



Government of Nepal



Nepal Rural Road Standards (2055) 2nd Revision, 2071



Ministry of Federal Affairs
and Local Development

Department of Local Infrastructure
Development and Agricultural
Roads (DoLIDAR)



December 2014



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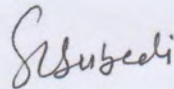
Foreword to Second Revision

I am pleased to bring forward this second revision of Nepal Rural Road Standards 2055; in order to provide valuable insight in setting the classification and geometric design standards for motorable bridges in the Local Road Network (LRN). It provides necessary guidance to all concerned bodies for maintaining consistency in local road bridge design and construction while implementing roads bridge projects/programmes.



Nepal Rural Road Standards is a prerequisite for planned development of rural roads and published in 2055 BS (1999). The first revision of Nepal Rural Road Standards 2055 was made in 2069 (January 2013). It has proved as cornerstone for carrying out road construction, upgrading and maintenance of local roads to provide all weather road access. However, it has not included many aspects of motorable bridges. Hence, the present revision has accommodated Motorable Bridge classification, carriageway and footpath/kerb in Local Road Network making it compatible with national practices.

This revised Standard shall be followed by all Government Institutions involved in LRN, Local Bridge Programmes/Projects as well as other stakeholders involved in the implementation of rural road bridges maintaining better technical standard.

A handwritten signature in black ink, appearing to read 'S. Subedi'.

Dr. Somlal Subedi

Secretary

Ministry of Federal Affairs and Local Development

Singha Durbar

Preface to Second Revision

Nepal Rural Road Standards was published by DoLIDAR in 2055 BS (1999) for development and management of local roads with minimum geometric standards. DoLIDAR is now responsible for the Local Road Network (LRN) of the whole country as well as bilateral and multilateral donor projects carrying out road construction, upgrading, maintenance and motorable bridge construction.



Because of significant change in LRN policy, there is a shift in priority from new construction to upgrading, maintenance and joining river crossing with bridges with an aim to provide all weather road access. This in turn has prompted the first revision of the Nepal Rural Road Standards (2055) in January 2013. It has provided DoLIDAR with the opportunity to make necessary changes in design to tackle issues relating to increasing scope of LRN, road safety and other mitigation measures.

This second revision has mainly based on the coordinated efforts and feedback from concerned professionals and agencies involved in the LRN sector, especially motorable bridge construction programme/projects. The present revision has accommodated aspects such as Motorable Bridge classification, carriageway and footpath/kerb making it compatible with national practices addressing the local needs.

This second revised version has been carried out with the support from Swiss Agency for Development Cooperation (SDC) funded Local Roads Bridge Programme (LRBP). In the meantime, I would like to express our gratitude to all the team members of DoLIDAR and other agencies involved directly and indirectly in the preparation and revision of this Standard.

A handwritten signature in black ink, appearing to read 'JK Shrestha'.

Er. Jeevan Kumar Shrestha

Director General

Department of Local Infrastructure Development and
Agricultural Roads (DoLIDAR)

Shreemahal, Pulchowk

Foreword

I am pleased to bring forward this first revision of Nepal Rural Road Standards, 2055 in order to provide necessary guidance to the local bodies for maintaining consistency in local road design and construction while implementing roads projects/programmes utilizing various resources. The present revision has accommodated enhanced design standards making it compatible with international and national practises addressing the need of local people. With amendment in Approach Manual for Preparing DTMP, that focuses on creation and development of local road network naming "District Road Core Network" that shall be all weather pliable condition; shall be further augmented as this amendment emphasises road safety, climate change and disaster risk reduction.

This revised standard shall be followed by all local government institutions, Local Road Programmes/Projects as well as other stakeholders involved in the implementation of rural roads maintaining better technical standard.

Finally, I would like to express my sincere thanks to all team members involved in revision of this standard and also express my gratitude to the Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR) for taking the initiative timely.

Shanta Bahadur Shrestha
Secretary
Ministry of Federal Affairs and Local Development
Singha Darbar

Preface

DoLIDAR's establishment has been instrumental in formulating technical documents that are applicable for implementation of physical infrastructures at local level and these documents have, to some extent, replaced the culture of haphazard investment by planned one. Among these, Rural Road Standards, 1999, was published considering it locally acceptable, easily implementable and simple, for development of local roads with minimum geometric standards then. In due course, DoLIDAR has become technically more capable and competent and accordingly the local road network has crossed 51,000 from a few kilometres of earthen, gravelled, black topped, fair weather and all weather roads. DoLIDAR is now also responsible for the Local Road Network (LRN) of the whole country as well as bilateral and multilateral donor projects carrying out road construction, upgrading and maintenance.

In the past two years there has also been a significant change in LRN policy including the revision of the District Transport Master Plans (DTMP) to link District to VDC HQs by means of all-weather District Road Core Network and a shift of priority from new construction to upgrading, maintenance and joining river crossing with bridges. This in turn has prompted the revision of the 1999 Rural Road Standards in January 2013 and provided DoLIDAR with the opportunity to make changes designed to tackle issues relating to cater present increasing scope of LRN, road safety, climate change and disaster risk reduction.

The revision has been carried out with support from UK AID through DFID, including Technical Assistance by RTI Sector Maintenance Pilot to DoLIDAR's Technical Committee which has led the review process. As a result of coordinated efforts by professionals both within and outside the Government of Nepal, I would like to thank the members of the DoLIDAR Technical Committee, including Messrs' Ganga Bahadur Basnet, Coordinator, Kumar Thapa (SDE-DoLIDAR), Jeevan Guragain (SDE-DoLIDAR), Krishna Bahadur Katuwal (Engineer-DoLIDAR) and Manoj Krishna Shrestha and Mitra Bahadur Shrestha of the Pilot TA team.

I am also grateful for the direction and guidance of the DDGs, Messrs Bhim Prasad Upadhyaya and Ram Krishna Sapkota and TA Team Leader Michael Green, who have been instrumental in shaping this revision. I would also like to express my gratitude to all the DoLIDAR Senior Divisional Engineer, Engineers, and representatives from different stakeholders who provided their comments on the initial draft during the District and Central level stakeholder workshops.

Any comments or suggestion regarding the improvement of this standard will be highly appreciated.

Bhupendra Bahadur Basnet
Director General
DoLIDAR

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ABBREVIATIONS AND ACRONYMS

DDC	District Development Committee
DoLIDAR	Department of Local Infrastructure Development and Agriculture Roads
DoR	Department of Road
DRCN	District Road (Core Network)
DTMP	District Transport Master Plan
DTO	District Technical Office
GoN	Government of Nepal
HFL	Highest Flood Level
HQ	Head Quarter
IRC	Indian Road Congress
Km/hr	Kilometer per Hour
LRN	Local Road Network
m	Metre
NRRS	Nepal Rural Road Standard
PCU	Passenger Car Unit
RoW	Right of Way
SEACAP	South East Asia Community Access Programme
SWAp	Sector Wide Approach
VDC	Village Development Committee
vpd	Vehicle Per Day
VR	Village Road

1 BACKGROUND

The Nepal Rural Road Standards (NRRS) were introduced in 2055 to set the classification and geometric design standards for the Local Road Network (LRN) to be followed by all those involved in the development of the network, including Users, User Committees, VDCs, DDCs, DTOs, DOLIDAR and its development partners.¹

It was revised in 2010 during the preparation of interim guidelines for District Transport Master Plan (DTMP) for the SWAp Pilot Districts, when existing district roads were reclassified as District Roads 'A' and all previous village roads were reclassified as District Roads "B" with no change in their geometric design parameters.

In March 2012 the Nepal Road Sector Assessment Study was completed together with recommendations regarding simplifying the DTMP to make it easier to understand, cheaper to implement and less time consuming. This review concluded that LRN investment should change its approach to new construction and concentrate on upgrading to a core network of maintainable, all-weather roads linking the District Centre to the VDC HQ's office or growth centre. This core district road network is defined as the minimum network necessary to ensure maintainable, all-weather access to all VDC HQs. If VDC HQs have not yet been connected to this network, new roads will need to be constructed. All roads not included in the core network will become village roads.

The all-weather construction of the core network has meant that the design speeds of the district roads has had to be increased and this has prompted a review of the geometric design standards for LRN. It has also provided DoLIDAR with the opportunity to make changes designed to tackle issues relating to road safety, climate change and disaster risk reduction.

2 DEFINITIONS

Camber – is the convexity given to the cross section of the surface of the carriageway to facilitate drainage

Horizontal Curve – is the curve in plan to change the direction of the centreline of a road

¹ *The standards for Strategic Road Network – National Highways, Feeder Roads, which are under the jurisdictions of Department of Roads (DoR) are excluded in this document but are available in the 'Nepal Road Standard (2027) – Second Revision'.*

Vertical Curve – is a curve in longitudinal section of a roadway to provide for easy and safe change of gradient

Hairpin bend – is a bend in alignment resulting in reversal of direction of flow of traffic. A bend may be of reversing road direction on same face of hill slope.

Ruling minimum radius of curve – is the minimum radius of curvature of the centreline of a curve necessary to negotiate a curve at ruling minimum design speed

Absolute minimum radius of curve – is the minimum radius of centreline of a curve necessary to negotiate a curve at absolute minimum design speed.

Ruling gradient – is the maximum gradient within which designer attempt to design the vertical profile of a road.

Limiting gradient – is gradient steeper than a ruling gradient and may be used in restricted lengths where maintaining ruling gradient is not feasible

Exceptional gradient – is a steeper than a limiting gradient, which may be used in short stretches only in extraordinary situation

Roadway width – is the sum total of carriageway width and shoulder width on either side. It is exclusive of parapets and side drains

Road lane width – refers to the width of carriageway of the road in terms of traffic lane.

Formation width – is the finished width of earthwork in fill or cut

Sight distance – is the distance along the road surface at which a driver can see objects (stationary or moving) at a specified height above the carriageway.

Super elevation – is the inward tilt or transverse inclination given to the section of a carriageway on a horizontal curve to reduce the effects of centrifugal force on a moving vehicle. Super elevation is generally expressed as a slope.

3 RURAL ROAD CLASSIFICATION

District Road (Core Network) - An important road joining a VDC HQ's office or nearest economic centre to the district headquarters, via either a neighbouring district headquarters or the Strategic Road Network.

Village Road - Smaller roads not falling under District Road (Core Network) category are Village Roads, including other Agriculture Road.

4 TERRAIN CLASSIFICATION

A simple classification of Terrain into 'Terai' and 'Hill' is adopted based on the topography of country. While classifying terrain, short isolated stretches of varying terrain should not be taken into consideration. Generally, 'Terai' covers the plain and rolling terrain and varies from 0 to 25 percent cross slope, 'Hills' covers mountainous and steep terrain and varies from 25 to 60 percent and more.

5 TRAFFIC

It is not financially viable to improve the standard of a rural transport link by a small margin since the heavy cost involved is not justified by the marginal benefits. Therefore, it is the accepted practice to design and construct new transport links or upgrade the existing ones using a traffic volume which is anticipated at some future date. For rural transport linkages in Nepal, the period shall be 10 years² i.e. the road shall be design with a capacity sufficient to cope with the estimated traffic volume 10 years after the date of completion of the works.

5.1 Vehicle type and dimension

In Nepal the most commonly used vehicles are of Indian make. Vehicle types adopted here are 'Type-2 both single tire and dual tire' having two axles and the maximum axle weight is 10.2 tonnes for rear axle with the following dimension.

Width – overall width 2.5 m

Height – 3.8 m for normal application

Length of wheel base – 6.1 m

Length – maximum overall length excluding front and rear bumpers, 11 m.

(Source: IRC: 64-1990)

5.2 Equivalency Factors

The result of the presence of slow moving vehicles in a traffic stream is that it affects the free flow of traffic. A way of accounting for the interaction of various kinds of vehicles is to express the capacity of a road in terms of a common unit such as the 'passenger car unit'. Tentative equivalency factors for conversion of different types of vehicles into equivalent passenger cars units are given in the Table below. These factors are meant for open sections and should not be applied to road intersections.

² Considered same as Nepal Rural Road Standard (2055)

Table 1- Equivalency Factor

SN	Vehicle Type	Equivalency Factor
1	Car, Light Van, jeeps and Pick Up	1.0
2	Light Truck up to 2.5 tonnes gross	1.5
3	Truck up to 10 tonnes gross	3.0
4	Truck up to 15 tonnes gross	4.0
5	4W Tractor towed trailers -standard	3.0
6	2W Tractor towed trailers -standard	1.5
7	Bus up to 40 passengers, Minibus	3.0
8	Bus over 40 passengers	4.0
9	Motorcycle or scooter	0.5
10	Bicycle	0.5
11	Rickshaw and Tricycle carrying goods	1.0
12	Auto Rickshaw	0.75
13	Hand Cart	2.0
14	Bullock Cart with Tire	6.0
15	Bullock Cart with Wooden Wheel	8.0
16	Mule or Horse drawn carts	6.0
17	Pack Animal and mules	2.0
18	Pedestrian	0.2
19	Porter	0.40

(Source: Nepal Rural Road Standard, 2055)

5.3 Design Capacity

It is advisable to design the width of a road pavement for a given traffic volume so that it meets the Level of Service B, defined as a stable flow zone which affords reasonable freedom to drivers in terms of speed selection and manoeuvres within the traffic stream. At this level, the volume of traffic will be around 0.5 times the maximum capacity. This is the 'design service volume' for the purpose of adopting design values.

Design Parameters	District Road (Core Network)		Village Road	
	Hill	Terai	Hill	Terai
Design Capacity– in both directions (Vehicle per day/PCU per day)	200 (400)	400 (800)	100 (200)	200 (400)

(Source: Nepal Rural Road Standard, 2055)

5.4 Design Speed:

Design speed is one of the basic parameters that determine geometric design features. The choice of design speeds is linked to terrain and road function and is shown in the table below. Normally ruling design speed should be the guiding criterion for the purpose of geometric design. Minimum design speed may, however, be adopted where the site condition and cost does not permit a design based on 'Ruling Design Speed'

Road Categories	Hills		Terai	
	Ruling	Minimum	Ruling	Minimum
District Road (Core Network)	25	20	50	40
Village Road	15		30	

6 CROSS SECTION

6.1 Carriage Way Width:

The width of the carriageway depends on: The dimensions of vehicles using the road, Speed of travel, Traffic volume, Width of shoulder

For district road (core network) with low volume of traffic (< 100 vpd), single lane operation is adequate as there will be only a small probability of vehicles meeting. The low number of passing manoeuvres can be undertaken at reduced speeds using either passing place (in Hill) and shoulders (in Terai), providing sight distance are adequate for safe stopping. These manoeuvres can be performed without hazards and overall loss in efficiency brought about by the reduced speeds will be small as only a few such manoeuvres will be involved. It is not cost effective to widen the running surface in such circumstances and a basic width of 3.0 m will normally suffice.

Carriage way width of District Road (core network) is 3.75 m but can be reduced to 3 m where traffic volume is less than 100 motorized vehicles per day and where the traffic is not likely to increase.

If a village Road carries a traffic volume of more than 100 motorized vehicles per day, the carriageway width will be 3.75 m and affect other design parameters accordingly.

In the case of built up/market area, extra width of pavement for pedestrians and lay-

bys can be considered with covered drains, which will be sufficient for parking other motorized and non-motorized vehicles.

For district roads (core network) with a volume of traffic > 400 vpd, single lane width may not be adequate for operation, therefore, should go for higher lane width of 5.5 m.

Desirable road surface for District Road (Core Network) is gravel or paved, whereas, for Village road is unpaved or gravel.

Standard recommended carriageway width of the road is depicted in Table 6.1 below.

6.2 Shoulder Width

Shoulder width is measured from the edge of the carriageway to the edge of the usable formation. Wide shoulders have following advantages;

- Space is available for vehicles to stand clear of the pavement
- Non-motorized traffic/pedestrian can travel with minimum encroachment on carriageway and greater safety.
- Additional manoeuvring space
- The capacity of the road can be increased by providing paved shoulder up to 15%
- Sealing of shoulder reduces maintenance costs and improves moisture condition under pavement

Non-motorized vehicles in hills are smaller than terai, hence shoulder width in hills are relatively smaller.

Shoulder widths of each type of road are presented in Table 6.1 below.

6.3 Road way width

If the available existing road way width is more than that stated below and the carriageway is to be paved, the partial remaining road way width between side drain/ditch and pavement edge can be maintained as hard shoulder and earthen shoulder.

If sufficient road way width is available and substantial movement of pedestrians and non-motorised vehicles occur, special provision should be made in this situation where such flows are significant with respect to the level of motorised vehicles movements. Some localised shoulder improvements may be appropriate as non-motorised traffic generally increases near towns and villages. The following two features are recommended

- The shoulder should be sealed

- Shoulders should be clearly segregated by the use of edge of carriageway surface marking or other measures.

Table 6.1- Carriageway, Shoulder, and Roadway width.

		Carriageway Width (m)	Shoulder width (m)	Roadway width (m)
District Road (core network)	Hill	5.5 (if traffic > 400 vpd)	0.75	7.0
		3.75 (if traffic > 100 vpd)	0.75	5.25
		3 (if traffic < 100 vpd)	0.75	4.5
	Terai	5.5 (if traffic > 400 vpd)	1.0	7.5
		3.75 (if traffic > 100 vpd)	1.5	6.75
		3 (if traffic < 100 vpd)	1.5	6
Village Road	Hill	3	0.5	4
	Terai	3	0.75	4.5

The above given road way widths exclude drain, parapet and top of retaining wall.

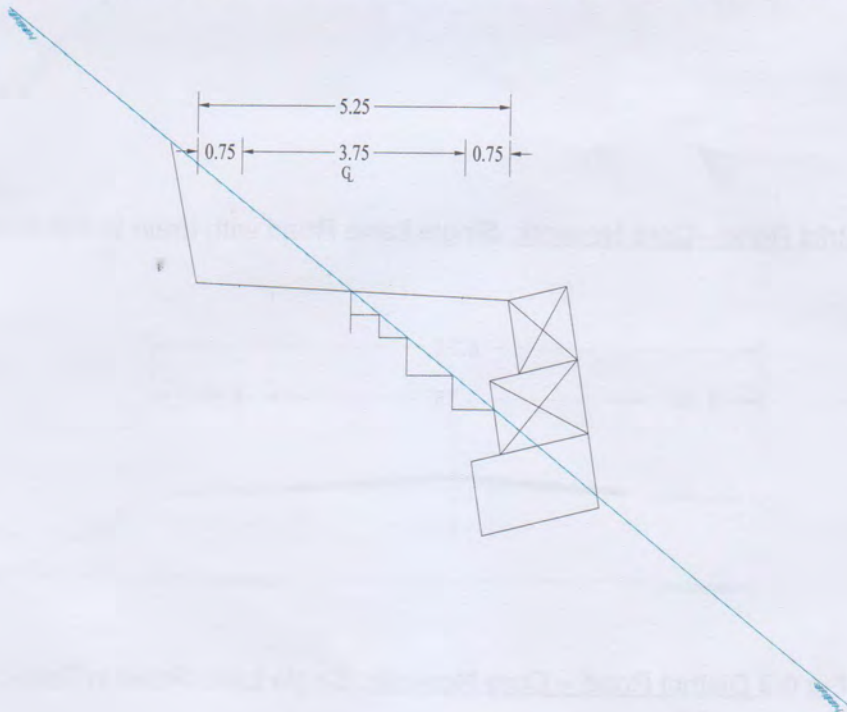


Fig 6.1 District Road –Core Network, Single Lane Road without drain in Hill area

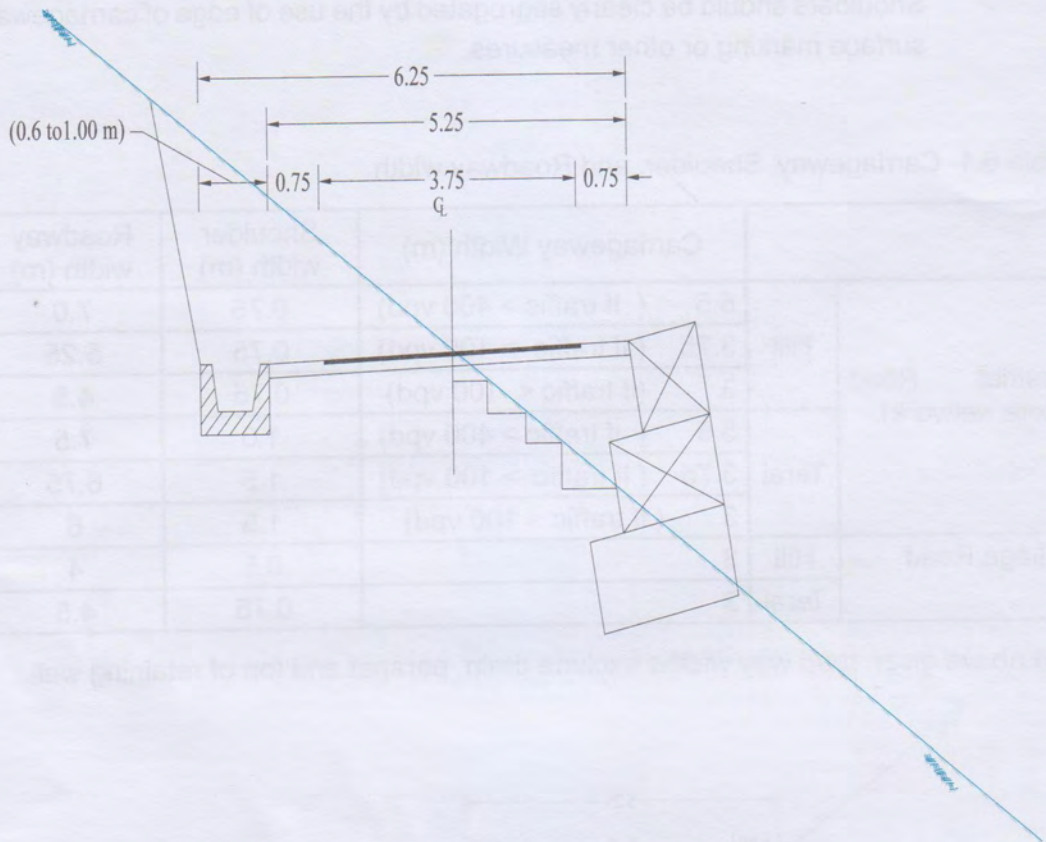


Fig 6.2 District Road –Core Network, Single Lane Road with drain in Hill area

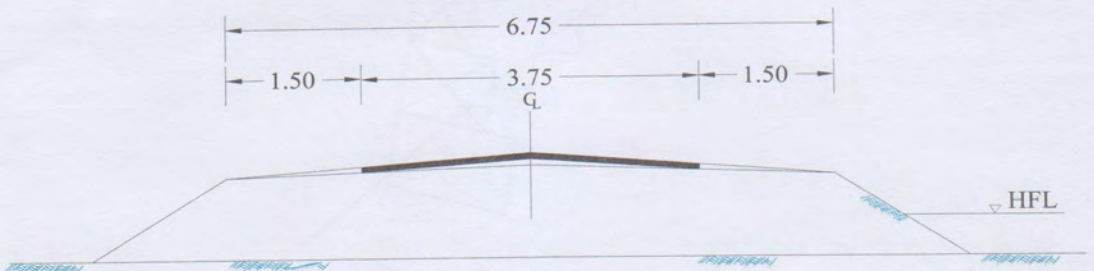


Fig 6.3 District Road – Core Network, Single Lane Road in Terai

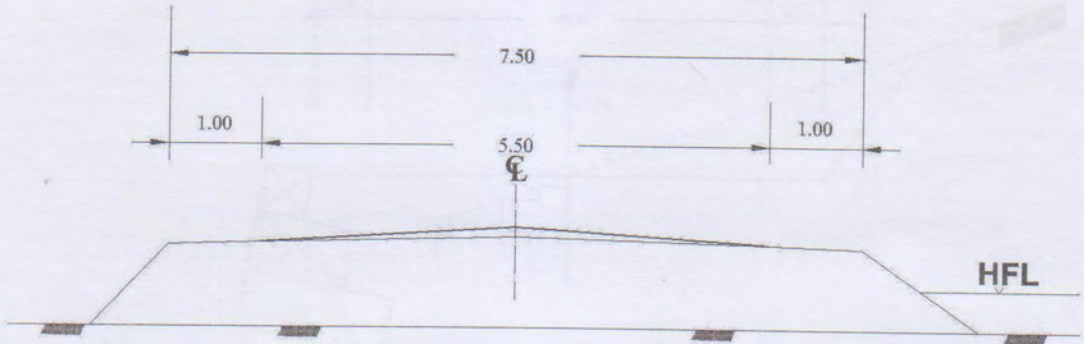


Fig 6.4 District Road – Core Network, Intermediate Lane Road without drain in Hill area

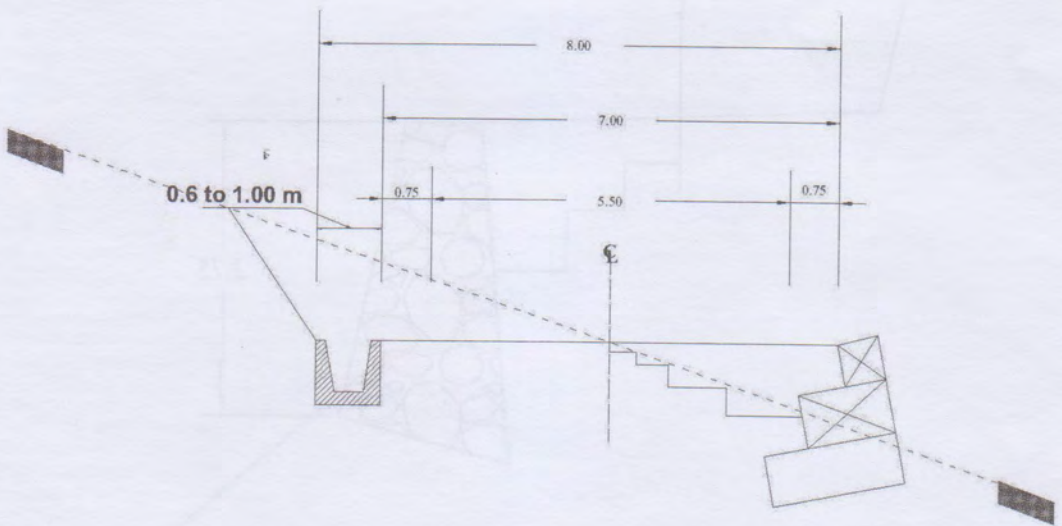


Fig 6.5 District Road – Core Network, Intermediate Lane Road with drain in Hill area

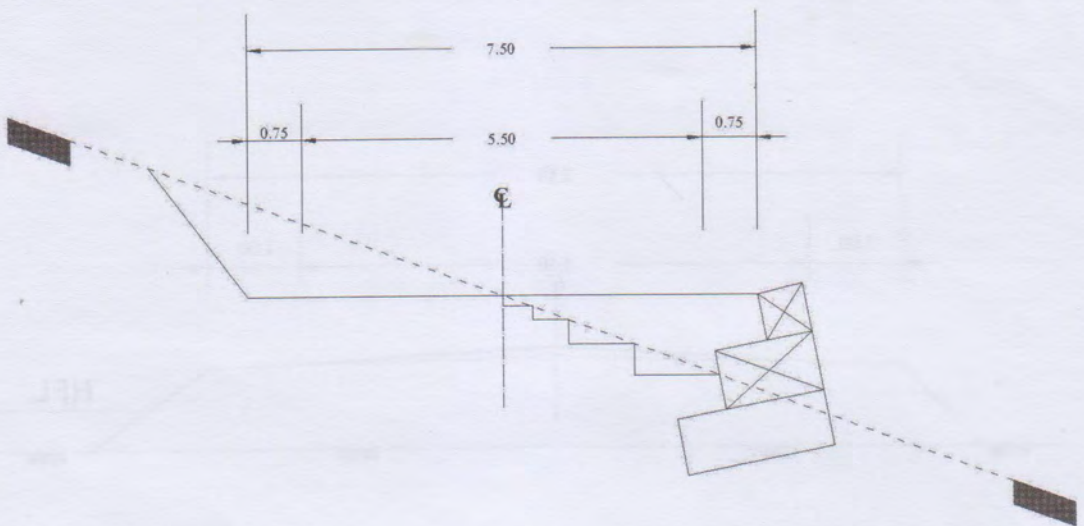


Fig 6.6 District Road – Core Network, Intermediate Lane Road in Terai

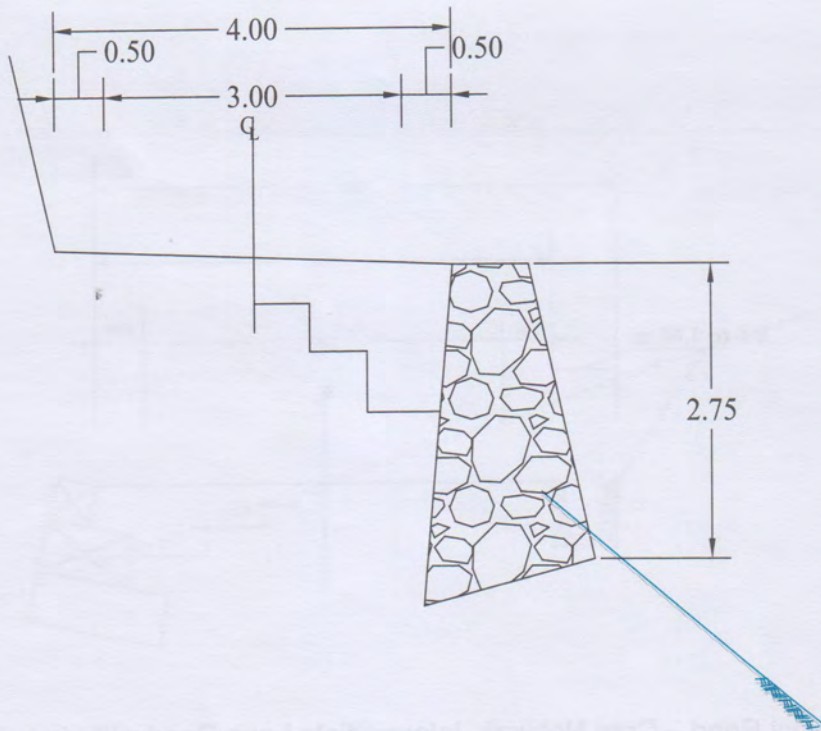


Fig 6.7. Village Road, Single Lane Road without drain in Hill area

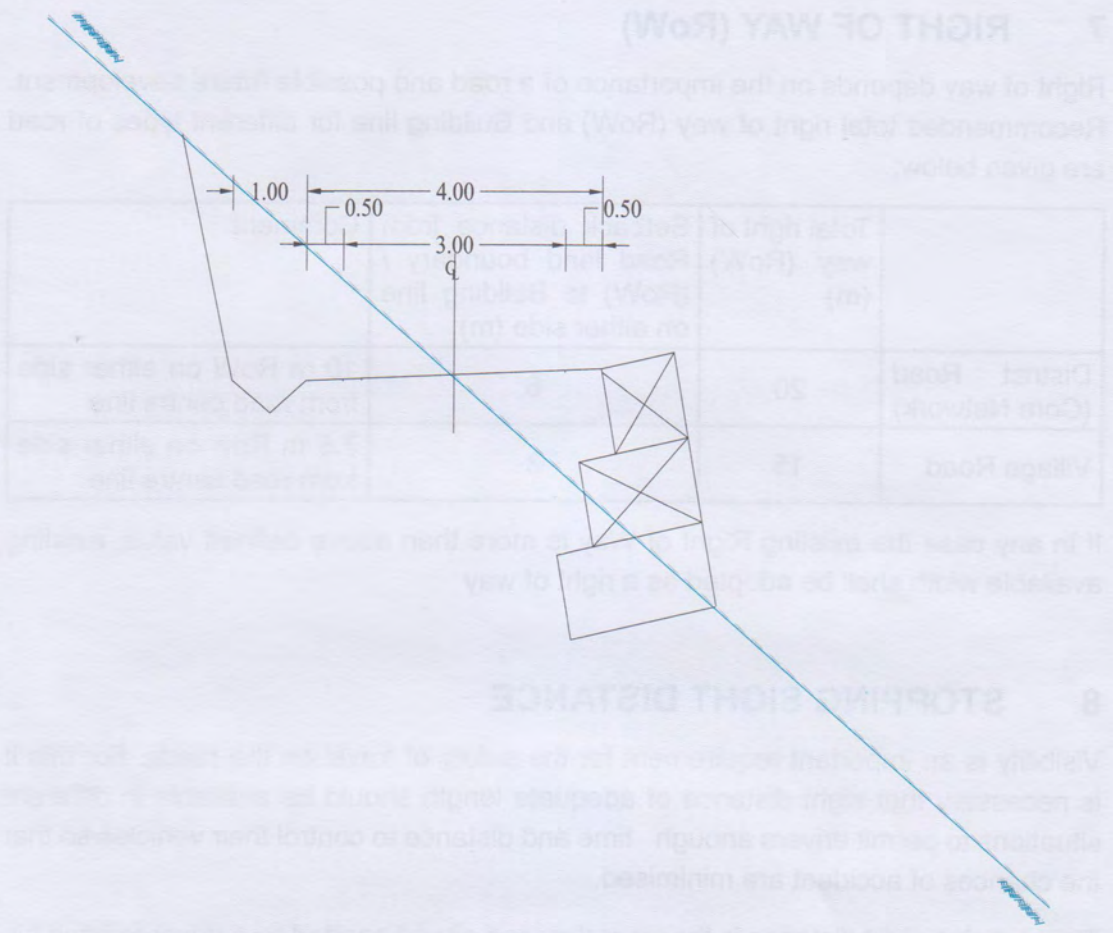


Fig 6.8 Village Road, Single Lane Road with drain in Hill area

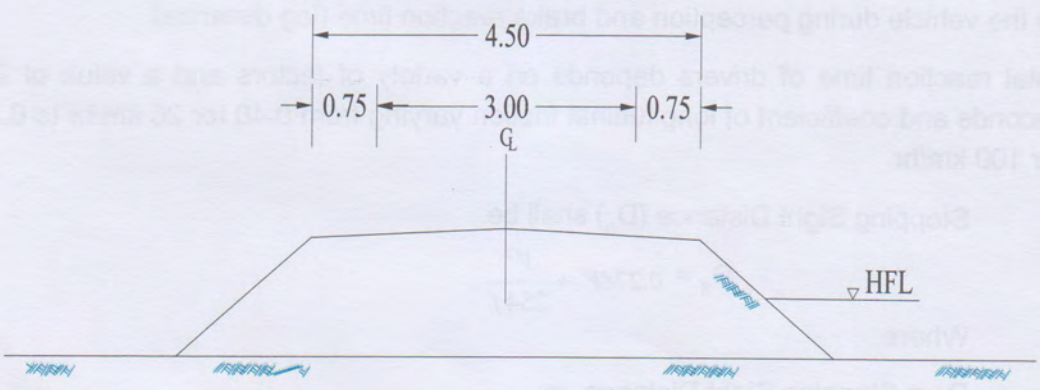


Fig 6.9 Village Road, Single Lane Road in Terai

7 RIGHT OF WAY (RoW)

Right of way depends on the importance of a road and possible future development. Recommended total right of way (RoW) and Building line for different types of road are given below:

	Total right of way (RoW) (m)	Setback distance from Road land boundary / (RoW) to Building line on either side (m)	Comment
District Road (Core Network)	20	6	10 m RoW on either side from road centre line
Village Road	15	3	7.5 m Row on either side from road centre line

If in any case the existing Right of Way is more than above defined value, existing available width shall be adopted as a right of way

8 STOPPING SIGHT DISTANCE

Visibility is an important requirement for the safety of travel on the roads. For this it is necessary that sight distance of adequate length should be available in different situations to permit drivers enough time and distance to control their vehicles so that the chances of accident are minimised.

The stopping sight distance is the clear distance ahead needed by a driver to bring his vehicle to a stop before collision with a stationary object in his path and is calculated as the sum of braking distance required at a particular speed plus the distance travelled by the vehicle during perception and brake reaction time (lag distance).

Total reaction time of drivers depends on a variety of factors and a value of 2.5 seconds and coefficient of longitudinal friction varying from 0.40 for 20 km/hr to 0.35 for 100 km/hr.

Stopping Sight Distance (D_s) shall be:

$$D_s = 0.278V + \frac{V^2}{254f}$$

Where,

D_s = Stopping Sight Distance, m

V = Speed, km/hr

t = Perception and Brake Reaction Time, seconds (2.5 seconds)

f = Coefficient of Longitudinal Friction (Varies as speed varies)

The Safe Stopping Site Distance is provided in Table 8.1

Table 8.1-Safe Stopping Site Distance

Speed, km/hr	Perception and Brake Reaction Time, t (sec)	Coefficient of Longitudinal Friction	Safe Stopping Sight Distance, m
15	2.5	0.4	15
20	2.5	0.40	20
25	2.5	0.40	25
30	2.5	0.40	30
40	2.5	0.38	45
50	2.5	0.37	60

Intermediate sight distance is twice the safe stopping sight distance. It is experienced that intermediate sight distance permits reasonably safe overtaking. Single lane roads should be designed for intermediate sight distance standard because opposing vehicles occupy the same lane. In mountainous and steep terrain, it might be difficult to design the horizontal alignment with intermediate sight distance values.

9 LATERAL AND VERTICAL CLEARANCE

9.1 Lateral clearance

Lateral clearance between roadside objects and the edge of the shoulder should normally be as given below

Hill road – normally 1.0 m but may be reduced to minimum 0.5 m in steep and difficult areas and where the cost of providing the full clearance is high.

Terai road – normally 1.5 m but may be reduced to a minimum of 1.0 m

9.2 Vertical Clearance

A vertical clearance of 5m should be ensured over the full width of roadway at all underpasses, and similarly at overhanging cliffs. The vertical clearance should be measured with reference to the highest point of the carriageway i.e the crown or super elevated edge of the carriageway. However, in the case of overhead wires, poles etc. clearance shall be at least 7.0 m above the road surface.

10 HORIZONTAL ALIGNMENT

Horizontal alignment should be as directional, fluent and match the surrounding topography to avoid abrupt changes. On new roads the curve should be designed to have the largest practical radius generally not less than the ruling value. Radii below absolute minimum should not be provided.

Sharp curves should not be introduced at the end of long tangents, since these can be extremely hazardous.

Design speed, super elevation and coefficient of side friction affect the design of circular curves.

10.1 Super elevation

Super elevation is provided to maintain the design traffic speed at a given radius.

Coefficient of Lateral Friction (f)

The value of the coefficient of lateral force depends basically upon vehicle speed, type and condition of road type and surface as well as the condition of tyres. It is assumed that factor affecting the coefficient (f) are similar in Nepal to neighbouring countries and thus the value of 'f' is adopted as per IRC recommendation i.e. if the value of 'f' = 0.15, is adopted, the passenger shall not feel discomfort.

Maximum Super Elevation Value

In plain terrain, non-motorized vehicles travel with high centre of gravity, so the maximum value of super elevation shall be limited to the following values;

Terai 7%

Hill 10%

The designer should aim at providing flatter super elevation but it should not be less than the camber.

10.2 Minimum Curve Radius

On a horizontal curve, the centrifugal force is balanced by the effects of superelevation and side friction. The following formula fulfills the condition of equilibrium:

$$e + f = \frac{V^2}{127R}$$

or

$$R = \frac{V^2}{127(e+f)}$$

Where,

V = Vehicle Design Speed, km/hr

R = Radius, m

e = Super elevation ratio, meter per meter.

f = Coefficient of side (lateral) friction between the vehicle tyres and pavement. A constant value of coefficient of side friction is adopted at 0.15.

The recommended minimum radius value is tabulated in Table 10.1

Table 10.1- Minimum Radius for Horizontal Curve

Design Speed km/hr	Recommended Minimum Radius, m	
	Super elevation e = 10%	Superelevation e = 7%
15	10	
20	12.5	
25	20	
30		30
40		60
50		90

10.3 Widening of Curve

At sharp horizontal curves, it is necessary to widen the carriageway to provide safe passage of vehicles. Widening is dependent on curve radius, width of carriageway and type of vehicle (length and width). Widening has two components: (1) mechanical widening to compensate for the extra width occupied by the vehicle on the curve due to tracing of the rear wheels, and (ii) psychological widening vehicles in a lane tend to wander more on a curve than on a straight reach.

In single lane roads the outer wheels of vehicles use the shoulders whether on the straight or on a curve. Therefore use of the mechanical component of widening should be sufficient on its own.

For single lane roads, only mechanical widening is required for low traffic speed.

$$W = \frac{L^2}{2R}$$

Where,

W = Widening, m

L = length of wheel base of longest vehicle (m)

R = Radius of horizontal curve, m

The recommended increase in width is given in Table 10.2 below

Table.10.2-Recommended Minimum Widening for Single Lane Road

Curve Radius (m)	Up to 20	21-60	Above 60
Increase in width (for 3 m carriageway) (m)	1.5	0.6	Nil
Increase in width (for 3.75 m carriageway),(m)	0.9	0.6	Nil

11 HAIRPIN BEND

A hair pin bend may be designed as a circular curve with transition at each end. Alternatively, compound circular curves may be provided. The following design criteria should be followed normally for the design of hairpin bends.

Table 11.1 Hairpin Bend Design Criteria

S.N.	Design standard	District Road (Core Network)	Village Road
		Hill	Hill
1	Minimum spacing between Hairpin Bends (m)	100 ¹	100 ²
2	Minimum radius of curve (m)	12.5	10
3	Minimum Roadway width at apex (m)	5.5 for a 4.5m roadway width 6.25 for a 5.25m roadway width	5 for a 4m roadway width
4	Maximum gradient (%)	4	4
5	Minimum gradient (%)	0.5 (max 1) ³	0.5 (max 1) ⁴
6	Maximum superelevation (%)	10	10
7	Minimum transition curve length (m)	15	15

Hairpin bends should be avoided as far as possible. The designer should locate the hairpin bends at suitable and flatter hill slopes, so that there is sufficient space for the layout of the hairpin bend. Similarly, series of hairpin bends in the same hill face should be avoided. Proper water management needs to be designed so that a disposal of water from the hairpin bend does not cause erosion problems on the slope.

12 VERTICAL ALIGNMENT

12.1 Gradient

The selection of ruling gradient depends on several factors such as type of terrain, length of the grade, speed, pulling power of vehicles and presence of horizontal curves. Recommended gradient for different terrain condition are given in Table 12.1

Table 12.1 Recommended gradients

S. N.	Design Standard	District Road (Core Network)		Village Road	
		Hill	Terai	Hill	Terai
1	Ruling gradient (%)	7	5*	7	5*
2	Limiting gradient (%)	10	6	10	6
3	Exceptional gradient (%)	12	7	12	7
4	Limitation of maximum gradient length (m) above average gradient of 7%	300	-	300	-
5	Maximum recovery gradient (%) to be applied after gradient in excess of 7% for a minimum recovery length of 150 m	4	-	4	-
6	Maximum gradient at bridge approach (%)	6	5 ^s	6	5
7	Minimum gradient on hill roads (for better drainage) (%)	0.5 (max1%)	-	0.5 (max1%)	-

If non-motorised vehicles are in significant numbers in the traffic stream then due consideration needs to be given to the pulling power of animal drawn vehicles and the ruling gradient limited to a maximum of 3%.

Whatever gradient used the pavement must have sufficient camber to drain storm water laterally. However, in cut sections or where the pavement is provided with kerbs, it is necessary that the road should have some gradient for efficient drainage. Desirable minimum gradient is 0.5 % if the side drains are lined and 1% if unlined.

Exceptional gradients should be adopted only in very difficult places and unstable locations in short length in hill.

(Footnotes)

- 1 100 m spacing is the desirable but it may be less as per site condition
- 2 100 m spacing is the desirable but it may be less as per site condition
- 3 Desirable minimum gradient for this purpose is 0.5%, if the side drains are lined and 1% if unlined.
- 4 Desirable minimum gradient for this purpose is 0.5%, if the side drains are lined and 1% if unlined.
- 5 In Terai, if non-motorised vehicles, bullock cart are in the traffic stream, maximum gradient is limited to 3% at bridge approaches.

12.2 Vertical curvet

Vertical curves are introduced for smooth transition at grade changes. Both summit curve and valley curve should be designed as parabolas. The length of vertical curves is controlled by sight distance requirements, but curves with greater lengths are aesthetically better. Curves should be provided at all grade changes exceeding those given in Table 12.2 and the minimum length as given in the same table.

Table 12.2. Minimum length of vertical curve

Design Speed (Kmph)	Maximum grade change (%) not requiring a vertical curve	Minimum length of vertical curve (m)
Up to 35	1.5	15
40	1.2	20
50	1.0	30

(Source: IRC: 73-1980)

12.3 Summit Curve

The length of summit curves is governed by the choice of sight distance. The length is calculated on the basis of the following formulae

Case	Length of summit curve (m)
	For safe stopping sight distance
When the length of the curve exceed the required sight distance (i.e. $L > S$)	$L = (N S^2) / (4.4)$
When the length of the curve is less than the required sight distance (i.e $L < S$)	$L = 2S - (4.4)/N$

N = deviation angle, i.e the algebraic difference between the two grade

L = Length of parabolic vertical curve (m)

S = stopping sight distance (m)

The above formula has been derived based on the following assumption

Height of driver's eye (H) = 1.2 m (above the pavement surface)

Height of subject above the pavement surface = 0.15 m

12.4 Valley Curve

The length of valley curves should be such that for night travel, the headlight beam distance is equal to the stopping sight distance. The length of curve may be calculated as follows:

Case	Length of summit curve (m)
	For safe stopping sight distance
When the length of the curve exceed the required sight distance (i.e. $L > S$)	$L = (N S^2) / (1.5 + 0.035 S)$
When the length of the curve is less than the required sight distance (i.e $L < S$)	$L = 2S - (1.5 + 0.035 S) / N$

Where,

N = deviation angle, i.e the algebraic difference between the two grade

L = Length of parabolic vertical curve (m)

S = stopping sight distance (m)

The above formula has been derived based on following assumption

Head light height = 0.75 m

The beam angle = 1°

Length of summit curve and valley curve for various cases mentioned above can be read from Fig 12.1 and 12.2

13 CO-ORDINATION OF HORIZONTAL AND VERTICAL ALIGNMENTS

The plan and profile of the road should be designed in proper coordination to ensure safety and utility of the road.

- 13.1 Sharp horizontal curves should be avoided at or near the apex of the summit, on vertical curves or the lowest point of valley curves.
- 13.2 Horizontal and vertical alignment should coincide with each other as far as possible and their length should be more or less equal. If this is difficult for any reason, the horizontal curve should be somewhat longer than the vertical curve.
- 13.3 The degree of curvature should be in proper balance with the gradients. Excessive curvature in a road with flat grades does not constitute balanced design and should be avoided.

14 CAMBER CROSS SLOPE

Recommended camber cross slope on straight road sections is given in Table 13.1 below.

Table 13.1. Recommended camber cross slope

Camber		District Road (Core Network)		Village Road	
		Hill	Terai	Hill	Terai
Carriageway cross slope (%)	Earthen(existing)	5	5	5	5
	Gravel	4	4	4	4
	Bituminous Seal Coat	3	3	-	-

The minimum acceptable value of cross fall should be related to carrying surface water away from the pavement in an effective manner. Considering possible changes in rainfall patterns due to the climate change, cross slopes are 0.5 to 1 percent steeper than that required where annual rainfall is less than 1000 mm.

Shoulders having the same surface as the carriageway should have the same cross slope. Unpaved shoulders on paved carriageway should be at least 0.5 per cent steeper than the cross fall of the carriageway. However, 1 per cent more slope than the carriageway is desirable.

15 PASSING ZONE AND LAY-BYS

15.1 Passing Zone

The increased width at passing zones should allow two trucks (2 axles) to pass.. The width of carriage way should be 5.5 m and length about 12 m along the outside edge

and 30 m along inside. This means that passing zones and lay bys should be tapered gradually towards the carriageway so that vehicles can leave or join the traffic stream safely. At passing places, vehicles would be expected to stop or slow to a very low speed.

Normally, passing place should be located every 300 m for Hill and 500 m for Terai. The location of passing place depends on the sight distance and should be provided at or near blind and sharp summit curves; where the likelihood of vehicles meeting between passing places is high; and where reversing would be difficult. In general passing places should be constructed at the most economic location as determined by the terrain and ground condition, such as at transitions from cut to fill, rather than at precise intervals.

15.2 Lay-bys

Lay-bys may be provided for parking or for bus stops to allow vehicles to stop safely without impeding passing traffic. The minimum bus lay-by width shall be 3 m (i.e. minimum 6 m carriageway widths) and the length 12 m along the outside edge and 30 m along the inside edge. This means that passing zones and lay bys should be tapered gradually towards the carriageway so that vehicles can leave or join the traffic stream safely.

16 CULVERT/BRIDGE

16.1 Carriageway Width at Culvert/Bridge

The recommended carriageway width at culverts and bridges is given below

Single lane 4.25 m

Intermediate lane 6 m

Width is measured from/between parapet walls or kerbs and additional width for footpath can be considered as per site requirement and volume of pedestrian flow.

16.2 Bridge Classification

- Following classification of “Nepal Bridge Standards – 2067” Department of Road (DoR) will also be used for Local Road Network.

- ✓ **Culvert** Length up to 6 m
- ✓ **Minor Bridge** When Length is ≤ 50 m (with span ≤ 25 m)
- ✓ **Major Bridge** When span > 25 m or length > 50 m (with smaller span)
- ✓ **Special Bridge** Bridge that require special design considerations, whose construction features (e.g. concrete girder bridges with > 50 m span, arch bridges, suspension bridges, cable-stayed bridges and other non-standard bridges).

- In case of Minor Bridges, two categories will be considered for Local Road Network (LRN)

- ✓ Minor A – Span 15 to 25 m and Total Length ≤ 50 m.
- ✓ Minor B – Span 6 m to less than 15 m and Total Length ≤ 25 m.

16.3 Carriageway and footpath/kerb

- All bridges in Local Road Network shall be designed with a minimum carriageway width of 4.25 m. with kerb of 0.6 m on both sides. Please refer figure 16.1
- For all bridges of length greater than 50 m, the carriageway width shall be 6.0 m. with kerb of 0.6 m on both sides. Please refer figure 16.2
- For the DRCN Road with intermediate lane and road in urban area, carriageway width of 6.0 m. with footpath of 1.0 m shall be provided on both sides. Please refer figure 16.3.

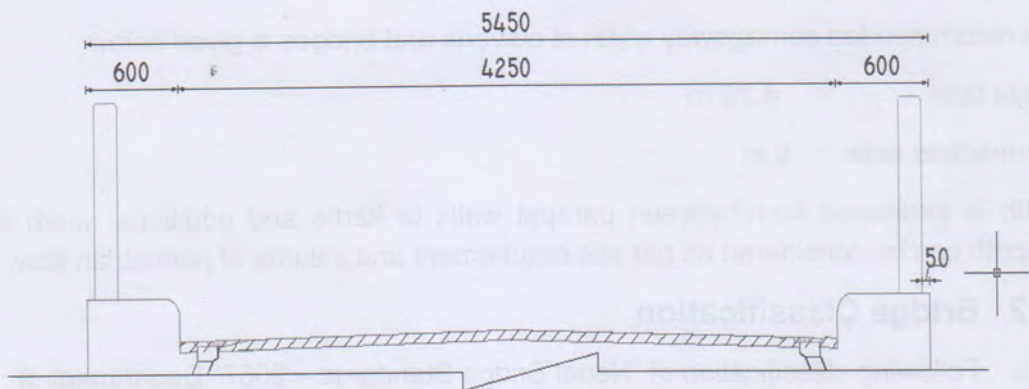


Figure 16.1 Single Lane 4.25 m and Kerb of 0.6 m on both sides

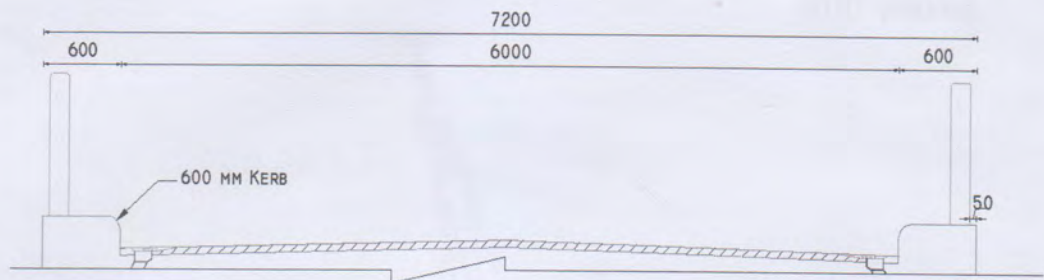


Figure 16.2 Intermediate Lane 6.0 m and Kerb of 0.6 m on both sides

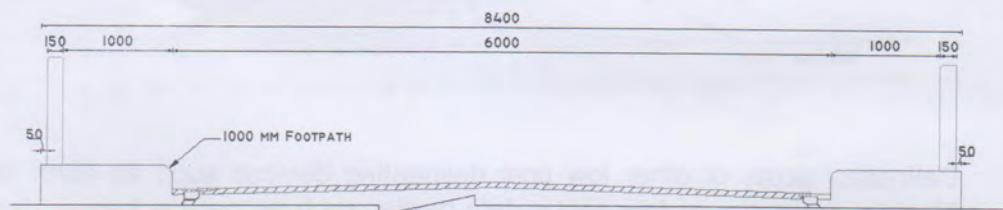


Figure 16.3 Intermediate Lane 6.0 m and footpath of 1.0 m on both sides

17 LEVEL OF ROAD EMBANKMENT ABOVE HFL

In flat terrain the road embankment should be high enough so that the level of subgrade is above the highest flood level (HFL). HFL at site can be found from inspecting the site and local enquiry. Minimum recommended level of subgrades are given below

For district road (core network) - 1 m desirable but minimum is 0.5 m

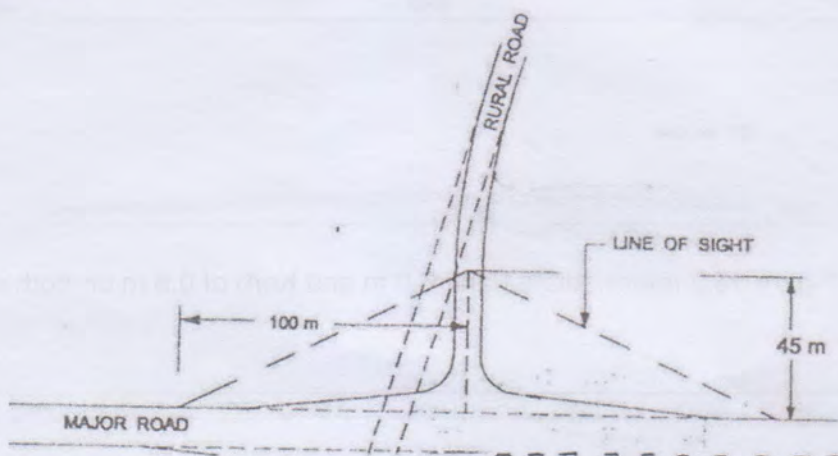
For village road - 0.5 m (minimum)

18 TRAFFIC SIGNS AND ROAD SAFETY

Different regulatory and warning signs for narrow road widths; sharp and blind curves; stop signs at junctions should be provided for rural roads that are in maintainable state. For detailed dimension refer to the Traffic Manual published by DoR, August 1997.

All-weather roads should have kilometre posts. The shape and size of kilometre posts can be used as given in DoR Standard Design, published in

January 1978.

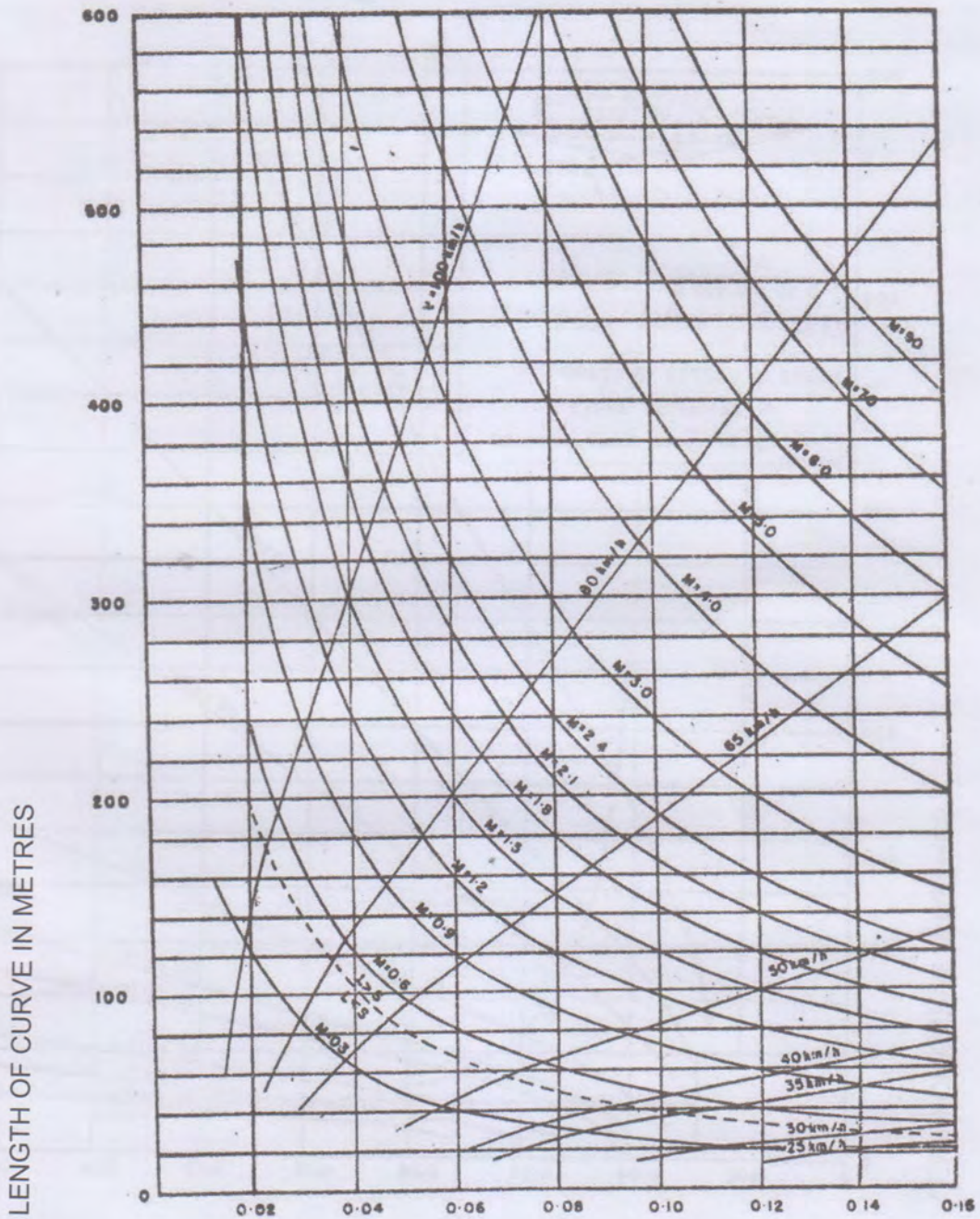


Delineator posts or other low cost delineating devices such as earth filled bitumen drum etc. or low cost safety barrier such as gabion barrier should be provided along the sharp curves and blind curves that have large (> 3 m) drops on the valley side.

In case of intersections with other road, since the higher category of road will normally have a wider right of way, the intersection is to be flared along the higher category of road. Rural roads should generally meet other roads at right angle junctions and should have a clear line of sight. This is a minimum 45 m for rural roads and 100 m along higher category roads and settlements should be discouraged within this area of intersection.

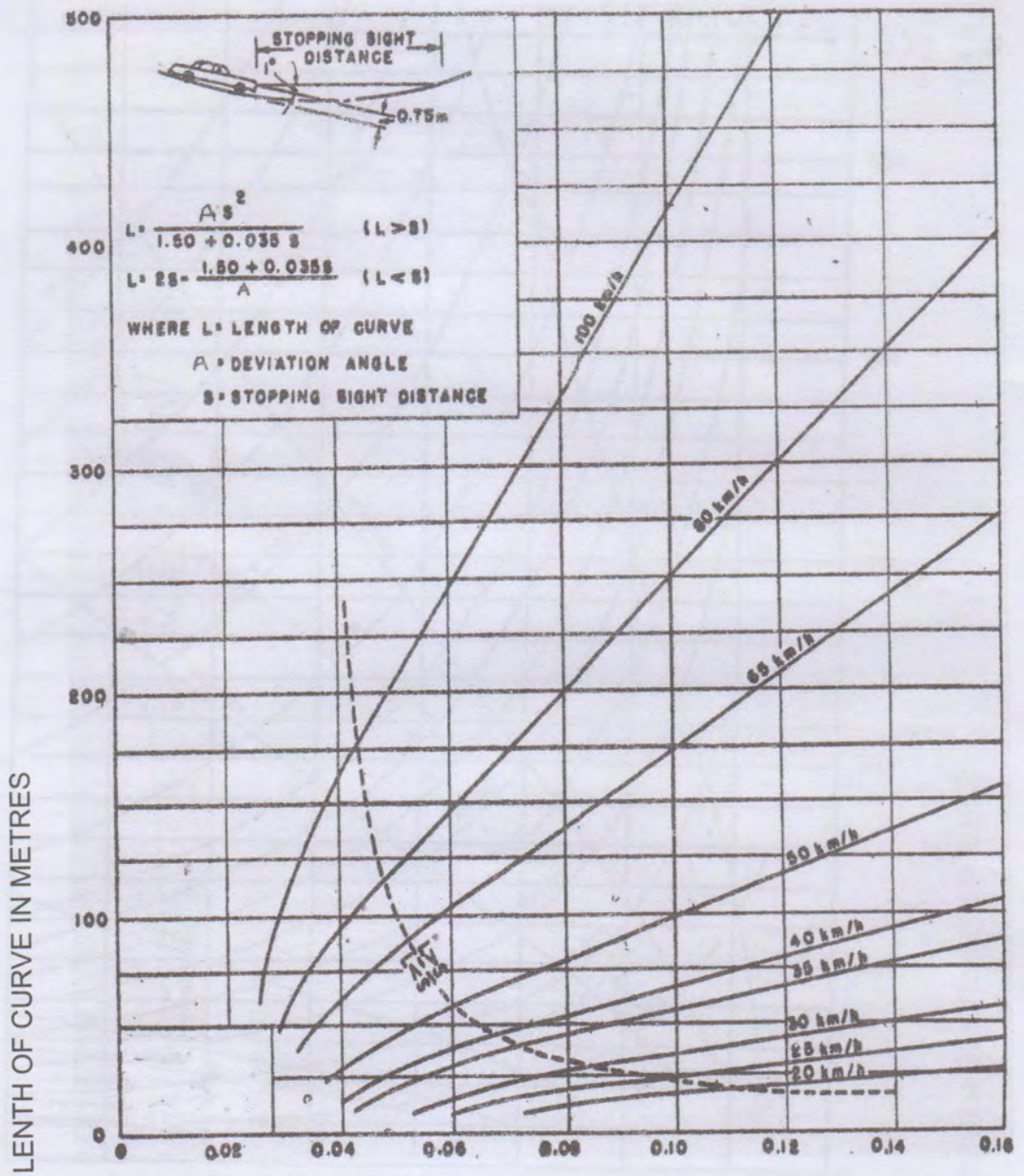
19 RELAXATION OF RURAL ROAD DESIGN STANDARD

The recommended standards are intended to provide guidance for designers rather than to be considered rigid minima. Standards may be relaxed by DoLIDAR to meet special circumstances such as very difficult terrain or high cost of construction.



ALGEBRAIC DIFFERENCE IN DEVIATION ANGLE - A

Fig. 12.1 Length of Summit Curve for Stopping Sight Distance



ALGEBRIC DIFFERENCE IN DEVIATION ANGLE - A

Source: IRC:73-1980 Reprinted on July, 2004

Fig.12.2 Length of Valley Curve

Summary of Nepal Rural Road Standard 2055, 2nd Revision

S.N	Design Parameters Hill	District Road (Core Network)		Village Road (VR)		Comments
		Terai	Hill	Terai		
1	Design capacity- in both directions(Vpd /P.C.U per day)	200 (400)	400 (800)	100 (200)	200 (400)	
2	Design speed (km per hour)	Ruling-25 Min -20	Ruling-50 Min -40	15	30	
3	Road way width (m)	7.0	7.5	4.0	4.5	<ul style="list-style-type: none"> Given road way width are <u>excluding</u> drain; parapet and top width of retaining wall If an available existing road way width is more than defined and carriageway has paved surface , distance between side drain and pavement edge can be maintained partially as hard shoulder and earthen shoulder
		5.25	6.75			
		4.5	6			
4	Carriageway width (m)	5.5	5.5	3	3	<ul style="list-style-type: none"> The carriageway width of District Road (core network) is 3.75 m but it can be reduced to 3 m where traffic intensity is less than 100 motorised vehicles per day and where the traffic is not likely to increase due to situation like dead end, low habitation and difficult terrain. Desirable road surface for District Road (Core Network) is gravel or paved, whereas, for Village road is unpaved or gravel. If a village Road carries traffic volume more than 100 motorised vehicles per day, the carriageway width will be 3.75 m and other parameters upgrade accordingly.
		3.75	3.75			
		3	3			
5	Shoulder width, either side (m)	0.75	1	0.5	0.75	<ul style="list-style-type: none"> District road (core network) with volume of traffic > 400 ADT, single lane width may not be adequate for operation, therefore, should go for higher lane width of 5.5 m
		0.75	1.5			
		0.75	1.5			
6	Total right of Way (RoW) (m)	20	20	15	15	<ul style="list-style-type: none"> In case of DRCN 10 m RoW on either side from road centre line In case of VR 7.5 m RoW on either side from road centre line If in any case existing RoW is more than defined value, existing available value shall be adopted as a right of way
7	Setback distance from Road land boundary / RoW to Building line on either side (m)	6	6	3	3	

Summary of Nepal Rural Road Standard 2055, 2nd Revision

S.N	Design Parameters Hill	District Road (Core Network)		Village Road (VR)		Comments
		Terai	Hill	Terai		
8	Minimum safe stopping sight (m)	20	45	15	30	Since, opposing vehicle occupies the same lane in single lane road; it should be designed for intermediate site distance. However, it might be difficult to design the horizontal alignment with intermediate sight distance for <u>hill</u> terrain.
9	Lateral Clearance between roadside object and the edge of the shoulder (m)	Normally -1 Min – 0.5	Normal-ly-1.5 Min - 1	Nor-mally -1 Min – 0.5	Normal-ly-1.5 Min - 1	5 m vertical clearance should be ensured at all underpasses, and similarly at overhanging cliffs. The vertical clearance should be measured in reference to the highest point of carriageway However, in case of overhead wires, poles etc. shall be at least 7.0 m above the road surface
10	Minimum radius in horizontal curve (m)	Ruling min -20 Min -12.5	Ruling min -90 Min-60	10	30	At sharp horizontal curve, it is necessary to widen the carriageway to provide safe passage of vehicles – refer 10.4 of text part of standard
11	<u>Hairpin Bends</u>					
	Minimum spacing between Hairpin Bends (m)	100		100		100 m spacing is desirable but it may be less as per site condition
	Minimum radius of curve (m)	12.5		10		
	Minimum Road way width at apex (m)	5.5 for 4.5 roadway width 6.25 for 5.25 roadway width		5 for 4 roadway width		
	Maximum gradient (%)	4		4		
	Minimum gradient (%)	0.5 (max 1)		0.5 (max 1)		Desirable minimum gradient for this purpose is 0.5%, if the side drains are lined and 1% if unlined
	Maximum super elevation (%)	10		10		
	Minimum transition curve length (m)	15		15		
12	Ruling gradient (%)	7	5	7	5	If non-motorised vehicles are in significant number in traffic stream then due consideration need to be given to the pulling power of animal drawn vehicles and ruling gradient need to be limited up to 3%

Summary of Nepal Rural Road Standard 2055, 2nd Revision

S.N	Design Parameters Hill		District Road (Core Network)		Village Road (VR)		Comments
			Terai	Hill	Terai		
13	Limiting gradient (%)		10	6	10	6	
14	Exceptional gradient (%)		12	7	12	7	
15	Limitation of maximum gradient length (m) above average gradient of 7%		300	-	300	-	
16	Maximum recovery gradient (%) to be applied after gradient in excess of 7% for a minimum recovery length of 150 m		4		4		
17	Maximum gradient at bridge approach (%)		6	5	6	5	In terai, If non-motorised vehicle like bullock cart, Tricycle are in traffic stream then maximum gradient limit to 3%
18	Minimum gradient on hill roads (for better drainage) (%)		0.5 (max1)	-	0.5 max1)	-	Desirable minimum gradient for this purpose is 0.5%, if the side drains are lined and 1% if unlined
19	Co-ordination of horizontal and vertical alignment		<ul style="list-style-type: none"> • Sharp horizontal curve should be avoided at or near the apex of the summit vertical curve or the lowest point of the valley curve. • Horizontal and vertical alignment should coincide with each other as far as possible and their length should be more or less equal. If this is difficult for any reason, the horizontal curve should be somewhat longer than the vertical curve. • The degree of curvature should be in proper balance with the gradients. Excessive curvature in a road with flat grades, do not constitute balanced design and should be avoided. 				
20	Cross slope in carriageway camber (%)	Earthen (existing)	5	5	5	5	<ul style="list-style-type: none"> • Shoulder having the same surface as the carriageway should have the same cross slope • Unpaved shoulder on paved carriageway should be at least 0.5% steeper than the cross fall of carriageway. However, 1% more slope than the carriageway is desirable.
		Gravel	4	4	4	4	
		Bituminous Seal Coat	3	3	-	-	

Summary of Nepal Rural Road Standard 2055, 2nd Revision

S.N	Design Parameters Hill	District Road (Core Network)		Village Road (VR)		Comments
		Terai	Hill	Terai		
21	Passing Zone, Dimensions (width x length) (m x m)	The width of carriage way should be 5.5 m and length is about 12 m along outside edge and 30 m along inside i.e. towards the carriageway side and each end it should be tapered gradually towards the carriageway.				
	Lay-bys, Dimension (width x Length) (m x m)	Minimum bus lay-bys width shall be additional 3 (i.e. total min carriageway width is 6 m) and the length is about 12 m along outside edge and 30 m along inside i.e. towards the carriageway side and at each end it should be tapered gradually towards the carriageway.				
22	passing zone strips at interval of (m) (maximum)	300	500	300	500	<ul style="list-style-type: none"> Lay-bys are provided as a where needed. The location of passing place depends on the sight distance – should provide at or near blind and sharp summit curve; the likelihood of vehicles meeting between passing places; and the potential difficulty of reversing.
23	Carriageway width at culvert/ bridge (m) (Single lane)	4.25	4.25	4.25	4.25	<ul style="list-style-type: none"> Measured from inside to inside of parapet walls or kerbs Additional width for footpath can be considered as per site requirement, volume of pedestrian flow.
	Carriageway width at culvert/ bridge (m) (Intermediate lane)	6	6	-	-	
24	Bridge Classification	<p>Culvert Length up to 6 m</p> <p>Minor Bridge When Length is ≤ 50 m (with span ≤ 25 m)</p> <p>Major Bridge When span > 25 m or length > 50 m (with smaller span)</p> <p>Special Bridge Bridge that require special design considerations, whose construction features (e.g. concrete girder bridges with > 50 m span, arch bridges, suspension bridges, cable-stayed bridges and other non-standard bridges).</p> <p>In case of Minor Bridges, two categories will be considered for Local Road Network (LRN)</p> <ul style="list-style-type: none"> Minor A – Span 15 to 25 m and Total Length ≤ 50 m. Minor B – Span 6 m to less than 15 m and Total Length ≤ 25 m. 				
25	Carriageway and footpath/kerb	<ul style="list-style-type: none"> All bridges in Local Road Network shall be designed with a minimum carriageway width of 4.25 m. with kerb of 0.6 m on both sides. For all bridges of length greater than 50 m, the carriageway width shall be 6.0 m. with kerb of 0.6 m on both sides. For the DRCN Road with intermediate lane and road in urban area, carriageway width of 6.0 m. with footpath of 1.0 m shall be provided on both sides. 				
26	Level of embankment above HFL (m)	1 (0.5 min)	1 (0.5 min)	0.5	0.5	1 m is desirable but minimum is 0.5 m

Summary of Nepal Rural Road Standard 2055, 2nd Revision

S.N	Design Parameters Hill	District Road (Core Network)		Village Road (VR)		Comments
		Terai	Hill	Terai		
27	Traffic sign and road safety					<ul style="list-style-type: none"> • Different regulatory and warning signs for narrow road width; sharp and blind curve; stop sign at the junction should be provided in rural roads, which are in maintainable state. For detail dimension follow traffic manual published by DoR, August 1997. • All-weather road should have kilometre post. The shape and size of kilometre post can be used as given in DoR standard design, published in January 1978. • Delineator post or other low cost delineating device such as earth filled bitumen drum etc. or low cost safety barrier such as gabion barrier should be provided along the sharp curve and blind curve, which has big (> 3 m) drop on valley side. • In case of intersection with other road, since the higher category of road will normally have wider right of way provision, the intersection is to be flared along the higher category of road and rural road should generally meet the other road at right angle junction, whereas, it should have clear line of sight, minimum 45 m along the rural road and 100 m along the higher category road and should discourage settlement development within this area of intersection.