GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH




ROAD DESIGN STANDARDS

RURAL ROAD

LOCAL GOVERNMENT ENGINEERING DEPARTMENT (LGED)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
2005

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The Chief Engineer
Local Government Engineering Department

PREFACE

Poverty is pervasive in Bangladesh. To minimize the severity of poverty is the prime consideration of the Government. All efforts of the Government are thus aimed at achieving excellence in the effective macro-economic management as a way to ensure the wellbeing of the poor. This has underlined the need for efficient and effective management in all sectors where communication is one of the dominant areas.

The necessity for surface communication has occupied universally a strong place among the multi-dimensional and essentially important needs. So is Bangladesh. Although the country is riverine, one can not remain oblivion about the very importance of this requirement to promote quick marketing of its various produce especially agricultural that are mostly perishable in nature. The country being overwhelmingly rural, enhancement of the well being of the vast majority of the poverty-stricken people living in the rural areas will ask for domination of a countrywide efficient rural road network management. Purpose of this document is directed towards attaining that vision.

The road standards that have been presented in this document are no doubt an honest and sincere attempt for the sake of building durable, cost-effective and efficient rural road structures. It has opened up an opportunity for every rural road development project of LGED to follow uniform standards all over the country. This will illustrate as an important tool for efficient administering of the countrywide rural road network by overcoming the current pitfalls.

I would confidently anticipate a strong contribution of this document in the efforts of LGED towards establishing an efficiently managed rural road system in Bangladesh that would certainly contribute to alleviate poverty in consistence with the vision, priority and target. A concerted effort by all in LGED is a must to that respect.

I would expect that this document is meticulously used by all within LGED that would once again demonstrate its intention to strive for excellence in the judicious use of the country's scarce resources.

I express my sincere thanks to all members of the Working Group who have given their diligence and intelligence in developing this document.

Md. Shahidul Hassan
Chief Engineer, LGED

The Superintending Engineer
Local Government Engineering Department

FOREWORD

The Strategy for the Rural Development Projects, 1984 broadly outlined the road classification in Bangladesh including the geometry for each class of road. However, no technical standard was developed. In the absence of such standards, interdepartmental and intradepartmental confusion became very much acute in preparing the road schemes. It also made cost rationalization very complex.

With the progress of time dimension of the rural road network in Bangladesh has widened tremendously. Continuous change in the sociopolitical climate has also changed the nature of demand influencing the characteristics of rural roads even in terms of terminology and the technicality. To match the changed situation, the necessity for reclassification of the rural road network in Bangladesh was strongly felt and the Planning Commission redintegrated the entire road system of the country taking into consideration their hierarchy and potentiality as well.

In this backdrop, formulation of uniform geometric and technical standards for each class of road alongwith their cross-drainage facilities has been found timely and conducive to their security and functional capacity in a longer perspective taking into account the resource constraint. This will complement the Government's intent to build cost-effective but sustainable road structures.

I have all the confidence that this latest version of rural road standards will serve as the beacon towards administering good governance with the installation of an efficient rural hierarchy in the country. This will add to the optimization in the use of the country's scarce financial resources and will help to fulfil the commitments and mandates of LGED so as to reach the benefit of planned development towards reduction of poverty.

I take this opportunity to thank all my colleagues, associates and consultants who have worked very hard to make this document possible despite time constraint and various odds.

Md. Wahidur Rahaman
Convener,
Standard Specification Committee

Contents

A C R O N Y M

AADT	-	Annual Average Daily Traffic
AASHTO	-	American Association of State Highway and Transportation Officials
AIV	-	Aggregate Impact Value
ASTM	-	American Society for Testing & Materials
BC	-	Bituminous Carpeting
BS	-	British Standard
CVD	-	Cumulative number of commercial vehicle per day
CBR	-	California Bearing Ratio
ESA	-	Equivalent Standard Axle
FM	-	Fineness Modulus
GDP	-	Gross Domestic Product
GI	-	Group Index
GVW	-	Gross Vehicle Weight in Tones
HBB	-	Herring-Bone-Bond
IRC	-	Indian Road Congress
ISG		Improved Sub-Grade
LAA	-	Los Angles Abrasion
LGED	-	Local Government Engineering Department
LGI		Local Government Institution
LL	-	Liquid Limit
MDD	-	Maximum Dry Density
Modified		Modified Proctor
OMC	-	Optimum Moisture Content
PI	-	Plasticity Index
RHD	-	Roads & Highways Department
RR	-	Rural Road
S	-	Cumulative Standard Axle
SB	-	Sub-base
SG		Sub-Grade
TRRL	-	Transport & Road Research Laboratory
UK	-	United Kingdom
WBM	-	Water Bound Macadam

INTRODUCTION

Bangladesh has characteristics of high population density, high productivity of land, intensive cultivation, small-scale farming and marketing of its petty production and diversified employment of rural under-employed in farms and non-farm activities. All these together generate intensive trading of goods and services in the rural areas and a high level of demand for movement of goods and people, which results the level of traffic in the rural areas of Bangladesh comparatively high.

The Roads and Highways Department (RHD) and the Local Government Engineering Department (LGED) share responsibilities for the entire road network of the country. While the former is to manage the National, Regional and Zila Road, the latter is to focus on the Upazila Road, Union Road and Village Road.

Establishing road communication network in the rural areas has become the dire necessity of the time with the ardent objective of stimulating trade and commerce in the rural areas – an inalienable area of the national economy. This paramount responsibility has been bestowed upon LGED, which is one of the largest works organisation in Bangladesh and has a well disciplined organization. As a matter of fact, all implementation responsibilities related to rural infrastructure development are vested with the functionaries of LGED at the Upazila and the District levels. It is thus a demand that the technical people at the field levels become proficient and well competent for producing economically viable quality output. With this end in view, Road Design standards' 05 has been prepared in line with geometric design of roads and bridges and pavement design configuration defined in the National Road Design Standards, 04 which will serve as a ease handbook on road pavement and will augment the efficiency of LGED's fully committed field level technical staff.

LOCAL GOVERNMENT ENGINEERING DEPARTMENT

Local Government Engineering Department is the prime engineering organization in pursuing rural development programme. LGED's main functions are planning and implementation of infrastructure development projects in rural and urban areas to improve transport network, in order to facilitate employment generation vis-a-vis poverty reduction, and to provide technical support to the Local Government Institutions.

Reflecting strong initiatives of Government for pursuing rural prosperity, the total volume of investment program on rural infrastructure has been continuously increasing. In addition, the better and reliable quality of development rural infrastructures is requested to meet the social demand for efficient use of public investment, LGED has been playing a key role in this respect with high performance and flexibility on each project component.

NATIONAL ROAD CLASSIFICATION

National Road Classification is shown in Table 1. Higher Road System and Rural Road are two broad classifications for which agencies responsible are RHD and LGED/LGI respectively.

LGED and LGI both belong to the Local Government Division under the Ministry of Local Government, Rural Development & Cooperatives (LGRD&C). LGED's one of the mandate is to provide technical support to the LGIs. LGED takes the responsibility to construct/re-construct, rehabilitate and maintain roads in conjunction with LGIs under the purview of Local Government Division.

Table 1: Description of the Types[τ] , Definitions and Agencies Responsible for various Roads of the Country (2003)

Sl. No.	Type	Definition	Ownership and Responsibility
01.	National Highways	Highways connecting National Capital with Divisional HQ/s or seaports or land ports or Asian Highways.	RHD*
02.	Regional Highways	Highways connecting District HQ/s or main river or land ports or with each other not connected by National Highways.	RHD
03.	Zila Road	Roads connecting District HQ/s with Upazila HQ/s or connecting one Upazila HQ to another Upazila HQ by a single main connection with National/Regional Highway, through shortest distance/route.	RHD
04.	Upazila Road	Roads connecting Upazila HQ/s with Growth Center/s with another Growth Center by a single main connection or connecting Growth Center to Higher Road System**, through shortest distance / route.	LGED*/LGI*
05.	Union Road	Roads connecting Union HQ/s with Upazila HQ/s, Growth Centers or Local Markets or with each other.	LGED*/LGI*
06.	Village Road	a) Roads connecting Villages with Union HQ/s, local markets, farms and ghats or with each other. b) Roads within a Village.	LGED*/LGI*
τ	The above road types do not include the roads belonging to the Pourashavas and the City Corporations. The responsibility for development and maintenance of such roads will lie with the respective Pourashavas and the City Corporations.		
*	RHD-Roads and Highways Department, LGED - Local Government Engineering Department, LGI - Local Government Institutions.		
**	Higher Road System - National Highway, Regional Highway and Zila Road.		

Rural Road

Rural road comprises of Upazila roads, Union roads and Village roads in the rural areas of Bangladesh.

THE ROAD DESIGN STANDARDS

The Road Design standards contains :

- Pavement cross-sections of Upazila Roads (Type 4, 5 & 6) with projected traffic of 600, 300 and 200 commercial vehicles (axle load 8.2 ton) and Union Roads (Type 7 & 8) with projected traffic of 100 and 50 commercial vehicles (axle load 8.2 ton).
- Road Geometry of Upazila and Union Roads as per National Road Design Standard, 04.
- Road Pavement Design criteria of Upazila and Union Roads as per National Road Design Standard, 04.
- Bridge Geometry of Upazila and Union Roads as per National Road Design Standard, 04.
- Bridge Approach Planning of Upazila and Union Roads as per National Road Design Standard, 04.
- Shoulder treatment when roads passing through built-up or market areas.
- Road Junction, Road Intersection and Road Widening for Bus Stop and rural traffic stand.
- Pavement cross-sections for Upazila Roads and Union Roads along with shoulder and drainage facilities in Hilly areas.
- Relevant information on for Gradients and Super Elevation of roads and extra width of pavement required at horizontal curves.
- Protective measures to road embankment vulnerable to erosion from wave action of floodwater in Char and Haor areas.
- Road safety Measures
- Road side landing steps/stairs

ROAD GEOMETRY

In December 2003 the Planning Commission made a re-classification and delineation of responsibilities for roads of Bangladesh. Recent economic growth has led to a change in the volume and composition of traffic on Bangladesh's roads. This has necessitated the adoption of demand driven geometric and pavement design standards. It is approved that there should be 5 basic geometric design types for Upazila, and Union Roads all based on traffic characteristics. Road Design types 5 - 8 should be based primarily on forecasts/survey of commercial vehicles. Design type 4 should be based primarily on forecasts of peak hour passenger car units (pcu). Passenger car unit are the values, compared to a private car that various vehicle types make to overall traffic composition, and the aggregate affect on the capacity of the road. A passenger car is 1.0 pcu. Larger vehicles have higher values. Conversion factors for vehicles to pcu's are shown in Table 2.

Table-2 : Passenger Car Unit (PCU) conversion factors for non-urban roads

Vehicle Type	PCU factor
Car	1.0
Bus	3.0
Truck	3.0
Auto rickshaw	0.5
Bicycle	0.3
Rickshaw	1.0
Motor Cycle	0.3
Tempo	1.0
Bullock Cart	4.0

Source : Transport Research Laboratory (UK) Overseas Road Note 13

A traffic criterion for each design type is shown in Table-3. Approved geometric design for each type of road is summarized in Table-4.

Table-3 : Traffic Criteria for Design Purposes

Design Type	Peak Hour maximum passenger car units (pcu)	Daily Commercial vehicles max. (Trucks and buses)
8	(90)	50
7	(130)	100
6	(210)	200
5	(290)	300
4	530	600

Note : For Types 5, 6, 7and 8 the criterion should be daily commercial vehicles. For Type 4 the criterion should be peak hour pcu(s). Figures in parenthesis are estimates for low-volume roads.

Table-4 : Geometric Design Standards

Design Type	Carriageway (m) / (ft)	Hard shoulder (m) / (ft)	Verge (m) / (ft)	Crest Width (m) / (ft)
8	3.0 / 10	0.0 / 0	1.25 / 4	5.5 /18
7	3.7 / 12	0.0 / 0	0.90 / 3	5.5 / 18
6	3.7 / 12	0.0 / 0	1.8 / 6	7.3 / 24
5	3.7 / 12	0.9 / 3	0.9 / 3	7.3 / 24
4*	5.5 / 18	0.0 / 0	2.15 / 7	9.8 / 32

Note : Design types above Type-8 shall be used for Village Roads

** In case of land acquisition problem and resource constraint, crest of 7.3 metre/24 feet may be allowed in special cases.*

The traffic criteria listed in Table 3 is the effective maximum numbers of vehicles that the approved design types in Table 4 can accommodate. Projected traffic volume should be adopted for either commercial vehicles or pcu(s) to a design life for 10 years. These should be measured against the figures in Table 2 to determine the appropriate design type.

The introduction of 5 design types allows flexibility in design, and provides for a more gradual change through geometric road widths, to meet the demand of the increasing traffic over the years.

Design type 8 provides for the same carriageway width for traffic volume up to 50 commercial vehicles per day, but with a widened verge where as Design Type 7 provides widened carriage way of 12'-0" width for traffic volume 50-100 commercial vehicles per day. This allows for a greater margin of safety for both pedestrians and vehicles.

Design type 6 has the same geometry as the present Upazila Road. It is the minimum requirement when traffic reaches up to 200 commercial vehicles per day.

Design types - 6, 7, and 8, a widened paved carriageway up to 5.5m width with required super-elevation should be provided at all turning points depending on radius of horizontal curves to prevent hazards of accidents. For immediate action, all the existing curve points on narrower roads with carriageway up to 3.7m should be widened to 5.5m with proper super-elevation allowing the both direction vehicles at these points to move with greater safety. Similarly proper widened road intersections shall be provided at all crossing points. At the same time initiative has to be taken for straightening zigzag road alignments, otherwise those alignments will not be qualified for any further investment.

Design type 5 has same carriageway as design type 6, but with a hard shoulder (0.9m) and reduced verge. Besides, at the turning points full 5.5m carriageway with proper super elevation should be paved to pass both way traffic.

Design type 4 is to be used when traffic is 300 - 600 commercial vehicle per day equivalent to pcu 290-530. Type 4 is approved on safety grounds, but 3 feet verge instead of 7 feet on either side could be adopted where there are land and/or resource constraints.

GEOMETRIC DESIGN CRITERIA OF UPAZILA ROAD AND UNION ROAD

1. Gradients

Gradient is the longitudinal slope of a road. The following gradients for Upazila Roads and Union Roads tentatively approved (Table-5):

Table-5 : Gradients

Terrain	Ruling grade (Maximum)	Limiting grade (Maximum)
Plane	1 in 30	1 in 20
Hills	1 in 20	1 in 15

a. Ruling gradient: This gradient is the slope of the road, which is adopted in road design and calculations of cuts and fills. This gradient is decided in such ways that slow moving and fast moving; both types of traffic can easily negotiate over this slope.

b. Limiting gradient: This gradient may be used, where topography of a place compels this course or where the adoption of gentler gradients would add enormously to the cost. In such cases, the lengths of the continuous grade line at a grade steeper than the ruling gradient should be limited as far as possible. In hills where limiting gradients have to be used rather frequently, it is important to separate such stretches by providing stretches of level road on easier grades.

2. Transition (easement or spiral) Curves

A transition curve has a progressively increasing (or decreasing) radius used in joining a tangent with a simple circular curve, or in joining two circular curves of different radii.

The length of a transition curve depends on the radius and the design speed of the vehicle. The sharper the radius the longer the transition length.

The length of Transition Curve shall be taken either of the following two equations, preferably longer one:

(i) $L = \frac{V^3}{28R}$; or (ii) $L = \frac{QV^2}{28R}$

Where : L is the length of transition curve in meters;

V is the speed is kilometres per hour;

R is the radius of the curve in metres.

Value of Q is taken 73 in flat country and 29 in hilly tracts.

Since the road width is also widened at the circular curve, both widening and super-elevation are provided at a uniformly increasing rate in the transition length.

The minimum length of transition provided for curves shall be as under :

(a) 15m for design speeds upto 40 km/hour.

(b) 20m for design speeds 40 to 50 km/hour

3. SUPER- ELEVATION

Transverse inclination to the pavement surface is known as super-elevation. A vehicle travelling a curve path on a flat surface has a tendency to slide outward or to overturn, about the points of contact between the outer wheels and the pavement, depending on the sharpness of the curve and the centre of gravity of vehicle weight and speed of the vehicle. To offset this the roadway surface is sloped upward towards the outside of the curve.

Super-elevation in flat lands,

$E = \frac{V^2}{127R}$ Subject to a maximum of 1/15.

Super-elevations in Hill Tracts,

$E = \frac{V^2}{225R}$

Where :

E = super-elevation in meters per metre width of carriageway,

V = design speed in km/hr. (is generally taken 3/4th to 2/3rd of the road speed),

R = radius of curve in metres

For Bangladesh conditions (as regards loaded cart traffic), a super-elevation of 1 in 15 (6.7 percent) has to be the limit. The greater the super-elevation, more the inconvenience to the slow-moving traffic with danger of side slip be further eased.

There are in general two methods of applying super-elevation: (a) Outer edge super-elevated and inner edge depressed, (b) Grade at inner edge retained and outer edge super-elevated.

Super-elevation where provided shall not be less than camber of the road recommended for the particular road type to facilitate drainage.

Super elevation should never be less than the camber appropriate to the type of surface namely.

- Bituminous Carpeting surface 1 in 60
- HBB 1 in 36 to 1 in 48

Table-6 : Radius beyond which no Super-elevation is required

Classification of Road	Radius beyond which super-elevation is not required (meters)
Upazila Roads (Flat terrain)	610 for Design Speed 50 KM per hour
Union Roads (Flat terrain)	460 for Design Speed 40 KM per hour

4. Extra Width of Pavement at Horizontal Curves

On all horizontal curves some extra width of the carriageway is to be provided. In Table-7 extra widths to be provided are shown. These extra widths are for one lane (3.70m) and two lane (5.50m) pavements.

Table-7: Extra Width to Pavement at Horizontal Curves

Radius of curvature in meters	Up to 60m	Above 60m to 150m	Above 150m to 300m	Above 300m to 900m	Above 900m
Extra width in meters	1.2m	90cm	60 cm	30cm	nil

Extra-widening should be provided on the inner.

The widening will start at the beginning or tangent point of the transition curve and progressively increases at the uniform rate till the maximum designed widening is reached at a point in the transition curve, where the full designed super-elevation is reached. Thereafter the same widening will be continued till a similar point in the further transition is reached, where the designed super-elevation starts reducing.

PAVEMENT DESIGN

Pavement designs are based on the forecast number of Equivalent Standard Axles (ESA's) that will use the road over its lifetime. An ESA is 8.2 tonnes. Data from motorised vehicles in Bangladesh is used to assess what are typical axle loads for various types of vehicles. These, along with an assessment of the traffic mix on the road, are used to determine total ESA's over the design period. Increase in axle weight limit in Bangladesh had already taken account

of in the calculation. The approved designs therefore show a logical progression of increasing pavement thickness with traffic volume.

The illogical progression with road class is expected to overcome by the adoption of the approved design types. As traffic volume increases, the overall pavement thickness increases. In the case of the progression from Type 8 to Type-7, the thickness remains the same, but because the carriageway width increases, there is less concentration of wheels on the same part of the road, and hence the same pavement thickness can accommodate a higher traffic level.

The approved design types have pavement thickness based on the principles embodied in the UK's Transport Research Laboratory Report Road Note 31.

Materials for pavements, structures and embankment protection works should always meet the requirements of Bangladesh's environmental laws and rules.

Typical applications

Because road design will henceforth be based on traffic volume, as opposed to road classification, then *in theory* a road could take any of the design types 3 to 8. In practice, traffic and traffic growth considerations mean that the typical applications of the designs will be as listed in Table-8.

Table-8 : Design applications

Road class	Typical design applications
Upazila	Types,6,5, 4*
Union	Types, 8, 7

* Special type to be used under special circumstances

Design Life

The design lives, based on the pavement thicknesses for each approved design are set out in Table 9 in terms of the cumulative number of equivalent standard axles (ESA's). Given typical traffic levels and a growth rate of 5% per year the expected design life for each type of existing road is provided. For each of the approved designs the forecast ESA's have been calculated from the traffic volume in the design year, to allow the design life to be estimated. Again, traffic growth of 5% on all roads is assumed. Table 10 contains a detailed set of traffic assumptions and ESA's. Design standards are based on actual axle loads, not legal weight limits. Thus any proposed change in the regulations is taken account of.

Table 9 : Design lives

Approved Design			
Road Class	Design Type	Design Life (Million ESA's)	Expected Design Life** (years)
Union	8	1.0	10
	7	1.0	10
Upazila	6	1.0	10
	5	1.6	10
	4*	2.0	10

*** Overlaying of 25-40mm BC will be required after every 7-8 yrs. * Special type to be used under special circumstances*

Table-10 : Traffic and ESA Equivalence Table

Design Type (maximum traffic)	Annual Average Daily traffic	4 Wheeled Motor Vehicles (per day)	Commercial Vehicles per day	PCU/hour (peak hour)	Cumulative M ESA's at		
					10 years	15 years	20years
8	2150	120	50	90	0.2	0.3	0.4
7	2250	180	100	130	0.4	0.5	0.6
	2350	240	150	170	0.5	0.7	0.8
6	2450	310	200	210	0.6	0.9	1.0
	2550	370	250	250	0.8	1.0	1.3
5	2650	430	300	290	0.9	1.2	1.5
	2750	500	350	330	1.1	1.4	1.7
	2850	560	400	370	1.2	1.6	1.9
	2950	620	450	410	1.3	1.8	2.1
	3050	690	500	450	1.5	2.0	2.4
	3150	750	550	490	1.6	2.1	2.6
4	3250	820	600	530	1.7	2.3	2.8
	3350	880	650	570	1.9	2.5	3.0
	3450	940	700	610	2.0	2.7	3.2
	3550	1010	750	650	2.2	2.9	3.5
	3650	1070	800	690	2.3	3.1	3.7
	3750	1130	850	730	2.4	3.3	3.9
	3850	1200	900	770	2.6	3.5	4.2
3	3950	1260	950	810	2.7	3.6	4.4
	4050	1320	1000	850	2.8	3.8	4.6
	4150	1390	1050	890	3.0	4.0	4.8
	4250	1455	1100	930	3.1	4.2	5.1
	4350	1520	1150	970	3.3	4.4	5.3
	4450	1585	1200	1010	3.4	4.6	5.5
	4550	1650	1250	1050	3.6	4.8	5.8
	4650	1715	1300	1090	3.7	5.0	6.0
	4750	1780	1350	1130	3.8	5.2	6.2
	4850	1845	1400	1170	4.0	5.4	6.4
	4950	1910	1450	1210	4.1	5.6	6.7
	5050	1975	1500	1250	4.3	5.7	6.9
	5150	2040	1550	1290	4.4	5.9	7.1
	5250	2105	1600	1330	4.6	6.1	7.4
	5350	2170	1650	1370	4.7	6.3	7.6
	5450	2235	1700	1410	4.9	6.5	7.8
	5550	2300	1750	1450	5.0	6.7	8.1
	5650	2365	1800	1490	5.1	6.9	8.3
	5750	2430	1850	1530	5.3	7.1	8.5
	5850	2495	1900	1570	5.4	7.3	8.8

Construction Materials and Terminology

The specified terminology and basic parameters for road pavement materials as mentioned in National Road Design Standards, 04 are shown in Tables-11 and 12.

Bituminous Bound Materials

Table-11

Pavement Layer	Basic Properties	Brief Description of materials
Dense Bituminous Surfacing (DBS)	ACV of aggregate <30%	Mixture of Stone, fine filler and bitumen carefully graded to give a dense material with no voids. Mixed and laid by machine whilst hot.
Double bituminous surface treatment (DBST)	ACV of aggregate <28%	A combination of hot bitumen sprayed onto the road by machine and a single sized stones spread and rolled into the bitumen whilst hot. The process is then repeated using a second layer of bitumen and smaller sized stone.
Single bituminous surface treatment (SBST)	ACV of aggregate <28%.	A combination of hot bitumen sprayed onto the road by machine and single sized stones spread and rolled into the bitumen whilst hot.
Seal Coat	------	A mixture of bitumen and coarse sand/ pea gravels mixed hot before spreading and rolling. Usually carried out using labour intensive methods.
Bituminous Carpeting	ACV of aggregate <30%.	A mixture of bitumen and graded stone mixed hot before spreading and rolling. Usually carried out using labour intensive methods.
Tack Coat	------	A coat of lightly cut-back bitumen sprayed onto an existing bituminous surfacing to provide a bond before laying a new bituminous layer such as carpeting or DBS.
Prime Coat	------	A coat of heavily cut-back bitumen sprayed onto an existing granular surfacing to provide a bond before laying a new bituminous layer such as carpeting or DBS. The spray rates for prime coats are normally about twice those of tack coats.

The layer of soil immediately below the road pavement is referred to as the sub-grade and this is normally more carefully selected soil which is given additional compaction to increase its strength. In all cases the depth of sub-grade compaction should be 300mm. Because in Bangladesh it is often difficult to achieve satisfactory CBR values on naturally occurring sub-grades; improved sub-grades usually consisting of fine sand are normally used. The thickness of improved sub-grade is to be determined by the CBR of the natural sub-grade according to Table 13 subjected to fulfillment of condition as per Article 13.b.

Granular Materials

Table- 12

Pavement Layer	Minimum CBR % (Lab. Test after 4 days soaking)	Maximum Field DCP Test mm/ blow	Maximum Aggregate Crushing Value %	Required Compaction	Typical Materials Likely to meet specification.
Base Type I	80%	3.5 mm/ blow	30%	98% Vibrating Hammer / Heavy Compaction (Modified Proctor*)	Graded stone or graded stone with some brick or brick if it can meet specification
Base Type Ia	80%	3.5 mm/ blow	30%	98% Vibrating Hammer / Heavy Compaction (Modified)	Brick if it can meet specification
Sub base	30%	9.0 mm/ blow	32%	98% Vibrating Hammer / Heavy Compaction (Modified)	Graded materials consisting of brick or brick sand mixtures. Re-cycled pavement materials such as brick, broken concrete, old surfacing etc.
Improved Sub-grade	8%	22 mm/ blow	---	98% Vibrating Hammer / Heavy Compaction (Modified)	Usually locally occurring fine sand
Sub-grade (compacted min. 300mm thickness)	4%	30 mm/ blow	---	98% Standard Compaction	Natural soil of low plasticity
Earthwork in Embankment	3%	45 mm/ blow	---	95% Standard Compaction	Natural soil of low/ medium plasticity

* Modified Proctor hereinafter abbreviated to Modified.

Table 13 : Thickness of improved sub-grade for various sub-grade CBR values.

Min. CBR Value of Sub-grade material (at specified compaction) %	Thickness of Improved Sub-grade to give CBR of 8%
2% $^{\gamma}$	450 mm
3% $^{\gamma}$	300 mm
4%	250 mm
5%	200 mm

$^{\gamma}$ If CBR value of sub-grade is less than 4% procedure given in Article 13.b shall be followed.

Road Network

With a view to developing an efficient road network in the country, it is essential to prepare a Road Master Plan. The Plan should address the long term objectives for the Bangladesh road network, and comprise a physical plan of the network required to meet the country's economic and social needs. Following are the criteria for road investment as considered in the Rural Road Master Plan:

- Traffic and transport need;
- Improvement of accessibility to the poorer sectors of society;
- Contribution to strategic economic growth targets
- Projects should provide links with the paved network;
- Roads should be implement able over a reasonable time period so as to bring benefits quickly (6 years maximum);
- Phased projects should provide staged benefits;
- Connections to the paved road network for growth centres and Union Parishads.

Road Widening

The criteria for road widening should be traffic. Road widening should not necessitate re-classification.

Road Types 5, and 6 all have 7.3m (24 feet) crest widths. Widening of Feeder Roads to Type 5 and widening of a Type 6 to a Type 5 do not involve any increase in the size of the embankment. All other widening requires embankment widening

Road Strengthening

Where road deflection survey indicates adequate CBR of the sub-base/base of the existing pavement, in that case strengthening may be adopted, where removal of the surfacing would be necessary and a new base layer with bituminous surfacing may be provided.

"Road Safety" Measures for Upazila and Union Roads♦

In order to ensure "Road Safety" the Local Government Engineering Department has undertaken various programmes to create public awareness apart from the technical aspects under its different projects. The following measures are to be taken into consideration to ensure Road Safety for Roads under development. In addition the following items are to apply for roads already completed by bringing them under the purview of Maintenance.

♦ *(According to ROAD SAFETY MEASURES – Vide letter of the Chief Engineers dated 7th February 2005)*

1. Issues to be considered during the Planning and Implementation of a Road.

The following technical matters should be considered on a priority basis at the planning and implementation stage to ensure road safety.

(a) Straighten sharp curves as much as possible in order to convert it into an easy curve.

(b) The level & grade should match at the point where LGED roads are meet national & regional roads and if necessary, divider/roundabout should be provided in order to bifurcate the circulation of traffic. Provisions for super elevation in compliance with the curvature

(c) Provision for prescribed shoulder on either side of the road

(d) All measures to be taken to provide “safe sight distance”

(e) The roads should be kept free from all unauthorized obstructions. In this regard, all markets, shops, billboards, utility lines such as telephone lines, street lights, electricity poles, gas connection lines etc. must be relocated.

(f) Upon an occurrence of an accident on LGED roads, the attached “Road accident form” should be completed and forwarded to the “Road safety unit”. Following an analysis of the information obtained measures should be taken to avert accidents.

(g) Undesirable hump on the road, if exists, should be removed. In case of speed needs to be regulated, then the hump should be replaced by rumble strips

(h) Grass can be grown (in particular on bridge approaches) and tree plantation programmes should be taken up following the construction/ maintenance of a road. However care should be taken that in no way the sight distance is obstructed. Plantation of trees is to be avoided on the inner side of the curve.

(i) Measures should be taken to prevent water stagnation of on the road surface.

(j) Pedestrian crossings/ boundary walls etc. can be constructed subject to availability of funds in order to ensure safety of the students at schools, colleges, madrasa, adjacent to the road.

(k) Railing/ rail posts of each bridge should be painted. In addition each alternate rails post should be provided with retro reflecting markings.

(l) The opposite direction of the bend (curve) of a bridge, bridge approach and market area should be provided with guide posts and each alternate guide post should be provided with retro reflecting markings

(m) Kilometer posts be put up on each road in accordance with the approved design, drawing and specification.

(n) It is compulsory that the following signs & markings are provided:

- Regulatory *"STOP"* sign or "*Give Way"* signs with retro reflecting markings should be erected at the Intersection of each road
- Regulatory speed limit signs with retro reflecting markings should be erected at major intersections, built-up area, markets, schools, colleges, madrasa, religious institutions, broken down bridges, narrow bridges and dangerous curves.
- Warnings and guide signs should be erected at intersections, large bridges, (>30 meters), narrow bridges, built-up areas and permanent hazard obstructions.
- If possible, rumble strips (a series of rough textured surface patches) should be installed at intersections, narrow bridges, built-up areas, and railway crossings.
- Sticker of retro reflecting material should be attached to the rear of non-motorized vehicles like rickshaws, rickshaw vans and bicycles.

2. The Issues to be considered during the operational phase.

The local people should be motivated about road safety while using the road. The Upazilla road safety community formed by the people's representatives, in particular the UP chairman, UP members, teachers of school, Girl Guides, and Boy Scouts, owners of transport and members of committees should launch road safety campaigns and community road patrolling (once in three months) to ensure proper use of roads already completed and to be completed.

The road safety campaigns will consist mainly of rallies on road safety, meetings, seminars and documentary film shows etc.

The community road patrolling activities will take measures to remove any unauthorized new erection on the road, bill boards and the like that hampers the circulation of traffic. The cost will be borne out of the funds for maintenance. Further, the following is a compulsory to-do list.

(a) Black spots, indicating accident-prone spots on the road or where maximum number of accidents has already occurred up to the present should be identified.

(b) Strict vigilance should be in force not to let anyone stack hay on the road. The local people should be motivated to avoid the habit of drying wood chips, hay, paddy sheaves, cow dung etc. on the road by explaining the harmful aspects of these practices.

(c) Strict vigilance should be in force in order that no one can cut the earth from the embankment and shoulders of the road and nothing is done to cause harm to the embankment and shoulders.

(d) Grass grown on the side of the road is very beneficial to prevent the earth from eroding and the people should be motivated that at no cost should this grass be mown for other alternative uses. At the same time proper care should be taken in respect of the trees and other plantations along the road – in particular, from the domestic animals grazing in the field.

(e) The people should be motivated to give up the use of the iron rim for the tractor, and wooden frame for the cartwheel drawn by cows or buffaloes – instead they should be encouraged to use rubber wheels.

(f) Care should be taken to remove stranded vehicles (bus, truck & other vehicles) as far as possible from the road

(g) People should be encouraged not to overload the bus and additionally, they should also be informed about the hazards of trucks loaded beyond their carrying capacity to dissuade them from such practices.

(h) Care should be taken to dissuade people from digging irrigation canals on the shoulder or slope

(i) Roads should be inspected following the occurrence of storms or floods or any other natural calamity. Measures should then be taken for the immediate removal of trees lying on the road after a storm or flood.

Note: For Road Traffic Signs LGED document 'Rural Road & Culvert Maintenance Guideline, June 2004, Appendix-1 shall be followed.

PAVEMENT DESIGN CONFIGURATION FOR UPAZILA ROAD

DESIGN TYPE 6

1.	Equivalent Axle Loading	:	8.2 Ton
2.	Traffic	:	101 to 200 CV/Day
3.	Growth rate	:	5%
4.	Design life	:	10 Years.
5.	Embankment fill	:	Min. 95% STD Compaction DCP Max 45mm per blow to ensure Min. 3% SOAKED CBR (Ref. Article 1.1)
6.	Sub-Grade, Min 300mm Thick	:	Min 98% STD Compaction DCP Max 30mm per blow to ensure Min 4% SOAKED CBR (Ref. Article 1.2)
7.	Improved Sub-Grade Sand FM 0.80 min, PI Value<6	:	Min 98% (Modified) Compaction DCP max 22mm per blow to ensure Min 8% SOAKED CBR (Ref. Article 1.3)
8.	Aggregate-Sand Sub-Base Course (Sand : Max. 50% of mix) Brick or Stone Aggregates, 38mm down graded according to the prescribed grading envelop, ACV <32%; Sand FM 0.80 min, PI Value<6)	:	Min 98% (Modified) Compaction DCP Max 9mm per blow to ensure Min 30% SOAKED CBR (Ref. Article 5.0)
9.	Base-Course, Water Bound Macadam with Brick or Stone Aggregate, 38mm down graded according to the prescribed grading envelop, ACV <30%; Sand FM 0.80 min, PI Value<6)	:	Min 98% (Modified) Compaction DCP Max 3.5mm per blow to ensure Min 80% SOAKED CBR (Ref. Article 6.0)
10.	Bituminous carpeting	:	25mm BC (Ref. Article 10.0) plus 7mm Seal coat (Ref. Article 11.0)
11.	Single Lane Carriageway width	:	3.7m.
12.	Earthen Shoulder	:	95% STD Compaction DCP Max 45mm per blow to ensure Min 3% SOAKED CBR (Ref. Article 1.1)
13.	Crest width	:	7.30m.
14.	Side Slope	:	1: 1.5 for clayey soil Road Embankment 1 : 2 for Clayey Sand Road Embankment 1 : 3 for Sand or silty Sand Road Embankment

Note: In absence of ACV testing equipment, LAA test of coarse aggregates shall be carried out provided LAA value of coarse aggregates should be less than 40 percent.

DESIGN TYPE 5

1.	Equivalent Axle Loading	:	8.2 Ton
2.	Traffic	:	201 - 300 CV/Day
3.	Growth rate	:	5%
4.	Design life	:	10 Years.
5.	Embankment fill	:	Min. 95% STD Compaction DCP Max 45mm per blow to ensure Min. 3% SOAKED CBR (Ref. Article 1.1)
6.	Sub-Grade, Min 300mm Thick	:	Min 98% STD Compaction DCP Max 30mm per blow to ensure Min 4% SOAKED CBR (Ref. Article 1.2)
7.	Improved Sub-Grade Sand FM 0.80 min, PI Value<6	:	Min 98% (Modified) Compaction DCP max 22mm per blow to ensure Min 8% SOAKED CBR (Ref. Article 1.3)
8.	Aggregate-Sand Sub-Base Course (Sand : Max. 50% of mix) Brick or Stone Aggregates, 38mm down graded according to the prescribed grading envelop, ACV <32%; Sand FM 0.80 min, PI Value<6)	:	Min 98% (Modified) Compaction DCP Max 9mm per blow to ensure Min 30% SOAKED CBR (Ref. Article 5.0)
9.	Base-Course, Water Bound Macadam with Brick or Stone Aggregate, 38mm down graded according to the prescribed grading envelop, ACV <30%; Sand FM 0.80 min, PI Value<6)	:	Min 98% (Modified) Compaction DCP Max 3.5mm per blow to ensure Min 80% SOAKED CBR (Ref. Article 6.0)
10.	Bituminous carpeting	:	40mm BC (Ref. Article 10.0) plus 7mm Seal coat (Ref. Article 11.0)
11.	Single Lane Carriageway width	:	3.7m.
12	Hard Shoulder		0.90m Wide Pavement Simile with 12 mm Seal Coat (Ref. Article 12.0)
13.	Earthen Shoulder	:	95% STD Compaction DCP Max 45mm per blow to ensure Min 3% SOAKED CBR (Ref. Article 1.1)
14.	Crest width	:	7.30m.
15.	Side Slope	:	1: 1.5 for clayey soil Road Embankment : 1 : 2 for Clayey Sand Road Embankment 1 : 3 for Sand or silty Sand Road Embankment

Note: In absence of ACV testing equipment, LAA test of coarse aggregates shall be carried out provided LAA value of coarse aggregates should be less than 40 percent.

DESIGN TYPE 4

1.	Equivalent Axle Loading	:	8.2 Ton
2.	Traffic	:	301 to 600 CV/Day
3.	Growth rate	:	5%
4.	Design life	:	10 Years.
5.	Embankment fill	:	Min. 95% STD Compaction DCP Max 45mm per blow to ensure Min. 3% SOAKED CBR (Ref. Article 1.1)
6.	Sub-Grade, Min 300mm Thick	:	Min 98% STD Compaction DCP Max 30mm per blow to ensure Min 4% SOAKED CBR (Ref. Article 1.2)
7.	Improved Sub-Grade Sand FM 0.80 min, PI Value<6	:	Min 98% (Modified) Compaction DCP max 22mm per blow to ensure Min 8% SOAKED CBR (Ref. Article 1.3)
8.	Aggregate-Sand Sub-Base Course (Sand : Max. 50% of mix) Brick or Stone Aggregates, 38mm down graded according to the prescribed grading envelop, ACV <32%; Sand FM 0.80 min, PI Value<6)	:	Min 98% (Modified) Compaction DCP Max 9mm per blow to ensure Min 30% SOAKED CBR (Ref. Article 5.0)
9.	Base-Course, Water Bound Macadam with Brick or Stone Aggregate, 38mm down graded according to the prescribed grading envelop, ACV <30%; Sand FM 0.80 min, PI Value<6)	:	Min 98% (Modified) Compaction DCP Max 3.5mm per blow to ensure Min 80% SOAKED CBR (Ref. Article 6.0)
10.	Bituminous carpeting	:	40mm BC (Ref. Article 10.0) plus 12mm Seal coat (Ref. Article12.0)
11.	Double Lane Carriageway width	:	5.5m
12.	Earthen Shoulder	:	95% STD Compaction DCP Max 45mm per blow to ensure Min 3% SOAKED CBR (Ref. Article 1.1)
13.	Crest width	:	9.80m
14.	Side Slope	:	1: 1.5 for clayey soil Road Embankment : 1 : 2 for Clayey Sand Road Embankment 1 : 3 for Sand or silty Sand Road Embankment

Note: In absence of ACV testing equipment, LAA test of coarse aggregates shall be carried out provided LAA value of coarse aggregates should be less than 40 percent.

PAVEMENT DESIGN COFIGURATION FOR UNION ROAD

DESIGN TYPE 8

1.	Equivalent Axle Loading	:	8.2 Ton
2.	Traffic	:	01 to 50 CV/Day
3.	Growth rate	:	5%
4.	Design life	:	10 Years.
5.	Embankment fill	:	Min. 95% STD Compaction DCP Max 45mm per blow to ensure Min. 3% SOAKED CBR (Ref. Article 1.1)
6.	Sub-Grade, Min 300mm Thick	:	Min 98% STD Compaction DCP Max 30mm per blow to ensure Min 4% SOAKED CBR (Ref. Article 1.2)
7.	Improved Sub-Grade Sand FM 0.80 min, PI Value<6	:	Min 98% (Modified) Compaction DCP max 22mm per blow to ensure Min 8% SOAKED CBR (Ref. Article 1.3)
8.	Aggregate-Sand Sub-Base Course (Sand : Max. 50% of mix) Brick or Stone Aggregates, 38mm down graded according to the prescribed grading envelop, ACV <32%; Sand FM 0.80 min, PI Value<6)	:	Min 98% (Modified) Compaction DCP Max 9mm per blow to ensure Min 30% SOAKED CBR (Ref. Article 5.0)
9.	Base-Course, Water Bound Macadam with Brick or Stone Aggregate, 38mm down graded according to the prescribed grading envelop, ACV <30%; Sand FM 0.80 min, PI Value<6)	:	Min 98% (Modified) Compaction DCP Max 3.5mm per blow to ensure Min 80% SOAKED CBR (Ref. Article 6.0)
10.	Bituminous carpeting	:	25mm BC (Ref. Article 10.0) plus 7mm Seal coat (Ref. Article 11.0)
11.	Single Lane Carriageway width	:	3.0m
12.	Earthen Shoulder	:	95% STD Compaction DCP Max 45mm per blow to ensure Min 3% SOAKED CBR (Ref. Article 1.1)
13.	Crest width	:	5.50m
14.	Side Slope	:	1: 1.5 for clayey soil Road Embankment : 1 : 2 for Clayey Sand Road Embankment 1 : 3 for Sand or silty Sand Road Embankment

Note: In absence of ACV testing equipment, LAA test of coarse aggregates shall be carried out provided LAA value of coarse aggregates should be less than 40 percent.

DESIGN TYPE 7

1.	Equivalent Axle Loading	:	8.2 Ton
2.	Traffic	:	51 to 100 CV/Day
3.	Growth rate	:	5%
4.	Design life	:	10 Years.
5.	Embankment fill	:	Min. 95% STD Compaction DCP Max 45mm per blow to ensure Min. 3% SOAKED CBR (Ref. Article 1.1)
6.	Sub-Grade, Min 300mm Thick	:	Min 98% STD Compaction DCP Max 30mm per blow to ensure Min 4% SOAKED CBR (Ref. Article 1.2)
7.	Improved Sub-Grade Sand FM 0.80 min, PI Value<6	:	Min 98% (Modified) Compaction DCP max 22mm per blow to ensure Min 8% SOAKED CBR (Ref. Article 1.3)
8.	Aggregate-Sand Sub-Base Course (Sand : Max. 50% of mix) Brick or Stone Aggregates, 38mm down graded according to the prescribed grading envelop, ACV <32%; Sand FM 0.80 min, PI Value<6)	:	Min 98% (Modified) Compaction DCP Max 9mm per blow to ensure Min 30% SOAKED CBR (Ref. Article 5.0)
9.	Base-Course, Water Bound Macadam with Brick or Stone Aggregate, 38mm down graded according to the prescribed grading envelop, ACV <30%; Sand FM 0.80 min, PI Value<6)	:	Min 98% (Modified) Compaction DCP Max 3.5mm per blow to ensure Min 80% SOAKED CBR (Ref. Article 6.0)
10.	Bituminous carpeting	:	25mm BC (Ref. Article 10.0) plus 7mm Seal coat (Ref. Article 11.0)
11.	Single Lane Carriageway width	:	3.7m.
12.	Earthen Shoulder	:	95% STD Compaction DCP Max 45mm per blow to ensure Min 3% SOAKED CBR (Ref. Article 1.1)
13.	Crest width	:	5.50m.
14.	Side Slope	:	1: 1.5 for clayey soil Road Embankment 1 : 2 for Clayey Sand Road Embankment 1 : 3 for Sand or silty Sand Road Embankment

Note: In absence of ACV testing equipment, LAA test of coarse aggregates shall be carried out provided LAA value of coarse aggregates should be less than 40 percent.

CULVERTS AND BRIDGES

Culverts should normally be no longer than 6m spans. Bridges should be used if the gap exceeds 6m spans.

Culverts and bridges shall be designed with H20S16 loading. Table 13 lists approved bridge widths. Schematic bridge layouts are shown in Figure 1.

Table 14 lists recommended RCC Box Culvert carriageway widths. Guard Post shall be provided if carriageway width of Box Culvert is less than crest width of the road. Cut-off Wall of RCC Box Culvert shall be provided at upstream and downstream away from Box by at least two-third of Box height.

Portable Steel Bridges (PSB) may be proposed with narrower carriageways, as emergency measures. Brick Arch Culverts may be proposed on Union and Village Roads with 3.7m carriageway width, where length is <=4.5m and height is limited to maximum of 4m. On higher roads wider Brick Arch Culverts with 5.5m and 7.3m width and a maximum of 4m heights could also be considered. This practice should be encouraged as steel reserve is gradually diminishing and if this alternative is found cost effective.

Table 13 : Bridge Carriageway Widths

Design Type	Class	Length less than 30m (100')	Length greater than 30m (100')
8, 7	Union	3.7 (12')	5.5 (18')
6,5,4	Upazila	5.5 (18')	5.5 (18')

Table 14 : RCC Box Culvert Carriageway Widths

Design Type	Class	Standard Carriageway width	Optional* Carriageway width
8, 7	Union	5.5 (18') Crest Width	3.7 (12')
6,5,4	Upazila	7.3 (24') Crest Width	5.5 (18')

** To be determined by the authority with justification*

Table 15 lists typical gap requirements for cross drainage by type of road. All roads should be provided with appropriate gaps, irrespective of road building agency, according to the design type and geographical location.

Table 15 : Typical gaps by type of road, meters per kilometer

	New Class	Road Design Type	Geographical location			
			Swampy	Hilly	Haor*	Plane
	Upazila & Union	Type 6, 5, 4 Types 8, 7	10-15	7-15	10-15	6-10

** To be determined case by case*

ROAD PAVEMENT CONSTRUCTION METHOD

1.0 EARTHWORKS FOR EMBANKMENT

a. REPORTING & MONITORING

The Contractor shall keep a Site Order Book on site at all times. Instructions on the work and all site visits shall be recorded in the Site Order book.

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1.1 EMBANKMENT

a. Description

This work shall consist of the construction of embankment and fill by furnishing, placing, compacting and shaping suitable material of acceptable quality obtained from approved sources in accordance with these specifications and to the lines, levels, grades, dimensions and cross sections shown on the Drawings or as required by the Engineer.

The location of borrow pit shall be approved by the Engineer and must be at a distance of 3.Om or 1.5 times the height of the embankment, whichever is higher from the toe to the designed embankment. The depth of excavation in borrow pits shall not exceed 0.8m under normal conditions.

b. Materials

All fill materials shall be free from roots, sods or other deleterious materials.

Materials for embankments shall be stockpiled outside the working areas. Materials shall be tested and approved by the Engineer.

The selected fill material so stockpiled shall satisfy the following criteria:

- Liquid limit of fraction passing 425 micron sieve shall not exceed 50%

- Plasticity index of fraction passing 425 micron sieve shall not exceed 20%

- The dry density after compaction in embankment layers more than 300mm below sub-grade level shall not be less than 95% (STD) of the maximum dry density.

- The dry density after compaction in embankment within 300mm below the top of the sub grade level (or such greater depth if shown in the plans and drawings) shall not be less than 98% (STD) maximum dry density

- Soaked (4 days) CBR greater than 3% at 95% MDD (STD).

- DCP Maximum 45mm per blow

- The moisture content at the time of compaction shall be the optimum moisture content (Standard Compaction) ± 5%.

In case if the embankment material is sand, side slopes and shoulders shall be covered by cohesive soil of PI value in between 8-20%.

1.1.1 Construction Methods

a. Preparation of Foundation for Embankment

Prior to placing materials for any embankment upon any area, all clearing and grubbing operations shall have been completed.

The original ground surface shall be prepared with scarifying, watering, aerating and compacting. The dry density after compaction shall not be less than 95% of MDD (STD).

Embankments in swamps or water shall be constructed as indicated on the Drawings and as described in these Specifications. The Contractor shall, when ordered by the Engineer, excavate or displace swampy ground and backfill with suitable material. Such backfill shall be river or beach sand unless otherwise directed by the Engineer.

b. Widening Existing Embankment

Where embankment fill is being carried out to widen an existing embankment the new fill material shall be fully keyed into the old embankment by means of benching which shall be in steps each not less than 300mm high and 600mm wide. Steps shall be cut in advance of the filling. Material cut in benches may be used as fill if it compiles with Article 1.1b above or as directed by the Engineer. Sample of stepping construction of widening road Embankment has been shown for Upazila Road in Plate No. URR-EW-WDI and for Union Road in Plate No. UNR-EW-WDI.

c. Embankment Fill from Roadway Excavation

Existing Sub-grade within 300mm depth of the existing road level, (or as specified) not having the required percentage of compaction, shall be excavated out.

Provided the excavated material is in accordance with article 1.1.1b then it shall be reworked and reused in widening or raising the embankment to the specified percentage of compaction and in accordance with paragraph 1.1.1d.

Where the item "embankment fill from roadway excavation" is used and paid for, there shall be no separate payment for sub grade preparation under section 1.2.

d. Compaction of Embankment

Embankment shall be constructed in layer not more than 150mm compacted layers. When necessary, each layer, before being compacted, shall be mixed with dry material or otherwise processed to bring the moisture content to within the limits established in Article 1.1b above. The material shall be so worked as to have uniform moisture content through the entire layer.

Each layer of material shall' be compacted uniformly by use of adequate and appropriate mechanical compaction equipment. The compaction shall be carried out in a longitudinal direction along the embankment and shall generally begin at the outer edges and progress toward the centre except in the super elevated area in such a manner that each section receives equal compactive effort.

Compaction equipment shall be operated over the full width of each layer as far as practicable.

Samples to determine the compaction, CBR & other parameters shall be taken regularly per finished layer as specified or as directed by the Engineer.

The Engineer shall test the compacted layer before the Contractor can commence a new layer. If the test results show that the density is less than the required density the Contractor shall carry out further compaction to obtain at least the required density.

e. Additional Filling

To ensure that, the embankment is properly compacted up to the edges of each layer, overfilling and compaction of minimum 300mm horizontally on both sides of the embankment is required, which later on has to be cut and removed. No extra payment will be made for this procedure.

Embankment construction or embankment widening must be completed before box cutting for pavement construction.

1.2 PREPARATION OF SUB-GRADE

a. Description

This work shall consist of the preparation of sub-grade in embankment in cut by scarifying, watering, aerating, compacting and shaping existing or previously placed material in accordance with these specifications and to the lines, levels grades, dimensions, camber and cross sections shown on the Drawings or as instructed by the Engineer.

b. Materials

All sub-grade material shall be suitable material in accordance with the requirements of Article 1.1b.

Any sub-grade material in cut or existing old embankment which is found to be unsuitable shall be removed and replaced as directed by the Engineer.

1.2.1 Construction Methods

The sub-grade shall be prepared after box cutting for pavement construction. Half width working may be allowed only with the prior written approval of the Engineer.

The sub-grade shall be prepared in lengths of not less than 100 meters and not more then 500 meters at a time.

When existing sub-grade compaction is found less than 98 percent STD, sub-grade material shall be excavated to a depth of 150mm and stockpiled and a further 150mm should be scarified and compacted to 98% STD. The excavated top layer material shall then be spread and compacted as specified. But if natural compaction of sub grade is 98% STD, two to three passes of 3-5 ton vibratory roller over natural sub-grade are specified to compact loose lump there upon and achieve rolled surface.

When necessary, each layer, before being compacted, shall be allowed to dry or be watered to bring the moisture content with ± 5% of optimum to make possible its compaction to the required density. The material shall be so worked as to have uniform moisture content through the entire layer.

The sub grade material shall be compacted uniformly by use of adequate and appropriate mechanical compaction equipment. The compaction shall be done in a longitudinal direction along the embankment and shall generally begin at the outer edges and progress toward the centre in such a manner that each section receives equal comp active effort.

Samples to determine the compaction, CBR & other properties shall be taken regularly per finished layer as specified or as directed by the Engineer.

However if sub-grade does not conform compaction to attain 4 percent soaked CBR, corrective procedure imparted in Article 13.b shall be followed.

1.3 IMPROVED SUB-GRADE

a. Description

This work shall consist of furnishing placing and compacting improved sub-grade material on a prepared and accepted sub-grade in accordance with these Specifications and to the lines, levels, grades, dimensions and cross sections shown on the Drawings or as instructed by the Engineer.

b. Materials

Material shall be of natural sand, free from vegetable matter, soft particles and excess clay. F. M. of Sand shall not be less than 0.8.

(a) Plasticity: The fraction passing the 425 micron sieve shall, have a Plasticity Index not greater than 6.

(b) CBR: The material shall have a soaked CBR value not less than 8% when compacted to 98% of maximum dry density (Modified).

(c) The material shall be free draining.

1.3.1 Construction Methods

a. Preparation of Improved Sub-grade

The sub-grade shall be shaped and compacted in conformity with the provisions of Section 1.2 and completed for at least 100 meters ahead of the placing of the improved sub-grade material. Notwithstanding any earlier approval of sub-grade, any damage to or deterioration of sub-grade shall be made good before improved sub-grade is laid.

Preparation of the sub-grade shall be carried out, unless otherwise agreed by the Engineer, immediately prior to laying the improved sub-grade.

b. Spreading

Improved sub-grade materials shall be spread in layers, with a compacted thickness up to 150mm subject to approval by the Engineer, and the layers shall be as nearly equal in thickness as possible.

Prior to spreading the improved sub-grade materials, full width of shoulder shall be constructed to the elevation of the top of Design Pavement.

c. Sprinkling, Rolling and Compacting

Immediately after each layer has been spread and shaped to camber or super elevation satisfactorily, it shall be thoroughly compacted with mechanical compaction equipment approved by the Engineer. Rolling operations shall begin from the outer edge of roadbed toward the centre, gradually in a longitudinal direction, except on super-elevated curves, where rolling shall begin at the low side and progress towards the high side.

The moisture content at the time of compaction shall be the optimum moisture content (Standard Compaction) ± 3%.

Each layer shall be compacted to at least 98% (modified) of the - maximum dry density. If the density measurement falls below the specified density level then further compaction shall be required, irrespective of the field compaction trial results.

In order to ensure required bearing capacity at the finished improved sub-grade level CBR tests shall be made. The CBR shall be such that the Laboratory Value obtained at the specified compaction and after 4 days soaking, shall exceed 8 percent. In areas where these requirements are not met, correction shall be made by such measures, as the Engineer deems necessary.

Improved sub-grade material that does not contain sufficient moisture to be compacted in accordance with the requirements of this section shall be reworked and watered as directed by the Engineer. The Contractor shall carry out this work at his own expense.

Improved sub-grade material containing excess moisture shall be reworked and dried prior to or during compaction. Drying of wet material shall be performed by methods approved by the Engineer, at the expense of the Contractor.

The finished improved sub-grade at any point shall not vary more than 20mm above or below the planned grade or adjusted grade. The thickness of the finished improved sub-grade shall be on average not less than the required thickness and not thinner than 20mm less than the required thickness at any point and the average of five thickness measurements in any 100 meters of road shall be not thinner than 15mm less than the required thickness. Improved sub-grade that does not conform to the above requirements shall be reworked, watered and thoroughly recompacted to conform.

Where the CBR value of Sub-Grade obtained more than 8% improved sub-grade may be discarded with the approval of proper authority.

1.4 PREPARATION OF IMPROVED SUB-GRADE FOR BITUMINOUS PAVEMENT REPLACING OLD HBB PAVEMENT

a. Description

This item will consist of leveling, dressing, cambering and compacting the existing improved sub-grade surface exposed after removal of the brick flat soling, HBB and the edging to receive new base course. Where necessary additional improved sub-grade materials shall be added to make the finished compacted improved sub-grade as per drawing.

b. Materials

Materials should meet the requirements of Article 1.3b.

1.4.1 Construction Method

The picking up of the brick pavement shall not be done for more than 100m at a time in order to avoid disturbance to traffic and damage to the sub-grade. The salvaged bricks from half or shall be stacked separately broken bricks in such a way that the disturbance to traffic is minimized.

Before picking up the brick pavement the contractor must provide base materials ready at the site so that this shall be placed and compacted immediately after preparation of the improved sub-grade.

The improved sub-grade shall be leveled, graded and cambered according to the design and compacted to 98% of MDD (Modified) using an appropriate roller. Where necessary additional improved sub-grade materials shall be added to make the finished compacted thickness as per drawing.

2.0 PAVEMENT WORKS

2.1 INTRODUCTION TO PAVEMENT WORKS

a. General

Section 3 of these Specifications covers all requirements for road pavements that will be incorporated in the works.

b. Preparation and Stockpiling of Materials

Materials to be used in pavement works shall be processed and stockpiled only in areas designated by the Contractor as approved by the Engineer. Preparation and storage of materials along the alignment will not be allowed. The Contractor shall make all arrangements and bear all costs associated with the provision of these storage areas.

The designated area shall be cleared of all vegetation and topsoil prior to commencing of work and the arrival of any materials.

Bricks of different frog marks, different materials and size fractions shall be kept in separate stockpiles divided as necessary to prevent contamination.

The site of the stockpile shall be cleared of all vegetation and debris, graded and drained and where the Engineer deems it necessary, the areas shall be surfaced with a 1 00mm layer of approved stone or with brick flat soling.

Each stockpile shall be built with a maximum height of 1.25m or as specified by the Engineer-in-Charge with sufficient space left in between two stacks for easy inspection.

The bottom 50mm layer of aggregate or any contaminated aggregate shall not be used in the work.

c. Brick aggregates/Stone aggregates

Brick aggregates may be replaced by stone aggregates. In case of hard shoulder both crushed and uncrushed stone can be used; in case of base course only crushed stone may be used provided that the quality of the stone satisfies the relevant specifications. Cost of stone aggregate will be determined by the Engineer and approved by concerned higher authority.

2.2 SHOULDERS

2.2.1 Pavement Simile Hard Shoulder

a. Description

This shoulder is an option similar to Design Pavement except Bituminous Carpeting. Bituminous Carpeting can be done over Pavement Simile Hard Shoulder when traffic volume exceeds 200 CVD per day. This Pavement Simile Hard Shoulder is constructed at the time pavement construction or later on.

b. Materials

The material shall be same as design pavement up to Base Course.

c. Construction Methods

The construction method shall be similar to design pavement construction up to Base Course.

2.2.2 HBB Hard Shoulder

2.2.2.1 Single Layer Brick Flat Soling

a. Description

This item consists of providing single layer brick flat soling on the sub-grade soil for Hard shoulder as directed by the Engineer.

b. Materials

The materials shall consist of First Class or Picked Jhama Bricks, which meet the requirements of Article 3.0b of these Specifications.

c. Construction Methods

The bricks shall be laid flat in one layer or as specified on the Sand Cushion of 125mm over consolidated and prepared surface. Bricks shall be laid in a regular and uniform manner. Interstices of bricks shall be filled with sand of min. FM 0.5 and water shall be applied by sprinkling. No bricks shall be laid on a foundation or any surface until the same has been inspected and approved by the Engineer. The gaps between two adjacent bricks should not exceed 10mm. The pattern and placing of the bricks shall be as indicated in the drawings.

2.2.2.2 Herringbone Bond Brick (HBB)

a. Description

This work shall consist of a base composed of bricks, laid on edge in a herringbone pattern, placed on a prepared single layer brick flat soling in accordance with these Specifications and to the lines, grades levels, dimensions and cross sections shown in the Drawings and as required by the Engineer.

b. Materials

The materials shall consist of First Class or Picked Jhama Bricks, which meet the requirements of Article 3.0b of these Specifications.

c. Construction Methods

Laying the Bricks

A sand cushion of 25mm thickness (minimum) with sand of F.M. not less than 0.5 will be placed over the brick flat soling. The brick then shall be laid on edge with 125mm across the surface in a single layer in a herringbone pattern to the lines, grades, levels, dimensions and cross section shown on the Drawings and as required by the Engineer. The edge of the layer shall be made with cut bricks to produce a line, which is compatible with brick edging. The joints shall be filled with sand of FM 0.5 brushed in and the completed layer shall be sprinkled liberally with water.

2.2.3 Earthen Shoulder

a. Description

This work consists of the provision of specified wide strips of shoulders adjacent to the pavement on either side. The shoulders shall be constructed in accordance with the lines, levels, dimensions and cross sections shown on the Drawings and as directed by the Engineer.

b. Materials

The material used shall meet the same requirements as that shown in Sections 1.1b.

c. Construction Methods

Pre-work measurement should be taken just before commencing the work. The material shall be spread in layers of uniform thickness to achieve 150mm of compacted thickness and sprinkled with water. After approval by the Engineer, compaction shall be carried out by approved mechanical plant. The material shall be compacted to a density of 95% (STD) of the maximum dry density and DCP maximum 45mm per blow to ensure minimum 3% soaked CBR. Samples to determine the compaction shall be taken regularly with a minimum one sample for each 100 linear meters per layer of each finished shoulder or as decided by the Engineer. Such density tests will be carried out. The Engineer shall approve the compacted layer before the Contractor can commence a new layer. If the test results show that the density is less than the required density the Contractor shall carry out further compaction to obtain at least the required density.

3.0 BRICK ON END EDGING

a. Description

This work consists of providing and placing brick on end edging along the road adjacent to the side of the pavement of single layer brick flat soling and herringbone bond brick or of water bound macadam and bitumen carpet.

b. Materials (Bricks)

The materials shall consist of First Class or Picked Jhama Bricks that should meet the requirements given below. First Class Bricks shall be made from good brick earth free from saline deposits, and shall be sand moulded. They shall be thoroughly burnt by coal without being vitrified, of uniform and good colour shall be regular and uniform in size, shape and texture with sharp square edges and parallel faces. They must be homogeneous in texture and emit a clear metallic ringing sound when struck one against the other. They shall be free from flaws, cracks, chips, stones, modules of lime or canker and other blemishes. A first Class Brick shall not absorb more than 16% of its weight of water after being soaked for one hour, and shall show no sign of efflorescence on drying.

Picked Jhama bricks are those that are so over-burnt as to become vitrified. Those bricks may be broken and used for aggregate in road works provided the vitrified mass has not become porous or spongy as a result of over-burning and the aggregate satisfies the requirements of those Specifications.

First Class Bricks should have the following dimensions after burning: 240mm x 115mm x 70mm (+5mm). Picked Jhama Bricks may have dimensions slightly below those for other brick but not less than 235mm x 110mm x 65mm. The unit weight of First Class Bricks shall not be less than 1100 kg per m^3 and the unit weight of picked Jhama Bricks shall not be less than 1200 kg per m^3.

The crushing strength of bricks shall be tested and the average crushing strength of Bricks shall not be less than 17 N/mm^2, but not less than 14 N/mm^2 in individual case.

c. Construction Methods

Bricks shall be laid on end edging with their longest side vertical and 75mm/125mm side as shown in the Drawing across the road including necessary excavation filling and ramming to the satisfaction of the Engineer. The completed work shall be true to line and level and grade as indicated on the Drawings. Interstices between brick edging and adjacent paving or brushing in sand until voids are filled shall fill soling; the edging shall be sprinkled then with water. End Edging shall be done before commencing Base Course.

4.0 HBB PAVEMENT

4.1 Single Layer Brick Flat Soling

a. Description

This item consists of providing single layer brick flat soling on the sub-grade or improved sub-grade as directed by the Engineer.

b. Materials

The materials shall consist of First Class or Picked Jhama Bricks, which meet the requirements of Article 3.0b of these Specifications.

c. Construction Methods

The bricks shall be laid flat in one layer or as specified on the Sand Cushioning of 125mm over consolidated and prepared surface. Bricks shall be laid in a regular and uniform manner. Interstices of bricks shall be filled with sand of FM 0.5 and water shall be applied by sprinkling. No bricks shall be laid on a foundation or any surface until the same has been inspected and approved by the Engineer. The gaps between two adjacent bricks should not exceed 10mm. The pattern and placing of the bricks shall be as indicated in the drawings.

4.2 Herringbone Bond Brick Pavement

a. Description

This work shall consist of a base composed of bricks, laid on edge in a herringbone pattern, placed on a prepared single layer brick flat soling in accordance with these Specifications and to the lines, grades levels, dimensions and cross sections shown in the Drawings and as required by the Engineer.

b. Materials

The materials shall consist of First Class or Picked Jhama Bricks that meet the requirements of Article 3.0b of these Specifications.

4.2.1 Construction Methods

a. Laying the Bricks

A sand cushion of 25mm thickness (minimum) with sand of F.M. not less than 0.5 would be placed over the brick flat soling. The brick then shall be laid on edge with 125mm across the surface in a single layer in a herringbone pattern to the lines, grades, levels, dimensions and cross section shown on the Drawings and as required by the Engineer. The edge of the layer shall be made with cut bricks to produce a line that is compatible with brick edging. The joints shall be filled with sand of FM 0.5 brushed in and the completed layer shall be sprinkled liberally with water.

b. Surface Tolerance

In those areas in which pavement is to be placed, any deviation in excess of five millimeters from the specified surface within 3 meter shall be corrected by removal, reshaping and relaying.

5.0 SUB-BASE

5.1 Description

This work shall consist of providing, laying and compacting sub-base on the finished approved sub-grade or improved sub-grade, to the lines, levels, dimensions and cross section shown on the drawings or as directed by the Engineer.

5.2 Aggregate-Sand Sub-base

5.2.1 Materials

The sub-base shall consist of AS (Aggregate & Sand), a homogeneous mixture of crushed stone or brick aggregates and local sand or natural or artificial mixture of sand free from vegetation and excess clay. The portion of sand in the mix shall not be more than 50 percent any way. The FM of sand shall not be less than 0.8 unless otherwise written permission of the authority.

5.2.2 The aggregate shall be crushed First Class or Picked Jhama Bricks or stones. The crushed bricks or stones shall comply with the following requirements:-

- water absorption shall not exceed 18%
- maximum size of aggregate shall be 38mm.
- Aggregate Crushing Value of not more than 32% or as directed by the Engineer in the case of reuse of salvaged materials.
- The material shall be well graded having no excess or deficiency in any size.

The Engineer may change the above grading when the laboratory results of the above proportion do not meet the quality requirements of the specification.

5.2.3 The resultant mixture Coarse Aggregate-Sand shall meet grading envelope as in Table 5.1 and also the following requirements:

a) Plasticity: The fraction passing the 425 micron sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6
b) CBR: The materials shall have a soaked CBR value not less than 30% when compacted to 98%(Modified) of maximum dry density.

Grading Requirements for Resultant Mixture of Sub-base material
Table 5.1

Sieve Size	% Passing by Weight
38 mm	100
20 mm	55-95
10 mm	35-75
4.8 mm	25-60
2.4 mm	15-50
600 micron	10-35
300 micron	10-25
75 micron	5-15

5.3 Construction Method

Sub-base materials shall be at or near the optimum moisture content (OMC) at the time of mixing. The coarse aggregate and sand shall be mixed thoroughly preferably over temporary stack yards made of steel plain sheets to obtain a homogeneous mix complying with the grading requirements of this section before placing it on the sub-grade or improved sub-grade. The mixing may be done by mechanical means or a combination of manual labour and machinery.

The mixed materials shall be spread uniformly upon the prepared and approved sub-grade or improved sub-grade. Total thickness required shall be in accordance with the drawings. The relationship between the loose thickness and compacted thickness shall be determined from field trials and used in controlling the loose thickness at the time of spreading the mix.

After spreading has been completed and the surface shaped according to the cross sectional requirements, rolling shall commence. A power roller weighing 8 to 10 tons or equivalent vibratory roller should do rolling. Rolling shall begin at the outer edge towards the centre of the road with the rear wheel overlapping the shoulder. When the aggregates become firm, the roller will be shifted to the opposite side of the road and the operation will be repeated. After both edges rolled modestly firm, the roller will be gradually moved towards the centre by overlapping 150mm of the rolled width until the mix has attained the required density. During initial stage of rolling sub-base materials shall be sprinkled with water to bring it to the correct moisture content, if found less.

Material shall conform to the grading envelope shown in the Table 5.1 and compacted to have a soaked CBR value not less than 30% for a layer of maximum 100mm (compacted) thickness.

The rolled surface shall be checked for correctness of levels and cross-falls and any irregularities therein shall be corrected by loosening the affected areas, adding or removing the necessary quantities of aggregate and re-rolling until the entire surface conforms to the correct levels and cross levels and cross-falls.

The dry density after compaction shall not be less than 98% of the maximum dry density (Modified). Samples to determine the compaction, CBR & other properties shall be taken regularly per finished layer as specified or as directed by the Engineer.

The prepared sub-base layer shall be protected against damage until covered by the base course. Moisture content at the time of compaction shall be the optimum moisture content ±3%.

The finished surface shall be within a tolerance of ± 10mm or of the elevation shown in the drawings and it shall no where vary more than 10mm from the straight edge 3m long applied to the surface parallel to the centre line of the pavement and no more than 12mm from a template conforming to the cross-section.

The depth over each 100m shall be measured in at least 3 places by digging holes. The average depth should be as per drawings but the minimum depth shall not be less than 95% of the specified depth.

6.0 WATER BOUND MACADAM BASE COURSE

a. Description

This work shall consist of providing, laying, watering and compacting water bound macadam base course on the prepared and accepted sub-base to the lines, levels, dimensions, and cross profiles shown on the Drawings or as directed by the Engineer in charge.

b. Materials

The base course material shall consist of crushed first class brick and/or picked Jhama brick aggregates well-graded and of desired strength, mechanically "Keyed" or locked by rolling and cemented or bounded together by the application of water.

The aggregate shall be crushed Picked Jhama or mixed with First class bricks. The crushed bricks shall comply with the following requirements:

- Water absorption shall not exceed 16%
- Maximum nominal size of aggregate shall be 38mm according to ASTM-C-131
- Los Angeles Abrasion Test (AASHTO Designation T-96) with a percentage of wears less than 40 at 500 revolutions or Aggregate Crushing Value of not more than 30% (According to BS-812).
- Flakiness index (as per BS-812) 15%
- Aggregate Impact Value of not more than 30% (According to B8-812).

Material shall conform to the grading envelope shown in the Table 6.1 and compacted to have a soaked CBR value not less than 80% for a layer of maximum 100mm (compacted) thickness

Grading Requirements for Water Bound Macadam Base Course

Table 6.1

SIEVE SIZE	% PASSING BY WEIGHT
38mm	100
20mm	60-80
10mm	40-60
4.8mm	25-45
2.4mm	15-32
600 micron	10-20
75 micron	0-15

The material shall be well graded with the envelope having no excess or deficiency in any size. The Engineer may change the above grading when the laboratory results of the above proportion do not meet the quality requirements of the specification.

6.1 Construction method

Prior to laying of base course the sub-base layer shall be shaped true to cross fall or super elevation and shall be rolled as necessary till the surface is smooth, firm and tight. The prepared sub-base layer shall be protected against damage until covered by the base course.

Mixing of various course aggregates should be carried out preferably over temporary stack yards made of steel plain sheets to obtain a homogeneous mix complying with the grading requirements of this section before placing it on the sub-base. Base materials shall be at or near the optimum moisture content (OMC) at the time of mixing.

Different kinds of materials shall not be mixed together except that sand or naturally occurring granular materials finer than 5mm size can be mixed with any of these materials to meet the grading requirements. The mixing may be done by mechanical means or a combination of manual labour and machinery.

During initial stage of rolling base materials shall be sprinkled with water to bring it to the correct moisture content, if found less.

The materials shall be spread in layers and the compacted thickness of each layer shall not exceed 100mm.

A powered roller weighing 8 to 10 tons or equivalent vibratory roller should do rolling. Rolling shall begin at the outer edge with the rear wheel overlapping the shoulder. When the broken aggregates become firm, the roller will be shifted to the opposite side of the road and the operation will be repeated. After both edges rolled modestly firm, the roller will be gradually moved towards the centre by overlapping 150mm of the rolled width until the entire base course is thoroughly compacted.

The base course shall be compacted to have a soaked CBR as specified in Article 6.0b. Samples to determine the compaction, CBR & other properties shall be taken regularly per finished layer as specified or as directed by the Engineer.

The finished surface of the base course shall at no place be more than ±l0mm from the designed level and the mean of five measurements of thickness taken in any 200 meters long section shall be equal to or more than the required base course thickness.

Engineer in-charge may allow spreading of sand of F.M. 0.8 as chocking materials to attain desired CBR in every compacted layer.

7.0 GENERAL REQUIREMENTS FOR BITUMINOUS SURFACING

7.1 Description

a. General

This work shall cover the general requirements that are applicable to all types of bituminous bound surfacing irrespective of gradation of mineral aggregate, grade and amount of bituminous materials used. Deviations from these general requirements are indicated in the specific requirements as set forth in the respective sections for each type.

The work shall consist of one or more courses of pre-mixed bituminous mixtures constructed on a prepared and accepted base course or other road bed in accordance with these Specifications and the specific requirements of the type under Contract, and in conformity with the required lines, levels, grades, dimensions and typical cross sections.

b. Composition of Mixtures

The bituminous mix shall be composed basically of coarse mineral aggregate, fine mineral aggregate, filler and bituminous binder. The several mineral constituents shall be sized, uniformly graded and combined in such proportions that the resulting blend meets the grading requirements for the specific type as required. To such composite blended aggregate shall be added bitumen within the percentage limits set in the specifications for the specific type. Grading of coarse aggregate shall conform Article 10.2.

7.2 Construction

7.2.1 Weather Limitation

Bituminous mixtures shall be placed only when the surface is dry, when the weather is not rainy and when the prepared roadbed is in a satisfactory condition. However, the Engineer may permit, in case of sudden rain, the placing of mixture then in transit if laid at specified temperature and if the roadbed is free from pools of water.

Such permission shall in no way waive the requirements for quality and smoothness of surface.

7.2.2 Progress of Work

No work shall be performed when there is insufficient hauling, spreading or finishing equipment or labour to ensure progress at a rate consistent with meeting proper temperatures and rates of compaction.

7.2.3 Equipment

a. Equipment for preparation of bituminous binder

Tanks or kettles for storage of bituminous binder shall be capable of heating the binder under effective control at all times to a temperature within the range specified. Bitumen shall not be heated in open pans or drums. Suitable means shall be provided for maintaining the specified temperature of the bituminous binder at all times. Generally Tar boilers fixed with thermometer are used to heat the bitumen.

b. Thermometric Equipment

Armoured thermometers in good condition reading from 50^0 C to 200^0C shall be available at the places of mixing and laying at all times.

c. Equipment for hauling bituminous mixtures shall have tight, clean and smooth metal sides that have been sprayed with soapy water, thinned fuel oil, paraffin oil or lime solution to prevent the mixture from adhering to the beds. The amount of sprayed fluid shall however be kept to the practical minimum. Any equipment causing excessive segregation of material by its suspension or other contributing factors, or that shows oil leaks in detrimental amount or that causes undue delays, shall upon direction of Engineer be removed from the site until such conditions are corrected.

d. The equipment for spreading and finishing shall be capable of spreading and finishing the mixture true to the lines, grades, levels dimensions and cross sections.

e. The Contractor shall provide suitable means for keeping all small tools clean and free from accumulation of bituminous material. He shall provide and have ready for use at all times enough tarpaulin or covers, as may be directed by the Engineer, for use during any emergency like rain, chilling wind, or unavoidable delay, for the purpose of covering or protecting any material that may have been dumped and not spread.

7.2.4 Preparation and Placing

a. Preparation of Existing Surface

Where the existing road bed is broken or shows instability, the unstable material shall be removed and disposed off as directed by the Engineer and be replaced with the same mixture as specified for the next course, compacted to the standard and elevation of the adjacent surface. The surface upon which the mixture is to be placed shall be swept thoroughly and cleaned of all loose dirt and other objectionable materials immediately before spreading the bituminous mixture, if directed by the Engineer Tack coat is to be applied before placing the next layer. If this has become necessary due to delays caused by the contractor in starting the next layer this will not be paid.

b. Preparation of Bituminous Binder

The bituminous binder shall be heated to the specified temperature (140^0C-155^0C for 60/70 or 80/100 penetration bitumen) in Tar boiler, kettle or tanks so designed as to avoid local overheating and to provide a supply of the bituminous binder at a uniform temperature at all times.

c. Preparation of Mineral Aggregate

The aggregates produced, whether by machine or by manual methods should be screened into the major component sizes prior to recombining in the correct proportions.

The mineral aggregates for the mixture shall be dried and heated at a temperature between 150^0C-170^0C before mixing. The aggregates shall be heated to the temperature specified in the relevant section.

d. Preparation of Mixture

The heated mineral aggregate prepared above, shall be combined in the amount of each fraction of aggregate required to meet the mix formula for the particular mixture. The bituminous material shall be measured or gauged and introduced into the mix in the amount determined by the Engineer. Only sufficient heat shall be applied during mixing to maintain the temperature of the mix without increasing the temperature. The proper amount of bituminous material shall be distributed over the mineral aggregate and the whole materials shall be thoroughly mixed for a period of at least 60 seconds, or longer if necessary to produce a homogeneous mixture in which all particles of the mineral aggregate are coated uniformly. Mixing should not be carried out on fire, but on separate tray lay away from fire (if mixing manually).

e. Transportation and Delivery of Mixture

The mixture shall be transported from the mixer to the point of use in equipment conforming to the requirements of Article 11.2. Loading and transporting shall be such that spreading; compaction and finishing shall all be carried out during daylight hours unless the Contractor provides satisfactory illumination.

f. Spreading and Finishing

Upon arrival at the point of use, the mixture shall be spread and struck off to the grade, elevation, and cross-section shape intended, either over the entire width or over such partial width as may be practicable. The mixture shall be laid upon prime coated and an approved surface for new pavement and tack-coated surface for old pavement and only when the Engineer considers weather conditions suitable.

g. Compaction of Mixture

(i) Immediately after the mixture has been spread and struck off, the surface shall be checked and any inequalities adjusted. The mixture shall then be thoroughly and uniformly compacted by rolling. Each course shall be rolled as soon after being placed, as the material will support the roller without undue displacement or cracking.

(ii) All rollers shall be self propelled, capable for being reversed without backlash. Each roller shall be in good condition and worked by a competent and experienced operator. Generally Tandem roller is suitable for B.C work; in addition Pneumatic Tyre roller is also needed.

(iii) Rolling shall start longitudinally at the sides and proceed toward the centre of the pavement except that on super-elevated curves rolling shall begin at the low side and progress toward the high side. Successive trips of the roller and alternative trips shall not terminate at the same point.

Rolling shall start at a temperature of at least 130^0C and shall be discontinued if temperature falls below 90^0C.

The speed of the rollers shall not exceed four kilometers per hour for steel wheeled rollers and 6 kilometers per hour for pneumatic tyred rollers and shall at all times be slow

enough to avoid displacement of the hot mixture. Any displacements occurring as a result of reversing the direction of the roller or from any other cause shall at once be corrected with rakes and fresh mixture where required. Care shall be exercised in rolling not to displace the line and grade of the edges.

Rolling shall progress continuously as may be necessary to obtain uniform compaction while the mixture is in a workable condition and until all roller marks are eliminated.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excess water shall not be permitted.

Heavy equipment or rollers shall not be permitted to stand on the finished surface until it has thoroughly cooled or set.

Any petroleum products dropped or spilled from the vehicles or equipment employed by the Contractor upon any portion of the pavement under construction is a cause for the removal and replacement of the contaminated pavement by the Contractor. The surface of the mixture after compaction shall be smooth and true to the established crown and grade within the tolerance specified. Any mixture that becomes loose and broken, mixed with dirt, or which is defective in any way, shall be removed and replaced with fresh hot mixture, which shall be compacted immediately to conform to the surrounding area. Any areas of one square meter or more showing an excess or deficiency of bituminous material shall be removed and replaced. All high spots, high joints, depressions, and honeycombs shall be adjusted as directed by the Engineer.

h. Joints

Both longitudinal and transverse joints in successive courses shall be staggered so as not to be one above the other. Longitudinal joints shall be arranged so that the longitudinal joint in the top course shall be at the location of the line dividing the traffic lanes. Lateral joints shall be staggered a minimum of 250 millimeters and shall be straight.

The edges of the pavement shall be straight and true to the required lines. Any excess material shall be cut off after final rolling and disposed off by the Contractor at the end of a day's work.

Just prior to recommencing operations, the sides of all longitudinal and transverse joints shall be painted with hot bitumen to ensure a satisfactory bond between the old and new work.

8.0 PRIME COAT

a. Description

This work shall consist of the careful cleaning of the surface of the granular base material to be primed and furnishing and applying bituminous material in accordance with these Specifications to the areas shown on the Drawings and as directed by the Engineer.

8.1 Materials

a. Bituminous Materials

Bituminous prime coat material shall be cut back bitumen, conforming to the requirements of ASTM/ AASHTO.

Cut back bitumen may be prepared by cutting back 60/70 (preferable) or 80/100 penetration grade straight run bitumen with kerosene/diesel in the ratio of 100 parts by volume of bitumen to 40-60 parts by volume of kerosene depending on the porosity of the surface and will be decided by field trials or as directed by the Engineer. The correct

amount is the quantity that is completely absorbed within 24 hours. The spraying temperature of the cutback bitumen shall be 100^0C to 120^0C.

b. Blotting Material

Blotting material shall be clean, dry, free-flowing sand not containing any cohesive materials or organic matter. Not more than 10 percent of the sand shall be finer than the 75-micron sieve.

8.2 Construction Methods

a. Weather Limitations

Prime coat work shall not be carried out when the weather conditions are, in the opinion of the Engineer, likely to adversely affect the stability of wet prime coat material. Such conditions may include but shall not necessarily be limited to rain, low temperatures or storms.

b. Cleaning Surface

Immediately before applying the prime coat material, all loose stones, dirt and other objectionable materials shall be removed from the surface with a broom or blower as appropriate. When so directed by the Engineer, a light application of water shall be made just before the application of the prime coat.

c. Application of Prime Coat

Prime coat material shall be applied by mechanical distributor or manually at a uniform rate of 1.20 liters/square meter as directed by the Engineer, and at a temperature between 100^0C to 120^0C. Additional primer shall be applied where surface conditions indicate this to be necessary as per decision of the Engineer. No further coatings shall be applied until the prime coat has been cured.

The contractor may be required to lay a trial section of prime coat for the approval of the Engineer regarding method of operations to achieve adequate penetration. Following the approval of the Engineer in writing of such trial section (s), the prime coat works may then be carried out strictly in accordance with the approved method and spray rate and the specification.

The surfaces of structures and trees adjacent to the areas being treated shall be protected in such a manner as to prevent their being splattered or marred. No bituminous material shall be discharged into a borrow pit, gutter or kerb.

d. Maintenance and Opening to Traffic

After application of the prime coat there shall be a curing period of 48 hours or more, when traffic shall not be permitted to move on the coated surface. In case of any damage caused by traffic, the surface shall be rectified at the cost of the Contractor. The period of curing shall be extended if necessary till the bituminous material has penetrated and dried and, in the opinion of the Engineer, will not be picked up by traffic. At the end of the curing period, minor areas where prime coat material is still not dry shall be treated by sprinkling, blotting sand as necessary to avoid picking up of prime coat material before allowing traffic to use the coated areas. For existing roads, the work shall be done over half width at a time, the other half being used to carry the traffic.

9.0 TACK COAT

a. Description

This work shall consist of the cleaning and preparation of the bituminous surface specified, or otherwise as directed by the Engineer, together with the furnishing and application of the tack coat in accordance with these Specifications to the areas shown on the Drawings and as directed by the Engineer.

Tack Coat should be applied only in between two bituminous surfaces.

b. Materials

Bituminous tack coat material shall be 60/70(preferable) or 80/100 penetration grade straight run bitumen complying with the requirements of ASTM / AASHTO.

9.1 Construction Methods

a. Weather Limitations

Tack coat work shall not be carried out when the weather conditions are, in the opinion of the Engineer, likely to adversely affect the stability of wet tack coat material. Such conditions may include but shall not necessarily be limited to rain, low temperatures or storms.

b. Cleaning Surfaces

Immediately before applying the tack coat all loose stone dirt and other objectionable materials shall be removed from the surface with a broom or blower as appropriate.

c. Application of Tack Coat

Tack coat material shall be applied by mechanical distributor or manually at a rate of 0.75kg-1.25kg/m^2 and at a temperature between 140^0C and 160^0C. Additional tack coat shall be applied where surface conditions indicate this to be necessary and, if the Engineer so directs.

The surfaces of structures and trees adjacent to the areas being treated shall be protected in such a manner as to prevent their being splattered or marred. No bituminous material shall be discharged into a borrow pit, gutter or kerb.

10.0 BITUMINOUS CARPETING (BC)

a. Description

This work shall consist of a bituminous carpet of a bituminous macadam type of material constructed on a prepared and primed granular base course in accordance with these Specifications and to the lines, levels, grades, dimensions and cross-sections shown on the Drawings and as directed by the Engineer. The bituminous carpeting shall consist of a compacted single layer of surfacing of thickness as shown on the drawings.

10.1 Materials

a. Bituminous Material

Bituminous material shall be 60/70 or 80/100 (Preferably 60/70) penetration grade straight run bitumen complying with the requirement of ASTM / AASHTO.

b. Coarse Aggregate

The coarse aggregate shall be the material component consist of clean crushed rock or crushed gravel or blended combinations of both, free from decomposed stone, organic matter, shale, clay and any other substances which, in the opinion of the Engineer, may be deleterious to the mixture. Coarse aggregate shall satisfy the following physical characteristics when tested:

- Aggregate Crushing Value not greater than 30%
- Bulk specific gravity not less than 2.50
- Flakiness index not greater than 35% except where specially approved by the Engineer

The course aggregate shall have weight loss not more than 12% when subjected to 5 alternations of the sodium sulphate soundness test, AASHTO: T. 104.

Not less than 75% by weight of the particles of course aggregate shall have at least two fractured faces.

c. Fine Aggregate

The portion of the aggregate passing a 4.75mm sieve shall be known as fine aggregate and shall consist of natural sand, stone screenings, or a combination of both. Fine aggregate shall be composed of clean, hard durable particles, rough surfaced and angular, free from vegetable matter, soft particles, clay balls or other objectionable materials.

10.2 Overall Aggregate Grading

The mix of the coarse and fine aggregates shall comply with the following grading given in Table 10.1.

Table 10.1

Serve Size	For 25mm B.C.	For 40mm B.C.
	% By Weight Passing	% By Weight Passing
25mm	100	100
20mm	100	75-100
16mm	100	-
12.5mm	75-100	60-80
10mm	60-80	-
6.3mm	-	-
4.75mm	35-55	35-55
2.4mm	20-35	20-33
600 micron	10-20	6-18
75 micron	2-8	2-8
Bitumen Content % by weight of total mix.	5.5% $\pm$ 0.3% (5.2% to 5.8%)	5.2% $\pm$ 0.3% (4.9% to 5.5%)

Required bitumen content should be determined by trials.

10.3 Bituminous Mixture Requirements

The resultant density of the compacted bituminous mixture shall be between 2250 and 2400 kg/m^3. The bitumen content and stability of mixture shall be as per specification or as decided by the Engineer.

10.4 Construction Methods

a. Preparation of the road base

A prime coat shall be applied and cured to the surface of the granular base material in accordance with Section 8.0 before spreading the premixed aggregates, or a tack coat shall be applied to the existing bituminous surface.

b. Mixing of Bituminous Material

Prior to heating, the various sizes of aggregate shall be thoroughly mixed together to give a stockpile of aggregate of the required grading of sufficient quantity for at least one day's surfacing work.

The bitumen and the aggregates shall be separately heated (mechanical heating preferable) to a temperature between 140°C to 155°C and 150°C to 170°C for bitumen and aggregate respectively before mixing. The temperature of bitumen aggregate mixture should be within 140°C to 160°C. Bitumen, or bitumen aggregate mixture, which has been overheated at any time, shall be rejected. The percentage of bitumen in the mix shall be between 5.2% and 5.8% by weight of total mix for 25mm BC and between 4.9% and 5.5% by weight of total mix for 40mm BC.

The final combined grading shall be within the limits of the specification and the actual bitumen content shall be determined on the basis of laboratory tests by the Engineer and the final grading of the combined aggregates and the bitumen content shall be approved by the Engineer.

The laying temperature of the mixture shall not be less than l3O°C.

The mixed materials shall be laid to a uniform thickness. The thickness and proper camber shall be maintained by the use of steel angle screeds of the correct size. The sides of the angle shall be at least 25% greater than the compacted thickness specified and as shown on the drawings or as directed by the Engineer.

c. Rolling

After laying, the materials shall immediately be compacted using a power driven road roller. The initial pass of the roller on the bituminous premix shall be at temperatures specified above and shall be carried out with these steel angles in position. Subsequent passes of the roller may be made with these steel angles removed.

The bituminous premix shall be compacted using an approved roller (preferably a pneumatic tyre roller of 8-10 Ton) and a minimum of five passes shall be made, or as directed by the Engineer from time to time. Material that falls below the minimum working temperature of 90^0C, that has not been compacted as described, may be rejected and shall be replaced by new materials to the required specification and compaction by the contractor at his own expenses.

When the temperature of the bituminous premix falls below 90^0C no further compaction should be allowed.

The premix carpeting shall be fully compacted maintaining the proper grade and camber and after completion of compaction blinding of sand of F.M. 0.8 at the rate of 0.012 cubic meter per square meter of surface for blotting purpose shall be carried out. The compacted thickness as shown in the drawing and as provided in the Bill of Quantities shall be uniformly maintained all along the road surface.

Rollers and other mechanical plants shall not be allowed to stand on newly laid material that may be deformed thereby. Sections of newly finished work shall be protected from traffic of any kind until the mixture has cooled to ambient air temperature.

The finished surface shall be within a tolerance of ± 5mm or of the elevation shown on the drawings and it shall not vary at any place more than 5mm from the straight edge 3m long applied to the surface both longitudinally and transverse.

d. Open to Traffic

When the initial rolling is completed, commercial traffic could be allowed in the surfaced area. The speed of traffic shall be temporarily reduced to avoid the damage to the surface. Maximum speed limit of 30-40 km/hour shall, therefore, be enforced during the first month after construction (by speed breaker as an example or any other method approved by the Engineer.)

11.0 BITUMINOUS SEAL COAT 7MM THICK

a. Description

This work shall consist of premix bituminous seal coat applied to a prepared and primed granular base course or over the bituminous surfacing in accordance with these Specifications or as directed by the Engineer. The compacted thickness of premix bituminous seal coat shall be 7mm.

11.1 Materials

a. Bituminous Material

Bituminous material shall be of 60/70(Preferable) or 80/100 penetration grade straight run bitumen complying with the requirements of ASTM AASHTO.

b. Aggregate

The aggregates shall consist of 6.33mm down graded stone or gravel free from any organic matter, clay and any other objectionable matter.

Where required to achieve the specified grading the aggregate shall be mixed with natural sand. Sand shall be non-plastic, clean and free from any deleterious substances. The minimum F.M. of sand for the sealing premix shall be between 2.00 to 2.80 and that of sand to be spread over the seal coat, as blotting material shall be within 0.80 to 1.00.

11.2 Overall Aggregate Grading

The mix of the aggregates and sand combined shall comply with the following grading given in Table-11.1

Table-11.1

Grading Requirements for 7mm Bituminous Seal Coat

Sieve Six	% By Weight Passing Sieve
6.3mm	100
4.75mm	80-100
2.4mm	70-95
600 micron	20-50
75 micron	5-15

11.3 Construction Methods

Bitumen and aggregates shall be heated separately at the following temperatures:

Only Bitumen	:	Within 140°C to 155°C (Max)
Only Aggregate	:	Within 150°C to 170°C
Mix of Bitumen & Aggregate	:	Within140°C to 160°C

Material that has been over-heated at any time shall be rejected. No mixing of pre-heated bitumen and aggregate should be done on fire, but on separate tray lay away from fire (if mixing manually). 0.01 M^3 of aggregate will be mixed with 1 liter of bitumen and mix shall be laid on 1 (one) square meter of road surface.

The aggregate mixed with bitumen shall be laid over the bituminous carpeting or over the primed granular base to a uniform thickness which shall be at least 25% greater than the compacted thickness and immediately compacted fully with a power driven road roller (8-10 Ton) to the satisfaction of the Engineer. Temperature of bitumen and aggregate mix at the time of starting of rolling should not be less than 130°C.

12.0 PREMIX BITUMINOUS SEAL COAT 12MM THICK

12.1 Description

The work shall consist of a premix bituminous seal coat applied to a prepared and primed granular base course or over bituminous surfacing in accordance with these Specifications or as directed by the Engineer. The thickness of the premix bituminous seal coat shall be 12mm.

12.2 Materials

12.2.1 Bituminous Material

Bituminous material shall be of 60/70 (preferable) or 80/100 penetration grade straight run bitumen complying with the requirements of ASTM/AASHTO.

12.2.2 Aggregate

The course aggregates shall consist of 10mm down graded stone chips free from any organic matter, clay and any other objectionable matter.

Where required to achieve the specified grading the aggregate shall be mixed with natural sand. Sand shall be non-plastic, clean and free from any deleterious substances. The F.M of sand for the sealing premix shall be between 2.00 and 2.80. The F.M of sand to be spread over the seal coat, as blotting material shall be between 0.80 and 1.00

12.2.3 Overall Aggregate Grading

The mix of the aggregates and sand combined shall comply with the following grading given in Table 12.1

Table 12.1

Grading Requirements for 12mm Premix Bituminous Seal Coat

Sieve Size	Percentage by Weight Passing Sieve
1omm	100
6.3mm	80-100
4.75mm	70-95
2.4mm	20-50
600 micron	5-15
75 micron	2-10

12.3 Construction Methods

Prior to heating the aggregate and sand shall be mixed together to give a stockpile of mixed aggregate of the required grading in sufficient quantity for at least one day's surfacing work.

Bitumen and aggregates shall be heated separately at the following temperatures:

Only Bitumen	:	Between 140°C to 155°C (Max)
Only Aggregate	:	Between 150°C to 170°C
Mix of Bitumen & Aggregate	:	Between 140°C to 160°C

Material that has been over-heated at any time shall be rejected. No mixing of pre-heated bitumen and aggregate should be done on fire, but on separate tray lay away from fire (if mixing manually). 0.016M3 of pea gravel will be mixed with 1.40 liter of bitumen and shall be laid on 1 (one) square meter of road surface.

The mixture shall be laid to a uniform thickness, which shall be at least 25% greater than the compacted thickness and immediately compacted fully with a power driven road roller (8-10 Ton) to the satisfaction of the Engineer.

13.0 IMPORTANT NOTES ON ROAD PAVEMENT CONSTRUCTION

a. Turfing or seedling with 'Durba' or 'Hikar' grass seed is a must at side slopes after dressing.

b. The approving authority in consultation with Design Unit shall determine thickness of improved sub-grade of the road segment where designed soaked CBR value (4%) of sub-grade can not be achieved with soil at site, even mixing any portion of sand with soil at site. In that case for increase of ISG thickness as per Table 12 approval from approving authority is a pre-requisite before preparation of scheme or commencing execution as applicable.

c. The approving authority in consultation with Design Unit shall determine thickness of sub-base of the road segment where designed soaked CBR value (8%) of improved sub-grade can not be achieved with locally available sand due to its F. M. is less than 0.8, but more than 0.5. In that case an increase in the sub-base thickness is to be designed depending on ISG CBR value before preparation of scheme or commencing execution as applicable. It is obvious that an increase in sub-base thickness will eventually result a proportionate decrease in thickness of improved sub-grade (ISG).

d. Compaction of any item of work in the road construction shall conform designated CBR value.

e. Initially applied bituminous carpeting (BC) shall have another overlay of 40mm thick BC with 7mm seal coat within 7 to 8 years after completion of construction for achieving durability of pavement for 10 years.

f. Special precautionary measures to be taken for drainage of surface run-off stagnant at depressions along longitudinal profile during construction as well as maintenance.

g. Earthen shoulder needs all-weather surfacing with bricks or concrete for road segment across market places and built up areas.

h. Run-off drainage along built-up areas may need special structural provision.

i. Drainage structure along hillock or hill-cut may be designed as per site condition.

j. Notwithstanding the test frequency specified in this document for any item of construction work, the test frequency specified in the Schedule of Rates of LGED (Current Version) shall prevail.

k. In absence of ACV testing equipment, LAA test of coarse aggregates shall be allowed, but in no case LAA value of coarse aggregates to be used in sub-base and base coarse shall be greater than 40 percent.

ROAD DESIGN PLATES

UPAZILA ROAD DESIGN PLATES FOR PLANE LANDS

Plate UPR-BC2-SL-1A for Design Type 6

This is a standard option of Upazila Road Pavement with single carriageway pavement to support 101 to 200 commercial vehicles per day. Road geometry of Design Type 6 is comprised of 3.70m pavement with 1.80m earthen shoulder on each side totaling 7.30m in crest.

The Pavement is designed with pavement configuration for Design Type 6 of National Road Design Standards, 04.

Brick on end edging (125mm) has been provided to safeguard the pavement.

Earthen shoulder is made of soil having PI value ranging from 8 to 20 compacted to minimum 95% STD.

Plate UPR-BC2-DL-1A for Design Type 5

This is a standard option of Upazila Road Pavement with double lane carriageway pavement to support 201 to 300 commercial vehicles per day. Road geometry of Design Type 5 is comprised of 3.7m wide pavement with 0.90m hard shoulder and 0.90m earthen shoulder on each side totaling 7.30m in crest.

The Pavement is designed with pavement configuration for Design Type 5 of National Road Design Standards, 04.

Brick on end edging (125mm) has been provided to safeguard the pavement.

Earthen shoulder is made of soil having PI value ranging from 8 to 20 compacted to minimum 95% STD.

Plate UPR-BC2-DL-1B for Design Type 5

This Option has same pavement configuration as Design Type 5 with special provision of 900 mm HBB hard Shoulders on both sides. It is specially designed for Upazila roads where it deems necessary to protect pavement, specially at bridge approach.

Plate UPR-BC2-DL-2A for Design Type 4

This is a standard option of Upazila Road Pavement with double lane carriageway pavement to support 301 to 600 commercial vehicles per day. Road geometry of Design Type 4 is comprised of 5.50m pavement with 2.15m earthen shoulder on each side totaling 9.80m in crest.

The Pavement is designed with pavement configuration for Design Type 4 of National Road Design Standards, 04.

Brick on end edging (125mm) has been provided to safeguard the pavement.

Earthen shoulder is made of soil having PI value ranging from 8 to 20 compacted to minimum 95% STD.

Plate UPR-BC2-DL-2B for Design Type 4

This is an upgraded option of Upazila Road Pavement from Type 5 to Type 4 to support 301 to 600 commercial vehicles per day. It has same road geometry of Design Type 4.

The Pavement other than bituminous carpeting is same as Upazila Road Type 5. Only the whole top of pavement is carpeted with 40mm bituminous carpeting and 12mm seal coat. Extended earthen shoulder is made of soil having PI value ranging from 8 to 20 compacted to minimum 95% STD.

THE PLATES

Plate UPR-BC2-SL-1A FOR DESIGN TYPE 6

Plate UPR-BC2-DL-1A FOR DESIGN TYPE 5

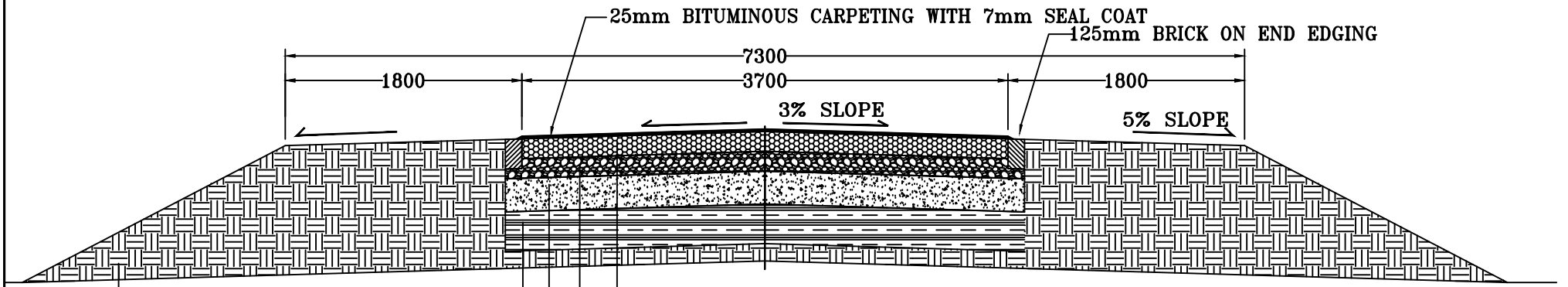
Plate UPR-BC2-DL-1B FOR DESIGN TYPE 5

Plate UPR-BC2-DL-2A FOR DESIGN TYPE 4

Plate UPR-BC2-DL-2B FOR DESIGN TYPE 4

UPAZILA ROAD SECTION

DESIGN TYPE 6



150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30% ,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32% , COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

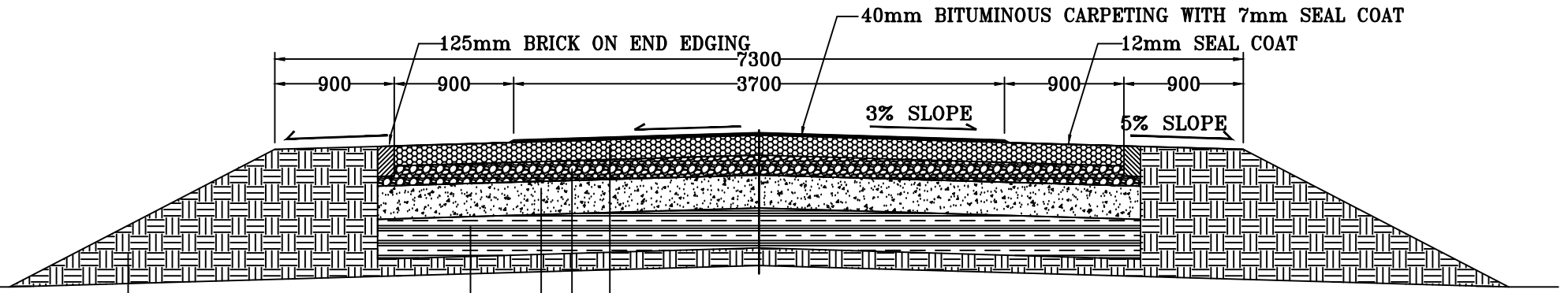
ORIGINAL SOIL CUT INTO DESIGNED SHAPE, OR FILL WITH NORMAL SOIL,
PI VALUE RANGE 8 TO 20%, COMPACTION min. 95% STD, DCP max. 45mm/BLOW,
SOAKED CBR min. 3% TO ACHIEVE DESIGNED CROSS-SECTION OF SIDE EMBANKMENT

DRAWING PLATE UPR-BC2-SL-1A

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA ROAD SECTION (ROAD TYPE 6)
	PROCESS: DESIGN UNIT
	DRAWING NO: UPR-06-1A
	DATE:

UPAZILA ROAD SECTION

DESIGN TYPE 5



150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30% ,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32% , COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

ORIGINAL SOIL CUT INTO DESIGNED SHAPE, OR FILL WITH NORMAL SOIL,
PI VALUE RANGE 8 TO 20%, COMPACTION min. 95% STD, DCP max. 45mm/BLOW,
SOAKED CBR min. 3% TO ACHIEVE DESIGNED CROSS-SECTION OF SIDE EMBANKMENT

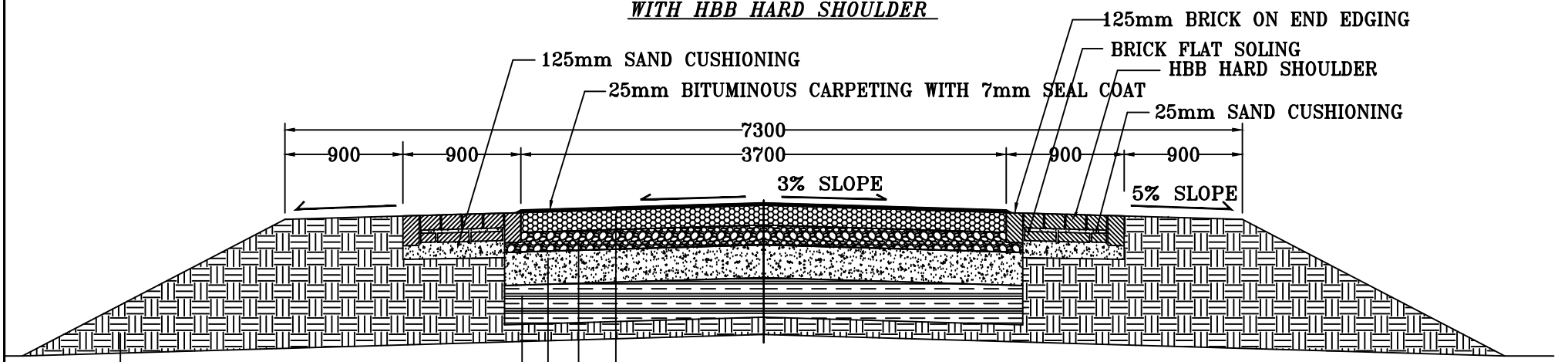
DRAWING PLATE UPR-BC2-DL-1A

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY	UPAZILA ROAD SECTION (ROAD TYPE 5)	
	PROCESS	DESIGN UNIT
MD. SHAHIDUL HASSAN CHIEF ENGINEER	DRAWING NO	UPR-05-1A
	DATE:	

UPAZILA ROAD SECTION

DESIGN TYPE 5

WITH HBB HARD SHOULDER



150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30% ,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32% , COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

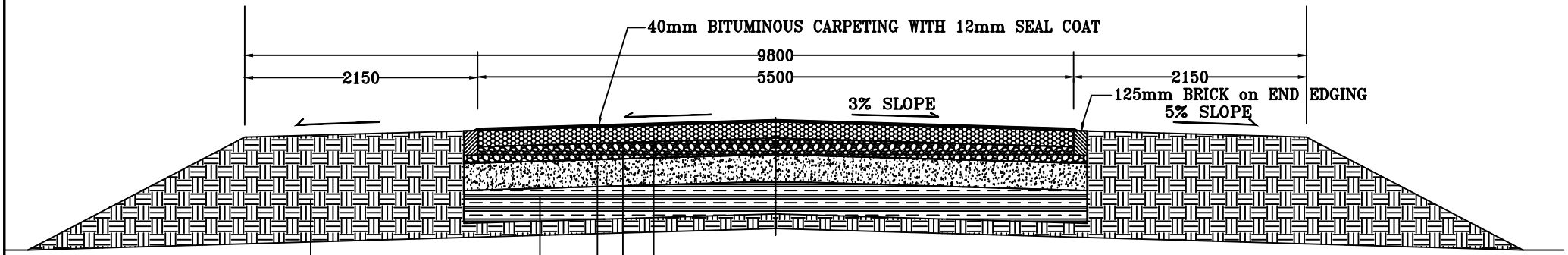
ORIGINAL SOIL CUT INTO DESIGNED SHAPE, OR FILL WITH NORMAL SOIL,
PI VALUE RANGE 8 TO 20%, COMPACTION min. 95% STD, DCP max. 45mm/BLOW,
SOAKED CBR min. 3% TO ACHIEVE DESIGNED CROSS-SECTION OF SIDE EMBANKMENT

DRAWING PLATE UPR-BC2-DL-1B

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA ROAD SECTION (ROAD TYPE 5)
	PROCESS: DESIGN UNIT
	DRAWING NO: UPR-06-1B
	DATE:

UPAZILA ROAD SECTION

DESIGN TYPE 4



200mm COMPACTED WBM BASE, AGGREGATE ACV max. 30% ,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

200mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32% , COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

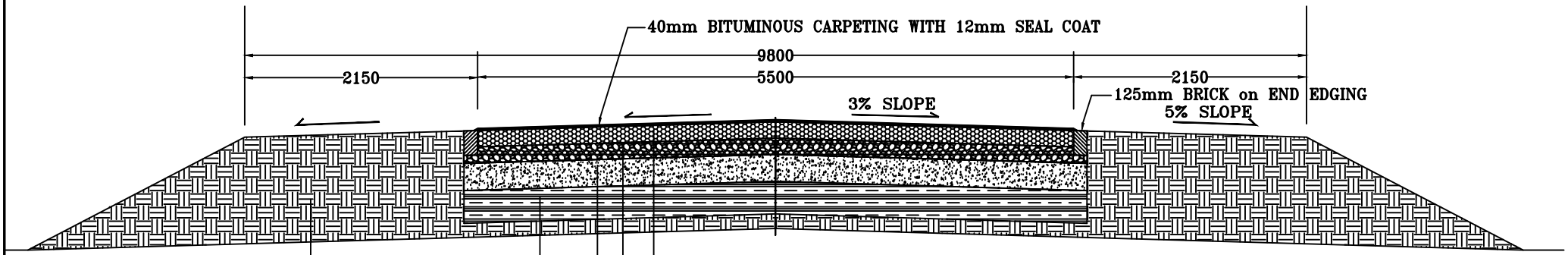
ORIGINAL SOIL CUT INTO DESIGNED SHAPE, OR FILL WITH NORMAL SOIL,
PI VALUE RANGE 8 TO 20%, COMPACTION min. 95% STD, DCP max. 45mm/BLOW,
SOAKED CBR min. 3% TO ACHIEVE DESIGNED CROSS-SECTION OF SIDE EMBANKMENT

DRAWING PLATE UPR-BC2-DL-2A

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA ROAD SECTION (ROAD TYPE 4)	
	PROCESS	DESIGN UNIT
	DRAWING NO	UPR-04-2A
	DATE:	

UPAZILA ROAD SECTION

DESIGN TYPE 4



150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30% ,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32% , COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

ORIGINAL SOIL CUT INTO DESIGNED SHAPE, OR FILL WITH NORMAL SOIL,
PI VALUE RANGE 8 TO 20%, COMPACTION min. 95% STD, DCP max. 45mm/BLOW,
SOAKED CBR min. 3% TO ACHIEVE DESIGNED CROSS-SECTION OF SIDE EMBANKMENT

DRAWING PLATE UPR-BC2-DL-2B

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA ROAD SECTION (ROAD TYPE 4, IF UPGRADED FROM TYPE 5)	
	PROCESS: DESIGN UNIT	
	DRAWING NO	UPR-04-2B
	DATE:	

UPAZILA ROAD DESIGN PLATES FOR HILLY AREA

Plate UPR-BC2-SL-HL-1A For Design Type 6

This is a standard single lane option of Upazila Road Pavement without Hard shoulder through Hill top without any run-off drainage chute on both sides. Shoulder treatment may be provided as needed. It has same road geometry and design configuration as Design Type 6.

Plate UPR-BC2-SL-HL-1B For Design Type 6

This is a standard single lane option of Upazila Road Pavement with HBB Hard shoulder and Drainage Chute through Hill-cut having hills on inward side of horizontal curve. Shoulder treatment may be revised or omitted as needed.

Geometric Dimensions and Pavement Configurations are same as Plate UPR-BC2-SL-HL-1A.

Plate UPR-BC2-SL-HL-1C For Design Type 6

This is a standard single lane option of Upazila Road Pavement with HBB Hard shoulder and Drainage Chute through Hill-cut having hills on outward side of horizontal curve. Shoulder treatment may be revised or omitted as needed.

Geometric Dimensions and Pavement Configurations are same as Plate UPR-BC2-SL-HL-1A.

Plate UPR-BC2-SL-HL-1D For Design Type 6

This is a standard single lane option of Upazila Road Pavement with HBB Hard shoulder and Drainage Chute through Hills having run-off drainage chute on both sides. Shoulder treatment may be revised or omitted as needed.

Geometric Dimensions and Pavement Configurations are same as Plate UPR-BC2-SL-HL-1A.

THE PLATES

Plate UPR-BC2-SL-HL-1A FOR DESIGN TYPE 6

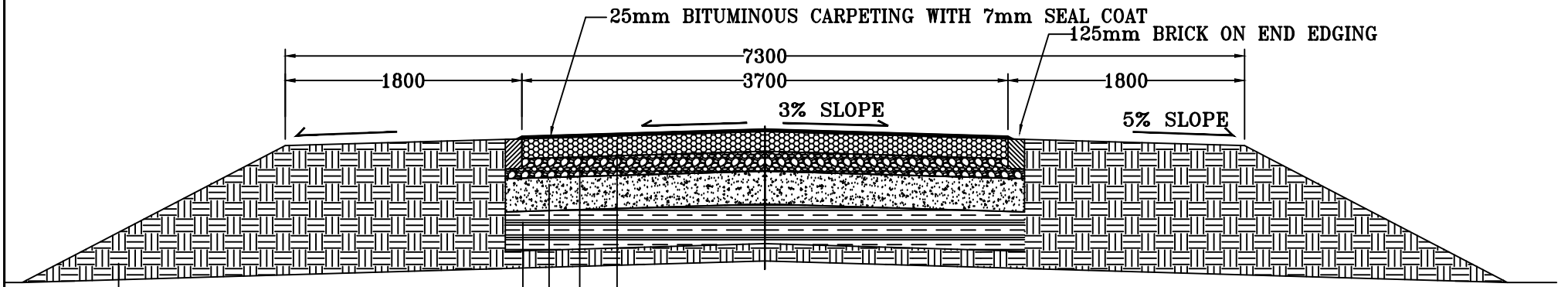
Plate UPR-BC2-SL-HL-1B FOR DESIGN TYPE 6

Plate UPR-BC2-SL-HL-1C FOR DESIGN TYPE 6

Plate UPR-BC2-SL-HL-1D FOR DESIGN TYPE 6

UPAZILA ROAD SECTION

DESIGN TYPE 6



150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30% ,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32% , COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

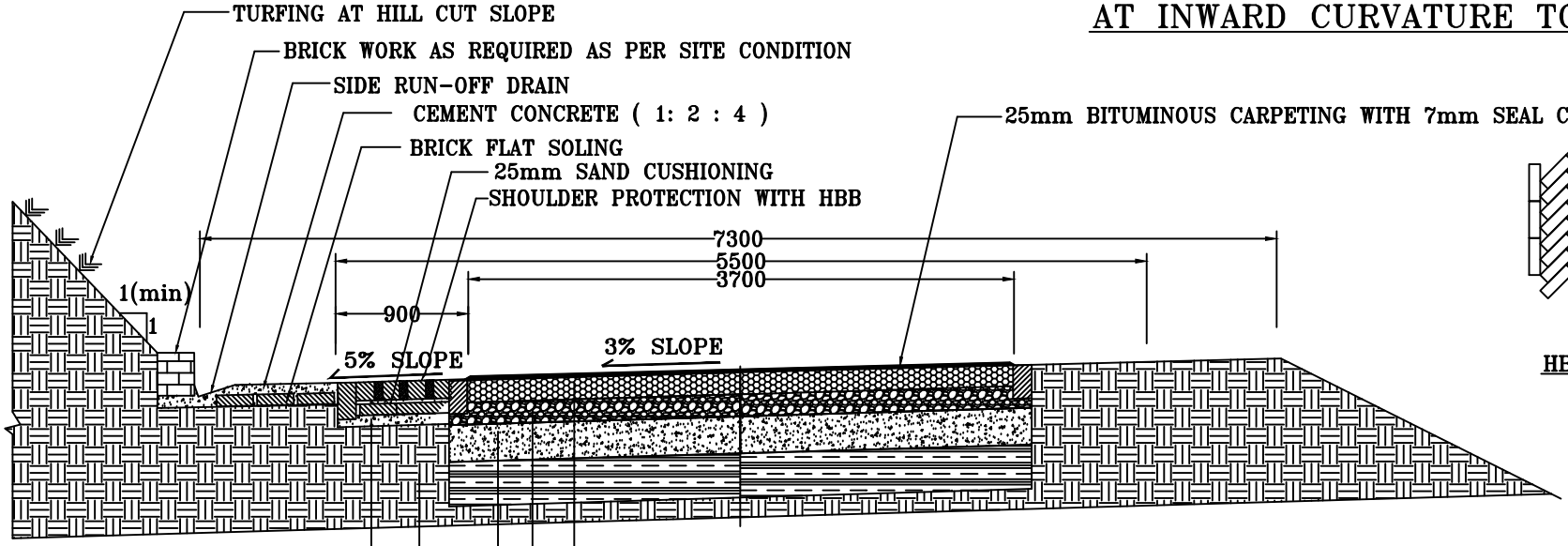
SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

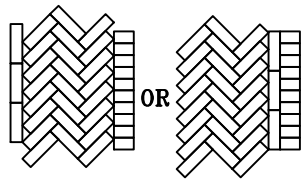
ORIGINAL SOIL CUT INTO DESIGNED SHAPE, OR FILL WITH NORMAL SOIL,
PI VALUE RANGE 8 TO 20%, COMPACTION min. 95% STD, DCP max. 45mm/BLOW,
SOAKED CBR min. 3% TO ACHIEVE DESIGNED CROSS-SECTION OF SIDE EMBANKMENT

DRAWING PLATE UPR-BC2-SL-1A

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA ROAD SECTION (ROAD TYPE 6)
	PROCESS: DESIGN UNIT
	DRAWING NO: UPR-06-1A
	DATE:

UPAZILA ROAD THROUGH HILLS
HAVING HILL–CUT ON ONE SIDE
AT INWARD CURVATURE TO HILL





PLAN
HBB HARD SHOULDER
(RIGHT SIDE)

75mm SAND CUSHIONING

150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30%,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE–SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32%, COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

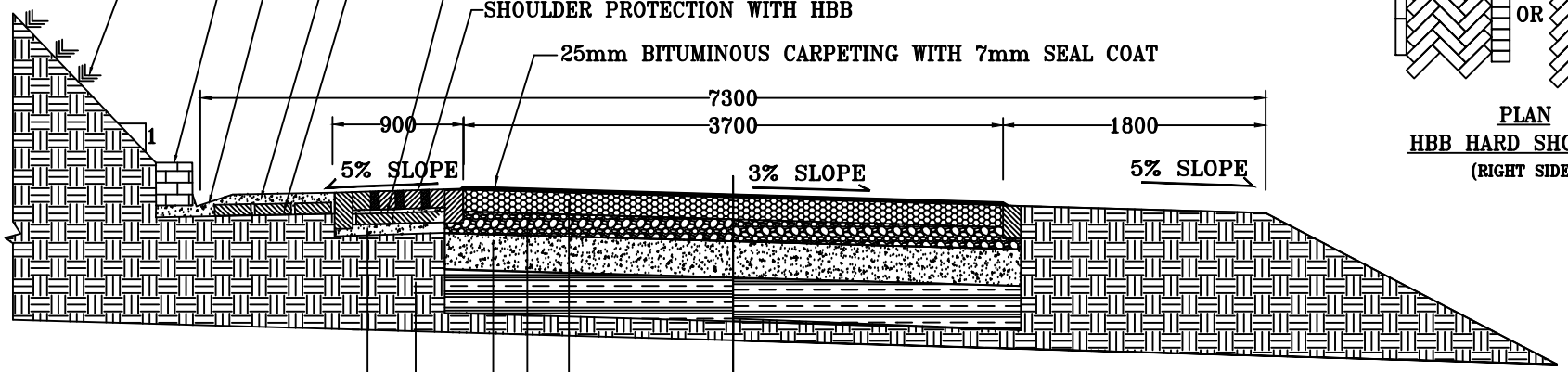
SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

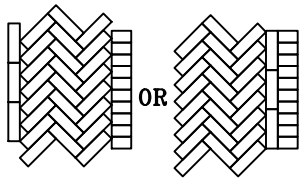
DRAWING PLATE UPR–BC2–SL–HL–1B

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY	UPAZILA ROAD SECTION THROUGH HILLS (ROAD TYPE 6)	
	PROCESS	DESIGN UNIT
MD. SHAHIDUL HASSAN CHIEF ENGINEER		01
	DATE:	

UPAZILA ROAD THROUGH HILLS

HAVING HILL–CUT ON ONE SIDE AT OUTWARD CURVATURE TO HILL





PLAN
HBB HARD SHOULDER
(RIGHT SIDE)

75mm SAND CUSHIONING

150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30%,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE–SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32%, COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

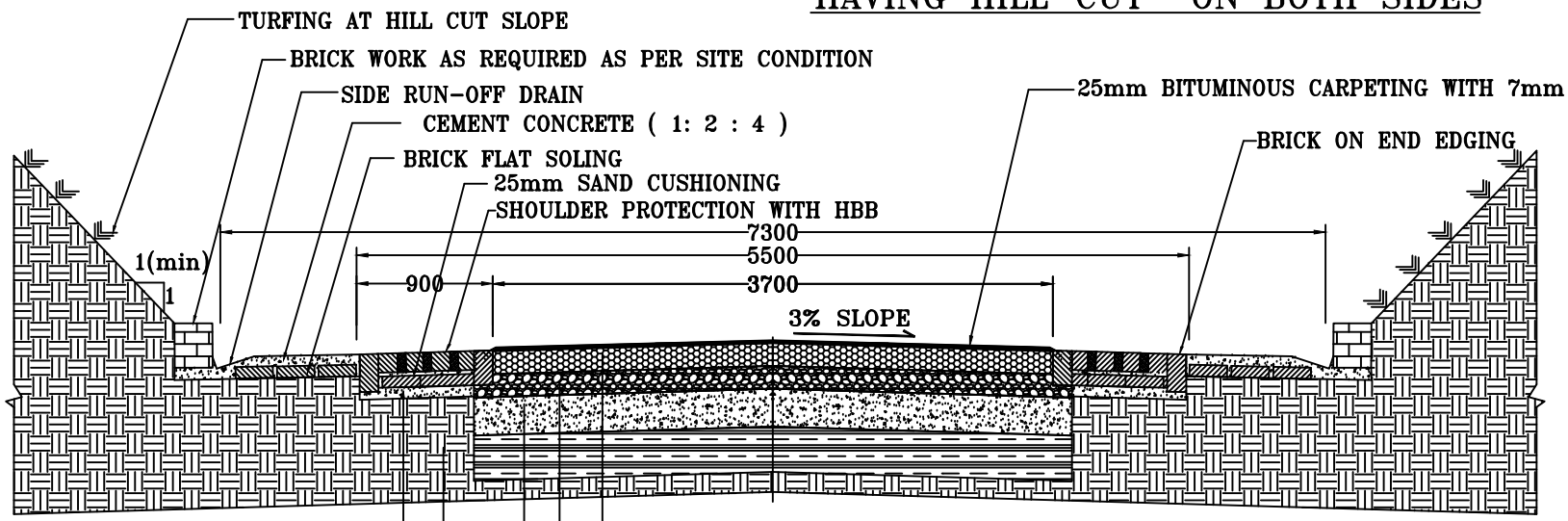
250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

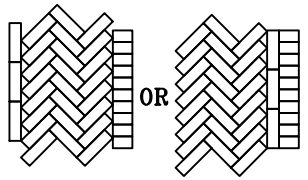
SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

DRAWING PLATE UPR–BC2–SL–HL–1C

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA ROAD SECTION THROUGH HILLS (ROAD TYPE 6)	
	PROCESS	DESIGN UNIT
		01
	DATE:	

UPAZILA ROAD THROUGH HILLS
HAVING HILL-CUT ON BOTH SIDES





PLAN
HBB HARD SHOULDER
(RIGHT SIDE)

75mm SAND CUSHIONING

150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30%,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32%, COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

DRAWING PLATE UPR-BC2-SL-HL-1D

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA ROAD SECTION THROUGH HILLS (ROAD TYPE 6)	
	PROCESS	DESIGN UNIT
		01
	DATE:	

UNION ROADS DESIGN PLATES FOR PLANE LANDS

Plate UNR-BC2-SL-1A of Design Type 8

This is a standard option of Union Road Pavement with single carriageway pavement to support up to 50 commercial vehicles per day. Road geometry of Design Type 8 is comprised of 3.00m pavement with 1.25m earthen shoulder on each side totaling 5.50m in crest.

The Pavement is designed with pavement configuration for Design Type 8 of National Road Design Standards, 04.

Brick on end edging (125mm) has been provided to safeguard the pavement.

Earthen shoulder is made of soil having PI value ranging from 8 to 20 compacted to minimum 95% STD.

Plate UNR-BC2-SL-2A of Design Type 7

This is a standard option of Union Road Pavement with single carriageway pavement to support 51 - 100 commercial vehicles per day. Road geometry of Design Type 7 is comprised of 3.70m pavement with 0.90m earthen shoulder on each side totaling 5.50m in crest.
The Pavement design configuration is same as Design Type 8.

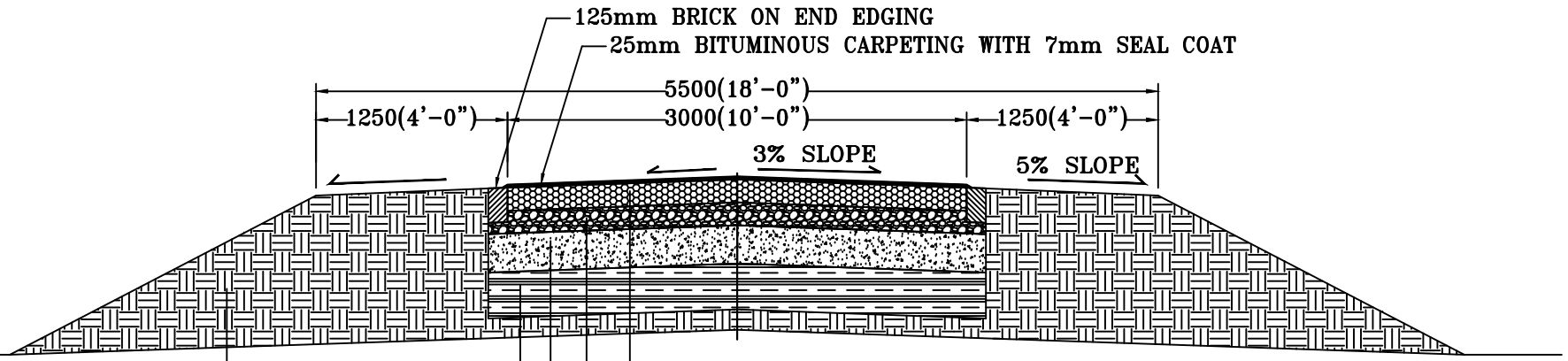
THE PLATES

Plate UNR-BC1-SL-1A FOR DESIGN TYPE 8

Plate UNR-BC1-SL-2A FOR DESIGN TYPE 7

UNION ROAD SECTION

DESIGN TYPE 8



150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30% ,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32% , COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

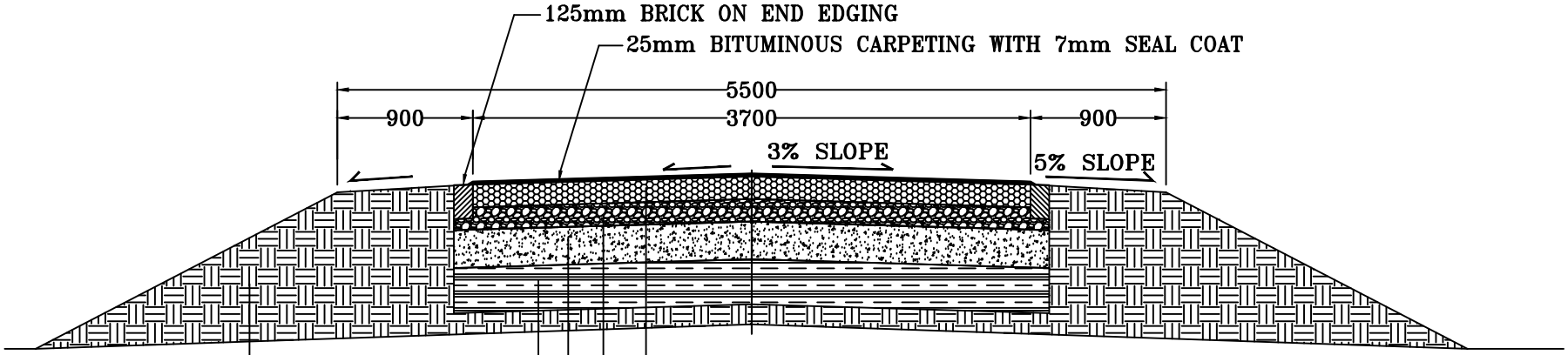
ORIGINAL SOIL CUT INTO DESIGNED SHAPE, OR FILL WITH NORMAL SOIL,
PI VALUE RANGE 8 TO 20%, COMPACTION min. 95% STD, DCP max. 45mm/BLOW,
SOAKED CBR min. 3% TO ACHIEVE DESIGNED CROSS-SECTION OF SIDE EMBANKMENT

DRAWING PLATE UNR-BC2-SL-1A

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UNION ROAD SECTION (ROAD TYPE 8)
	PROCESS: DESIGN UNIT
	DRAWING NO: UNR-08-1A
	DATE:

UNION ROAD SECTION

DESIGN TYPE 7



150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30% ,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32% , COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

ORIGINAL SOIL CUT INTO DESIGNED SHAPE, OR FILL WITH NORMAL SOIL,
PI VALUE RANGE 8 TO 20%, COMPACTION min. 95% STD, DCP max. 45mm/BLOW,
SOAKED CBR min. 3% TO ACHIEVE DESIGNED CROSS-SECTION OF SIDE EMBANKMENT

DRAWING PLATE UNR-BC2-SL-2A

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UNION ROAD SECTION (ROAD TYPE 7)
	PROCESS: DESIGN UNIT
	DRAWING NO: UNR-07-2A
	DATE:

UNION ROADS DESIGN PLATES FOR HILLY AREAS

Plate UNR-BC2-SL-HL-1A For Design Type 8

This is a standard single lane option of Union Road Pavement without Hard shoulder through Hill top without any run-off drainage chute on both sides. Shoulder treatment may be provided as needed. It is a single carriageway pavement to support up to 50 commercial vehicles per day.

It has same road geometry and pavement design of Design Type 8.

Plate UNR-BC2-SL-HL-1B For Design Type 8

This is a standard single lane option of Union Road Pavement with Drainage Chute through Hill-cut having hills on inward side of horizontal curve. Drainage Chute may be revised or omitted as needed.

It has same road geometry and pavement design of Design Type 8.

Plate UNR-BC2-SL-HL-1C For Design Type 8

This is a standard single lane option of Union Road Pavement with Drainage Chute through Hill-cut having hills on outward side of horizontal curve. Drainage Chute may be revised or omitted as needed.

It has same road geometry and pavement design of Design Type 8.

Plate UNR-BC2-SL-HL-1D For Design Type 8

This is a standard single lane option of Union Road Pavement with Drainage Chute through Hills having run-off drainage chute on both sides. Drainage Chute may be revised or omitted as needed.

It has same road geometry and pavement design of Design Type 8.

THE PLATES

Plate UNR-BC2-SL-HL-1A FOR DESIGN TYPE 8

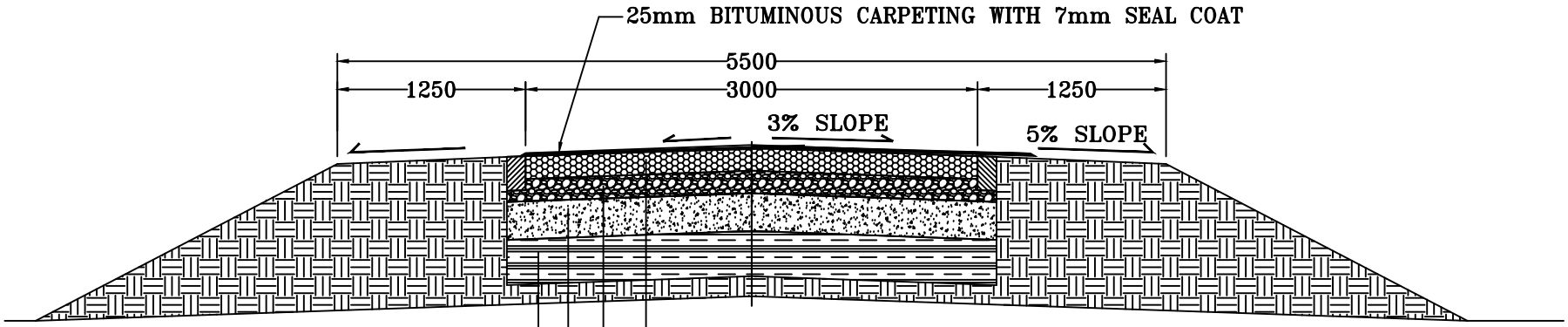
Plate UNR-BC2-SL-HL-1B FOR DESIGN TYPE 8

Plate UNR-BC2-SL-HL-1C FOR DESIGN TYPE 8

Plate UNR-BC2-SL-HL-1D FOR DESIGN TYPE 8

UNION ROAD SECTION THROUGH HILL TOP

DESIGN TYPE 8



150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30%,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32%, COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

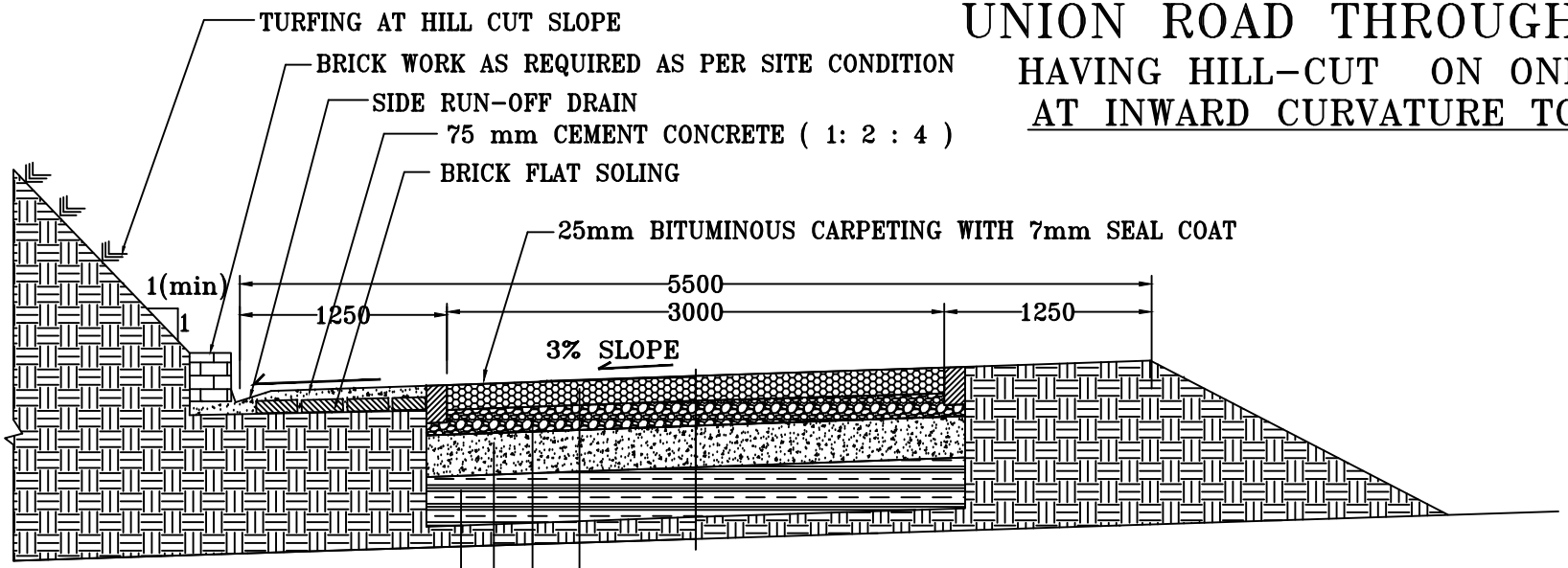
250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

DRAWING PLATE UNR-BC2-SL-HL-1A

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UNION ROAD SECTION THROUGH HILLS (ROAD TYPE 8)	
	PROCESS	DESIGN UNIT
		01
	DATE:	

UNION ROAD THROUGH HILLS
HAVING HILL-CUT ON ONE SIDE
AT INWARD CURVATURE TO HILL



150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30%,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32%, COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

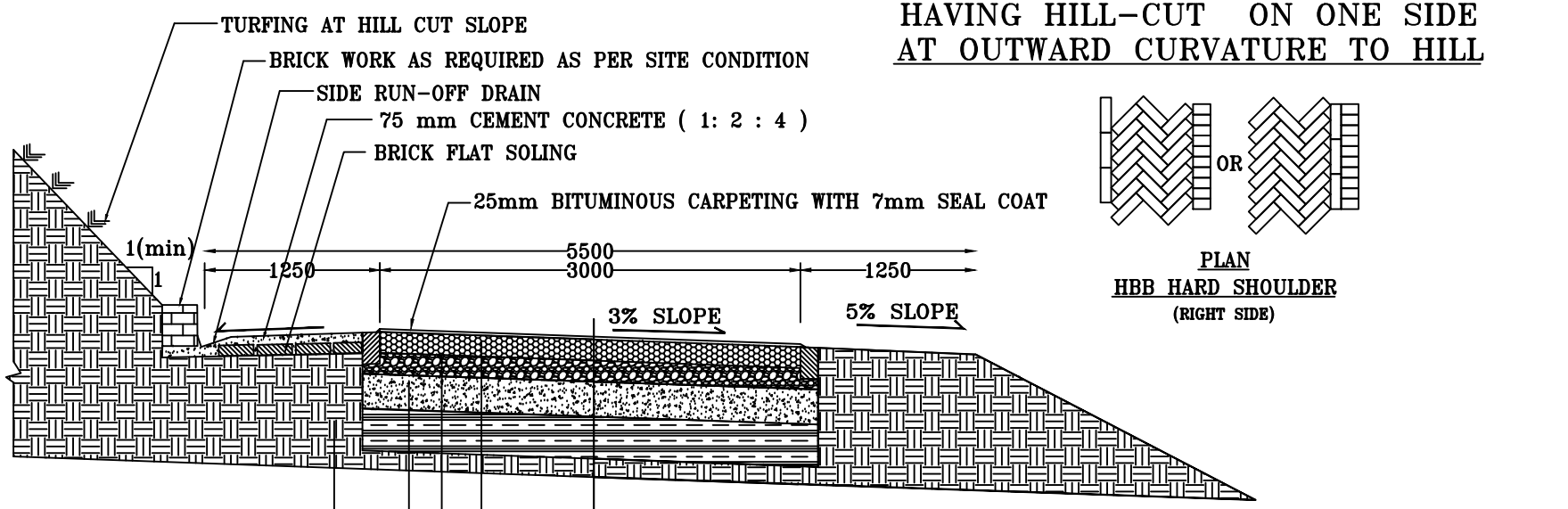
SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

DRAWING PLATE UNR-BC2-SL-HL-1B

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY	UNION ROAD SECTION THROUGH HILLS (ROAD TYPE 8)	
	PROCESS	DESIGN UNIT
MD. SHAHIDUL HASSAN CHIEF ENGINEER		01
	DATE:	

UNION ROAD THROUGH HILLS

HAVING HILL-CUT ON ONE SIDE AT OUTWARD CURVATURE TO HILL

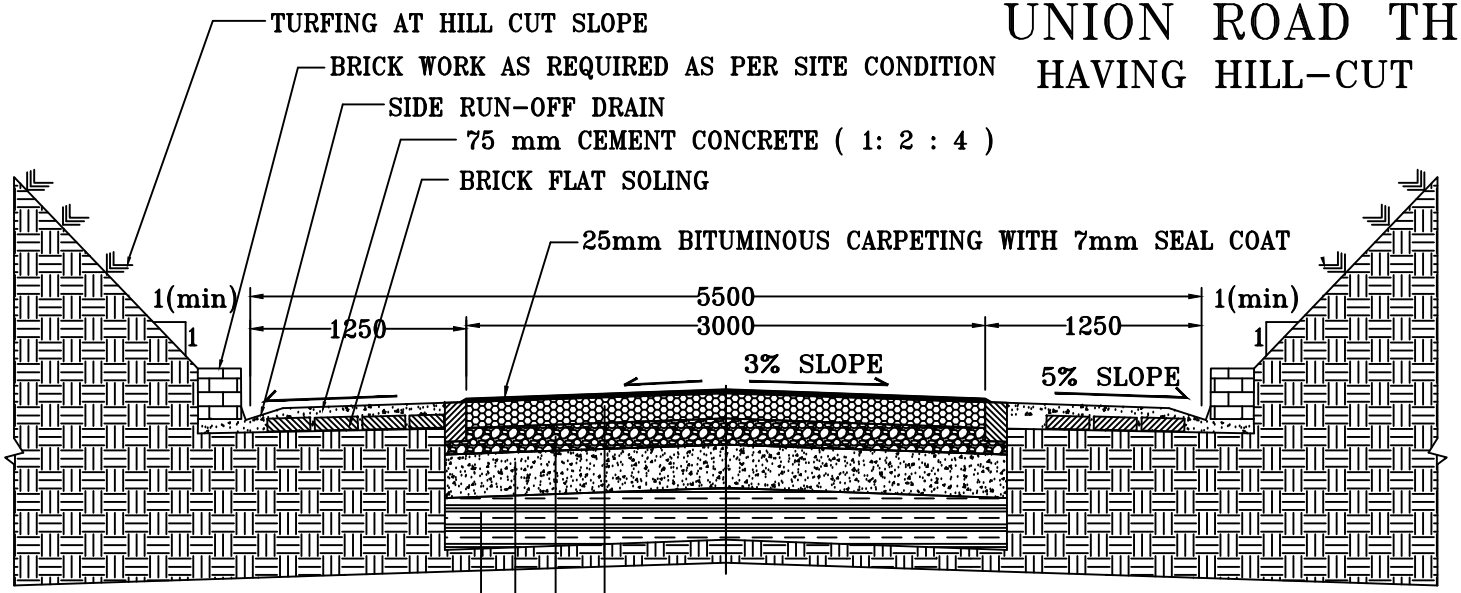


PLAN
HBB HARD SHOULDER
(RIGHT SIDE)

DRAWING PLATE UNR-BC2-SL-HL-1C

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA ROAD SECTION THROUGH HILLS (ROAD TYPE 8)
	PROCESS: DESIGN UNIT
	01
	DATE:

UNION ROAD THROUGH HILLS
HAVING HILL-CUT ON BOTH SIDES



150mm COMPACTED WBM BASE, AGGREGATE ACV max. 30%,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 80%, DPC max. 3.5mm/BLOW,
COMPACTED TO min. 98% MODIFIED

150mm COMPACTED AGGREGATE-SAND SUBBASE (SAND : MAXIMUM 50% OF MIX),
AGGREGATE ACV max. 32%, COMPACTED IN TWO LAYERS,
EACH LAYER SOAKED CBR min. 30%, DCP max. 3.5mm/BLOW, COMPACTED TO min. 98% MODIFIED

250mm COMPACTED SAND IMPROVED SUBGRADE, SAND FM min. 0.8, PI VALUE<6,
COMPACTED IN TWO LAYERS, EACH LAYER SOAKED CBR min. 8% & DCP max. 22mm/BLOW,
COMPACTED TO min. 98% MODIFIED

SUBGRADE COMPACTION min. 98% STD, SOAKED CBR min. 4%, DCP max. 30mm/BLOW
(IF NOT AVAILABLE, 300mm SUBGRADE, COMPACTED TO min. 98% STD IN TWO LAYERS,
SOAKED CBR min. 4%, DCP max. 30mm/BLOW)

DRAWING PLATE UNR-BC2-SL-HL-1D

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UNION ROAD SECTION THROUGH HILLS (ROAD TYPE 8)
	PROCESS: DESIGN UNIT
	01
	DATE:

UNION ROAD HBB PAVEMENT

Plate UNR-HBB -1A For Road Type 8

This is a standard single lane option of Union Road with Herring Bone Bond (HBB) Pavement. This HBB pavement is proposed where quality control is hard to ensure or traffic volume does not justify bituminous pavement. It is aimed at all weather traffic flow at the initial stage.

Road geometry of this HBB Pavement Road is comprised of 3.00m HBB pavement with 1.25m earthen shoulder on each side totaling 5.50m in crest.

It has sub-grade having 4% Soaked CBR and 125 mm sand cushioning compacted to 100 percent STD. Another 25mm sand cushioning has been provided in between flat soling and HBB. This is an option of HBB pavement for Union Road in plane lands and also in hilly areas.

Plate UNR-HBB-1A FOR ROAD TYPE 8

SUBMERSIBLE ROAD PAVEMENT

Plate UPR-UNR -SRP-1A For Submersible Road

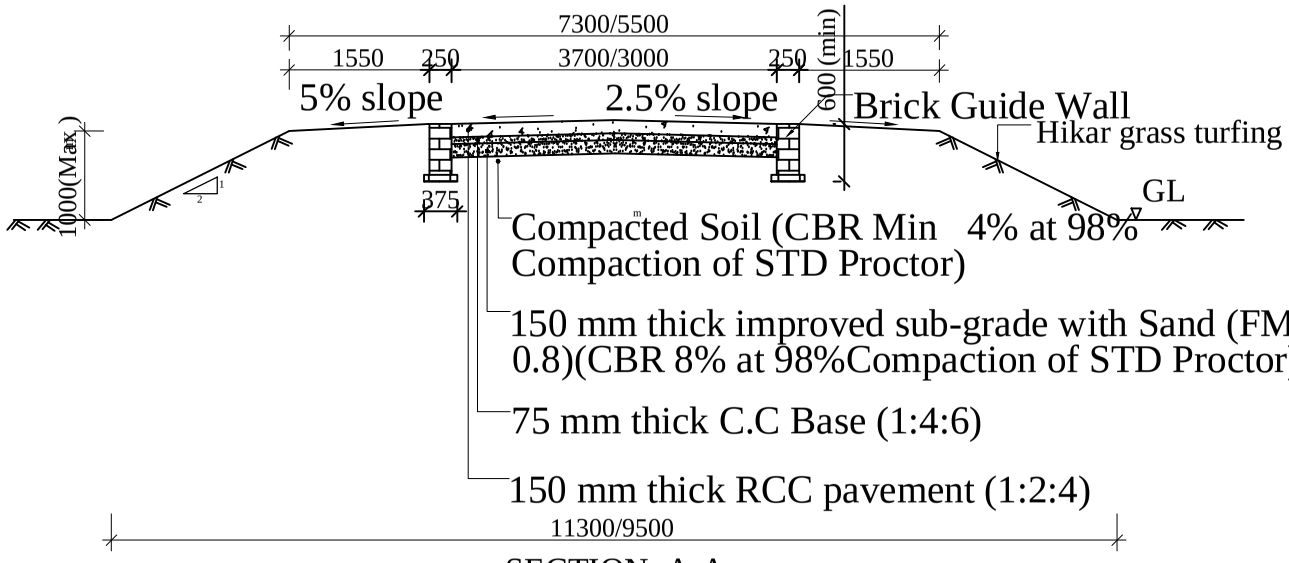
This is a standard single lane option of Upazila/Union Road with RCC Pavement. This RCC pavement is proposed in haor area.

Road geometry of this RCC Pavement Road is comprised of 3.70m or 3.00m RCC pavement with 1.8m earthen shoulder on each side totaling 7.30m or 5.50m in crest for Upazila or Union Road respectively.

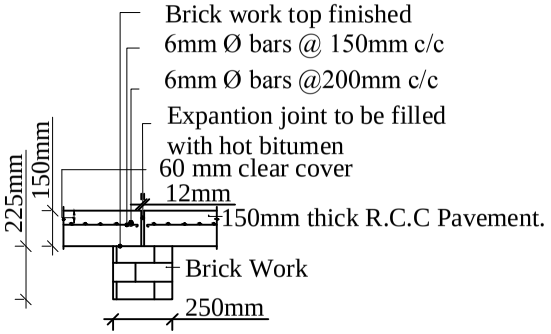
It has sub-grade having 4% Soaked CBR and 150 mm sand (F.M. 0.80) cushioning compacted to 100 percent STD to achieve 10% soaked CBR.
It has 75mm CC Base and 150mm RCC pavement.

Plate UPR-UNR-SRP-1A FOR ROAD TYPE 6

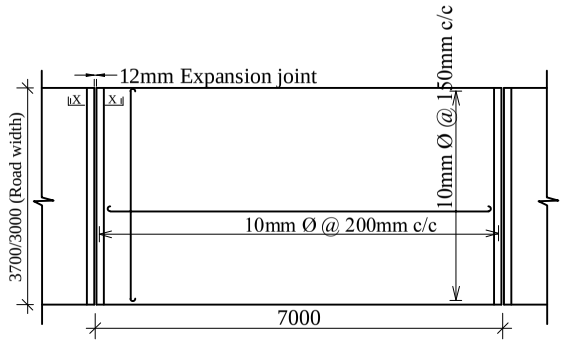
SUBMERSIBLE ROAD PAVEMENT
UPAZILA/UNION ROAD

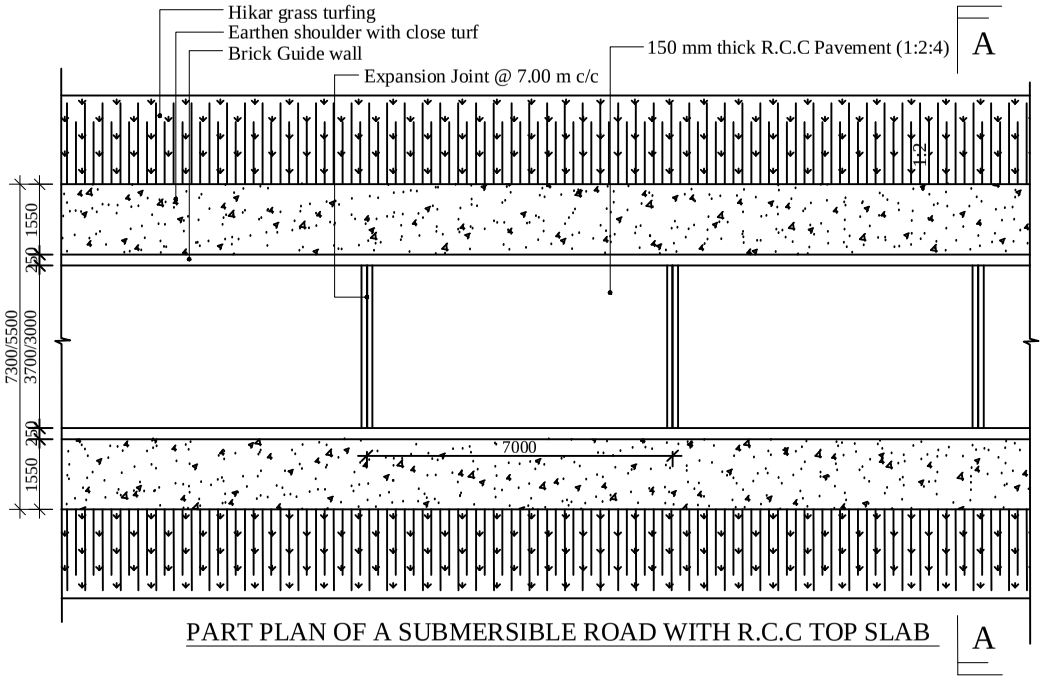


SECTION A-A



SECTION X-X





PART PLAN OF A SUBMERSIBLE ROAD WITH R.C.C TOP SLAB

REINFORCEMENT DETAILS OF R.C.C PAVEMENT ROAD

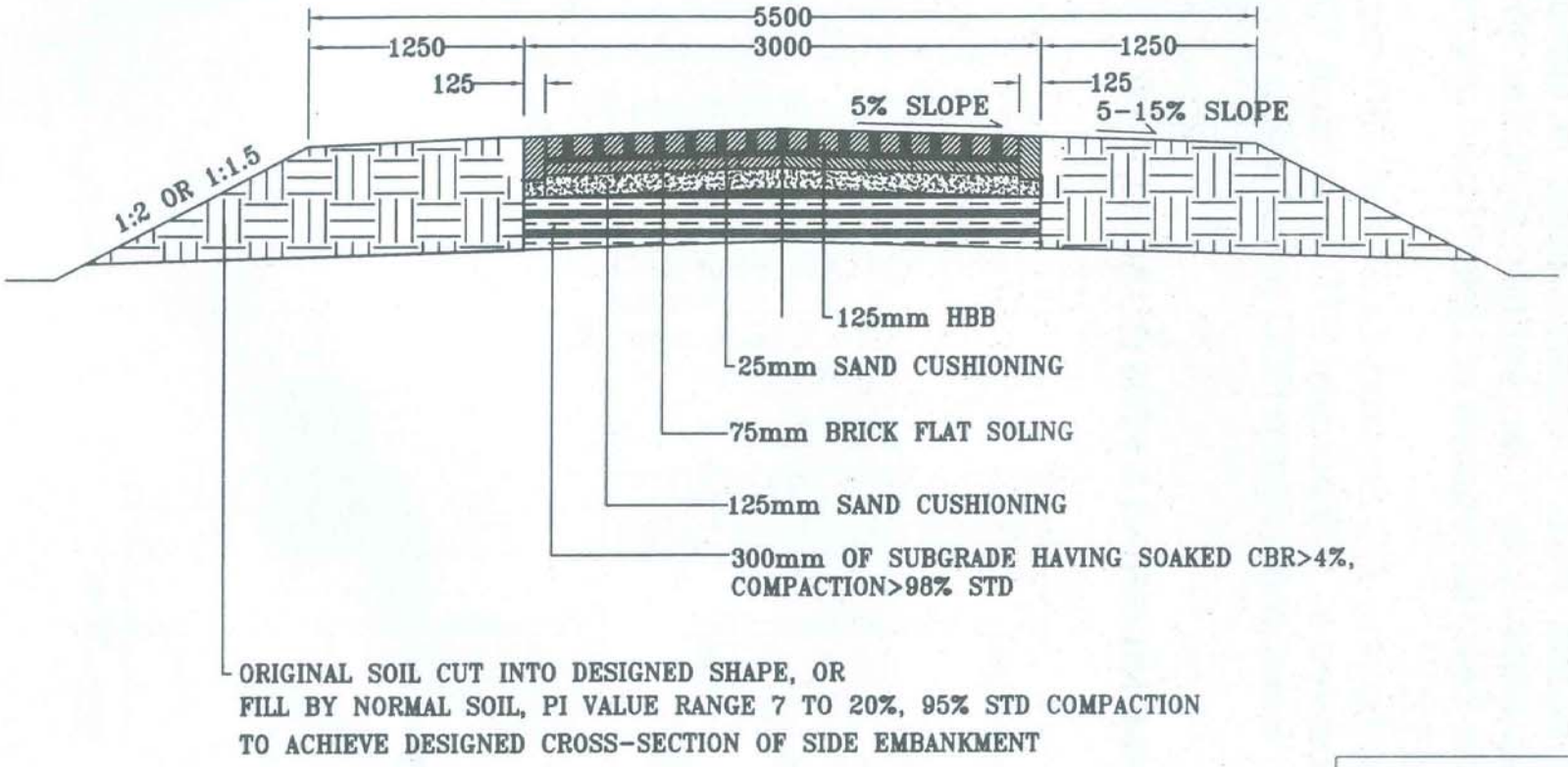
NOTES:

1. All dimension are in millimeter unless otherwise mentioned .
2. 28 days cylinder crushing strength of concrete f'c=20.68 N/mm (3000 psi)
3. Yield strength of M.S. bar fy= 276 N/mm (40000psi)
4. Provide one layer Polythene sheet on the top of improved sub-grade before casting 75mm thick CC.

DRAWING PLATE UPR-UNR-SRP-1A

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SUBMERSIBLE ROAD PAVEMENT DETAILS
	PROCESS: DESIGN UNIT
	DRAWING NO: UPR-UNR-SRP-1A
	DATE:

RURAL ROAD SECTION WITH HBB PAVEMENT



DRAWING PLATE UNR-HBB-1A

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UNION/ RR ROAD SECTION THROUGH HILLS (ROAD TYPE 8)
	PROCESS: DESIGN UNIT
	01
	DATE:

SHOULDER TREATMENT OF UPAZILA ROADS OR UNION ROADS CROSSING MARKET PLACE OR BUILT-UP AREAS

Plate UPR-UNR-BT-SLD-1

This is a shoulder development option of Upazila Roads and Union Roads crossing market place or built-up areas. This treatment is provided beyond road pavement or hard shoulder.

It is made of brick bonded concrete (BBC) of 1.0 meter wide each side. Beyond BBC, it is proposed brick flat soling extending up to drain at road boundary line.

Plate UPR-UNR-BT-SLD-2

This is a shoulder development option of Upazila Roads and Union Roads crossing market place or built-up areas. This treatment is provided beyond road pavement or hard shoulder where sufficient wide shoulders are available.

It is made of brick bonded concrete (BBC) of 2.0 meter wide each side having raised kerbstone divider along edge of pavement to restrict parking on pavement. Raised kerbstone shall have segmental construction with 150mm gap at depression to ease rain water drainage. Beyond BBC, it is proposed brick kerbstone to provide 1.0m walkway and side drain at points of depression.

Plate UPR-UNR-BT-SLD-3

This is a shoulder development option of Upazila Roads and Union Roads crossing market place or built-up areas. This treatment is provided beyond road pavement or hard shoulder.

It is made of HBB of 1.0 meter wide each side. Beyond HBB, it is proposed brick kerbstone to provide 1.0m walkway and side drain at depressions.

Plate UPR-UNR-BT-SLD-4

This is a shoulder development option of Upazila Roads and Union Roads crossing market place or built-up areas. This treatment is provided beyond road pavement or hard shoulder.

It is made of brick bonded concrete of 1.0 meter wide each side. Beyond BBC, it is proposed earthen shoulder maintaining slope for run-off drainage at random.

Plate UPR-UNR-BT-SLD-5

This is an option of shallow drain/chute for surface run off drainage along edge of roadway. It has minimum operational involvement.

THE PLATES

Plate UPR-UNR-BT-SLD-1
Plate UPR-UNR-BT-SLD-2
Plate UPR-UNR-BT-SLD-3
Plate UPR-UNR-BT-SLD-4
Plate UPR-UNR-BT-SLD-5

OPTION–1

SHOULDER TREATMENT OF UPAZILA OR UNION ROAD CROSSING MARKET PLACE / BUILT–UP AREA

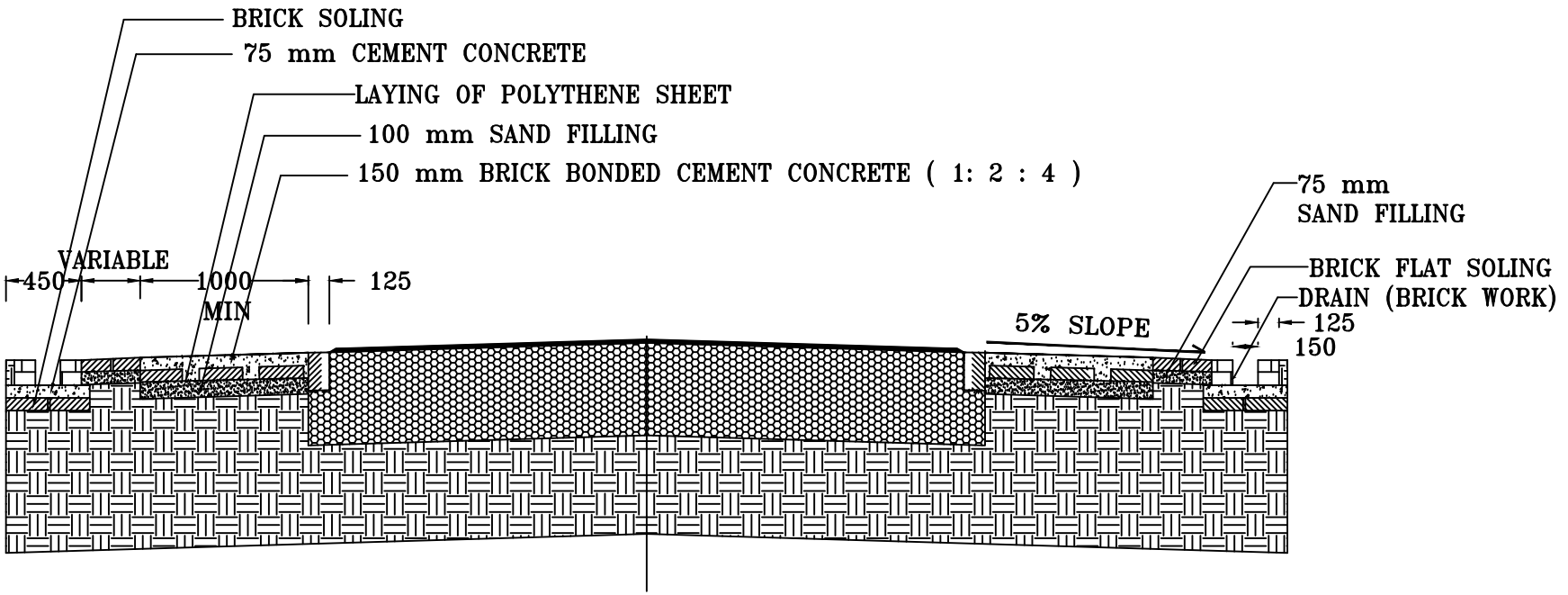
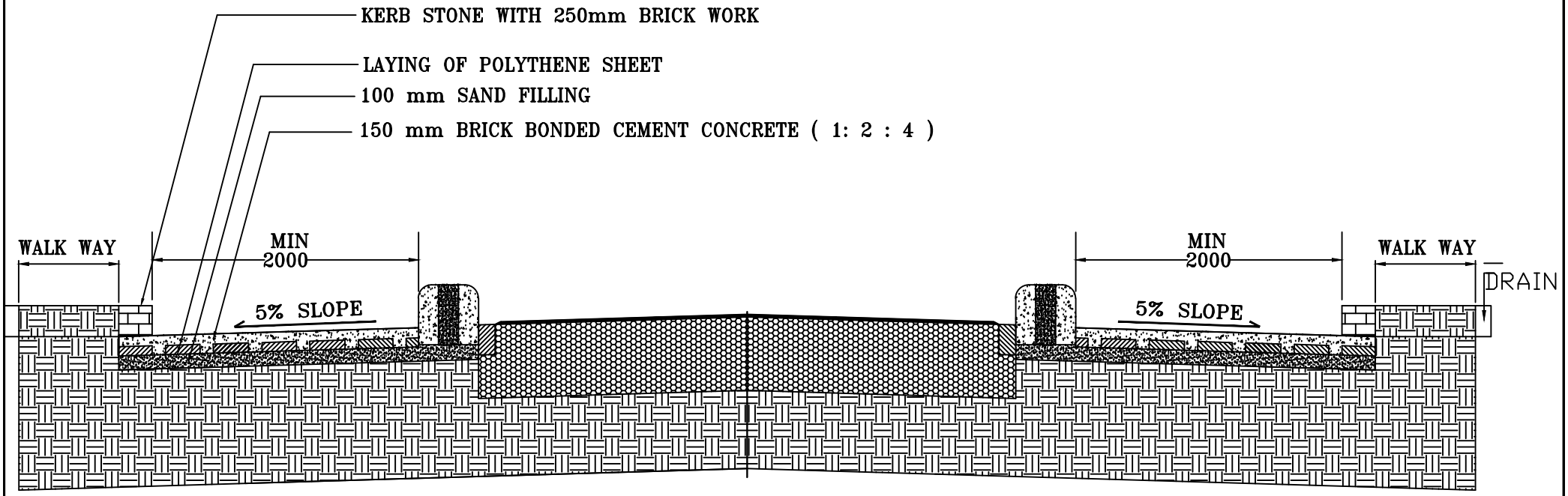


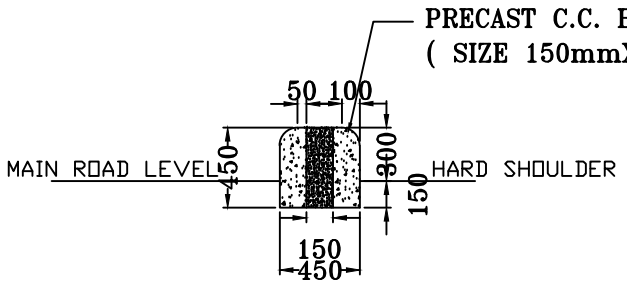
PLATE NO. UPR–UNR–BT–SLD–1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA–UNION ROAD EARTHEN SHOULDER PROTECTION THROUGH BUILT–UP AREA
	PROCESS: DESIGN UNIT
	DATE:

OPTION-2

SHOULDER TREATMENT OF UPAZILA OR UNION ROAD CROSSING MARKET PLACE / BUILT-UP AREA





RAISED KERBSTONE DEVIDER

PLATE NO. UPR-UNR-BT-SLD-2

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA-UNION ROAD EARTHEN SHOULDER PROTECTION THROUGH BUILT-UP AREA
	PROCESS: DESIGN UNIT
	DATE:

OPTION–3

SHOULDER TREATMENT OF UPAZILA OR UNION ROAD CROSSING MARKET PLACE / BUILT–UP AREA

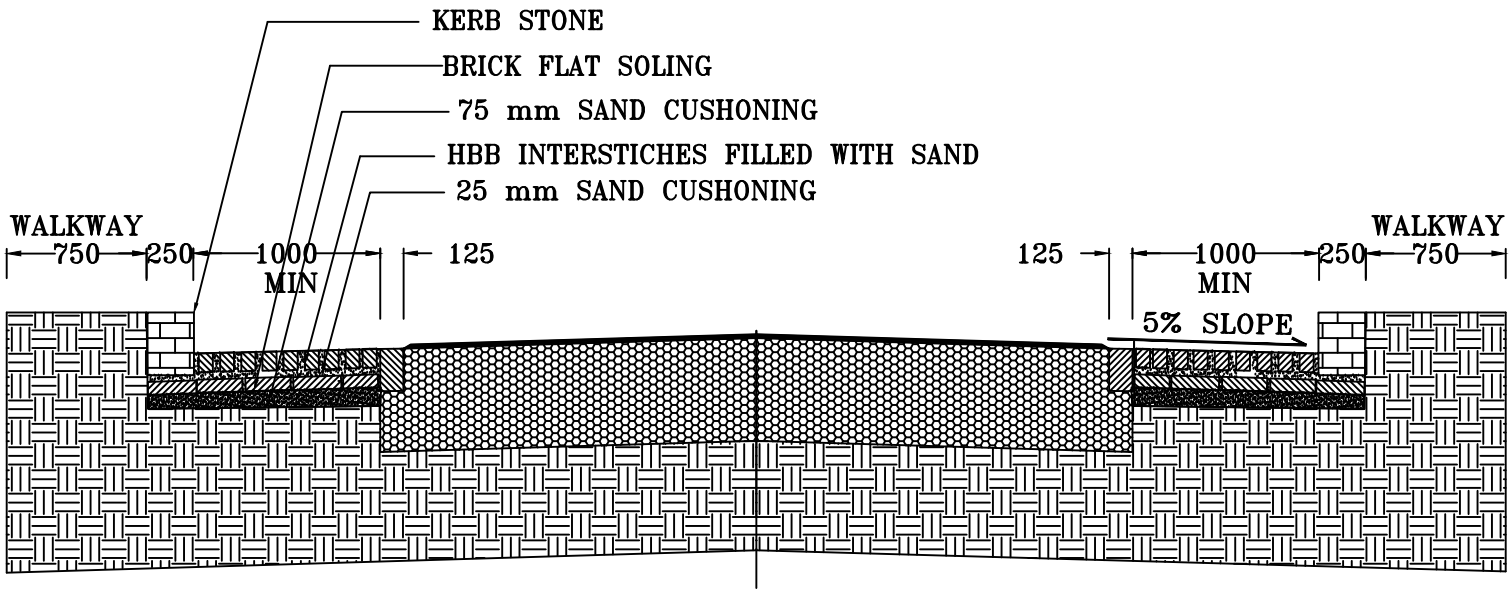


PLATE NO. UPR–UNR–BT–SLD–3

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA–UNION ROAD EARTHEN SHOULDER PROTECTION THROUGH BUILT–UP AREA
	PROCESS: DESIGN UNIT
	DATE:

OPTION–4

SHOULDER TREATMENT OF UPAZILA OR UNION ROAD CROSSING MARKET PLACE / BUILT–UP AREA

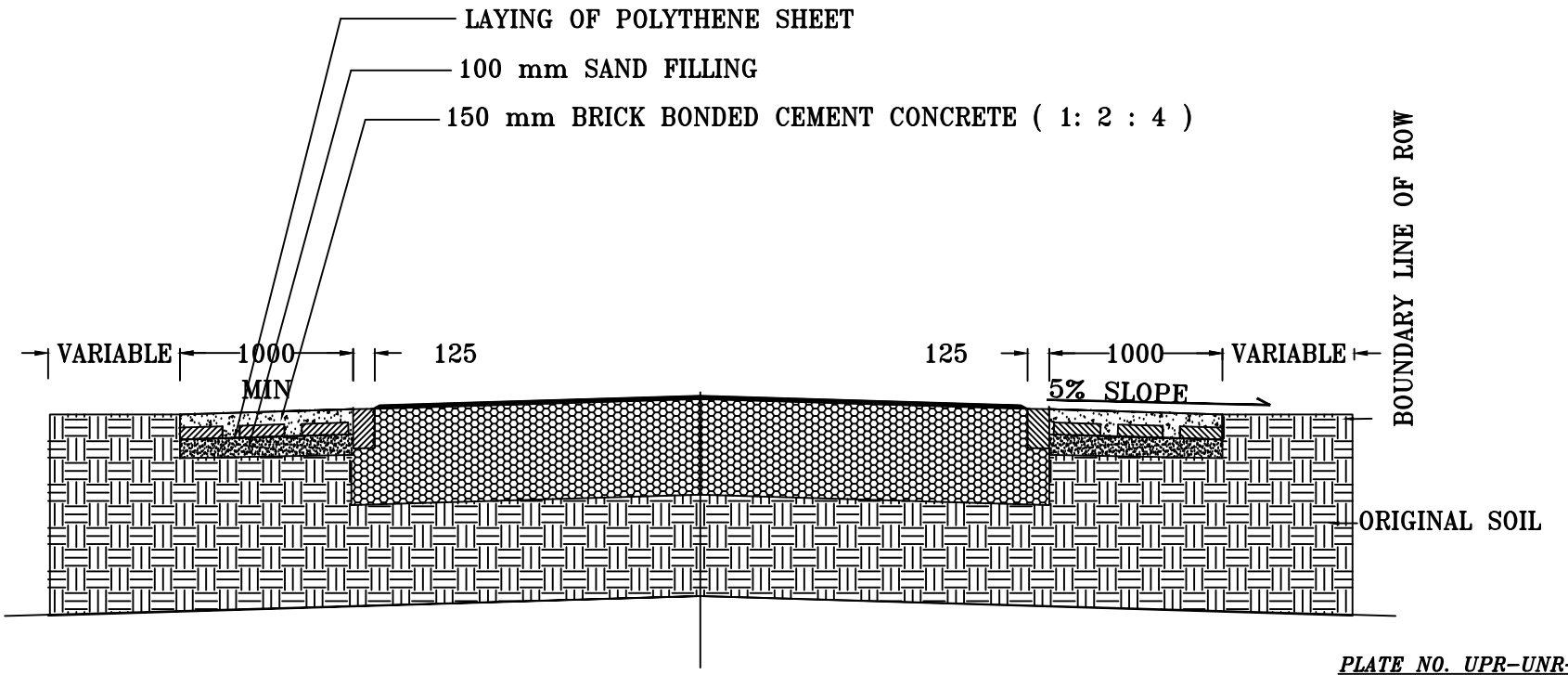
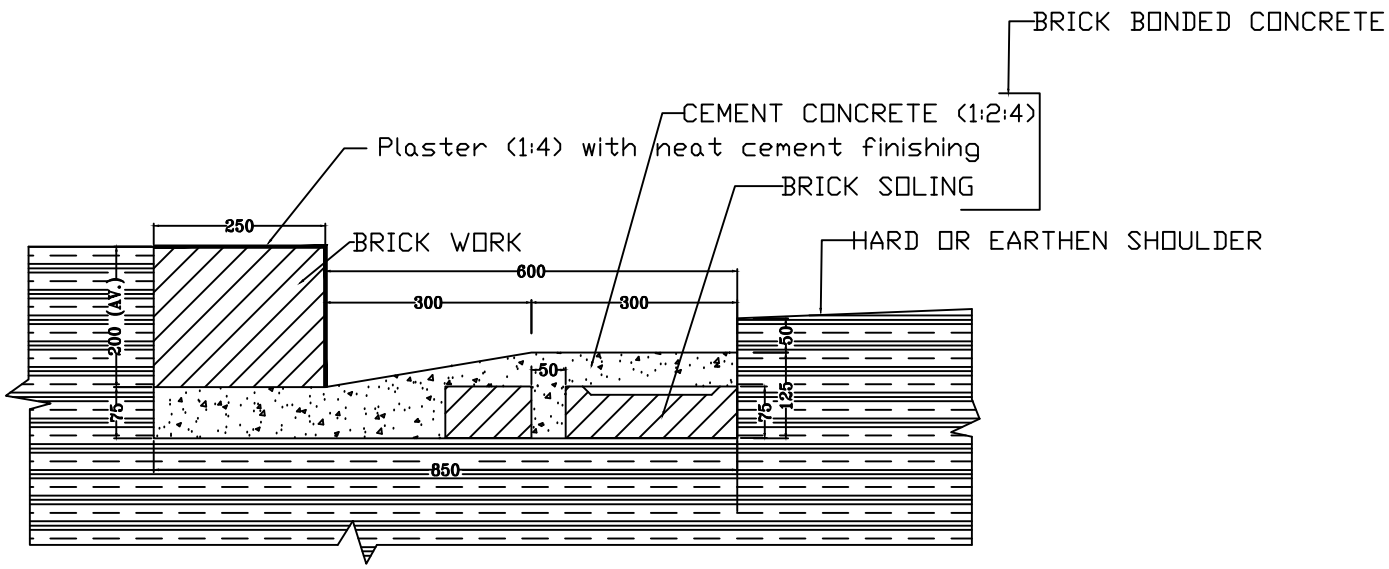


PLATE NO. UPR–UNR–BT–SLD–4

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA–UNION ROAD EARTHEN SHOULDER PROTECTION THROUGH BUILT–UP AREA
	PROCESS: DESIGN UNIT
	DATE:

ROAD SIDE RUN-OFF DRAINAGE CHUTE



TYPICAL X-SECTION

NOTE: ALL DIMENTIONS ARE IN MILLIMETER

PLATE NO. UPR-UNR-BT-SLD-5

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA-UNION ROAD ROAD SIDE RUN-OFF DRAINAGE CHUTE SECTION STANDARD OPTION TO SHOULDER FOR PLANE LANDS	
	PROCESS	DESIGN UNIT
	DATE:	

ROAD JUNCTION AND BUS STOP AT UPAZILA ROAD

Plate UPR-BC2-RJ-1

This is an Upazila Road Junction option with a link road eventually generating Bus Stop and Rickshaw Stand. It needs widening of Upazila Road pavement and construction of pavement on link road up to certain length. It will contribute ease traffic flow at Junction and durability of pavement.

Plate UPR-BC2-RJ-2

This is an Upazila Road Junction option with a cross-link of a road eventually generating Bus Stop and Rickshaw Stand. It needs widening of Upazila Road pavement and construction of pavement on link road up to certain length. It will contribute ease traffic flow at Junction and durability of pavement.

Plate UPR-BC2-BS-1

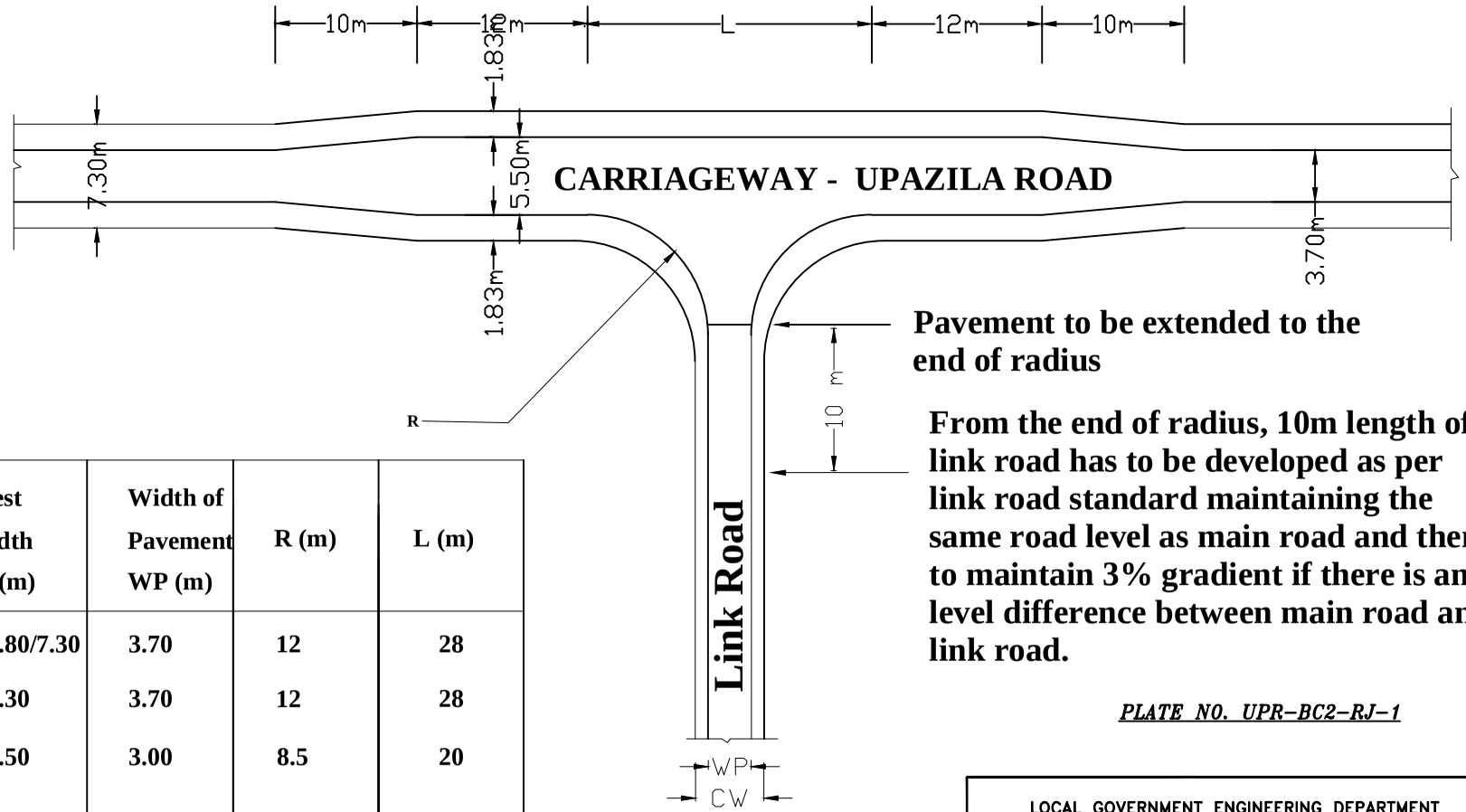
This is an Upazila Road Bus stop option at mid block location. It needs widening of Upazila Road pavement. It will contribute ease traffic flow at Bus stop and durability of pavement life.

Plate UPR-BC2-MP-1

This is an Upazila Road Bus stop option through a market place. It needs widening of Upazila Road pavement. It will contribute ease traffic flow through market place and durability of pavement life.

THE PLATES

UPAZILA ROAD JUNCTION TYPE – 1
(With Bus Stops & Rickshaw Stand)



Pavement to be extended to the end of radius

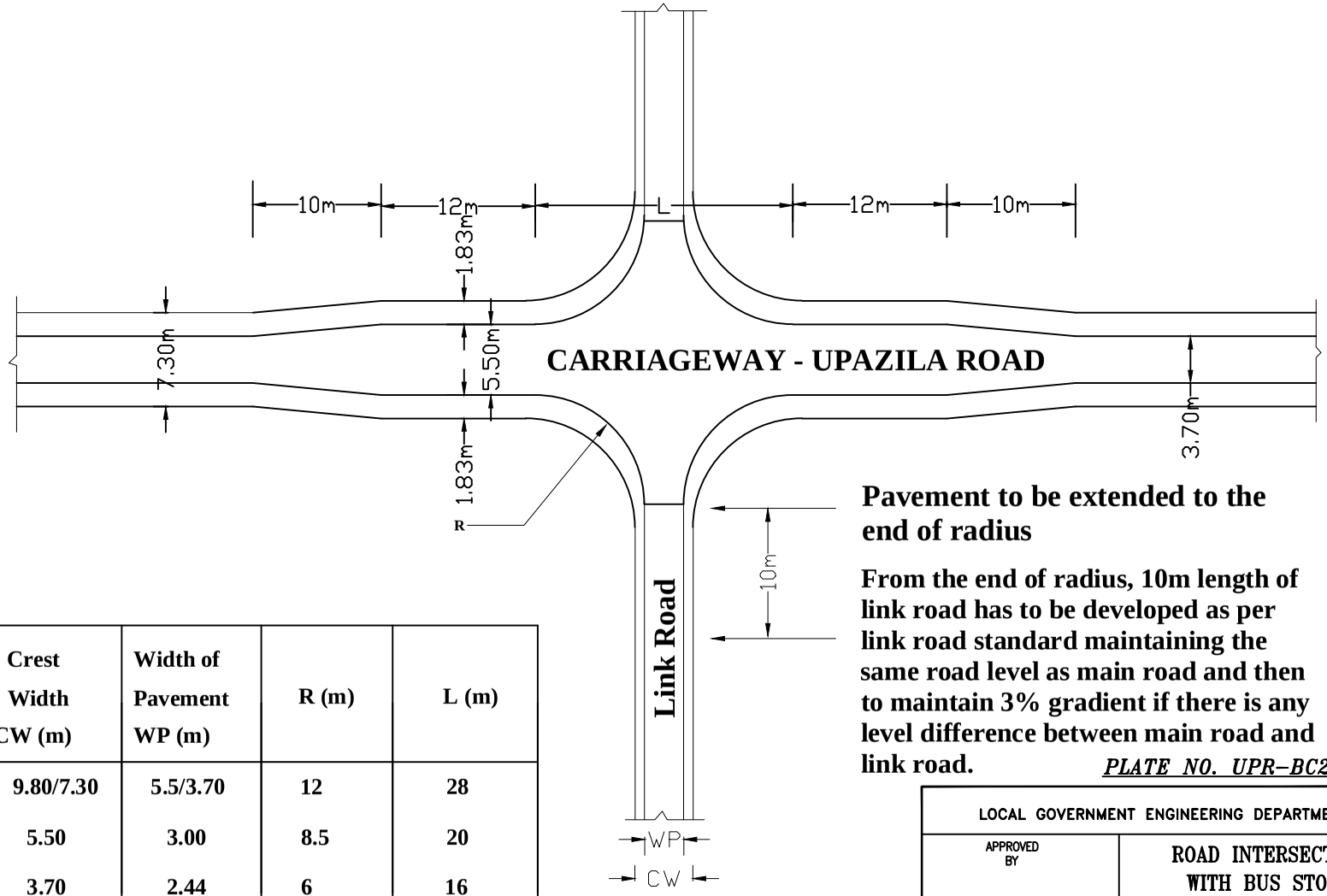
From the end of radius, 10m length of link road has to be developed as per link road standard maintaining the same road level as main road and then to maintain 3% gradient if there is any level difference between main road and link road.

Type of Link Road	Crest Width CW (m)	Width of Pavement WP (m)	R (m)	L (m)
ZILA ROAD	9.80/7.30	3.70	12	28
UPAZILA ROAD	7.30	3.70	12	28
UNION ROAD	5.50	3.00	8.5	20
VILLAGE ROAD	3.70	2.44	6	16
VILLAGE ROAD	2.44		3	6

PLATE NO. UPR-BC2-RJ-1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	ROAD JUNCTION WITH BUS STOP UPAZILA ROAD
	PROCESS: DESIGN UNIT
	DATE:

UPAZILA ROAD INTERSECTION, TYPE – 1
(With Bus Stops & Rickshaw Stand)



Pavement to be extended to the end of radius

From the end of radius, 10m length of link road has to be developed as per link road standard maintaining the same road level as main road and then to maintain 3% gradient if there is any level difference between main road and link road.

PLATE NO. UPR–BC2–RJ–2

Type of Link Road	Crest Width CW (m)	Width of Pavement WP (m)	R (m)	L (m)
ZILA / UPAZILA ROAD	9.80/7.30	5.5/3.70	12	28
UNION ROAD	5.50	3.00	8.5	20
VILLAGE ROAD	3.70	2.44	6	16
VILLAGE ROAD	2.44		3	6

LOCAL GOVERNMENT ENGINEERING DEPARTMENT

APPROVED BY

MD. SHAHIDUL HASSAN
CHIEF ENGINEER

ROAD INTERSECTION WITH BUS STOP UPAZILA ROAD

PROCESS | DESIGN UNIT

DATE:

TYPICAL BUS STOP – AT MID BLOCK LOCATION
(Wih Bus Stop & Rickshaw Stand)

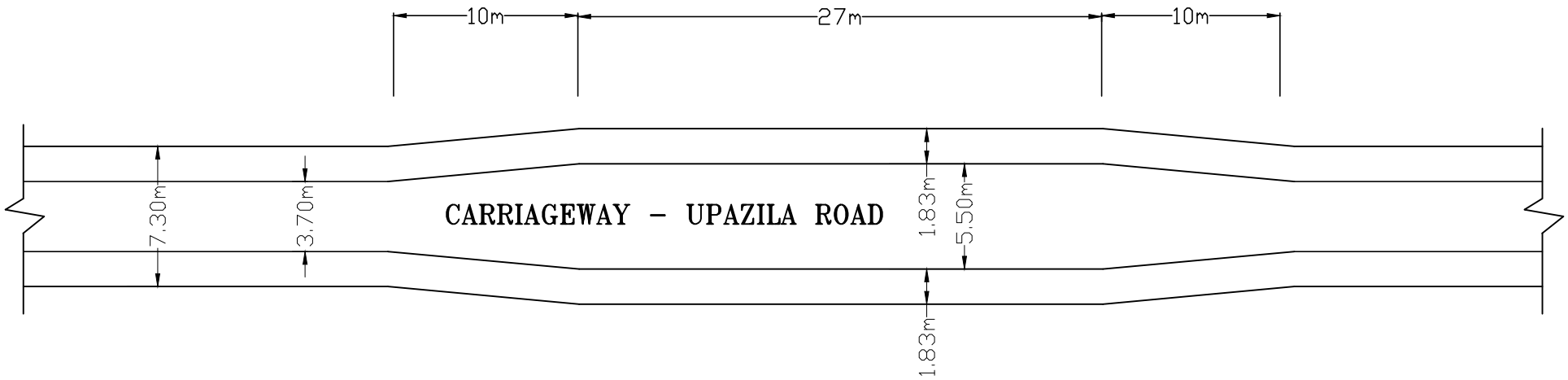


PLATE NO. UPR–BC2–BS–1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	PAVEMENT WIDENING WITH BUS STOP UPAZILA ROAD
	PROCESS: DESIGN UNIT
	DATE:

PAVEMENT WIDENING THROUGH MARKET AREA TYPE-1

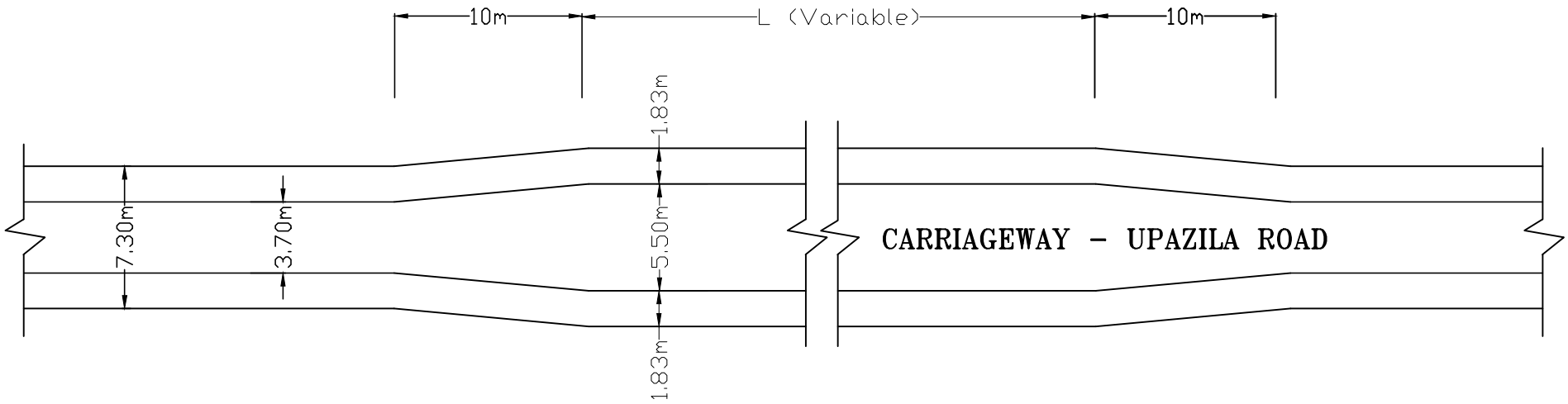


PLATE NO. UPR-BC2-MP-1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	PAVEMENT WIDENING THROUGH MARKET PLACE UPAZILA ROAD
	PROCESS: DESIGN UNIT
	DATE:

ROAD JUNCTION AND BUS STOP AT UNION ROAD

Drawing plates have been provided for road junction treatment and bus stop for Union Roads.

THE PLATES

Plate UNR-BC2-RJ-1

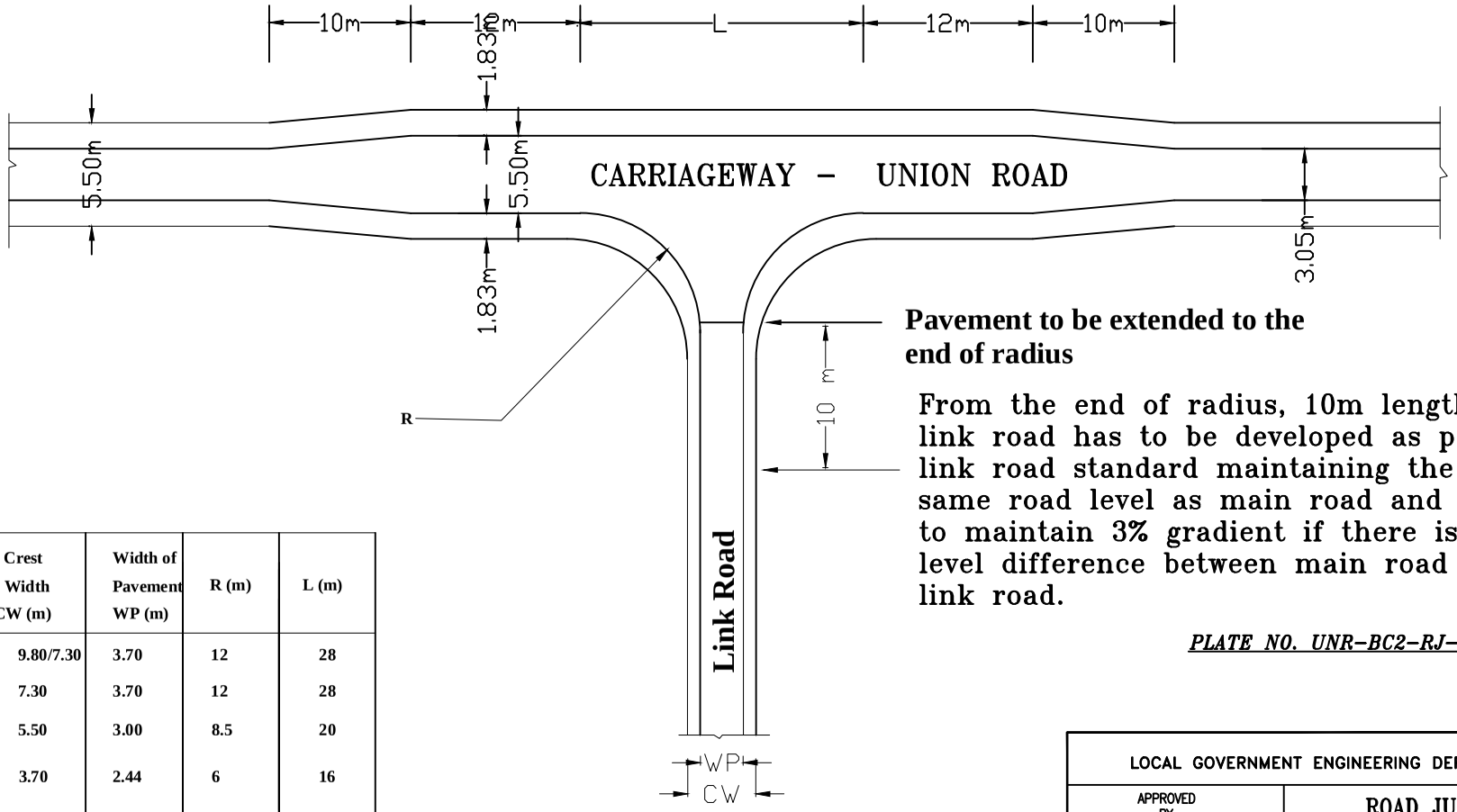
Plate UNR-BC2-RJ-2

Plate UNR-BC2-BS-1

Plate UNR-BC2-MP-1

UNION ROAD JUNCTION, TYPE – 1

(With Bus Stops & Rickshaw Stand)



Pavement to be extended to the end of radius

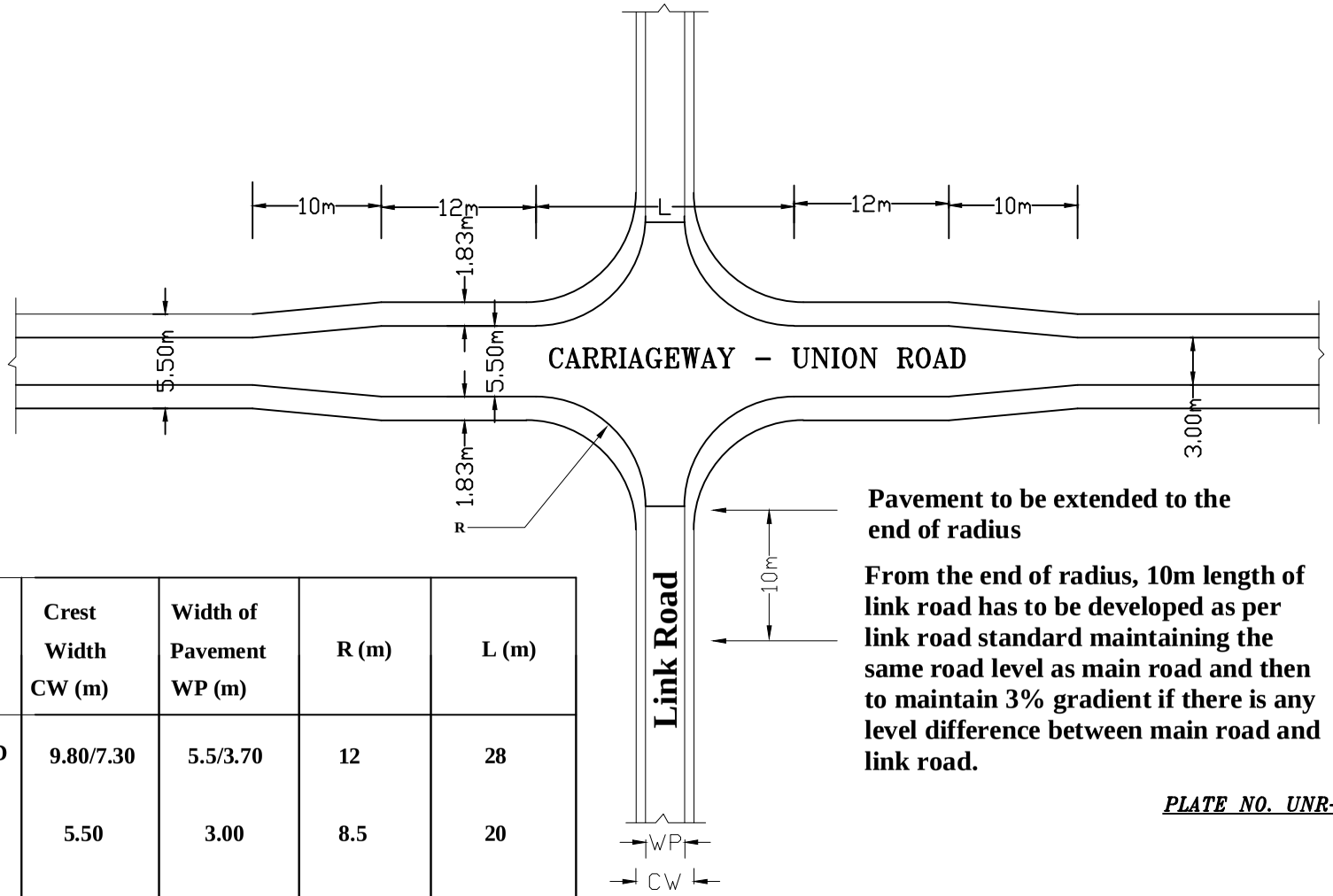
From the end of radius, 10m length of link road has to be developed as per link road standard maintaining the same road level as main road and then to maintain 3% gradient if there is any level difference between main road and link road.

PLATE NO. UNR-BC2-RJ-1

Type of Link Road	Crest Width CW (m)	Width of Pavement WP (m)	R (m)	L (m)
ZILA ROAD	9.80/7.30	3.70	12	28
UPAZILA ROAD	7.30	3.70	12	28
UNION ROAD	5.50	3.00	8.5	20
VILLAGE ROAD	3.70	2.44	6	16
VILLAGE ROAD	2.44		3	6

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY	ROAD JUNCTION WITH BUS STOP UNION ROAD
	PROCESS: DESIGN UNIT
MD. SHAHIDUL HASSAN CHIEF ENGINEER	DATE:

UNION ROAD INTERSECTION, TYPE – 1
(With Bus Stops & Rickshaw Stand)



Type of Link Road	Crest Width CW (m)	Width of Pavement WP (m)	R (m)	L (m)
ZILA / UPAZILA ROAD	9.80/7.30	5.5/3.70	12	28
UNION ROAD	5.50	3.00	8.5	20
VILLAGE ROAD	3.70	2.44	6	16
VILLAGE ROAD	2.44		3	6

Pavement to be extended to the end of radius

From the end of radius, 10m length of link road has to be developed as per link road standard maintaining the same road level as main road and then to maintain 3% gradient if there is any level difference between main road and link road.

PLATE NO. UNR–BC2–RJ–2

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY	ROAD INTERSECTION WITH BUS STOP UNION ROAD	
	PROCESS	DESIGN UNIT
MD. SHAHIDUL HASSAN CHIEF ENGINEER		
	DATE:	

TYPICAL BUS STOP - AT MID BLOCK LOCATION
(Wih Bus Stop & Rickshaw Stand)

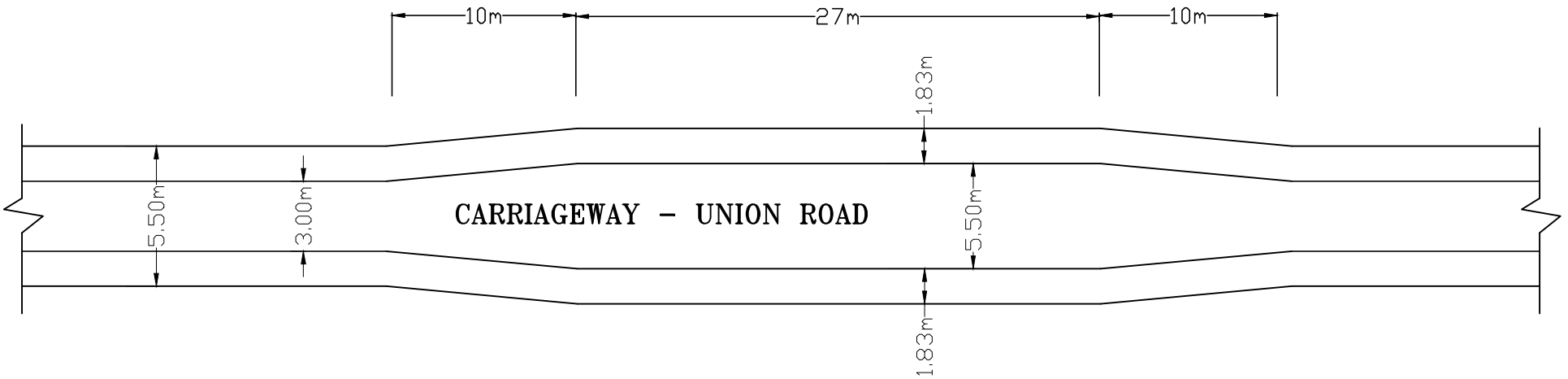


PLATE NO. UNR-BC2-BS-1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	ROAD INTERSECTION WITH BUS STOP UNION ROAD
	PROCESS: DESIGN UNIT
	DATE:

PAVEMENT WIDENING THROUGH MARKET AREA TYPE-1

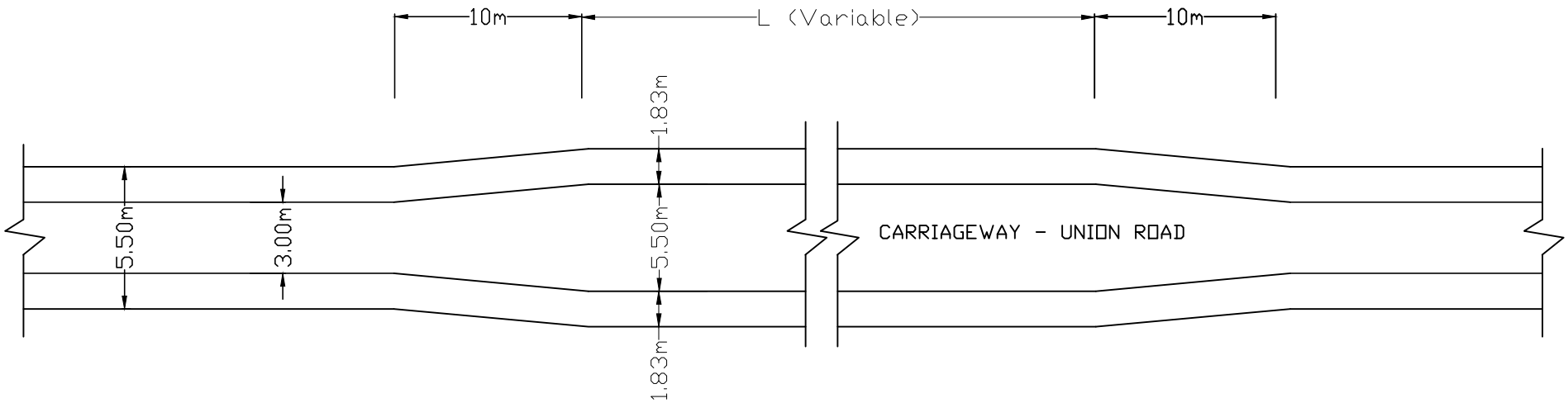


PLATE NO. UNR-BC2-MP-1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	PAVEMENT WIDENING THROUGH MARKET PLACE UNION ROAD
	PROCESS: DESIGN UNIT
	DATE:

ROAD EMBANKMENT PROTECTION AT CHAR AND HAOR AREA or WHERE IT DEEMS NECESSORY

Plate UPR-UNR-EM1-1-1 to Plate UPR-UNR-EM1-3-1

These are options of Road Embankment Protection at Haor or waterlogged Areas where tremendous wave action results erosion on the Embankment due to storm and high-speed wind.

Plate UPR-UNR-EM2-1

This is an option of Road Embankment Protection at char and water logged areas where lands are inundated due to normal floods and wave action results erosion to the Embankment during floods.

Note: If char land remains above normal flood water level, embankment of road shall be lined with clayey soil (0.30m thick), PI value range 8 to 20%. Turfing or seedling with ‘Durba’ grass is a must over lining of side embankment.

Any Design imparted in Plate UPR-UNR-EM2-2, Plate UPR-UNR-EM2-3, Plate UPR-UNR-EM2-4 and Plate UPR-UNR-EM3-1 may be used where it is most appropriate.

THE PLATES

Plate UPR-UNR-EM1-1-1

Plate UPR-UNR-EM1-1-2

Plate UPR-UNR-EM1-2-1

Plate UPR-UNR-EM1-2-2

Plate UPR-UNR-EM1-3-1

Plate UPR-UNR-EM1-3-2

Plate UPR-UNR-EM2-1

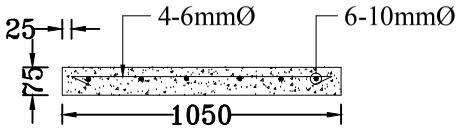
Plate UPR-UNR-EM2-2

Plate UPR-UNR-EM2-3

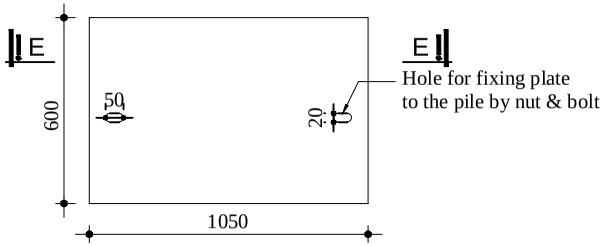
Plate UPR-UNR-EM2-4

Plate UPR-UNR-EM3-1

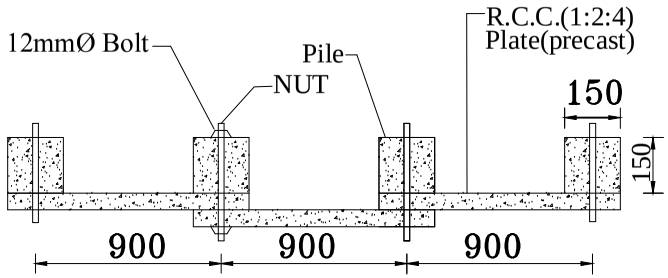
SLOPE PROTECTION WORK
WITH C.C. SLAB ON SLOPE AND PALISADING WORK AT TOE



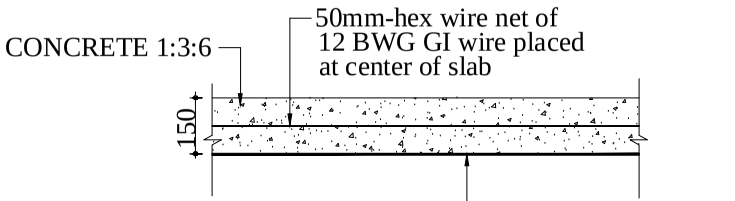
SECTION E–E



PLAN OF PLATE



PLAN OF PILE AND PLATE JOINT
AT SEC 2–2



DETAIL–C

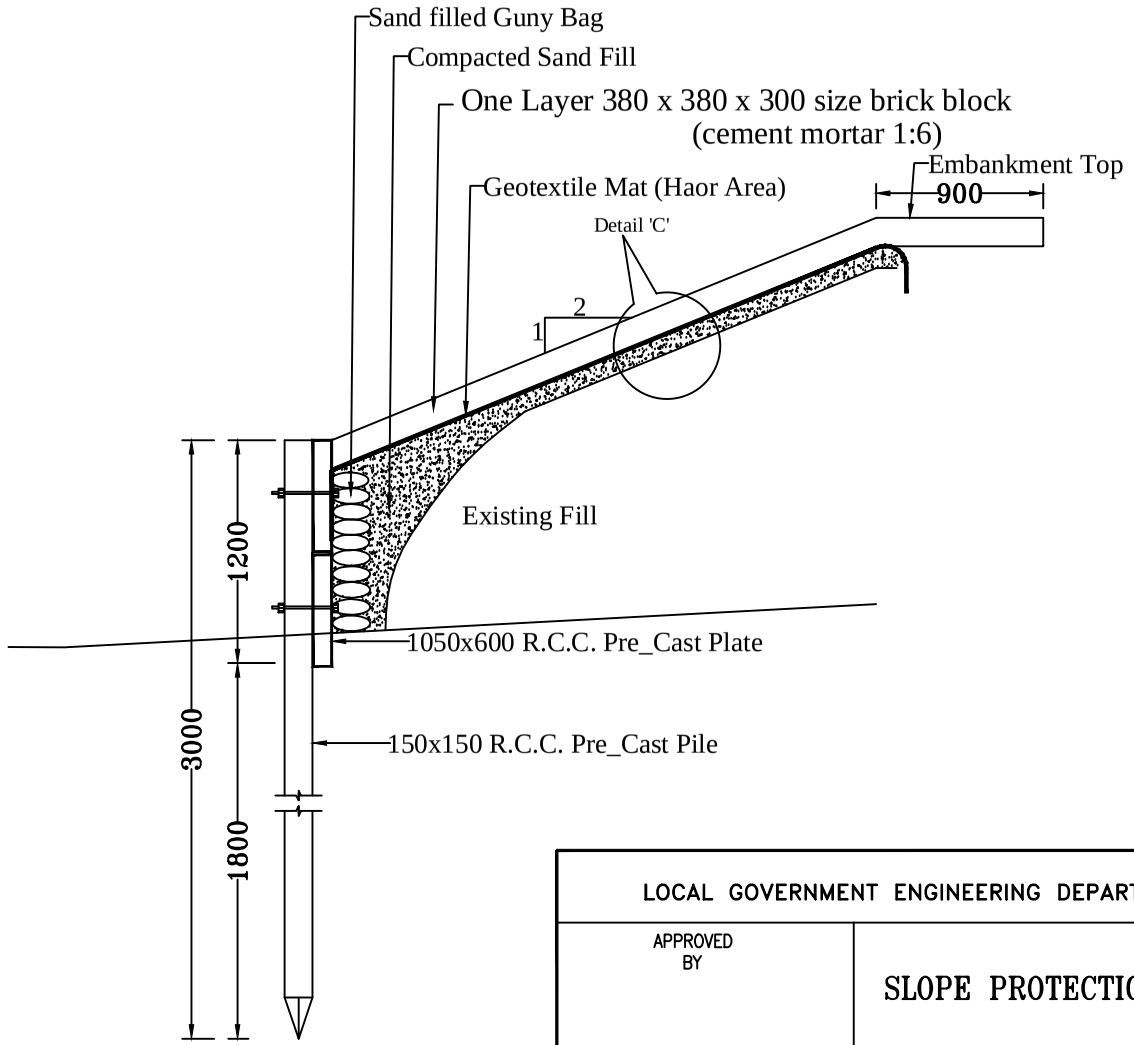
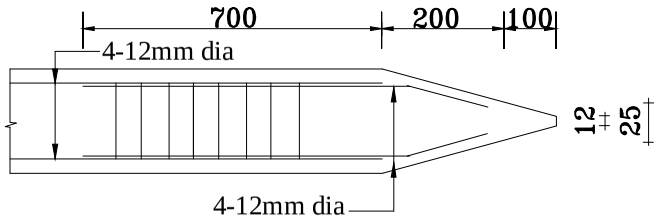


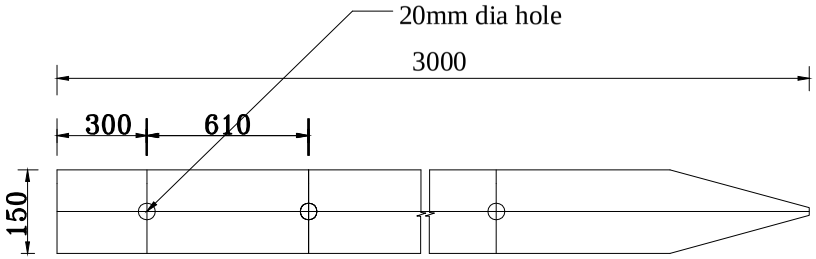
PLATE UPR-UNR-EM1-1-1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SLOPE PROTECTION WORK
	PROCESS: DESIGN UNIT
	DATE:

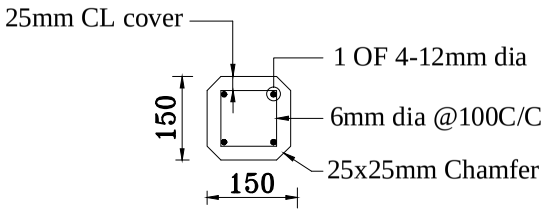
SLOPE PROTECTION WORK
WITH C.C. SLAB ON SLOPE AND PALISADING WORK AT TOE



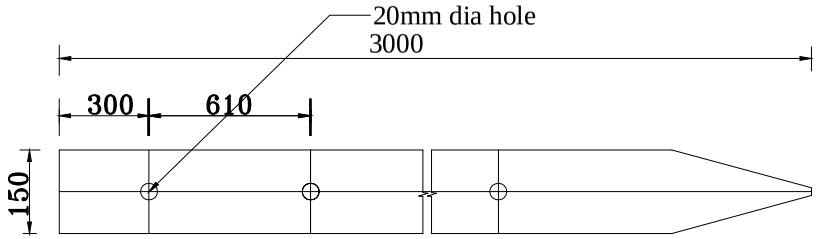
PILE SHOE DETAIL



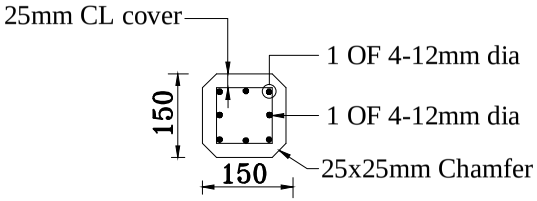
LOCATION OF HOLE
(Under the cap)



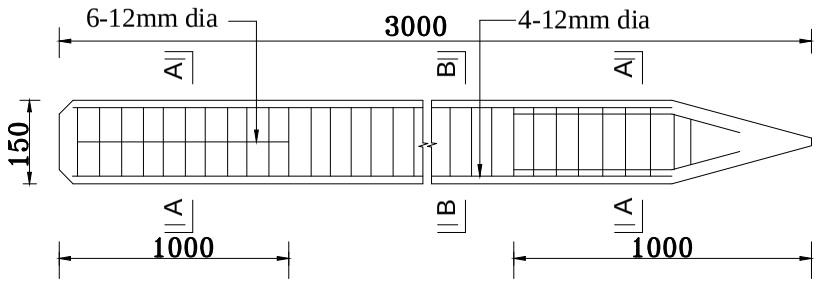
SEC. B–B



LOCATION OF HOLE
(WITHOUT CAP)



SEC. A–A



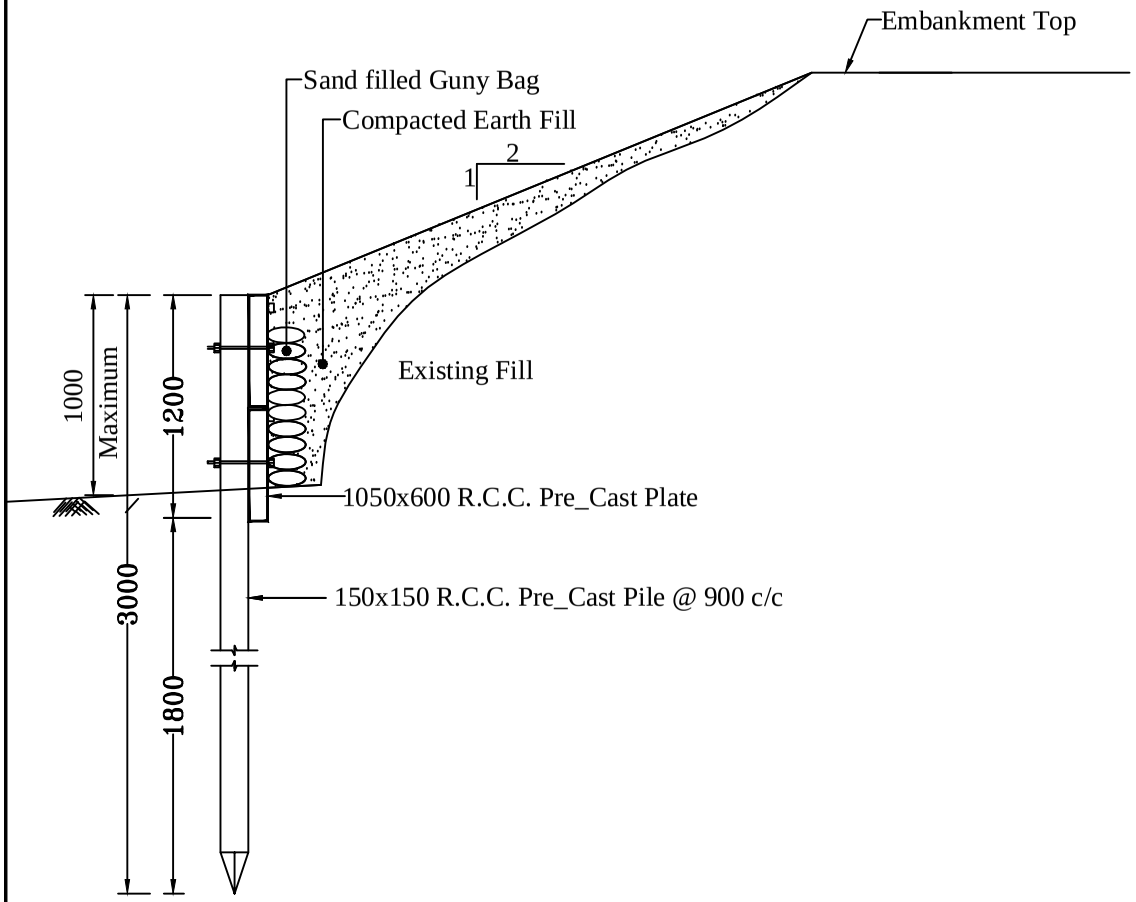
LONG SEC OF PILE

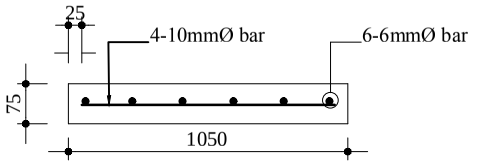
Details OF Pile for 3.00m Length

PLATE UPR-UNR-EM1-1-2

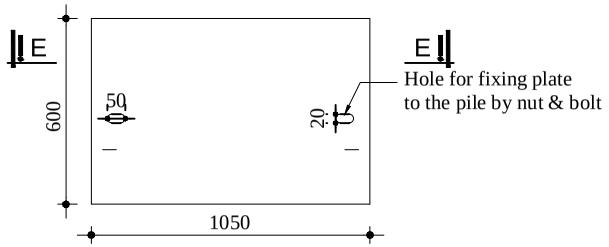
LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SLOPE PROTECTION WORK
	PROCESS: DESIGN UNIT
	DATE:

SLOPE PROTECTION WORK
WITH R.C.C. PALISADING WORK AT TOE

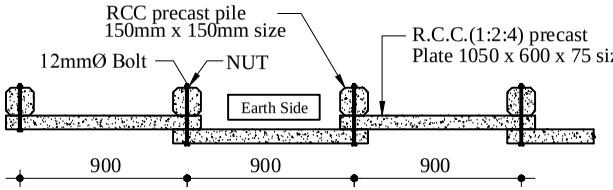




SECTION E-E



PLAN OF PLATE

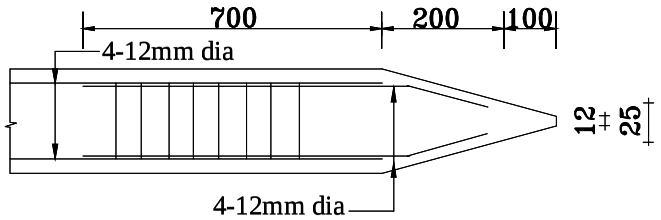


PLAN OF PILE AND PLATE
Showing fixing arrangement.

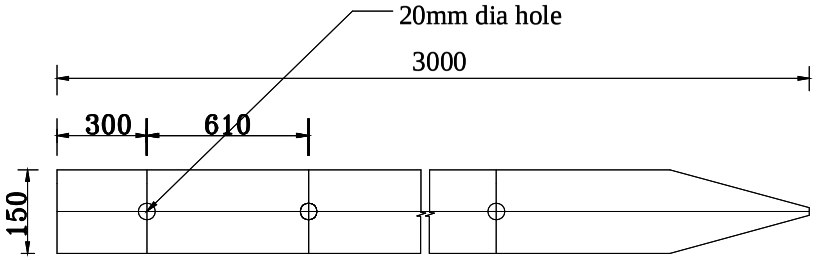
PLATE UPR-UNR-EM1-2-1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SLOPE PROTECTION WORK
	PROCESS: DESIGN UNIT
	DATE:

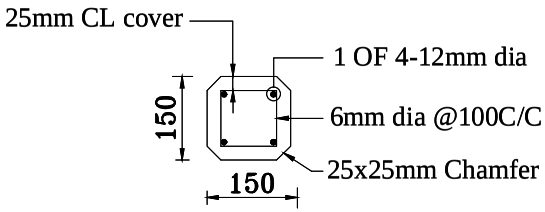
SLOPE PROTECTION WORK
WITH C.C. SLAB ON SLOPE AND PALISADING WORK AT TOE



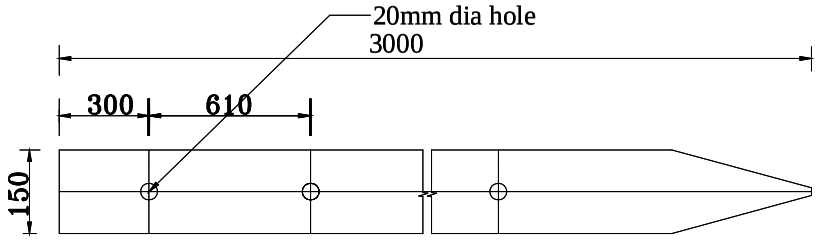
PILE SHOE DETAIL



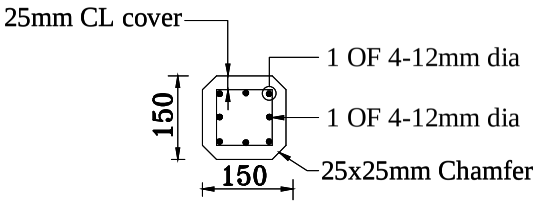
LOCATION OF HOLE
(Under the cap)



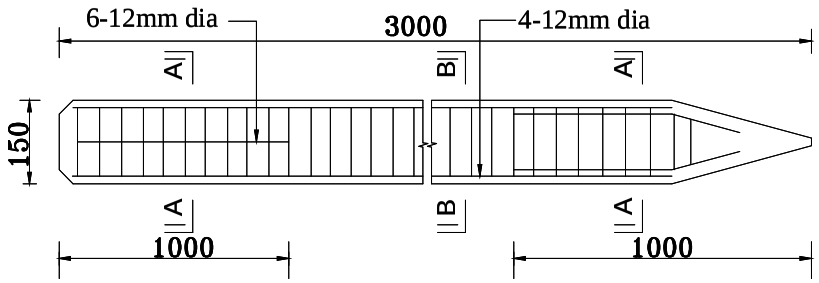
SEC. B-B



LOCATION OF HOLE
(WITHOUT CAP)



SEC. A-A



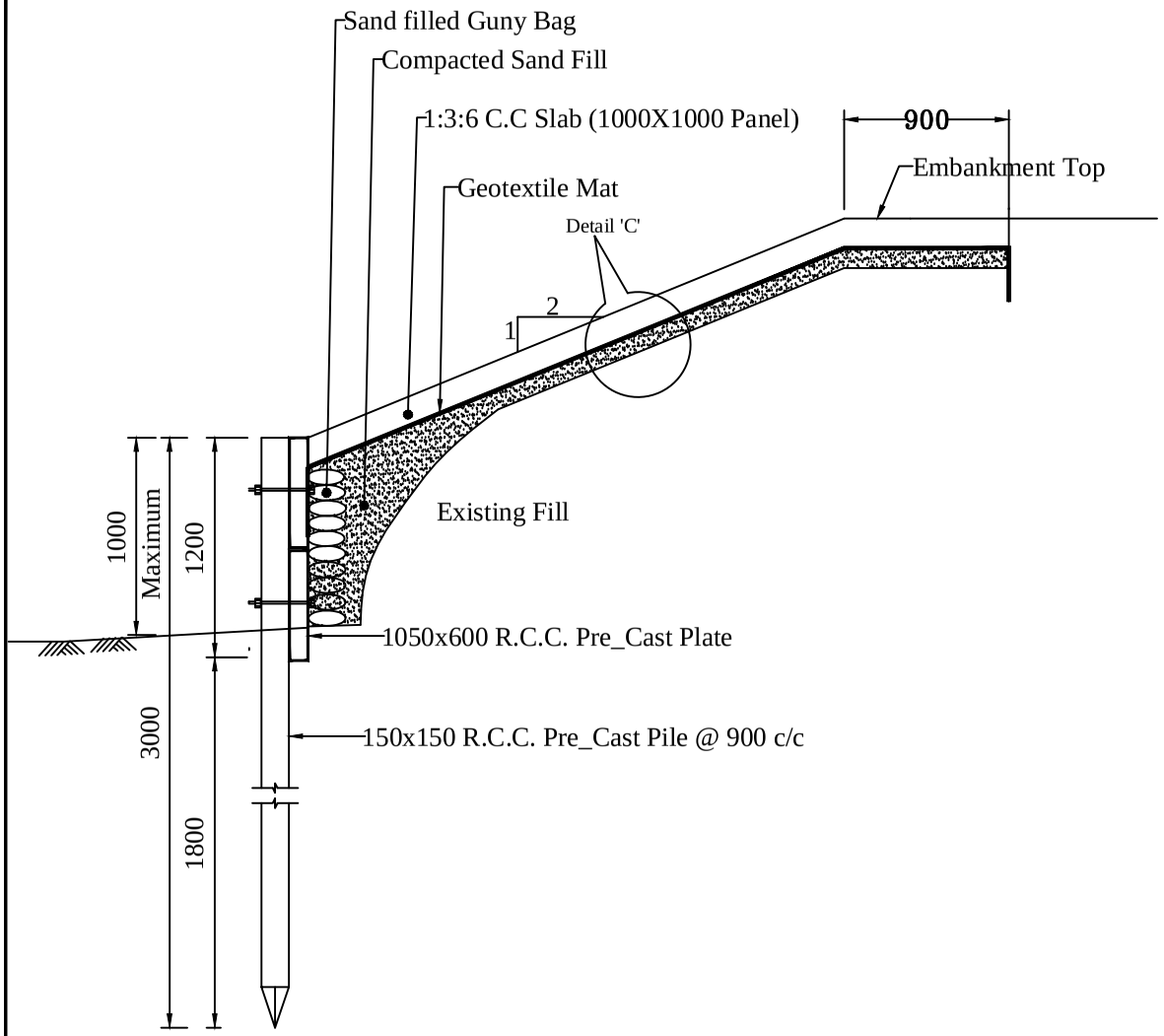
LONG SEC OF PILE

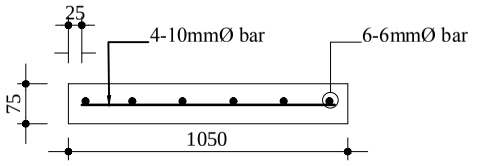
Details OF Pile for 3.00m Length

PLATE UPR-UNR-EM1-2-2

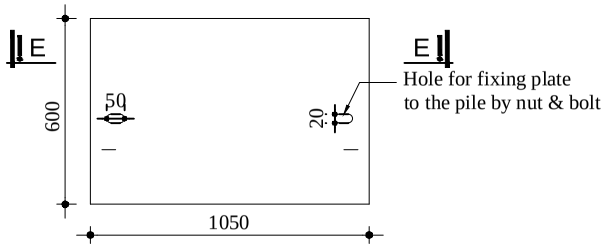
LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SLOPE PROTECTION WORK
	PROCESS: DESIGN UNIT
	DATE:

SLOPE PROTECTION WORK
WITH C.C. SLAB ON SLOPE AND PALISADING WORK AT TOE

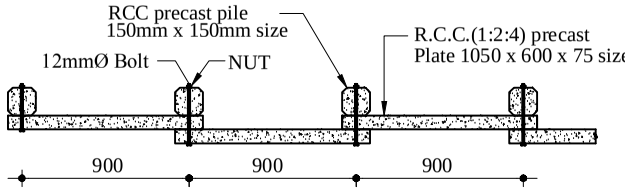




SECTION E-E



PLAN OF PLATE

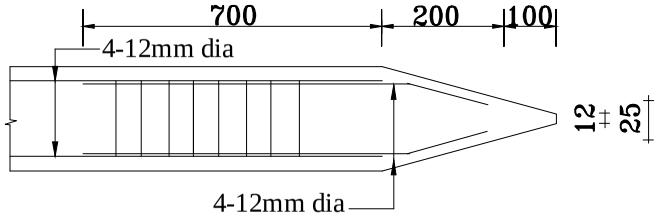


PLAN OF PILE AND PLATE
Showing fixing arrangement.

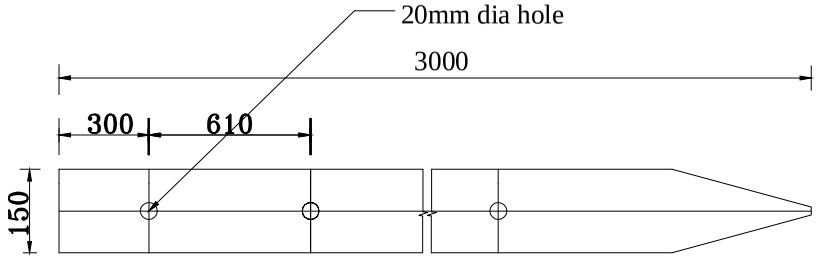
PLATE UPR-UNR-EM1-3-1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SLOPE PROTECTION WORK
	PROCESS: DESIGN UNIT
	DATE:

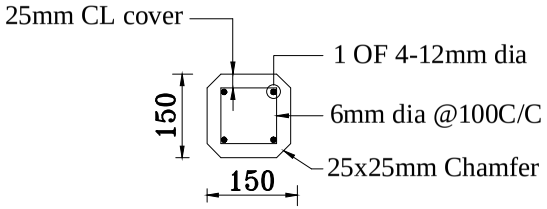
SLOPE PROTECTION WORK
WITH C.C. SLAB ON SLOPE AND PALISADING WORK AT TOE



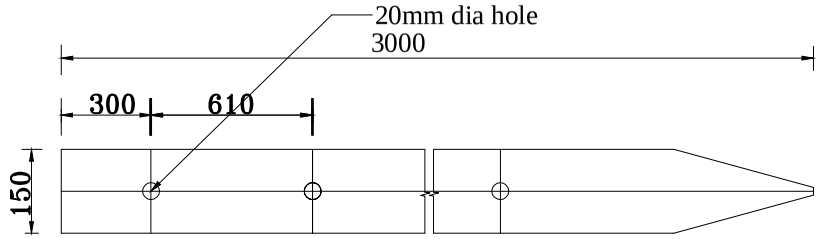
PILE SHOE DETAIL



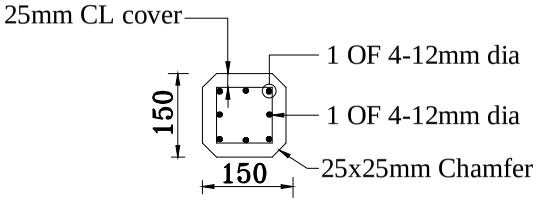
LOCATION OF HOLE
(Under the cap)



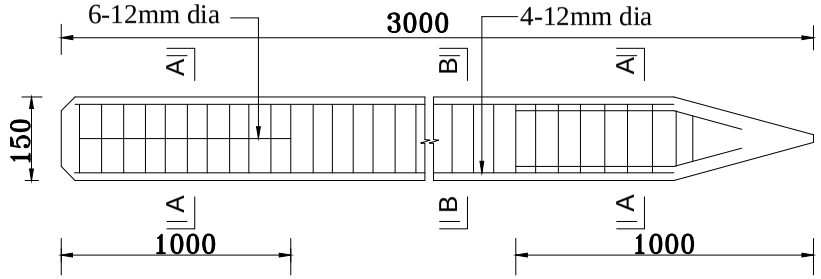
SEC. B–B



LOCATION OF HOLE
(WITHOUT CAP)



SEC. A–A



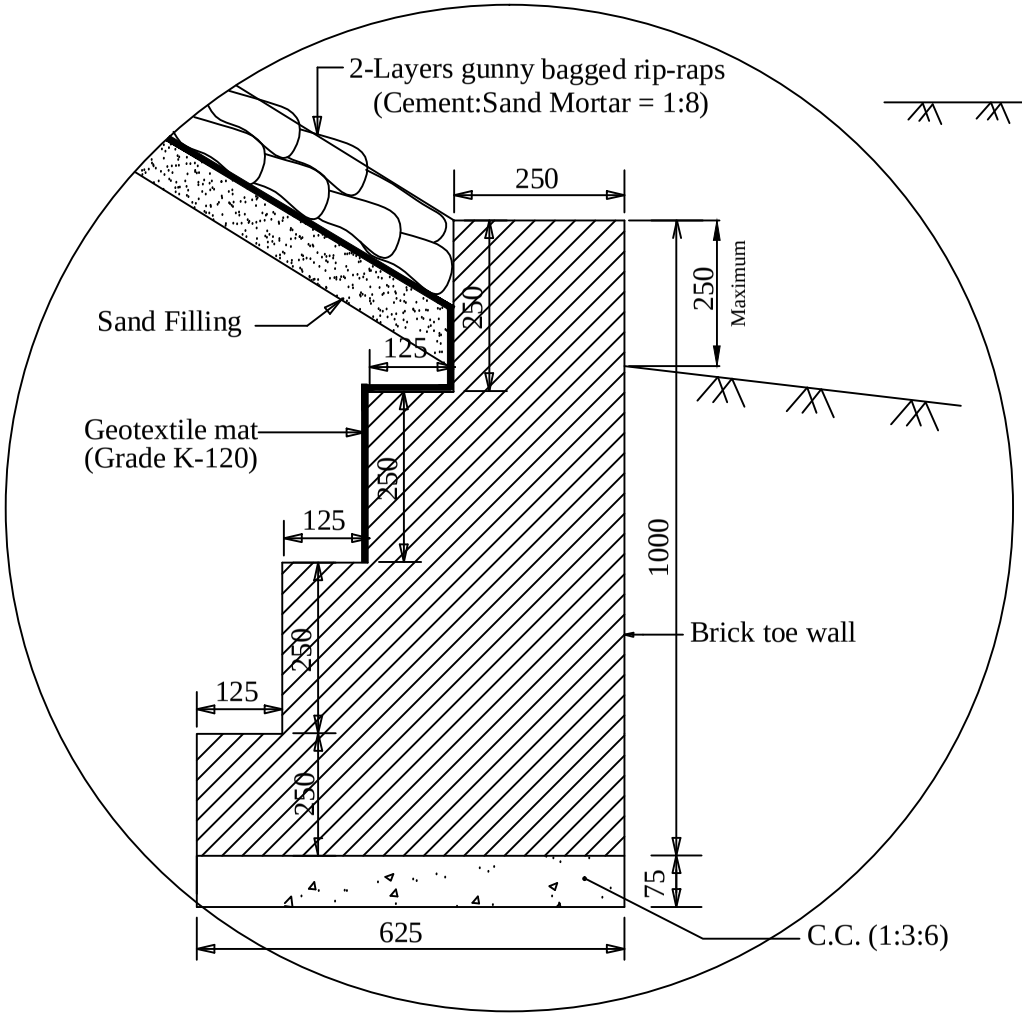
LONG SEC OF PILE

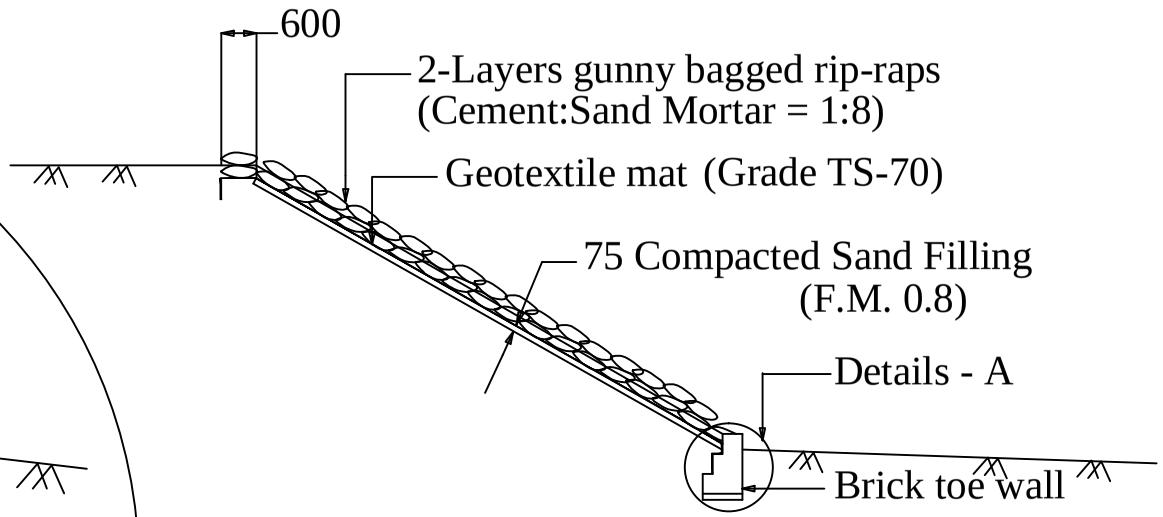
Details OF Pile for 3.00m Length

PLATE UPR-UNR-EM1-3-2

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SLOPE PROTECTION WORK
	PROCESS: DESIGN UNIT
	DATE:

SLOPE PROTECTION WORK
WITH GUNNY BAGGED RIP-RAP AND GEOTEXTILE



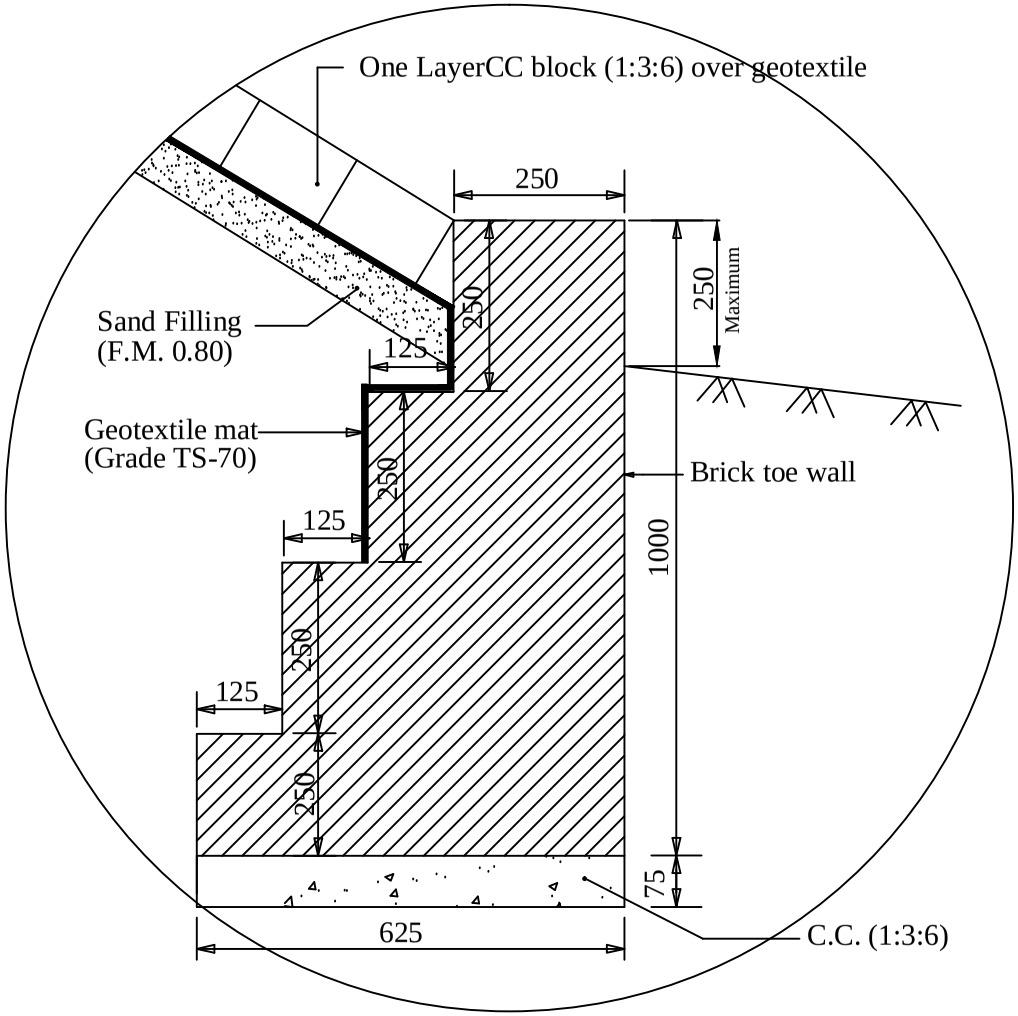


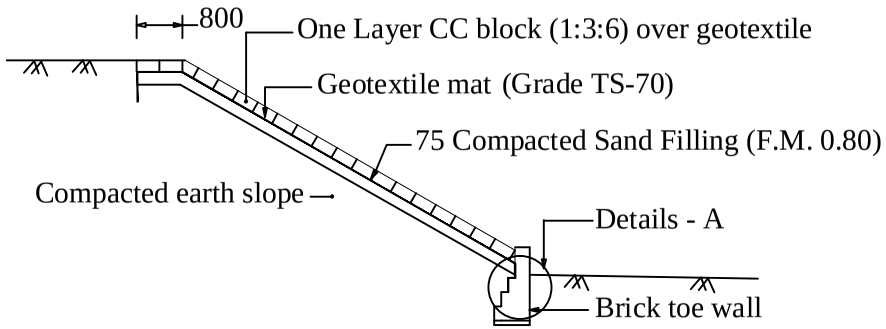
DETAIL-A

PLATE UPR-UNR-EM2-1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SLOPE PROTECTION WORK
	PROCESS: DESIGN UNIT
	DATE:

SLOPE PROTECTION WORK
WITH C.C. BLOCK AND GEOTEXTILE



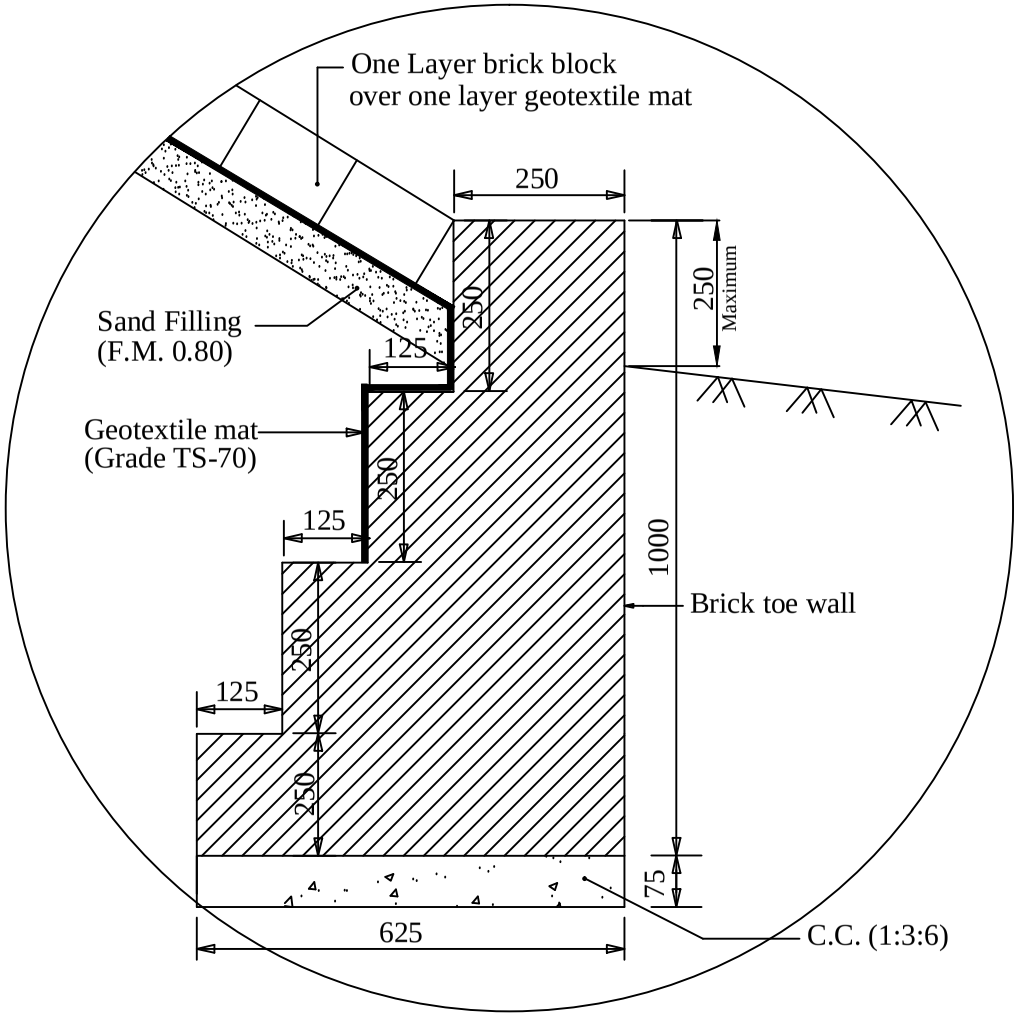


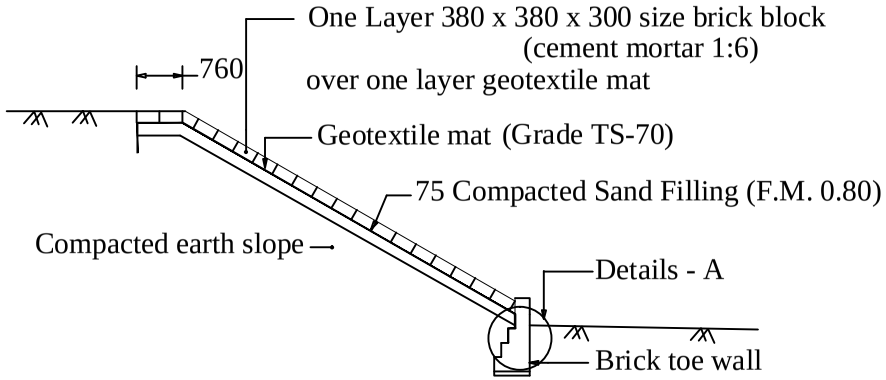
DETAIL-A

PLATE UPR–UNR–EM2–2

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SLOPE PROTECTION WORK	
	PROCESS	DESIGN UNIT
	DATE:	

SLOPE PROTECTION WORK
WITH BRICK BLOCK AND GEOTEXTILE



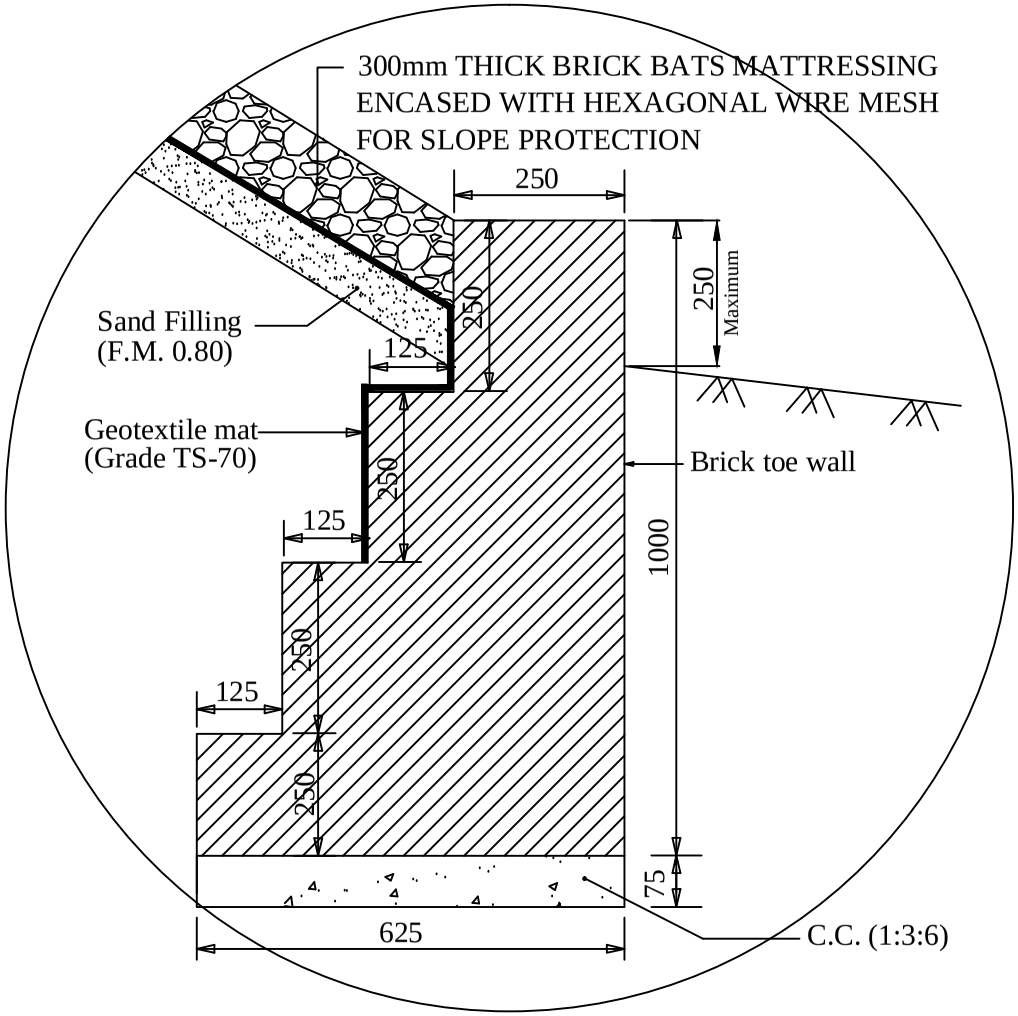


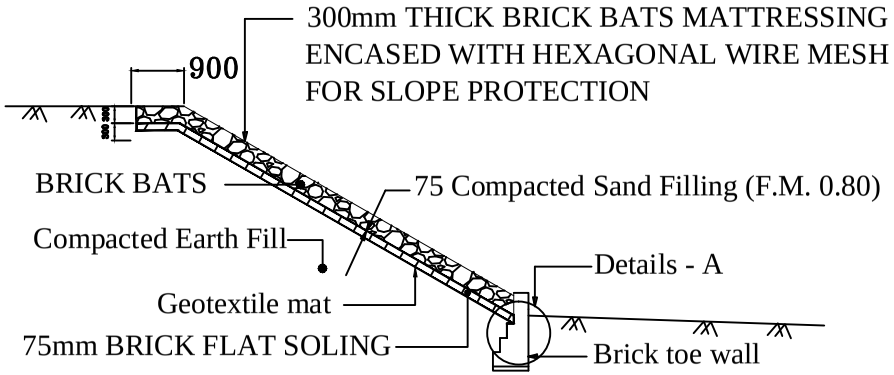
DETAIL-A

PLATE UPR–UNR–EM2–3

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SLOPE PROTECTION WORK
	PROCESS: DESIGN UNIT
	DATE:

SLOPE PROTECTION WORK
WITH BRICK BATS MATTRESSING AND GEOTEXTILE





DETAIL-A

PLATE UPR–UNR–EM2–4

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SLOPE PROTECTION WORK	
	PROCESS	DESIGN UNIT
	DATE:	

SLOPE PROTECTION WORK
WITH GRASS TURFING ON SLOPE

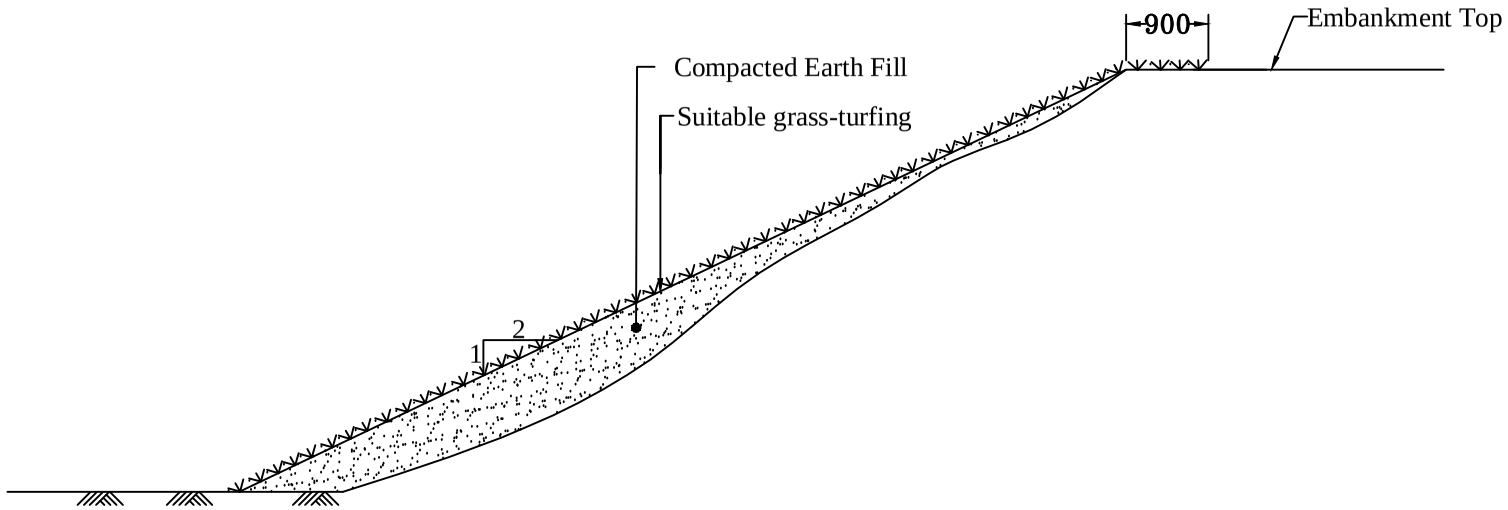


PLATE UPR-UNR-EM3-1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	SLOPE PROTECTION WORK
	PROCESS: DESIGN UNIT
	DATE:

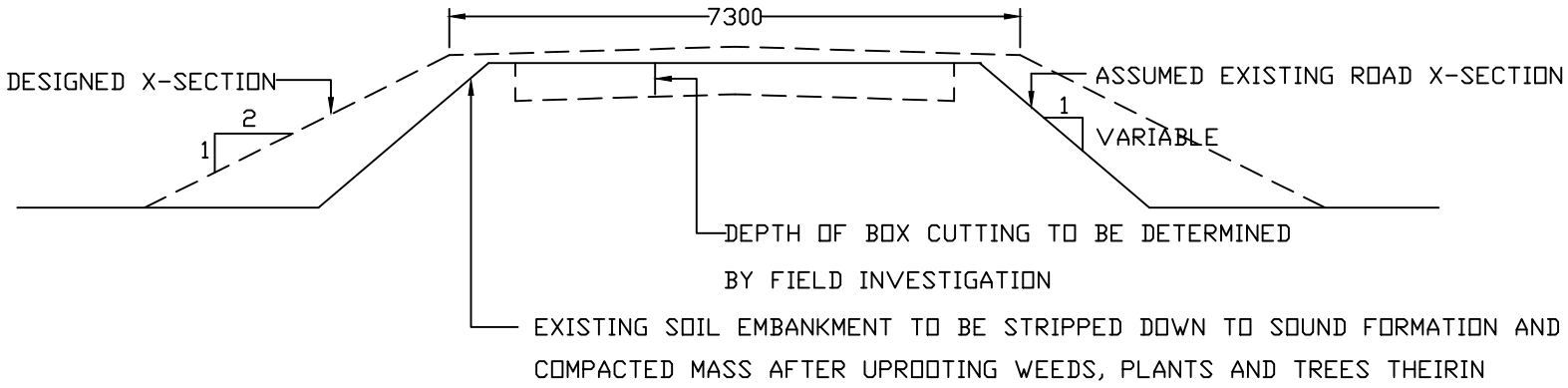
ROAD EMBANKMENT WIDENING

Earth filling work with specified soil in any type of embankment from the toe of embankment including cutting, carrying, filling by throwing earth in layers not more than 150mm in each layer in proper alignment, grade, camber and side slope in all types of soil except rocky, gravelly and slushy including benching not more than 30cm in vertical and 60cm in horizontal steps along the sides while widening any embankment.

THE PLATES

Plate UPR -EW1-1

Plate UNR-EW1-1



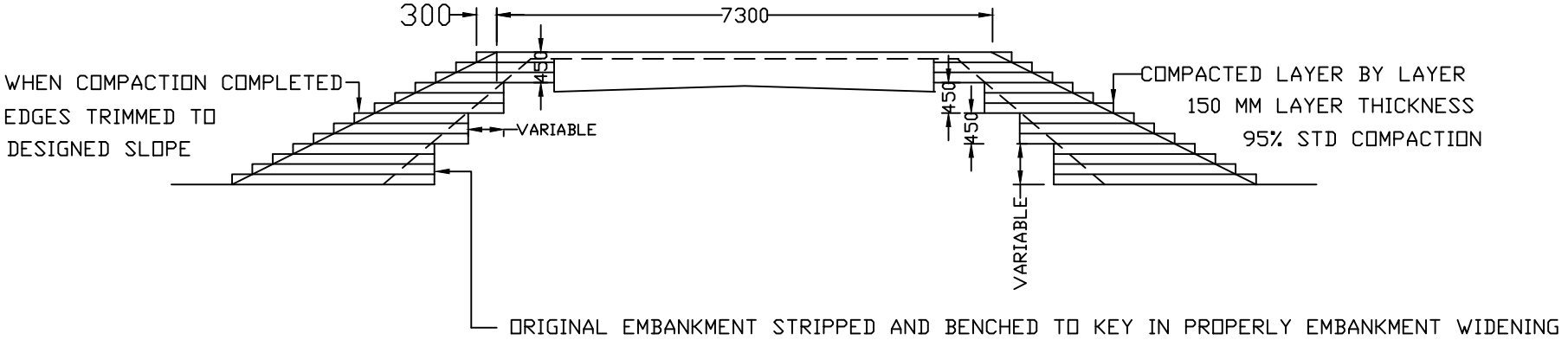
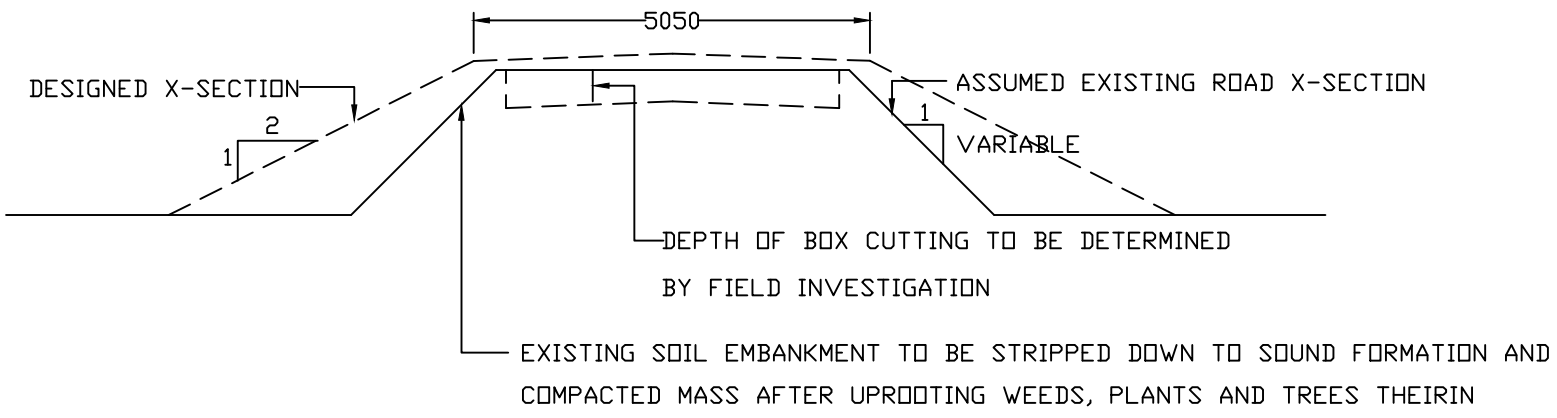
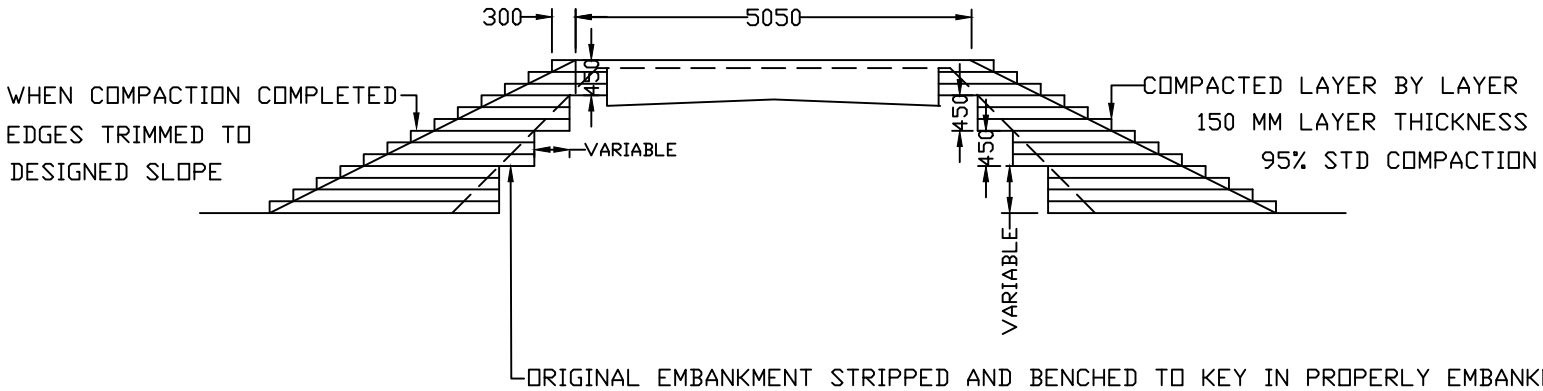


PLATE NO. UPR-EW-WD1

METHOD OF EARTHWORK FOR EMBANKMENT WIDENING

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	EMBANKMENT WIDENING TYPICAL CROSS-SECTION UPAZILA ROAD
	PROCESS: DESIGN UNIT
	DATE:





METHOD OF EARTHWORK FOR EMBANKMENT WIDENING

PLATE NO. UNR-EW-WD1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	EMBANKMENT WIDENING TYPICAL CROSS-SECTION UNION ROAD
	PROCESS: DESIGN UNIT
	DATE:

ROAD SIDE LANDING STEPS/STAIRS

Roadside landing structure is intended to provide protection to embankment damage due to people's walkway towards fields or water bodies.

Plate UPR-UNR-RSL-1
This option may be provided for landing of people or livestock from embankment of road to lands where sufficient embankment slope is available. Riser of steps may be reduced to half and tread enlarged to double for cows and buffaloes.

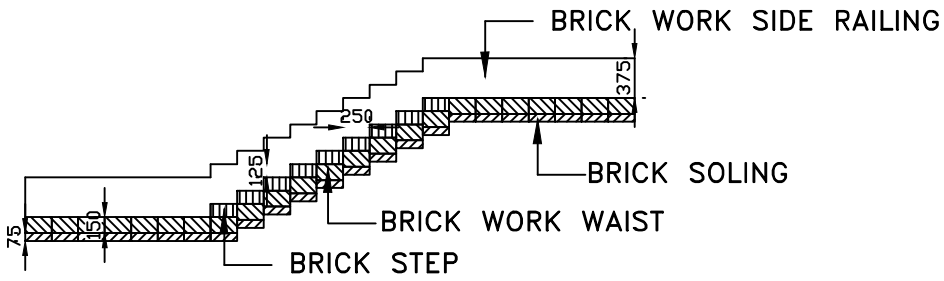
Plate UPR-UNR-RSL-2
This option may be provided for landing of people or livestock from embankment of road to lands or water bodies where sufficient embankment slope is not available. Riser of steps may be reduced to half and tread enlarged to double for cows and buffaloes.

Plate UPR-UNR-RSL-3
This option may be provided for landing of people from embankment of road to water bodies.

THE PLATES

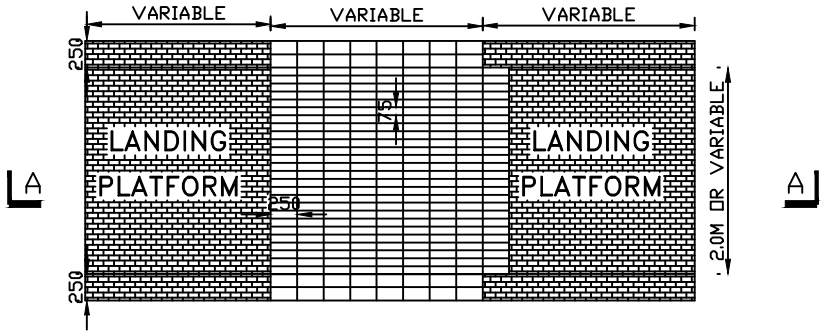
Plate UPR-UNR-RSL-1

Plate UPR-UNR-RSL-2
.
Plate UPR-UNR-RSL-3



SECTION A – A

NOTE: LENGTH OF LANDING PLATFORM AND NUMBER OF STEPS WILL BE CONSTRUCTED CONFORMING NATURE OF SLOPE

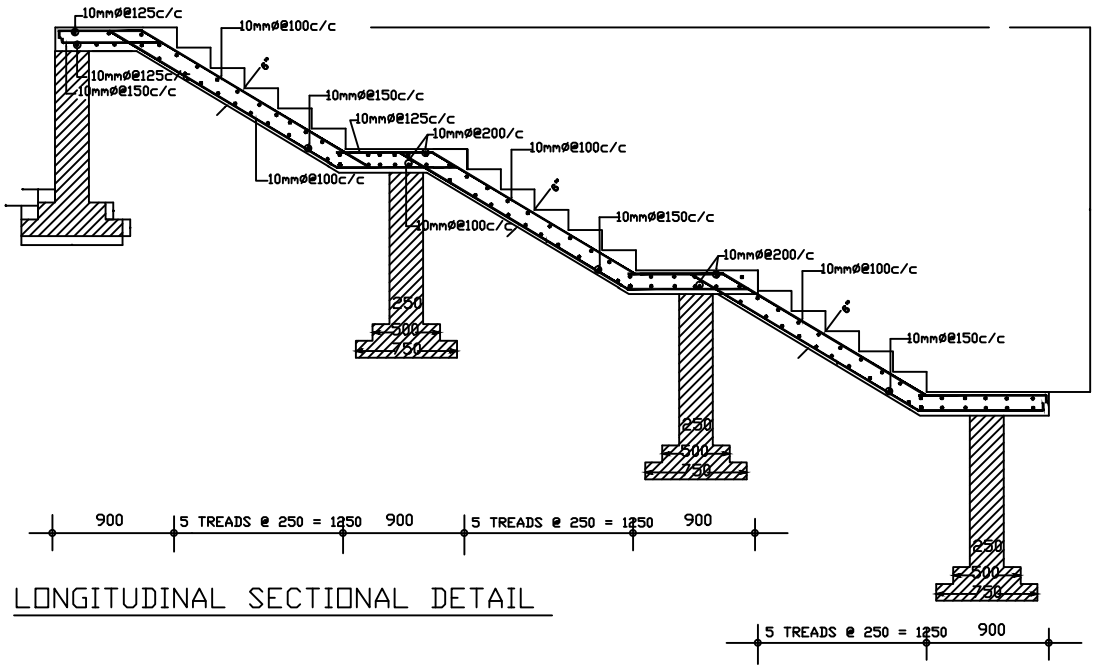


PLAN

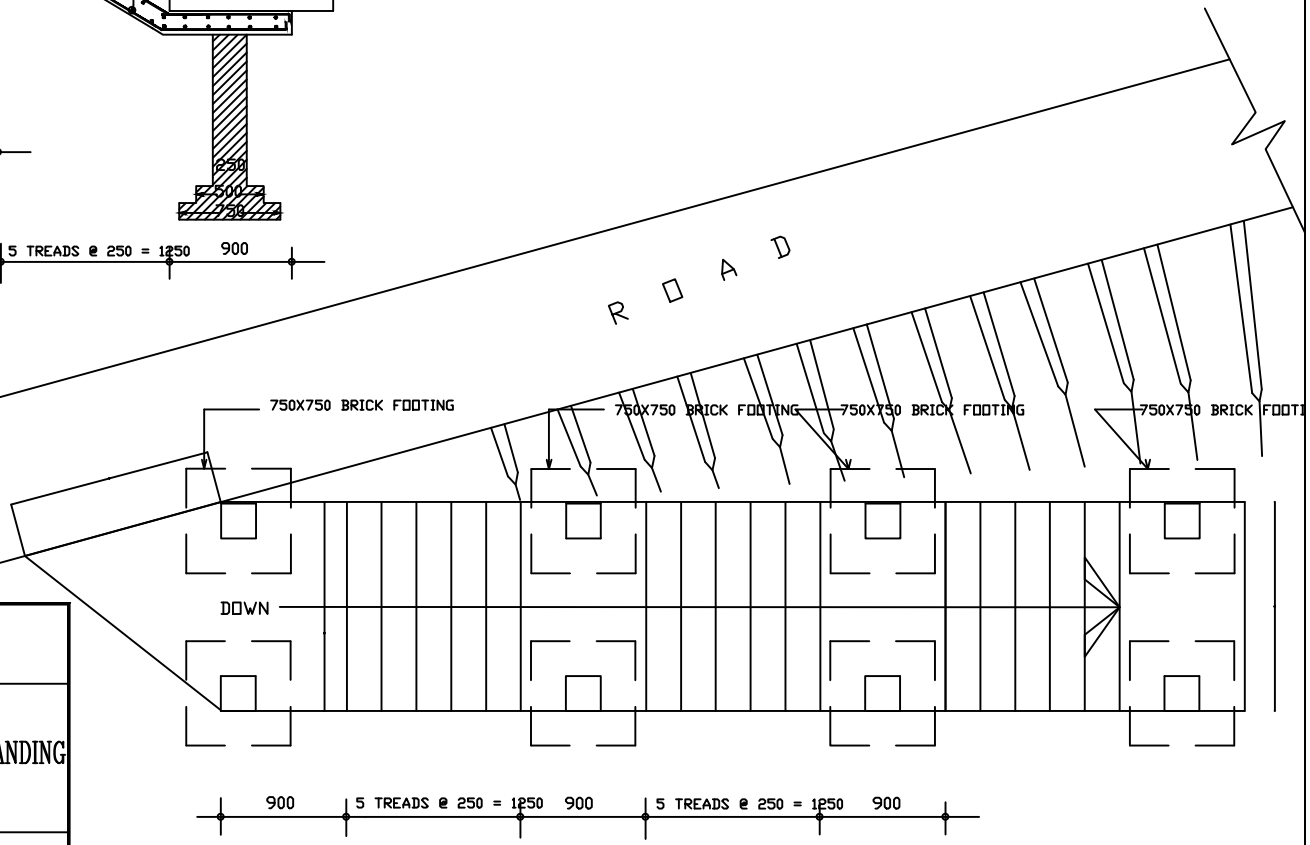
PLATE UPR-UNR-RLS-1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	BRICK MASONRY STEPS FOR ROAD SIDE LANDING
	PROCESS: DESIGN UNIT
	DATE:

PLATE UPR-UNR-RLS-2

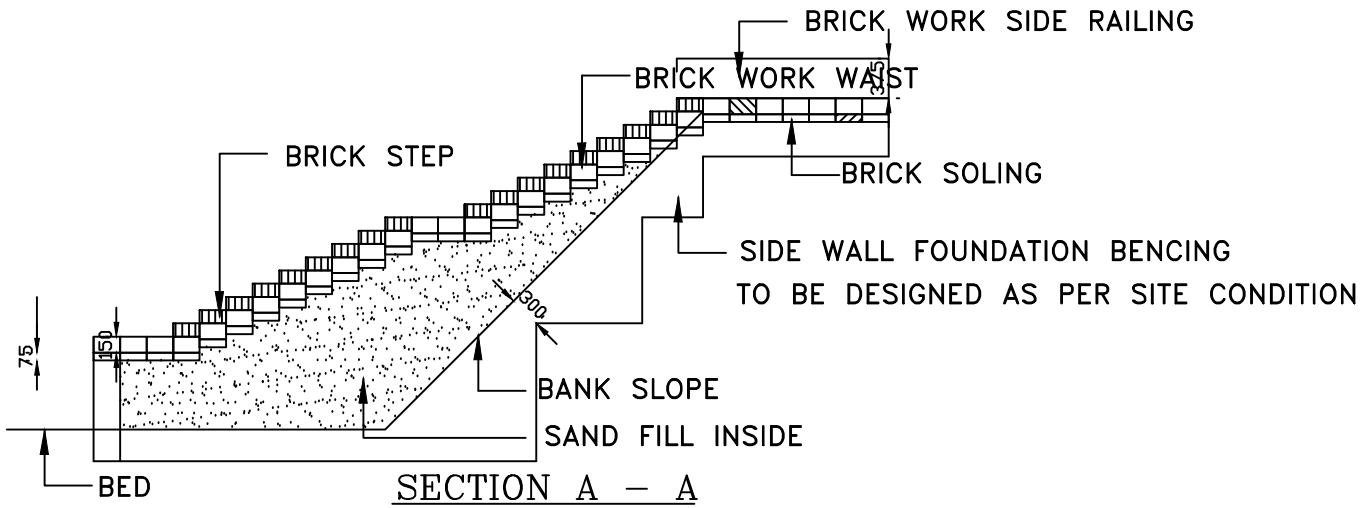


LONGITUDINAL SECTIONAL DETAIL



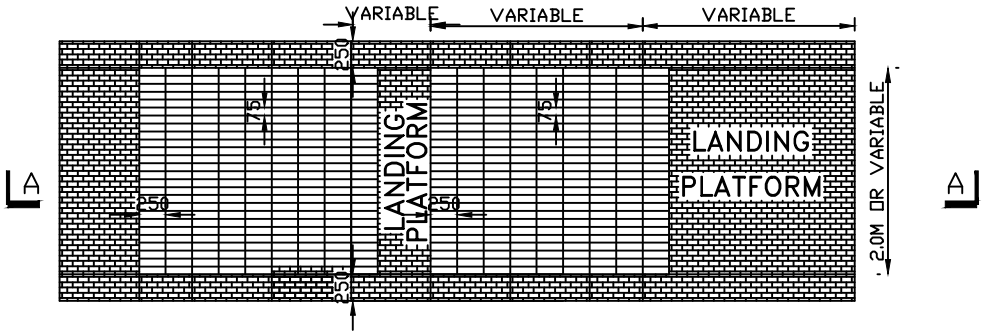
PLAN OF STAIR DOWN IN CONSISTENT WITH EMBANKMENT SLOPE

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	BRICK MASONRY STEPS FOR ROAD SIDE LANDING	
	PROCESS	DESIGN UNIT
	DATE:	



SECTION A – A

NOTE: LENGTH OF LANDING PLATFORM AND NUMBER OF STEPS WILL BE CONSTRUCTED CONFORMING NATURE OF SLOPE



PLAN

PLATE UPR-UNR-RLS-3

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	BRICK MASONRY STEPS FOR ROAD SIDE LANDING
	PROCESS: DESIGN UNIT
	DATE:

ROAD SIDE RUN-OFF DRAINAGE CHUTE

Roadside run-off drainage chute is intended to provide run-off drainage along hillside

Plate UPR-UNR-DC-HL-1

This option is for short way catchments.

Plate UPR-UNR-DC-HL-2

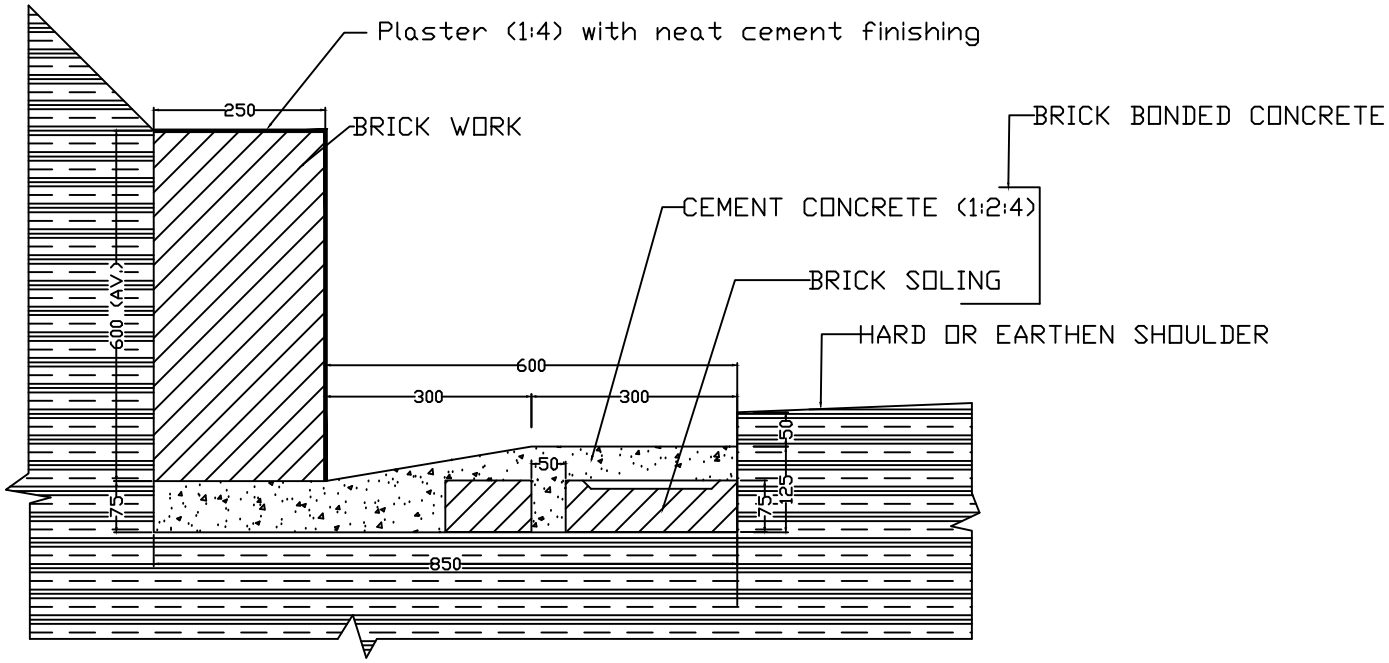
This option is for long way catchments and also for protection to earthen shoulder from rain cut.

THE PLATES

Plate UPR-UNR-DC-HL-1

Plate UPR-UNR-DC-HL-2

ROAD SIDE RUN-OFF DRAINAGE CHUTE



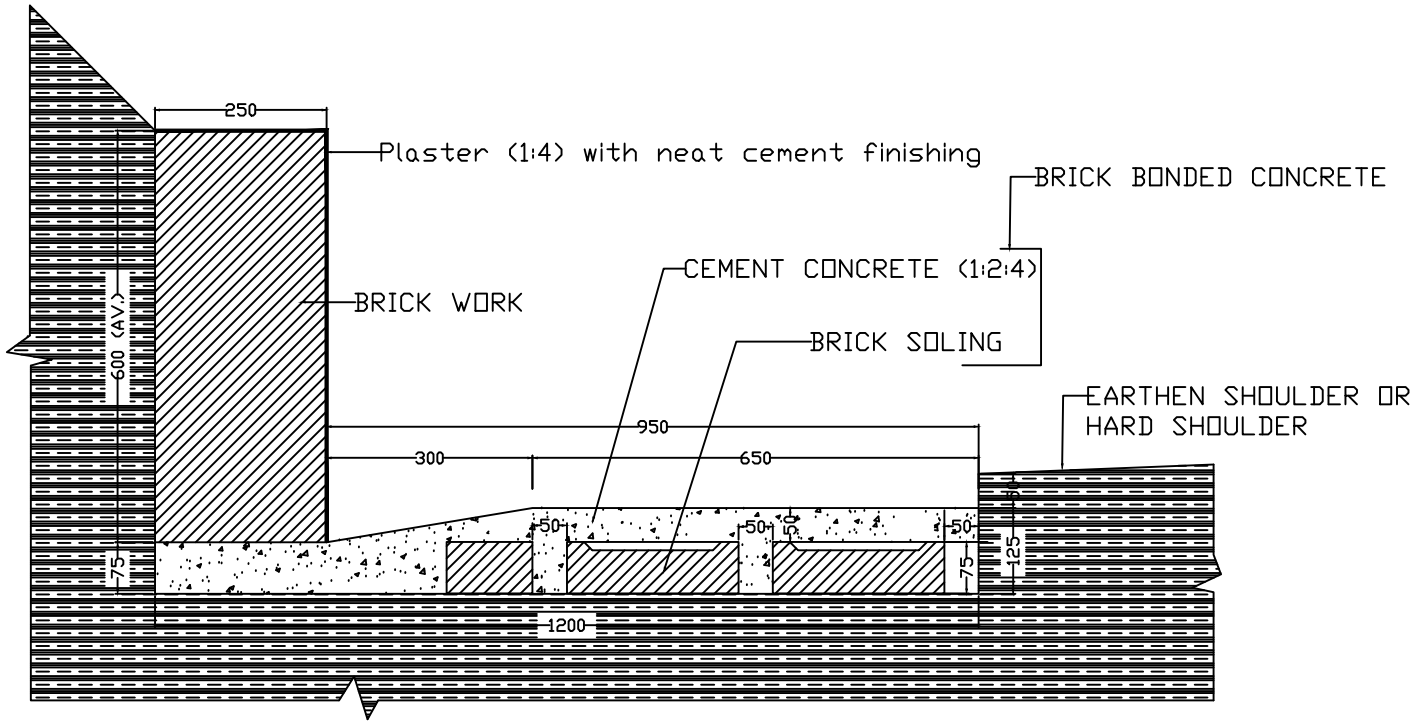
TYPICAL X-SECTION

NOTE: ALL DIMENTIONS ARE IN MILLIMETER

PLATE NO. UPR-UNR-DC-HL-1

LOCAL GOVERNMENT ENGINEERING DEPARTMENT	
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA-UNION ROAD ROAD SIDE RUN-OFF DRAINAGE CHUTE SECTION STANDARD OPTION TO SHOULDER AT HILL SIDE
PROCESS	DESIGN UNIT
DATE:	

ROAD SIDE RUN-OFF DRAINAGE CHUTE



TYPICAL X-SECTION

PLATE NO. UPR-UNR-DC-HL-2

NOTE: ALL DIMENTIONS ARE IN MILLIMETER

LOCAL GOVERNMENT ENGINEERING DEPARTMENT		
APPROVED BY MD. SHAHIDUL HASSAN CHIEF ENGINEER	UPAZILA-UNION ROAD ROAD SIDE RUN-OFF DRAINAGE CHUTE SECTION STANDARD OPTION TO SHOULDER AT HILL SIDE	
	PROCESS	DESIGN UNIT
	DATE:	

COMMITTEE FOR PREPARATION OF STANDARD SPECIFICATION

1. Mr. Md. Wahidur Rahman , Superintending Engineer (Administration) Convenor.
2. Mr. S. M. Zakaria, Superintending Engineer (Design) Member
3. Mr. Rubaiyet Nurul Hassan, Consultant, Member.
4. Mr. Md. Haider Ali , PD, LBC Project Member.
5. Mr. Md. Abdus Shaheed, PD, RDP-25 Member.
6. Mr. Md. Azizul Hoque, PD, RDP-26 Member.
7. Mr. Md. Mokshed Alam, Sr. Design Consultant Member.
8. Mr. A.B.M. Nazrul Islam, Sr. Design Specialist Member.
9. Mr. Md. Joynal Abedin, (Addl. Charge), Priority Project Member
10. Mr. Md. Azizul Hoque, Executive Engineer, (Admin.) Member.
11. Mr. Amir Azam, Executive Engineer, (Maintenance) Member.
12. Mr. Md. Abul Bashar, Executive Engineer, (Quality Control) Member.
13. Mr. Md. Mizanur Rahman, Design Consultant Member.
14. Mr. Md. Mafizul Islam, Sr. Structural Engineer, RDP-25 Member
15. Mr. Noriyasu Nishino, Expert on Design, RDEC, Setting up Project, LGED