Table of Contents

28.06.2018
Version: 10

1. Definitions 3

2. General Planning Principles for Road Network..... 3

3. How to determine Right of Way (ROW)..... 4

4. Carriageway..... 4
   a. Widths
   b. Speeds
   c. Construction
   d. Driveway testing
   e. Maintenance
   f. Drop-off
   g. BRTS considerations
   h. Bus stops
   i. Bicycle lane
   j. Traffic Signs
   k. Road Markings
   l. Speed Breakers

5. Footpaths & Verges 14
   a. Pedestrian throughway
   b. Verges/landscape/Street furniture
   c. Street lighting

6. Intersections 17
   a. Road – Road
   b. Road – Pedestrian/Bicycle

7. Parking 19
   a. Location
   b. Size
   c. Parking charging mechanism e.g. parking meter

8. Signage..... 19
   a. Street signages
   b. Street names.

9. Services 20
   a. List of utilities
   b. Placement of utilities
   c. Prioritization of utilities in placement
   d. Service Crossings
   e. Utility Tunnels
   f. Drainage
   g. Irrigation

10. Other..... 23
   a. Guard Houses

List of Tables

- Table 2.1: Measures to Prioritize Pedestrian/Cyclists..... 3
- Table 2.2: Design Criteria for Different Types of Roads 4
- Table 3.1: Level of Service and Flow conditions 4
- Table 4.1: Traffic Lane Widths for Different Road Types 5
- Table 4.2: Carriageway Widths for On-Street Parking 5
- Table 4.3: Design Speeds based on Levels of Service 6
- Table 4.4: Design Standards based on MSA (traffic loads) and CBR rating (Soil conditions) 9
- Table 4.5: Public Transport for Different Road Types 11
- Table 5.1: General Guidelines for Street Lights 16
- Table 5.2: Guidelines for Street Lights for Different Road Types 16
- Table 6.1: Guidelines for Intersections for Different Road Types 17

List of Figures

- Figure 4.1 : Traffic Lane Markings at Intersections 6
- Figure 4.2: Indicative Plan for a Drop-off Bay for Residential Buildings 10
- Figure 4.3: Bus Lay by 11
- Figure 4.4: Indicative Plan of a Bus Lay bye..... 12
- Figure 5.1: Components of Pedestrian Area 14
- Picture 5.2: Example of Railing to Buffer Pedestrians from Vehicular Traffic 15
- Picture 5.3: Example of Railing to Buffer Pedestrians from Vehicular Traffic 15
- Figure 6.1: Ensuring Pedestrian Safety through Bulb-outs at Intersections 18
- Figure 6.2: Ensuring Pedestrian Safety through Adequate Sight Lines at Intersections 18
- Figure 6.3: Ensuring Cyclist Safety at Intersections 19
- Figure 8.1: Example of a Street Name Plate 19
- Figure 9.1: Indicative Section for Utilities 21

Annexure:

- Annexure 1 - Maintenance of Road Works
- Annexure 2 - Manual of Traffic Signs

1. Definitions

Roads are an integral part of the overall quality of the development and require special focus and attention.

a. Right of Way (ROW): The total land width secured for movement of all users (pedestrians, vehicles, bicyclists) and which make up a typical cross-section between buildings is known as the Right-of-Way and the same is stated in all master-plan / layout plans. Demarcation of the ROW between various users viz. vehicle (carriageway), cycle (bicycling lane), pedestrian (footpath) and trees/street furniture etc. is to be designed.
b. Carriageway: Part of the road used for movement of vehicular traffic – ranges from a single lane to multiple lanes. Can be divided (by a median/railing etc.) or undivided.
c. Pavement: Cross-section of a carriageway indicating different layers in construction.
d. Arterial: A street primarily for through traffic, usually on a continuous route.
e. Sub Arterial: A street primarily for through traffic, usually on a continuous route, but offering somewhat lower level of traffic mobility than the Arterial.
f. Collector: A street for collecting and distributing traffic from and to local streets and also for providing access to Arterial or Sub Arterial streets.
g. Local: A street primarily for access to residence, business or other abutting property.
h. Level of Service (LOS): LOS is a qualitative measure describing traffic operation conditions. Of six levels (A to F), A is the best with free flow condition, while F is the worst with traffic breakdown condition.

2. General Planning Principles for Road Network

a. All the different intended uses with the road (vehicle, pedestrian, bike, plantation etc.) should be distinctly demarcated either through differential heights or different visible material usage.
b. Roads should be prioritized for pedestrians and cyclists (Refer Table 2.1)

	Pedestrians	**Cyclists**
Consider First	Traffic volume reduction	Traffic volume reduction
	Traffic speed reduction	Traffic speed reduction
	Reallocation of road space to pedestrians	Junction treatment, hazard site treatment, traffic management
	Provision of direct at-grade crossings, improved pedestrian routes on existing desire lines	Cycle tracks away from roads
Consider Last	New pedestrian alignment or grade alignment	Conversion of footways/footpaths to adjacent* or shared-use routes for pedestrians and cyclists

Table 2.1: Measures to Prioritize Pedestrian/Cyclists

* Adjacent-use routes are those where the cyclists are segregated from pedestrians

c. Footpaths are required on both sides of the road. If this needs to be reduced to one side of the road for any reason approval of Director-Design is required.
d. Urban Roads should be classified based on a hierarchy (arterial, sub-arterial, collector, local, sub-local) and the priority use (mobility or access or both). Table 2.2 defines the criteria for different types of roads. **It is essential to classify the road into one of the following 4 categories before further design.**

	Arterial	Sub-arterial	Collector	Local
ROW Width	50 to 60 (m)	30 to 40 (m)	20 to 30 (m)	10 to 20 (m)
Spacing	1.5 kms in CBD	1 to 2 kms	TBD	TBD
Priority	Mobility	Mobility	Mobility + Access	Access
Public Transport	Yes	Yes	Yes	Yes

Table 2.2: Design Criteria for Different Types of Roads

3. How to determine Right-of-Way (ROW)

a. The Right-of-Way width may be specified by mandate. If not specified or not clear, the width should be calculated based on understanding of traffic requirement as follows:

- One lane (1x1 lane)
- Two lane (1 x 2 lanes or 1x1 lane + 1x1 lane)
- Three lane (1 x 2 lanes and 1 x 1 lane)
- Four lane (2 x 2 lanes each)
- Six lane (2 x 3 lanes each)
- Eight lane (2 x 4 lanes each)

ROW = Width of carriageway (See table 4.1) + additional carriageway (if any) required to service parking (see table 4.2) + width of bicycling lane (if applicable, see section 4 (i)) + width of footpath (see Section 5) + width of plantation verge / street furniture.

In addition to traffic volumes, ROW width is also based on Level of service (LOS) adopted for the design. LOS C is recommended for roads within the boundary of Lodha projects (if LOS C is not feasible inspite of significant efforts, LOS D can be accepted in rare instance with approval of HOD-Design or Director-Design) - **this service level should be clarified to road consultant prior to road section design.**

V/C	LOS	Performance	% of Free Flow Speed	Level of Utility
< 0.3	A	Excellent: (Free Flow)	90%	Under Utility
0.3 <V/C < 0.5	B	Very Good: (Stable Flow)	70%	Under Utility
0.5 <V/C < 0.7	C	Good: (Stable Flow)	50%	Satisfactory
0.7 <V/C < 1	D	Fair: (Limit of Stable Flow)	40%	Satisfactory
V/C=1	E	Poor: (Flow at or Close to Capacity)	33%	Optimal
V/C > 1	F	Worst: (Breakdown Flow)	< 25	Over Utility

Table 3.1: Level of Service and Flow conditions

In addition, for Collector, Sub Arterial and Arterial roads with 2 lanes in each direction, a divider (such as railing, median etc) is to be provided. For any road with 3 lanes in each direction, a pedestrian refuge in the median area 1.2m wide minimum is to be provided.

4. Carriageways

a. Widths

- Traffic lane widths should be based on the type of road. Wider traffic lanes along higher order roads facilitate faster movement of traffic; narrower lanes along local neighbourhood roads facilitate traffic calming – which is important since these generally have on-street parking as well as kids/pedestrians.

	Arterial	Sub-Arterial	Collector	Local
Public Transport	Yes	Yes	Yes	No
Traffic Land Widths				
Optimal	3.5	3.5	3.5	3
Minimal	3	3	3	2.75
Traffic Lane for Buses	3.5	3.5	3	n/a

Table 4.1: Traffic Lane Widths for Different Road Types

- Lanes should be of uniform width throughout; else travel will be inefficient if width changes frequently or unexpectedly.

- Traffic lane widths should also consider on-street parking requirements. In case of parking on/adjacent to the road, the road section should bear in mind the impact and ease of using these parking spaces. Parking space requirements should follow Lodha's parking policy. Table 4.2 provides aisle widths for different parking scenarios.

Parking Type	Recommended Carriageway Width (m)[1]	Notes
Perpendicular (90°)	6 (2 way)/5.5 (1 way)	Effective in low turnover rates or long-term parking areas. Most efficient and economical as it accommodates most vehicles per linear meter. Public parking lots. Unless additional carriageway of atleast 3 m (for one side of parking), not suggested on any road other than local.
Angular[2] (60°)	6 (2 way) / 4.5 (1 way)	Ideal for fast turnover rate or short-term use. Often offset by inefficient circulation patterns and one-way aisles. Additional carriageway of atleast 1.5 m is required to service such parking on roads other than local roads.
Angular[2] (30°)	6 (2 way) / 3 (1 way)	
Angular[2] (45°)	6 (2 way) / 3.6 (1 way)	
Parallel	As provided	Requires experience. No additional carriageway required. Local roads

Table 4.2: Carriageway Widths for On-Street Parking

Notes:
1. Driving aisle widths are minimum recommended widths with parking on both sides
2. For angular (60,45,30) the parking stall dimensions are the same as the perpendicular (90) however, perpendicular distances from the carriageway edge in each case are 6.6m, 6.2m and 5.4m respectively.

- Lane markings should be used to delineate lanes as well and are especially critical near intersections to guide orderly movement of traffic near congestion points (such as near intersections. For example, each lane can be marked turning left only, straight only, or turning right only or a combination of these).

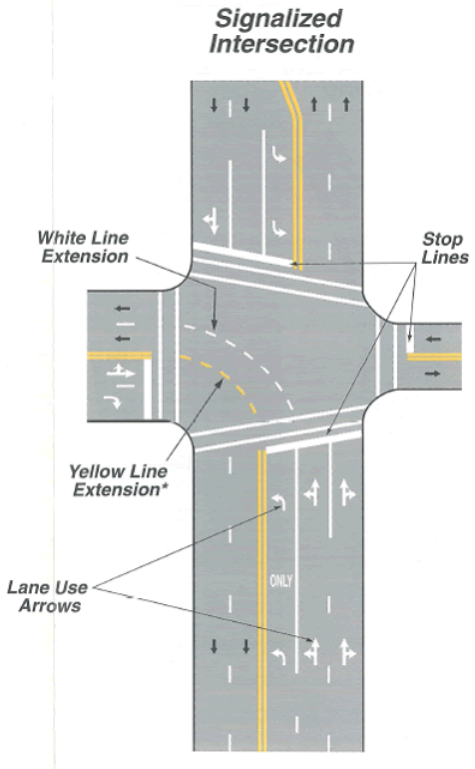


Figure 4.1[1]: Traffic Lane Markings at Intersections

b. Speeds

Roads should be designed for target Level of Service (LOS) (see 3 a.) as per IRC 106-990 or better. Likely travel speeds can be estimated accordingly for purposes of traffic/congestion analysis and other requirments:

Road Classification	Design Speed	Vehicular Speed Based on Level of Service (kmph)					
		A	B	C	D	E	F
Sub Arterial	60	60	43	35	24	19.8	15
Collector	50	50	35	25	20	16.5	12.5
Local	30	30	21	15	12	9.9	7.5

Table 4.3: Design Speeds based on Levels of Service

[1] Figure 4.1 is indicative – concept is similar for left-side moving traffic.

c. Construction

- Road sections should be designed by the Architect/Master planner/Landscape designers.
- In all projects where total road length exceeds 1000 m, a specialist consultant is to be consulted for purposes of design of the driveway base cross-section. The norms contained in this policy should be informed to such specialist consultant. Mandate to consultants for design of driveway base cross-section and top coating is to ensure that the said road would require no major repair / upgrade for minimum period of 5 years after operationalization, if executed properly by a Grade A contractor and taking into account likely traffic/load patterns, soil strata and weather conditions. Based on the mandate, they should provide the most economic cross-section design and top-coating to achieve the mandate and also provide qualification criteria for the contractors.
- In project for which there is no specialist consultant for driveway base cross-section and top coating, design team should follow norms as detailed herein.
- Initial design of road pavement shall be based on IRC 37-2001 standards (Refer Table 4.4). These standards propose designs based on varying traffic loads (MSA value[2]) and soil strengths (CBR rating[3]).

- Roads should be designed for life of 20 years.

- A minimum height of 1m between sub-grade level & highest ground water level should be ensured.

- Generally, for driveway, compaction has to be done every 150mm
    - It is preferable to do 2-Phased execution: Execute until the top layer (Wait for one monsoon or 6 months to allow settling) and then execute the top layer.
    - Slope to ensure no water accumulation: 1": 72" towards the curb to allow water to drain.
    - **WMM (factory made) instead of WBM should be used.** If WBM is to be used, written approval of COO should be taken by Construction Management head of the site.

- Road Components:

    - **Pavers:** Generally used for parking areas: A typical parking pavement section consists of Sub-grade (500mm), Granular Sub-base (150mm), Wet Mix Macadam (200 mm), Sand bedding (30 mm) pavers (60mm).

      If there is fire-tender movement and road section is pavers, then thickness of pavers will increase to 80 mm. In case of heavy traffic, dry lean concrete sub-base is desirable to afford even support to pavers. Paver thickness of 60 mm is adequate if the specified strength is not less than 450 kgs/ sqcm. Moreover it is necessary to introduce concrete curbs at regular intervals to prevent sinusoidal settlement along the length of road.

2 MSA:This measures the design traffic in terms of cumulative number of million standard axles based on initial traffic, traffic growth rate, design life, vehicle damage factor, and distribution of traffic over the carriageway.

[3] CBR: CBR: California Bearing Ratio rating measures the load-bearing capacity of soils used for building roads. The test is performed by measuring the pressure required to penetrate a soil sample with a plunger of standard area. The harder the surface, the higher the CBR rating. A CBR of 3 equates to tilled farmland, a CBR of 4.75 equates to turf or moist clay, while moist sand may have a CBR of 10. High quality crushed rock has a CBR over 80. The standard material for this test is crushed California limestone which has a value of 100.

- **Asphalt Driveway design** (Typically for Sub-Arterial /Collector/Local Road): Most critical aspects in execution are listed below.
  - CBR is to be determined prior to deciding the cross section of the road.
  - **Proper backfilling of service trenches including watering and compacting in layers of 300 mm.**
  - Proper preparation of sub-grade with good non plastic material with CBR not less than 8, laid to proper slope and camber as needed in final finished paved surface, compacted with 12 T roller at optimum water content to give Proctor Dry Density of > 96. Sub-grade needs to be watered and compacted in layers of thickness not exceeding 300 mm.
  - The next two layers shall be of free draining granular sub-base each with spread thickness of 110 mm compacted to 75 mm with 12 T roller .
  - **Granular sub-base is overlaid by two layers of Wet Mix Macadam (WMM) of thickness as specified but not less than 150 mm laid in two layers of spread thickness not less than 110 mm compacted to final thickness of 75 mm each.**
  - It is important to ensure that proper edge restraint in the form of curbs along both edges of road is available so that compaction does not result in thinning out the edges. Where curbs not possible, well compacted edge berming must be provided.
  - **WMM is overlaid with Bituminous Macadam / Asphalt Concrete for a minimum thickness of 65 mm compacted thickness with minimum bitumen content of 4%. It is important to ensure that the WMM is dry and thoroughly cleaned off loose particles and dust and applied with a tack coat of bitumen of grade 100/70 at the rate of 1.7 kg/sqmtr . The temperature of bituminous macadam at the laying point should be checked and should be not less than 85 degrees Celsius. This is overlaid by a seal coat of minimum 10mm compacted thickness to seal voids in the macadam, Bitumen content in seal coat is not less than 6%.**
  - Where the sub-grade is weak , thickness of GSB and WMM has to be increased to reduce the load intensity on sub-grade. Alternately rigid pavements (i.e.) concrete pavement will have to be adopted .

  - **Paver/Asphalt combination**: To be avoided as each material settles differently and therefore causes uneven surface

  - **Concrete driveway design**: Generally not be done, unless where access for road rolling machinery is limited or where underground services are at a higher level and there is a risk of damage because of heavy machinery movement. Avoid building contractor. Execution should be done by infrastructure contractor.

IRC 37 Standards for Design of Roads

CBR (%)-->	CBR 2%					CBR 3%					CBR 4%					CBR 5%				
MSA-->	1	2	3	5	10	1	2	3	5	10	1	2	3	5	10	1	2	3	5	10
Total Thickness		715	750	795	850	550	610	645	690	760	480	540	580	620	700	430	490	530	580	660
Wearing Course (mm)	20 PC	20 PC	20 PC	25 SDBC	40 BC	20 PC	20 PC	20 PC	25 SDBC	40 BC	20 PC	20 PC	20 PC	25 SDBC	40 BC	20 PC	20 PC	20 PC	25 SDBC	40 BC
Binding course (mm)		50 BM	60 BM	70 DBM	100 DBM		50 BM	60 BM	60 DBM	90 DBM		50 BM	50 BM	60 DBM	80 DBM		50 BM	50 BM	55 DBM	70 DBM
Granular base (mm)	225	225	250	250	250	225	225	250	250	250	225	225	250	250	250	225	225	250	250	250
Granular Sub base (mm)	435	440	440	450	460	435	335	335	335	380	255	265	280	285	330	205	215	230	250	300
CBR (%)-->	CBR 6%					CBR 7%					CBR 8%					CBR 9 % &10%				
MSA-->	1	2	3	5	10	1	2	3	5	10	1	2	3	5	10	1	2	3	5	10
Total Thickness	390	450	490	535	615	375	425	460	505	580	375	425	450	475	550	375	425	450	475	540
Wearing Course (mm)	20 PC	20 PC	20 PC	25 SDBC	40 BC	20 PC	20 PC	20 PC	25 SDBC	40 BC	20 PC	20 PC	20 PC	25 SDBC	40 BC	20 PC	20 PC	20 PC	25 SDBC	40 BC
Binding course (mm)		50 BM	50 BM	50 DBM	65 DBM		50 BM	50 BM	50 DBM	60 DBM		50 BM	50 BM	50 DBM	60 DBM		50 BM	50 BM	50 DBM	50 DBM
Granular base (mm)	225	225	250	250	250	225	225	250	250	250	225	225	250	250	250	225	225	250	250	250
Granular Sub base (mm)	165	175	190	210	260	150	150	160	180	230	150	150	150	150	200	150	150	150	150	200

GSB: Granular Sub-base
GB:Granular Base
Binding Course: BM/DBM
Wearing Course: BC/PC/DBC

Table 4.4: Design Standards based on MSA (traffic loads) and CBR rating (Soil conditions)

d. Driveway testing

When a new street is constructed or an existing carriageway is widened, road tests shall be carried out to determine the quality of the materials used. In the case of failure and rejection, the failed sections shall be re-laid and retested. Chapter 10 of Singapore LTA's Materials and Workmanship Specifications contain an elaborate write-up on this subject (See chpt 10 of http://www.lta.gov.sg/content/dam/ltaweb/corp/Industry/files/EGD09104A1-Overall.pdf).

The QP is required to submit a coloured site plan showing the street(s) under testing for road materials and the locations where samples are extracted.

For premix - cut samples shall be obtained from the pavement at every 50m, on each carriageway. For rigid pavement - cut samples shall be obtained at every 50m3 on each carriageway. For precast curbs, three (3) test curbs shall be taken, at random, for every one thousand (1000) units. A minimum of 3 samples shall be taken for testing where the street is less than 50m in length.

Core samples for premix shall be 150mm in diameter while sample for concrete shall be 100mm in diameter.

e. Maintenance: Refer 'Annexure 1- *Maintenance of Road Works*'.

f. Drop-off: Width of the drop-off bay adjacent to the footpath should be min. 9m (max. 14 m) to facilitate vehicle pulling up along the curb.

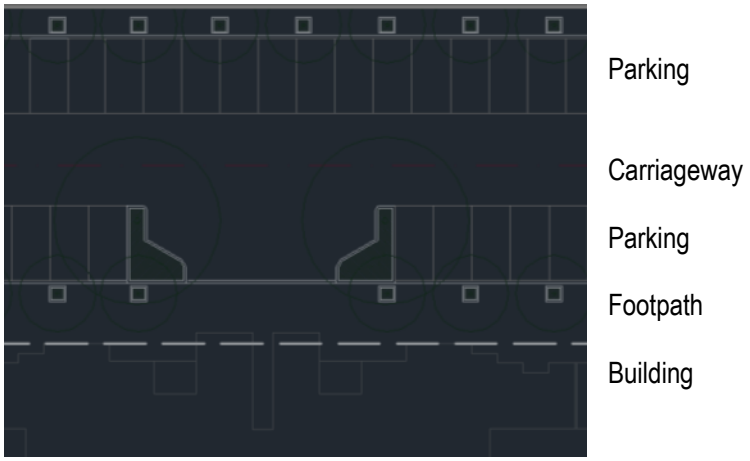


Figure 4.2: Indicative Plan for a Drop-off Bay for Residential Buildings

g. BRTS considerations

- **Threshold traffic to support mas**s transit
  BRT/LRT: 8000 ph**p**dt (peak hour peak direction traffic)
  MRTS: 15,000 phpdt
- 3.5 lane width is optimal for buses along Arterial/Sub-arterial, 3m on Collector roads. Designated bus lane for Arterial/Sub-Arterial is optimal.

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	500m	2 km	4.7 km		1-1.5km	2 km	Every Bus Stop	Every Bus Stop
Sub-Arterial	500m			500m	1-1.5km	3 km		
Collector	400m			300-400m				
Local				300-400m				

Table 4.5: Public Transport for Different Road Types

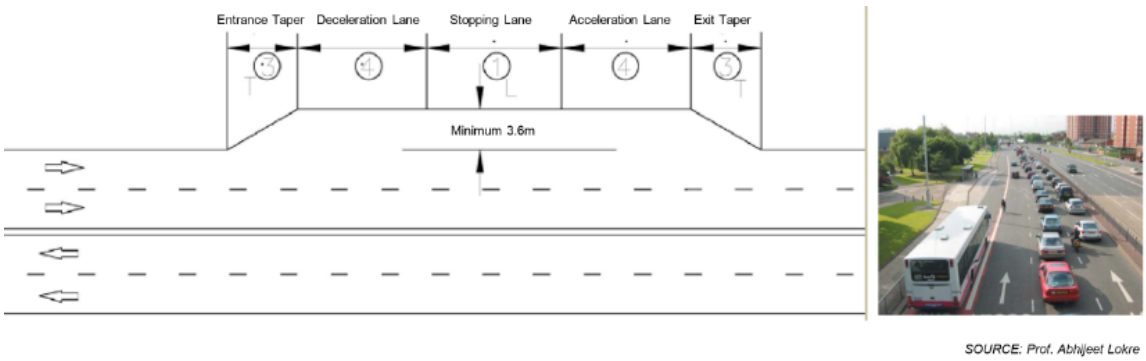
h. Bus stops

- Bus stops should be designed with weather protected waiting areas and should be so located as to minimize impact on flow of vehicular traffic.
- Bus stops should have minimum width of 1.2m and can be built into the sidewalk OR along the curb in carriageways where curb side parking is provided. This is optimal for Collector roads. It should be ensured that bus stops do not reduce the width of the footpath below 1.2 m.
- Far side placement is desirable, near side placement to be avoided. If the bus stop is to be located nearside (just before an intersection), clearance of 35m is to be provided. If the bus stop is located far side) just after an intersection), clearance of 42m is to be provided. If the bus stop is to be located mid-block, clearance of 25m is to be provided.
- A bus lay by along the curb is optimal for Arterial/Sub-arterial roads; it has adequate space for the bus to decelerate/accelerate and a safe harbour for passengers to board/disembark safely and comfortably. In addition, it does not reduce capacity by causing traffic to stop in adjoining lane.

.



Figure 4.3: Bus Lay bye



SOURCE: Prof. Abhijeet Lokre

Figure 4.4: Indicative Plan of a Bus Lay bye

A bus bay is a specially constructed area separated from travel lanes and off the normal section of a roadway that provides for pick up and discharge of passengers
Generally provided on high volume or high speed roadways.
Total length of bus bay should allow for entrance taper, deceleration lane, stopping area, acceleration lane and exit taper
Far side placement is desirable
Near side placement should be avoided to avoid conflicts with left turning vehicles
Stopping lane of 15m for 12m standard bus and 21m for 18m bus
Bus bay width is desirably 3.6m; may be 3m for traffic speeds below 45kmph
Taper of 5:1 is desirable for entrance taper; exit taper should not be sharper than 3:1

i. Bicycle lane

If bike lanes are provided then dedicated bicycle lane should be considered on Arterial and Sub-arterial roads as the traffic is generally heavier and faster; however, dedicated lanes may not be required on Collector and local roads. The lane should be:

- Asphalt or concrete lane, and elevated above the carriageway
- A minimum of 1.2m for one-way and 2 m for two-way movement; with a buffer of 0.5m between the lane and between travel lane and parking.
- No paver blocks or manhole covers should be in the lane. If covers are unavoidable, then they should be flush with the lane surface.
- Separate waiting area for bicycles should be accommodated at intersections adjacent to pedestrian crossings.

j. Traffic Signs: Traffic signs may be mandatory (e.g. STOP sign), cautionary (e.g. Pedestrian crossing) or Informatory (e.g. Bus Stop).
The signs shall be either reflectorised or non-reflectorised.

- Reference Standard
  - Refer to IRC: 67-2001 for detailed design and installation guidelines for traffic signs.
- Material / Colour: Refer IRC 67 for colour speci**fic**ations of traffic signs. The colours shall be durable & uniform in acceptable hue when viewed in day light or under normal head light at night. Refer 'Annexure 2 - *Manual of Traffic Signs*'.
- Location
  - Generally, traffic signs are to be placed on the left side of the road, no less than 60 cm from the edge of the curb, mounted at height of 2m and placed at right angles to the approaching traffic.
  - STOP sign has to be placed at where vehicle is required to stop or as close to it as possible, 1.5 to 3m from intersection. Where there is a pedestrian crossing, the sign has to be 1.2m in advance of the crossing. The sign has to be placed at an angle between 30 to 45 degrees to approaching traffic ensuring that there is no glare.
  - Cautionary sign has to be placed in advance of 50m from the intersection. In case of high speeds (such as on Arterial/Sub-arterial road), signs can be placed 200m in advance.

k. Road Markings

The colour, width and layout of road markings shall be in accordance with the Code of Practice for Road Markings with paints, IRC: 35. Road markings can be ordinary road marking paint, hot applied thermoplastic compound, or reflectorised paint as per criteria enumerated hereinbelow:

- Ordinary Road Marking Paint should be used in areas where there is no wear and tear (such as curb edges, median edges). It should conform to Grade I as per IS: 164. The road marking shall preferably be laid with appropriate road marking machinery.
- Hot applied thermoplastic Road Marking should be used in high wear and tear areas such as on carriageways.
    - The thermoplastic material shall be homogeneous composed of aggregate, pigment, resins and glass reflectorizing beads.
    - The work under this section consists of marking traffic stripes using a thermoplastic compound meeting the requirements specified herein.
    - The thermoplastic compound shall be screeded / extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate upon cooling to ambient pavement temperature; it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic.
    - The colour of the compound shall be white or yellow (IS colour No.356).
    - Where the compound is to be supplied to cement concrete pavement, a sealing primer as recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and/or curing compound shall be removed before the markings are applied.
- Reflectorized Paint should be used in low light areas.
    - Marking shall be done by machine. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the Engineer. The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer for the particular method of laying being used.
    - The pavement temperature shall not be less than 10oC during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint.
    - The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall so bond itself to the old line that no splitting or separation takes place.
    - Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted Specification shall be sprayed uniformly into a mono-layer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square metre area.
    - The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

l. **Speed Breakers**: These are to be provided along Collector/Local roads where road intersections are not controlled by traffic signals and near major pedestrian activity areas such as School, Hospitals, Public Parks etc.

5. Footpaths & Verges:

Footpaths are required on both sides of the road. If this needs to be reduced to one side of the road for any reason approval of Director-Design is required.

Figure 5.1: Components of Pedestrian Area



(Clear Footpath)

Foothpaths:

a. If for large scale public use - shoud be made of continuous material (not having grass/pebble patches in middle) for ease of walking/running.
b. Layout should be designed from perspective of pedestrians first:
    a. Should be continuous i.e. no abrupt breaks or narrowing down of footpaths.
    b. Crossover points on road should have raised crossing to slow down vehicles and enable pedestrians to not have to step up and down.

a. Pedestrian throughway:

- Width of clear pedestrian footpath (excluding any plantation / street lights / street furniture / signage) should be min. 1.8 m and max. 3.5 m[4]. In exception circumstances, especially to obtain footpath on both sides of the road, the width of the throughway zone may be reduced to 1.2 m with approval of HOD-Design or Director-Design.
- The number of vehicular breaks on a footpath should be minimized to encourage pedestrian safety and also to reduce traffic congestion on the adjacent driveway. Ingress/egress from building should be avoided on any road other than 'local'/'secondary' roads (if required they should be spaced apart by at least 60 m). Further, it is to be ensured that the ingress/egress paths for vehicles respect the footpath's levels and don't lead to awkward rise in levels for pedestrians.

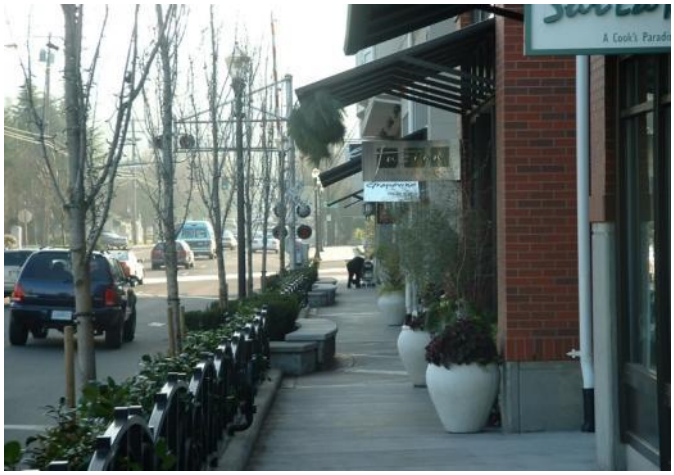
b. Verges/landscape/Street Furniture

Plantation zone is called the verge. Guidelines for verge:

- If plantation is planned with medium / large trees, minimum width of 1.2 m is required for plantation zone and preferably up to 2.5 m.
- Minimum width for landscaping strip along local road is 0.4m.
- Trees should be planted min. 0.7m from edge of curb (Counted to centre of trunk).
- Trash cans/dust bins should be placed 0.2m from edge of curb.
- Traffic signs should be placed 0.6m from edge of curb.
- Street light poles should be placed 0.5 m from the edge of curb.
- The plantation zone may be used for other non-vehicular and non-pedestrian uses like street lights / street furniture / signage etc.
- The verge edge can have a buffer such as railing or bollard to buffer parking/vehicular traffic from pedestrians, especially if pedestrian area is narrow and the road has heavy or fast moving traffic. Refer Picture 5.2 and 5.3
-



Picture 5.2: Example of Railing to Buffer Pedestrians from Vehicular Traffic



Picture 5.3: Example of Railing to Buffer Pedestrians from Vehicular Traffic

Making layout appear green

a. All walking paths should be shaded from both sides – can be trees on both sides or tree on one side and building edge on the other. If building edge, use shrubs to soften the edge. The tree size to be proportionate to the width of the footpath – generally small or medium trees can be used.
b. Parking areas need to have a tree canopy. To enable this, need a 0.6-1 m patch after every 3 car parks (~7 m-7.5 m) which should be planted with medium/tall trees.
c. For all buildings > 15 m in height, it is important to break the visual perspective of their height/mass as perceived from the ground. This can be achieved by a tree line at a distance of 3-6 m from the building line. This can preferably be part of a. or b. above or if not, additional tree line.
d. Wherever trees are planted, ensure sufficient soil depth so that they don't cause uplift/damage to the footpath / parking etc. adjacent to it.
e. Corners of buildings and footpaths (which do not obstruct walking path or roads) should be developed as pocket gardens (see image 1 (appropriate pocket garden) and 2 (missed opportunity)).

c. Street lighting

Street lights should also be affixed to property in case the width of the street allows this viz. generally for ROW widths <= 18.3 m. In other cases street light can be placed in the planting verge. They can be located one or both sides. Lighting Requirement shall be as per British standards.

- For any road section, following are the average Lux levels required by street lighting:
  - Main carriageway: 15-17 Lux with high & mixed traffic flow like main city streets and throughways. In case of low traffic flow, can be reduced to 12 Lux
  - Parking on side of carriageway (if any): 5-10 Lux
  - Footpath / Pathways on side of carriageway/parking: 3-5 Lux
- Power backup: Streetlights do not require 100% power backup. % of backed up lights can range from 0% (where power reliability is high eg. Palava or Pune) to 50%. If backup is to be provided, any one of the following options can be considered based on what is lowest cost (and taking into consideration electrical looping and backup source i.e. inverter or DG):
  a. Backup only for 1 side of the road (less preferred)
  b. Backup for every 2nd (50%) or 3rd (33%) streetlight on both sides of road, with the backed up lights selected in staggered fashion on the two sides of the road.
- Color of lights: In general street lights are available in white light or yellow light variants. For Lodha owned projects (or where we plan to run / operate common areas for an extended period), we should consider energy efficient lighting systems that optimize capital and operating costs. For other projects, where we will handover to society / customers, we should focus on reducing upfront capex costs.
  a. Energy efficient systems to consider: LED or Solar lights are to be used.
  b. For other projects, sodium vapour lights are to be used.

Light type	Color	Cap Ex	Op Ex	Mounting Height	Spacing (m)
Solar LED	White	Highest	Lowest	Ideally up to 6m	Max 15m
LED	White	Highest	Lower	Can go up to 9m	25 to 30 m
Metal halide	White	Medium	Medium	Can go up to 9m	25 to 30 m

Sodium Vapor	Yellow	Lowest	Highest	Can go up to 9m	25 to 30 m

Table 5.1: General Guidelines for Street Lights

- Guidelines for location and Spacing of lights
  - Street lights should not be placed in the walkway/footpath/bicycle lane width.
  - Local or sub-local roads: Single-sided
  - Roads with more than 3 travel lanes: Staggered on both sides; Height of light should be equal to width of carriageway and spacing should be 3 to 3.5 times the height.
  - Arterial roads: Central for highways and arterial roads. Mounting height at 0.8 times carriageway width and spacing at 3 to 3.5 times height.
  - Sub-arterial and collector roads where there is no median: Opposite, mounting height at 0.5 times the height of carriageway and spacing at 3 to 4 times.

Street Type	Recommended	Spacing (m)	Staging Height (m)	Type
Local	Single-sided	10	6	
Collector	Staggered/Opposite	15	9	
Sub Arterial	Central	30	12	
Arterial	Central+Opposite	30	12+6	

Table 5.2: Guidelines for Street Lights for Different Road Types

  - For any road section, the desired Lux levels need to be calculated on design basis and then final height/spacing needs to be finalized
  - For LED lights, normally only upto 6m poles are available. Beyond 6m, the structure of the street light becomes unstable and not recommended
  - For solar,
    - The panel direction should be south facing at a tilt of ~20 deg – hence applicable only on North-South roads or East-West roads if the South side is clear
    - There should not be any shading over the solar panels by trees, buildings or any external structures
  - Pole finish to be considered is GI – any deviation will increase cost and lead time for procurement
  - At time of finalization, generally 110% of desired Lux levels are to be considered since over life of the lamp, the Lux levels reduce to the average value desired.
  - In case of 6m pole height, the circumference of the light has a smaller radius compared to the 9 m poles for conventional street lights – hence might reduce Lux levels on the end of the section (footpaths, landscape etc.)

- Within white light options, LED lighting is much whiter with CRI >70 (approx.). Similar in case sodium vapor lamps is CRI <25. Hence the color recognition , perceived light is much better with LEDs even under lower lighting levels

Suggested finishes for footpaths

Nature of Project	Luxury / Hi-end Residential; Excelus / Supremus Office; Experia Retail	All other
Top surface	Granite / Concrete or Coloured concrete in panel format (max 3 m x 3m)	Concrete or Coloured concrete in panel format (max 3 m x 3m)
	Granite:  Concrete  Coloured concrete:	Concrete:  Coloured concrete:

		
Kerb	Concrete (pre-cast - plain or texture finish, with special attention to be paid to non regular pieces and to be ensured that even those are pre-cast and not 'moulded' on site)	Concrete (pre-cast - plain or texture finish, with special attention to be paid to non regular pieces and to be ensured that even those are pre-cast and not 'moulded' on site)
		

6. Intersections

a. Road – Road

- To the maximum extent possible, road intersections should follow road hierarchy to make them safe and efficient. For example, a high speed arterial road should not directly intersect with a low-speed local road. Typically, intersections of local + local and Local + Collector may not require extensive design, but higher order intersections will benefit from design interventions. Traffic management interventions at intersections include:
  - Less than 3,000 vehicles per hour – Calming Measures
  - 3000 to 6000 vehicles per hour – Mini traffic circle or Rotary
  - 6000 to 8000 vehicles per hour – Signalized Intersections
  - 10,000+ vehicles per hour – Grade separators

Intersection	Main Traffic Circle (slightly more than rotary)	Rotary with single circulatory lane (3000 veh/hr)	Rotary with single circulatory lane (3000 veh/hr)	Signalized (up to 10000 veh/hr)	Grade separator (Above 10000 veh/hr)
Arterial+Arterial					**X**
Arterial+Sub Arterial					**X**
Arterial+Colletor				**X**	**X**
Sub Arterial+ Sub				**X**	**X**

Arterial					
Sub Arterial+Collector				**X**	**X**
Collector+Collector		**x**	**X**	**X**	
Collector+Local		**X**	**X**		
Local+Local	**x**				

Table 6.1: Guidelines for Intersections for Different Road Types

- Intersections of Collector roads with local roads with parking on both sides should be designed for ease of pedestrian crossing – bulb-outs make the crossing shorter while improving visibility of pedestrians to vehicular traffic.

Figure 6.1: Ensuring Pedestrian Safety through Bulb-outs at Intersections

- Intersections of Collector roads with Sub-arterial roads need to be designed for high visibility for both pedestrians and vehicular traffic. This can be accommodated either by pedestrian bulb-outs or designing buildings to accommodate sight lines such that the driver of the first vehicle can clearly see the first vehicle at adjacent crossings.



Figure 6.2: Ensuring Pedestrian Safety through Adequate Sight Lines at Intersections

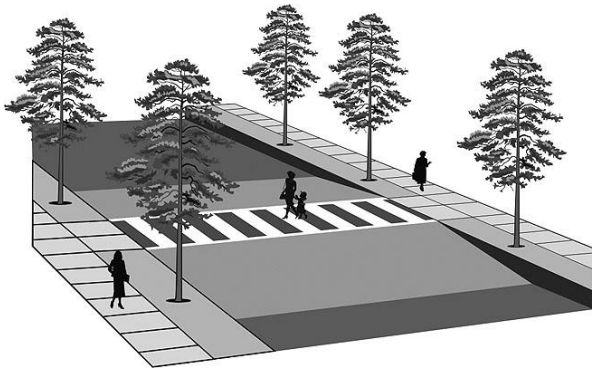
b. Road – Pedestrian/Bicycle

- When Pedestrian footpath / bicycle lanes intersect vehicular driveways, adequate provisions should be made to:
  - Appropriately slow down the other class, when one class is using the intersection (e.g. speed breaker, signal, and pedestrian signal).
  - Intersection should be clearly marked (e.g. by zebra crossing, change in material pattern etc.).
  - The intersection should be designed such that handicapped / those with baby strollers etc. can easily navigate the different levels (e.g. Through gentle ramps).



Figure 6.3: Ensuring Cyclist Safety at Intersections

- Pedestrians to have right of way wherever zebra crossing is marked. At other crossings, just two parallel white lines to indicate pedestrian zone and pedestrians to cross when signalled ('man signal'). Also pedestrian walkway should seamlessly flow between footpath and road crossing using slopes ('stroller test' – stroller should be able to move without anyone have to lift it). See 'UK or Singapore' standards
- Pedestrian crossings should be at all intersections where there is potential for conflict between vehicles and pedestrians. For providing such crossings, two options are available that ensure minimal inconvenience for pedestrians, especially those with strollers, wheelchairs and those who are physically challenged.
  - Option 1 (to be used on all Collector and local roads): A speed table can be provided which ensures that the level of the footpath and that of the crossing is the same. The speed table would also force vehicles to slow down in advance of the crossing. A sign regarding the same can be put at a distance of 100 ft before the vehicle reaches the crossing.





Speed tables can be used in areas of particularly high pedestrian crossing demand on narrower streets (maximum of two moving lanes), such as locations with pedestrian generators (e.g., major commercial or cultural destinations, transit entrances, parks) on opposite sides of the street

The details of the various dimensions (indicative) and materials are as provided below:

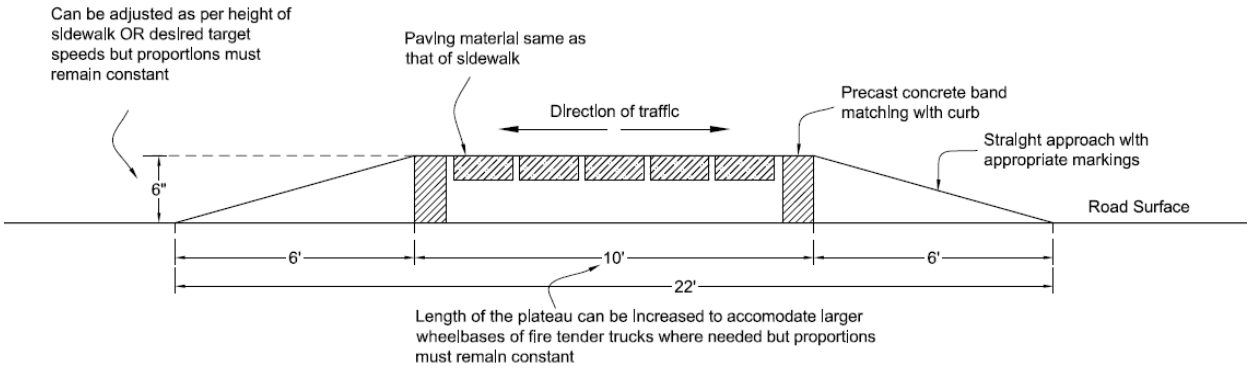


Fig 1.2 TYPICAL SECTION: SPEED TABLE / RAISED CROSSWALK (Not to scale)

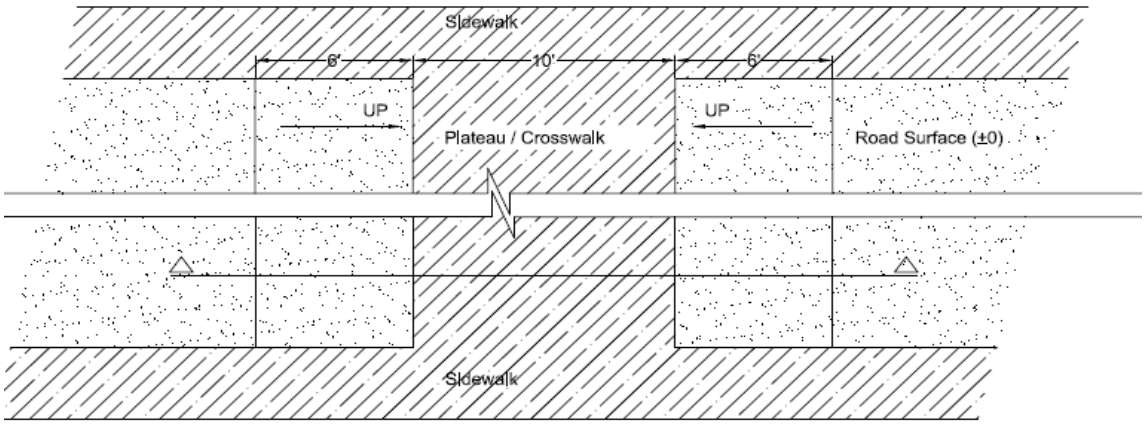
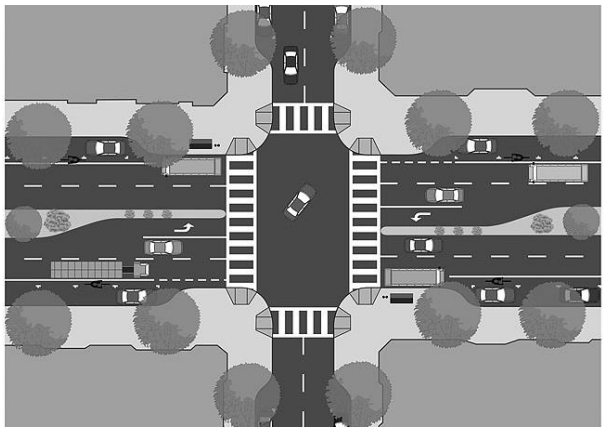


Fig 1.1 TYPICAL LAYOUT: SPEED TABLE / RAISED CROSSWALK (Not to scale)

- **Option 2 (preferred on sub-arterial and arterial roads or junctions thereto):** The other option is to have a slope from the footpath to go on to the road i.e. a kerb ramp and a

zebra crossing marked on the road. The vehicular traffic can be controlled by a sign in advance of the crossing and (optionally) by having a speed-breaker before the crossing.







Minimum width of a crossing should be 2m, maximum width of 4m, and marking bands should be 0.5m wide and 0.5m apart. Vehicle stop line marking should be minimum 1m and maximum 3m behind the pedestrian crossing. Width of the stop line is 20 cm.

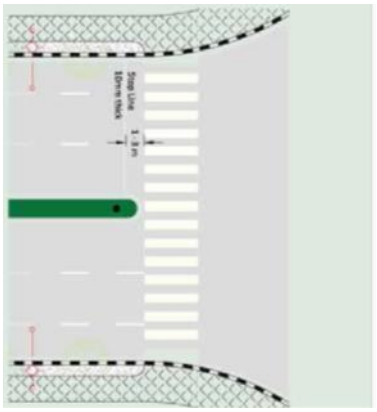


Figure 6.3: Guidelines for Pedestrian Crossings at Intersections

Pedestrian signals may be provided at major pedestrian crossings based on the following guidelines – (for information, unlikely to be used)

i. Minimum pedestrian volume: The signals should be provided where pedestrian traffic is at least 200 persons in 8 hours

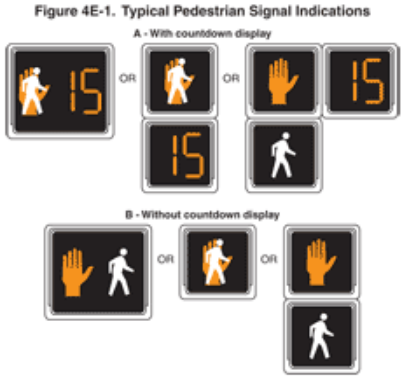
ii. Distance to nearest protected crossing: Pedestrian signals shall not be installed less than 215 metres from another protected crossing (e.g. a traffic signal, a manually guarded location etc.) on a two-way street

iii. The above requirements may be relaxed and a pedestrian crossing installed for safety reasons in areas near schools, hospitals etc.

iv. The pedestrian signal should provide sufficient time to cross the road depending on the width of the road and the type of pedestrians (e.g. students, patients etc.); ideally the signal should have a counter showing the time available

v. Where possible, accessible pedestrian signals (that can be used by visually impaired/ low vision individuals) should be provided





When vehicle driveway has to be provided across footpath

a. Generally frequent vehicle crossings over footpaths are to be avoided and should absolutely not be done on arterial and sub-arterial roads. Even if they are to be provided (on local or collector roads), the distance between two should not be less than 50 m.

b. When such entry is being created, significant care should be taken to ensure that bicycle and pedestrian movement (including handicapped and stroller) is not adversely affected. This is done by providing appropriate slope as specified for road-pedestrian/bicycle junction above.



7. Parking – Refer Lodha Parking and Parking Management System Policy for details

8. Signage

a. Street signages of three main types:

- Regulatory/ Mandatory signs: Signs that provide information about regulations, prohibitions or restrictions e.g. signs providing speed restrictions, Stop signs, one-way signs etc. These

signs are always circular in shape (with rectangular plates provided below for additional information)





Some of the mandatory signages to be provided at Lodha developments are:

c. Indicating one-way / no entry
d. Indicating parking restrictions
e. Indicating speed limits

- Warning/ Cautionary signs: These signs are used to warn the road users of the existence of certain hazardous conditions either on or adjacent to the roadway e.g. Pedestrian crossing, steep ascent/ descent, left/ right turns etc. These are in the form of an equilateral triangle with the apex at the top.





- Mandatory and cautionary street signages typically have standard shapes and colour combinations (Red-white-black, Yellow-black etc.) mandated by various authorities. The Mumbai Police has a set of basic signs on its website. More detailed reports have been published by the Department of Transport (UK), Federal Highway Administration (US), Ministry of Transportation and Highways (British Columbia, Canada) among others. It is suggested that the design suggested by the Department of Transport (UK) be used.

Optional – for information only (generally shall not be used at Lodha developments):

- Informative signs: These signs are used to guide road users along routes, inform them about destination and distance, identify points of geographical and historical interest and provide other information that will make the road travel easier, safe and pleasant.









Informative signages can vary significantly both in terms of the colour combinations and the level of details provided. In general, for signages that are expected to be read by motorists, the following guide lines should be followed-

i. The maximum time required to read the sign should not exceed 4 seconds
ii. Drivers should not have to divert their eyes by more than 10 degrees away from the road
iii. Ideographic representation is preferable; where lettering is necessary, the message needs to be compressed into few comprehensible words

Electronic signs

- Electronic signs can be used for multiple applications including mandatory and warning signs as well as for information and messages of public interest. They are dynamic and one sign can be used for multiple purposes.







Optional section ends

Some examples of informative signages for motorists are given below-

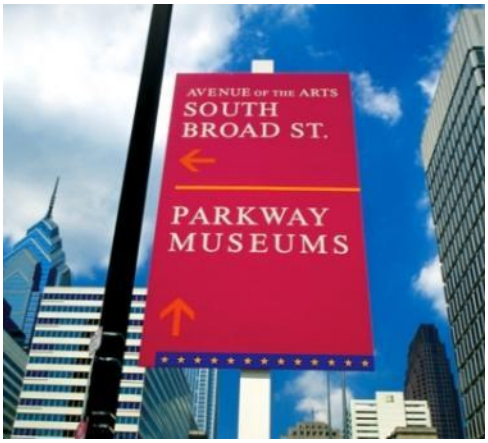
b. **Street Names**: Street name plates should be affixed to building face at level of about 4-6 meters above ground level, at the intersection of each street and avenue.

Figure 8.1: Example of a Street Name Plate



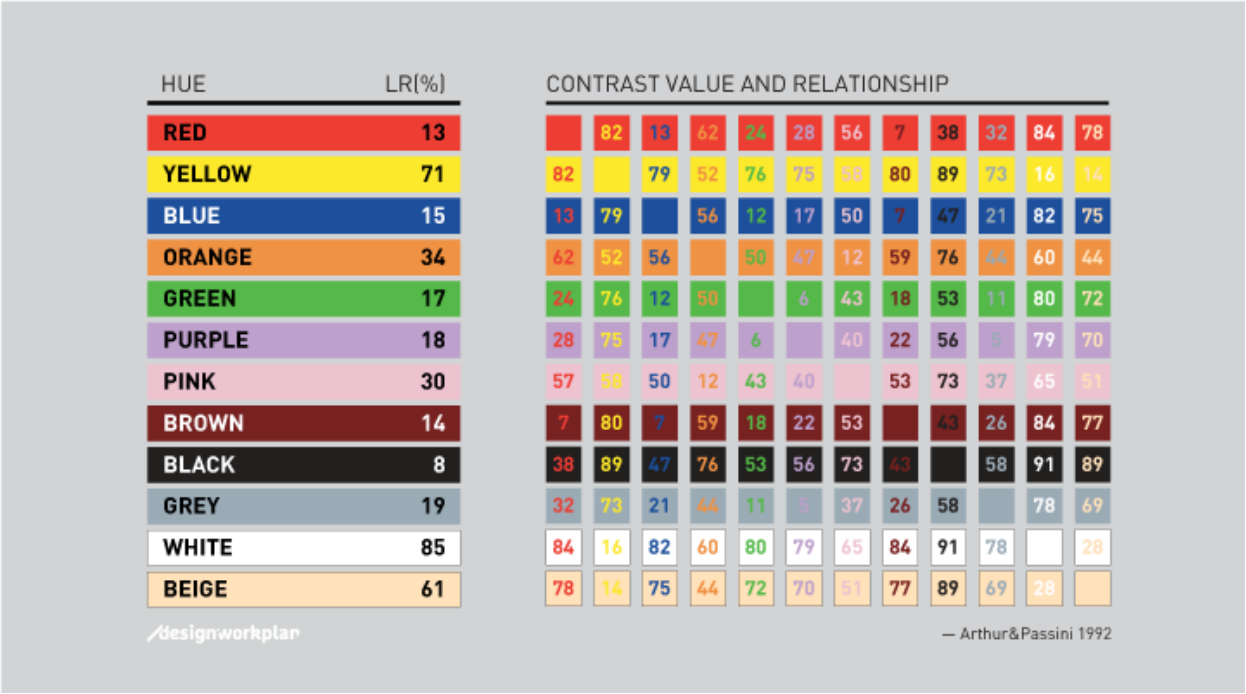
Further, in very large developments, any of the following formats can be used to guide people at key junctions (also see Policy 34 Signage's Guidelines for Residential Projects):

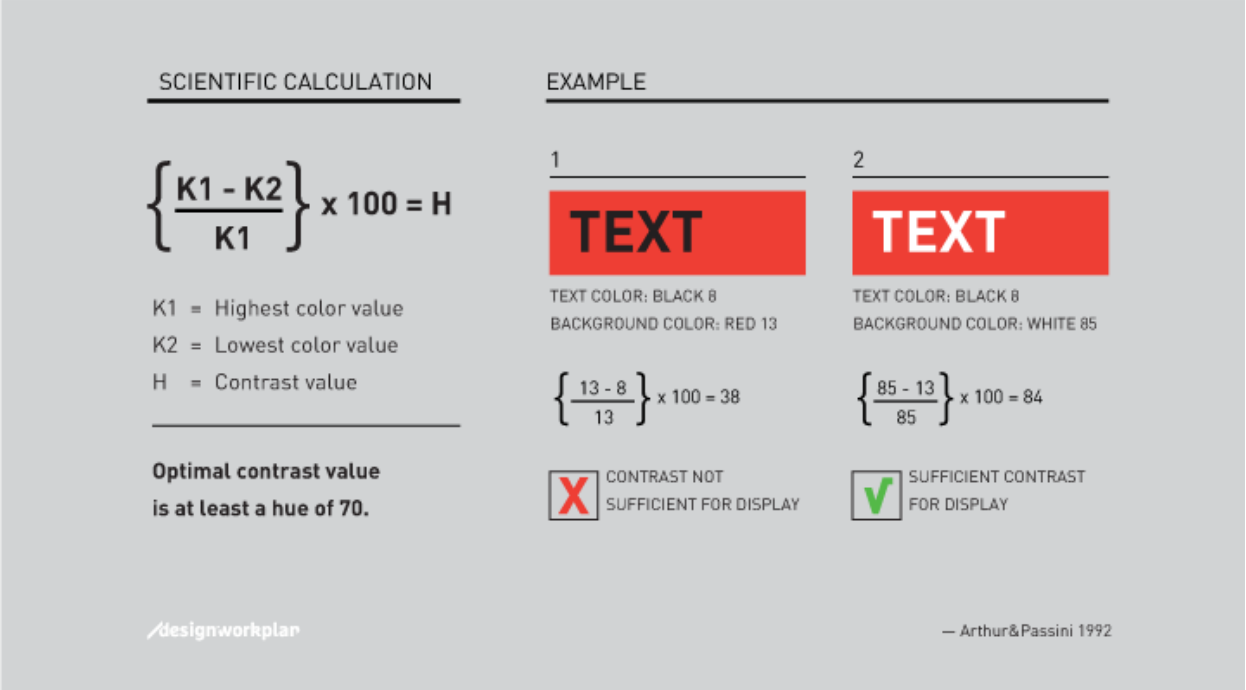




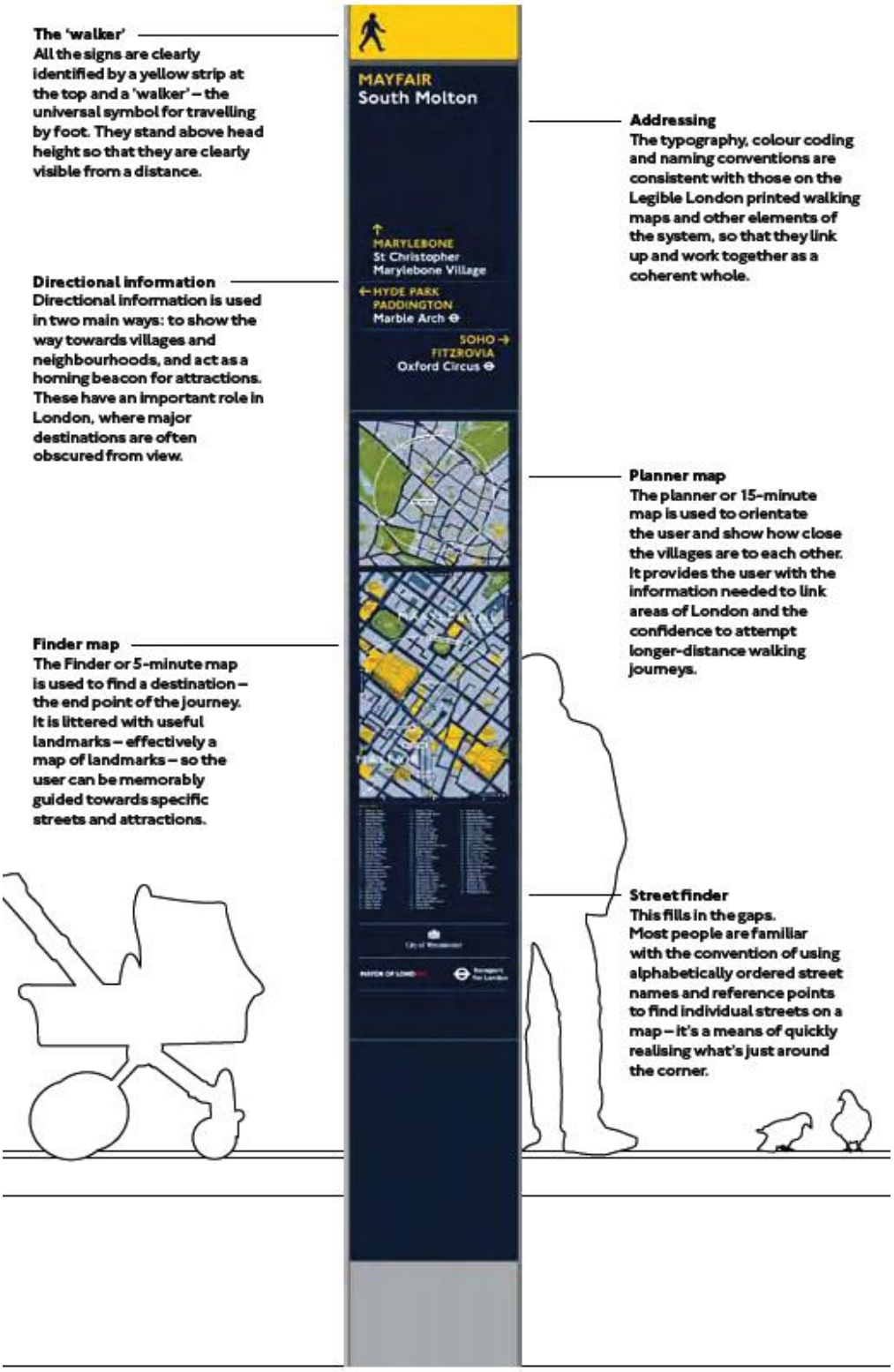


In general, colour combinations can be decided on the basis of contrast value. The description and calculation for the same is given below (Arthur & Passini, *"Wayfinding",* 1992)-





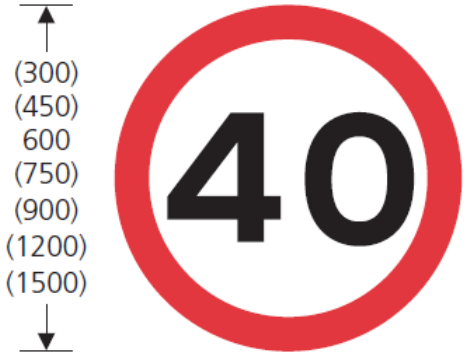
For signages meant for pedestrians, significantly more information can be provided on the signage to help navigate in the area on foot (e.g. the Legible London initiative)

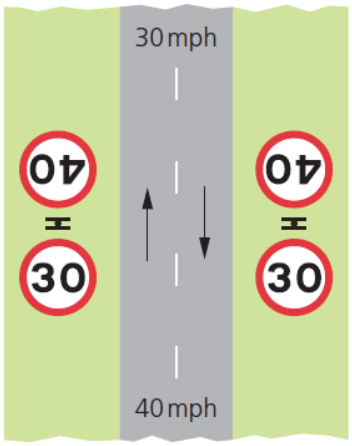

The 'walker'
All the signs are clearly identified by a yellow strip at the top and a 'walker' – the universal symbol for travelling by foot. They stand above head height so that they are clearly visible from a distance.
Directional information
Directional information is used in two main ways: to show the way towards villages and neighbourhoods, and act as a homing beacon for attractions. These have an important role in London, where major destinations are often obscured from view.
Finder map
The Finder or 5-minute map is used to find a destination – the end point of the journey. It is littered with useful landmarks – effectively a map of landmarks – so the user can be memorably guided towards specific streets and attractions.
MAYFAIR
South Molton
MARYLEBONE
St Christopher
Marylebone Village
HYDE PARK
PADDINGTON
Marble Arch
SOHO
FITZROVIA
Oxford Circus
Addressing
The typography, colour coding and naming conventions are consistent with those on the Legible London printed walking maps and other elements of the system, so that they link up and work together as a coherent whole.
Planner map
The planner or 15-minute map is used to orientate the user and show how close the villages are to each other. It provides the user with the information needed to link areas of London and the confidence to attempt longer-distance walking journeys.
Street finder
This fills in the gaps. Most people are familiar with the convention of using alphabetically ordered street names and reference points to find individual streets on a map – it's a means of quickly realising what's just around the corner.

Some examples of specific signages:

- Speed Limit (Regulatory)-

Speed limit signs are used to indicate the beginning of maximum speed limits on a particular road. In some cases, a minimum speed limit may also be prescribed.



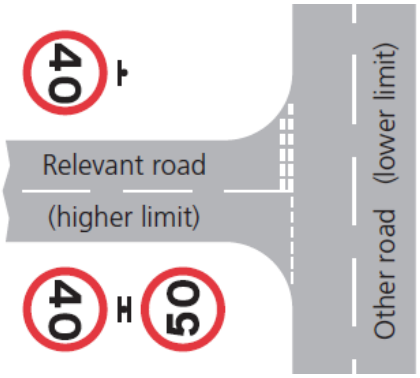


The speed limit sign defines the speed limit in KM/ Hour. The regular size of the speed limit sign is 600 mm. However, larger sizes may be used if required for better visibility on high speed roads. The speed limit sign should be placed on each side of the road or on each side of the carriageway (in case of dual carriageway) at or as practicable to the point where the speed limit begins.

A confirmatory speed sign may be erected between 300 m and 600m beyond the beginning of a speed zone, and a short distance beyond each major intersection.

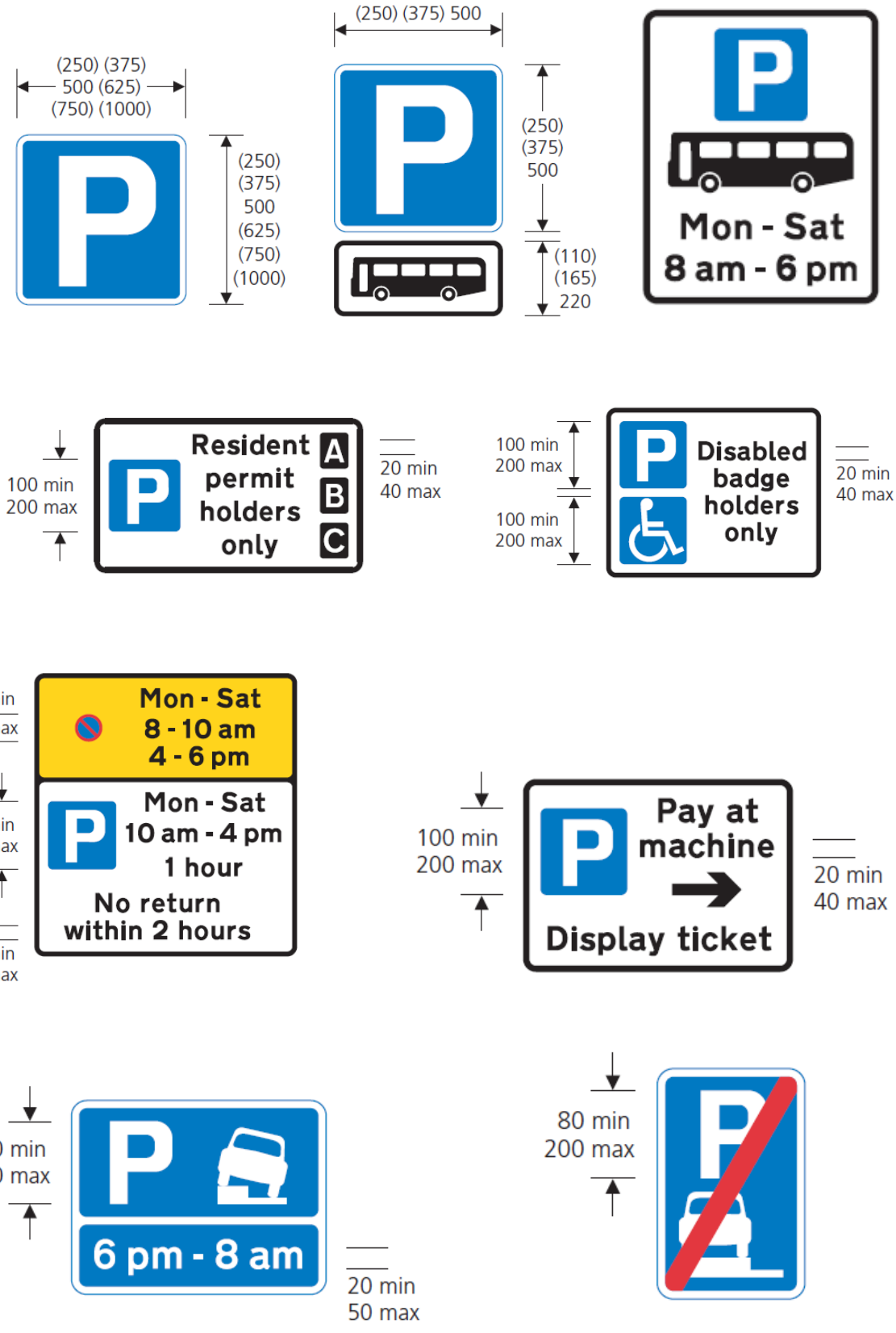
A "Reduced Speed Limit Ahead" sign should be put at a suitable distance before the actual speed limit sign if the reduction in speed between the two zones is more than 15 km/ hour.

In case of a junction, the speed limit signs should be placed at no more than 50 m from the junction.



- Parking (Informatory)-

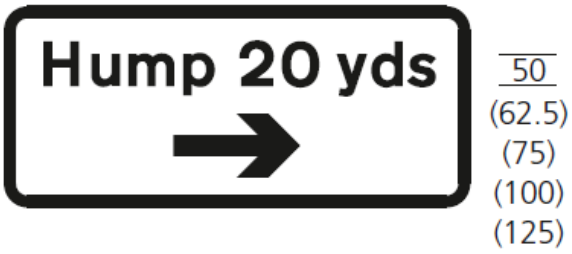
The Parking sign in conjunction with parking bay markings is used to indicate an area designated for stationary vehicles. The basic parking sign can be combined with various complementary signs to provide additional/ specific information. A few examples are provided below.


(250) (375)
500 (625)
(750) (1000)
(250)
(375)
500
(625)
(750)
(1000)
(250) (375) 500
(250)
(375)
500
(110)
(165)
220
Mon - Sat
8 am - 6 pm
100 min
200 max
Resident
permit
holders
only
A
B
C
20 min
40 max
100 min
200 max
100 min
200 max
Disabled
badge
holders
only
20 min
40 max
30 min
80 max
Mon - Sat
8 - 10 am
4 - 6 pm
75 min
200 max
Mon - Sat
10 am - 4 pm
1 hour
No return
within 2 hours
15 min
40 max
100 min
200 max
Pay at
machine
Display ticket
20 min
40 max
80 min
200 max
6 pm - 8 am
20 min
50 max
80 min
200 max

- Road hump/ Speed breaker (Warning)-
  The sign below is used to warn of the presence of a road hump or a series of road humps. The typical size of the sign is 600mm but the size can be changed depending on the situation.



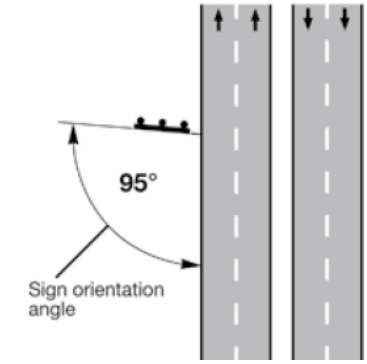
The size should be placed approximately 250 feet before the first bump. In addition to the basic warning sign, additional information about speed limit and distance to the bump may also be provided on supplementary plates.

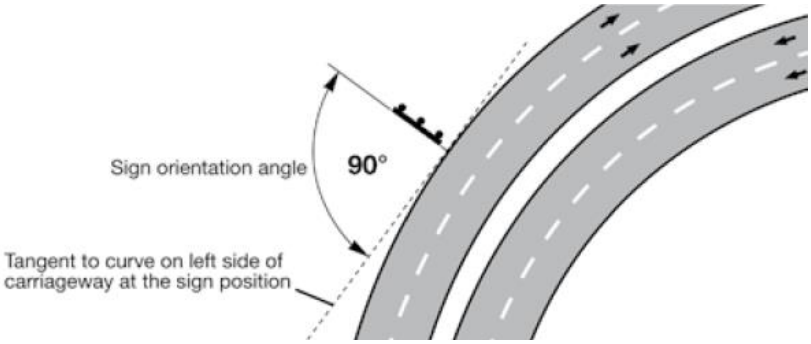


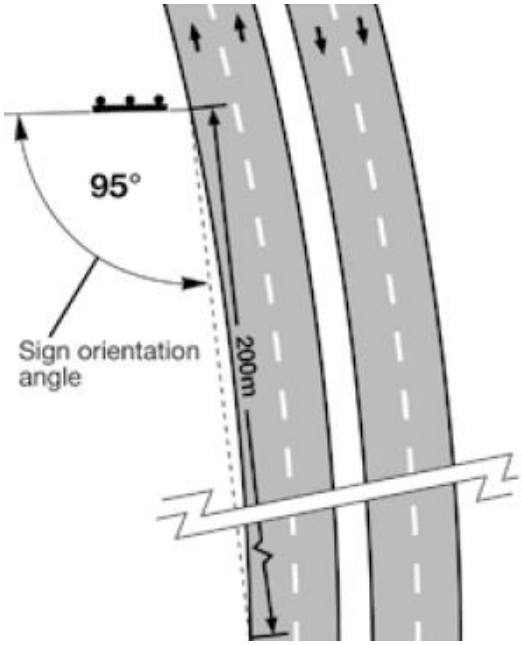
General guidelines for posting of signs

- Height-
  Where possible the lower edge of the sign should be between 900mm and 1500mm above the highest point of the road alongside. Where they are erected on footways and transverse to them they must allow sufficient clearance for pedestrians: 2100mm is the absolute minimum recommended but 2300mm is preferable.
- Placement-
  Signs should be set at least 450mm from the edge of the road. This should be increased to 600mm where there is a severe camber or a hardened verge.
- Siting-
  Signs should normally be placed on the left hand side. However, right hand side sitting is preferable at sharp left-hand bends and can also be considered where worthwhile economies are to be gained such as at T junctions where one sign facing both ways will suffice instead of a sign on the left for each approach. For signs like speed limits and No Entry, duplication of signs on both sides is recommended. The distance at which the sign is put up before the indicated site depends on the average speed of traffic on the road.

- Orientation-







9. Services

a. List of utilities which need to be planned for while deciding road design

- Telecommunication network;
- District cooling system (if applicable)
- Gas network;
- Wastewater collection system;
- Urban storm water drainage system;
- Water distribution system;
- Landscape irrigation water supply system;
- Power supply, including high voltage (HV) that supplies primary substations, medium voltage (MV), low voltage (LV);
- Fiber optic networks, including fiber optic systems to include: Traffic control and management systems; Safety & emergency response system; and
- Street Lighting.

b. Placement of utilities

- Within footpath: Generally, all services should be planned within the footpath zone, in the medians or under parking, never in the carriageway.
- Location of Manhole chambers for utilities shall be staggered to avoid congestion.
- The plantation zone is known as 'verge': Services should be avoided under the verge but if needed, due to congestion in the footpath, can be planned. In such cases, only plants with shallow root systems should be planted in such verges.
- Within carriageway: Generally no services should be planned in the carriageway. If really needed, due to congestion in the footpaths, carriageways can have sewer and storm water drains under them. This shall be done only with approval of HOD-Design or Director-Design.

c. Prioritization of Utilities in Placement

- While location the utilities, following prioritization shall be followed:
    a. The telecom corridor shall have the first priority since this utility is more frequently accessed than the other utilities placed under the carriageway;
    b. The second priority shall be given to the district cooling system, if required;
    c. The third priority shall be given to the gas system provided the minimum safe distance from the plot boundary (as per the utility provider requirements) is satisfied; and
    d. The wastewater corridor shall be the fourth priority, followed by the storm water drainage corridor.

d. Service crossings

- Vertical Clearance: The minimum vertical clearance when crossing a utility is 0.3 m. All vertical clearances are measured from the closest outside edge to the closest outside edge of the utility plant.
- Horizontal clearance: The minimum horizontal clearance between utilities is 0.9 m, with the exception of access chambers, valve boxes and street light bases etc. where the minimum horizontal clearance between these and other utilities is 0.3 m. All horizontal clearances are measured from the closest outside edge to the closet outside edge of the utility plant. However, minimum horizontal clearance of 1.5 m is required from sewer line if a new sewer line is being added adjacent to other live utilities.
- **Driveways: While crossing across driveways (from one side of the road to other), adequately oversized conduits should be placed so that any future addition of capacity does not require the driveway to be dug up. Alternatively, utility tunnels may be considered for such crossings (see note below, generally quite expensive).**

  A representative section – which takes into account both horizontal as well as a vertical separation is displayed for reference below – this is indicative only and does not reflect an actual or mandated section

e. Utility tunnels:

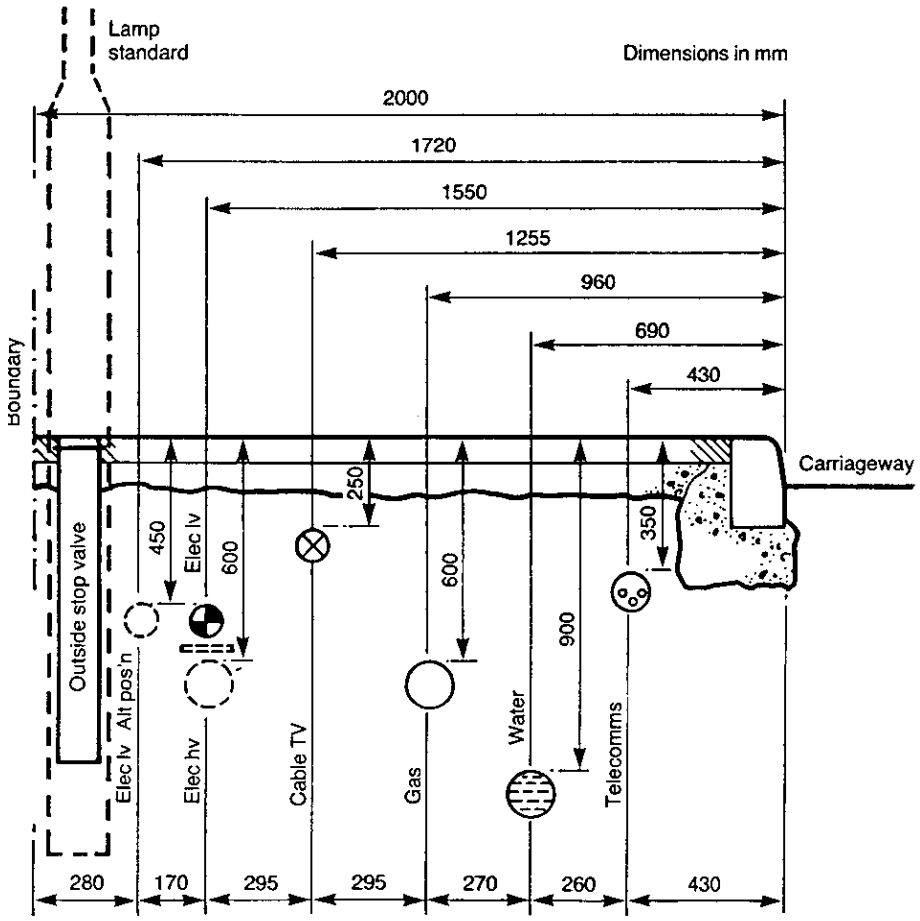


Figure 9.1: Indicative Section for Utilities

Advantages of Utility Tunnels include:

- They provide easier accessibility to utilities for maintenance, upgrading and future expansion.
- They can also minimize environmental impacts like noise, vibration, dust, disruption to traffic and services, street maintenance requirements.

Limitations / disadvantages of Utility Tunnels include:

- High initial construction cost as compared to traditional open excavation methods.
- Issue of compatibility between the utilities housed in the tunnel. A defect in one system may adversely affect the other systems. There has been considerable concern about compatibility between utilities, issues such as induction between electrical and communication lines, gas conduits explosion hazards, in tunnel temperature rising due to heating and electrical lines.
- A utility tunnel may be required for boulevards with absolute minimum Right-of-Way where the Right-of- Way may not be sufficient for installing all the utilities, while respecting the utility providers / agencies corridor requirements.
- A utility tunnel is considered an optimal solution to avoid underground crowding of utilities in narrow Right-of-Ways. However the use of utility tunnels shall be justified and subject to the approval of UPC. It can only be considered for a limited number of cases over short distances.

- **Design considerations for utility tunnels:**
  - Wet utilities shall be separated from the dry utilities and installed in a separate compartment.
  - Tunnels shall be designed to be a walk-through system. Tunnels shall be designed to provide walkway access, and allow for removal and replacement of valves, expansion joints etc.
  - Tunnels shall typically have a minimum of 4.0m clear interior height.
  - Tunnels shall not be less than 4.0m wide. This width is intended to accommodate not less than a 1.0m interior clear walkway width between the anticipated utility lines and their support systems.
  - Tunnels shall be accessible through on-grade entrances with sloped hatches and sloping walkways.
  - Tunnels shall be properly ventilated; ventilation shafts shall be constructed at a minimum spacing of 50-75m or as deemed necessary based on actual tunnel dimensions.
  - Lighting shall be designed to maintain a minimum light level of 150 LUX at the walk surface.
  - Wet utilities tunnels shall include floor drains draining into a sump.
  - Cable joints shall not be allowed in tunnels.
  - Utility pipes and cables shall be secured and fixed in their locations in the tunnel; for example, cables shall be supported with cable cleats every 1.0 – 1.5m.

f. Drainage: SWD drains may be either box-drains or Hume Pipes with catch basin covered with grating/ kerb inlet at regular intervals, generally at 15m intervals. This can be reduced as per site condition. If SWD is under footpath, then pipe drains should be used. If SWD is under parking or carriageway area, then box drains should be used as they can handle the weight of the vehicles.

g. Irrigation: Irrigation and road washing needs are mandated to be met by recycled water. For linear landscaped areas (medians, along footpaths), use manual method, QRC (quick release cork) are to be provided at 60m intervals. QRC location has to be planned such that there is no cross-over of hose across carriageways. Sprinklers are to be used for areas with a minimum diameter of 6m. These may include traffic islands, large landscaped areas, public parks etc.

10. Others

a. Guard houses

- The Guard house at entry should be on the same side of the road as the 'Driving In' Direction. The footpath at entry should be on the same side of the road as the 'Driving In' direction. The Guard House should be located between the driving lane(s) and the footpath, to enable the Guard house to control both car and pedestrian entry simultaneously.
- The vehicular entry should primarily be controlled by boom barriers, which may be operated from the Guard House through push button/equivalent or from the vehicle through RFID/dial pad/equivalent. The pedestrian entry should be controlled by a magnetic lock wicket gate, which may be operated from the Guard House through push button/equivalent or by through swipe card/dial pad/equivalent. The guard house should have communication with the residences through intercom/equivalent. The vehicular entry should be 'lockable' in emergency situations by a sliding/openable gate, which gate will be kept open at all times (except in emergency) – since such gate will be seldom use, its aesthetics are not very important. (Refer to 'Security Design Guidelines').

Annexure 1- MAINTENANCE OF ROAD WORKS

BITUMINOUS WORK IN CONNECTION WITH MAINTENANCE AND REPAIRS

Filling Potholes and Patch Repairs:

The work shall include the removal of all failed material, in the pavement courses and, if necessary, below the pavement, until the root cause of the failure is removed; the trimming of the completed excavation to provide firm vertical faces; the replacement of material of at least as high a standard as that which was, originally specified for the pavement layer; the painting of tack coat on to the sides and bases of excavations prior to placing of any bituminous materials and the compaction, trimming and finishing of the surfaces of all patches to form a smooth continuous surface, level with the surrounding road.

Materials :

All materials used for the pothole and patch repair of bituminous surface and underlying layers shall be in accordance with this Specification and shall be of the same type as specified for the original construction. A mix superior to the one on the existing surface may also be used for repair work. An emulsified bitumen/modified bitumen mix compatible with the existing layer shall also be considered appropriate.

The bituminous mixture used for such patch repairs shall be in accordance with the appropriate Clause of these Specifications. Materials to be used for patching shall always be of the same type and standard of construction as, or better than, the material being patched at the same level of construction. Materials used for patching shall never be of lesser bearing capacity nor of a greater porosity than the adjacent previous construction. Non-bituminous material must not be used for patching bituminous materials.

Preparation of the area for pothole and patch repair :

Each pothole and patch repair area shall be inspected and all loose material removed. The area shall be cut/trimmed either with jack hammers or with hand tools suitable for the purpose, such that the defective material responsible for the failure is all removed and such that the excavation is of a regular shape.

The edges of the excavation shall be cut vertically. The area shall be thoroughly cleaned with compressed air or any appropriate method approved by the Engineer to remove all dust and loose particles. Layers below the level of the bituminous construction shall be replaced using material of the equivalent specification to the original construction, which shall particularly include the specified standards of compaction. The area for bituminous construction shall be tacked or primed with cutback or emulsion depending upon whether the lower area is bituminous or granular in nature. The sides, however, are to be painted with hot tack coat material.

Backfilling operation :

The mixture to be used in bituminous patching shall be either a hot mix or a cold mix in accordance with the appropriate Clauses of these Specifications. Mixing shall be done in a plant of suitable capacity. The bituminous mixture shall be placed in layers of thickness not more than 100 mm (loose) and shall be compacted in layers with roller/plate compactor/hand roller/rammer to the compaction standards defined in the appropriate Clauses of these Specification& While placing the final layer, the mix shall be spread slightly proud of the surface so that after rolling, the surface shall be flush with the adjoining surface. If the area is large, the spreading and levelling shall be done using band shovels and wooden straight edges. During the process of compaction, the surface levels shall be checked using a 3m straight edge.

Crack Sealing:

Scope: Crack sealing shall consist of one or more of the following operations as instructed under the Contract:

1. fog seal
2. filling cracks with a binder, or a combination of crusher dust and a binder
3. by treating the crack sealing as a patch repair.

Fog seal:

Scope : Fog seal for use in maintenance work shall consist of an application of emulsified bitumen, without any aggregate cover for sealing fine hair cracks or for rejuvenating oxidised bituminous surfaces. Areas having cracks with less than 3mm width shall be considered for this treatment, unless otherwise instructed by the Engineer.

Material: Bituminous emulsion for Fog Seal shall be of a slow setting type.

Application : The area to be treated with fog seal shall be thoroughly cleaned using compressed air, scrubbers, etc. The cracks shall be cleaned with a compressed air jet to remove all dirt, dust, etc. The fog seal shall be applied at the rate of 0.5 1.0 litre/sq.m. of emulsion, or as otherwise instructed by the Engineer, using equipment, such as, a pressure tank, flexible hose and spraying bar or lance. Traffic shall be allowed on to the surface only after the seal has set to a non-tacky and firm condition so that it is not picked up by the traffic.

Crack filling

Scope: Crack filling shall be carried out using a binder of a suitable viscosity, normally a slow-curing bitumen emulsion. For wider cracks, in excess of an average of 3 mm in width the application of emulsion may be preceded by an application of crusher dust, or other fine material.

Materials: Bitumen for use in crack sealing shall be of a slow curing type. Dust for crack sealing, when used, shall be crusher dust or some other suitable fine material approved by the Engineer, passing the 4.75 mm sieve but with a maximum of 10 per cent passing the 0.075 mm sieve.

Construction: If dust is to be used it shall be placed in the cracks before the application of binder and the cracks filled to a level approximately 5 mm below road surface level. The surface of the road shall be swept clear of dust prior to the application of binder. Binder shall be poured into the cracks, taldng care to minimise spillage. If spillage onto the road surface does occur, dust shall be applied to the excess bitumen until it is blotted up.

Dusting

Scope:

Dusting shall consist of the application of crusher dust or other fine graded material to areas of road where bleeding of excess bitumen is occurring.

Material:

Dust shall consist of crusher dust or other graded fine material acceptable to the Engineer, and shall generally be finer than 3.0 mm with not more than 10 per cent passing the 0.075 mm sieve.

Dust shall be spread by manual application, to the areas of road defined by the Engineer. Dust shall generally be applied during the hottest part of the day and surplus dust displaced by passing traffic shall be manually swept back onto the area where further bleeding of excess bitumen is apparent. Dust shall be applied at a, nominal rate of 2.5 kg per square metre.

MAINTENANCE OF CEMENT CONCRETE ROAD:

Repair of Joint Grooves with Epoxy Mortar or Epoxy Concrete

Scope :

The work shall consist of repair of spalled joint grooves of contraction joints, longitudinal joints and expansion joints in a concrete pavement using epoxy mortar or epoxy concrete.

Materials : The type /grade of epoxy compatible with the coefficient of thermal expansion of concrete shall be used with either processed fine aggregate or fine stone chips to produce a dry mix for repairing spalled or damaged edges.

Repairing Procedure:

Spalled or broken edges shall be shaped neatly with a vertical cut with chisels into the shape of rectangle. Small pneumatic chisels also may be used, provided the cutting depth can be controlled. The depth of the cut shall be the minimum to effect repair. After shaping the spalled area, it shall be cleaned and primed. The epoxy mortar/concrete is then applied using hand tools like trowels, straight edges, brushes etc. The repaired edge shall be in line with the joint groove and shall be flush with the concrete slabs. During the repair work, any damage noticed to the joint sealant shall be made good by raking out the affected portion and resealing.

Repair Involving Removal of Old Joint Sealant and Sealing with Fresh Sealant in Cement Concrete Pavements

Scope:

The repair of sealant of contraction, longitudinal or expansion joints shall include removal of the existing sealant and resealing the joint with fresh sealant material.

Material:

Sealant material to be replaced shall be either hot poured rubberised bitumen or polysulphide type of sealant. As per the recommendation of the manufacturer, appropriate type of primer also shall be applied.

Repairing procedure: The existing sealant shall be raked out with the help of a metal raker such that most of the sealant is removed. Subsequently, the sealant stuck to the sides of the grooves shall be removed thoroughly either by using saw cutting machine so that grooves may be widened by one mm or by sand blasting. In no base the old sealant shall be present during resealing operation. If joint grooves are found inadequate in depth, they shall be deepened as directed by the Engineer.

Before commencing the sealing operation, compressed air shall be used to clean the joint grooves to clean the joint groove. A heat resistant, paper backed compressible debonding strip or tape should be inserted in accordance with the requirement. Sealant may be poured either using hand held pourer or using mechanised sealing machines. Sealants should not be heated directly but in double-jacketed machine. All precautions and arrangements shall be taken not to spill the sealant on the concrete pavement. The sealant may be poured to a depth of 5 ± 2 mm from the pavement surface.

Annexure 2 – Manual of Traffic signs



Standard Sign Colors

Red - used for STOP and YIELD signs, multiway supplemental plates, DO NOT ENTER and WRONG WAY signs, for legend or symbols on some regulatory signs, and as part of Interstate and some state route markers

Fluorescent Pink - used as background color for incident management signs

Coral - reserved for future use

Orange - used as background color for temporary traffic control signs

Yellow - used as background color for warning signs (except temporary signs) and school signs

Fluorescent Yellow-Green - used as background color for pedestrian, bicycle, and school warning signs


Green - used as background color for guide and information signs, and for legend on permissive regulation and parking signs
Light Blue - reserved for future use
Blue - used as background color for traveler services information signs, emergency evacuation route signs, and as part of Interstate and some state route markers
Purple - reserved for future use
Brown - used as background color for guide and information signs related to points of recreational or cultural interest
Black - used as background color for ONE WAY, night speed limit, and truck regulatory signs, and as legend color on signs with white, yellow, orange, fluorescent pink, and fluorescent yellow-green backgrounds
White - used as background color for most regulatory signs and some route markers, and as legend color on signs with red, green, blue, brown, and black backgrounds