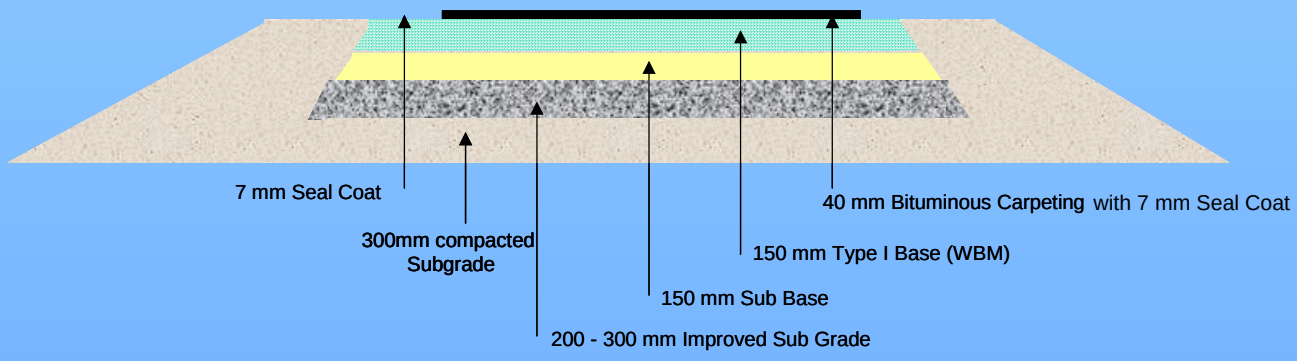
Government of the People's Republic of Bangladesh

Planning Commission

ROAD DESIGN STANDARDS

Standard Designs and Costing for Zila, Upazila and Union Roads, Bridges and Culverts



May, 2004

Preface

The paved road network in Bangladesh has increased dramatically from 600 km in 1947, to 3,600 km at independence in 1971, to a current figure of 41,000 km. The development of this infrastructure was necessary to underpin economic growth, business opportunities, increased agricultural production and international trade. The basic road infrastructure now needs investment in repair and rehabilitation as well as widening and strengthening to take account of increased levels of traffic.

To this end the Government has adopted standards for a range of road classes, in order to ensure that investment in roads matches the traffic demands that will be placed on them and to make sure that government resources are used wisely. To support each of the design standards unit costs have been proposed to guide road agencies in the preparation of bids for expenditure. The Planning Commission will use these cost estimates to ensure that roads are being constructed and rehabilitated in the most efficient way, and we expect to see an improvement in value for money in the road sector in the future.

The overriding objective of the Government is equitable economic growth leading to poverty reduction in the country. Better use of resources is part of the strategy for reaching this goal. In parallel the Government will also try to ensure that expenditure on roads is also directed towards achieving these objectives.

S.Y. Khan Mojlish
Member (Infrastructure)
Planning Commission

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1.0 Introduction

1.1 For the country's economic and social development and for poverty alleviation, development of the road network is essential. For this reason the transport sector has been accepted as a priority sector. With the development of the economy the volume of vehicles, passengers and goods has been increasing. In the meantime a notification regarding classification, definition and responsible organizations for all roads was issued. In this context standardization and cost rationalization of the roads in the country, especially the Zila, Upazila, Union and Village roads, have become very essential. For the development of Multimodal Transportation System (Road-Rail-River) such a standardization/cost rationalization of roads and bridges/culverts is a need of the hour. Standardization including cost rationalization will provide the basis of appraisal of road/bridge projects leading to optimal development of the transport system as a whole. At present there is no standard design and national unit cost for construction and maintenance of various roads and bridges and culverts. As a result substantial cost difference has been proposed by the agencies for same type of road/bridges for the same area.

1.2 In order to undertake the above tasks, a committee was set up in November 2003 with the members as listed in Appendix B to fix/refix the standards of Zila, Upazila, Union and Village roads and work out their cost rationalization. The Terms of Reference for the Committee are set out in Appendix A.

2.0 Activities of the Committee

2.1 The Committee set up a technical sub-committee to address the detailed engineering and cost issues necessary for the preparation of this report. The sub-committee members are listed in Appendix C. This sub-committee met on a number of occasions, and each time it reviewed and improved previous drafts of this report. The sub-committee provided the important technical content for this report, and this paper represents the results of agreements reached at the last sub-committee meeting of 24 December 2003.

2.2 The contents of this report were agreed by a meeting of the main committee, held on 7 January 2004 in the Planning Commission.

3.0 Summary of Issues Covered

3.1 The Committee reviewed the design standards for the Union, Upazila, Zila Roads, and concluded that the key design criteria for all roads should be traffic and axle loads, and not the classification of the roads.

3.2 The six design standards agreed by the Committee to form a logical progression in terms of road width and pavement thickness, all based on traffic considerations. They are not directly related to road classification.

3.3 The agreed design standards are to be used by all road agencies. Road agencies will be required to use appropriate standards for roads according to the traffic criteria.

4.0 Definition

Following definitions of road projects have been adopted :

4.1 **Reconstruction** – full pavement reconstruction on an existing embankment

4.2 **New road Construction** – completely new embankment and road pavement, including bridges, culverts and any necessary slope protection. This is likely to prove a rare category of road project in Bangladesh

4.3 **Widening** – road widening and upgrading, including full re-construction of the existing pavement

4.4 **Strengthening -** removing existing road surfacing and providing a new base layer of Base Type-1 and surfacing

5.0 Principle of Design Standards

5.1 Existing design standards relate the width of the road (geometric design) and the thickness of the various layers (pavement) to the classification of the road. Hence LGED and RHD have different design standards, because they are responsible for different classes of road. Most countries relate their design standards to traffic levels on roads. This is because the amount of traffic affects :

- The required width of the road, so that traffic may pass safely and efficiently; and
- The ultimate life of the pavement.

5.2 It is recommended that, in future, design standards for all roads and highways in Bangladesh will be on the basis of traffic demand. Design standards are intended to reflect the travel and safety needs of all road users, not just motorized vehicles. The recommended standards should be used for all Government of Bangladesh and foreign-aided projects.

6.0 Geometric design

6.1 Geometric design standards were adopted in 1984. In 1996, some changes to the classification of roads were made based on World Bank recommendations. Existing geometric standards are set out in Table 1.

Table 1 : Existing Geometric Standards

Road Class	Carriageway (m) / (ft)	Hard shoulder (m) / (ft)	Verge (m) / (ft)	Crest Width (m) / (ft)
Rural Road 1	3.0 / 10	0.0 / 0	0.9 / 3	4.8 / 16
Feeder Road B	3.7 / 12	0.0 / 0	1.8 / 6	7.3 / 24
Feeder Road A	3.7 / 12	0.0 / 0	1.83/ 6	7.3 / 24
Regional	5.5 / 18	0.0 / 0	2.74 / 9	10.98 / 36

6.2 In December 2003 a further re-classification and assignation of responsibilities for roads was made by the Planning Commission. 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 geometric and pavement design standards which are in line with present conditions. It is recommended that there should be 6 basic geometric design types for Zila, Upazila, and Union Roads all based on traffic criteria. Design types 5 - 8 should be based primarily on forecasts/Survey of commercial vehicles. Design types 3 and 4 should be based primarily on forecasts of peak hour passenger car units (pcu's). Passenger car units 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
Autorickshaw	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

6.3 Traffic criteria for each design type is shown in Table 3. Recommended geometric design for each type of road are summarized in Table 4. Standards for roads having traffic volume exceeding 800 pcu at peak hours will be addressed in a further report on case by case basis.

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**
3	**800**	

Note : *For Types 5, 6, 7and 8 the criterion should be daily commercial vehicles. For Types 3 and 4 the criterion should be peak hour pcu's. Figures in brackets are estimates for low-volume roads.*

Table 4 : Recommended 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
3	5.5 / 18	1.2 / 4	0.95 / 3	9.8 / 32

Note : *Design types 1 and 2 are reserved for National Highways. Design types above type 8 shall be used for Village Roads*

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

6.4 The traffic criteria listed in Table 3 is effective maximum numbers of vehicles that the recommended design types in Table 4 can accommodate. Traffic forecasts should be prepared for both commercial vehicles or pcu's to a design horizon of 10 years. These should be measured against the figures in Table 3 to determine the appropriate design type. Where traffic levels exceed the corresponding figures for the design type, then congestion will result, along with damage to the embankment due to excessive numbers of motorized vehicles being forced off the main carriageway.

6.5 The introduction of 6 design types (instead) of the previous four, allows flexibility in design, and provides for a more gradual change through geometric road widths, increasing in line with traffic.

6.6 Design type 8 provides for the same carriageway width as the existing Rural Road 1, but with a widened verge where as Design Type 7 provides widened carriage way of 12'-0" width. This allows for a greater margin of safety for both pedestrians and vehicles.

6.7 Design type 6 has the same geometry as the existing Feeder Roads A and B. It is the minimum requirement when traffic reaches 100-200 commercial vehicles per day.

6.8 Design types - 6, 7, and 8, a widened paved carriageway up to 5.5m width with proper super-elevation should be provided at all turning point on curves, to reduce the chances of accidents. For immediate action, all the existing curve points on narrower roads with carriageway width up to 12'-0" should be widened to 18'-0" 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.

6.9 Design types 5 has same carriageway width as design type 6, but with a hard shoulder (0.9m) and reduced verge. This means that, as traffic volumes increase, the road can accommodate vehicles that pass each other on the pavement, not in the soft verge. It also provides a margin in safety for rickshaws. Besides, at the turning points full 5.5m carriageway with proper super elevation should be paved to pass both way traffic.

6.10 Design type 4 is to be used when traffic is 300 - 600 commercial vehicle per day equivalent to pcu 290-530. The widened (18ft) carriageway allows a better distribution on the pavement for this high level of traffic, increasing the design life of the pavement. Design type 4 is recommended 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.

6.11 Design type 3 has the same carriageway width as the existing Regional Road, but with a hard shoulder (1.2m) and reduced verge. However, Design type 4 has the wider soft verge width, and is safe and appropriate for traffic levels up to a maximum of 530 passenger car units per hour. With higher traffic levels it is necessary to introduce a hard shoulder so that the embankment is protected from rearside wheels coming off the carriageway (Design type 3).

6.12 In future, when traffic levels rise above 800 passenger car units per hour, it will be necessary to use higher design type, which has more wide carriageway, allowing for passing vehicles to always remain on the carriageway, which should be designed following further traffic study on a specific road alignment.

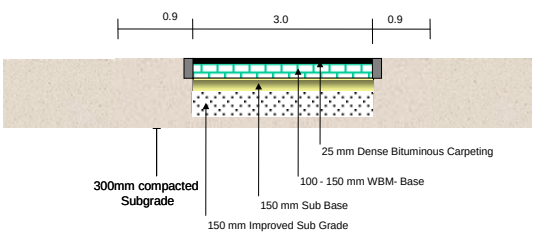
6.13 Where land needs to be acquired to meet the geometric design standards, cost estimates should be provided.

7.0 Pavement Designs

7.1 Existing and recommended pavement designs are shown in Figures 1 to 3. Design types 3 and 4 show a sand layer (Sand Sub-base) for drainage which should be included if the freeboard is greater than 1m (3.3 feet). Details on construction materials and terminology are given in Appendix D.

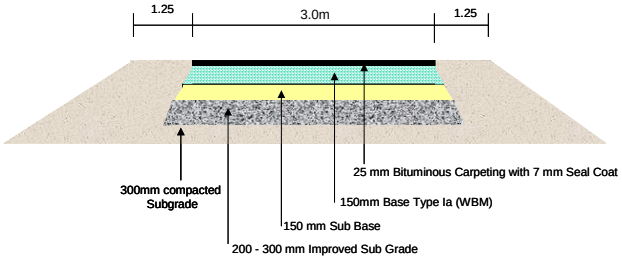
Figure 1 : Existing Pavement Design for Rural Road 1, and Recommended Pavement Designs for Union Roads

Existing

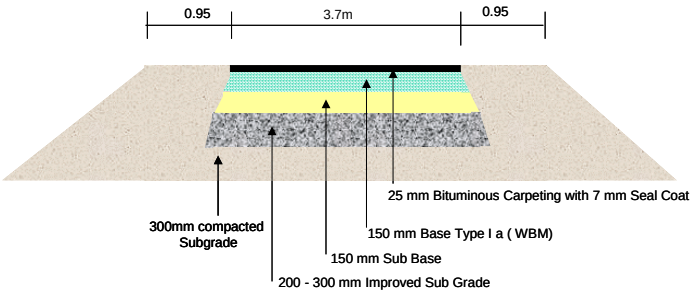


Rural Road 1

Recommended



Design Type 8

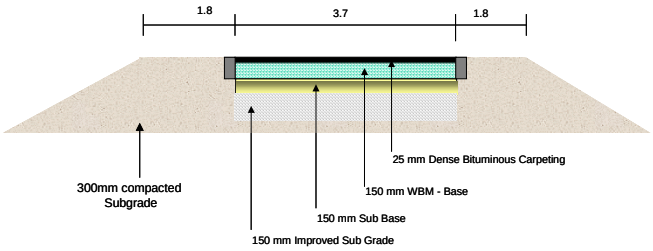


Design Type 7

Rural Road defined in 1996, Union Road defined in 2003

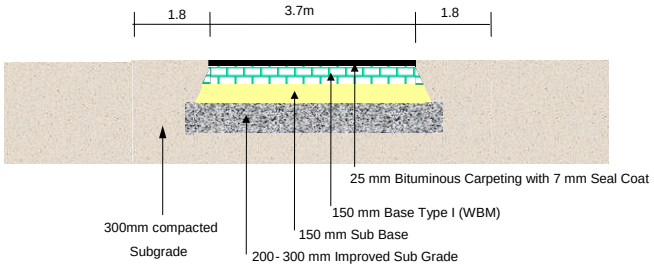
Figure 2 : Existing Pavement Design for Feeder Road B, and Recommended Pavement Designs for Upazila Roads

Existing

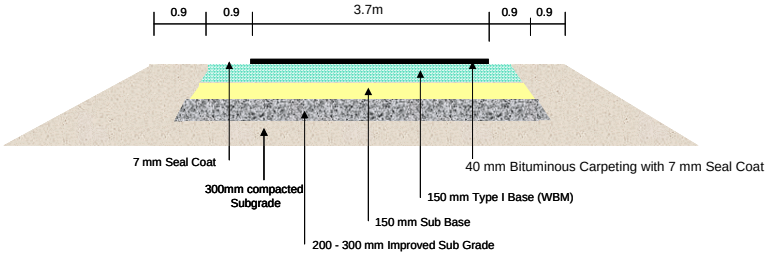


Feeder Road B

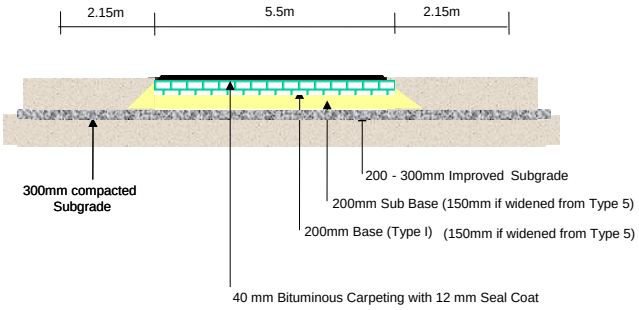
Recommended



Design Type 6



Design Type 5

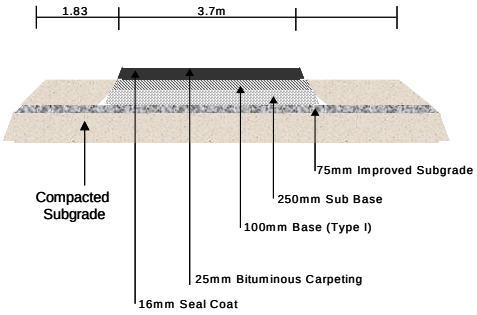


Design Type 4

Feeder Road B defined in 1996, Upazila Road defined in 2003

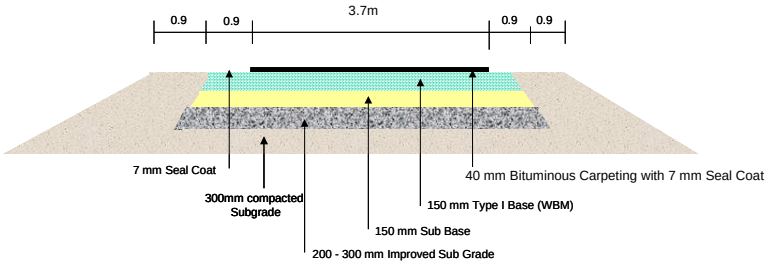
Figure 3 : Existing Pavement Design for Feeder Road A, and Recommended Pavement Designs for Zila Roads

Existing

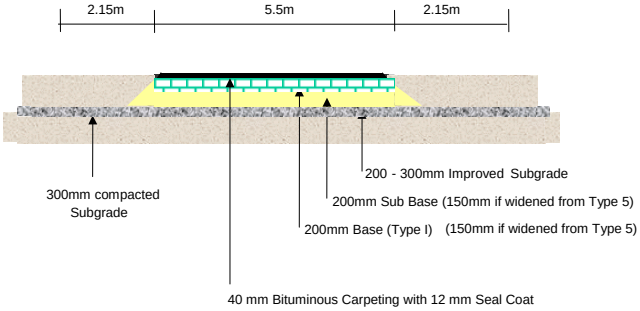


Feeder Road A

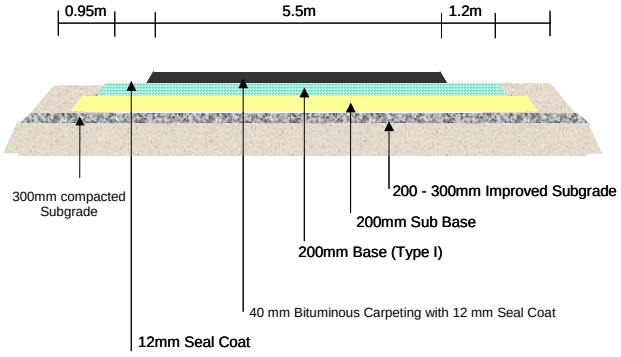
Recommended



Design Type 5



Design Type 4



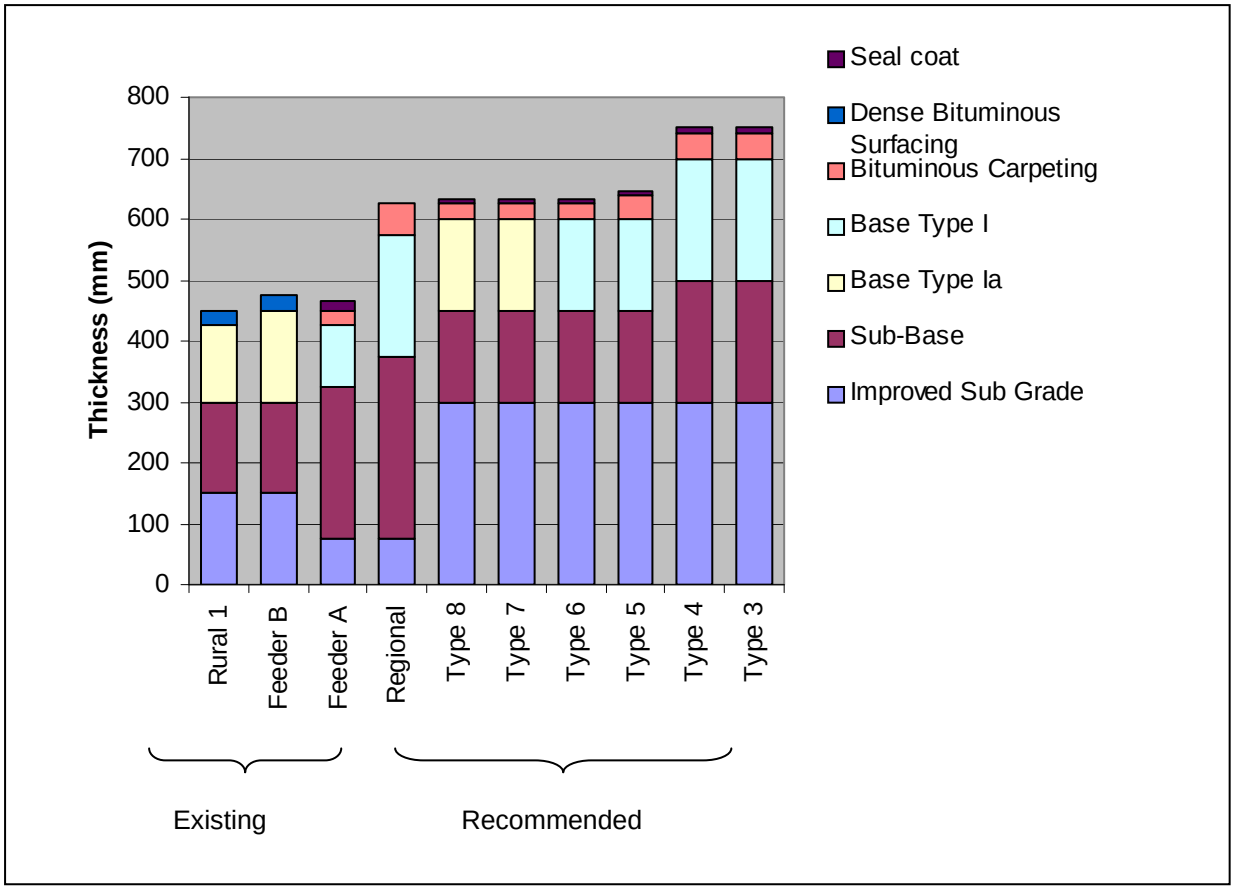
Design Type 3

Feeder Road A defined in 1996, Zila Road defined in 2003

7.2

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. The proposal to increase the axle weight limit in Bangladesh is already taken account of in this calculation. Figure 4 shows pavement thicknesses graphically. The recommended designs therefore show a logical progression of increasing pavement thickness with traffic volume.

Figure 4 : Pavement thicknesses



7.3 The existing designs display an illogical progression with road class. This is proposed to be overcome by the adoption of the recommended 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.

7.4 The recommended design types have pavement thickness based on the principles embodied in the UK's Transport Research Laboratory Report Road Note 31. These have proved resilient and efficient, when laid properly, in a range of tropical countries.

7.5 The recommended design types provide for ease of upgrading. For low volume roads the new designs provide for widening of the pavement as one goes down the layers, instead of the previous vertical box-cuts. This gives additional strength to the pavement, as loads are dispersed through the embankment, instead of being concentrated.

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

8.0 Typical applications

8.1 Because road design will henceforth be based on traffic criteria, 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 5.

Table 5 : Design applications

Road class	Typical design applications
Zila	Types 5, 4, 3*
Upazila	Types,6,5, 4*
Union	Types, 8, 7

* Special type to be used under special circumstances

9.0 Design Life

The design lives, based on the pavement thicknesses for each existing design and each recommended design are set out in Table 6 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 recommended designs the forecast ESA's have been calculated from the traffic capacity in the design year, to allow the design life to be estimated. Again, traffic growth of 5% on all roads is assumed. Appendix E 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 6 : Existing and Recommended Design lives

	Existing Design			Recommended Design		
Road Class	Cumulative Million ESA's	Typical Expected Design Life (years)	New Class	Design Type	Design Life (Million ESA's)	Expected Design Life** (years)
Rural Road / Union Road	0.5	10	Uion	8	1.0	10
				7	1.0	10
Feeder Road B / Upazila Road	1.0	10	Upazila	6	1.0	10
				5	1.6	10
				4*	2.0	10
Feeder Road A / Zila Road	1.0	10	Zila	5	1.6	10
				4	5.0	20
				3	6.5	20

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

10.0 Culverts and Bridges

10.1 Culverts should normally be no longer than 6m. Bridges should be used if the gap exceeds 6m. Bridge and culvert costs per metre decrease with increasing length at normal circumstances upto a certain span.

10.2 RHD bridges are more expensive than LGED because RHD bridges are typically wider (5.5m and 7.3m on Zila and Regional Roads). Most existing LGED bridges are 3.7m wide, with a few of 5.5m. Table 7 lists existing bridge widths.

Table 7 : Existing bridge carriageway widths

Road Class	Width (m)
Rural Road 1	3.7 (12)
Feeder Road B	3.7 – 5.5 (12-18)
Feeder Road A	5.5 (18)
Regional Road	5.5 (18) - 7.3 (24)

10.3 In future, the standards for bridge widths should be improved to increase safety, and allow for future road widening to be accommodated, without re-constructing bridges. Culverts and bridges should continue to have a 50-year design life. Table 8 lists recommended bridge widths. Schematic bridge layouts are shown in Figure 5, and typical bridge 2D views are shown in Figure 6, 6a & 6b. 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 carriaveway 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 height could also be considered. This practice should be encouraged as steel reserve is gradually diminishing and if this alternative is found cost effective.

Table 8 : Recommended Bridge Carriageway Widths

Design Type	New Class	Length less than 30m (100')	Lane Type	Length greater than 30m (100')
8, 7	Union	3.7 (12')	Single Lane	5.5 (18')
6,5,4	Upazila	5.5 (18')	Double Lane	5.5 (18')
5,4,3	Zila	7.3 (24')	Wider Double Lane	7.3 (24')

Existing bridge and culvert costs are listed in Table 9.

Table 9 : Existing Bridge and Culvert Costs per metre (lac Taka)

	Bridge	Culvert	Brick Arch Culvert <=4.5m Span	PSB
LGED	1.8 – 2.7	1.6 – 2.5	1.8 - 2.6	2.5 - 3.4
RHD	2.2 – 7.0	2.0 – 5.0	-	2.5 - 3.5

10.4 The average cost for such bridges of 5.5m (18') carriageway should be around 2.5 lac Taka per metre. Bridges with a carriageway width of 7.3m (24'), should have an average cost of around 4.5 lac Taka per metre. Recommended bridge and culvert costs are shown in Table 10. Use of Box Culvert should be specially justified - normally open foundation culvert or slab culvert should be used.

Table 10 : Recommended Bridge and Culvert Costs (upto 30m (100')span)

Design Type	New Class	Bridge Cost per m (Lac Tk.)	Culvert Cost per m (Lac Tk.)	Brick Arch Culvert <= 4.5m Cost per m (Lac Tk.)	PSB Cost per m (Lac Tk.) (Single Lane)
8, 7	Union	1.0-1.75	1.8-2.5	2.0	3.5
6,5, 4	Upazila	1.5-3.0	2.0-3.0	2.8	
5,4,3	Zila	3.5-5.5	3.0-4.0		

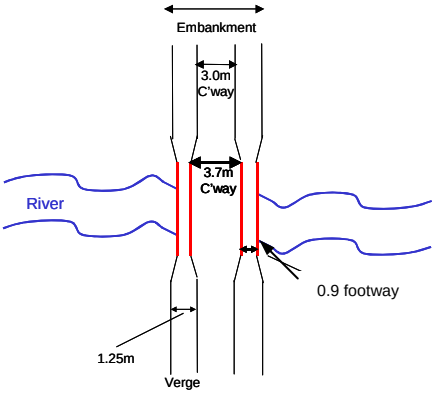
10.5 Table 11 lists typical gap requirements for cross drainage by type of road, and these are used for cost estimates. All roads should be provided with appropriate gaps, irrespective of road building agency, according to the design type and geographical location. It was observed that some of the roads built under the Food For Work programme were built without proper pavement and drainage structures. As a result adequate gaps were not provided, and has resulted in water-logging and flooding. This practice should cease. The Ministry of Disaster Management & Relief and the District Administration should be advised adequately to follow meticulously the above guidance.

Table 11 : Typical gaps by type of road, metres per kilometer

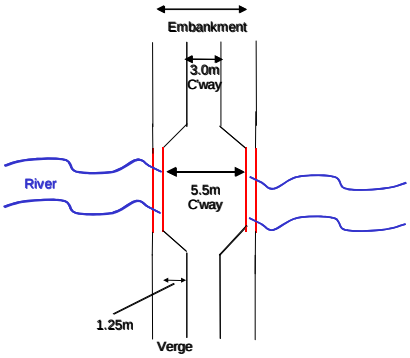
Existing Class	New Class	Road Design Type	Geographical location			
			Swampy	Hilly	Haor*	Plane
Feeder Road A	Zila	Types 3,4,5	10 - 15	7-15	10 -15	6 - 10
Feeder Road B and Rural Road 1	Upazila & Union	Type 6, 5, 4 Types 8, 7				

** To be determined case by case*

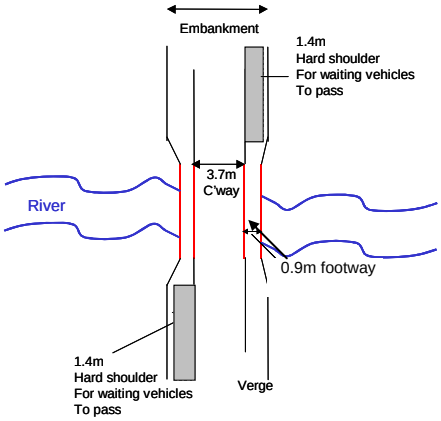
Figure 5 : Schematic Bridge Layouts



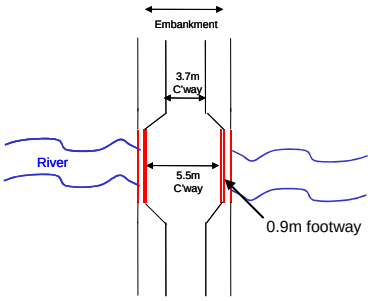
Type 8 (< 30m)



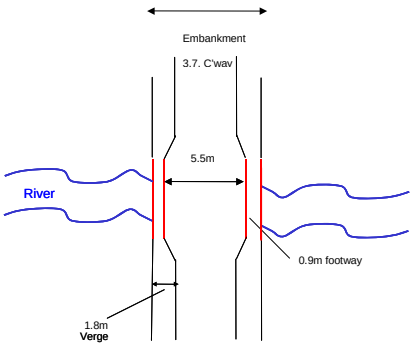
Type 8 (> 30m)



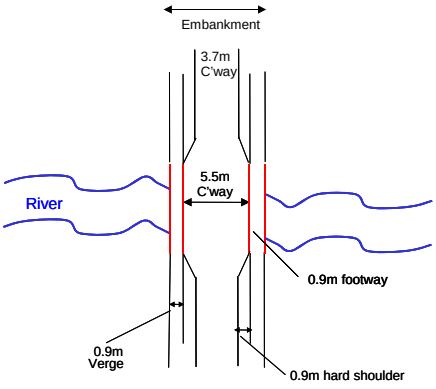
Type 7 (< 30m)



Type 7(> 30m)

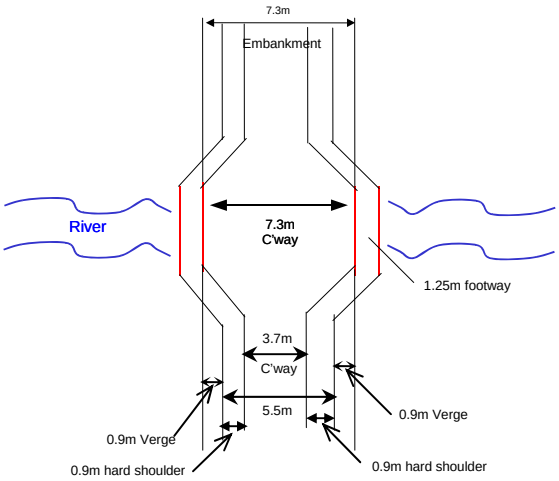


Type 6

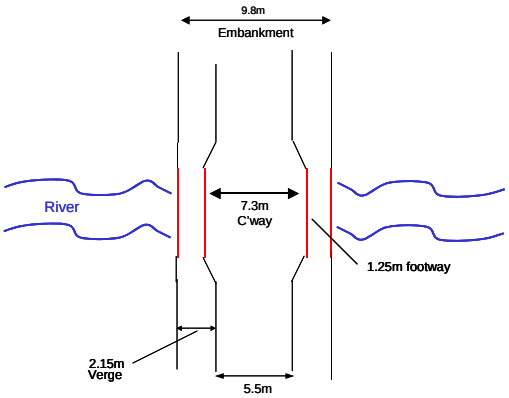


Type 5 (Upazila)

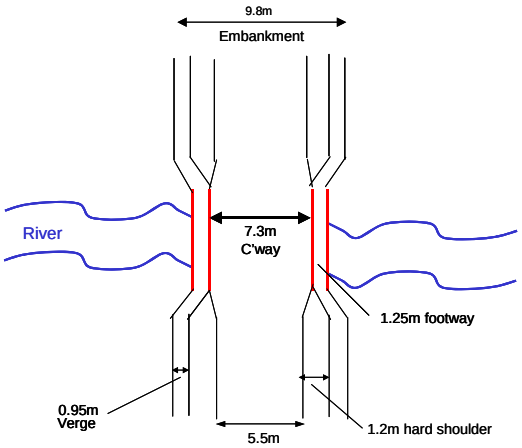
Figure 5 (continued)



Type 5 (Zila)



Type 4



Type 3

Figure - 6

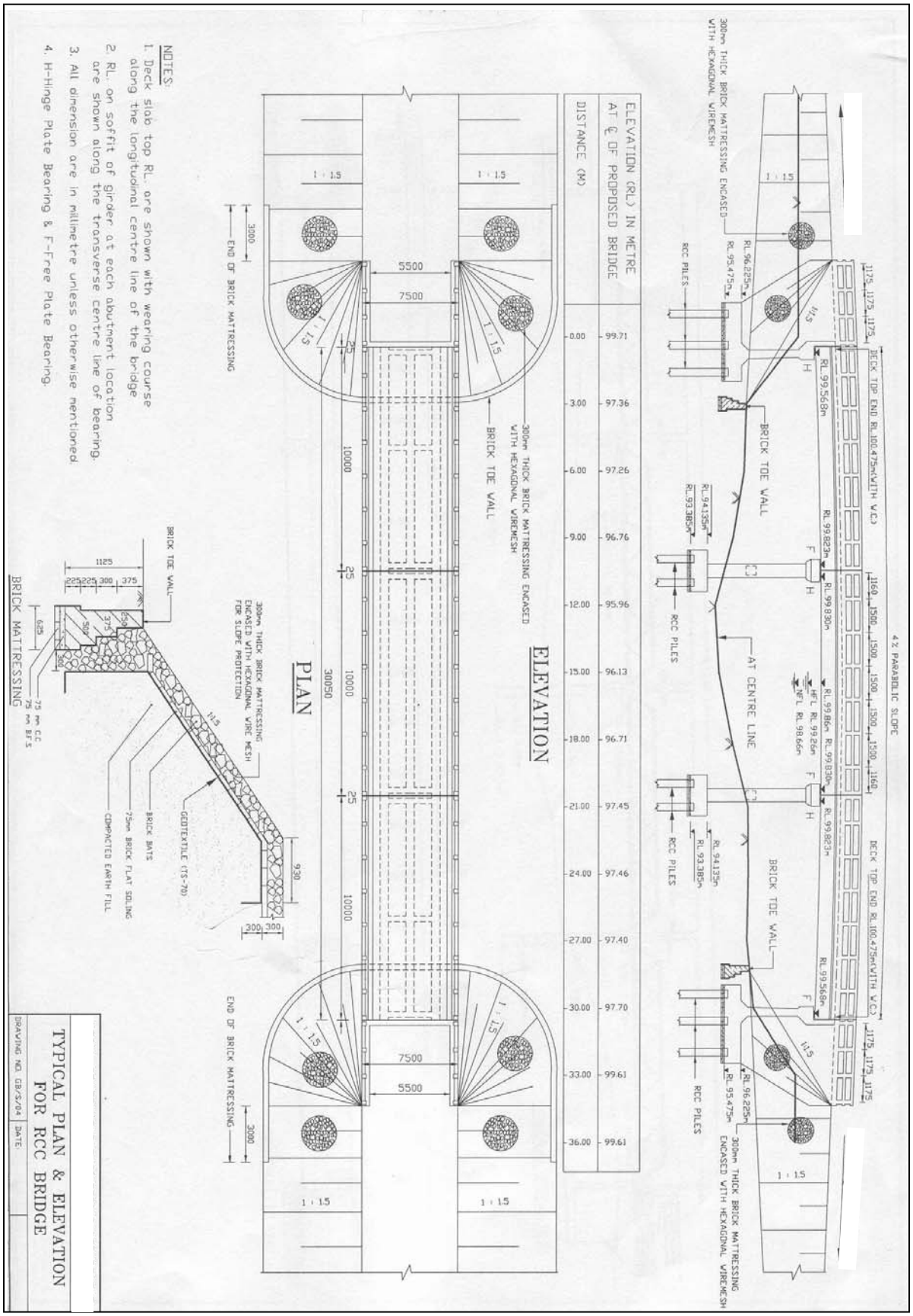


Figure – 6(A)

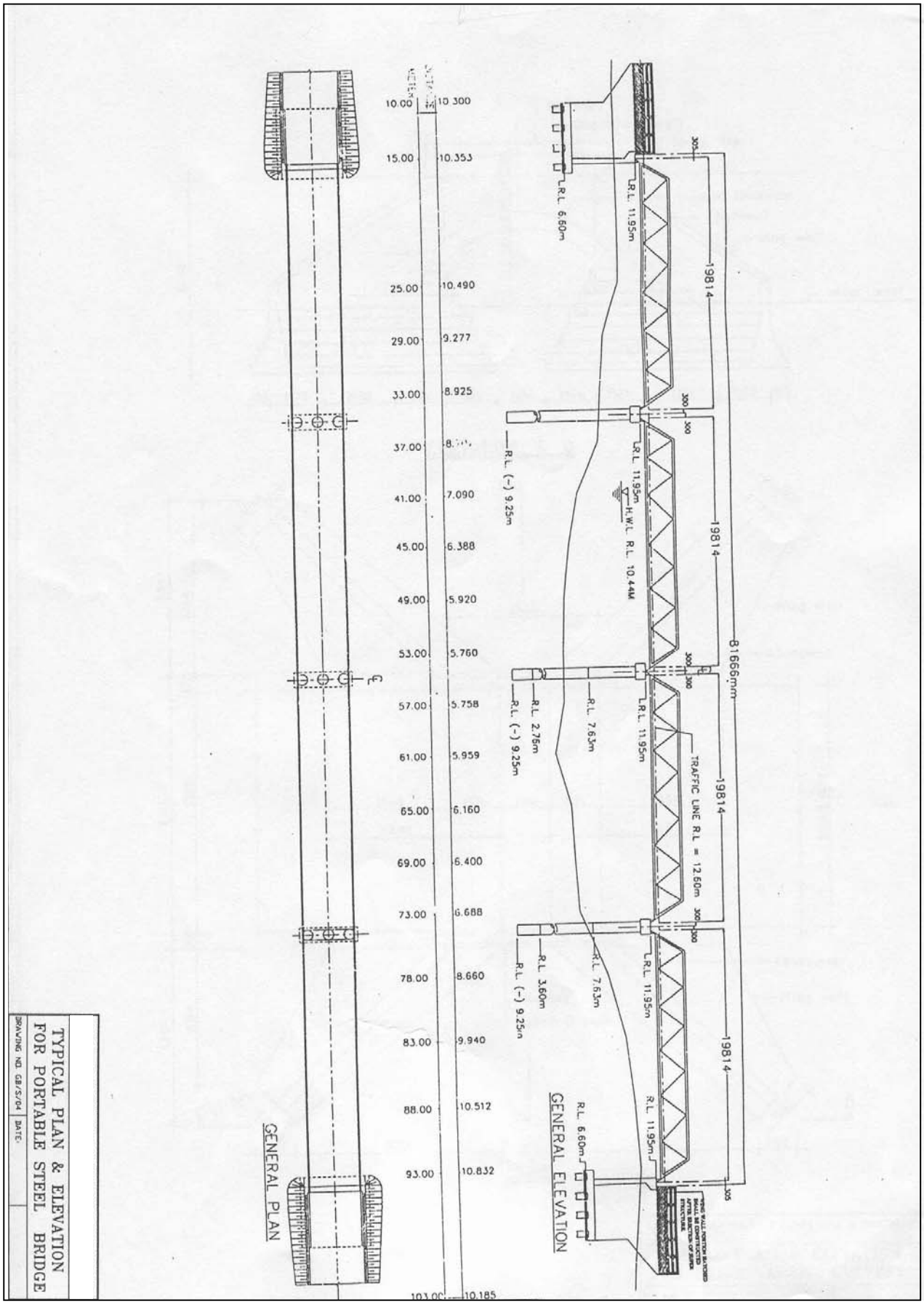
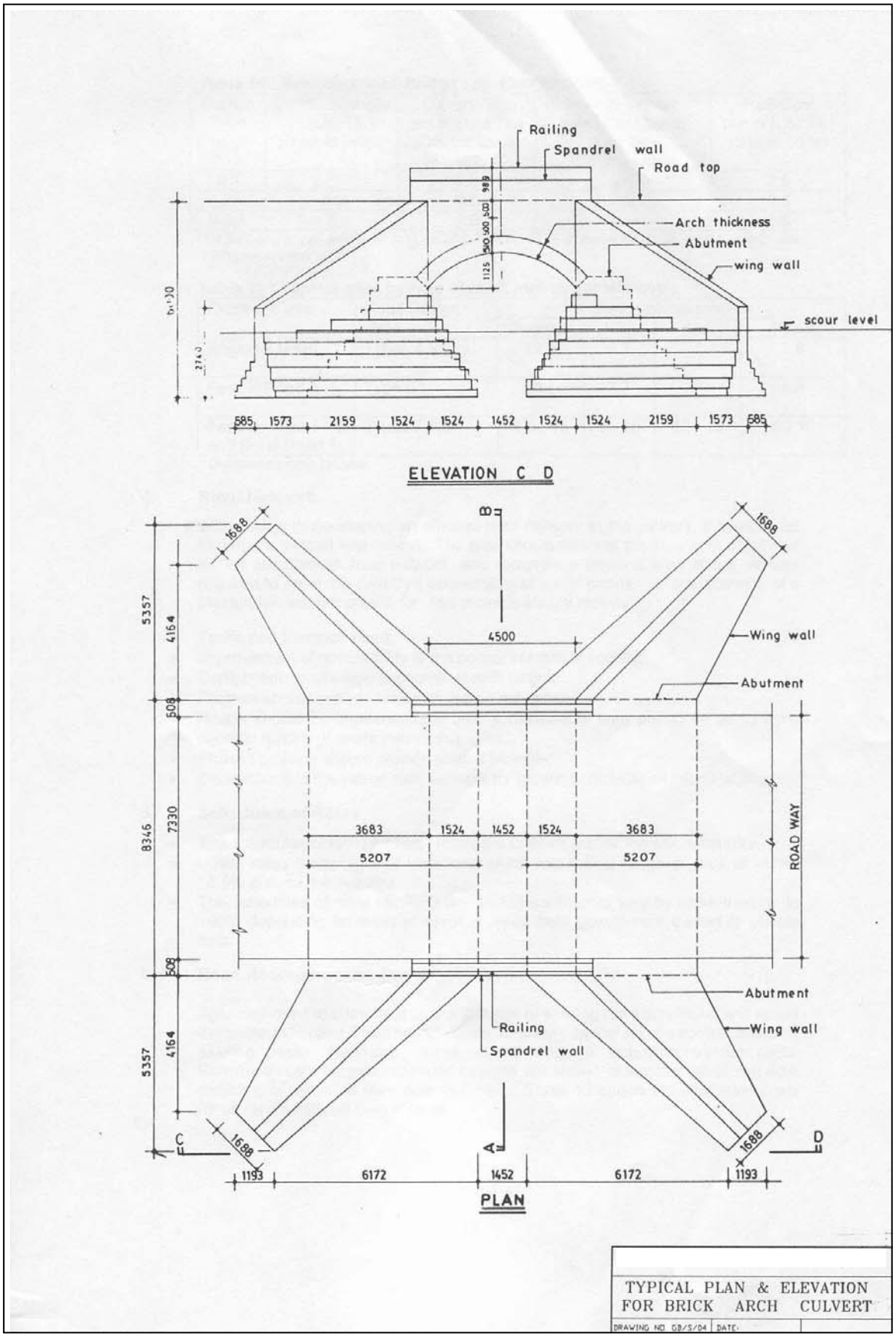


Figure – 6 (B)



11.0 Road Network

11.1 With a view to developing an efficient road network in the country, it is essential to prepare a Road Masterplan. 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. In the absence of a Masterplan, interim criteria for road projects should include:

- 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 implementable 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.

12.0 Schedules of Rates

- The schedules of rates for RHD roads are uniform across the whole country.
- LGED rates have regional variations which result in a range of plus or minus 12.5% around the average.
- The schedules of rates for RHD and LGED earthworks vary by more than up to 100% depending on whether earth is taken from government owned or private land.

13.0 Road Reconstruction Costs

13.1 Agencies need to undertake proper surveys of existing road conditions and reflect the same in Project Documents. Table 12 shows typical reconstruction costs for existing design standards, along with a range of actual contracted costs. Estimated costs for recommended designs are shown alongside, assuming 50% recycling of materials (see note to table-13). Table 13 shows the estimated costs for all recommended design types.

Table 12 : Comparison of Estimated Road pavement reconstruction costs for existing and recommended designs

Existing Class Road	Typical PCP cost estimates (2002/03)	New Classification of Road	Typical Design Type	Estimated Cost/km Lac Taka (1) Based on present schedule of rates
Rural Road 1	20.6 – 27.0	Union	8	22.0 – 26.2
Feeder Road B	36.5 – 49.9	Upazila	6	29.3 – 37.9
Feeder Road A	55.9	Zila	5	44.0 – 56.6

(1) All estimated figures assume 50% recycling of existing materials (bricks, khoa etc.) in the road base that can used in the sub-base. Estimates for alternative assumptions are found in Appendix-F. Where there is a cost range, it represents regional variations in LGED schedules of rates.

13.2 In general, the estimated cost ranges of the recommended design types are similar to the cost estimates of the existing designs. By relating design directly to traffic, it will be possible, in many cases, to make cost savings.

Table 13 : Estimated Costs of pavement reconstruction for Recommended Design Types

Recommended Design Type	Cost/km Lac Taka (1)
8	22.0 – 26.2
7	26.7 – 31.8
6	29.3 – 37.9
5	44.0 – 56.6
4*	56.0 - 63.8
4	58.6 – 75.3
3	78.3 – 100.7

(1) All estimated figures assume 50% recycling of existing materials (bricks, khoa etc.) in the road base that can be used in the sub-base. Ranges reflect regional variations in rates, and between agencies.

* *For 24' crest*

14.0 New Road Construction Costs

14.1 The assumptions regarding costing for new roads are set out in Table 14. An important component of new road construction is the measures required to protect embankments from water. Example cost rates for these are given in Table 15, and these are used in the cost estimates.

Table 14 : Construction assumptions for typical new roads

Type of Area	Slope Protection	Embankment Height	Bridges (per km)	Culverts (per km)	Design Types
Plane	Turfing only	3m	5m - 7m	1m - 3m	For all design types
Hilly	Concrete retaining wall (lower slope), and slope protection on upper slope	1m	4m - 7m	3m - 8m	For all design Types
Swampy and Haor	Brick block and geotextile	4m	8m -11m	2m-4m	For all design Types

Table 15 : Example Slope Protection Costs

Sl.	Protection Measure	Cost per m^3 (taka)	Cost per m^2 (Taka)	Cost per m (taka)
1.	Slope Prtection Work with C.C Block and Geo-textile		985.00	-
2.	Slope Protection Work with Brick Block and Geo-textile		1455.00	-
3.	Slope Protection Work with Brick Mattressing and Geo-textile		900.00	-
4.	Slope Protection Work with Gunny Bagged Rip-Rap and Geo-textile		730.00	-
5.	Slope Protection Work with RCC palisading work at Toe		1055.00	-
6.	Slope Protection Work with CC slab on slop and Palisading work at Toe		-	2020.00
7.	Slope Protection Work with Grass turfing on slope		13.00	-
8.	Turfing with toe wall	-	204.00	-
9.	Toe-wall with brick work	2899.00	-	-
10.	Concrete Slope Protection (concrete Block)		679.00	-
11.	Grouted Riprap	-	971.00	-
12.	Brick Mattressing	-	394.00	-

(1) Geo-textile may be replaced by geo-jute if material is proven to have a similar life. (2)appendix-H. for design detail of protective measure.

14.2 Table 16 shows estimated construction costs for the existing and recommended design standards. The cost bases are Dhaka for plane conditions, Chittagong Hill Tracts for hilly conditions and Sylhet for swampy conditions.

Table 16 : Cost comparison of new roads based on existing and recommended designs (lac taka per km

Existing Road Class	Hilly	Plane	Swampy	New Road Class	Design Type	Hilly	Plane	Swampy	Haor
Rural Road 1	60.2	49.2	124.2	Union	8	64.9	52.2	125.4	
					7	71.2	58.2	131.3	
Feeder Road B	68.4	58.4	134.7	Upazila	6	81.6	70.3	142.4	
					5	97.2	104.9	184.9	45.0 *(*)*
					4*	107.7	110.4	213.5	
Feeder Road A	91.7	105.2	195.1	Zila	5	97.2	104.9	184.9	
					4	135.7	145.0	234.6	
					3	164.4	174.0	263.4	

(*)Not Design Type 6, but re-inforced concrete submersible causeway Breakdown of costs shown in Appendix G Where there is a range it is because road could be built by different agencies, with different schedules of rates

** 24' Crest*

Table 17 : Estimated Range of Costs of New Roads with recommended design types (Lac taka per km)

Recommend ed Design Type	Hilly		Plane		Swampy	
8	64.9		52.2		125.4	
7	71.2	72.2	58.2	60.9	131.3	134.4
6	81.6	83.1	70.3	72.1	142.4	169.2
5	95.4	106.9	102.6	114.5	176.5	148.5
4	135.7		145.0		234.6	
3	164.4		174.0		263.4	

Where there is a range it is because road could be built by different agencies, with different schedules of rates

15.0 Road Widening

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

15.2 Feeder Roads A and B, and Types 5, and 6 all have 7.3m (24 feet) crest widths. Widening of Feeder Roads to Type 5, widening of a Type 6 to a Type 5 and widening a Type 4 to a Type 3 do not involve any increases in the size of the embankment. All other widening requires embankment widening. For these cases an embankment with a 3m height has been assumed. No improvement works or widening of bridges is assumed in the costs presented in Table 18.

Table 18 : Estimated Road Widening Costs (lac taka per km)

		Type 7	Type 6	Type 5	Type 4	Type 3
Widened from	Rural Road 1		18	38		
	Feeder Road B			24		
	Feeder Road A			19	42	69
	Type 8	7	12	31	55	
	Type 7		5	24	48	74
	Type 6			19	43	69
	Type 5					50
	Type 4					27

Note : No re-use of materials in the base assumed.

15.3 Costs of widening are always more than the costs of pavement reconstruction. Care should be exercised in developing projects for widening, to ensure that there is sufficient traffic justification.

16.0 Road Strengthening

16.1 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 of base type 1 with bituminous surfacing may be provided.

Table 19 : Road Pavement Strengthening Costs

Type of Road	Typical Recent PCP cost Estimate (2002/03)	New Classification	Recommended Design Type	Estimated cost/km (Lac Taka) based on present schedule of rates
Rural Road - 1	20.6-27.0	Union	8 7	18.0-20.0 22.0-24.0
Feeder Road B	36.5-49.9	Upazila	6 5 4*	22.0-24.0 37.0-42.0 46.0-51.0
Feeder Road A	55.9	Zila	5 4 3	37.0-42.0 46.0-51.0 66.0

** For 24' Crest*

17.0 Conclusions

17.1 These standards have looked into 3 major classes of road (Union, Upazila, and Zila), but according to the notification issued in November 2003 the Committee on Standards is expected to cover Village Roads as well. However, Village Roads are not included in this report as these are constructed according to local needs. National Roads should be subject of feasibility and design studies on a case-by-case basis.

17.2 These standards have been compiled with the active participation of RHD, LGED, BWDB, Dhaka University, BUET, IMED, Planning Commission, Centre for Policy Dialogue, and the Consolidation of Institutional Development Component (CIDC3), a programme of the Ministry of Communications. The road agencies responsible for non-urban roads – RHD and LGED – have agreed with the contents of these standards.

17.3 Design standards to be adopted for new roads, reconstruction and widening should be strictly related to traffic volume.

17.4 Six design types (Design types 8 to 3) are recommended for the Zila, Upazila & Union roads. These should be adopted by all road agencies, depending upon traffic volume.

17.5 In order to avoid water-logging and flooding, adequate gaps should be provided for drainage, and no road should be built by any agency without proper design of such structures.

17.6 Cost estimates prepared by the road agencies for the six new design types should be in line with estimates provided in this document. Any variance should be justified by reference to special circumstances resulting from detailed field work and surveys.

17.7 The contents of this document should be used for providing guidance to the road agencies (RHD, LGED, and local government institutions) so that all future roads are planned and built based on the traffic and corresponding design standards contained in this document. These standards should be used in the preparation of future project documents. These standards will also provide guidance to the Planning Commission in examining proposed road projects and the corresponding project documents.

Appendix A : Terms of Reference for the Steering Committee

(1) On the basis of geographic location review the existing standards of the Zila, Upazila, Union & Village roads and fix/refix their standards.

(2) After reviewing the existing number and their gap lengths of the roads mentioned in para (1) above fix or refix their standard.

(3) Considering geographic location of existing road network set standards for new roads including verification of justification of their need.

(4) Review the existing schedule of rates of (i) RHD and (ii) LGED.

(5) On the basis of the existing conditions of the existing roads find out per kilometer cost of reconstruction/repair (on the basis of zones).

(6) To fix cost per kilometer for new roads (on zonal basis).

(7) To find out cost per kilometer (on the basis of each zone) for upgrading roads to higher class/widening as per requirement.

Appendix B : Membership of the Road Design Standards Committee

Division Chief, Physical Infrastructure Division, Planning Commission (Convenor)

Joint Chief, Rural Institution Wing, Planning Commission (Member)

Joint Chief, Road Transport Wing, Planning Commission (Member)

Director General, IMED (Member)

Mr. Nazrul Islam, Professor, Geography Department, Dhaka University (Member)

Representative of BUET - Rank of Professor) (Member)
Dr. Hasib Mohammed Ahsan

Representative of RHD (Rank of S.E.) (Member)
Mr. K.C. Mazumdar,

Representative of LGED (Rank of S.E.) (Member)
Mr. Wahidur Rahman

Representative of Water Development Board (Rank of S.E.) (Member)
Mr. Kazi Md. Shamsul Haque, E.E.

Representative (Economist) of BIDS (Member)
Absent

Co-opted : *Dr. M. Rahmatullah*, Programme Director, Centre for Policy Dialogue
(Member)

Appendix C : Membership of the Road Desin Standards Technical Sub-Committee

1. Dr. M .Rahmatullah, Programme Director, Centre for Policy Dialogue – Convenor
2. Dr. Sion Haworth, Consultant, CIDC3
3. Jonathan Essex, Consultant, CIDC3
4. A.N.M. Serajul Islam, Consultant, CIDC3
5. Bill Hodgkinson, Consultant, CIDC3
6. Abed Uddin Ahmed, Addl. Chief Engineer, RHD
7. K.C. Mazumdar, Superintending Engineer, RHD
8. Zakir Hossain, Executive Engineer, RHD
9. Md. Wahidur Rahman, Superintending Engineer, LGED
10. Md. Amir Azam, Executive Engineer, LGED
11. Md. Abul Bashar, Executive Engineer, LGED
12. Rubaiyat Nurul Hasan, Consultant, LGED
13. A.B.M. Nazrul Islam, Consultant, LGED
14. Momtaz Mannan, Joint Chief, Road Transport Wing, Planning Commission
15. Md. Mohsin Ali Khandaker, Sr. Asstt. Chief, Planning Commission
16. Engr. Sarwar Alam, Deputy Director, IMED
17. Kazi Md. Shamsul Haque, Executive Engineer, Water Development Board

Appendix D : Construction Materials and Terminology

In order to develop unified standards it is first necessary to agree on the terminology, nature and basic parameters of the various materials which will be used during the construction of a road.

The agreed terminology and basic parameters for road pavement materials are shown in Tables D1 and D2.

Bituminous Bound Materials **Table D1**

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 subgrade and this is normally more carefully selected soil which is given additional compaction to increase its strength. The committee decided that in all cases the depth of subgrade compaction should be 300mm. Because in Bangladesh it is often difficult to achieve satisfactory CBR values on naturally occurring subgrades; improved subgrades usually consisting of fine sand are normally used. The thickness of improved subgrade is to be determined by the CBR of the natural subgrade according to Table D3.

Granular Materials **Table D2**

Pavement Layer	Minimum CBR % (Lab. Test after 4 days soaking)	Maximum Field DCP Test mm/ blow	Maximum Aggregate Crushing Value %	Required Compaction (Lab. Test after 4 days soaking)	Typical Materials Likely to meet specification.
Base Type I	80%	3.5 mm/ blow	30%	98% Vibrating Hammer / Heavy Compaction	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	Brick if it can meet specification
Subbase	30%	9.0 mm/ blow	32%	98% Vibrating Hammer / Heavy Compaction	Graded materials consisting of brick or brick sand mixtures. Re-cycled pavement materials such as brick, broken concrete, old surfacings etc.
Improved Subgrade	8%	22 mm/ blow	---	98% Vibrating Hammer / Heavy Compaction	Usually locally occurring fine sand
Subgrade (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

Table D3 : Thickness of improved subgrade for various subgrade CBR values.

Min. CBR Value of Subgrade material (at specified compaction) %	Thickness of Improved Subgrade to give CBR of 8%
2%	450 mm
3%	300 mm
4%	250 mm
5%	200 mm

Appendix E : 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

Appendix F : Road Reconstruction Costs

Table F1 : Road Pavement Reconstruction Costs - No re-use of material

Type of Road	Typical Recent PCP cost Estimate (2002/03)	New Classification	Recommended Design Type	Estimated cost/km (Lac Taka) based on present schedule of rates
Rural Road - 1	20.6-27.0	Union	8 7	27.0-31.3 32.8-38.0
Feeder Road B	36.5-49.9	Upazila	6 5 4*	35.4-44.1 52.7-65.5 67.9-74.60
Feeder Road A	55.9	Zila	5 4 3	52.7-65.5 70.6-87.4 95.1-117.8

Appendix F2 : Road Pavement Reconstruction Costs – 25% re-use of material

Type of Road	Typical Recent PCP cost Estimate (2002/03)	New Classification	Recommended Design Type	Estimated cost/km (Lac Taka) based on present schedule of rates
Rural Road - 1	20.6-27.0	Union	8 7	24.5-28.7 29.8-34.9
Feeder Road B	36.5-49.9	Upazila	6 5 4*	32.4-41.0 48.3-61.0 62.0-69.20
Feeder Road A	55.9	Zila	5 4 3	48.3-61.0 64.6-81.3 86.7-109.2

Appendix F3 : Road Pavement Reconstruction Costs – 50% re-use of material

Type of Road	Typical Recent PCP cost Estimate (2002/03)	New Classification	Recommended Design Type	Estimated cost/km (Lac Taka) based on present schedule of rates
Rural Road - 1	20.6-27.0	Union	8 7	22.0-26.2 26.7-31.8
Feeder Road B	24.0-46.0	Upazila	6 5 4*	29.3-37.9 44.0-56.6 56.0-63.8
Feeder Road A	22.8-55.9	Zila	5 4 3	44.0-56.6 58.6-75.3 78.3-100.7

** Crest width of 7.3m (24')*

Appendix F4 : Road Pavement Reconstruction Costs – 75% re-use of material

Type of Road	Typical Recent PCP cost Estimate (2002/03)	New Classification	Recommended Design Type	Estimated cost/km (Lac Taka) based on present schedule of rates
Rural Road - 1	20.6-27.0	Union	8 7	19.4-23.6 23.6-28.7
Feeder Road B	36.5-49.9	Upazila	6 5 4*	26.3-34.8 39.6-52.2 50.10-58.4
Feeder Road A	55.9	Zila	5 4 3	39.6-52.2 52.6-69.2 69.8-92.2

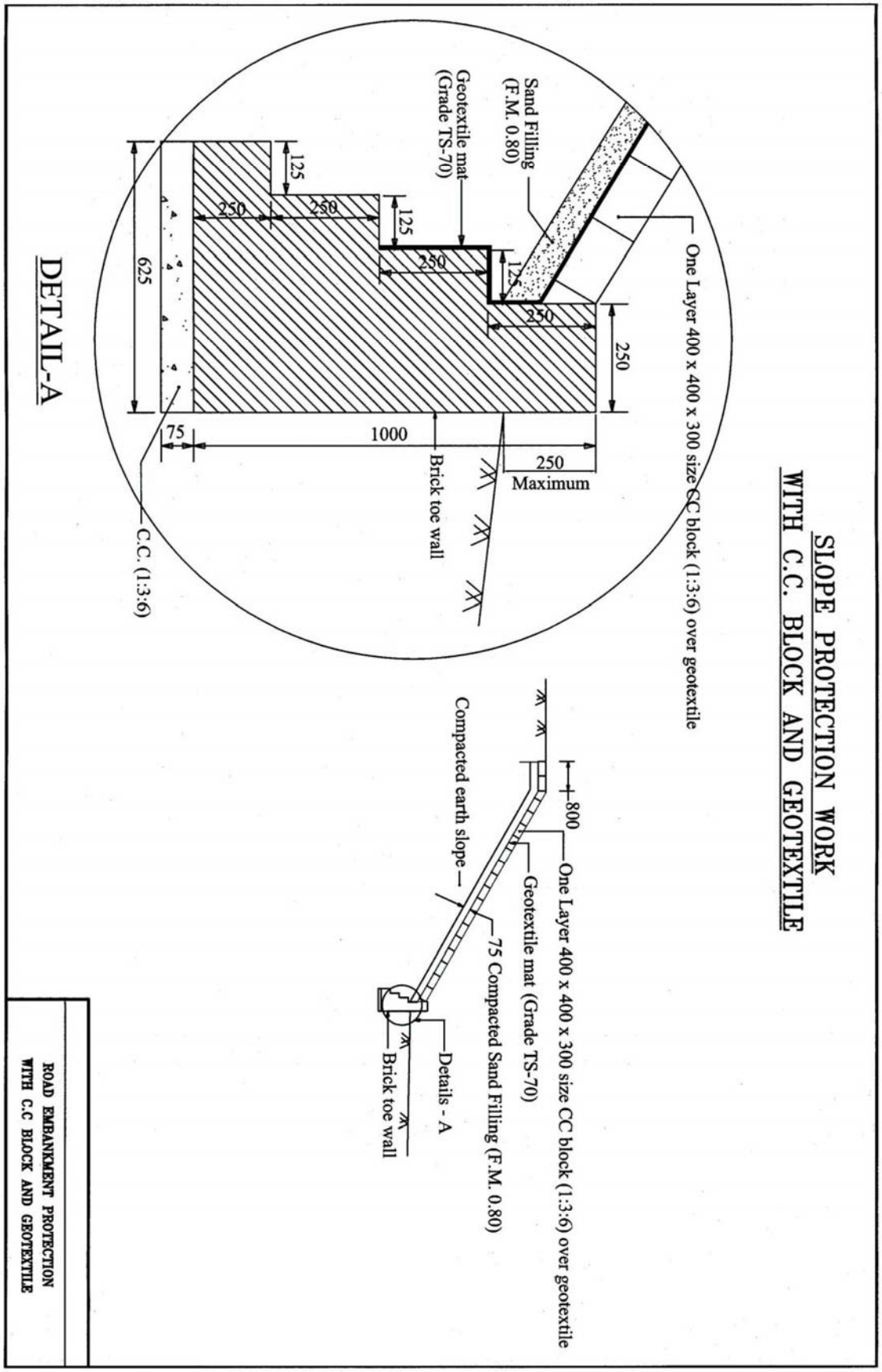
** Cost for crest width 24'*

Appendix G : New Road Construction Costs

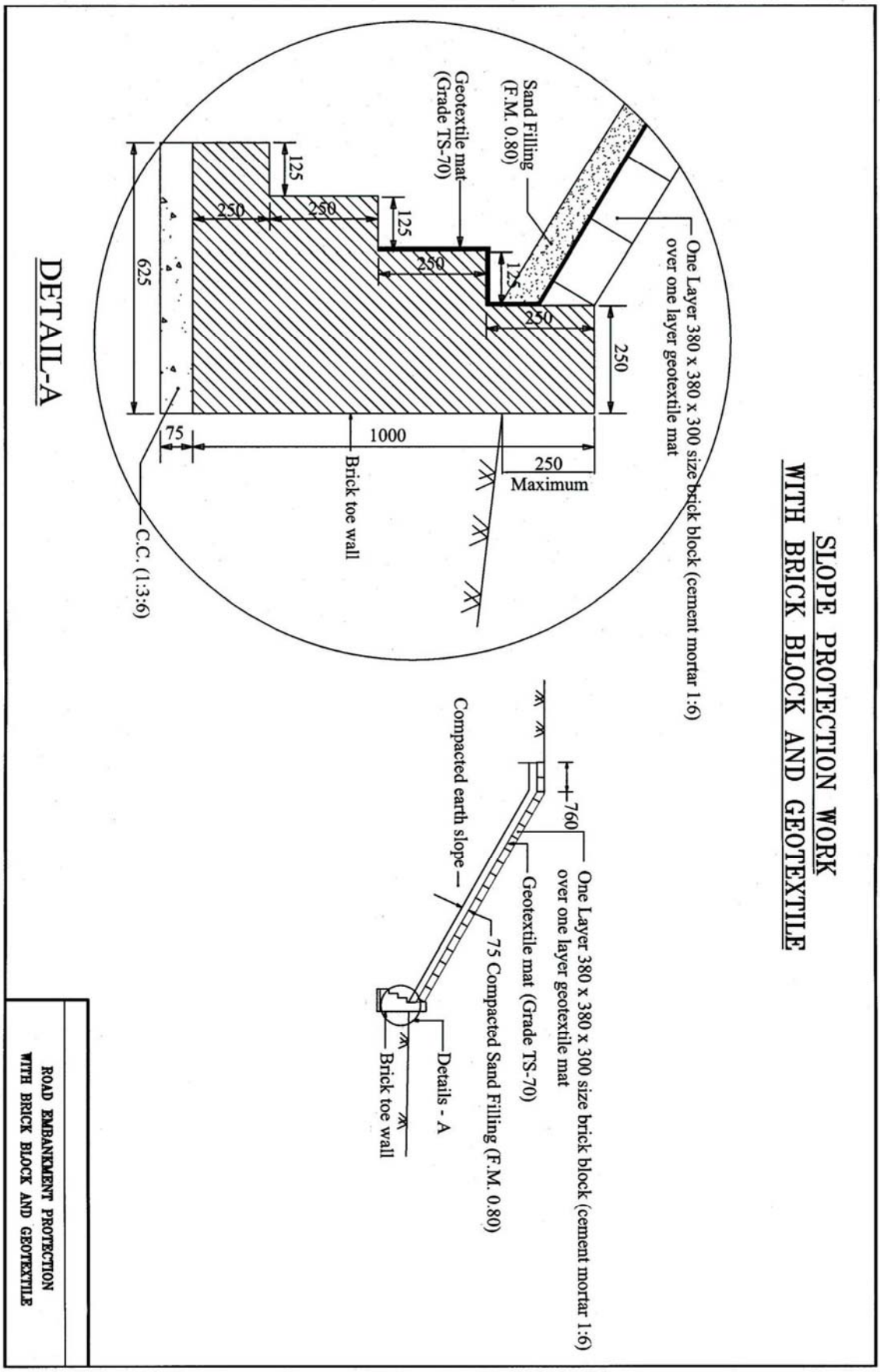
Lac Tk./ Km

Design Type	Bridges	Culverts	Slope	Earthwork	Pavement	Total
	Hilly					
Rural Road 1	8.0	16.0	9.7	1.5	24.9	60.2
Feeder Road B	8.0	16.0	9.7	2.1	32.6	68.4
Feeder Road A	19.6	13.2	9.8	3.9	45.3	91.7
Regional Road	22.1	18.6	9.8	5.3	93.3	149.1
Type 3	15.5	18.6	9.8	4.0	116.6	164.4
Type 4	15.5	18.6	9.8	5.3	86.5	135.7
Type 5	7.8	9.4	9.8	5.2	65.0	97.2
Type 6	8.0	20.0	9.7	1.8	42.0	81.6
Type 7	6.0	17.6	9.7	1.4	36.5	71.2
Type 8	6.0	17.6	9.7	1.5	30.1	64.9
	Plane					
Rural Road 1	12.0	4.0	0.4	9.2	23.6	49.2
Feeder Road B	12.0	4.0	0.4	11.3	30.7	58.4
Feeder Road A	29.4	3.3	0.4	26.8	45.3	105.2
Regional Road	33.2	4.7	0.4	30.7	93.4	162.3
Type 3	23.2	4.7	0.4	28.9	116.8	174.0
Type 4	23.2	4.7	0.4	30.1	86.7	145.0
Type 5	11.7	2.4	0.4	25.4	65.0	104.9
Type 6	12.0	5.0	0.4	11.0	41.9	70.3
Type 7	9.0	4.4	0.4	9.4	35.0	58.2
Type 8	9.0	4.4	0.4	9.6	28.9	52.2
	Swampy					
Rural Road 1	18.0	8.0	57.4	16.7	24.0	124.2
Feeder Road B	18.0	8.0	57.4	19.9	31.4	134.7
Feeder Road A	44.1	6.6	57.6	41.8	45.2	195.1
Regional Road	49.7	9.3	57.5	47.4	93.0	256.9
Type 3	34.8	9.3	57.5	45.6	116.3	263.4
Type 4	34.8	9.3	57.5	46.8	86.3	234.6
Type 5	17.6	4.7	57.6	40.3	64.8	184.9
Type 6	18.0	10.0	57.4	19.6	37.4	142.4
Type 7	13.5	8.8	57.4	17.2	34.4	131.3
Type 8	13.5	8.8	57.4	17.3	28.3	125.4

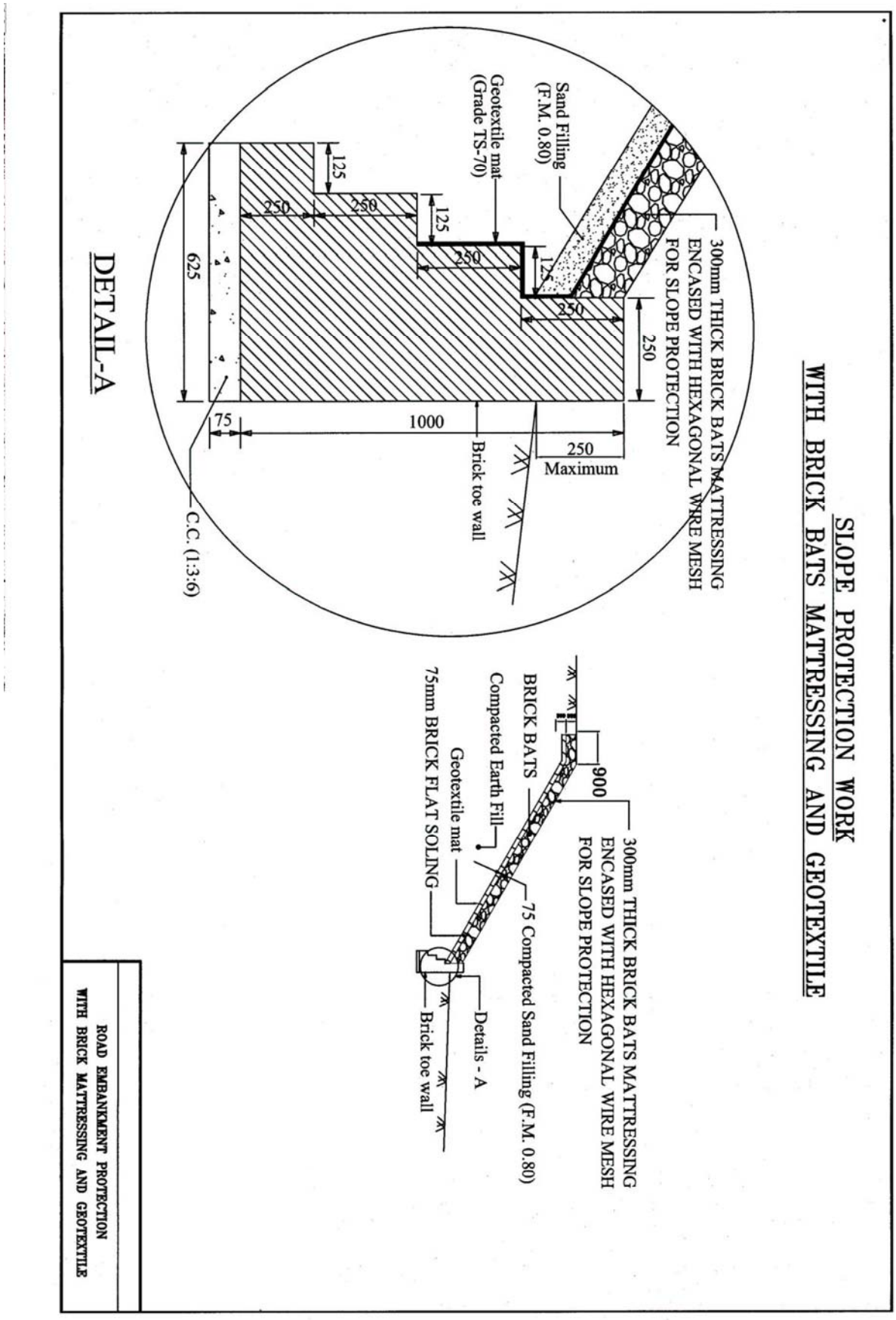
Appendix H : Slope Protection Work with CC Block and Geo Textile



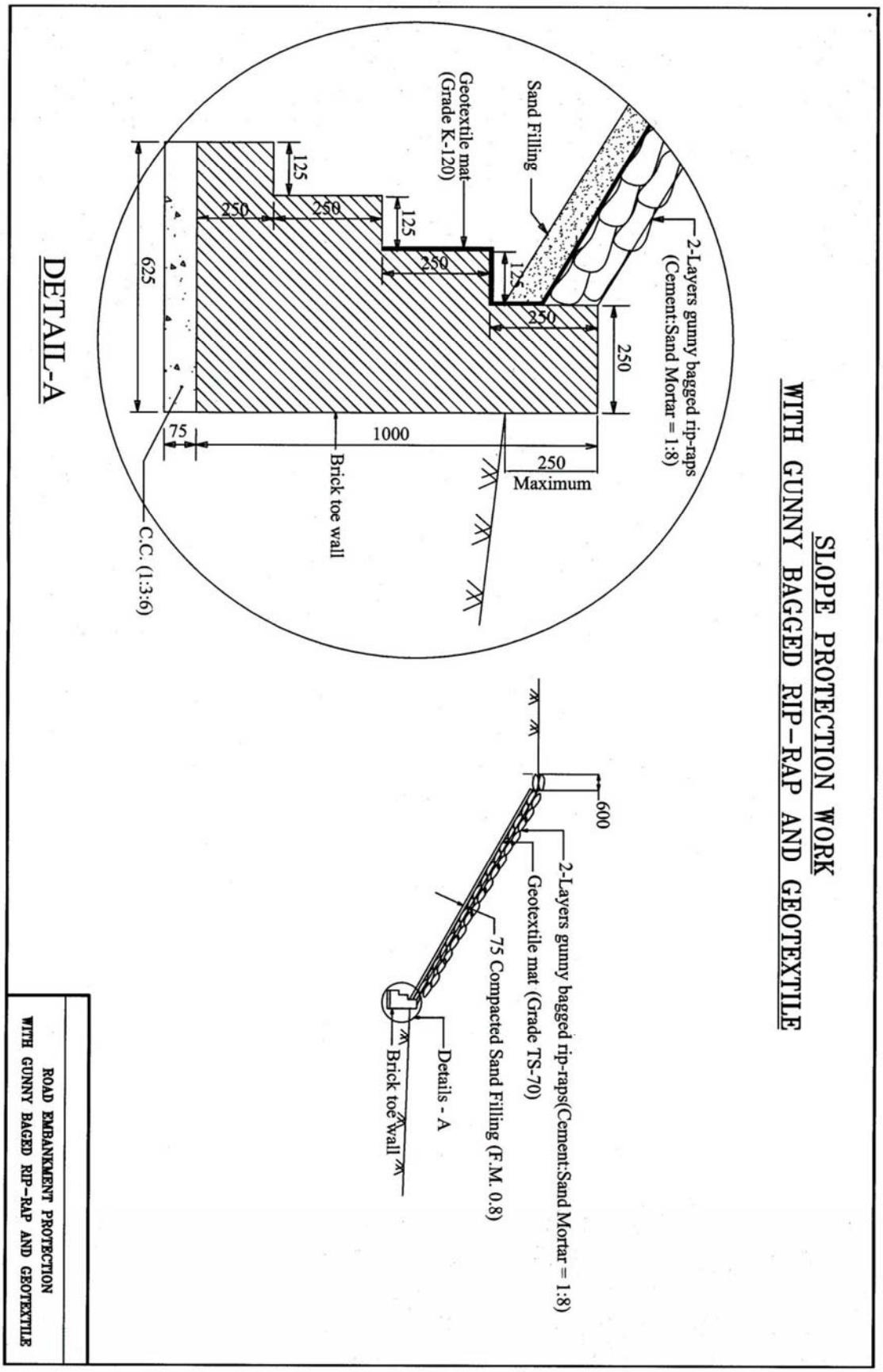
Appendix H : Slope Protection Work with Brick Block and Geo Textile



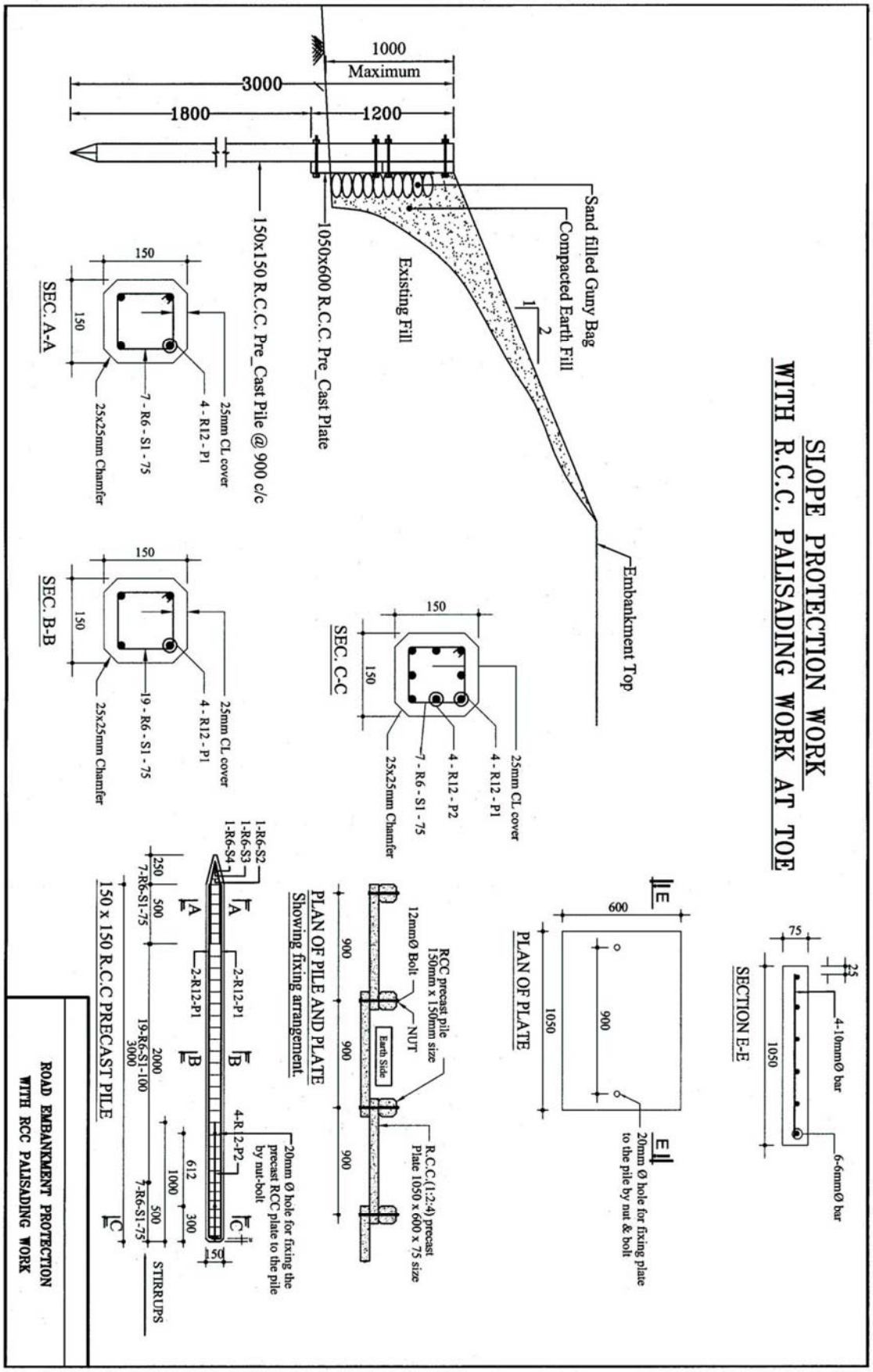
Appendix H : Slope Protection Work with Brick Bats Mattressing and Geo Textile



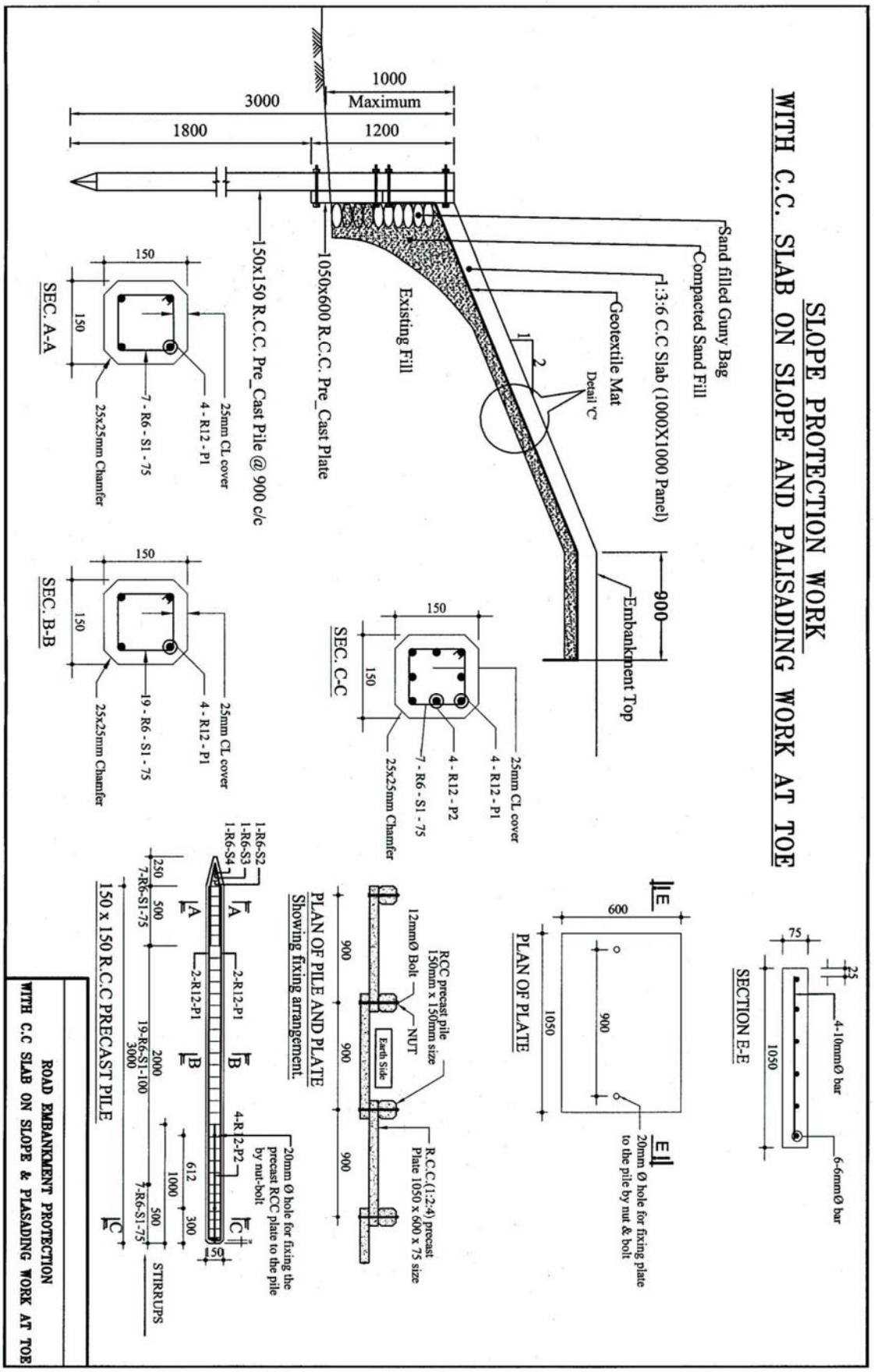
Appendix H : Slope Protection Work with Gunny Bagged Rip–Rap and Geo Textile



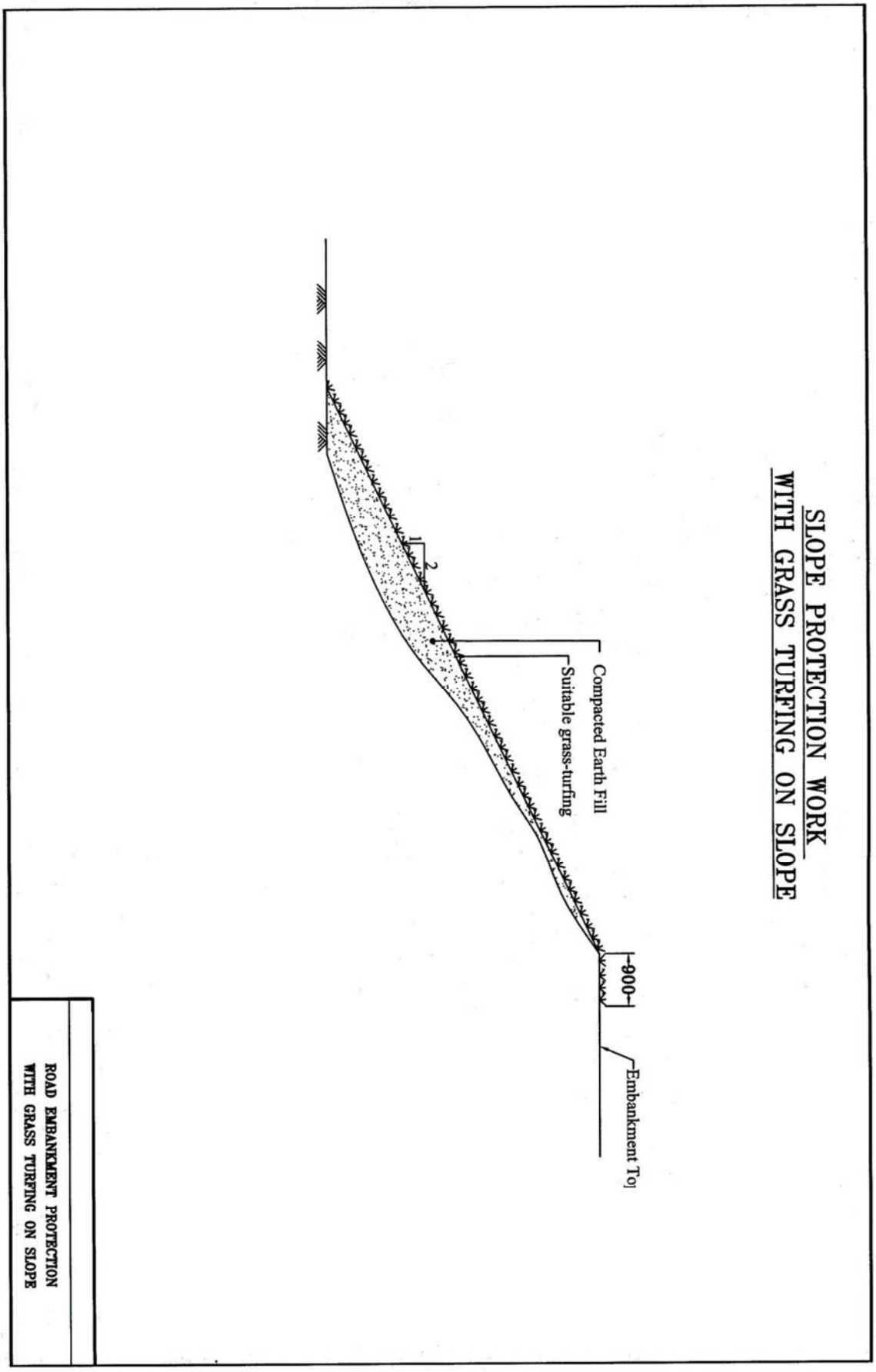
Appendix H : Slope Protection Work with RCC Palisading Work at Toe



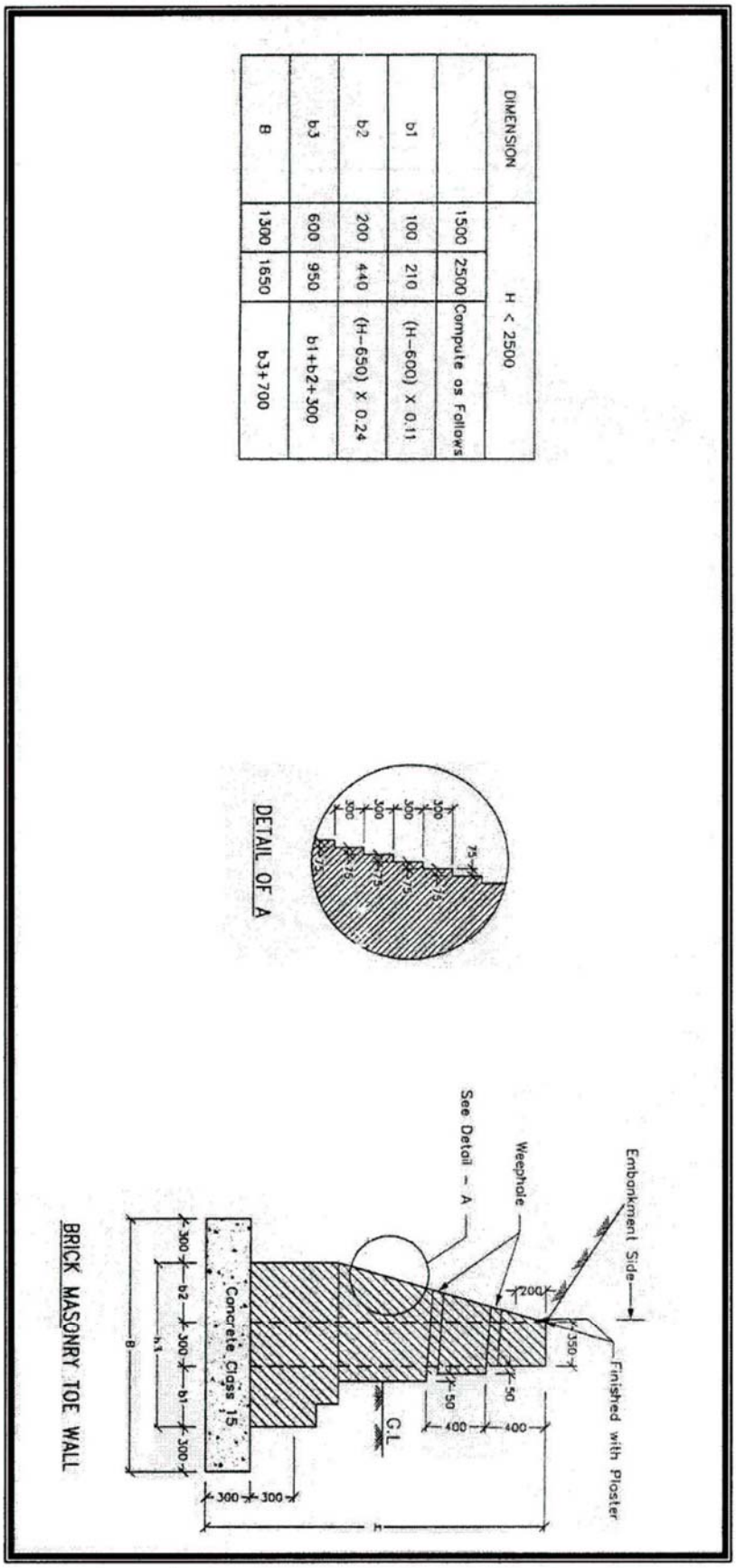
Appendix H : Slope Protection Work with CC Slab on Slope and Palisading Work at Toe



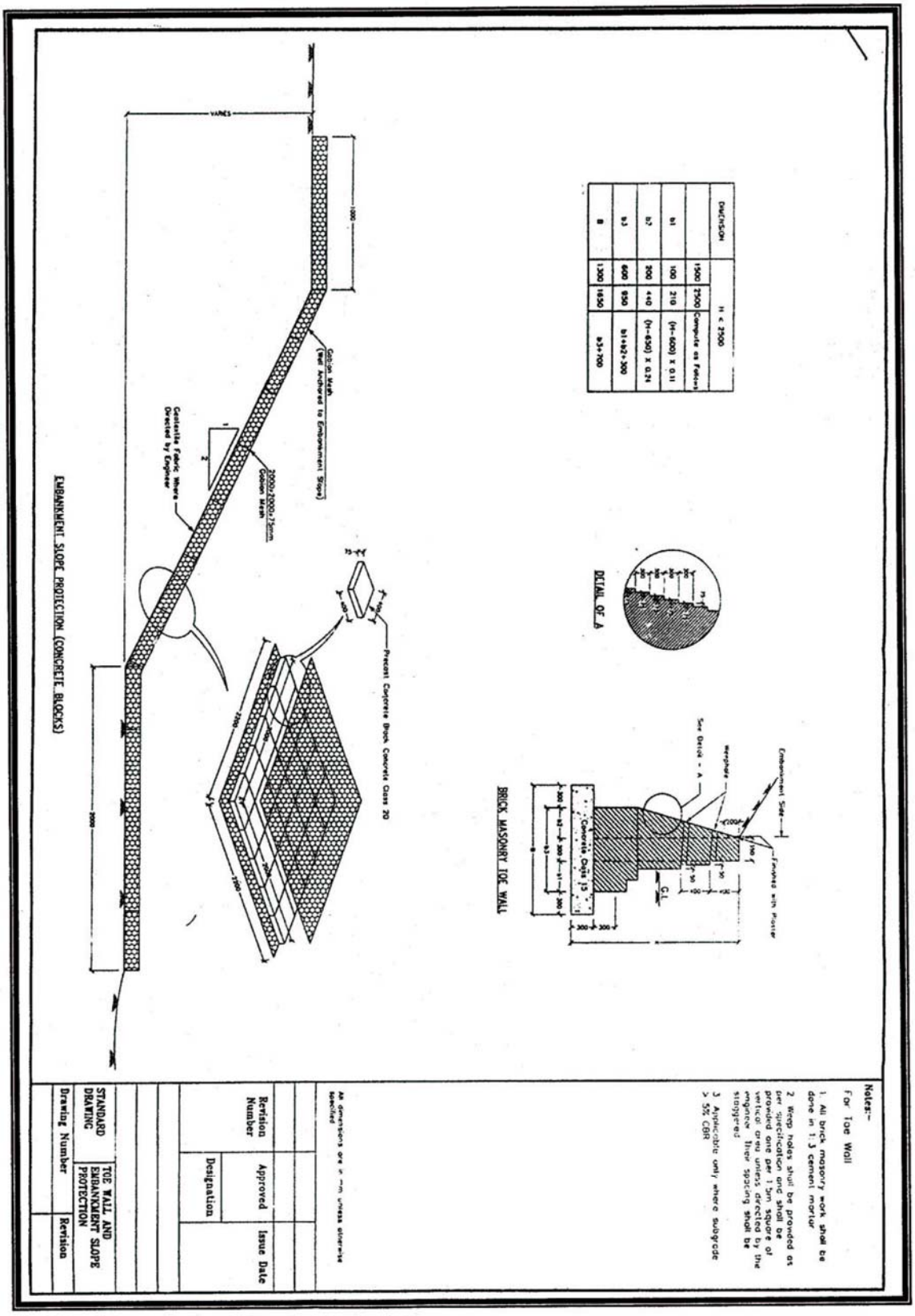
Appendix H : Slope Protection Work with Grass Turfing on Slope



Appendix H : Slope Protection Work with Toe Wall



Appendix H : Concrete Slope Protection (Concrete Block)



Appendix H : Slope Protection Work with Grouted Rip Rap