CHAPTER 4: DESIGN STANDARDS

4.1 GENERAL

Indian roads are under 5 classifications defined by Ministry of Road Transport & Highway (MoRTH). i) National Highway (NH), ii) State Highway (SH), iii) Major District roads (MDR), iv) Other District Roads (ODR) and v) Village Roads (VR). Objectives of setting design standards is to confirm the proposed road with the codes of practice, to gives a clear picture of how the proposed facility would look like once implemented and also to maintain uniformity throughout the corridor to achieve the desired purpose of the facility and to ensure safety and comfort for the road users. Non-uniform or inadequate design standards lead to confusion for the drivers to adapt to the changing road characteristics and cause accidents.

For the present Project, it is proposed to follow Design standards given in Indian Roads Congress (IRC), Tender SURE specifications, codes of practice, guidelines and special publications, as well as applicable MORT&H circulars and reports. Where the said standards are silent for any particular element of design, other standards like, American Association of State Highway and Transport Officials (AASHTO) Standards and Any other National or International Standard as considered suitable shall be referred to and the one considered the best and relevant adopted:

References
Tender SURE guidelines

In India, IRC has recently revised the Engineers Pocketbook for Highway Construction to include classification and definition of urban roads. The classification of urban roads is given in following table 4.1.

Table 4.1 Classification of urban roads

Classification	Width
Arterial	50 to 60m
Sub-Arterial	30 to 40m
Collector Street	20 to 30m
Local Street	10 to 20m

Table 4.2 R-o-W allocation for existing roads

Road Type	R-o-W (M)	Travel Lane	Footpath	Dedicated cycle lane	Parking lane	BRTS Lane
Sub-Local	2	2	---	---	---	---
	3	2	1	---	---	---

Road Type	R-o-W (M)	Travel Lane	Footpath	Dedicated cycle lane	Parking lane	BRTS Lane
	5	3.5	1.5	---	---	---
	6	3	2+1	---	---	---
	7	4.5	1.5+1.0	---	---	---
	7	3.5	1.5+2.0	---	---	---
	8	5	1.5+1.5	---	---	---
	10	3+3	2+2	---	---	---
Local	10	2.5+2.5	1.5+1.5	---	2	---
	12	4+4	2+2	---	---	---
	12	3+3	2+2	---	2	---
	13	3.5+3.5	2+2	---	2	---
	13	2.5+2.5	2+2	---	2+2	---
	15	3.5+3.5	2+2	---	2+2	---
	15	2.5+2.5	2+2	1+1	2+2	---
	18	3+3	2+2	2+2	2+2	---
	18	5+5	2+2	2+2	---	---
Collector	21	6+6	2+2	2	2	---
	21	6+6	2+2	2+2	2 (Alt)	---
	28	6+6	2.5+2.5	2+2	2+2	---
	30	5.5+5.5	3+3	2+2	---	3.5+3.5*
Sub-arterial	33	6.5+6.5	3+3	2+2	---	3.5+3.5*
	34	7+7	3+3	2+2	---	3.5+3.5*
	39	10.5+10.5	2.5+2.5	2+2	---	3.5+3.5*
	40	10.5+10.5	3+3	2+2	---	3.5+3.5
	45	12+12	3+3	2+2	---	3.5+3.5
	46	12.5+12.5	2+2	2+2	2+2	3.5+3.5
	47	12.5+12.5	2.5+2.5	2+2	2+2	3.5+3.5

Road Type	R-o-W (M)	Travel Lane	Footpath	Dedicated cycle lane	Parking lane	BRTS Lane
Arterial	48	11+11	2.5+2.5	2.5+2.5	2+2	3.5+3.5
	48	12.5+12.5	3+3	2+2	2+2	3.5+3.5
	50	12.5+12.5	3+3	2+2	2+2	3.5+3.5
	50	12.5+12.5	3+3	---	2+2	3.5+3.5
	60	17.5+17.5	3+3	2+2	---	3.5+3.5
	80	21.5+21.5	3.5+3.5	2.5+2.5	2+2	3.5+3.5

- *BRT on sub arterial road is an option that can also be utilized as a dedicated bus lane.*
- *Road widths mentioned above are excluding medians.*
- *Travel lane includes service lane.*
- *Alt = Alternative Parking*

4.2 RIGHT OF WAY COMPONENTS

There are five elements specified in the RoW design.

- Footpaths
- Cycle paths
- MRTS lanes
- Traffic Lanes
- On-street parking

References
Tender SURE guidelines

Traffic area includes travel lanes, medians and turn lanes. Planned raised medians divide the traffic in opposite directions. Right turning lanes are located by the centre / median. The traffic area can be extended into the parking / bicycle area when left turning lanes need to be provided.

Table 4.3 Traffic lane width on urban roads

Road Classification (Typical)	Traffic Lane Width	
	Max (m)	Min (m)
Arterial (48m)	3.50	3.00
Sub-Arterial (30m)	3.50	3.00
Collector Street (21m)	3.50	2.75
Local Street (10m)	3.50	2.50

References
Tender SURE guidelines

Level of Services (LOS) of a road depends on the carrying capacity of the road, which is dependent on the efficiency of available travel lanes. If the volume of the traffic on any particular lane increases more than its carrying capacity or the travel lane is not completely available for through traffic, that road offers poor level of service to the traffic flow. The following table gives the relationship between speed of travel and level of service achieved for the different types of urban roads.

Table 4.4 Vehicular Speed based on Level of Service

Road Classification (Typical)	Design Speed (kmph)	Vehicular Speed based on level of Service (kmph)					
		A	B	C	D	E	F
Arterial (48m)	80	80	56	40	32	26	20
Sub-Arterial (30m)	60	60	43	35	24	20	15
Collector Street (21m)	50	50	35	25	20	17	13
Local Street (10m)	30	30	21	15	12	10	8

4.3 GEOMETRIC DESIGN STANDARDS

4.3.1 General

References
IRC: 73-1980
IRC: 38-1988
IRC: 86-1983
AASHTO-Green Book

Design Standards for major features have been extracted from IRC standards conforming to design speeds 80 Kmph and 60 Kmph.

4.3.2 Transition Curves

As per IRC: 86-1983, Geometric Design Standards for Urban Roads, suggests that the length of the transition curve should be the larger of the two values arrived at on the basis of the following criteria:

- Rate of change of centrifugal acceleration; and
- Rate of change of super elevation (not steeper than 1 in 150)

The values given in the IRC Geometric Design Standards for Urban Roads are obtained from the criterion of rate of change of centrifugal acceleration, with a pavement width of 7.50m. The transition lengths so obtained for various radii are presented in Table 4.5. Traffic is diverted well ahead of the construction zone by providing transition lanes and allowed to move in service road till the construction zone ends.

Table 4.5 Transition Length for Design speeds

Radius (m)	Design Speed 30 kmph	Design Speed 50 kmph	Design Speed 60 kmph	Design Speed 80 kmph
30	80			
50	50	NA		
100	25	70	NA	
150	20	45	65	
200	15	35	50	NA
250	NR	30	40	85
300		25	35	75
400		20	25	55
500		NR	20	45
600			20	35
800			NR	30
1000				30

NA – Not Applicable NR – Not Required

4.3.3 Acceleration and Deceleration lanes

Acceleration and decelerations lanes at major junctions and interchanges shall be provided in accordance with IRC: SP: 41-1994 and AASHTO Green Book on Geometric Designs. Acceleration and Deceleration lanes are provided where through traffic in Ring Road is diverted to adjacent service roads.

References
IRC: SP: 41-1994
AASHTO-Green Book

4.3.4 Sight distance at intersection

Sight distance is measured along the major roadway from the center of the entrance lane of the minor roadway to the center of the near approach lane (right or left) of the major roadway.

The intersection sight distance is a major control for the safe operation of roadways. Sight distance at intersection plays very important role, mainly at uncontrolled intersection, so as to provide the driver to cross the intersection without causing delay or accident. The uncontrolled intersection sight distance requires that drivers approaching an uncontrolled intersection on a cross street must have sufficient sight distance across the intersection corners to adjust speeds or stop.

At signalized intersections, the first vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches.

Table 4.6 Safe Stopping Sight Distance at Intersection

Speed (kmph)	SSSD (m)
20	20
25	25
30	30
40	45
50	60
60	80
70	90
80	100

4.4 SEWER/ DRAINAGE, WATER SUPPLY LINES

Sewage lines are to be laid at a substantial depth below grade and ideally located away from water and rainwater drainage network to avoid accidental contaminations.

References
Tender SURE guidelines

Water lines are maintained under pressure and are to be laid away from the road traffic areas so as to avoid damage to the surface due to any leakages.

The recommended depth for a trunk sewer line is 2.0m to 6.0m and a depth of 1.0 to 1.5m for a trunk water line and 0.6m to 1.0m for service water line.

Roads also serve as a channel for rainwater directing it into shoulder drains below the footpath leading to the side drains which then directs the water through culverts below the road surface and then onto the main storm water drains.

An effective drainage system shall be planned for the drainage of roadway. The following types of drains shall be provided for surface drainage of roadway and ROW:

References
IRC: SP: 42-1994
IRC: SP: 50-1999
IRC: 73-1980
IRC: 98-1988

- Longitudinal unlined trapezoidal shape drains at toe lines with outlets at cross-drainage structures in rural sections. The drain size and shape shall be adequate to take design run off, and prevent soil erosion.
- Pucca size stone masonry drains in built-up sections
- Combination of longitudinal drains and chute drains in high embankments of 5m and above.

Side drains are covered to the required width where the main carriageway diverts and joins the service road.

4.5 SAFETY BARRIERS

Temporary Barricades shall be provided on the Inner edges of the roadway where the carriageway diversion starts and adjacent to construction zones. These shall be of metal beam with metal posts.

References
IRC: SP: 44-1994

4.6 TRAFFIC CONTROL DEVICES

Road marking is critical and highly under-valued tool in Indian cities for guiding and controlling traffic on an urban roadway. The markings serve as a psychological barrier and signify the delineation of traffic path and its lateral clearance from traffic hazards for safe movement of traffic.

Pavement edge lines indicate the edges of the carriageway and the limit of the traffic lane. The edge line is indicated as a single continuous line placed about 15cm from the edge. The width of the line is 15-20cm. Road Markings Standards and Road Signs Standards shall be as per IRC: 35-1997 and IRC: 67-2001 respectively.

4.7 PUBLIC TRANSPORT LANES

Provisioning for mass transit and regular public transit should be made in the planning stage in terms of space availability. The related infrastructure can be provided when required. Mass rapid transit could be bus, light rail or heavy rail systems.

References
Tender SURE guidelines

Metro Rail System or MRTS is a passenger railway in an urban area with a high capacity and frequency, and grade separation from other traffic.

Light Rail Transit System or LRTS is an electric short rail system operating with single cars at grade on streets with exclusive RoW lane, below grade in subways, or above grade structures. They cater to mid to high commuter volumes.

Bus Rapid Transit System or BRTS is a team applied to a rapid public transportation system using buses to provide faster, more efficient service than an ordinary bus line, but with service quality of a rail system. Due to high speed achieved by this system, it is provided close to the median. Space required is 3.5m per lane on either side of the median.

Local Bus Routes: A local bus transit operates on fixed routes and schedules and in most Indian cities is the only transit option available.

The lay out for Bus stops will be in accordance with IRC: 80-1981. The bus stop structure shall be structurally safe, aesthetically pleasing and functional so as to protect the waiting passengers from sun, rain and

References
IRC: 80-1981

wind. Adequate drainage shall be provided at bus stops and bus bays.

Table 4.7 Recommended distances between various elements of public transport system for a commuter access

Public Transport Matrix								
Road Type	**Bus Stops**	**Bus Bays**	**Transit Hubs**	**Feeder Bus Stop**	**Bus Rapid Transit**	**Mass Rapid Transit**	**Trip Planners**	**Route Maps**
Arterial	500 m	2 Km	4.7 Sq Km		1-1.5 Km	2 km	Every Bus Stop	Every Bus Stop
Sub-Arterial	500 m			500m	1-1.5 Km	3 km		
Collector	400 m			300 - 400 m				
Local				300 - 400 m				

Bus stop locations & clearance lengths:

Near side: Just before an intersection – clearance of **35m**

Far side: just after an intersection – clearance of **42m**

Mid block: between two intersections – clearance of **25m**

4.8 PARKING

With more and bigger cars on urban roads every day, the impact is not just on traffic movement, but on street congestion that hampers pedestrian movement and access to dwellings. The issue of parking is reaching alarming proportions.

Considerations for provision of parking types:

Free public parking: Residents obtain permits, and visitors have off-peak parking.

Paid Public Parking: In designated areas and streets, around transit stops and high traffic destinations.

Paid Private Parking: Through PPPs using hi-tech for multilevel parking, in CBD areas and key high traffic centers, around major rail stops, and where pedestrian use is desirable.

4.9 NON MOTORIZED TRANSPORT (NMT)

Non Motorized Transport (NMT) must be given greater weightage while designing urban mobility. Mobility is allowing people to move from one place to another, safely and conveniently, considering socio-economic conditions, characteristics of the area and accessibility to other modes. Therefore it is important to develop a comprehensive mobility plan that accommodates motorized and non-motorized transport (NMT). Slow moving non-motorized transport modes, like bullock carts, cycle rickshaws and hand drawn carts are not touched upon in Tender SURE.

Footpaths

References
Tender SURE guidelines

Recommended minimum width for pedestrian walkway/footpath and bicycle track is 1.5m. They should have well maintained surface with a cross fall within the range of 2.5 to 3%. Except sub-local 2m and 3m RoW, footpath is provided either side of the road in all scenarios.

Kerb

References
Tender SURE guidelines

Kerb is a key element that divides travel lanes and pedestrian walkway. The main purpose of kerb stone is to protect and strengthen pavement edge, to control drainage, clearly defining the edge to vehicle operators.

Height of a kerb usually varies from 15cm to 25cm. Kerbs are painted with either alternating black and white stripes 500mm wide or chequered black and white design of same width.

Kerbs need to be dropped to facilitate mobility of persons with physical challenge. Footpaths are ramped to the street level along with the kerb ramps. The gradient of the flared side should not be steeper than 1:10. The ramp should not project onto a roadway.

Bicycle Path

References
Tender SURE guidelines

The bicycle is a core mode of urban transport. It is desirable to re-design RoW prioritizing bike lanes in all arterial, sub-arterial and collector roads by narrowing existing travel lanes, removing a travel lane, removing parking and covering drains and extending the footpath.

The minimum width required is 1.5m for one way movement and 2.5m for two way movement. A buffer of 0.5m between the bicycle track and parking area or the travel lane is provided.

Pedestrian Crossing

References
Tender SURE guidelines

Intersections are critical areas of pedestrian congregation and require safe and efficient facilities while ensuring minimum delay to vehicular traffic. Skywalk bridges/foot over bridges forms a very important aspect for overall improvement of transport infrastructure in the city and helps pedestrians to improve their safety and mobility.

Design considerations for pedestrian underpasses, bridges and subways:

References
Tender SURE guidelines

The flow should not normally exceed 20 persons per 300mm width per minute on level or up to 1:20 gradient and 14 persons per 300mm width per minute on stairs or ramps steeper than 1:20. A dead width of 0.75m is usually allowed adjoining any display windows in subway.

The gradients of continuous ramps should not be steeper than 1:10. If a landing is provided at mid-height, a maximum slope of 1:7 can perhaps be allowed. A minimum height of 2.3m and a width of 2.45m should be provided for subways up to about 23m length, and for longer subways the dimensions need to be increased to 2.6m height and width of 2.75m.

In order to overcome the drawbacks of pedestrian subway, the middle portion of the junction may be raised.

4.10 HIGHWAY LANDSCAPING

References
IRC: SP: 21-1979

A dedicated space is provided adjacent to the kerb for landscape elements such as shrubs and flower plants, trees, street furniture such as street bench, trash bins and above grade utility fixtures such as light poles and signage etc. Trees shall be planted in rows and on either side of the road with staggered pitch as per the IRC: SP: 21-1979. Indicative arrangements for plantation of trees shall be in accordance with the MOST Technical Circular No. NHI-41 (34)/69 dated.

4.11 HIGHWAY LIGHTING SYSTEM

References
IS: 1944-1970 (Part-I & II)

Highway lighting shall be provided in urban and semi-urban areas of the project road. IS: 1944 (Part I and II) 1970 shall be followed in regard to lighting installations.

Table 4.8 Standard spacing to be followed for lighting installations

Sl. No	Street Type	Recommended	Spacing (m)	Staging Height (m)
1	Sub-local	Single sided	10	3

Sl. No	Street Type	Recommended	Spacing (m)	Staging Height (m)
2	Local	Single sided	10	6
3	Collector	Staggered/Opposite	15	9
4	Sub-Arterial	Central	30	12
5	Arterial	Central + Opposite	30	12 + 6

4.12 ROAD INTERSECTION

Intersection is a point at which two or more roads cross. This area is designated for movement to turn directions. Overall traffic flow depends on the performance of the intersections.

Variables to be considered for Intersection Design:

- Number of roads converging
- RoW widths of intersecting roads
- Amount of traffic
  - ✓ Traffic < 3000 vehicles/hr – Calming measures
  - ✓ Traffic 3000 – 6000 vehicles/hr – Mini traffic circle or rotary
  - ✓ Traffic 6000 – 8000 vehicles/hr – Signalised intersection
  - ✓ Traffic 10000 & above vehicles/hr – Grade Separators

Traffic calming measures (TCM) on roads – such as changing alignment, introducing barriers, etc. reduce traffic volume/speed. This improves the road safety and livability standards, especially to residential neighborhoods.

Table 4.9 Reduction in Traffic Volume with Traffic Calming Measures (TCM) on roads

Sl. No	Traffic Calming Measures (TCM)	Average % reduction in traffic volume
1	Speed Humps	20
2	Speed Tables	25
3	Traffic Circles	30
4	Narrowing	45
5	Full Closures	60
6	Half Closures	80

7	Diagonal Diverters	90

4.13 PAVEMENT DESIGN

Designs for new pavement and overlays shall be produced in accordance with IRC codes. Generally, the recommendation for rehabilitating the existing pavement depends upon the functional condition, structural condition of the pavement, Subgrade type, Subgrade strength and characteristics. Once the improvement proposals are finalized the pavement composition shall be designed as per IRC: 37:2001.

References
IRC: 37-2001
IRC: 81-1997