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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF COMMUNICATIONS
THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

THE STUDY
ON
CONSTRUCTION OF THE BRIDGE OVER THE RIVER RUPSA
IN KHULNA
(Phase 2)

TECHNICAL REPORT
VOLUME 3 : ROAD AND RIVER FACILITIES

MARCH 2000

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JAPAN OVERSEAS CONSULTANTS

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TECHNICAL REPORT

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3. ROAD FACILITIES

3. DESIGN FOR ROAD

3.1 Geometric Design Standard

1. Background

Since the geometric design standard of National Highways and urban streets must reflect the desired goals targeted by the Government of Bangladesh, it is preferable to apply uniform standards through the country if these are available.

Table 1.1 shows the adopted design standards and comparison of major design elements in Bangladesh.

Table 1.1 Adopted Design Standards and Major Design Elements

Project Name	Design Standard	Classification	Design Speed (km/h)	Max. Grade (%)	Remark
Jamuna Bridge Access Roads	AASHTO	National Highway	65-100	4-6	OECF & ADB
Jamuna Bridge	BS	National Highway	100	2 (0.5)	WB/ADB/OECF
5-Bridges	AASHTO, Japanese Standard	National Highway	100	Level	Japan's Grant Aid
Paksey Bridge	AASHTO	National Highway	100	3 (2.4)	OECF
Second Buriganga Bridge	AASHTO	National Highway	65	2 (2)	Chinese Loan
Meghna-Gumuti Bridge	AASHTO	National Highway Category A	80	3 (3)	Japan's Grant Aid
Meghna Bridge	AASHTO	National Highway Category A	80	3 (3)	Japan's Grant Aid

Notes : Figures in parenthesis show actually adopted value.

As referred to Table 1.1, a Policy on Geometric Design of Highways and Streets published by AASHTO has been widely referred to make framework of geometric design standard in Bangladesh as well as many other countries, even though each criteria of design control may be discussed within such framework to reflect characteristics of traffic as well as physical and natural conditions in each country or region.

The Road Materials and Standards Study Bangladesh (hereinafter called "RMSS") was prepared in June 1994 under financed by European Economic Community, and it successfully revealed such characteristics in Bangladesh. On the other hand, Japan also has made efforts to revise its own standard for the sake of warranting public investment and to develop several criteria from experiences.

It is a matter of fact that amenity or good performance brought by a new road is recognized not in the design stage but in the operation after open to the public. On the contrary, good performance could be expected not only by good engineering practice itself but also both education to drivers and enforcement against illegal users may be required.

It is significant for this working paper to discuss geometric design criteria suitable to the Study, although it is designated one of work items enumerated in the Scope of Work.

2. Objectives

The objectives of the working paper are as follows;

1) to review applied design criteria in the past to meet local yet social requirements in Khulna;
2) to keep intended level of service by engineering to cope with current problems as well as to accommodate amenity and good performance;
3) to determine geometric design criteria applicable to the Study.

3. Definition of Terms

The following technical terms as defined are commonly used in this working paper (refer to Fig. 3.1).

Roadway : the portion of a highway, including shoulder, for vehicular use.

Traveled Way : the portion of the roadway for the movement of vehicles, exclusive of shoulders.

Shoulder : the portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use and lateral support of subbase, base, and surface courses.

Hard Shoulder is the portion to be paved or surface treated.

Soft Shoulder is the portion to be covered by sod or turf.

Marginal Strip : the portion of the shoulder and the same pavement structure of the traveled way extended, usually 0.25 m - 0.3 m. This is also the space for road marking at both ends of traveled way.

Median : the portion of a divided highway separating the traveled way for traffic in opposing directions. The Median Width is expressed as the dimension between edges of each through traveled way and includes the inner shoulders, if any.

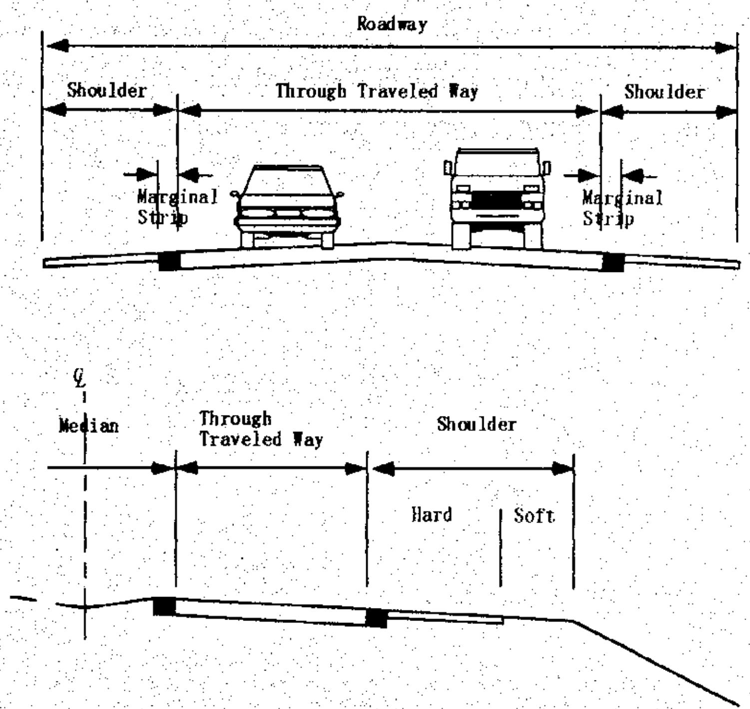


Fig. 3.1 Configuration of Road Structure

4. Geometric Design Criteria for the Southern Section of Khulna Bypass (SSKB)

(1) Functional Classification as a Design Type

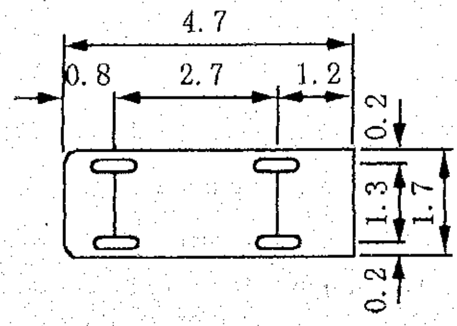
Since the Southern Section of Khulna Bypass is planned to substitute congested Rupsa Ferry and a part of existing National Highway No. 7 in the downtown Khulna, it is designated as Urban Arterial Street with the primary road function of mobility and the priority given to motorized vehicles.

(2) Design Vehicle

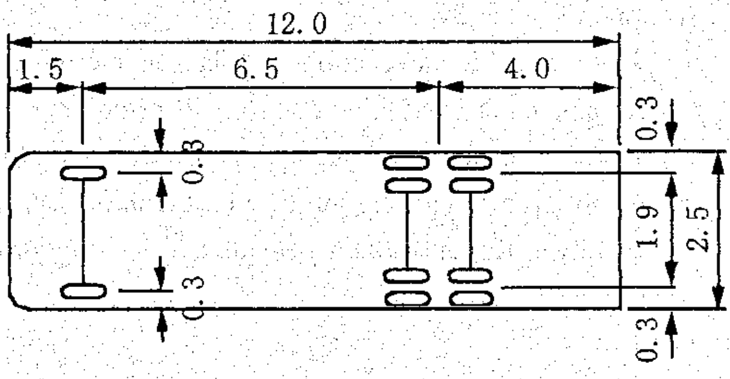
The physical characteristics of vehicles and proportions of variously sized vehicles using urban street are positive controls in geometric design. For purpose of geometric design, each design vehicle has larger physical dimensions and larger minimum turning radius than those of almost all vehicles in its class.

Three general classes of vehicles have been selected, namely Passenger Car, Truck and Semitrailer. The Passenger Car class includes sedan, wagon, van and pick-up, while the Truck class includes bus, single-unit truck and so forth. The Semitrailer class represents truck tractor-semitrailer combination, especially for targeting 40 ft container transport.

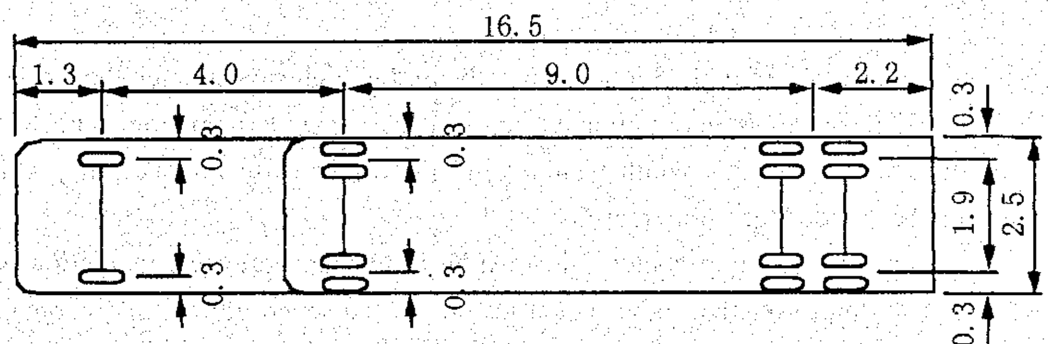
Taking into consideration similar vehicular size and composition to Japan, the same design vehicles as shown in Fig. 4.1 are applied to the study, and the Semitrailer class is to apply to “Through Traveled Way”, the Truck to “Major At-grade Intersection”, and the Passenger Car to “Minor At-grade Intersection”, standing on the economical yet practical viewpoint.



Passenger Car



Truck



Semitrailer Combination

Unit : meter

Fig. 4.1 Design Vehicles

(3) Design Speed

Design speed is the maximum safe speed that can be maintained over a specified section of road when conditions are so favorable that design features of road govern. The design speed is to be determined logically with respect to the terrain, adjacent land use, type of road and the design speed of adjoining section.

The design speed selected will directly affect many geometric elements, namely horizontal and vertical alignments, sight distance, provision of superelevation, etc. Other features such as traveled way width and roadside clearances are also influenced by design speed but to a lesser degree.

The followings may warrant the design speed of 60 km/h applied to the Southern Section of Khulna Bypass;

- Six (6) at-grade intersections are planned intermittently in 10 km stretch;
- No passing or overtaking control will be enforced on the Rupsa Bridge and its approach sections covering approximately 1.5 km long; and
- A toll plaza of barrier-gate type on the through traveled way is planned in the vicinity of Rupsa Bridge where all vehicles stop for paying toll.

(4) Grade

The grade of 3% prevails in Bangladesh on the bridge approach section because of the traffic characteristics such as high percentage of over-laden trucks, trucks and buses of old vintage and other slow moving vehicles.

(5) Cross Section Elements

<u>Lane Width for Fast-moving Vehicles</u>

Lane widths of 2.7 m to 3.75 m are generally used in highways through the world. 3.75 m lane width is internationally accepted as the widest possible lane width because wider than this width would result in two-lane use for one lane, which should be avoided for safety reasons.

The regulated maximum standard lane width in the Japanese road regulation was historically narrower than other countries due to the severe terrain and economic requirements. Originally the standard width in Japan was 3.50 m for Class-1 (flat terrain, heavy traffic), Class-2 and Class-3 (hilly terrain, medium traffic), and 3.25 m for Class-4 (mountainous terrain, less traffic).

However, experience in actual practice revealed that 3.50 meter lane width was narrow for roads with high design speed (more than 100 km/hr.) and with high traffic volume of heavy vehicles on . In other countries, AASHTO (U.S.A.) regulates that the widest lane width is 12 ft (3.66 m), and some expressways in Germany and Italy apply a 3.75 meter lane width. Japan has been, therefore, revised to allow 3.75 m for Class-1 and 2 on the condition that the traffic volume and heavy vehicle ratio are particularly high.

Lane Width for Expressway in Major Countries

Countries	U.S.A.	Germany	Sweden	Holland	France	Italy
Lane width	3.66 m (12 ft)	3.75 m	3.50 m	3.63 m	3.50 m	3.75 m

In Bangladesh, 7.5 m wide 2-lane Carriageway is regulated as most high-type highways, and it is equivalent to 7.0 m wide 2-lane Traveled Ways with marginal strips at both sides (0.25 m + 3.5 m x 2 + 0.25 m).

The lane width of 3.50 m is applied to the Study, and it is sure this width accords with that of regulated Carriageway for National Highway in Bangladesh.

<u>Track for Slow-moving Vehicles</u>

One of the salient features of the traffic characteristics in the Study Area is a large number of slow-moving vehicles such as motor bikes and auto-rickshaws. As the mixture with such slow-moving vehicles may reduce the traffic capacity as well as traffic safety, it is preferable to separate them from fast-moving vehicles. Therefore, the track for the slow-moving vehicles is planned to be contiguous to the fast-moving traveled way.

Fig.4.2 illustrates dimensions of auto-rickshaw, which is 1.2 m wide 2.4 m long.

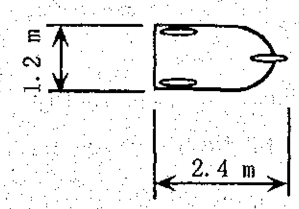


Fig. 4.2 Dimensions of Auto-rickshaw

The slow-moving track is assumed to require 2.5 m wide on the embankment section because one auto-rickshaw could manage to pass by even though another stuck or out-of-order auto-rickshaw blocks the track. The slow-moving track may be reduced up to 2.0 m on the Rupsa Bridge from economical viewpoint where a stuck or out-of-order auto-rickshaw should shear the space for pedestrian to stop.

Shoulder Width on Embankment

Considering the functions of the shoulder together with land acquisition condition and service level as National Highway, 2.5 m outer shoulders and 1.0 m inner shoulders are recommended in the Study.

Median Width on Embankment

The median width of 5.5 m including 1.0 m inner shoulder at both sides is recommended to the Study. The median is to provide a recovery area for out-of-control vehicles, provide a stopping area in case of emergencies, allow the space for auxiliary lane for right-turning and U-turning, construction of piers of grade separation structures and overhead pedestrian crossing facilities, drainage at section with superelevation, minimize headlight glare or anti-glare facilities on horizontal curves, provide width for future lanes and so forth.

(6) Crossfall of Traveled Way and Shoulder

A crossfall of 2 percent is adopted as a standard on the urban street, considering the advantage in rapidly draining the pavement during rainstorms as well as comfort of drivers.

A crossfall of 4 percent is adopted for the treated outer shoulders in order to use them effectively for surface rainwater flow.

Normal crown arrangement is applied to the roads except at sections with superelevation.

(7) Type of Pavement

Considering the ease of construction and maintenance, the economical and functional viewpoints, flexible type pavement is selected generally for the urban street. The flexible type pavement agrees with the RHD's policy to utilize the existing pavement as much as possible as a component of the total structure of pavement where overlay method is applicable.

A rigid type pavement is used at the toll plaza to prevent damage to the pavement caused by oil and repeated wheel loads in regulated paths at toll booths.

(8) Maximum Superelevation (i_{max}), Minimum Radius (R_{min}) and Value of

Superelevation on Curvature (i)

These three factors, i_{max}, R_{min} and i are related each other together with the design speed. The design speeds of 60 km/h is recommended as discussed previously to the Southern Section of Khulna Bypass.

The relation between minimum radius and maximum superelevation is calculated from the following formula.

$$R = \frac{Vd^2}{127*(i+f)}$$

where R : Radius (m)

Vd : Design Speed (km/h)

i : Superelevation (m/m)

f : Side Friction Factor

The side friction factor of 0.15 at the normal high speed are selected as the maximum allowable value in the RMSS, considering comfort of drivers and traffic safety.

Absolute maximum side friction factor of 0.4 may be used in order to check the safety on curves assuming that a vehicle is being operated at an excessive speed (20 km/h higher than the design speed i.e. Vd= 80 km/h) as shown in Table 4.1.

Table 4.1 Maximum Superelevation And Minimum Radius

Design Speed (km/h)	60
Max. Allowable Side Friction Factor (f)	0.15
Max. Superelevation (i max) %	3.0
Minimum Radius (m)	160
Side Friction Factor if 20 km/h higher than Vd	0.28
Absolute Max. Side Friction Factor	0.40

The side friction factor f = 0.15 and resulting maximum Superelevation i max = 3% are also justified to be applicable to the urban street where the high accessibility to adjacent buildings and facilities should be maintained.

Crossfall of 2% applicable to traveled ways is mainly determined by drainage requirements. The minimum curvature which requires superelevation is determined by setting consistently low friction factor values, considering the effect of crossfall. Side friction factor of 0.05 recommended in the RMSS are used to determine sharpest curve without superelevation as shown in Table 4.2.

Table 4.2 Sharpest Curve without Superelevation

Design Speed (km/h)	60
Side Friction Factor (f)	0.05
Crossfall (%)	-2.0
Sharpest Curve without Superelevation (m)	950

(9) Sight Distance

Stopping sight distance is the sum of two distances:

- The distance traversed by the vehicle from the instant that the driver sights an object necessitating a stop to the instant that the brakes are applied (Brake Reaction Time); and
- The distance required to stop the vehicle the brake from the instant that brake application begins (Braking Distance).

2.5 seconds is used for the former and the later is dependent on the initial speed and the coefficient of friction between tires and pavement .

The following equation is used for the calculation of stopping sight distance:

$$D = 0.694 * V + 0.00394 * V^2/f$$

where

D: Stopping Sight Distance (m)

V: Initial Speed (km/h)

f: Coefficient of Friction between Tires and Pavement

Stopping sight distances by each design speeds on the wet condition are shown in Table 4.3.

Table 4.3 Stopping Sight Distance on Wet Pavement

Design Speed (km/h)	Initial Speed		Friction Coefficient on Wet Pavement	Stopping Sight Distance (m)	
	%	km/h		Calculated	Rounded
80	100	80	0.30	139.6	140
60	100	60	0.33	84.6	85

Sight distance is defined as the distance along a roadway that an object of specified height is continuously visible to the driver with eye-height above the road surface. The height of 0.15 m of object height is recommended by the RMSS and it is also specified in AASHTO. The height of driver's eye ranges 1.07 m to 1.2 m in international standards.

1.2 m is used as the eye-height for the Study, which is recommended by the RMSS and also specified in Japanese Standard. Table 4.4 tabulates the object and eye height specified in the RMSS and other standards.

As far as the Study may concerns, only the design element of minimum vertical curve length is affected by this value.

Table 4.4 Summary of Object and Eye Height Specified

	Japan	AASHTO	RMSS	the Study
Driver's Eye Height for Stopping (m)	1.20	1.07	1.20	1.20
Object (m)	0.10	0.15	0.15	0.15

Vehicles frequently overtake slower moving vehicles on 2-lane two ways highway such as the Southern Section of Khulna Bypass. The passing must accomplished on lanes regularly used by opposing traffic. Accordingly, passing sight distance for use in design should be determined on the basis of the length to safely complete normal passing maneuvers.

AASHTO recommends the minimum passing sight distance of 407 m for Vd= 60km/h. If the design speed should increase up to 80 km/h, it would have to extend to 541 m or more.

Either passing sight distances could not be applicable on Rupsa Bridge because the bridge length should extend considerably due to applying larger vertical curve, and accordingly no passing/overtaking is allowed.

(10) Minimum Vertical Curve Length

Vertical curves effect gradual change between tangent grades in crest and sag curves and should result in a design that is safe, comfortable in operation, pleasing in appearance and adequate for drainage.

The major control for safe operation on crest vertical curves is the provision of ample sight distance for the design speed and rider comfort, while headlight sight distance and rider comfort govern the length of a sag vertical curve.

The following equations are used for the calculation of required vertical curve length and radius of vertical curve, of which longer length is applicable.

1. Rider comfort (tolerable limit)

$$L = \frac{Vd}{3.6} * t$$

where

L : Vertical curve length (m)

Vd : Design speed (km/h)

t : Minimum required time, t = 3 sec.

2. On Crest Curve (object height : 0.15 m, eye-height : 1.2 m)

$$L = \frac{D^2 * i}{440} \quad \text{OR} \quad R = \frac{100 * D^2}{440}$$

where

L = Vertical curve length (m)

D = Sight distance (m)

R = Radius of vertical curve (m)

i : Algebraic difference in grade (%)

As discussed previously, the design speeds of 60 km/h is recommended to the Southern Section of Khulna Bypass. However, the following comparison may ascertain its justification.

Design Speed	Sight	On Crest Curve	
Vd (Km/h)	Distance (m)	Min. Vertical Curve Length (m)	Min. Radius (m)
60	85	99	1,643
80	140	267	4,458

Note: The computation is made on the condition that the algebraic difference of grades is 6%.

In case that the elevations of the top surface of Rupsa Bridge and the abutment are kept the same level, the bridge length will increase 84m long.

3. On Sag Curve (headlight sight distance : headlight height=0.75 m, angle=1°)

$$L = \frac{D^2 * i}{150 + 3.49 * D} \quad OR \quad R = \frac{100 * D^2}{150 + 3.49 * D}$$

where

L = Vertical curve length (m)
D = Sight distance (m)
R = Radius of vertical curve (m)
i : Algebraic difference in grade (%)

Design Speed Vd (Km/h)	Sight Distance (m)	On Sag Curve	
		Min. Vertical Curve Length (m)	Min. Radius (m)
60	85	97	1,617

Note: The computation is made on the condition that the algebraic difference of grades is 6%.

(11) Minimum Transition Curve Length

Transition curves are desirable on high speed roads between circular curves of substantially different radii and between tangents and circular curves.

The length necessary for controlling the steering on a curve is calculated from the following formula which provides required length for a natural and easy-to-follow path for drivers.

$$L = \frac{Vd}{3.6} * t$$

where

L : Minimum transition curve length (m)
V : Design speed (km/h)
t : Running time through the transition curve (sec)

Desirable running time through the curve to allow control of the steering is reported to be 3 to 5 seconds. The minimum transition curve length is set 50 m using the running time through the transition curve t = 3 sec and the design speed Vd = 60 km/h.

To make the change of centrifugal acceleration tolerable, the rate of increase of centripetal acceleration (P m/sec^3) is examined by Short's equation where Pmax = 0.75 m/sec^3 for the urban street are adopted.:

$$P = \frac{\left(\frac{Vd}{3.6}\right)^3}{L * R}$$

where

P : Rate of increase of centripetal acceleration (m/sec^3)

V : Design speed (kin/h)

L : Minimum transition curve length (m)

R : Minimum curve radius (m)

Table 4.5 Minimum Transition Curve Lengths and its Rate of Acceleration.

Design Speed (km/h)	60
Running Time t (sec)	3
Minimum Transition Curve Length : L (m)	50
Minimum Curve Radius : R (m)	160
Rate of Increase of Centripetal Acceleration : P (m/sec^3)	0.58 < 0.75

(12) Minimum Horizontal Curve Length

The following values are designated to cover all the horizontal curve lengths, including transition curves if any, and to be of sufficient length for drivers to comfortably adjust their steering to allow for the change in curvature.

Rider Comfort (tolerable limit)

$$L = 0.278 * Vd * t$$

where

L : Minimum horizontal curve length (m)

Vd : Design speed (km/h)

t : Minimum required steering time on curve (sec), t = 6 sec

Design Speed (km/h)	60
Min. length calculated (m)	100
Adopted Value (m)	100

In the cases where the intersection angle (θ) is small, 7° or less, it is desirable to use a longer horizontal curve length than the minimum value. Minimum horizontal curve length is calculated as follows:

<u>Minimum Secant Length, N min</u>

$N\ min = \theta_0 * L/6 = 0.020 * L$

where

θ_0: Intersecting angle to govern min. secant length $\theta_0 = 7° = 0.122$ rad.

L : Minimum transition curve length (m)

Design Speed (km/h)	60
Min. Transition Curve Length (m)	50
Min. Secant Length (m) N min	1.00

<u>Minimum Horizontal Curve Length, L min</u>

$L\ min = 12 * N\ min/\theta\ (rad.) = 688 * N\ min/\theta\ (degree)$

Design Speed (km/h)	60
Min. Secant Length (m) N min	1.00
Min. Curve Length (m)	$700/\theta$

(13) Minimum Radius of Curve not Required Transition Curves

The minimum radius of curve for which no transition curves are required is calculated by using the following formula:

$$R = \frac{1}{24} \times \frac{L^2}{S}$$

where

S : Shift in meters between curve and tangent

L : Transition curve length (m)

R : Radius of circular curve (m)

Maximum shift Smax = 0.20 applied to the above formula and then minimum radius R min is calculated as follows:

Design Speed (km/h)	Min. Transition Curve Length (m)	Min. Rudius (m)	
		Calculated	Rounded
60	50	520	500

(14) Pavement widening on Curves

Pavements on curves are sometimes widened to make operating conditions on curves comparable to those on tangents or large radii of horizontal curves.

These widening on curves occur on ramps of interchange and turning roadways at channelizations of at-grade intersection.

Table 4.6 shows the design widths of the pavement for turning roadways at channelizations.

Table 4.6 Widening of Auxiliary Lane for At-grade Intersection for 1-lane One-way

in Meter

Radius on Turning R (m)	Widening excluding Shoulder		
	Semitrailer	Truck	Passenger Car
6			R≧6.82 m
7			
8			3.5
9			
10			
11			
12	R≧13.0 m	R≧13.36 m	
13	9.5		
14	8.5	6.0	
15	8.0		
16	7.5	5.5	
17			
18	7.0		
19			
20	6.5	5.0	
21			
22			
23	6.0		
24			
25			
26			
27			
28			
29	5.5	4.5	
30			
32			
34			
36	5.0		
38			
40	4.5		
45			
50			
55			
60		4.0	
70			
80			
90			
100	4.0		
110			
120			
130			
140			
150	3.5	3.5	3.0

(15) Superelevation Runoff

For added comfort and safety, the superelevation runoff should be effected uniformly over a length adequate for the design speed. In other words the length of superelevation runoff should exceed what is specified by the maximum relative slope mentioned below.

On the contrary, for the requirements of pavement drainage, the length of superelevation runoff in between -2% and 2% should not exceed what is computed by the minimum relative slope of 1/300.

$$1/q = \frac{Vd}{3.6 * B * W}$$

where

B : Roadway width from axle of rotation (m)

W : Rolling speed of vehicle (radian/sec.)

Design Speed (km/h)		60
B (m)		6.0
W (rad./sec)		0.020
q	calculated value	139
	adopted value	140

Note: The axle of rotation is located at the inner edge of through traveled lane.

(16) Horizontal and Vertical Clearances

(a) Horizontal Clearance

Each case of horizontal clearance limit illustrated in Fig.4.2 indicates at least 0.25 m additional clearance beyond the outer edge of the shoulder except in the stretch where a 2.5 m wide Slow-moving Track is provided for the urban street.

(b) Vertical Clearance

RHD has decided that 4.9 m headroom for the National Highway and 4.6 m for crossing feeder roads are the applicable standards.

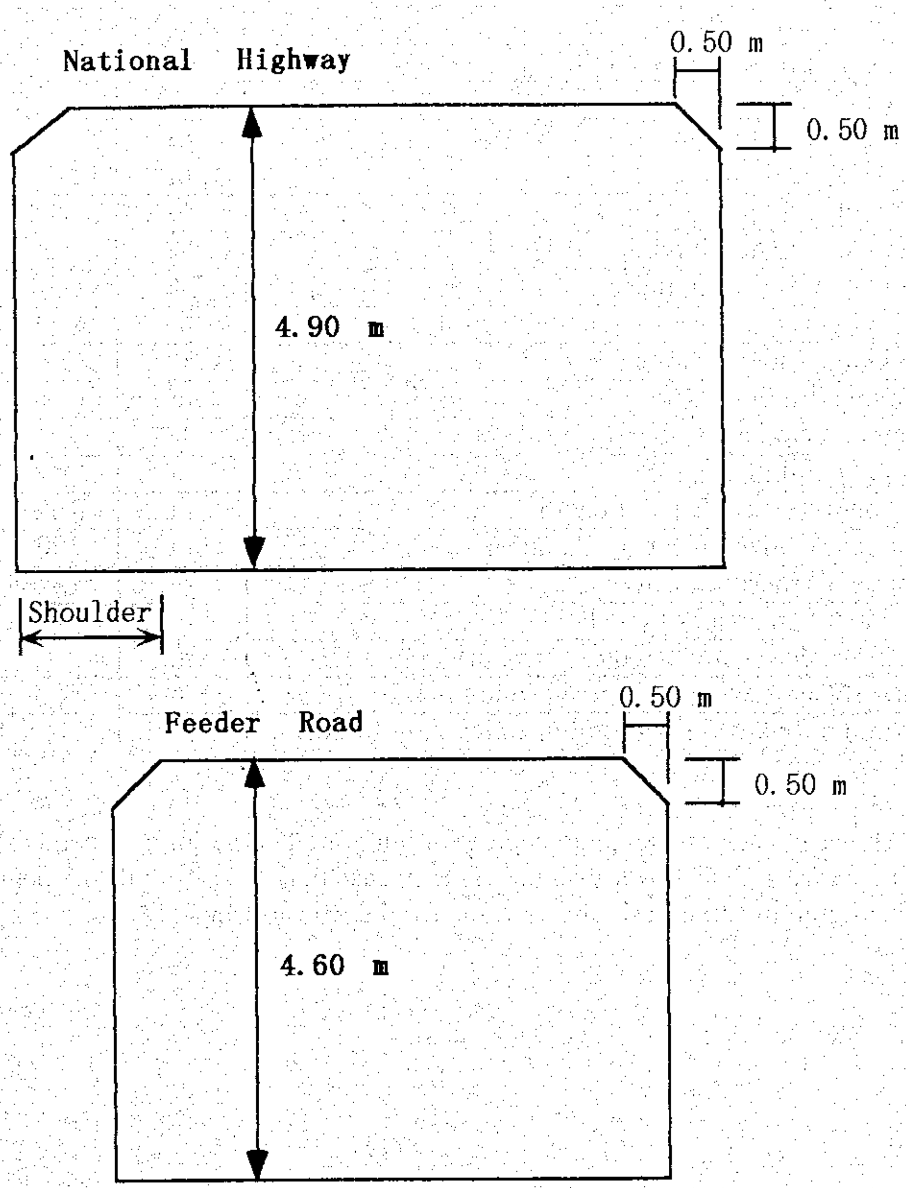


Fig. 4.2 Horizontal and Vertical Clearances

(17) Summary of Geometric Design Criteria

Table 4.7 summarizes the geometric design criteria for the Southern Section of Khulna Bypass.

Table 4.7 Summary of Geometric Design Criteria for the Southern Section of Khulna Bypass

Item	Unit	Design Criteria
1 Design Speed	km/h	60
2 Through Traveled Lane Width	m	3.5
3 Slow-moving Track	m	2.5 (2.0)
4 Outer Shoulder Width	m	2.5 (0.0)
5 Inner Shoulder Width	m	1.0 (0.0)
6 Crossfall of Traveled Way	%	2
7 Crossfall of Outer Shoulder	%	4
8 Crossfall of Inner Shoulder	%	4
9 Type of Pavement	-	Asphaltic Concrete
10 Maximum Superelevation	%	3
11 Minimum Radius	m	160
12 Maximum Grade	%	3
13 Stopping Sight Distance	m	85
14 Minimum Vertical Curve Length	m	Refer to Table 4.8
15 Minimum Horizontal Curve Length	m	100* or 700/ θ
16 Minimum Transition Curve Length	m	50
17 Minimum Parameter of Clothoid Curve	m	80
18 Sharpest Curve without Transition Curve	m	500
19 Sharpest Curve without Superelevation	m	950
20 Maximum Relative Slope for Superelevation Runoff	-	1/140

Notes :

1. θ shows intersecting angle in degree for horizontal curve (min. 2 degrees).
2. The figure with * shows absolute value in case that θ is more than 7 degrees .
3. The figure in parenthesis shows value for the Rupsa Bridge.

Table 4.8 Minimum Vertical Curve Length

Algebraic Differenc in Grade (%)	On Crest Curve			On Sag Curve		
	Rider Comfort	Sight Dictence	Adopted Value	Rider Comfort	Sight Dictence	Adopted Value
6	50	99	99	50	97	97
5.5	50	90	90	50	89	89
5	50	82	82	50	81	81
4.5	50	74	74	50	73	73
4	50	66	66	50	65	65
3.5	50	57	57	50	57	57
3	50	49	50	50	49	50
2.5	50	41	50	50	40	50
2	50	33	50	50	32	50
1.5	50	25	50	50	24	50
1	50	16	50	50	16	50
0.5	50	8	50	50	8	50

5. Further Considerations

5.1 Cross Sectional Configuration of the Rupsa Bridge

Fig. 5.1 shows the proposed typical cross section for the Rupsa Bridge based on the selected scheme of Phase 1 Study and that of other major bridges in Bangladesh, and Fig. 5.2 shows the typical cross sections of embankment and bridge other than Rupsa Bridge.

The proposed cross sectional configuration has following advantages and justifications made by Phase 1 Study;

i) Rupsa Bridge is located in the urbanized area of Khulna and major users are expected local commuters although major benefits are brought from transport cost savings of heavy trucks and long distance buses on regional and arterial road. It is necessary to deliberate transport means for citizens such as auto-rickshaws and motorcycles, and accordingly separated slow-moving tracks accommodate commuters as well as contribute traffic safety and steady flow of traffic on through traveled ways.

ii) Number of trucks and buses of quite an old vintage with overloaded or shortage of horsepower make it justify to adopt flatter 3% grade in approach section because mixed traffic of slow-moving vehicles causes mainly present traffic congestion taken place on National Highway No. 7. It is desirable that separated slow-moving vehicles enhance traffic safety as well as smooth traffic flow.

iii) This cross sectional configuration has remarkable advantage to expand 2-lane traveled ways up to 4-lane just in case that traffic demand might increase beyond forecasted one. Total width of roadway is 13.5 m wide including 2 slow-moving tracks, and it is still practical to modify it divided 4-lane with lane width of 3 m wide as shown in Fig. 5.3.

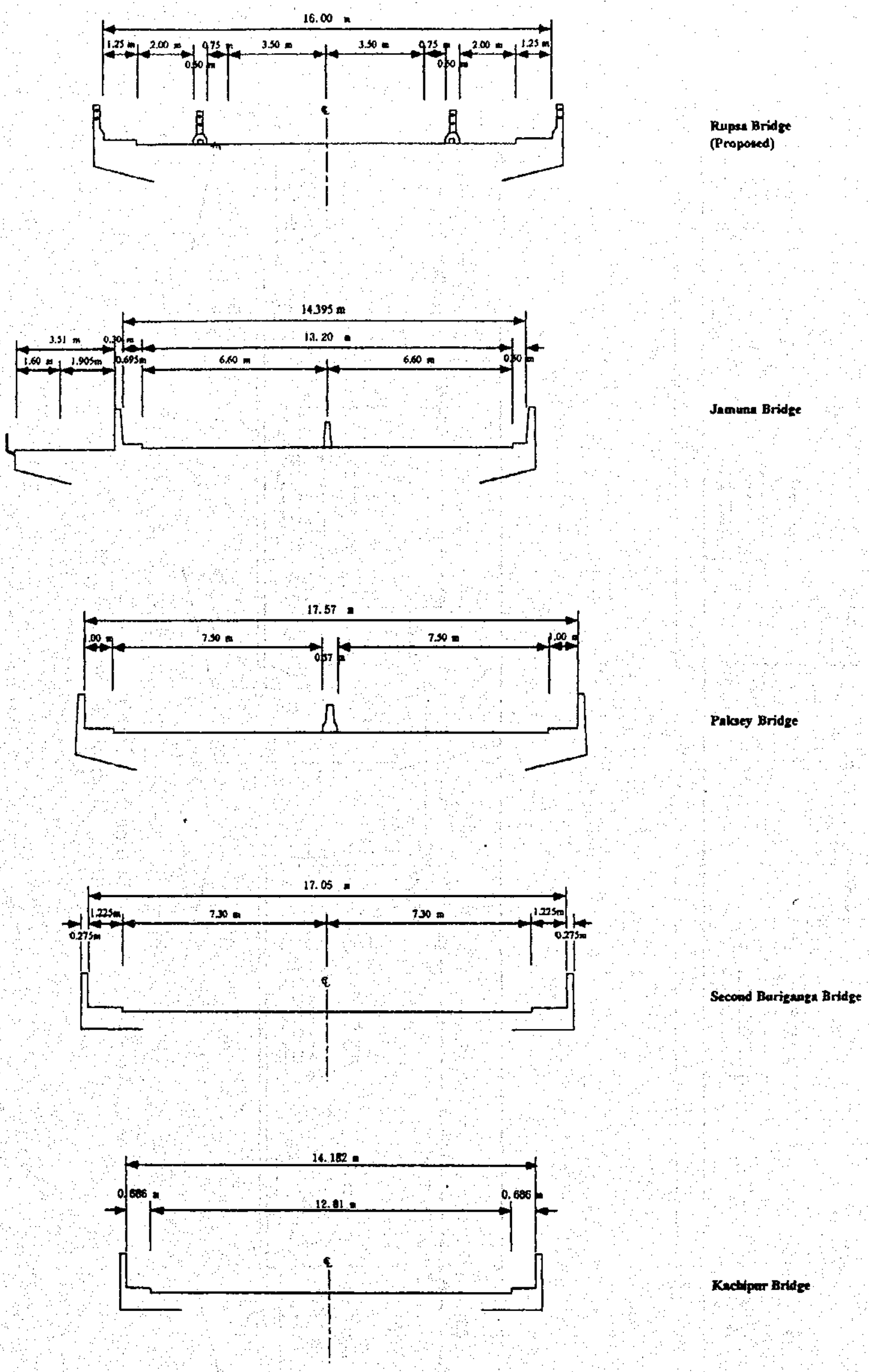


Fig. 5.1 **Comparison of Bridge Cross Section**

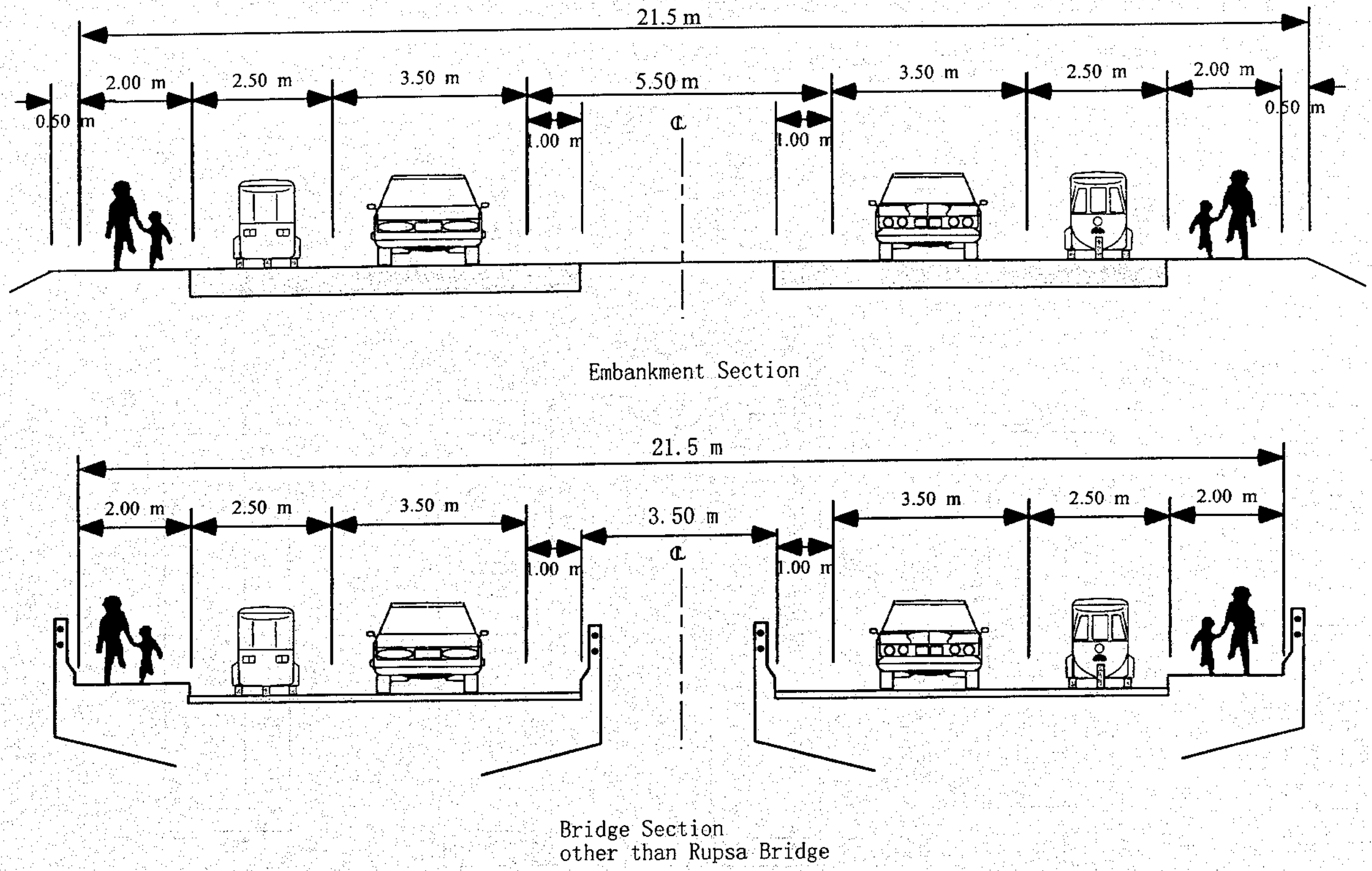


Fig. 5.2 Typical Cross Sections of Embankment and Bridges other than Rupsa Bridge

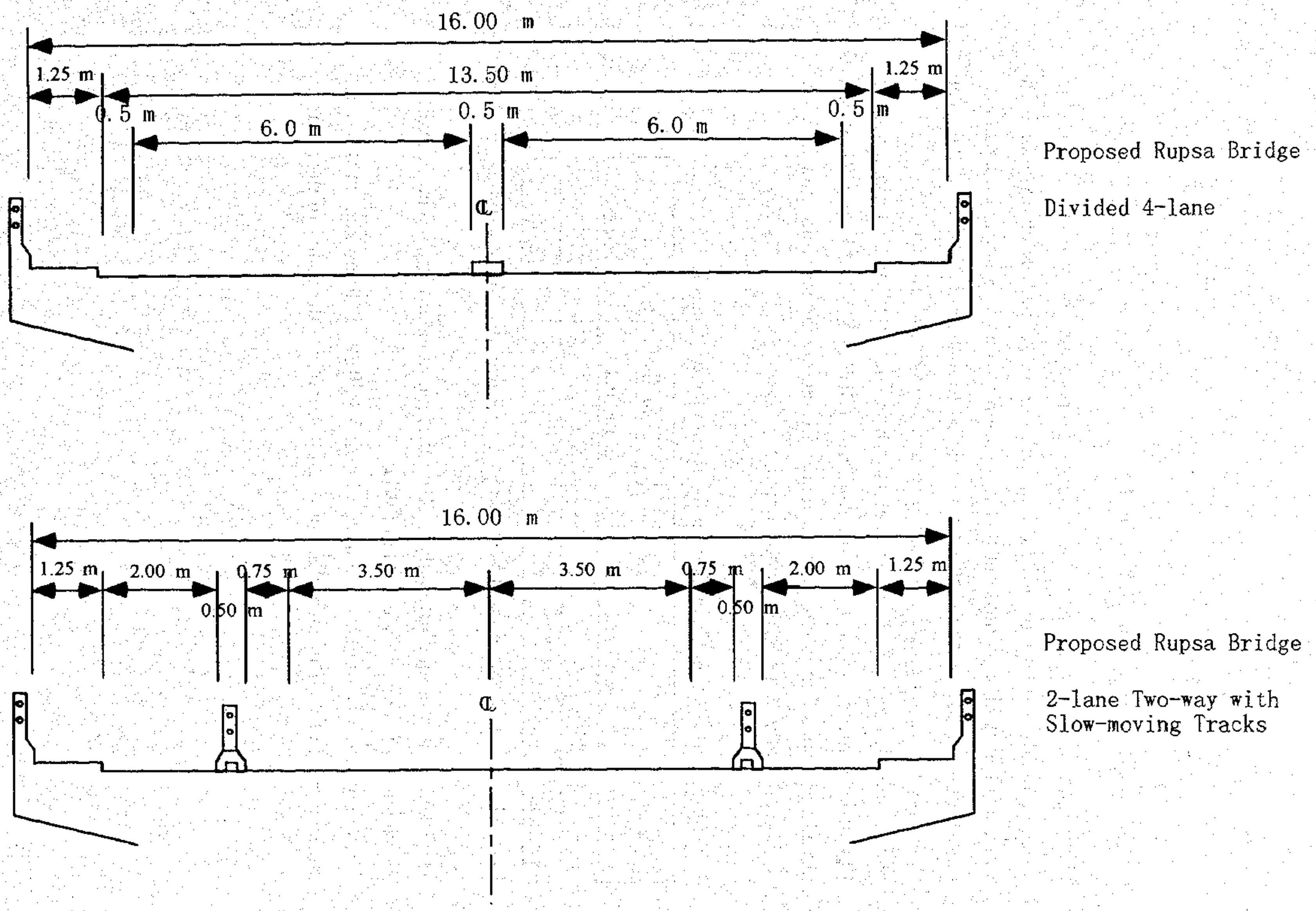


Fig. 5.3 Proposed Rupsa Bridge and its Variation

5.2 Navigation Clearance for the Rupsa River

Navigation clearance beneath the Bridge is appropriately reserved to provide space vertically and horizontally for letting design vessel pass safely even on high water level. It is also pointed out that navigation clearance is not only dependent on maximum vessel in the past but also related to managerial policy of the river such as future development along the river and salvaging allowance.

Navigation clearance of rivers in Bangladesh is controlled under jurisdiction of Bangladesh Inland Water Transport Authority (BIWTA). The Rupsa River has already had specified navigation clearances by the document which the BIWTA replied officially to the RHD's questionnaire.

Table 5.1 Navigation Clearance for the Rupsa River (Class I)

	Navigation Clearance	
	in Feet	in Meters
Horizontal Clearance	250	76.22
Vertical Clearance	60	18.30

Note : The vertical clearance shall be kept above the Standard High Water Level.

The BIWTA also replied officially to RHD that the Standard High Water Level in the vicinity of Khulna City is 3.00 m PWD.

Accordingly, the navigation clearance of 60ft x 250 ft is to be kept at the river crossing point of the Rupsa Bridge above 3.00 m PWD at the center of the river.