and design considerations for the movement of not only fast-moving vehicles but also non-motorized transport such as cycles and pedestrians and also to keep pace with Government of India's National Urban Transport Policy which emphasis that road should be designed for people and not for vehicles, thereby focusing on sustainable modes of transport i.e. walking, cycling and public transport.

In the year 2015, the task was assigned to the Urban Roads & Streets Committee (H-8). Subsequently, H-8 Committee constituted a subgroup headed by Ms. Shreya Gadepalli comprising Shri Ashok Bhattacharjee and Ms. Sonal Shah. The initial draft prepared by the Sub-group was deliberated at length in the main Committee and the H-8 Committee finally approved the draft document in its meeting held on 20th May, 2017 for placing before the HSS Committee.

The composition of the H-8 Committee is given below:

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Director General (Road Development) & Special Secretary to Govt. of India	(Kumar, Manoj), Ministry of Road Transport & Highways
Secretary General, Indian Roads Congress	Nirmal, Sanjay Kumar

The Highways Specifications & Standards Committee (HSS) considered and approved the draft document in its meeting held on 23rd June, 2017. Thereafter, the Executive Committee of IRC in its meeting held on 13th July, 2017 considered and approved the same for placing it before the Council. The Council in its 212th meeting held at Udaipur on 14th July, 2017 considered and approved the draft IRC: 70 “Guidelines on Regulation and Control of Mixed Traffic in Urban Areas” (*First Revision*) for printing.

A transport system enables access to goods and services within an urban area. The traffic in urban areas in India is heterogeneous in nature and differs in terms of purpose, speed, dimension, capacity, ease of travel, pollution caused etc. This traffic can be characterized as follows:

(i) Pedestrians

(ii) Cyclists and Human Driven Vehicles

(iii) Animal Driven Vehicles

(iv) Public Transport (PT) - Buses

(v) Intermediate Public Transport (IPT) (Auto Rickshaw, Electric Rickshaw, Taxi)

(vi) Freight Vehicles – Trucks, Light Commercial Vehicle (LCV) etc.

(vii) Two Wheelers – Bikes, Scooters etc.

(viii) Four Wheelers

(ix) Emergency Vehicles – Ambulance, Fire Fighting Vehicles

(x) Other Non-Transport Vehicles (road rollers, excavators etc.)

While the number of motor vehicles in India has grown from 72.7 million in 2004 to approximately 182 million in 2013, pedestrians, non-motorized vehicles and public transport users still constitute more than half of all trips. According to a national level study commissioned by the Ministry of Housing and Urban Affairs (MoHUA) in 2008, more than half the trips in cities above 0.5 million and 75% of the trips in the cities above 8 million population were by non-motorized and public transport. The lack of sufficient public transport and non-motorized transport facilities along with the increase in use of personal motor vehicles has created a congestion leading to unsafe and uncomfortable experience for all road users. Some of the issues faced by them are as follows:

- Road safety: The Ministry of Road Transport and Highways (MoRTH) reported 1.5 lakhs road accident fatalities in 2016. Urban areas, which constitute around one-third of the population, contribute close to 46% of all road accidents and 39% of all road fatalities. In the absence of adequate and safe transport facilities, fast moving vehicle like car commuting at a speed of 50 km/hr creates an unsafe environment for pedestrians who travel at 5 km/hr and cyclists who travel at 15 km/hr.
- Lack of access and comfort for road users: While urban roads in India have heterogeneous traffic, planning and design of urban roads has been oriented towards increasing mobility for motor vehicles, often at the cost of accessibility for other road users. Similarly, road widening projects and those aimed at increasing the number of on-street parking spaces, reassign the space allocated for pedestrians and cyclists for use of cars and motorized two-wheelers.
- Air Pollution: There is a direct relationship between road transport system and air pollution in an urban area. Vehicular emissions depend on vehicle speed, vehicle kilometers, age of the vehicle, and its emission rate. In India, transport sector emissions were estimated at 258.10 Tg (teragrams) of CO_2, of which 94.5% is contributed by road transport in 2003-04. Vehicular emissions in urban India can be attributed to increasing number of private motor vehicles, especially cars and two-wheelers, predominance of older vehicles, inadequate public transport systems, lack of integration of land use and urban transport, amongst others.

1.1 Hierarchy of Street Elements

Taking road safety, lack of access and comfort, delays and emissions into consideration, the regulation of mixed traffic in urban areas should aim at planning, designing and managing urban streets to (i) rebalance the allocation of road space and prioritize safe, comfortable and convenient experience for pedestrians, non-motorized vehicles and public transport users as shown below in **Fig. 1** and (ii) regulate use and control through movement of personal motor vehicles.

Facilities for pedestrians **First**

Facilities for human driven vehicles (Cycles, Three wheeler Cycle Rickshaw)

Facilities for public transport

Facilities for intermediate public transport/shared mobility (Auto Rickshaws, Taxis)

Economic activities – Street Vendors, road side stalls

Facilities for light freight vehicles

Facilities for personal motor vehicle

Facilities for heavy freight vehicles **Last**

Fig. 1 Hierarchy of Street Elements

2 SCOPE

The erstwhile IRC:70 identifies traffic engineering and management measures to improve the speed of faster moving vehicles on urban roads. The engineering measures provide guidelines for carriageway, segregated space for pedestrians and cyclists, mid-block pedestrian crossings and intersections and location of kerb-side bus stops, bus bays. The management measures focus on restricting slow moving traffic on congested and arterial roads, Heavy Commercial Vehicles (HCV) and public transport buses on certain streets, one-way streets, loading and unloading of commercial traffic.

The current IRC:70 has been revised due to the following reasons:

- The current guidelines suggest design recommendations independent of the road typology these are located on. This document, on the other hand, outlines a planning framework for road typologies within which design/ engineering and management measures can be undertaken. This will ensure that proposed measures facilitate the efficient functioning of each typology of road.
- The National Urban Transport Policy (2006 and 2014) has emphasized that roads should be designed for people and not vehicles, thereby focusing on sustainable modes of transport i.e. walking, cycling and public transport. Therefore, this document uses the existing national policy framework to prioritize the safety and comfort of these users.
- Furthermore, a number of IRC documents have been revised and added such as IRC:103 “Guidelines for Pedestrian Facilities” *(First Revision)*,

IRC:67 on “Code of Practice for Road Signs” *(Third Revision)*, IRC:35 on “Code of Practice for Road Markings” *(Second Revision)*, IRC:SP:55 on “Guidelines on Traffic Management in Work Zones” *(First Revision)*, IRC:124 “BRT Design Guidelines for Indian Cities” and IRC:11 on “Recommended Practice for the Design and Layout of Cycle Tracks” *(First Revision)*. The document needs to be updated as per the above-mentioned guidelines.

Similarly, MoHUA has created a number of toolkits for the design of pedestrian, cycling and public transport facilities, which need to be considered and adopted.

3 CROSS SECTIONAL ELEMENTS

A complete street should provide safe accessibility and mobility to all users.Its cross-sectional elements include footpaths and cycle tracks for pedestrians and non-motorized vehicles, carriageway for motorized vehicles, dedicated Bus Rapid Transit (BRT) corridor for public transport, service roads and space for landscape and utilities. Depending on factors such as the available right-of-way, traffic volumes, street-side activities, and adjacent land uses, the street should be designed for due requirements of various users.

In general, smaller right-of-way can function as slow shared spaces used by both pedestrians and vehicles as shown in **Fig. 2**. A narrow driving lane and other traffic calming elements help keep vehicle speeds low, so that vehicle movement remains compatible with the other uses. A larger street can cater to walking and stationary activities as well as through movement, and the slow, shared zone can be differentiated from the mobility zone as shown in **Fig. 2**. The cycle track, though part of the mobility zone, may be segregated from motor vehicle traffic.

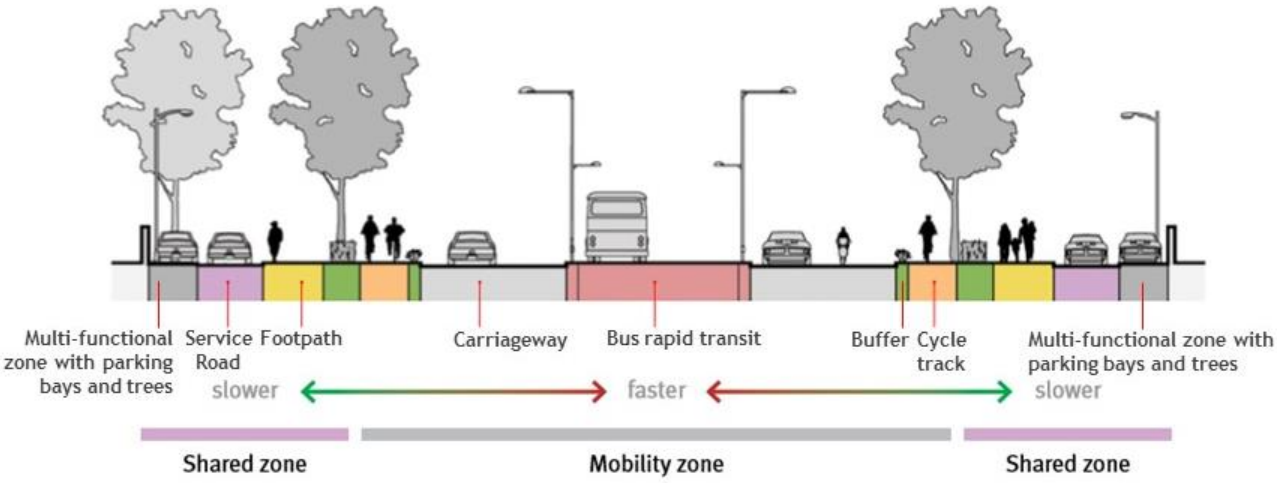

Fig. 2 Cross Sectional Elements of a Street for Slow and Faster Moving Traffic

4 URBAN STREET PLANNING MEASURES

4.1 Urban Road Classification

Due to the heterogeneity of traffic characteristics, speed and size variations of different vehicular modes, deviation of the existing functional character from its planned character, segregation requirement of motorized, non-motorized modes and pedestrians, the following main four typologies of urban roads with specific functions and development norms are recommended:

a. Arterial Road
b. Sub Arterial Road
c. Collector Street
d. Local Street

Additionally, special cases of roads are recommended:

e. Urban Expressways
f. Non-Motorized Transport (NMT) Streets and Greenways

4.2 Planning Considerations

The planning guidelines are given for classification of roads as per para 4.1 and are provided according to its role in the urban fabric. The right of way for various hierarchies of road traffic needs to allocate space drawing a balance between the requirement of motorized vehicles, non-motorized vehicles and pedestrians. The road cross sections for the above mentioned road categories have been illustrated in the IRC Manual for Planning and Development of Urban Roads and Streets and IRC:86 “Geometric Design Standards for Urban Roads in Plains”.

a. Arterial Road

- Arterial roads facilitate mobility across the city and connect to long distance destinations within/outside the city, while providing safe non-motorized transport facilities.
- Arterial roads in new areas shall have a right of way of 45-60 m with future provision for mass rapid transit.
- In existing areas with a right of way less than 45 m, the arterial roads shall be classified based on their function in the street network and ensure minimum pedestrian and/or cycling facilities. The redesign shall increase passenger capacity by increasing frequency of mainline buses and/or implementing high-quality mass rapid transit, such as Bus Rapid Transit (BRT) or metro-rail.
- Safety for pedestrians will be ensured by providing dedicated footpaths, at-grade pedestrian crossing with a median refuge and at distances as per IRC:103. A dedicated non-motorized vehicle track network shall be provided.
- The total carriageway may not exceed three lanes per direction.

- On-street parking shall be prohibited or restricted, except when there is space available for a service lane with parking.

b. Sub Arterial Road

These are larger collector streets meant for movement through neighbourhoods and to connect to arterial roads.

- In new areas, the right of way shall vary from 30-45 m along with future provision for mass transit.
- In existing areas with a right of way less than 30 m, the sub-arterial roads can be classified based on their function in the street network and after ensuring minimum pedestrian, public transport and/or cycling facilities. The redesign shall be based on increasing passenger capacity by increasing frequency of mainline buses and/or implementing high-frequency and high-quality mass rapid transit, such as Bus Rapid Transit (BRT) or Metro-Rail.
- Sub-arterial roads shall have adequately sized footpaths as per IRC:103, continuous non-motorized vehicle network and street furniture to cater to the adjacent land use. The medians shall include pedestrian refuges for safe street-level crossing and at distances as per IRC:103.
- The carriageway may not exceed two lanes per direction with a median of 1-2 m width.
- Public transport feeder buses as well as medium frequency main line buses may operate on such streets.

c. Collector Street

Collector streets form the backbone of neighbourhoods, where local shopping centres and markets may be located. They serve local traffic and connect local streets to arterial and sub-arterial streets.

- In new areas, the right of way shall vary from 15-30 m.
    - o Collector roads with a right of way of 24 m and above may have a divided carriageway with a maximum of 2 lanes per direction, pedestrian facilities as per IRC:103 and cycle tracks. The median shall be intermittent to allow for connectivity to local streets and U-turns.
    - o Collector roads with a right of way less than 24 m may have an undivided carriageway with one lane per direction and pedestrian facilities as per IRC:103. A combined cycle track may be considered for roads with RoW varying between 20-24 m.
- Where non-motorized vehicles share the carriageway with motor vehicles, speed reduction measures such as speed breakers and table-top crossings will be employed to limit vehicle speeds to less than 40 kmph and ensure safety of non-motorized vehicle users.
- Public transport feeder buses may operate on such streets.

d. Local Street

Their primary function is for access to properties, local activities and not through movement of traffic.

- For new areas, the right of way is recommended at 10-15 m.
- In existing areas, local streets may have a right of way less than 12 m, which primarily provide access to properties. In such cases, the streets may not have a dedicated footpath and can be designed as shared space that gives priority to non-motorized transport users. Various traffic calming elements will be employed to ensure that vehicle speeds are below 20 kmph - safe for intermingling of pedestrians, cyclists, and motor vehicles. Staggered on-street parking, chicanes, speed humps can serve as a traffic calming measure.

e. Urban Expressways

An urban expressway is an access controlled road, which distributes inter-city or inter-state passenger and goods traffic.

- In new areas, urban expressways may be planned as a primary ring road around a city or metropolitan region to connect with the regional road network comprising primarily of National Highways, State Highways and other expressways.
- All regional level passenger and freight terminal centres may be located on this ring road to have faster access, regional distribution and intermodal transfer opportunity.
- Urban expressways should connect to the arterial road network at specific locations.
- Entry junctions with highways and primary ring roads of the city may have flyovers with/without cloverleaf structure to facilitate signal free movement of traffic either to destined or bypassing the city.
- New urban expressways within city boundaries may be discouraged and bypass roads may be considered for inter-city traffic. They shall be considered after a careful evaluation of alternate route options and a comparison of social, environmental/pollution and economic costs to users and non-users.
- Planning/urban development authorities should consult with road development agencies when planning urban expressways.

f. Non-Motorized Transport (NMT) Streets and Greenways

Non-Motorized Transport-only streets: All motor vehicle traffic will be prohibited, using barriers and enforcement to prevent their entry and encroachment of non-motorized transport space. Appropriate penalties will be applicable on infractions. Such streets will be designed in compliance with disability access guidelines, with bicycle parking, and access for emergency response vehicles. Commercial deliveries to properties on such streets will be restricted to outside of normal hours. Streets shall be identified where pedestrian density is the highest,

such as those in important market streets, historical and cultural areas, and develop them as non-motorized transport-only streets with plazas, seating, trees and structures for shade, as well as space for organized street vending.

Non-Motorized Transport – Public Transport (NMT-PT) only streets: Private motorized vehicle traffic will be prohibited but public transport services will be allowed, in addition to pedestrians and cyclists. Streets shall be identified based on the amount of non-motorized transport traffic and the need for access by and through movement of public transport modes.

Greenways: The spaces along natural features such as water bodies, lakes, marshes, and parks, shall be developed as a network of exclusive facilities for walking and cycling only, with a variety of public spaces and natural features. Motor vehicle traffic will be prohibited on this network. Such greenways shall have a minimum clear width of 7.5 m to accommodate two-way movement of cyclists and pedestrians.

5 STREET DESIGN FOR REGULATING MIXED TRAFFIC

5.1 Design Speed

The design speeds for the following road types is given below in **Table 1**:

Table 1 Design Speed for Different Road Classification in km/hr

	Arterial Road	Sub Arterial Road	Collector Street	Local Street	Urban Expressway
Plain	60	60	40	30	80
Rolling	50	50	40	30	70
Mountainous	40	40	30	20	60
Steep	40	40	30	20	60

5.2 Segregation of Lanes

The segregation of slow moving traffic from fast moving vehicles can be considered in heterogeneous traffic to ensure pedestrian and non-motorized vehicle users' safety.

5.2.1 *Lane Segregation for Motorized and Non-Motorized Traffic*

- The National Urban Transport Policy (NUTP) 2014 acknowledges the importance of non-motorised transport and prioritizes the construction of cycle tracks and facilities for cycle rickshaws in all cities to enhance safety and use of non-motorized modes.
- Ministry of Housing and Urban Affairs (MoHUA) has made it mandatory to provide non-motorized vehicle tracks along proposed Bus Rapid Transport (BRT) corridors for getting approval by the Central Sanctioning and Monitoring Committee (CS&MC).

- Motorized and non-motorized traffic should be segregated depending on the type of the road. Following table shows the need for non-motorized vehicle tracks based on road classification:

Table 2 Need of Non-Motorized Vehicle Tracks for Different Road Classification

Arterial and Sub-Arterial Roads	Collector Streets	Local Streets
• Minimum 2 m non-motorized vehicle track for one-way movement and minimum 2.5 m for one-way movement with cycle rickshaws. • Minimum 3 m track width for two-way movement of cycles and minimum 3.5 m width for a two-way movement in case of cycle rickshaws.	• May have non-motorized vehicle tracks if part of a non-motorized vehicle network, and where friction and encroachment expected. • Can be in mixed traffic for right of way less than 20 m and, if the speed limit is <40 kmph through traffic calming measures. Traffic calming is essential where non-motorized vehicle tracks are not provided.	In mixed traffic

- No separate cycle tracks are needed if the speed limits are below 40 kmph. On streets between 40-60 kmph, separate cycle tracks can be justified if there are more than 6000 passenger car units (PCU) per 24 hours. **At speeds of 60 kmph and above, separate tracks are always recommended**.
- If cycle volumes on a given street are greater than 1000 per hour. No physical design measures for preventing motorcycles off bicycle lanes are necessary.
- Periodic audits of the non-motorized transport infrastructure should be conducted to assess their use, design issues and address them.

5.2.2 *Lane Segregation for Bicycle and Pedestrian Traffic*

- The footpaths should be segregated from cycle tracks, preferably through a level difference or a physical demarcation, to avoid conflict between pedestrians and cyclists and ensure smooth movement of cyclists.

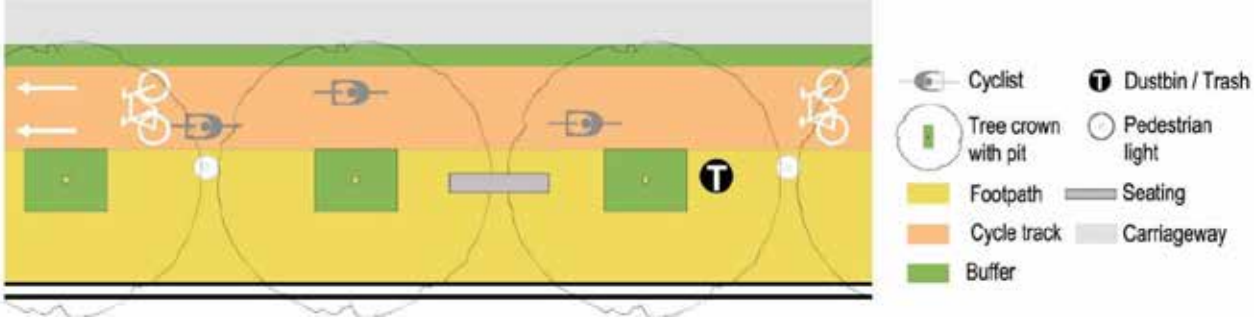

Fig. 3 Cycle Track and Footpaths Segregated by a Multi-Functional Zone

- The segregation between the cycle tracks and footpaths can be achieved visually through markings, kerb line border (at same level) or through the Multi-Functional Zone (MFZ) between the two.
- The MFZ should be 1.5-2 m wide to accommodate a tree line, landscape elements, benches, utilities, street lights and where feasible, on-street parking.
- Cycle tracks can be further differentiated by a contrasting colour or material difference with appropriate signs and markings.
- Cyclists may be permitted on pedestrian only streets provided they acknowledge pedestrian safety especially that of children, elderly and persons with disabilities.

5.2.3 *Lane Segregation for Public Transport*

- Segregated bus lanes can provide faster movement of buses in slow moving traffic and congested roads, thereby improving efficiency and dependency of public transport, reducing emissions while providing faster connectivity and reliability to commuters.
- Bus lanes are of two types – Kerb side bus lanes and Median bus lanes.
- Kerb side bus lanes are typically painted and not segregated. Bus movement on kerb side are often impeded by on-street parking, loading/unloading activities, street vendors, drop-off activities, and movement of non-motorized and motorized vehicles inside the lanes, vehicles entering private properties and turning left. This reduces the efficiency in the bus speed and lowers the purpose of a bus lane. Moreover, it is difficult for bus to manoeuvre when turning right.
- As the name suggests, median bus lanes are located in the median. Painted bus lanes can be encroached by motorized vehicles especially two wheelers unless enforced and managed efficiently. Median bus lanes/busways should be segregated from the motorized vehicle lanes by a kerb with railings or landscape and provide safe pedestrians crossings to median bus stations.
- Segregated median busways can be proposed on Bus Rapid Transit (BRT) corridors on arterial, sub-arterial roads and urban expressways with a minimum width of 3.5 m wide one way.

- Many cities like Singapore, London, New York and Sao Paulo have painted kerb side bus lanes. These lanes are somewhat useful at raising bus speeds when effectively enforced combined with congestion pricing, parking control and other measures to reduce personal motor vehicle traffic.
- In London, bus lanes can be used by certain vehicles that are permitted on certain hours depending on volume and frequency of buses using the route. Vehicles such as cycles, tricycles (non-motorized, without side car), motorcycles, licensed taxis and buses with minimum 10 seats are permitted in the bus lanes depending on the volume of bus. Each bus lane displays which vehicles are allowed and the hours of operation. Any vehicle can use the bus lane outside the hours of operation depending on the time for a particular lane. There are bus lanes which are only reserved for buses.

- In Paris, 118 km of shared bus lanes are designed to accommodate both buses and cycles. A bus and cycle lane is wider than a standard bus lane so that buses and bicycles could pass one another comfortably.

- Kerb side bus lanes are suggested only on urban expressways and arterial roads with service lanes.
- Median busways with bus rapid transit can be considered on corridors with a demand of 3000 persons per hour per direction.
- Shared bus lanes are not recommended due to speed differences and safety of non-motorized vehicles. Other vehicles should not be allowed in Bus Rapid Transit (BRT) lanes except for emergency vehicles.

5.2.4 *Lane Segregation for Motorized Two-wheelers and Other Vehicles*

Motorized two-wheelers may be segregated from general traffic. Special motorcycle lanes may be built. The segregation aims to improve the capacity of the carriageway and to reduce vehicular conflicts caused due to motorized two wheelers. The capacity of a road can increases when segregated lanes and specially designed intersection for motorcycles are provided as they can transport more passengers per lane than private cars due to their faster relative speed.

In Taiwan, motorcycle lanes are separated from regular traffic by painted lines except on certain bridges. The motorcycle lane is generally accompanied by a holding box at the junction because motorcycles can start much faster than a regular vehicle and can clear the intersection faster than other vehicles. By allowing motorcycles to move to the front of the traffic, the efficiency of the junction is increased. Tests of roads with the head start holding zone for motorcycles in Taiwan indicated an average reduction of delay by 4.8 seconds per motorcycle and 4.3 seconds per car.

Bangalore began enforcing lane segregation for auto-rickshaws on M.G Road in 2002 and gradually extended it to 12 major arterial roads. Eventually, this measure did not find support from auto-rickshaw drivers and their passengers because it ended up slowing down auto-rickshaws significantly. The system did not offer the same flexibility to overtake slow moving and stationary vehicles that mixed traffic conditions permitted. The separate auto-rickshaw lanes were designed to allow overtaking but proved too narrow to be feasible in actual traffic conditions. Drivers were frequently forced to move in one line at the speed of the slower vehicles ahead and come to a stand when the lanes were obstructed by disabled vehicles or those picking up and dropping off passengers.

In Malaysia, design guidelines have been created for separate motorcycle lanes.

Brazil experimented with an exclusive motorcycle lane along the central median of Avenida Sumare and Avenida Paulo VI arterial streets in Sao Paulo. Most motorcyclists in the country work for delivery services and tend to travel at high speeds. The road selected for the test had a modest volume of motorcycles (300 per hour). A year later, 95% of the motorcyclists used the exclusive lane, and 60% of them supported it because they thought it was safer. However, accidents along the corridor doubled, mainly because pedestrians misled by the fact that cars stuck in traffic were not moving, did not cross in the correct places and were hit by motorcycles travelling in the exclusive lane. Furthermore, cars turning left also caused conflict with motorcycles and resulted in accidents. Eventually the exclusive motorcycle lanes had to be deactivated.

The following principles should be followed for a separate motorcycle lane:

- For roads where motorcycles and three-wheelers constitute over 50% of the vehicle modal split there is no point in separate lane demarcation.
- Roads with an intended operational speed of 40 kmph or less should be designed for safe integration of traffic at slow speeds rather than segregate different forms of traffic into special lanes.
- It is recommended not to segregate motorized two and three wheelers. Priority should be given to segregation for public transport if required.
- The segregated lanes for motorized two and three wheelers if required can be provided in urban expressways for safe mobility.

5.2.5 *Lane Segregation for Emergency Vehicles*

- **Emergency vehicles include fire fighting tenders, medical ambulances and police vans. They need fast and easy access to reach their destination in the minimum possible time**.
- As per Rule 10 of Rules of Road Regulations, 1989 under the Motor Vehicles Act, 1988, every driver shall, on the approach of a fire service vehicle or of an ambulance allow free passage by drawing to the side of the road.
- As per the Motor Vehicle Act (Amendment) Bill, 2017 (Draft) , the driver of every other vehicle, including VIP vehicles and VIP convoys shall yield the right-of-way, immediately drive to a position parallel to, and as close as possible to the edge or kerb of the road and clear off any intersection. Whoever while driving a motor vehicle fails to yield the movement of a fire service vehicle or of an ambulance or other emergency vehicle shall be punishable as specified by the State Government.
- Bus Rapid Transport (BRT) corridors and bus lanes can be used as emergency lanes.
- Emergency vehicles shall not follow the speed limits and signals at intersection; however, safety of other users should be taken into consideration.

5.3 Traffic Calming Measures

Well-designed traffic calming measures provide safe access for pedestrians and cyclists by reducing the speed of motorized vehicles. Traffic calming measures involve physically altering the road layout or geometry to actively or passively slow traffic. It slows down vehicles through altering the geometry of the road. The measures can result in more attentive driving, reduced speeds, reduced crashes, improved conditions for cycling, and greater safety to pedestrians. These measures are especially important around shopping areas, schools, parks and recreational areas, places of worship, and community centers. Following are the different types of traffic calming elements:

- **Speed Humps**

Speed humps are raised mounts that can reduce speeds to a certain limit based on the height and length of the hump. A hump is often designed as a circular, trapezoidal, or sinusoidal

curve. Speed humps can be designed for different target speeds, and are not limited to low traffic streets. Ideally, speed humps will enable vehicles to travel at a target speed consistently along a road, rather than slowing down and speeding up before and after each hump.

Photo 1 A Road Hump at IIT Delhi Campus

- **Speed Bumps**

Speed bumps are similar to speed humps except they are shorter in length. They considerably reduce the speed of vehicles; however, it creates discomfort.

Photo 2 Speed Bump Made of Asphalt

Photo 3 Speed Bump Made of Plastic

- **Plateau**

Plateau extends the full width of the carriageway between the curbs and extends over a longer length of road than humps. The surface should be of a different material than the carriageway and footways. Plateau is more suitable than road humps when the measures are implemented on bus routes. The length of the plateau should be sufficient to accommodate the full wheelbase of the bus to reduce passenger discomfort to a minimum.

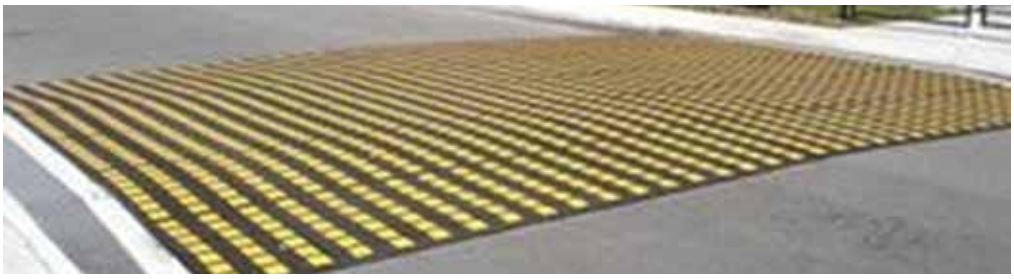

Photo 4 An Instance of a Plateau

- **Chicanes**

Chicanes are artificial turns created to slow traffic. They lead to a reduction in the width of the roadway, either on one side or on both sides or constructed in a zigzag, staggered pattern that directs drivers away from a straight line, which can reduce vehicular speeds.

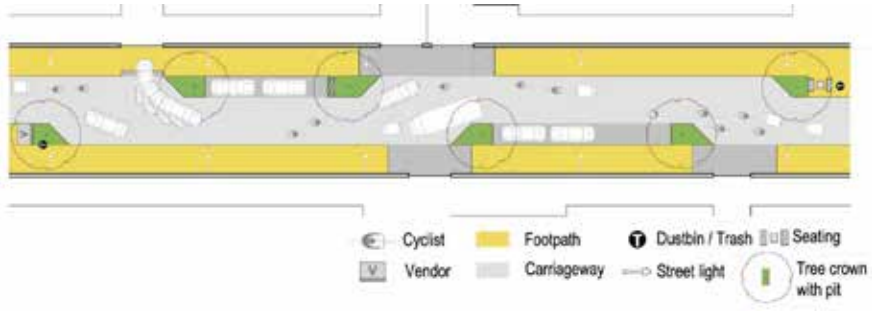

Fig. 4 An Instance of a Chicane

- **Chokers**

Chokers are curb extensions that narrow a street by widening the footpaths or placing planting strips, effectively creating a pinch point along the street. They lead to a reduction in the width of the roadway, vehicular speeds, and pedestrian crossing distance.

Fig. 5 An Instance of Choker

- **Central Islands**

Central islands have only a limited effect on reducing speeds unless combined with another measure such as a chicane. They provide useful pedestrian refuge areas.

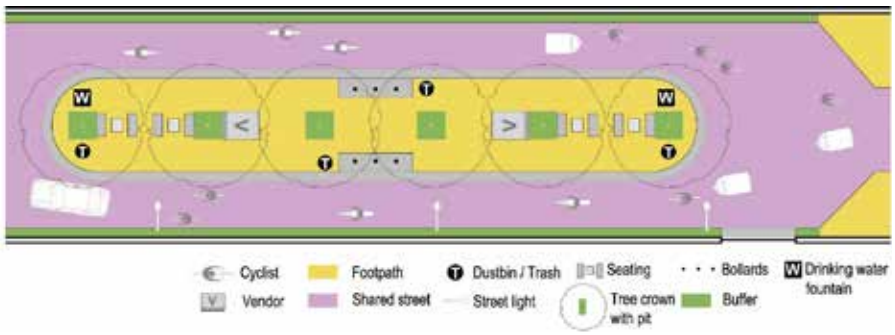

Fig. 6 Central Islands

IRC document on 'Guidelines for traffic calming for rural and urban areas' shall be further referred for additional details on traffic calming measures. Additional traffic calming elements such as rumble strips and rough stone surfaces can also be considered. The length of the rough stone surface is related to desired reduction in the speed of the vehicle. IRC: 99-2018 "Guidelines for Traffic Calming Measures in Urban and Rural Areas" may be referred to.

6 PUBLIC TRANSPORT

6.1 Bus Stops

- Bus stops provide safety and comfort for passengers while waiting, and should be conveniently placed to allow for continuous footpaths and cycle tracks. Bus stops should have minimum 1.2 m wide clear waiting space and a clear height of 3 m. It should have space to incorporate facilities such as information on route maps, bus numbers etc.
- Bus stops should be placed adjacent to the bus linear line of travel so that the bus does not need to pull over to the left (IRC:103).
- The length of the bus stop should be determined based on the number of buses expected to use the stop.
- If there is a parking space between the footpath and the carriageway, bus stops should be located on the bulb-out of the parking lane. The bulb out combined with passenger waiting area prevents passengers from standing on the carriageway, thereby providing safety and allowing smooth traffic flow.
- It is recommended to place the bus stop at the far side of the intersection than the near side. Far side located bus stops result in increased efficiency of the bus movement. They tend to reduce the travel time thereby saving time and fuel on the entire route. Near side bus stops at the intersection make it difficult for buses to manoeuvre in mixed traffic conditions when turning right

and are often hindered by left moving vehicles. This often creates conflicts and accidents. Far side located bus stops allow pedestrian crossing at the rear end of the bus.

- The far side bus stops are recommended at 40-45 m away from the pedestrian crosswalk edge in the intersection to avoid traffic queuing in the intersection. However, depending on the number of buses expected on the bus stop, the distance can be increased to ensure smooth flow of traffic.
- Near side bus stops should be placed 40-45 m before the intersection.
- Spaces for street vending space and dedicated cycle parking wherever required shall be provided.

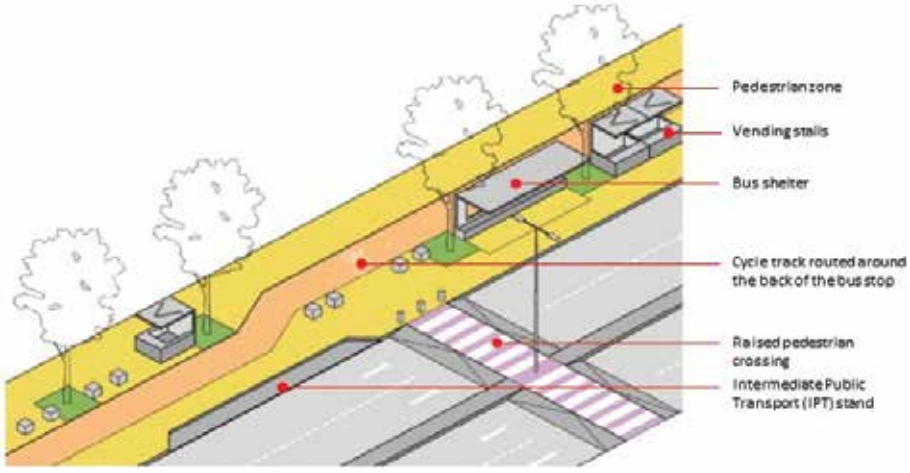

Fig. 7 Planning of Cycle Track Around a Bus Stop

- Tree branches that protrude out in the carriageway should be trimmed to a clear height of 4.5 m from road level for easy movement of bus and other heavy vehicles.
- Intermediate Public Transport (IPT) stands for auto rickshaws, cycle rickshaws and taxis etc. should be provided near the bus stop to facilitate last mile connectivity.
- As shown below, a cycle track should be routed around the back of a bus stop to reduce the chances of pedestrian encroachment. A 50 mm grade difference helps define the boundary between the cycle track and footpath. The bus stop is at the same level as the cycle track, but tree pits, vending stalls, and bollards help define the boundary of the passenger waiting area.

6.2 Bus Bays

- Bus bays in mixed traffic conditions in urban areas can reduce efficiency for buses as they may find it difficult to re-enter the carriageway during high traffic conditions. It is also observed that bus drivers stop on the carriageway forcing passengers to wait in the bus bays, thereby compromising their safety.

- It is difficult for buses to merge inside the carriageway during peak hour traffic. There are possibilities of vehicular conflicts due to side swipe or rear end collisions.
- Bus bays are effective when they are free from encroachment due to parking, street vending and loading/unloading activities. They shall be free of parking.
- Bus bays remove potential street parking space due to area required for entry and exit of bus inside the bay.
- Bus manoeuvring in and out of bus bay also creates conflicts with cyclists if on-street kerb side cycle lanes are provided.
- Bus bays can be provided on urban expressways where the speeds are high and separated from the carriageway by a verge.

6.3 Bus Rapid Transit

Photo 5 A Bus Rapid Transit (BRT) System

Photo 6 Level Boarding BRT Delhi (Photo Courtesy SAMARTHYAM)

Bus Rapid Transit (BRT) can offer high-capacity and high-quality public transport, similar to a metro rail but at a lower cost, by providing an exclusive right-of-way. It helps in segregating public transport buses from the mixed traffic scenario thereby providing the commuters with a high-quality service in terms of speed, reliability and comfort.

- A bus rapid transit should be sited on street with moderate to high demand for public transport, which is over 3000 pphpd (persons per hour per direction). A well-designed bus rapid transit system can carry passengers ranging from 12,000 pphpd with a single lane per direction to 45,000 pphpd with passing lanes.
- A bus rapid transit system with one lane per direction in station areas can handle about 70 regular buses an hour, or around 5,000 pphpd. The factors that determine the capacity of a bus rapid transit system is the configuration of the lanes and stations.
- Bus rapid transit with median bus lanes also improves safety for cyclists and pedestrians by eliminating conflict points at bus stops. Bus rapid transit corridors will have dedicated median bus lanes that are physically separated

from mixed traffic lanes. Dedicated lanes are crucial for ensuring the buses can move quickly and avoid congestion. The clear width of a bus rapid transit lane shall be 3.5 m, plus 1 m buffer space next to mixed traffic.

- Bus rapid transit can become a barrier to pedestrian and cyclist movement if at-grade crosswalks are not provided at reasonable intervals. Passengers may have trouble reaching bus stations unless pedestrian refuges and traffic calming measures improve pedestrian safety. At-grade pedestrian crossing will be provided at reasonable intervals to ensure safety of pedestrians. Pedestrian crossings at stations must be elevated to the height of the adjacent footpath, with a slope of 1:10 gradient for buses.
- Detailed guidelines for bus rapid transit systems are outlined in the IRC:124 “Bus Rapid Transit (BRT) Design Guidelines for Indian Cities”.

6.4 Multi-Modal Integration

Streets and public spaces shall be integrated with public transport services. Wherever possible and necessary, Multi-Modal Interchanges (MMIs) shall be developed at intercity transit station, public transport stations and bus stops to help regulate the mixed traffic flow. The following principles shall be adopted for multi-modal integration around public and mass transit stations.

- Create clear, direct, and short transfers between metro/rail systems, bus stops, and para-transit stops to minimise horizontal and vertical displacement. These pathways should comply with disability access guidelines and shall offer consistency and clarity in station entrances and interfaces, spaces, layout, and visual cues. At-grade access to bus rapid transit stations shall be prioritized.
- Provide intermediate public transport stands at key destinations and at frequent intervals.
- Provide rain and sun protected shelters, stops and connection between modes.
- Coordinate feeder service schedules and routes with schedules of trunk services to minimise customer wait times.
- Prioritize measures to ensure the efficient movement of surface public transport modes, such as buses and rickshaws, to and from the station area.
- Provide clear and consistent way-finding and signage to support efficient navigation to public transport stations in station areas. This includes static information such as route maps, route destinations, and transfer opportunities.
- Provide for safe and efficient movement of pedestrians and cyclists in the influence areas around public transport stops and stations.
- Provide an attractive pedestrian environment on all approach streets within one km radius of Mass Rapid Transit (MRT) stations, particularly on routes serving major destinations. All pedestrian links should provide a high level of priority and safety and shall be compliant with IRC:103.

- Provide clearly marked and protected access for pedestrians and cyclists at station areas to minimise conflicts, particularly at passenger pick-up and drop-offs, bus facilities, and parking access points.
- Provide secure and plentiful bicycle parking at station entrances with additional cycling amenities at high volume locations.
- Provide last mile connectivity to mass rapid transit stations via innovative programs such as cycle sharing.

7 INTERMEDIATE PUBLIC TRANSPORT

- The term Intermediate Public Transport (IPT) refers to vehicles like auto rickshaws, cycle rickshaws, vans, tempo, jeeps, private city buses and private city mini buses that operate on a metered, shared or per seat basis on routes operated by the private sector with intermediate stops. The service may or may not have a predefined fare structure.
- Cycle rickshaw, auto rickshaw, taxis and local buses are feeder services and need to be integrated with mass rapid transit stations to enhance seamless multi-modal accessibility. Local bus stops, rickshaw and taxi parking areas are provided adjacent to the bus rapid transit station to make intermodal transfers as convenient as possible.
- Sheltered alighting and boarding bays for auto, cycle rickshaws and taxis should be provided for the convenience of passengers and to avoid traffic congestion. The bay length can be determined based on the number of rickshaws and taxis waiting. In some cases, separate waiting lanes for metered and share auto rickshaws can also be provided.
- All the Intermediate Public Transport (IPT) stops should have signages and information as specified in IRC:67, displaying the number, tariff and routes (if necessary) for commuters' convenience.

8 COMMERCIAL TRAFFIC

Urban freight plays a major role in the economic growth of city. However, there are frequent conflicts between a city's liveability and its freight movement. It is characterised by environmental pollution, congestion and these issues have to be dealt with judiciously. An urban transportation system must balance the city's economic growth and environmental sustainability.

8.1 Planning and Design Measures

- Roads meant for movement of freight vehicles must be channelized through alternate routes to avoid the city centre and other congested corridors.
- In localities where frequent movement of freight occurs, consolidation centres must be located for freight vehicles to load and unload goods. These could be

supported by light commercial vehicles and non-motorized transport modes of delivery.

- On-street parking could be managed such that spaces which are currently provisioned for parking private motorized vehicles could be repurposed for providing road space for freight vehicles to park during loading and unloading, which could avoid problem of double parking and congestion.
- Adequate off-street loading and unloading facilities should be provided before approvals for commercial and industrial buildings are granted. Buildings such as hotels, hospitals, wholesale depots, godowns, booking offices of commercial transport companies, industries and manufacturing establishments could be brought within the purview of such a regulation.
- A parking bay of 3.5 m x 9 m for heavy freight vehicles may be provided.

9 CYCLE TRAFFIC

9.1 Types of Cycle Tracks

- Cycle tracks may be (i) adjacent to the carriageway but at a higher level, (ii) separated from the carriageway or (iii) median cycle track. The cycle tracks may be elevated 100 mm above the carriageway, so that they do not form the lowest level of the road, which can lead to water logging. However, in case of storm water drain located under median, cycle tracks on the kerb side can be provided at the level of carriageway.
- Painted cycle lanes without segregation on the kerb side can be provided after addressing on-street parking, loading and unloading activities, street vendors and other on-site conditions and activities.
- A buffer of 0.5 m between the cycle track and parking areas or the carriageway shall be maintained.
- Median cycle tracks reduce conflicts with parking and property access. Frequent access points with ramps are essential. Turning movement conflicts at intersections can be mitigated through bicycle boxes and appropriate signal phasing.

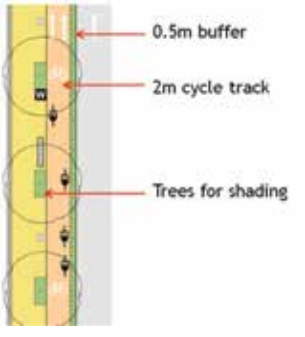

Fig. 8 Cycle Track

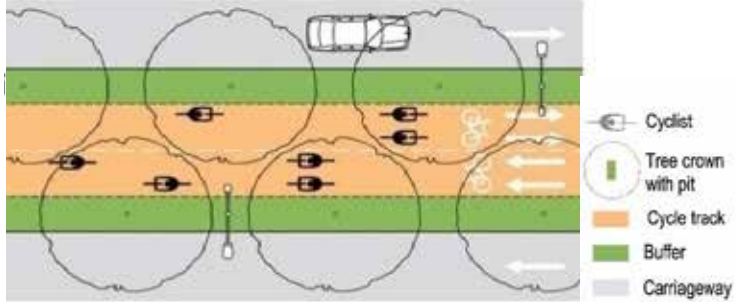

Fig. 9 Median Cycle Track

9.2 Location and Width of Cycle Track

Cycle tracks shall be provided on arterial roads, and sub arterial roads. Following table recommends the width of the cycle tracks:

Table 3 Recommended Minimum Widths for Cycle Tracks

Non-motorized vehicle tracks with cycles only (excluding kerbs)
Min. 2.0 m for a one-way cycle track
Min. 3.0 m for a two-way cycle track
Non-motorized vehicle tracks with cycle rickshaws (excluding kerbs)
Min. 2.5 m for a one-way track
Min. 3.5 m for a two-way track

As per IRC:11, it was observed that a 2.5 m segregated cycle track in Delhi could carry 3000 cyclists per hour in one-way cycle track on either side of the carriageway at a good level of service and comfortable speeds.

9.3 Riding Surface and Lighting

- Cycle tracks must have a smooth surface like asphalt or concrete and paver blocks should be avoided. The cycle track surface should be well defined through material and colour difference and well drained.
- Manhole covers should be avoided, however if unavoidable, they should be levelled and not kept open for the safety of cyclists. Wherever drain covers with grating is provided, care should be taken that the grating is placed perpendicular to the motion of wheels to avoid catching of wheels.
- The tracks should have necessary markings and cycle symbol at regular intervals as specified in IRC:67. It should be well lit. Lighting of 30 lux at 12-16 m spacing for a 6 m high light pole should be provided.

Photo 7 Cycle Track

9.4 Bicycle Parking Infrastructure

- Bicycle parking infrastructure such as racks, stands and storage facilities such as lockers and cycle centres allow cyclists to park their bicycles safely and in an orderly and convenient way. They can be broadly classified into two types – bicycle parking for short time (less than 2 hours) and bicycle parking for longer time (more than 2 hours, all day).
- Bicycle parking facility should be provided near mass rapid transit stations, near public buildings, high intensity commercial areas etc.
- Bicycle parking should be free to encourage cycling.
- The simplest way is to demarcate a bicycle parking space, without installing any parking system. This can be achieved by simple marking or different surface material. It is recommended that it should be raised. It can be provided on footpath in multi utility zone.
- A fixed structure that allows the bicycle to be attached may be provided. This can be in the form of a stand, for a single bike or one on each side, or of a rack, for multiple bicycles in a row.
- The inverted U-shaped bar height ranges between 0.7 m to 0.8 m. The bicycle frame and a wheel can be attached with a single lock to the bar. It is easy to use and difficult to vandalize. It is inexpensive and requires minimal maintenance.
- Horizontal front wheel grip rack can be provided. They can be repeated and installed for more number of bicycles as required.

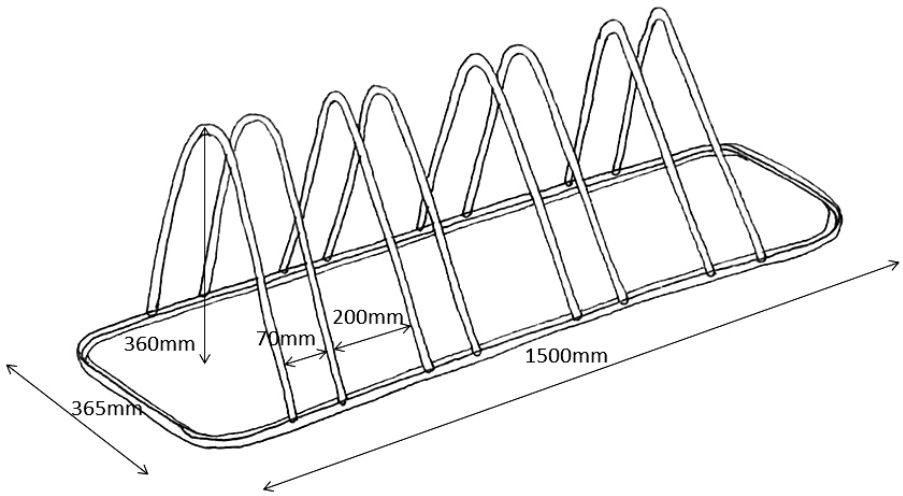

Fig. 10 Horizontal Front Wheel Grip Rack

IRC:11 “Guidelines for Design and Layout of Cycle Tracks” shall be referred for additional details.

10 PEDESTRIAN TRAFFIC

10.1 Pedestrian and Non-Motorized Transport Precincts

In areas with high pedestrian traffic such as market or retail streets/zones, dense urban cores, historical and cultural areas or business centers/offices, markets, pedestrian and non-motorized transport-only streets/zones may be created to provide comfortable pedestrian access. Motor vehicle traffic should be prohibited, except for delivery vehicles and garbage vans during specified hours during the day or night and emergency response vehicles. Such streets/zones should be designed in compliance with disability access guidelines, with bicycle parking, plazas, seating, trees and structures for shade, as well as space for organized street vending. Plazas shall be considered for retail streets, market streets, feeder streets to mass transit stations or inner-city areas.

10.2 Green Corridors

Spaces along natural features such as water bodies, lakes and parks can be developed as a network of exclusive facilities for walking and cycling only with a variety of public spaces and natural features. Motor vehicle traffic will be prohibited on this network. Such greenways shall have a minimum clear width of 4 m for pedestrian paths and 7.5 m for a combined path for cyclists and pedestrians.

10.3 Footpaths

Adequate and good footpaths promote safe and comfortable pedestrian mobility by segregating cars and two wheelers from the pedestrians. A significant proportion of trips, especially those below 2 km, are performed on foot. Additionally, all public transport passengers and many private vehicle users start and end their trips as pedestrians on public streets. Hence accommodating pedestrians is an essential, if not the most important task.

There are lot of challenges and issues faced in designing footpaths. Streets often are designed from the centreline outward, with priority given to motorized vehicles. Whatever space is left over after creating the carriageway and parking is designated as the footpath. The placement of utility boxes, trees, and light poles on the footpath leaves no clear space for pedestrians. Even with an adequate width, a footpath may be difficult to use if it ends frequently at access points. High curb heights and steps make footpaths difficult to use. Poorly designed footpaths remain un-utilised and are easily encroached by parked vehicles and shops. In the absence of an adequately sized and usable footpath, the only clear space left for pedestrians is the carriageway. Therefore, footpaths must be well planned and designed so as to safeguard pedestrians from other modes of transport and obstacles caused by other street elements. Some of the norms and principles to design footpaths are given below:

- A footpath should consist of a dead or frontage zone, pedestrian zone and a multi-functional zone as per IRC:103 “Guidelines for Pedestrian Facilities”.
- Frontage Zone or Dead Zone: A dead space in front of active commercial

frontage is required for passive slow speed widow shoppers clear from the regular pedestrian movement space to avoid conflict and increase the walking space capacity.

- The Pedestrian Zone: An uninterrupted walking zone of minimum 1.8 m (width) and 2.2 m (height) shall be provided. No tree branches, trees, utility poles, electric/water/telecom boxes or signage should be placed within the clear height and width of the pedestrian zone. However, subject to this minimum, the width of the zone shall be based on the design flows and levels of service outlined in Table 1 and 2 of IRC:103.

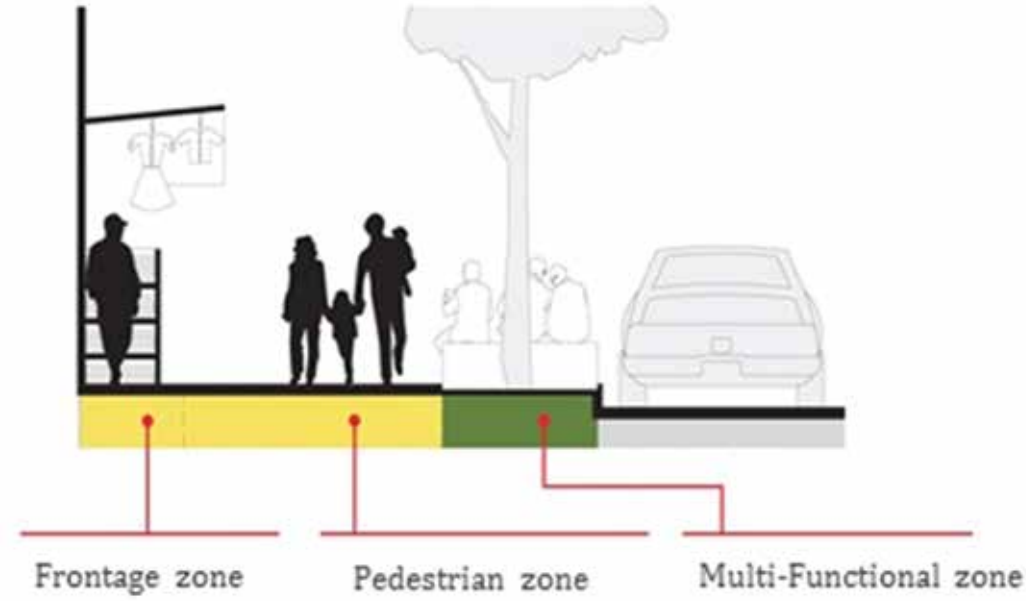

Fig. 11 Zoning of Footpath Space

- Multi-Functional Zone (MFZ): A multi-functional zone (also known as a Planting Zone or Street Furniture Zone) of minimum 1-2 m width (depending on the hierarchy of urban road) shall be provided between the pedestrian zone and carriageway to provide amenities for road users and also to help smooth and orderly movement of all kinds of traffic. It shall accommodate tree planting and planting for storm water management, auto-rickshaw stands, cycle-rickshaw stands, hawker zones, paid car parking, bus stops, traffic police booths, Telephone boxes, fire hydrants, junction boxes, street lights/ pedestrian lights etc. Verges are not required for urban roads, as their role is served by the multi-functional zone of a footpath.
- Footpaths will be provided where there are none; and where footpaths exist. The widths will be increased depending on pedestrian volumes in order to prevent pedestrian overflow onto the carriageway and to ensure continuity. Footpaths shall meet the following standards, in compliance with IRC:103.
- The height of a footpath shall not exceed 150 mm above the carriageway.

- Footpath surface shall be evenly paved and smooth for all users, including those on wheelchairs. Service covers and gratings should be non-slip, flush/ levelled with the footpath surface, and be such that openings are not more than 10 mm wide. Gratings and slot type drainage should be sited away from pedestrian flows and perpendicular to the main line of pedestrian flows so as not to trap small wheels.
- Existing vehicle parking, junction boxes and other obstructions shall be removed or realigned, so as to free up space for footpaths and prioritise street amenities such as street furniture, landscaping, and trees.
- Footpaths and other elements of the pedestrian environment should be accessible to all users, in compliance with Ministry of Urban Development's Harmonised Guidelines and Space Standards for Barrier-Free Built Environment for persons with Disability and Elderly Persons (2016).

Capacity and Clear Pedestrian Zone

The width of the pedestrian zone is fundamental to the effective functioning of the pedestrian system. A minimum width of 1.8 m (IRC:103) for an uninterrupted pedestrian zone is recommended for residential areas, which shall increase based on adjoining land uses as shown in **Table 4**. Footpaths should normally be designed to provide wide pedestrian facilities for pleasant and comfortable walking.

Table 4 Minimum Width of Pedestrian Zone as per Adjacent Land-use

	Zone	Minimum Width in meters
1.	Predominantly Residential Zone	1.8 m
2.	Predominantly Commercial Zone	2.50 m
3.	High Intensity Commercial Zone	4.0 m

10.4 Median

- A median reduces conflict between opposite directions of traffic and acts as pedestrian refuge but has frequent enough breaks to discourage motor vehicle users from driving in the wrong direction. Medians can help streamline traffic and ensure safety on higher-speed streets where there is a risk of collisions involving right-turning traffic.
- In addition, they prevent speeding drivers from crossing into the opposing traffic lane. Medians improve safety for pedestrians by functioning as refuge islands, which allow pedestrians to cross one direction of travel at a time. Central medians can accommodate other elements such as lighting, landscaping, pedestrian and cycling boulevards, utilities, advertisement boards etc.
- Medians that extend too far without any opportunities to cross, turn right, or make a U-turn make the other side inaccessible and unnecessarily increase

the total distance travelled. They encourage vehicle movement on the wrong side, thereby compromising safety. Hence, the provision of breaks in a median at appropriate intervals is critical.

- Sometimes, guardrails or high curbs are built to prevent pedestrians from crossing the street. However, they are surmounted anyway. If a median is not wide enough, pedestrians may spill over into the carriageway while waiting for traffic to clear. The recommended width of the median should be 2.0 m to accommodate the length of wheelchair. The absolute minimum width of median shall be 1.2 m (IRC:103).

10.5 Foot overbridge, Subways and Skywalks

Grade separated facilities such as foot overbridges, subways and skywalks are often unsafe and inaccessible and inconvenient to many users. They are also unsafe with regard to sexual assault and general crime, and often double as urinals. Authorities may create skywalks to link railway or public transport terminal pedestrian bridges with key destinations, provided that doing so does not compromise pedestrian, non-motorized transport and vehicular infrastructure below the skywalk. Skywalks should be integrated strategically with the adjoining land use, mass rapid transit stations, Intermediate Public Transport (IPT) stands and markets. They should be well lit, easily accessible and safe.

10.6 Other Elements

10.6.1 *Bollards*

Bollards are often used to stop vehicles from mounting the footpath and to keep pedestrian away from traffic. To stop use by bicycles/bikes, bollards at suitable locations should be provided with clear 1.2 m space between two bollards. Staggered bollards do not prohibit motorized two wheelers and make it more difficult for them to pass through, while allowing convenient access for wheelchair users and cyclists.

10.6.2 *Guard Rails*

Currently designed guard rails impede pedestrian access to footpaths. Their judicious use can help to ensure that pedestrian cross the streets at predetermined and safe locations. As the guard-rails would confine the movement of pedestrian to the footpath, it is required that sufficient width of footpath be made available (IRC:103).

10.6.3 *Kerb Edge*

Footpaths are recommended to be continuous at property entrances for uninterrupted pedestrian movement, so that the height of the footpath remains the same. To provide access to private properties, vehicle ramps can be provided in the furniture zone with a gradient of 1:6.

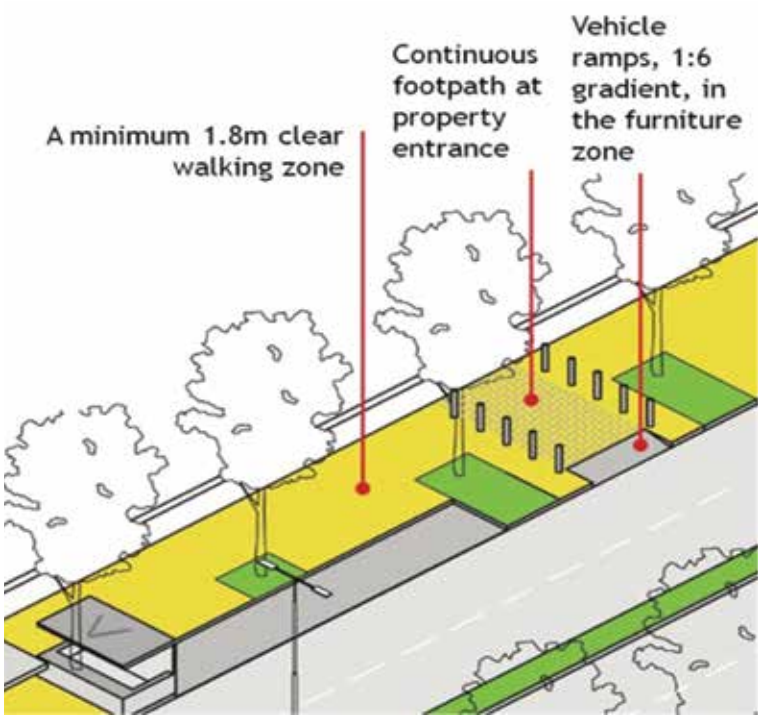

Fig. 12 Desired Kerb Edge

10.6.4 *Crossfalls*

Crossfalls should only be provided where absolutely necessary for drainage purposes and should be 1:50 maximum. If the change in cross fall is so severe that one wheel of a wheelchair or one foot of a walker leaves the ground, it may cause the user of the wheelchair or walker to fall. Steeper gradients tend to misdirect buggies and wheelchairs. Where falls are not adequate, silt will accumulate after rain and cause the surface to become slippery.

10.6.5 *Pedestrian Crossing: Midblock*

- Pedestrian crossings will be constructed as raised crosswalks, or painted zebra crossings. Zebra crossings will comply with IRC:103.
- It is recommended to have at-grade pedestrian crossings.
- Pedestrian crossings will be located at every 80-250 m in residential areas, and every 80-150 m in commercial and mixed-use area.
- At unsignalized crossings, raised crosswalks shall be constructed. Raised crosswalks shall have a minimum width of 3 m, elevated to the level of the adjacent footpath, with ramps for motor vehicles with a slope of 1:8 (IRC:103).
- Medians shall be designed as surmountable pedestrian refuge to enhance pedestrian safety. Roads with 4 or more traffic lanes shall have medians with pedestrian refuges of minimum 2 m depth, and 3 m width (IRC:103), with bollards located in the refuge space to disallow vehicles from entering and to enhance pedestrian safety.

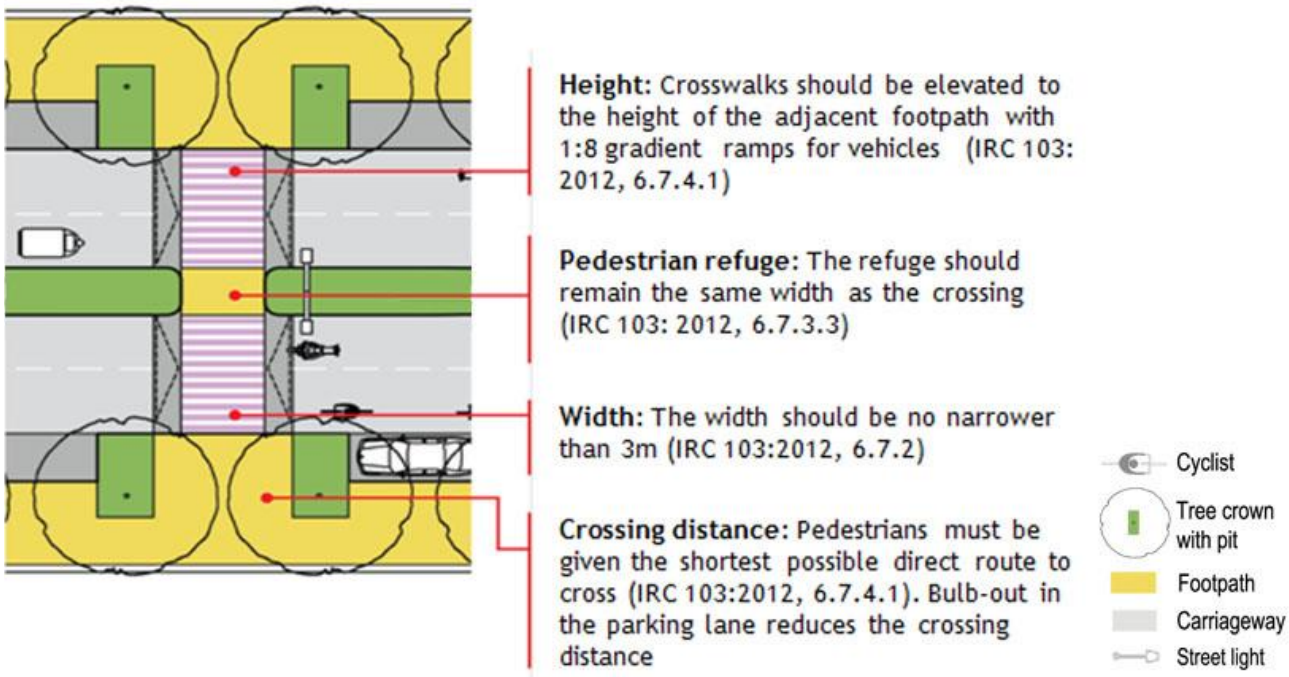

Fig. 13 Raised Pedestrian Crossing

11 ON-STREET PARKING

11.1 Design Consideration

The provision of on-street parking shall follow the below guidelines and standards.

- On-street parking shall be provided after providing sufficient pedestrian, non-motorized vehicles, public transport and other facilities.
- On-street parking shall be provided as per following hierarchy as shown below:

First Non-motorized vehicle parking (cycle)

Non-motorized intermediate public transport vehicle stand up and drop off areas (cycle rickshaws)

Motorized IPT vehicle stand and pick-up and drop off areas (3- and 4-wheelers such as auto rickshaws and taxis)

Freight loading/unloading areas

Personal motor vehicle parking (2-wheelers)

Last Personal motor vehicles parking (4-wheelers)

- The following criteria must be taken into account for determining location of on-street parking slots:
    - On large streets with dedicated transit corridors (including arterial streets in cities), parking, loading & unloading activities must usually be restricted.
    - All parking slots must be defined through physical means such as kerbs, paving and road markings.
    - Parking bays should not be continuous, so as to prevent through driving. Parking bays should be interrupted by bulb-outs, tree pits and other street amenities. Frequent at-grade pedestrian crossings must be provided in accordance with IRC:103.
    - Parking bays can be located along the kerb so as to protect cycle tracks from high-speed vehicular traffic. In such cases, a buffer of 0.5 m must be provided between cycle tracks and the parking.
    - Parking bays should not have guard rails or other features that might prevent direct access to footpath from parking slots or the street.
- Parking slots should not be allocated at the following locations:
    - Roads designated as non-motorized transport-only zones, and greenways.
    - In front of property entrances. A plot must avoid having more than one vehicular entry and one exit of maximum width of 3 m each.
    - Within or under structures such as bridges, tunnels and underpasses.
    - Parking should not be allowed within 5 m before and after the crosswalk and bus stops.
    - In addition to physical design of streets, cities can designate additional streets/locations where parking for different vehicle types can be prohibited, to give priority to sustainable transport modes.
- Parallel parking should be preferred with a priority for non-motorized vehicles, motorized intermediate public transport, freight vehicles, personal two-wheelers and personal four wheelers.
- Parallel parking configuration, where vehicles are parked parallel to the kerb, must be preferred over angular and perpendicular parking configurations for all three-wheeled and four-wheeled vehicles including motor cars, Light Commercial Vehicles (LCV), buses and trucks. Angular and perpendicular parking occupy a large portion of the right-of-way. Exiting angular and perpendicular parking bays can be dangerous because drivers have limited visibility. Perpendicular parking configuration must be preferred for motorized two-wheelers as well as bicycles.

For details please refer to IRC:SP:12 “Guidelines for Parking Facilities in Urban Roads”.

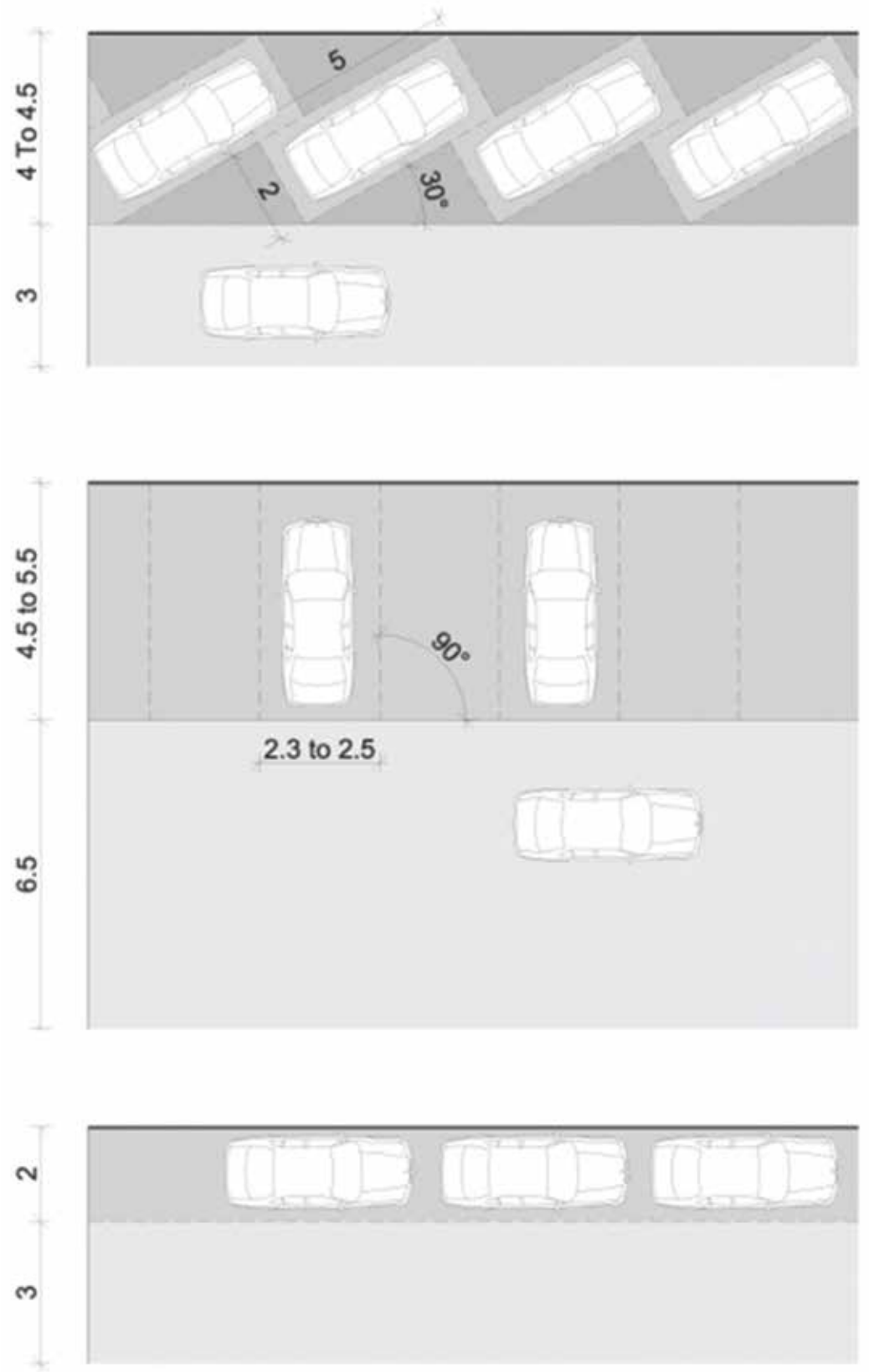

Fig. 14 Parallel Parking is Preferred for all 3 and 4 - Wheelers

12 INTERSECTIONS

Intersection design involves weighing the potentially conflicting goals of safety and vehicle throughput. Intersections, rather than the standard section of a street, are the limiting factor in vehicle capacity. Therefore, intersection design needs to take into account the impact of design choices on mobility. It may be desirable to design an intersection in such a way that prioritises throughput of public transport, cycles, and pedestrians. Intersection design involves a number of factors:

12.1 Turning Radius

The concept of the turning radius is relevant in the context of designing street corners. Smaller turning radii increase pedestrian and non-motorized transport safety by slowing down vehicles and enabling them to see pedestrians and cyclists. Larger vehicles require more space in order to take a turn, so intersection designs need to take into account the size of vehicles that are expected to pass through an intersection. Turning radii at intersections of arterial, sub-arterial and collector streets shall not exceed 9 m. The turning radii at intersections with local streets shall not exceed 4 m.

12.2 Left Turn Pockets

Left turn pockets or slip lanes are generally designed as signal free turns and compromise pedestrian safety. Existing slip lanes should have table top crossings or a signal to provide a safe crossing opportunity for pedestrians.

12.3 Refuge Islands and Medians

Pedestrian refuge islands separate conflicts so that pedestrians can judge whether it is safe to cross by looking at and analysing fewer travel lanes and directions of traffic at a time. Tall, bushy plants should be avoided in medians because they obstruct pedestrian visibility. In the case of triangular islands adjacent to free left turn lanes, the island should serve as a refuge for pedestrians and remove landscaping and fencing, if required.

12.4 Levels

The level of the carriageway at intersections and pedestrian crossings can be raised to that of the footpath or cycle track in order to improve safety and convenience for pedestrians. Vehicles from all directions pass over a ramp as they enter the intersection, causing them to slow down. As pedestrians pass from the footpath over the intersection to the footpath on the opposite side, they remain at the same level. In general, unsignalized intersections should be raised or accompanied with speed humps since pedestrian safety is not ensured by any other means. Signalised intersections can be raised if warranted by safety concerns. If signals operate only during peak hours, a level difference ensures safety when the signals are not operating. If raising the intersection prevents adequate vehicle throughput, then ramps should be installed at least on left turn pockets.

12.5 Crosswalks

Crosswalks delineate an area that is reserved for pedestrian movement while perpendicular traffic is stopped. They should only be marked where vehicles are required to stop, such as at signalled intersections. At unsignalized intersections, painted crosswalks do not necessarily improve pedestrian safety unless accompanied by a physical measure such as a speed bump or speed table. The stop lines for vehicles should be located prior to this crossing area. Since many drivers do not respect painted markings, stop lines require vigilant enforcement if the crosswalk is to remain free of queuing vehicles.

12.5.1 *Pedestrian Crossings*

- At unsignalized intersections, raised crossings shall be provided to ensure pedestrians can cross safely. They shall be elevated to the level of the adjacent footpath, with ramps for motor vehicles with a slope of 1:8.
- Smaller turning radii increase pedestrian safety by reducing vehicle speeds. Turning radii at intersections shall not exceed 4 m on non bus-route roads, and 9 m on bus-route roads.
- Pedestrian crossings will be located in alignment with pedestrian desired line- pedestrian travel path.

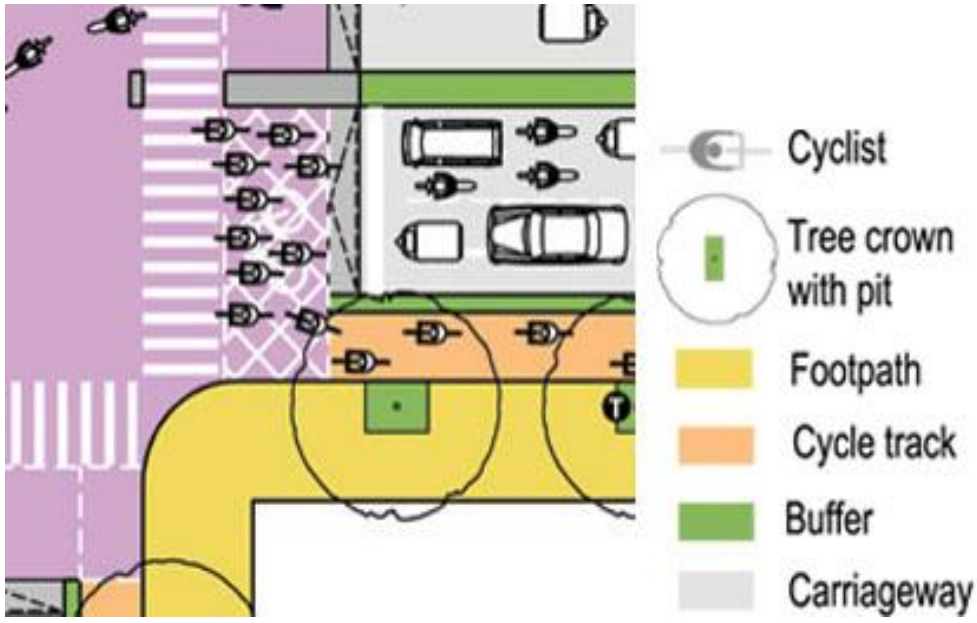

Fig. 15 A Bicycle Box Allows Right-Turning Cyclists to Queue Ahead of Mixed Traffic

12.6 Bicycle Box

Bicycle Boxes may be considered for cyclists at intersections. They typically provide a space for right turning cyclists to wait at a signal ahead of mixed traffic. When the light turns green, cycles start their turning movements first, and motor vehicles follow immediately behind. Cyclists using a bicycle box have better visibility since they are the first road users to move into the intersection. This feature makes it possible to send them along with main traffic

in a single signal phase instead of adding exclusive cycle phases or requiring cyclists to make right turns in two stages with straight-bound motor vehicles. Bicycle boxes also give an advantage to through cyclists who might be cut off by aggressive left turning motorists. Bicycle boxes should be at least 3 m deep to accommodate one row of cyclists. IRC:11 could be further referred for intersection facilities for cyclists. Cyclist crossings must be marked in accordance with IRC:35.

12.7 Bollards

Bollards help define refuge islands and other pedestrian spaces and prevent vehicles from driving over these spaces. Bollards are especially helpful when a pedestrian area is at the same level as the surrounding road surface. Possible shapes range from slender posts to larger and heavier obstacles that can double as seats. A minimum width of 1.2 m is required for the passage of wheelchairs and to be identifiable by using contrasting colours.

12.8 Signal Phasing

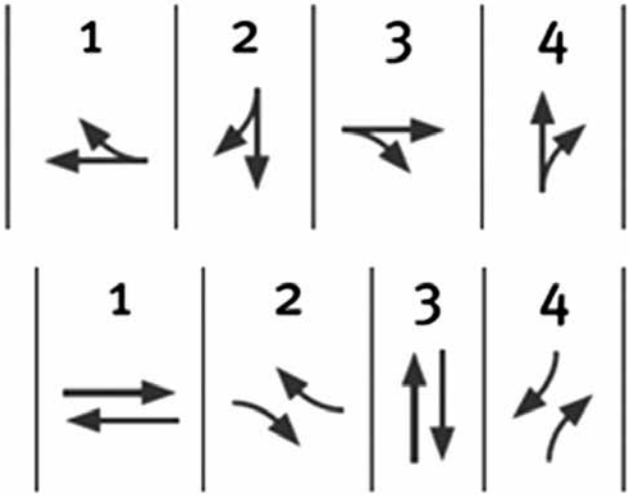

Fig. 16 Signal Phasing Options for a Typical Four Arm Intersection

The physical layout of an intersection must be designed in conjunction with the signal phasing. There are generally several possible sequences of signal phases. The optimal phasing design is determined by the relative volumes of the various movements taking place at an intersection. Phasing sequences ensure that the final vehicles from each phase are in a different part of the junction from the starting vehicles in the next phase. The simplification of signal cycles through the elimination of turning movements can help reduce delay at intersections, particularly along BRT corridors. **Fig. 16** shows the two possible signal phasing options for a typical four arm intersection alternately combine or separate the right turning and straight movements.

12.9 Queuing Space

The carriageway can be widened at intersections to provide additional queuing space for vehicles, which reduces overall signal time. Where the additional space is provided, the

road's cross section usually becomes asymmetrical. Even if the regular street section is symmetrical—in order to claim the additional space, space from both sides of the cross section should be carved out evenly instead of eating deeply into the pedestrian/cycle space only on one side. The number of straight bound lanes entering an intersection should not be greater than the number of outgoing lanes in the same direction. Otherwise, the intersection may become congested as vehicles try to merge into the narrower outgoing carriageway.

12.10 Roundabouts

12.10.1 *Unsignalized Roundabout*

In unsignalized intersections, a roundabout can improve safety by consolidating intersection movements and reducing speeds. Roundabouts also simplify the conflict associated with right turns, which are a major cause of intersection crashes. In small intersections, the roundabout itself as well as the islands in the centre of the four street arms may be constructed with truck aprons that are surmountable by trucks and buses but not by cars and two-wheelers. Such a design accommodates the larger turning radius of heavy vehicles while maintaining a smaller turning radius for other vehicles.

12.10.2 *Signalised Roundabout - Squareabout*

Squareabouts are a special kind of a roundabout, which manage right-turning traffic at large intersections while minimising signal cycle time. Squareabouts make the right-turn phase obsolete by creating right-turn queuing space within the intersection itself. Vehicles queue in this space during one phase and exit during the next phase. Squareabouts are a valuable option on bus rapid transit corridors. While the bus rapid transitwould require the addition of extra phases to a typical four-phase signal cycle, the squareabout accommodates all turning movements in only two phases. Squareabouts only work where the amount of right turning traffic can be accommodated in the right turn queuing space.

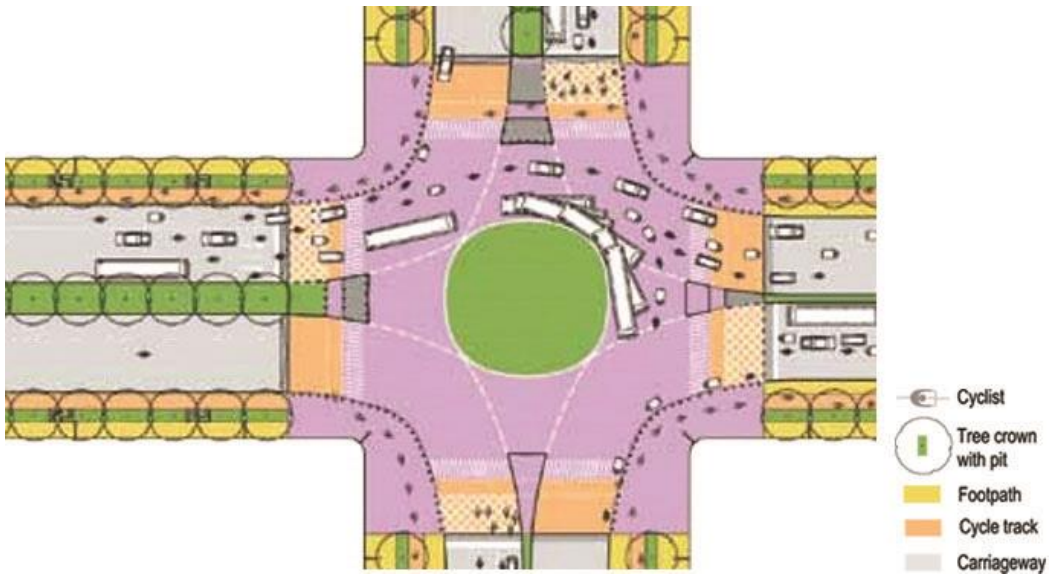

Fig. 17 Squareabout

12.11 Rotaries

- Rotaries are designed to keep traffic flowing at high speeds.
- High speeds and traffic volumes can cause traffic lockups in the circle.
- They are not recommended as they induce high conflicts and result in accidents due to high speeds.
- They discourage pedestrian crossing due to large diameter.
- They are not preferred and are replaced by roundabouts which provide greater vehicular and pedestrian safety.

13 REGULATION AND MANAGEMENT OF TRAFFIC

13.1 Avoiding Penetration of Through Traffic

The movement of through traffic in cities can be addressed in multiple ways.

- By-pass roads can be created to divert through traffic, which might currently congest existing city roads.
- Further, in areas with high density of pedestrians and public transport commuters, private motorized vehicle access can be prohibited by creating non-motorized transport only, public transport-non-motorized transport streets or zones. This shall be achieved through physical barriers or by financial incentives and disincentives.
- Personal motor vehicle access can also be regulated through on-street parking management to reduce congestion, prevent encroachment of footpaths and non-motorized vehicle infrastructure.
- Non-motorized traffic-public transport only streets/zones: Certain streets or zones such as feeder streets to mass transit stations can permit only pedestrian, non-motorized vehicles and public transport access and prohibit personal motor vehicles. Such streets and zones need to be identified based on the amount of non-motorized traffic and the need for access by and through movement of public transport modes.
- Most vehicle restrictions are implemented by local or regional governments, often as part of a revitalization program or neighborhood traffic management plan, or during a period of exceptional traffic congestion or pollution. In addition to earmarking these streets or zones for managing traffic, it is very important that these be enforced by traffic police or other assigned personnels for its success. The infrastructure provided must be well maintained to attract more people to public and non-motorized transport for long term sustainability.

13.2 Congestion Charging/Road Pricing

- Congestion charging is a type of road fee, which levies charges on personal motor vehicles for the use of roads under conditions of congestion and otherwise. The objective is to restrict the use of personal motor vehicles in congested areas.

- This applies only to vehicles that cause higher congestion –personal motor vehicles and not to non-motorized vehicles. A congestion charge may apply over and above other road tolls levied.
- Congestion charging is levied on vehicles entering into central business districts. This can either be generally applicable or linked to times of peak traffic in the area. The vehicle drivers concerned need to have passes or need to pay the charge at entry points into the area.
- Congestion charging aims to reduce traffic to optimal volumes and can be achieved by variable pricing depending on demand, instead of a fixed pricing schedule. However, the rates should be high enough in all cases for it to work as a disincentive for a good number of private motorized vehicles users. Similarly, parking prices can also be hiked in the event of 'parking congestion' during peak demand or otherwise.
- This calls for investing in technology-enabled monitoring and decision support systems to guide a dynamic and data-driven travel demand management approach.

13.3 Public Parking Management

Along with road design and investments in sustainable transport, cities must implement a robust parking management system with the following features:

- Features parking design that
  - Rationalises available parking slots on streets, allowing parking only in those areas where parking activities do not affect movement of pedestrians, cyclists, and public transport users.
  - Does not increase supply of parking.
- Features dynamic pricing systems that
  - Reduces demand for parking by using fee structures that vary with parking demand.
  - Maximises turnover and enables economic vibrancy, by prioritising short term parking over long term parking, and by actively discouraging long term parking.
  - Optimises utilisation of available parking spaces, by increasing turnover of each available space.
- Use of information-technology (IT) systems for parking operations that
  - Supports effective management.
  - Provides real time monitoring that enables data-driven decision making.
  - Reduces revenue leakage, and helps ensure transparency.
  - Helps in better enforcement.
- Features robust user information systems (signages, customer portals etc.) that
  - Clarifies parking rules to users.

  - Provides high quality customer service for payment of parking fees and fines.
  - Communicates benefits of the systems and its impact.
- Generates revenue for cities to support sustainable transport improvements.

Implementing such a system involves the following:

13.3.1 *Defining Parking Districts*

Cities must adopt a zone-based approach to minimise spill over parking from high-priced areas. Cities must be sub-divided into multiple parking districts, based on existing administrative boundaries (such as wards or zones) or level of public transport access. A parking district will be the main unit for administering parking regulations and management.

Each parking district must comprise the entire street network within the area — including streets with no parking, paid parking, and unpaid parking — as well as any paid or unpaid off-street parking. The management of on-street as well as off-street parking in each district may be managed by a single parking service provider.

Each stretch of a street between two intersections, called a block face, would be the smallest unit of parking management within each parking district. Different block faces within a parking district may have different parking rates and rules. A block face can be designated either as paid parking, unpaid parking, or no-parking areas (which must be monitored to ensure no parking occurs).

13.3.2 *Assessing Public Parking Facilities in each Parking District*

Cities must conduct a comprehensive audit of all public parking facilities, both on-street and off-street, to understand existing parking supply and demand. While cities can also assess off-street private parking facilities, guidance on management of private off-street parking is beyond the scope of this guideline. The audit can help the city identify those parking districts where parking management must be prioritised, define guidelines for setting parking prices and rules etc.

- Cities must determine parking supply, by creating a complete inventory of the public parking supply for each parking district, determine occupancy levels of existing parking facilities, and assess turnover rates for these facilities.
- Cities must use the Equivalent Car Space (ECS) factor and dimensions for determining on-street parking facilities.

13.3.3 *Enforcement*

Parking violations can be categorised into two primary types — non-payment of parking fees and parking in a no-parking zone. Enforcement activities must address both types of violations.

- To ensure effective implementation of parking rules, parking service provider must manage parking enforcement in coordination with the Traffic Police. Cities may strengthen existing system or outsource parking enforcement activities to the parking service provider. In such a case, the service provider

can enlist enforcement officers to monitor parking violations through regular random spot checks or other means of enforcement selected by the city. The service provider can be paid a fee for registering an offense and clamping or towing the vehicle on behalf of the Traffic Police.

- All parking violations must be recorded and monitored from the central control centre set up at the city-level.
- Cities must identify vehicle impound yards within each parking district, where towed vehicles can be stored until the vehicle is released on payment of fine by the user. Enforcement officers of the service provider must not be authorized to directly collect fines.

13.3.4 *Real-time Monitoring of Parking Events*

Cities must set up a control centre to monitor parking operations in real-time. All details related to parking events must be recorded in the control centre. These can include parking start time, parking end time, registration number and time of vehicle parked in the parking slot, location, fee amount collected etc.

The control centre must also provide real time assessment of number or vehicles parking on each block face and in each parking district, as well as details on enforcement for the activities of enforcement staff such as assigned itinerary, actual path taken, details of vehicles checked, and details of vehicles immobilized.

13.3.5 *Public Information*

In addition to parking payment systems mentioned, cities must put in place effective publicr information systems to inform on various aspects of parking. This can primarily be in the form of parking website along with supporting mobile applications and social media platforms. These platforms

- Must provide real-time information on parking occupancy and parking fee levels at all on-and-off-street paid parking locations covered by the parking management system.
- Include 'How-to' guides on using the parking system, setting up user accounts, fee payment, and fine payment.
- Can include regular blog posts and articles with news about fee structures, changes in parking rules so as to encourage compliance with parking rules in the city.

13.3.6 *Monitoring Parking Management Systems*

Cities must adopt different metrics to

- Monitor impact of parking management systems and guide planning decisions.
- Oversee parking operations of the service provider.
- Optimise systems costs and revenue, and
- Assess user satisfaction.

Examples of such metrics include

- Average turnover per parking slot for different time periods (such as per peak or non-peak periods, day of the week or month).
- Average parking duration.
- Number of parking spaces per enforcement officer.
- Compliance with parking rules, i.e. reduction in unauthorised or illegal parking, parking fines issued etc.
- Revenue generated from parking fees, enforcement, and advertisement.
- Capital, operational and management costs of the parking management system, etc.

13.3.7 *Reclaiming Underused Parking Slots for Walking, Cycling and Public Transport*

Robust parking management systems, coupled with improvements in sustainable transport, may help shift users from personal motor vehicles to sustainable transport modes, or into off-street parking facilities. This may result in reduced demand for on-street parking facilities.

Cities can use street space freed up from parking to build better streets featuring cycle lanes, footpaths, public spaces and other public amenities. Such public space improvements can not only minimise traffic congestion, but also help cities demonstrate impact of efficient parking management system in improving quality of life in the parking district.

13.4 Management of Urban Freight

In scenarios where freight vehicles enter the city for loading and unloading of goods, the vehicles must be permitted to enter during non-peak hours i.e. during early morning or late-night hours. Light Commercial Vehicles (LCVs) or smaller trucks/carriers can be used for lower volume of goods to reduce pollution and congestion. Similarly, heavy commercial vehicles can be prohibited in certain types of roads, especially narrow ones.

13.5 One-way Streets

The goals for one-way roads should be carefully reviewed, and may be created to accommodate rapid transit (such as bus rapid transit) corridors or pedestrian zones and in mixed-use districts with heavy footfalls. One-way roads can also be created to improve capacity of motorized vehicles. However, it may result in longer trip distances, higher vehicle speeds and also make it difficult for new drivers to navigate who are not familiar with the locality. In such cases, signalized pedestrian and cyclist crossings and traffic signage shall be considered to enable safe crossing and inform drivers. One-way streets should not result in a carriageway of more than three lanes of lane widths ranging from 3.0 m to 3.5 m.

Further, couplets with two-phase signalling can be created when a parallel street at a close distance of 150-200 m is available. Where one-way streets or couplets are sanctioned, two-way movement for non-motorized transport modes must be provided. However, violations such as contra flow movement may be expected. To address the same, strict enforcement measures may be necessary.

13.6 Restriction of Animal-drawn Vehicles

If space is unavailable, animal drawn vehicles may be prohibited along major mobility corridors during peak hours. Such measures should be determined based on local conditions. Human powered vehicles must be excluded from such a regulation.

13.7 Traffic Restriction during Temporary Events

Special Event Transport Management encourages the use of alternative travel modes to occasional events that draw large crowds, such as festivals, games and fairs. Such plans can reduce traffic and parking problems, improve safety and security and improve transportation options, particularly for non-drivers. Provisions for effective continuity of accessible circulation paths for pedestrians should be incorporated in temporary traffic management plan where existing pedestrian routes are blocked or detoured. The information should be provided about alternative routes that are usable by pedestrians with disabilities, particularly those who have visual disabilities. Before any new detour or temporary route is opened to traffic, all necessary signs shall be in place.

Access to temporary bus stops, reasonably safe travel across intersections with accessible pedestrian signals, and other routing issues should be considered where temporary pedestrian routes are channelized. Barriers and channelizing devices that are detectable by people with visual disabilities should be provided.

13.8 Traffic Management around Construction Zones

Work Zones Traffic Management Plans (WTMPs) should be created during construction of roads, mass rapid transit and road widening projects to ensure that there is safe movement for pedestrians and non-motorized vehicles and they are not exposed to motor vehicles. While designing the WTMP, care needs to be taken so that anyone coming along the road or the footpath from any direction understands exactly what is happening and what is expected of him/her. The details on road safety and traffic management around construction zones is elaborated in IRC:SP:55.

- Provisions should be made for the safe operation of work, particularly on high-volume roads ensuring safety to all road users and workers.
- Bicyclists and pedestrians, including those with disabilities, should be provided with access and safe passage through the work zones.
- Roadway occupancy (i.e. using the roadway for construction activities) should be scheduled during off-peak hours, and if necessary, night work should be considered after carefully assessing its pros and cons.
- Road users and worker safety and accessibility in work zones should be an integral and high-priority element of every project, from planning through design and construction.
- Appropriate traffic management practices shall be implemented as mentioned in IRC:SP:55 to regulate vehicular traffic and ensure workers' safety.

- Early coordination with officials having jurisdiction over the affected cross streets, and those providing emergency services, should take place before roadway or side street closings.
- Special plan preparation and coordination with transit, other highway agencies, law enforcement and other emergency units, utilities, schools, and railways are needed for reducing unexpected and unusual road users' resistance.
- Special attention may be needed to regulate and control heavy commercial vehicle traffic in the work zones.
- Appropriate warning, delineation, and channelization will ensure that road users have a good understanding of what is happening and what is expected of them-minimizing the chance of errors.
- Required appropriate warning, delineation, and channelization should be provided to assist in guiding road users in advance of and through the work zone by using proper pavement marking, signing, or other devices that are effective under varying conditions. Providing information that is in usable formats by pedestrians with visual disabilities should also be considered and provided for. Appropriate signages shall be provided in accordance with IRC:67.

Photo 8 Testing of a Proposed Intersection Design in Coimbatore

13.9 Test on Site

- Before retrofitting existing right of way or intersection as per proposed design, it is recommended to test the proposed design to ensure that it responds to on-site conditions and renders safety to all users.

- Concept proposals should be marked on the road using chalk, traffic cones, and other temporary means and tested for functionality. Necessary instructions, barricades and signages shall be put in accordance with IRC:SP:55 and IRC:67.
- In case any aspect of design is not compatible, the design must be modified as per site conditions. Detailed drawings must be prepared only after the concerned authority or street design cell approves the concept plans.

14 ROAD SIGNS AND MARKINGS

14.1 Road Signs

The purpose of road signs is to promote road safety and efficiency by facilitating orderly movement of all road users. Road signs notify road users of regulations and provide warning and guidance needed for safe, uniform and efficient operation. Road signs are broadly classified into mandatory, warning and informatory signs. Road signs should be followed as per the guidelines and specifications laid down in IRC:67 for graphics, dimensions, placement of signs, colour, material, font size and visibility. Some of the guiding principles are outlined below:

- Stop, give way and prohibition signs for certain vehicles should be placed wherever required.
- Signs indicating appropriate speed limits shall be placed depending on different street typologies.
- Parking signs for different vehicles shall be placed at designated locations and signs should also indicate no parking zones or locations.
- Signs for dedicated taxi stands, auto rickshaw stands and bus stops should be placed.
- Signs indicating loading and unloading bays for freight vehicles should be placed.
- Appropriate road signs for pedestrians indicating crossings, public amenities and information panels showing directions etc. should be placed.
- Various caution signs that indicate prohibition of overtaking, sharp turns, landslides etc. should be placed.
- Necessary signs indicating road construction work or temporary events shall be placed to direct pedestrians and vehicles.

14.2 Road Markings

Road markings are lines, patterns, words or other devices that are applied or painted on the carriageway or kerbs or to objects within or adjacent to the carriageway for controlling, warning, guiding and informing users. All road markings applied or painted on the carriageway should follow the guidelines and specifications laid down under IRC:35 with respect to design graphics, dimensions, font size, colour and material. Some of the guiding principles are

outlined below:

- Painted bus lanes shall be clearly separated with 250 mm thick white line. Also 'BUS LANE' should be written on the bus lane carriageway at its commencement and repeated after each junction. Where junctions are 300 m apart, it should repeat at regular intervals of 150 m.
- Painted bicycle lanes shall be separated from motor vehicle lanes with a 150 mm thick white solid line. The cycle symbol should be marked on cycle lanes as specified under IRC:35.
- At intersections, markings indicating stop line, pedestrian crossing, cyclist crossing, directional arrows, junction marking, diagonal lines and chevron should be applied.
- Markings indicating parking, prohibition of parking, bus stops and intermediate para transit stand such as taxi and auto rickshaw stands should be clearly applied.

15 LEGISLATIVE MEASURES

15.1 Rule to Promote Pedestrian Movement on Footpaths

- Footpaths should be designed to accommodate dead zone, clear walking zone and multi-functional zone.
- Rules should be created to provide dedicated vending areas in the multi-functional zone of the footpath, prohibit extensions by abutting shops and parking on the footpaths.

15.2 Rules concerning Bicycles

Bicycles form a large portion of urban traffic in the country. The Motor Vehicle Act (Amendment) Bill, 2017 (Draft) states that:

- Cyclists should use the cycle tracks wherever they are provided.
- A cyclist shall abide by the regulations drafted by the National Authority specifying the protective gear requirements including types of helmets, reflector material and jackets, required for protection to cyclists from death or injury in the event of a crash.

Additionally, legislative measures should recommend the following:

- Cyclists should not ride on footpaths. On shared pedestrian and non-motorized transport streets, cyclists shall take care of the pedestrians especially children, older or disabled people, and allow them plenty of room. They should be prepared to slow down and stop if necessary.
- Cyclists should not ride under the influence of alcohol and drugs including medicine.
- Cyclists must not cross the stop line when the traffic lights are red.

15.3 Rules concerning Speed of Vehicles

- The Motor Vehicles Act, 1988 states that no individual shall exceed the maximum speed determined for the vehicle under the act or under any law that is in force. This maximum speed shall in no case exceed beyond the maximum determined for motor vehicles by the Central Government by notification in the official gazette.
- The State Government can determine or restrict the traffic speed if it is in the interest of public safety or convenience or because of the nature of road or bridge, by notification in the official gazette. It can also place and erect traffic signals at suitable places if needed for safety and accessibility.

Additionally, legislative measures should recommend the following:

- The speed limits indicated in **Table 5** are recommended as a measure of safety on urban roads under mixed traffic conditions. These are only for guidance and the actual limits may be imposed after duly considering all relevant conditions including percentage of mixed traffic.

Table 5 Speed Limits for Different Types of Vehicles Under Mixed Traffic Conditions

Different categories of roads and streets	Speed limits in kilometres per hour	
	Light and Medium Vehicles	Heavy Vehicles
Arterial & Sub-Arterial roads	50	40
Road stretches within 100 m of land uses with high pedestrian foot fall such as mass transit stations, hospitals, universities, markets etc.	20	20

15.4 Rules concerning Parking of Vehicles

The Motor Vehicles Act, 1988, states that the State Government can plan and determine zones for vehicle parking, loading/unloading zones for urban freight and other utility vehicles. Apart from parking charges, it shall also decide the time duration for parking if needed, in consultation with urban local bodies.

Additionally, legislative measures should recommend the following:

- The Traffic Police should ensure that footpaths, cycle tracks, and other non-motorized transport facilities remain free of encroachment by parked vehicles.

15.5 Rules concerning Motor Cycles and Scooters

The Motor Vehicle Act (Amendment) Bill, 2017 (Draft) states that:

- Motor cycles shall abide by the regulations drafted by the National Authority specifying the protective gear requirements including types of helmets,

reflector material and jackets, required for protection to motor cyclists from death or injury in the event of a crash.

- Fines for not following road safety and traffic regulations and carrying excess passengers shall be levied as specified.
- Motor cyclists shall not ride under the influence of alcohol and drugs including medicines or under any disability.
- The driver of a motor vehicle in any public place shall, on demand by any police officer in uniform, produce licence for examination.

Additionally, legislative measures should recommend the following:

- Motor cycles and scooters shall in no case ride on pedestrian walkways, non-motorized vehicle tracks, lanes, bus lanes and bus ways.

15.6 Rules concerning Loading and Unloading of Commercial Goods Transport Vehicles

Following measures could be enforced to regulate loading and unloading by commercial vehicles:

- Vehicles are parked parallel to the kerb for the purpose of loading and unloading.
- The loading and unloading shall not be permitted –
  - At and within 50 m of an intersection
  - On a pedestrian crossing or within 6 m on either side of it
  - At turnings and entrances and driveways of properties
  - On footpaths and cycle tracks
  - Within 20 m of a bus stop

15.7 Rules governing Carrying of Long Pipes, Iron Rods etc.

The Motor Vehicle Act (Amendment) Bill, 2017 (Draft) states that:

- Long pipes, protruding iron rods and structural member have proven to be dangerous to road users and often pose hindrance to the users. Motor vehicles carrying iron pipes, iron roads and other structural members that protrude out of the vehicle body shall be prohibited.
- A driver observed violating this rule shall be liable to pay a fine as specified unless exempted by the competent authority authorised by the State Government or the Central Government.

15.8 Rules concerning Handcarts

The following rules governing the use of handcarts could be helpful:

- Handcarts may be restricted along major mobility corridors during peak hours. Such measures should be determined based on local conditions.

- Goods on the handcarts shall be handled such that they do not impede pedestrian and traffic flow.
- Pushing carts on elevated roads shall be avoided.
- Handcarts shall not be kept unattended which shall cause inconvenience to pedestrians and vehicular traffic.
- Load on the handcart shall not exceed the permissible limits. If load exceeds 225 kg, two attendants shall be provided and in case of load more than 500 kg, pneumatic tyres and efficient brakes shall be provided.

15.9 Rules governing Animal Drawn Vehicles

The following rules governing the use of animal drawn vehicles could be helpful:

- Use of animal drawn vehicles for purpose of transportation of timber or metals like iron rods and girders or other articles exceeding the length of the carts be provided with red flags to prevent obstruction to traffic or inconvenience to other road users.
- Proper signages need to be put up near the commercial markets and roads prone to traffic jams where animal driven carts are generally used for transportation.
- Animal drawn vehicles may be restricted along major mobility corridors during peak hours. Such measures should be determined based on local conditions.
- The load shall not cause over burdening of animals.

15.10 Enforcement

The Motor Vehicle Act (Amendment) Bill, 2017 (Draft) states that:

- The Central Government shall make rules, design, construction and maintenance standards for national highways whereas the state government shall make standards for roads other than national highways.
- Any designated authority, contractor or consultant responsible for the design, construction or maintenance of the safety standards of the road shall follow standards as prescribed by the Central Government.
- The Central Government shall, by notification in the Official Gazette, constitute a National Road Safety Board. The National Road Safety Board shall advise central government or state governments on all aspects pertaining to road safety and traffic management.

16 ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGIES

- Traffic management includes measures aimed at rerouting, restricting and regulating private motorized vehicles to enable orderly movement of all road users through traffic signals and enforcement.

- Information and communication technology can play a key role in enabling these functions. For example, the easy availability of real time information, Global Positioning Systems (GPS) can help commuters plan their journey based on distance, time and cost. ITS (Intelligent Transport System) is a cost-effective means of increasing the efficiency of the urban transport network, to manage the crisis of congestion in urban areas, reduce the number of crashes and fatalities, improving safety and security of commuters, promoting public transport usage, and efficient management of freight traffic.
- Some of the examples are Wireless Traffic Control System, Real Time Traffic Counting and Monitoring System, Intelligent Parking Lot Management System, Advanced Travelers Information System, Red Violation Detection System, Intelligent Transit Trip Planner and Real Time Route Information etc.
- The system would not only help in management of mixed traffic, but also in enforcement by reducing human errors and loop holes in the system.

17 PUBLIC AWARENESS AND EDUCATION

There is often little connection between the traffic rules that are taught and what people actually observe: transportation regulations may be flouted and violations seldom punished. Public footpaths may be taken over by vendors, homeless people and vehicle parking. Vehicle and fuel taxes may be unpaid. Such problems must be corrected as part of effective mobility management. This requires developing institutional capacity, professional skills and training, adequate pay and modern equipment. The following public awareness campaigns can be undertaken:

- Prepare a communication strategy for successful implementation of urban transport projects and programs.
- Urban local bodies should work with Traffic Police to educate children and adults on the importance of following traffic rules and imparting knowledge to them about basic road safety rules and environmental impacts.
- Carry out a diverse public information campaign to generate widespread support and publicize the individual and social benefits of transport by non-motorized transport and public transport modes. The urban local body will also coordinate non-motorized transport-public transport advocacy and planning through national organisations. While policy impacts are local, interfacing with national bodies can help coordinate local groups with national efforts to fund and promote India-wide non-motorized transport and public transport initiatives.
- Reward successful transportation programs. For example, higher levels of government can provide additional funding to local governments that are successful at achieving traffic management, road safety and emission reduction objectives.

(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the Code/Guidelines/Manual, etc. from the date specified therein)