# Review of Low Volume Rural Road Standards and Specifications in Myanmar

Final Report

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*MYA2118B*

**April 2018**

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Rob Dingen

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## Abstract

The *Review of Rural Road Standards and Specifications in Myanmar* project is the first phase of a two-staged project. This report provides a record of activities completed in Phase 1, comprising a gap analyses of low volume rural road standards and specifications, following a review of existing Myanmar standards and standards and specifications used in the region and elsewhere. The report identifies possible refinements of the existing standards and specifications, and recommends on the development of a LVRR Manual for Myanmar during Phase 2.



## Key words

Low volume roads, rural roads standards, rural road design specifications, technical specifications, appropriate pavement design, sustainable transport infrastructure, rural access.


## ASIA COMMUNITY ACCESS PARTNERSHIP (AsCAP)

***Safe and sustainable transport for rural communities***

AsCAP is a research programme, funded by UK Aid, with the aim of promoting safe and sustainable transport for rural communities in Asia. The AsCAP partnership supports knowledge sharing between participating countries in order to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources. AsCAP is brought together with the Africa Community Access Partnership (AfCAP) under the Research for Community Access Partnership (ReCAP), managed by Cardno Emerging Markets (UK) Ltd.

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## Acronyms, Units and Currencies

| | |
|---|---|
| $ | United States Dollar ($ 1.00 ≈ MMK 1,350) |
| £ | GBP – Great Britain Pounds (£ 1.00 ≈ MK 1,790) |
| A(A)DT | Annual (Average) Daily Traffic |
| AASHTO | American Association of State Highway and Transportation Officials |
| ASTM | American Society for Testing Materials |
| ADB | Asian Development Bank |
| AfCAP | Africa Community Access Partnership |
| AsCAP | Asia Community Access Partnership |
| CBR | California Bearing Ratio |
| CDC | City Development Committee |
| CRRN | Core Rural Road Network |
| DDG | Deputy Director General |
| DG | Director General |
| DPBANRD | Department of Progress of Border Areas and National Races Development |
| DRD | Department of Rural Development (DOALI) |
| DRRD | Department of Rural Road Development (MOC) |
| DOB | Department of Bridges (MOC) |
| DOH | Department of Highways (MOC) |
| ESA | Equivalent Standard Axle |
| GIS | Geographical Information System |
| GPS | Global Positioning System |
| HVR | High Volume Road |
| Jica | Japan International Cooperation Agency |
| KfW | Kreditanstellung für Wiederaufbau (German Development Bank) |
| LV(R)R | Low Volume (Rural) Road |
| LVSR | Low Volume Sealed Road |
| MCEA | Myanmar Construction Entrepreneur Association |
| MESA | Million Equivalent Standard Axle (ESAx$10^6$) |
| MES | Myanmar Engineering Society |
| MOALI | Ministry of Agriculture, Livestock and Irrigation |
| MOBA | Ministry of Border Affairs |
| MOC | Ministry of Construction |
| NCDDP | National Community Driven Development Project |
| NCDP | National Comprehensive Development Plan |
| NSRRA | National Strategy for Rural Road and Access |
| PMU | Project Management Unit |
| RAI | Rural Access Index |
| RDU | Research and Development Unit |
| RECAP | Research for Community Access Partnership |
| RRAP | Rural Road and Access Project-DRRD with ADB funding |
| SAD | Self-administered division |
| SADC | Southern African Development Committee |
| SATCC | Southern Africa Transport and Communication Commission |

| | |
|---|---|
| SAZ | Self-administered zone |
| SEACAP | South East Asia Community Access Project |
| TDC | Township Development Committee |
| TL | Team Leader |
| TOR | Terms of Reference |
| TRL | Transport Research Laboratory |
| UK | United Kingdom (of Great Britain and Northern Ireland) |
| UKAid | United Kingdom Aid (Department for International Development, UK) |
| VDC | Village Development Committee |
| WB | The World Bank |

## Contents

**Annexes**

# 1 Background

## 1.1 Background: Project Context

The DFID funded Research in Community Access Partnership (ReCAP) through the Asian Community Access Partnership (AsCAP), agreed in January 2017 a research and development cooperation MOU with the Myanmar Department of Rural Development (DRD) within the Ministry of Agriculture, Livestock and Irrigation (MOALI). In July 2017 the roads elements of DRD were transferred to the Ministry of Construction (MoC) as the Department of Rural Roads Development (DRRD).

An AsCAP-DRD scoping study[1] identified a priority list of key projects to be addressed by the AsCAP-DRD (now DRRD) initiative. A review of the current Myanmar rural road standards and specification in relation to regional and international good practice was identified as an essential precursor to the development of a Myanmar Rural Roads Design Manual.

This topic is also clearly in line with the Government of Myanmar's policy that fully recognises the importance of access in sustainable rural development. It has, in cooperation with the Asian Development Bank (ADB) and the Ministry of Border Affairs (MBA), drafted a National Strategy for Rural Road and Access (NSRRA). This document summarises the Government's policy and includes a proposed strategy based on the development of a Core Rural Road Network (CRRN).

As stated in the National Strategy document, the long-term development objective of the Government of Myanmar is to provide all-season access to all villages in Myanmar. In support of this long-term development objective, this NSRRA targets the next 15 years up to 2030, during which the Government of Myanmar aims to provide all-season road access to at least 80% of the villages in each state/region in Myanmar. DRRD, with the support of the Asian Development Bank (ADB), is preparing a programme of rural road rehabilitation and construction in two initial areas (Ayeyarwady Region and Magwe Region) that will complement the Rural Development Programmes already underway in southern Shan State with the support of KfW. Appropriate rural road standards and specifications are crucial in supporting the above initiatives and their succeeding phases.

## 1.2 Project Objective

The objective of the project is a review of existing Myanmar LVRR technical standards, specifications and design guidelines in comparison with current regional and international good practice. This will lead to recommendations on their upgrade and expansion within the current NRSSA classification framework. It is intended that these revised standards and specifications will be available for adoption within parallel ADB, World Bank and KfW supported DRRD programmes. The outcomes from this standards and specifications project will also contribute to a separate but related wider DRRD-AsCAP aim, which is the development of an effective LVRR Design Manual.

The scope of the project is therefore to produce findings on (i) existence of specifications in the rural road sector, used in Myanmar; (ii) the appropriateness of these specifications; (iii) which standards and specifications could benefit from improvement or refinement; (iv) which standards and specifications are yet to be developed in the Myanmar context; and (v) what can be learned from design manuals and specifications used elsewhere. As defined in the ToR this review is focussed on the two contrasting regions of Ayeyarwady (low-lying delta/coastal) and southern Shan State (upland plateaus/steep hill). Lessons can be drawn from these regions for a country-wide roll-out.

[1] Serge Cartier van Dissel, 2016. Myanmar Research Programme Planning with the Department of Rural Development. ReCAP report MYA2080A

## 1.3 Report Structure

This Draft Final Report starts with an outline of the context of the project. Section 2 presents the project framework, while section 3 discuss the key issues in relation to standards and technical specifications. Sections 4 and 5 showcase international standards and specifications and present an overview for comparison with existing Myanmar documents. Section 6 outlines the road environment in Myanmar and concludes on the regional differences with respect to other countries. Section 7 presents the current status of development of standards and specifications in Myanmar. This is followed by the findings and feedback from stakeholders and the recommendations from the Review Workshop in Section 8. Section 9 consolidates the stakeholders review and the assessment of international manuals and proposes an outline for the LVRR manual for Myanmar. Section 10 presents recommendations for the development of the manual. Finally, Section 11 lists the consulted reference documents.

# 2 Project Framework

## 2.1 Work Undertaken

An Inception Report was submitted to the AsCAP Project Management Unit (PMU) at the end July 2017 which summarised key issues and confirmed the agreed programme. During the start-up phase, the consultants made an inventory of stakeholders and sources of data and planned subsequent data collection, field visits and discussions with stakeholders.

The main data collection commenced in September 2017 with field visits to the Ayeyarwady Region and southern Shan State, to assess local conditions on and around rural roads. Discussions were held with representatives from the RDP (KfW) project in Taunggyi, the RRAP (ADB) project in Ayeyarwady and Magwe regions, field offices of DRRD in Maubin, Pathein (Ayeyarwady Region) and Taunggyi. Further discussions were held with representatives from JICA, World Bank, ADB, KfW, Myanmar Engineering Society (MES), the Myanmar Construction Entrepreneur Association (MCEA) and the MOC materials laboratory in Yangon. Existing data and drawings on standards were collected and transcribed from the DRRD and MOC. Information from the RDP, RRAP and other organisations were tabulated and analysed. A brief Interim Report was submitted to the PMU on 27 December 2017.

Subsequent data analyses and findings were discussed during a stakeholder workshop on 24 January 2018 in Nay Pyi Taw. The workshop proceedings report was submitted on 30 January 2018.

## 2.2 The Department of Rural Road Development

Institutionally, as from July 2017, the Department of Rural Road Development (DRRD) is located within the Ministry of Construction (MoC). The DRRD has taken over all the rural-road related responsibilities, both centrally and regionally, that were previously the responsibility of the Department of Rural Development within the Ministry of Agriculture, Livestock and Irrigation.

A Research and Development Unit (RDU) is currently being established within DRRD, with support from AsCAP/ReCAP. It is likely that in the future the RDU will be the Directorate within MoC that will have the responsibility for the research and development of the rural road standards, specifications and manual. The transfer of this directorate into MoC will facilitate the cooperation with other road-related directorates, Figure 2-1

## 2.3 Parallel Projects

In parallel with the development of rural road standards, the DRRD is implementing several rural road related projects including the Rural Development Project in southern Shan State, with funding from KfW, and the Rural Road and Access Project, with support from ADB and a World Bank financed Flood Landslide Emergency Recovery Credit Project (FLERC). Additionally, the World Bank is funding a nationwide Community Driven Development (CDD) Project under the DRD MOALI, with relevance to local rural roads in Myanmar.

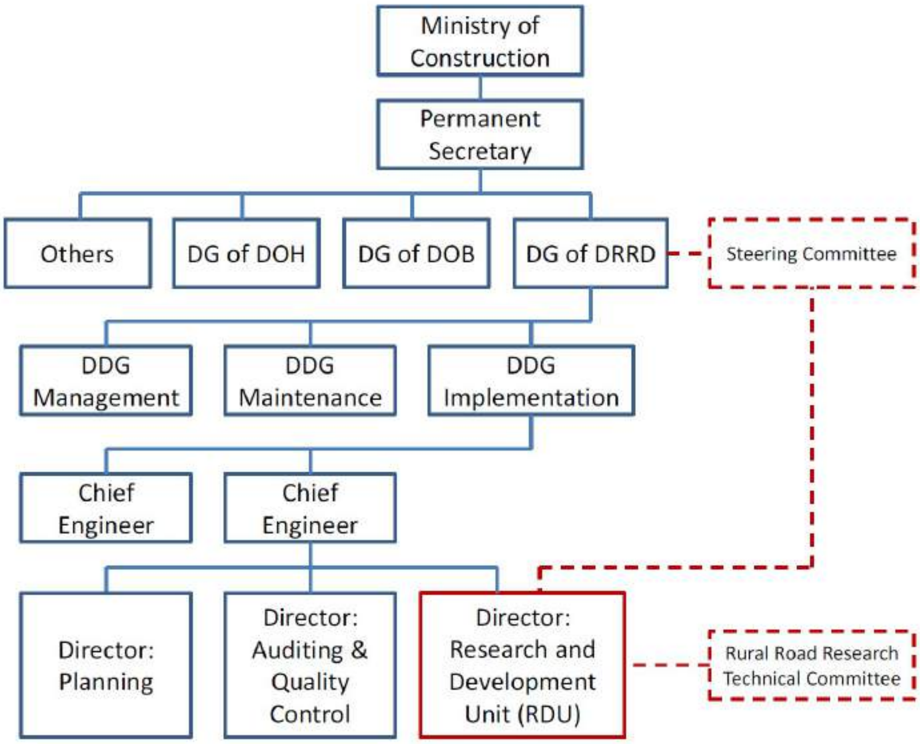
The KfW-DRRD RDP programme has been underway since 2014, while the RRAP is in the Project Preparation stage. The KfW-DRRD RDP programme has developed its own set of standards and specification, based on regional experience. Experience from the RDP in the application of these project standards and specifications is very useful in the development of Myanmar rural road standards. The development of standards and specifications to be used in the RRAP project is part of an ongoing cooperation with the AsCAP programme, including development of LVRR standards. Close coordination has been set up with the RRAP to exchange information.

Through a loan for the Regional Development Project for Poverty Reduction, The Japan International Cooperation Agency (JICA) supports various sectors in Myanmar: Water supply, Power supply and secondary road and bridges (with MOC), and through the Small-Scale Infrastructure Improvement for Poverty Reduction, in Sagaing region, JICA also supports agricultural development (MOALI). A new project is under preparation that would support Rural Infrastructure Development in Local Areas and planned to be implemented in Chin State and Ayeyarwady Region. This grant aims to improve income and living standards in local areas by contributing the balanced growth between rural and urban areas through development of rural infrastructures: targeting roads and bridges, water supply, agricultural mechanisation and irrigation.

JICA does not have pre-set standards or specifications in place to be used in future projects and is interested in the progress on the development of LVRR standards and specifications, to apply these in future interventions.

KfW is keen on further development of appropriate rural road standards and specifications and granted the consultant access to information through the Rural Development Project (RDP). This project is very relevant, as it focusses its interventions on rural road rehabilitation in southern Shan State. The project is starting the second phase and lessons learned from the review could benefit the project and DRRD. In addition, the project offers valuable lessons and experiences from phase 1, discussed further in this report.

**Figure 2-1: Structure of DRRD within MoC**



# 3 Rural Road Standards and Specifications: Key Issues

## 3.1 A Practical Framework

Standards and specifications for LVRR fall within a framework that is aimed at delivering a sustainable fit-for-purpose rural road network within an affordable budget. Key elements of this framework are:

- Design Guidance (3.2)
- Classification (3.3)
- Standards (3.4)
- Technical Specifications (3.5)

Experience indicates that the road classification-standards -specification framework should be based around road task or purpose. This allows for a consistent treatment of all similar roads within the road infrastructure system in terms of their design, construction, maintenance requirements, users expectations, and safety with the clear aim that the roads within a rural network can be designed to be “fit-for-purpose”.

## 3.2 Design Guidance

The relation between standards and specifications could be illustrated by the following analogy:

| | |
|---|---|
| **Cook book** | **= Design Manual / Design Guideline** |
| **Menu** | **= Set of Standards** |
| **Dish** | **= Particular Standard** |
| **Recipe** | **= Technical Specifications** |

Design guidelines, or manuals, are the means by which the road classification, standards and specifications are drawn together into accepted procedures in order to achieve the required outcome. Most road authorities have standard guidelines or manuals for the design, construction and maintenance of road and associated structures. This issue is further discussed in Section 10.

## 3.3 Classification

Classification allows for the division of road networks into manageable groups that allow for broadly similar good practice design options that are neither under-designed or over-conservative and costly. It is generally expected that there is a strong correlation between current and future traffic levels and the administrative function of a road and therefore an administrative classification is commonly seen as a suitable option. Although traffic levels often increase in line with the administrative classification hierarchy, this is not always true. Furthermore, the traffic levels are likely to differ considerably between different areas and different regions of Myanmar; the traffic on a village-to-village road in Ayeyarwady Region might be considerably different from that than on a similar road in Magwe or Taunggyi. Therefore, the design of the road should reflect the above complexities.

A Classification system is not only necessary for effective management and delegation of responsibilities for different parts of the road network but also provides important outcomes that depend on the class assigned to each road, including:

- Definition of road purpose
- Establishment of road design criteria
- Development of road management systems
- Planning of road construction and maintenance
- Guidance to the general public

## 3.4 Standards

A national road 'standard' defines a minimum level of service and performance that should be achieved at all times. This translates to a set of agreed norms, uniformly applied in the design. Amongst other things this ensures consistency across the country. Thus, for roads this means that people know exactly what to expect and road managers know what they must achieve and maintain. In terms of safety, drivers are not 'caught out' by unexpected changes in quality and will not unexpectedly find that a road is too narrow, or that they must alter their speed drastically to avoid losing control of their vehicle. Thus, standards are a guarantee of a particular quality level and although they are not synonymous with specifications they could, and often are, incorporated into specifications and contract documents.

Experience has shown that simply adopting international standards from developed countries is not an appropriate way forward for rural road network development, as these normally do not take the immediate road environment and financial constraints into account. There is also a need to differentiate between high volume road standards and low volume road standards. The difference between high volume roads and low volume road design is explained in Table 3-1.

**Table 3-1: High Volume versus Low Volume Road Design**

| High Volume Road Design | Low Volume Road Design |
|---|---|
| Traffic dominant in pavement deterioration | Environment dominant in pavement deterioration |
| Design reliability high (typically > 90%) | Design reliability modest (typically 50-90%) |
| Designed for higher speed (>80 km/h) | Designed for lower speed (< 40 - 60 km/h) |
| Main traffic composition: motorized vehicles | Main traffic composition may include large percentage of 2-3 wheelers and non-motorized vehicles |
| Focus on mobility function (speed) | Focus on access function (reliability) |
| Traditional thinking related to road design (what should be done) | Innovative and flexible thinking focusing on appropriate engineering judgment (what can be done with the resources available) |
| Designed by experienced Consultants | Designed by Local Consultants and/or in-house by the Client with limited means |
| Implemented by experienced and well-equipped contractors | Implemented by local contractors using intermediate equipment and labour |
| Use of traditional materials (e.g. crushed stone, cement stabilized layers, hot mix asphalt, etc.) | Use of non-traditional natural in gravels (e.g. pedogenic, in situ, materials), surfacing seals using cold mix asphalt, emulsion based seals, etc. |

There is a range of standards associated with road networks including those, for example, covering road geometry, safety, environmental compliance and climate resilience. However, a principle set of standards that in many ways lead to, or are associated with, the broader range are those that are commonly referred to as "Geometric Standards": Table 3-2.

**Table 3-2: Examples of standards**

| Standards | Description |
|---|---|
| **Geometric** | Covers road carriageway width and shoulders, cross-fall, horizontal and vertical alignments and sight lines, and the transverse profile or cross-section. The cross-sectional profile includes the design elements of side drains, embankment heights and side slopes, and is a vital part of geometric design for low volume roads. The cross-section essentially adapts the pavement or roadway to the road environment and is part of the drainage design. |
| **Pavement** | Provide minimum levels of service for the intended traffic (design vehicle); this includes comfort, speed, strength to withstand the total axle loads over the life of the road. There are wide ranges of LVRR options to consider in pavement standards, unsealed, stone, bitumen sealed and concrete. For LVRRs it is crucial that local conditions, availability of materials and life-cycle costs are taken into consideration. |
| **Hydraulic/drainage** | Set minimum hydraulic capacity (opening) for structures conveying water to cross the road in a controlled way. Standards include minimum freeboard on structures and embankment heights above projected high flood water levels. Hydrological standards relate to the statistical occurrence (return periods) of rainfall events and the resulting runoff from catchments.<br>Hydraulic standards include a freeboard or safety margin to allow for errors. In addition to this, for each type of structure a different return period is set for the design. Typically for cross drainage structure a 1 to 5 or 10-year event is used and for bridges it is set often at a minimum of 1:50 or 1:100 years. |
| **Safety** | In the context of engineering standards, methods to improve safety through safer design are of paramount importance. These standards are cross cutting and impacting on geometric design, pavement design, structural design, design of road furniture |
| **Small Structures** | The geometry, strength and hydrological criteria to be incorporated within LVRR small structures |
| **Climate Resilience** | Levels of climate resilience need to be set as targets for different road classifications within a network in order to balance climate change adaption with the available budget. Standards usually come in the form of performance levels and are cross cutting and impacting on hydrological analyses, hydraulic design, geometric design, construction methods, environmental engineering, structural design |
| **Structural (construction)** | Structural standards define the loading criteria to be considered for structures, the strength to be obtained for the adopted design load and define quality criteria for materials to be used in construction |
| **Maintenance** | Levels of maintenance need to set as targets for different classification levels as a guide to network managers. |

Although more often defined in guidelines, standards can also be formulated for:

- Survey and geotechnical investigation
- Road asset management
- Procurement
- Social and Environmental safeguards
- Land acquisition and compensation

## 3.5 Technical Specifications

Technical specifications define and provide guidance on the design and construction criteria for rural roads to meet their required level of service. Specifications appropriate to the local engineering environment are an essential element of an effective operational (enabling) environment to design sustainable cost-effective road infrastructure. The use of locally available, but frequently non-standard, pavement construction materials plays a significant role within this concept.

Technical specifications define actions, procedures or materials that should be used to design, construct and maintain LVRR networks and their constituent roads. As with LVRR standards the use of locally appropriate documents is imperative. Technical specifications cover a wide range of issues. Table 3-3 defines key specification types.

Technical Specifications can be defined as the norms, methods and features of design (inputs) that lead to the desired standard. In addition, the following issues should be considered with respect to specifications:

- There can be more than one specification leading to the same result
- Specifications can be method based (describing the process) or performance based (describing the output)
- Specifications may vary by road environment
- Specifications are drawn up in contracts to ensure uniformity and quality control of the works, facilitate measurements, define acceptable tolerances and define unit of payments.

**Table 3-3: Typical Technical Specifications**

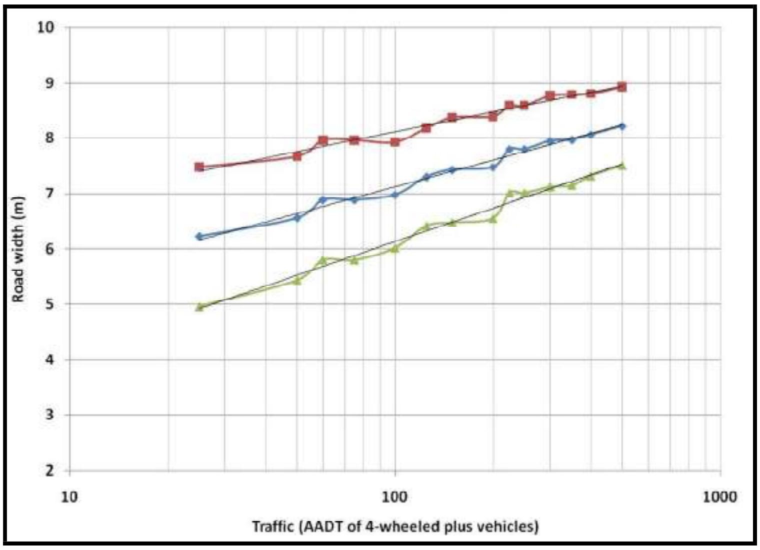
| Specifications | Description |
|---|---|
| **Construction Methodology** | These provide detailed methodologies by which elements of a LVRR should be constructed and include such key issues as:<br>•a Pavement<br>•a Earthworks<br>•a Drainage<br>•a Small structures<br>•a Bio-engineering |
| **Construction Materials** | These define the acceptable limits (properties, strength, durability etc.) for the selection and use of construction materials, both natural and man-made and will cover such item as:<br>•a Pavement aggregate<br>•a Concrete<br>•a Bitumen<br>•a Wood (wooden bridges) |
| **Quality Assurance and Quality Control** | Defines the methods to be used in terms of supervising the quality of LVR elements and the use of specified equipment and testing procedures. |
| **Maintenance Activities** | Defines the procedures to be used in undertaking the different types of LVRR maintenance; routine (mechanical and non-mechanical); periodic and emergency. |
| **Laboratory Testing** | Defines the laboratory testing procedures to be used in collaboration with construction, materials and quality specifications. In contrast to other standards and specification these are usually more effectively based on established international procedures, such as AASHTO or ASTM. |

# 4 Regional and International Standards

## 4.1 General

Development of appropriate standards for LVRR has increasingly been a focus for international research through programs such as SEACAP, AFCAP, and recently, RECAP. It has become apparent that the uptake and embedment of such standards and the cost-beneficial outcomes can only be achieved through a framework of dedicated national standards and specifications. For example, works undertaken by the DFID-funded SEACAP initiative undertook reviews both in Laos and Cambodia on the key principles of geometric standards. Figure 4-1 and Table 4-1 present some outcomes from these surveys that illustrates the basic practical relationships between traffic and geometry.

**Figure 4-1: Plot of Traffic versus Road Width (carriageway and shoulders)**




**Median, and upper and lower standard deviations shown**

**Source:** TRL Ltd. (2009), *Rural Road Standards and Specifications: Classification, Geometric Standards and Pavement Options*, Cambodia: OTB-KACE-TRL, SEACAP 19.03, Ministry of Rural Development, Cambodia

## 4.2 Geometric Standards Issues

To quantify traffic, the concept of equivalent passenger car units (PCUs) is often used. This is the relative space a vehicle takes on the road compared to a normal car. Thus, a typical 3-axle truck occupies about three times as much road space than a typical car hence it is equivalent to 3 PCUs. A motorcycle requires less than half the space of a car and is therefore equivalent to around 0.3 to 0.5 PCUs. Vehicles, such as ox-carts, are slow-moving and cause congestion because of their speed rather than because of their size. In effect, they can be considered to occupy more road space than would be expected from their size alone. Thus, the real PCU rating of a vehicle is affected by the type of traffic and varies with the traffic mix, volume and speed. Common agreement on the PCU rating of different vehicles is therefore difficult to achieve because of variations in traffic and roads between regions and between countries. Developing specific conventions on the PCUs based on the composition of the local traffic for the Myanmar regions would be beneficial.

The importance of the equivalent vehicle (PCU) in the rural context is illustrated in Table 4-2. The values recognise both the space a vehicle takes on the road as well as the duration the vehicle occupies that space. Larger and slower vehicles therefore are given a high PCU value, while small and fast vehicles are assigned a low PCU value. Appropriate PCUs can be used as equivalency factors to adjust the Annual Daily Traffic (ADT) or Annual Average Daily Traffic (AADT) figures for more realistic assessment of geometric requirements.

**Table 4-1: List of international LVRR classifications and Geometry**

| No. | Source | Classification | Traffic Divisions | Terrain Class. | Carriageway and shoulder width (m) | Design Speed (km/h) | Vertical Gradient % |
|---|---|---|---|---|---|---|---|
| 1 | **India** | 1. Other District Roads (ODR)<br>2. Village Roads (VR). | Definition | Plain<br>Rolling<br>Mountainous<br>Steep | 7.5, 4.75 & 4.35 for ODR.<br>6.0, 4.0 & 3.75 for VR. | 20 to 50 for ODR.<br>20 to 40 for VR. | 3.3 to 8 for both ODR and VR. |
| 2 | **Vietnam** | A & B | By axle Load<br>6T for A &<br>2.5T for B | Mountainous<br>Upland Hilly<br>Lowland<br>Deltaic<br>Sandy Coastal | 5.0 for A<br>4.0 for B | 25 for A<br>15 for B | 15% for A<br>20% for B |
| 4 | **World Bank** | Basic Access | Less than 50 VPD | Flat<br>Rolling<br>Mountainous | 3.5 to 5.0 for Flat<br>3.0 to 5.0 for Rolling<br>3.0 to 4.0 for Mountainous | Less than 30 km/h | N/A for Flat<br>12% for Rolling<br>12 to 15% for Mountainous |
| 5 | **Southern African Development Committee (SADC)** | D and E | AADT<br>Less than 200<br>50-200 for D<br><50 for E | Flat<br>Rolling<br>Mountainous | 8.0 m for D.<br>6.0 m for E. | 70 km/h: flat.<br>70 km/h: rolling.<br>50 km/hr mountainous. | N/A |
| 6 | **Australia** | Minor, Local Access without buses, Local Access with buses and Local Access Industrial. | AADT | N/A | N/A | 80 km/h: flat.<br>70 km/h: rolling.<br>50 km/h: mountainous. | N/A |
| 7 | **USA** | Rural Major Access<br>Rural Minor Access<br>Rural Commercial Access<br>Rural Agricultural Access<br>Rural Recreational<br>Rural Resource Recovery. | Access function and ADT less than 400. | N/A | 5.4 m to 8.0 m depending on the selected speed. | From 20 Km/h to 100 Km/h for all road classification. | Calculate from Equation. |
| 8 | **Thailand** | 4 and 5 | ADT<br>300-1,000 class 4<br><300 for class 5 | Flat-mod. rolling<br>Rolling or hilly<br>Mountainous | 9.0 m for 4<br>8.0 m for 5 | 70-90, 55-70 and 40-55 (4)<br>60-80, 50-60 and 30-50 (5) | 4% for flat<br>8% for rolling and<br>12% for mountainous. |
| 9 | **Overseas Road Note (ORN) 6** | D, E and F | ADT<br>100-400 for D.<br>20-100 for E.<br><20 for F | Level<br>Rolling<br>Mountainous | 7.0 for D<br>6.0 for E<br>2.5-3.0 for F. | 50, 60 and 70 km/h for D<br>40, 50 and 60 km/h for E.<br>N/A for F.<br>(depends on terrain) | 10% for D.<br>15% for E.<br>15-20% for F |

**Table 4-2: Equivalency Factor for ADTs (PCU system)**

| Ref. | Vehicle Type | Equivalency Factor (PCU) | | |
|---|---|---|---|---|
| | | Nepal | Bangladesh | Cambodia |
| **1** | Car, Light Van, jeeps and Pick Up | 1.0 | 1.0 | 1.0 |
| **2** | Light Truck up to 2.5 tonnes gross | 1.5 | 3.0 | 1.5 |
| **3** | Truck up to 10 tonnes gross | 3.0 | | 1 |
| **4** | 4wheel Truck up to 15 tonnes gross | 4.0 | | 2.5 |
| **5** | 4-wheel Tractor towed trailers -standard | 3.0 | | |
| **6** | 2W Tractor towed trailers -standard | 1.5 | | 1.0 |
| **7** | Bus up to 40 passengers | 3.0 | 3.0 | 1.1 |
| **8** | Bus over 40 passengers | 4.0 | | 2.3 |
| **9** | Motorcycle or scooter | 0.5 | 0.3 | 0.4 |
| **10** | Bicycle | 0.5 | 0.3 | 0.3 |
| **11** | Rickshaw and Tricycle carrying goods | 1.0 | 1.0 | |
| **12** | Motorcycle with trailer | | | 1.0 |
| **13** | Auto Rickshaw | 0.75 | 1.0 | |
| **14** | Hand Cart | 2.0 | | |
| **15** | Bullock Cart with Tire | 6.0 | 4.0 | 0.4 |
| **16** | Bullock Cart with Wooden Wheel | 8.0 | | |
| **17** | Mule or Horse drawn carts | 6.0 | | |
| **18** | Pack Animal and mules | 2.0 | | |
| **19** | Pedestrian | 0.2 | | |
| **20** | Porter | 0.4 | | |

**Source:** Nepal: Rural Road Standards, Dolidar (2012). Bangladesh: Road Design Standards, Rural Roads, LGED (2005), Cambodia: Rural Road Standards and Specifications: classification, Geometric Standards and Pavement Options, MRRD / SEACAP (2009)

Table 4-3 presents ADT data (not adjusted to PCU) in relation to carriageway and shoulder widths from the standards documentation for number of regional countries.

**Table 4-3: Relevant Regional Road Width Recommendations on widths**

| Country, Reference | Road Type | Terrain | Traffic (ADT) | Carriageway (m) | Shoulder (x2) (m) | RoW (m) |
|---|---|---|---|---|---|---|
| **Nepal, DoLIDAR 2012** | Core Network (District) | Hill/Mountain | >400 ADT | 5.50 | 0.75 | 20.00 |
| | | | >100 ADT | 3.75 | 0.75 | |
| | | | <100 ADT | 3.00 | 0.75 | |
| | | Flat to rolling | >400 ADT | 5.5 | 1.00 | |
| | | | >100 ADT | 3.75 | 1.50 | |
| | | | <100 ADT | 3.00 | 1.50 | |
| | Village Road | Hill/Mountain | Not defined | 3.00 | 0.5 | 15.00 |
| | | Flat to rolling | | 3.00 | 0.75 | |
| **Bangladesh, LGED, 2005** | 4 | Flat | 530 ADT | 5.50 | 2.15 | |
| | 5 | | 290 ADT | 3.70 | 1.80[1] | |
| | 6 | | 210 ADT | 3.70 | 1.80[2] | |
| | 7 | | 130 ADT | 3.70 | 0.90[2] | |
| | 8 | | 90 ADT | 3.00 | 1.25[2] | |
| **Cambodia, SEACAP, 2009.** | RR1 | | 200-500 ADT (A)[3] | 6.00 | 1.50 | |
| | | | 200-500 ADT (B)[4] | 6.00 | 1.00 | |
| | RR2 | | 100-200 ADT (A)[3] | 5.00 | 1.50 | |
| | | | 100-200 ADT (B)[4] | 5.00 | 1.00 | |
| | RR3 | | 30-100 ADT (A)[3] | 3.50 | 1.50 | |
| | | | 30-100 ADT (B)[4] | 3.50 | 1.00 | |
| | RR4 | | 5-30 ADT (A)[3] | 3.00 | 1.00 | |
| | | | 5-30 ADT (B)[4] | 3.00 | 0.75 | |
| | RR5 | | <5 ADT (A)[3] | 2.50 | 1.00 | |
| | | | <5 ADT (B)[4] | 2.50 | 0.75 | |
| **Thailand** | 4 | All terrain | 300-1000 ADT | 9.00[5] | | |
| | 5 | | <300 ADT | 8.00[5] | | |
| **Lao PDR, MPWT-ADB, 2017** | IV | Flat | 300-1000 ADT | 6.00 | 1.00 | 20-25m |
| | | Rolling | 300-1000 ADT | 6.00 | 1.00 | |
| | | Mountainous | 300-1000 ADT | 6.00 | 0.75 | |
| | V | Flat | 100-300 ADT | 5.50 | 0.75 | |
| | | Rolling | 100-300 ADT | 5.50 | 0.75 | |
| | | Mountainous | 100-300 ADT | 5.00 | 0.50 | |
| | VI | Flat | 50-100 ADT | 3.50 | 1.50 | |
| | | Rolling | 50-100 ADT | 3.50 | 1.50 | |
| | | Mountainous | 50-100 ADT | 3.50 | 1.25 | |
| | VII | Flat | <50 ADT | 3.50 | 1.25 | |
| | | Rolling | <50 ADT | 3.50 | 1.25 | |
| | | Mountainous | <50 ADT | 3.50 | 1.00 | |

**Footnotes:**

1 = 0.90m shoulder + 0.90m verge

2 = Verge only

3 = ADT of 2 or more axle vehicles and >300 PCU of <2 axle transport

4 = ADT of 2 or more axle vehicles and <300 PCU of <2 axle transport

5 + Total roadway width

## 4.3 Road Safety Standards

Experience has shown that simply adopting 'international' design standards from developed countries will not necessarily result in acceptable levels of safety on rural roads. The main reasons include the different mix of traffic, including relatively slow-moving and usually overloaded vehicles with large number of pedestrians, animal drawn carts and, possibly, motorcycle-based forms of transport and other intermediate means of transport (IMTs). Often driver's knowledge of traffic rules is poor and regulations are rarely enforced. In such an environment, methods to improve safety through engineering design are of paramount importance.

The iRAP (International Road Assessment Programme; (http://www.irap.net/en/)[2] program built knowledge on road safety assessment across countries in partnership with government and non-government organizations to (i) inspect high-risk roads and develop 'Star Ratings' and 'Safer Roads Investment Plans', and (ii) provide training, technology and support that will build and sustain local, national, regional capability.

Information and lessons learnt from iRAP, clearly highlights the relationship between the additional investments in lane and shoulder widening and the resultant cost savings from reductions in road crashes, deaths and injuries. Monitoring road safety performance of improved roads enables funding agencies to assess the benefits of road safety investments.

With respect to the **impact of lane width on road safety** the findings were:

- Effectiveness: Lane widening typically resulted in a 25-40% reduction in crashes.
- Benefits: Increased lane widths reduced head-on crashes, reduced run-off-road crashes, reduced sideswipe crashes, and improved traffic flow.
- Traffic lanes on rural roads with less than 3.0 meters width tend to have higher crash rates. A lane width of 3.5 meters is often recommended (except where the presence of ***cyclists*** means that wider lanes are needed).
- It is usually safe for lanes approaching signalized urban intersections to be narrower than high speed through lanes on straight road sections.

**Table 4-4: The Relationship of Lane Width and Accident Risk**

| **Lane Width (m)** | 2.5 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 3.8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Relative Risk** | 3.4 | 3.4 | 3.3 | 3.2 | 3.0 | 2.9 | 2.7 | 2.5 | 2.3 | 2.1 | 1.8 | 1.6 | 1.3 | 1.0 |

**Note:** Relative Casualty crash risk (expressed as a factor) for urban arterials where speed limit is ≥ 80 km/hr. **Source:** Queensland, Australia (ARRB group, Crash Rates Database, from Turner et. al (2009))
)

In relation to the **width of paved shoulder** the findings indicate:

- Effectiveness: as with lane widening, paved shoulder widths typically reduces occurrences of crashes with 25-40%.

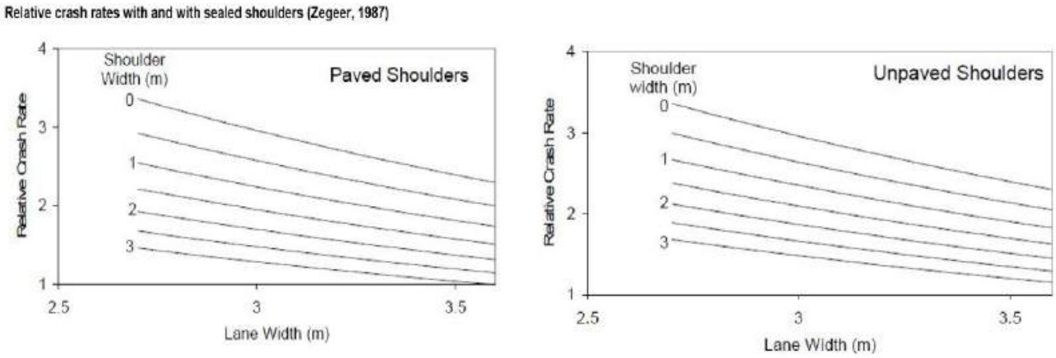
- Benefits of Paved Shoulders resulting in:
    - reduced run-off-road and head-on crashes,
    - wider shoulders allow vehicles to pull off the road in emergency situations, providing clearance for through traffic

[2] *Text and figures are from iRAP selected factsheets: on Lane Width and Shoulder Width*

- Sealed shoulders (designed to the same standard as the seal of the carriageway) provide a safe (motor) cycling space, and can be marked as bicycle lanes, sealed shoulders provide structural support to the road pavement, sealing can reduce 'edge drop' (where there is a difference between the height of the road surface and the height of the shoulder).

- Wider sealed shoulders also have a positive impact on the pavement structure as it limits moisture ingression beneath the wheel tracks.

**Figure 4-2: Crash Rates with and without sealed /paved shoulders Zegeer, (1987)**




**Source:** Zegeer, C.V. & Deacon, J.A. (1987). Effect of lane width, shoulder width and shoulder type on highway safety. In: Relationships between safety and key highway features; State of the art report 6. Transportation Research Board, Washington, D.C.

The SATCC guideline (in line with ORN6 and AASHTO standards) on geometric standards says: "The selection of lane width is based on traffic volume and vehicle type and speed. Higher volumes and speeds require wider lanes, and the greatest lane width recommended is 3.7 m. No operational or safety benefit accrues from lane widths wider than 3.7 m although, for different reasons, urban lane widths can be as great as 5.5 m. The narrowest width recommended for roads with mixed slow and fast traffic (urban and rural) is 3.1 m, giving a clear space of 0.3 m on either side of a vehicle that is 2.5 m wide. This lane width will normally be employed only where speeds or traffic volumes are expected to be low. Intermediate conditions of volume and speed can be adequately catered for by a lane width of 3.4 m. It should be noted that "low traffic volumes" in the SATCC contexts means the lower range of High Volume Roads (HVRs) and upper range of Low Volume Roads (LVRs).

# 5 Regional and International Specifications

## 5.1 Summary

Section 3.5 identified key LVRR-related technical specifications groups:

- **Construction Methodology**
    - Pavement
    - Earthworks
    - Drainage
    - Small structures
    - Bioengineering
- **Construction Materials for use in:**
    - Pavement/earthworks/drainage
    - Small structures
- **Quality Supervision**
- **Maintenance Activities**
- **Laboratory Testing**

Table 5-2 lists some of the recent work relevant to these technical specification groups with specific reference to rural roads and related structures in the South Asia and South East Asia region. References are listed in Table 5-1.

**Table 5-1: Key References**

| | |
|---|---|
| **Vietnam,2006 Intech-TRL, SEACAP** | Intech-TRL, 2007. Rural Road Standards and Specifications: Classification, Geometric Standards and Pavement Options. SEACAP 19.03. Ministry of Rural Development, Cambodia. |
| **Laos, 2007 SEACAP 17** | Roughton, 2007. Local resource solutions to problematic rural roads access in Lao PDR; SEACAP access roads in Route 3. SEACAP 17, DfID report for MPWT, Lao PDR |
| **Cambodia, 2009 SEACAP 19** | TRL-OTB, 2009. Rural Road Standards and Specifications: Classification, Geometric Standards and Pavement Options. SEACAP 19.03. Ministry of Rural Development, Cambodia |
| **Laos, 2009 SEACAP 3** | TRL-LTEC, 2009. Low volume rural roads standards and specifications; Part II Pavement options and technical specifications. SEACAP 3, DfID for MPWT Lao PDR. |
| **Inter-regional, 2001 TRL** | Cook, J R et al. The selection and use of construction materials for road construction in tropical and sub-tropical countries. DfID KaR Report R6898, TRL Ltd, UK. |
| **Nepal, 2005 Dept. of Roads.** | Department of Roads, Nepal (2006). Roadside Geotechnical Problems: A Practical Guide to their Solution. Road Maintenance and Development Project, IDA Credit No. 3293-NEP |
| **Vietnam, 2016 ICEM-ADB** | ICEM, 2017. Promoting Climate Resilient Rural Infrastructure in Northern Viet Nam TR-18 Sample Drawings and Specifications for Slope Protection, ADB TA 8102 VN for MARD, Vietnam |
| **Laos, 2008 SEACAP 21** | Scott Wilson, 2008.Slope Maintenance Manual, Ministry of Public Works and Transport, Lao PDR |
| **Nepal, 1997 TRL** | TRL 1997. Principles of Low Cost Road Engineering in Mountainous Regions, ORN 16 Transport Research Laboratory, Crowthorne, UK |
| **Regional 2010 ADB-DFID** | Larcher P., Petts R. and Spence R. 2010. Small Structures for Rural Roads. A Practical Planning, Design, Construction & Maintenance Guide. ADB and DFID |

In contrast to most of Technical Specifications for the Asia Region, those for laboratory testing are based on or adopted straight from international sources such as AASHTO, ASTM or Euro Codes.

**Table 5-2: Regionally Relevant Work on Technical Specifications**

| Country Reference | Specification Group | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | – 1 – Construction method / design | | | | | – 2 – Construction Materials | | – 3 – Quality Supervision | – 4 – Maintenance Activities | – 5 – Laboratory Testing |
| | 1a Pavement | 1b Earthworks | 1c Drainage | 1d Small structures | 1e Bioengineering | 2a Pavement, Earthwork, Drainage | 2b Small structures | | | |
| Vietnam,2006<br>Intech-TRL, SEACAP | √ | | | | | √ | | √ | √ | |
| Laos, 2007<br>Roughton, SEACAP | √ | | | | | √ | | | | |
| Cambodia, 2009<br>TRL-OTB, SEACAP | √ | | | | | | | | | |
| Laos, 2009<br>TRL-OTB, SEACAP | √ | | √ | | | √ | | | | |
| Inter-regional, 2000<br>TRL | | | | | | √ | | | | √ |
| Nepal, 2005<br>World Bank | | √ | √ | | √ | | | | | |
| Vietnam, 2016<br>ICEM-ADB | | √ | √ | | √ | | | √ | √ | |
| Laos, 2008<br>Scott Wilson, SEACAP, | | √ | √ | | | | | √ | √ | |
| Nepal, 1998<br>TRL | | √ | √ | √ | √ | | | | | |
| Regional 2009<br>ADB-SEACAP | | | | √ | | | √ | | | |

## 5.2 Technical Specifications: Key Issues

Key lessons learnt from regional experience in the application of LVRR technical specifications are:

1.a There is wide ranging suite of detailed specifications within the principal groups required even for simple LVRR, for example SEACAP research into pavement options for LVRRs developed 25 separate technical specifications for pavement layers alone.

2.a It is necessary for the relevant Ministry or Road Authority to have a comprehensive library of approved specifications rather than relying on individual project consultants or Loan Agencies to develop their own. This latter approach potentially leads to inefficiency and confusion for contractors.

3.a Ideally the key technical speciation should be backed by government of ministerial decree.

4.a Specifications should be applicable for local road environments and particularly, with respect to construction materials the specifications must be achievable.

5.a Different technical specifications are likely to be required for LVRRs compared to those developed for high volume roads and national highway/toll roads

6.a They need to be clear and understandable for local national as well as international consultants and contractors.

7.a There needs to be linkage between key groups of specifications, for example between those defining the use of construction materials within a pavement and those defining the actions required in quality control.

8.a Specifications developed for adjacent countries that can be adopted for use in Myanmar will require reviewing for particular circumstance, for example the principles of specifications developed for bioengineering in Nepal were adapted for use in Vietnam but with significant changes in terms of local plant usage.

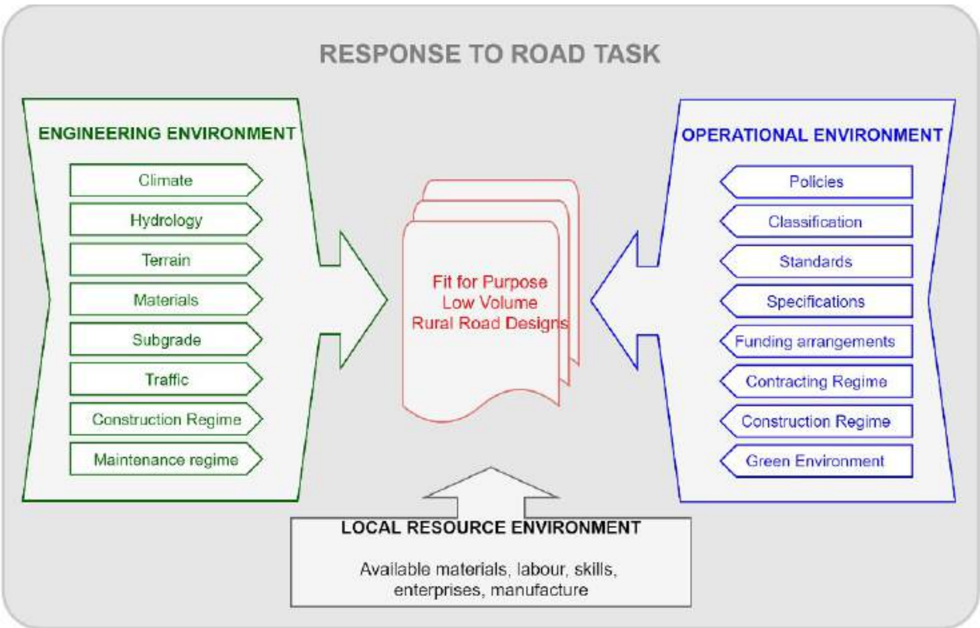
9.a Technical specifications for lower class LVRRs have to be appropriate for use mainly by local small contractors or community groups, some of whom will have limited experience in road building procedures other than those associated with unsealed gravel wearing course or stone macadam construction.

# 6 The Myanmar LVRR Environment

## 6.1 Introduction

Unlike high volume roads, it has become increasingly recognised that the life-time performance of LVRRs is influenced by the impacts of what is termed as the 'Road Environment' (Cook, Petts and Rolt, 2013). In a sector that is under significant pressure with regard to budgets and resources, the importance of the "Road Environment" with respect to the sustainable rural road networks becomes crucial. Taking on board the impacts of the road environment and their implications is seen as giving a rational and sound basis for LVRR design. Three key groups of factors have been identified: (i) an Engineering Environment, (ii) an Operational Environment and (iii) a Resource Environment, that feed into an appropriate design in response to a road, or road network task; Figure 6-1.

**Figure 6-1: The Low Volume Rural Road (LVRR) Environment**




Classification, Standards and Specifications occupy key positions within the Operational Environment. Classifications, standards and specifications themselves should be developed in compliance with the nature of the other road environment factors. Figure 6.2 illustrates this concept. Table 6-1 defines key impact factors and the following sections 6.2 and 6.3 define them with respect to the review areas, Ayeyarwady Region and southern Shan State.

**Figure 6-2: Key Road Engineering Environment Factors Impacting on Standards and Specifications**

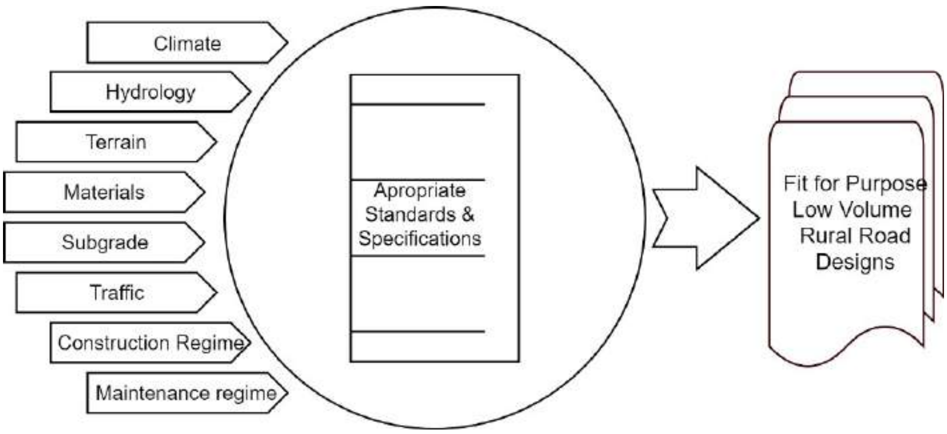


**Table 6-1: Key Road Environment Issues to be Considered**

| Impact Factor | Issue to be Considered |
|---|---|
| Climate. | LVRR networks are particularly vulnerable to climate impacts, principally either directly through erosion or indirectly through flooding, sea level rise. Additional impacts resulting from temperature changes and wind actions are also recognised. To be accommodated in line with the levels of Climate Resilience that may be required. |
| Hydrology | Hydrology is closely linked with climate in terms of flood levels, storm intensity and changes in ground water levels. The hydrology of the larger road environment and the catchments impact on the road hydraulic design and drainage system design. Storm event and peak runoff determine the hydraulic capacity required for cross water structures, while especially in flood prone areas the design level of the road embankment depends on the flood water levels. |
| Terrain | Of particular relevance to geometric and related safety standards. Steep hill or mountainous terrain can place some severe constraints on horizontal and vertical geometry and flexibility of standards may be required. |
| Construction Materials | The use of locally available materials where possible is a key principle of LVRR design. The implication is that specifications for material use need to be flexible and based on local experience rather than international norms. For rural networks the issue must be; 'what design options are compatible with the available materials?' rather than seeking to find material to meet standard specifications, as is the case with higher level roads. |
| Sub-grade | Assessment of in-service sub-grade condition is traditionally critical to pavement design. The range of strength of the foundation, or subgrade, is a fundamental input into pavement design and as such a factor to consider in design standards. |
| Traffic | Traffic needs to be incorporated into appropriate LVRR network standards in two ways. Firstly, in terms of accommodating the type and density of traffic in the geometry of the roads and secondly with respect to the strength of the roads and their structures. A related third issue is axle loading (and overloading) and how that is dealt with by standards. |
| Construction Regime | Key elements at rural network level are issues such as the experience and skill of the contractors or construction groups; quality control and supervision. Standards may need to be modified in terms of, or consider, different modes of construction; labour-based, plant-based, or appropriate-technology based. |
| Maintenance Regime | Design standards and specification should acknowledge a pragmatic assessment of the effectiveness of the governing maintenance regimes. |

## 6.2 The Low-Lying Coastal-Deltaic Environment: Ayeyarwady Region

Table 6.2 summarises relevant Ayeyarwady Region road engineering factors. Key issues are summarised in the following notes.

**Table 6-2: Ayeyarwady Region Road Engineering Factors**

| Impact Factor | Issue to be Considered |
|---|---|
| Climate. | Tropical monsoon in Myanmar "wet zone". Historical rainfall 2900-3700mm/yr. Rainfall May-October Anticipated increase in "very wet days" to 2039: 10%; to 2059: 20% |
| Hydrology | Coastal areas of Ayeyarwady Region are vulnerable to cyclone, storm surge, Tsunami, high wave and strong wind. Future climate threats are sea level rise and increased cyclone occurrence. Inland areas subject to river flood. General high-water tables, poor drainage. |
| Terrain | Low lying flat alluvial plain with a network of tributaries of the Ayeyarwady River. Elevation 0-5m ASL. |
| Construction Materials | Rock scarce and marginal quality. Local sand. |
| Sub-grade | Likely to be predominantly weak subgrades and foundations for embankments. Silty clays to silty sands, generally high plasticity. |
| LVRR Traffic | Standard design vehicle likely to be small truck. Some areas freight transport by river/canal. Possible use of low-axle load (4-5t) designs. |
| Design Construction Regime | Traditionally staged approach to upgrading of roads. Generically narrow existing road widths. Widening often requires land acquisition, where agriculture and urban build-up encroached the road reserve. Staged approach to upgrading from earth to macadam and macadam to sealed road allows for consolidation of soft subgrades. Problems with sinking of pavement materials. Local relaxation of legal road reserve and carriageway width may be needed. |
| Maintenance Regime | Periodic as well as regular routine maintenance and resource allocations for emergency maintenance are required to sustain road infrastructure. Performance based maintenance is often effective for maintenance activities off the carriageway (off-road), while output based maintenance regimes is better suited for maintenance on the carriageway. Community engagement in routine maintenance activities may be cost-effective and creates ownership and has local wage transfer benefits. |

## 6.3 Hilly to Mountainous Environment : Southern Shan State

Table 6.3 summarises relevant southern Shan State road engineering factors. Key issues are summarised in the following notes.

**Table 6-3: Southern Shan State Road Engineering Factors**

| Impact Factor | Issue to be Considered |
|---|---|
| Climate. | Tropical to temperate monsoon, within the Myanmar “intermediate zone”. Historical rainfall 1500-2000 mm/yr. Rain season May-October. Anticipated increase in “very wet days” to 2039 - 0%; to 2059 - 0% |
| Hydrology | Localised flooding river valleys. |
| Terrain | Upland plateau (1000m ASL). Rolling terrain with localised steep hill terrain |
| Construction Materials | Generally abundant rock for aggregate, principally limestone. Local scarcity of natural gravels and sand. |
| Sub-grade | Predominantly strong subgrades with localised weak areas in river valleys. |
| LVRR Traffic | Standard design vehicle likely to be a light to medium sized truck. Provisions for animal carts needed. Significant risk of axle overloading on some key routes |
| Design Construction Regime | Relaxation of geometric standards, in terms of vertical and horizontal alignment on hill slopes, may need to be considered to save costs. Road safety considerations include passing bays. |
| Maintenance Regime | Periodic as well as regular routine maintenance and resource allocations for emergency maintenance are required to sustain road infrastructure. Performance based maintenance is often effective for maintenance activities off the carriageway (off-road), while output based maintenance regimes is better suited for maintenance on the carriageway. Community engagement in routine maintenance activities may be cost-effective and creates ownership and has local wage transfer benefits. |

## 6.4 Key Lessons

Key lesson to draw out from the review of the road environments are:

•a The nature of local traffic is likely to differ between regions and this needs to be accommodated in the design standards. This needs confirmation by more detailed traffic surveys.

•a Need for flexibility in geometry to fit an engineering functionality related to traffic volume mix and to cater for local terrain conditions.

•a Material specifications need to be related to the locally available materials.

•a Differing sub-grade strengths should be catered for in design standards.

•a Hydrology of small confined catchments is very different from large flood areas. Variations in pavement standards, and small structure standards are necessary to cater for inundation, and weakening of embankment and pavement layers as well as scouring of structures.

a

The above section emphasises the variability within and between the areas investigated. Although the project was tasked with focussing on these two contrasting areas (Ayeyarwady Region and southern Shan State) only, it is worth noting that a national system of standards and specification would also have to consider the whole suite of states and divisions. Variations on the environments represented by Ayeyarwady Region and southern Shan State would be:

- Dry Zone areas in the Central Myanmar rain shadow area, for example Mandalay with rainfall at an average of only 1000mm/yr. In dry areas, without nearby water sources, pavements such as water bound macadam may not be suitable.

- High mountainous areas as represented by parts of Chin State where the combination of steep terrain, geology and rainfall produce road alignments vulnerable to landslide and erosion. Steep terrain and high rainfall in catchments, with runoff water crossing roads, causing flash floods and wash out of structures

This leads to a recommended diversification of four generic environments:

1. Low lying coastal / deltaic, with moderate to high rainfall
2. Hilly / rolling terrain with moderate rainfall
3. Dry zones
4. Mountainous zones with steep terrain and high rainfall

Within these zones local variations in rainfall intensity and volumes and terrain occur.

# 7 Current Myanmar Rural Road Strategy and Documentation

## 7.1 Study Review

The review included field visits to Ayeyarwady Region and southern Shan State, discussions with DRRD state and district offices, MOC-DRRD, the MOC materials laboratory, development partners and private and academic institutions, see Annex 1 for stakeholders consulted.

The relevant documentation for this review include the amended rural road standards and specifications, compiled in the 'Book of Standards', which is the result of an internal review by MOC of national road construction specifications, which originate from 1983 and stipulate work methods and material specifications for construction, earthwork and pavement. The 'Book of Standards' includes a series of standard drawings for 3 classes of rural roads, 4 types of bridges and a range of box and pipe culverts as well as a vented causeway. The drawings and the road construction technical specifications are tabulated and indicated on the standard drawings. These are discussed in sections 7.5 through 7.7.

Further documentation reviewed included the technical specifications and applied standards of the KfW RDP and the World Bank supported CDD programme, as well as a range of international and regional manuals and specifications, hydrological data, climate change forecast data, geological reports, topographic and demographic data and documentation on the National Rural Road Strategy and the committees for the development of rural road standards and planning for rural access improvements.

## 7.2 The National Strategy for Rural Roads and Access

The key extract from the National Strategy for Rural Roads and Access (NSRRA) is

- "*The Government of Myanmar aims to provide registered villages with road access of an all-season standard. Such an all-season standard may still experience road closures during heavy rains or periods of flooding, but such closures will be limited to a maximum of a few days, as opposed to a dry-season road that is impassable for much of the rainy season"*
- *"The NSRRA outlines the development of rural road access and provides guidance on the classification and prioritisation of the rural road network. This strategy document is a prelude to the development of National Rural Road Standards and Specifications (NRRSS), currently under preparation by the government with assistance of the development partners, including ReCAP. The NRRSS will define minimum specifications of the all-season standard. Where there is a difference between this strategy and the NRRSS, the NRRSS will have precedence*."

## 7.3 Core Rural Road Network (CRRN).

The Core Rural Road Network (CRRN) refers to the "minimum rural road network in a township required to connect all villages to each other and to the higher-level road network". This comprises all rural roads that enable rural populations to reach village tracts and the township capital, and connect to higher-level roads that link to the district capital, state/regional capitals and major cities of the country. The following connectivity rules apply:

- Villages that are not directly connected by higher-level roads will be connected by a single rural road that will be classified as a CRRN road.
- Where a village is connected only by one rural road, that road will be selected as part of the CRRN.

- Where a village is connected by more than one rural road, the *best* road will be selected to form part of the CRRN, taking account of the length, surface type, condition and traffic volumes in the different existing rural roads.
- Where a village is not connected by any road, if possible, a tentative alignment will be identified, which will be selected as part of the CRRN for new construction.

The CRRN will consist of the existing single road access for each connected village, as well as the tentative alignments for new construction linking unconnected villages. Locations with important economic or cultural importance may also be connected by the CRRN (e.g. temples, touristic places, important agricultural areas, etc.), considering the limitation of single road access.

## 7.4 Rural Road Classes

In parallel with the work undertaken to establish the NSRAA the Central Committee for the Development of Regional Roads and Bridges has broadly classified rural roads into three administrative classes. The first two administrative classes (A and B) may include core network roads, while the third class (C) are lower level rural roads. The classes are defined as follows:

- Class A rural roads include all core rural roads that connect village tracts or that connect rural populations of over 1,000 people with the higher-level road network. This may involve a road connecting a single large village, but may also involve a road (section) connecting multiple villages with a combined population of more than 1,000 people. Due to the larger populations served by class A roads and the importance of providing good connectivity for village development committees and for services and facilities provided in the village tracts, higher standards and specifications will be applied to class A rural roads. Class A rural roads generally connect directly to the higher-level roads or to towns and cities[3].
- Class B rural roads include all other core rural roads connecting villages and serving populations of less than 1,000 people. These class B rural roads serve smaller villages or fewer villages, and will have lower standards and specifications than class A roads, but will be constructed and upgraded to an all-season standard. Class B rural roads will generally connect to class A rural roads, although it is possible that they connect smaller villages directly to higher-level roads or towns.
- Class C rural roads include all other rural roads that are not defined as part of the core rural road network and that do not serve as the main connection to a village. Although these class C rural roads provide additional access to agricultural fields and link habitations that are located away from the main village, they do not contribute to the main objective of this strategy. As such, they do not have priority for upgrading to an all-season standard.

The classification provides the following further guidance on the **road surface type**.

Class A and Class B rural roads will be constructed and upgraded to have an improved, *unsealed* surface. In most cases this will involve a dry-bound or water-bound macadam surface, although gravel and other suitable materials may be applied in some areas in line with the National Rural Road Standards and Specifications (NRRSS). Such an improved unsealed road surface will allow the road to be used in most weather conditions and throughout the year (roads may be impassable during heavy rains and periods of flooding, but this should generally not last longer than a few days).

[3] However, roads connecting smaller villages to the higher-level road network will not be considered class A roads, since they only benefit a small population and are likely to carry low traffic volumes.

Class A roads will gradually be *further upgraded to have a sealed surface* (cement concrete or bituminous) in line with their importance and the envisaged traffic levels of these roads. Class C rural roads will have an earthen surface and will not receive priority for upgrading to a higher surface standard under this strategy.

An approach of stepped upgrading will be applied, where class B rural roads that have traffic volumes that exceed the minimum threshold for sealing as defined in the NRRSS, will be eligible for a higher surface standard and will be upgraded to have a sealed surface. In built-up areas (through villages), roads may also be sealed to reduce dust pollution. In areas subject to frequent flooding, higher construction standards may be applied that are more resistant to flooding and that ensure the sustainability of the road (e.g. stone paving or cement concrete). Higher surface standards may also be applied on steep slopes with the aim of reducing erosion and avoiding accelerated deterioration of the road surface (e.g. stone paving or sealed surfaces).

## 7.5 Standards

The rural road related policy statement of the Government of Myanmar is:
**"To develop the regional Roads and Bridges for Socio-economic development of the People from Rural areas"**

And the objectives are:

1.a Sustainable development of Rural Regions.
2.a Rural agricultural and livestock products shall reach the market quickly with cheap transport cost
3.a Effective use of rural road networks to access Education, Health and Social affairs of people from rural areas
4.a To improve the rural road network annually to all seasons roads.

The Central Committee for the Development of Regional Roads and Bridges has the responsibility to:

- "Coordinate with related government departments to ensure activities are in line with existing Laws and Regulations.
- Set priorities for development and improvement of district road networks, village road networks, village track road networks, village roads connecting to towns and national highways, owned by the Ministry of Construction, through coordination with government departments and international organizations
- Provide the necessary advice in coordination with the related ministries and local authorities for smooth and quick implementation of development of all related regional roads and bridges projects
- Prepare separate and detailed design specifications and standardization between Regional and Ministries owned Roads and Bridges."

The national roads are designed to standards for highways as stipulated in the MOC Department of Highway Road Manual, based on British standards. The road construction specifications originate from 1983 and stipulate work methods and material specifications for construction, earthwork and pavement. Specific rural road standards are under review by MOC, coordinated by the Central Committee. All drawings with guiding notes are presented in the MOC DRRD Book of Standard. Annex 2A presents a selection. Annex 2B includes the current versions of standard drawings with technical specifications. The standard designs are based on ORN 31.

Under the DRD/MOALI/WB Community Driven Development project, a guideline was issued to all field offices, titled “DRD Standard Design and Estimate for Rural Infrastructure”. Included are standard drawings with specifications for design (from the book of standards), and standard Bills of Quantities for works for all road classes for earth roads, and paved roads with macadam, concrete, bitumen seal and for bitumen overlay of macadam roads, for bridges and vented causeway, schools and health facilities

Uniform design standards and specifications are provided for the 3 classes of rural roads (A,B,C) (Table 7-1), with 3 pavement options (Table 7-2). The unpaved earth ”standard” is considered a temporary solution.

**Table 7-1: Rural Road Geometric Standards**

| Rural Road Category | Traffic (ADT) | Carriageway width (m) | Shoulder width (m) | Total (m) |
|---|---|---|---|---|
| **Class A** | <50 | 3.65 | 3 | 9.65 |
| **Class A** | 50<ADT<500 | 5.5 | 3 | 11.5 |
| **Class B** | - | 3.65 | 1.2 | 6.05 |
| **Class C** | - | - | - | - |

**Table 7-2: Pavement standards**

| Rural Road Category | Earth | Macadam | DBST | Concrete |
|---|---|---|---|---|
| **Class A** | | | ✓ | ✓ |
| **Class B** | | ✓ | ✓ | ✓ |
| **Class C** | ✓ | ✓ | | |

The standards further prescribe the width of **cattle cart roads** of 10 to 15 ft wide, to be provided on one side of Class A and B bitumen and concrete roads.

## 7.6 Small Structures

The DRRD standard drawings include a selection of bridges for three classes of roads, a vented causeway, box culverts and pipe culverts. These are also presented in the “Book of Standard” (Annex 2).

The drawings include specifications for geometry, pavement layers and materials (ORN31) and AASHTO HS20-44 for bridges (36 t and 20 t)

**Table 7-3: Rural Bridge Standards**

| Bridge type | Concrete bridge (Type 1) | Bailey bridge (Type 2) | Steel Plate Girder (Type 3) | Timber bridge (Type 4) |
|---|---|---|---|---|
| **Standard** | AASHTO, HS20-44 | | AASHTO, HS20-44 | |
| **Design load** | 20t | 13t | 36t | 13t |
| **Span** | 14 ft | 12 ft | 14 ft | 14 ft |

The Timber bridge option is considered a temporary option. The concrete bridge type 1 is the current standard, but the MOC is intending to upgrade this to a 36-t standard in the future.

## 7.7 Technical Specifications

The Myanmar technical specifications for construction are amended from the road construction specifications, MOC, 1983. The amended specifications indicated in Table 7.4 are shown on the standard drawings.

**Table 7-4: Technical Specifications for 3 rural road classes**

| Rural Road Category | Class A Concrete | Class A Bitumen | Class B Concrete | Class B Bitumen | Class B Macadam | Class C Macadam |
|---|---|---|---|---|---|---|
| **Traffic Class(1)** | T1, T2 | | | - | | |
| **ESA** | <300,000 | | | - | | |
| **Design Strength** | 36 t | | | 20 t | | |
| **Standard** | AASHTO HS20-44 | | | - | | |
| **Design Subgrade(2)** | CBR 4% (S2) | | | CBR 3% (S2) | | |
| **Improved subgrade/ Capping layer** | PI max 14<br>Liquid limit 40 | | | | | |
| **Subbase CBR:** | 30% | | | | | |
| **Subbase aggregate:** | <100mm (Crushed Rock) or <50mm Granular | | | | | |
| **Subbase thickness:** | 150 – 175 mm | | | | | |
| **Base course CBR:** | - | 80% | - | 80% | | |
| **Base course aggregate:** | - | 75/37.5 mm | - | <75mm or <37.5 mm | | |
| **Base course thickness:** | - | 150 mm | - | 150 mm | | |
| **Concrete (28 MPI)** | 175 mm | - | 175 mm | - | | |
| **Bitumen prime:** | | | | | | |
| **Penetration thickness** | | 3-10 mm | | 3-10 mm | | |
| **Spray temperature** | | 150-175 C | | 150-175 C | | |
| **Spray rate (L/m²)** | | 0.27-0.91 | | 0.27-0.91 | | |
| **Bitumen water cutback** | | PK-3 /CRS-1 | | PK-3 /CRS-1 | | |
| **DBST:** | | | | | | |
| **Layer thickness:** | | <25mm | | <25mm | | |
| **1st layer crushed stone:** | | 5-2.5 mm | | 5-2.5 mm | | |
| **Bitumen 1st layer (L):** | | 60-80 | | 60-80 | | |
| **2nd layer crushed stone:** | | 5-13 mm | | 5-13 mm | | |
| **Bitumen 2nd layer (L):** | | 80-100 | | 80-100 | | |

(1) ORN31: Chart 1: mesa<0.3: Traffic class T1/T2
(2) ORN31: Chart 1: CBR3-4%: Subgrade strength class S2

The current specifications are fixed at a standard pavement design thickness, based on ORN 31, Chart 1 for bituminous surface dressing, with a granular road base. The subbase and base thickness is however fixed to one standard. The subgrade strength is assumed to be weak (up to 4 % CBR) and the traffic class is assumed to be T1 up to T2.

The consequences of these uniform assumptions are:

- In weak subgrades with high plasticity, a subgrade of CBR 4% is a safe assumption.
- In firm subgrades the assumption of 4% CBR leads to overdesign of the subbase and base course.
- On class A and class B roads with lower traffic than 0.3 esa, the specifications lead to overdesign, especially in combination with a firm subgrade.
- Where the actual traffic is more than 0.3 mesa, and in weak subgrades there is a small risk of designing the pavement layers too thin.
- Depending on the traffic mix and type of vehicles, the assumed ADT of max 500, would likely lead to an esa of lower than 100,000 over the lifecycle of the road, but likely much lower, as most of the traffic are light vehicles.

Overall, the uniform standards are likely to lead to overdesign of the pavement layers.

Table 7-5 shows the comparison of current DRRD specifications with those used in the KfW RDP and in the projects in Laos and Cambodia. In the RDP and the RIP in Laos and Cambodia, the range of specifications to address different subgrade strength and traffic classes is greater than the current DRRD specifications, thus allowing greater flexibility in the design.

**Table 7-5: Comparison of DRRD specifications**

| Specification | DRRD (Class A) | RDP (Southern Shan State) | KfW-RIP (Cambodia/Laos) |
|---|---|---|---|
| | | | |
| **Traffic Class** | T1, T2 | T1~T5 | T1~T5 |
| **esa** | 300,000 | up to 1 million | up to 1 million |
| **ADT** | <500 | | <2000 |
| **Axle load** | not provided, but ORN31: 8.1t | 8-10 t | 4.5 t (LVRR), 4.5-10 t |
| **Subgrade** | S1, S2 (up to 4%CBR) | all subgrades | all subgrades |
| **Carriageway width** | 5.5m (Class A) (3.5m for Class B, C) | 4.5 m | 2.5-5.5m |
| **Type of pavement:** | Macadam/DBST/CC | DBST/Penmac/CC | GWC/DBST/CC |
| **Pavement layers** | Boxed to carriageway width | full width | full width |
| **Shoulder width** | 3m (Class A) (1.2m for Class B, C) | 1 m | 1 - 1.5m |
| **Embankment** | | | |
| **Soaked CBR:** | ≥ 3% @ 95% AASHTO T180 | ≥ 6% @ 93% AASHTO T180 | ≥ 8% @ 93% AASHTO T180 |
| **Swell:** | - | < 1.5% | target DN <27 mm/blow |
| **Improved Subgrade** | | | |
| **Soaked CBR:** | ≥3-4% @ 95% of AASHTO T 180 | ≥10% @ 95% of AASHTO T 180 | ≥11% @ 95% of AASHTO T 180 |
| **Swell:** | - | < 1.5% | < 1.5% |
| **Plasticity index:** | <14% | < 18% | < 18% |
| **Linear shrinkage** | - | < 4% | < 4% |
| **Max size:** | - | 75mm | 100mm |
| **Layer thickness** | min 200 mm | max 300 mm | <50% layer thickness |
| | | | |
| **Capping Layer** | | | |
| **Soaked CBR:** | ≥3-4% @ 95% of AASHTO T 180 | ≥12% @ 95% of AASHTO T 180 | ≥11% @ 95% of AASHTO T 180 |
| | | (target DN 18mm/blow) | (target DN 18mm/blow) |
| **Subbase** | | | |
| **(Sieve curves not included in this comparison)** | | | |
| **Materials** | Crushed rock or granular | crushed aggregate | Crushed rock or granular |
| **IP** | | <11% | <12% |
| **LAA** | | <40 (AASHTO T-96) | <40 (AASHTO T-96) |
| **CBR** | ≥ 30% @ 95% AASHTO T180 | ≥ 30% @ 95% AASHTO T180 | ≥ 25% @95% AASHTO T-180 |
| | | (target DN 8mm/blow) | ≥ 30% @ 95% AASHTO, for axle load>5t and esa >100,000 |
| **Swell:** | - | <1% | < 1 % |

| Specification | DRRD (Class A) | RDP (Southern Shan State) | KfW-RIP (Cambodia/Laos) |
|---|---|---|---|
| **Base** | | | |
| **(Sieve curves not included in this comparison)** | | | |
| **Materials** | Crushed rock or granular | Water bound Macadam | Aggregate, crushed rock |
| **CBR** | ≥ 80% @ 95% AASHTO T180 | LAA <35 (AASHTO T-96) | ≥ 80% @ 95% AASHTO T180 |
| | | Sodium Sulphate <25% | Aggr> 2.0 mm: Los Angeles: ≤ 35% AASHTO T 96 |
| | | max 50% of layer thickness | fraction< 0.425mm: PI <12% |
| **max size of aggregates:** | 75mm for crushed rock | specific grading curve provided | specific grading curve provided |
| | 37.5mm for granular | | |
| | | | |
| **Side Drainage** | minimum depth and width | specs for hydraulic capacity, | specs for hydraulic capacity, |
| | | lining, scour checks, mitre drains | lining, scour checks, mitre drains |
| | | catch water drains | catch water drains |

## 7.8 Key Points Arising

(i)a Most rural road standards base the carriageway width on the 'design vehicle' in combination with traffic volume, and adapt the shoulder width to accommodate differences in traffic mix (for road safety reasons). Other considerations may include varying the road shoulder width if on an embankment or in cut on a hill slope.

(ii)a The current Myanmar outline rural roads standards assume a maximum of ADT 500 There may be arguments to include a category of roads with ADT > 500, and have sub diffusion of classes below ADT 500.

(iii)a In the current classification, the traffic loading is uniformly assumed to be 300,000 esa, while subgrade strength is assumed weak (up to CBR 4%). This will lead to overdesign of the pavement layers in stronger subgrades and with lower traffic loading and possibly to under-design of roads with higher traffic loading. A flexibility in both traffic and sub-grade is essential so that a design chart could be developed that incorporates subgrade strength and traffic as key variables for pavement design.

(iv)a Only three basic pavements options are considered in the current outline A and B classes: Macadam (water-bound), Bituminous seal and Concrete. Unsealed earth/gravel options are allowed for class C. Regional experience indicates a wider series of options is appropriate (see Section 9).

(v)a The pavement standards for class A roads are bitumen and concrete surface options. Even for traffic flows of 50 ADT or less the pavement standard option is not adjusted to allow for alternative less costly pavement options. Greater differentiation in pavement design is needed, including low-cost surface where traffic volumes are low, irrespective of the road class.

(vi)a Full width pavement layers (as practiced under KfW-RDP) are not shown on the cross-sections accompanying the outline classification. Full width construction promotes pavement drainage, reduces risk of water logging and layer weakening. Quality of construction is easier to control and full width pavements are in general more cost-effective over the lifespan of the road.

(vii)a Geometric standards and drawings are yet to be developed for horizontal and vertical alignment options, including horizontal and vertical curves widening of curves, transition curves, superelevation, and for hill sections in cut/fill.

(viii)a The review indicated that traffic counts are normally not done to establish the ADT, PCU or esa. The current estimates of traffic volumes come from interviews with the local offices, which groups the traffic into a broad range of ADT, without discrimination in vehicle type.

(ix)a Cattle carts are officially not allowed on roads because the steel rims of the cattle carts damage the surface of gravel and bitumen roads and the skid resistance of the rims and hoofs of the animals (mostly oxen) is low, resulting in unsafe conditions, especially on paved roads on inclines. Cattle carts are however widely used in the two focus areas. The design standards therefore need to reflect the dependence of served populations on this vehicle access.

# 8 Stakeholder Input

## 8.1 Stakeholder Review

**JICA:**
Through a loan for the Regional Development Project for Poverty Reduction, The Japan International Cooperation Agency (JICA) supports Myanmar in various sectors: Water supply, Power supply and secondary road and bridges (with MOC), and through the Small-Scale Infrastructure Improvement for Poverty Reduction, in Sagaing region, JICA also supports agricultural development (MOALI).

A new project is under preparation that would support Rural Infrastructure Development in Local Areas and is planned to be implemented in Chin State and Ayeyarwady Region. This grant aims to improve income and living standards in local areas by contributing the balanced growth between rural and urban areas through development of rural infrastructures targeting roads and bridges, water supply, agricultural mechanisation and irrigation.

JICA does not have pre-set standards or specifications in place to be used in future projects and is interested in the progress on the development of LVRR standards and specifications, in order to apply these in future interventions.

**KfW:**
The German Development Bank, KfW, is keen on further development of appropriate rural road standards and specifications and granted the consultant access to information through the Rural Development Project (RDP). This project is very relevant, as it focuses its interventions on rural road rehabilitation in southern Shan State. The project is close to starting the second phase and lessons learned from the review could benefit the project and DRRD. The project offers valuable lessons and experiences from phase 1, discussed further in this report. Of further relevance is the Rural Road Rehabilitation Programme, which undertakes to improve road access and especially crucial water crossings, after flood damage. This project is located in Kalay district in the Sagaing Region.

**MOC Materials Laboratory, Yangon:**
The main issue is access to the testing facilities. There is recognition of the need for quick turnaround of test results when undertaking quality assurance testing on construction projects. The laboratory confirmed that the use of DCPs for quality control is helping immediate needs in establishing compaction rates, but that other tests are needed as well. In this respect, there are two initiatives to improve access to materials testing facilities. The first is with Indian Government grant funding through the setting up of 'mini' labs in each region and state to reduce the pressure on the main laboratory and reduce time and costs of transportation of samples. A second initiative is the procurement of mobile field labs. One of these is supplied through the KfW RDP.

**Myanmar Engineering Society (MES), Yangon**
The society offers various technical support that could be of great value to the DRRD and contractors in terms of training and development of building codes and standards. The MES would like to be involved as a training provider and as a peer reviewer of standards and specifications.

Some technical observations were also made by MES. The flood level embankment protection in Ayeyarwady became too costly in hauling fill materials. The adopted practice is to use borrow from the sides and thus creating parallel channels. This is practiced extensively across the delta. In most cases this borrow material is however unsuitable to use as fill, resulting in weak road embankments and poor roads. MES sees not so much the lack of specifications as the main problem but rather the ignorance of technical officers and the non-adherence to quality control.

**Myanmar Construction Entrepreneur Association (MCEA), Yangon:**
The organisation was established in 1996 and has approximately 10,000 members. The discussion evolved around the availability and quality control of (road) construction materials. The member contractors are almost exclusively involved in the private sector funded works and mostly in building construction. MCEA associated contractors have not yet been involved by MOC in the road sector. The MCEA pointed out that MOC contracts stipulate uniform unit rates and apply a fixed budget for the cost of works. This according to the MCEA often has a disconnect with actual quantities and cost of works. Contractors therefore have limited experience with road construction, and involving the contracting industry in this sector would require substantial training. The association is now registered as a Federation and has signed a joint venture agreement with the Yangon Regional Government. There is potential for the MCEA to provide training and skills development. The existing programme includes training modules for works supervision staff up to registration level 1 and 2 supervisors. (ASEAN standard).

**DRRD offices at state and district level**
The following opinions were recorded from discussions with the field offices:

- The offices in Ayeyarwady Region pointed out that the weak subgrades are a problem and that even when stones are imported to strengthen the subgrade, the stones often sink into the soft clays. The consensus is that there is a need for soil stabilisation.
- In Ayeyarwady Region the availability of rock and granular materials is scarce and often of poor quality. Haulage is expensive.
- There is a general recognition that standards need to fit all conditions of Myanmar, but allow for local variations in hydrology (floods, flash flood), subgrade strength, (un)availability of construction materials and terrain.
- Geometric minimum requirements to be relaxed, especially road width and curves, and road reserve, depending on terrain conditions.
- Sub-divide road classes into sub-classes depending on traffic and road use;
- Need for standard cross sections of all possible alignments: hill side, in cut/fill, on embankments and flat terrain.
- Need for a pavement design catalogue to include various standard materials and subgrade improvement applications.
- Need for training in survey and geotechnical investigation and design. The offices already use DCPs in checking of compaction rates and subgrade strength, but would like to be trained on how to apply this in design and in civil works implementation quality control.
- Need for a local resource based unit rate analyses; the unified rates in the contracts are deemed unrealistic.
- Need for standard contract documents and for separate maintenance contracts; many construction contracts (under the DRD, MoALI) included a defect liability period of 3 years post construction during which the contractor is supposed to keep the road in good condition, but without providing sufficient technical guidance to the contractor this is resulting in poor performance.

## 8.2 Workshop

DRRD/MOC hosted a review workshop on 24 January 2018, which was opened by the Deputy Minister of the Ministry of Construction, U Kyaw Linn. The workshop brought together participants from DRRD representing various states and regions with the different road environments (terrain, geological and climatic zones). Also present were representatives from academic and private institutions and representatives from development partners and ReCAP. A workshop report was submitted to ReCAP PMU on 30 January 2018 and can be downloaded here:
http://www.research4cap.org/Library/DingenSann-2018-LVRRStandardsSpecsMyanmar-WorkshopReport-AsCAP-MYA2118B-180202.pdf

The workshop discussed the finding of the review of existing rural road standards and invited participants to comment on the standards and specifications and on the way forward in the development of a Myanmar LVRR manual. The summary findings are tabulated in Table 8-1, through to Table 8-3. The first table lists the feedback on existing standards and specifications and the following three tables present the feedback on the development of the LVRR manual.

The following comments (Table 8-1 through Table 8-4) are disaggregated into responses from delegates relevant to coastal/deltaic, mountainous and dry zone areas. For this exercise the fourth generic zone of rolling/hilly terrain with moderate rainfall was not considered for the lack of distinctive characteristics:

**Table 8-1: Workshop feedback on existing standards**

| | |
|---|---|
| **1. Do existing road design standards and specifications in Myanmar require differentiation for different road environments and road tasks?** | |
| *Dry Zone* | -aDiversification of design standards are needed taking account of dry/wet areas, Steep/flat terrain (hill and flat cross sections, granular/plastic soils, Riverbanks / protection, -Rainfall (climate change safety factors, Return periods, hydraulic design).<br>-aLocal Materials Design for Limestone (Kankar) and Granular pavements (Locally Available)<br>-aRoad width (3m – 4m) restricts space for drainage system |
| *Delta areas* | -aDesign charts needed for geometric, pavement, hydraulics, structural standards<br>-aMost roads are unsealed, in poor condition, lack drainage, weak subgrade.<br>-aExisting alignments are narrow: uniform standard lead to problems with road reserve standards, land acquisition. Need for greater differentiation in road classes<br>-aTraffic is an unknown factor but needed to determine geometric standards |
| *Mountainous areas* | -Design chart should be developed to differentiate in subgrade strengths. CBR may be higher than 4% and requires less thick pavement design / fewer layers<br>- Design required for: (i) second seal layer, (ii) shoulder of 3 m (earth or hard shoulder), depending on road safety and available space, (iii) one side hill drains on slopes, catchwater drains and protection works; variations in standard cross sections needed<br>-Maximum gradient should be designed at < 6%, but variations possible in hard rock. Adjust pavement to gradient.<br>- Attention to sight lines in blind comers: horizontal and vertical minimum curves. |
| **2. The geometric and pavement design standards currently under preparation for DRRD consider a maximum traffic of 500 vehicles per day (geometric design) and a maximum of 0.3 MESA (pavement design) over the road design life? Are these thresholds appropriate?** | |
| *Dry Zone* | -aDifficult to comply with geometric design due to required road reserve, requiring land acquisition (of farm land). Relaxation of road reserve standards are needed |
| *Delta areas* | Three classes are proposed based on traffic volume:<br>class 1: > 500 ADT,<br>class 2: between 100 and 500 ADT<br>class 3: < 100 ADT<br>-aProposed Design life 10–15 years, depending on class |
| *Mountainous areas* | For steep terrain, current standards are not appropriate. CBRs generally much higher than the assumed CBRs. Risk of overdesign. Axle load surveys are needed for low or higher traffic and design standards need to be developed for different traffic classes; Lower and higher than 500 ADT – In Chin State, 2 axle Vehicles (Hine Mon- Jeep) are often overloaded. |
| **3. Should there be more options for pavement design? Which?** | |
| *Dry Zone* | Yes, tailored to local conditions, see above |
| *Delta areas* | Penetration macadam, pre-mix and pre-mix carpeting should be considered as options |
| *Mountainous areas* | Penetration macadam pavement difficult to construct in low temperature conditions. Difficult also for necessary machines to manoeuvre on narrow and steep roads. Take account of implementation conditions in the design of standards. |
| **4. Name at least three main issues of LVRR design in Myanmar that should be addressed by a LVRR manual?** | |
| *Dry Zone* | -a Right of way<br>-a Funding / planning<br>-a AADT design base |
| *Delta areas* | -a Demand for training<br>-a Design for flood resilient including submersible structures, -Hydraulic and structural design of cross drainage, -embankment protection,<br>-a Refining design standards for each climatic and topographic zone / condition,<br>-a Road furniture designs<br>-a Soil stabilisation techniques for road construction & maintenance. |
| *Mountainous areas* | -a Geometric design charts, including standards for hill sections<br>-a Structural Pavement Design charts<br>-a Side Slope Stability (cut/fill, environmental protection) |

The following comments are disaggregated into responses from topical discussion groups: Geometric Standards, Pavement Standards and Hydrological / Hydraulic standards:

**Table 8-2: Feedback on Geometric Standards**

| **Questions on Geometric standards** | **Feedback** |
|---|---|
| 1.a In view of what is needed for your work as rural road design engineer, what subjects should be included in a Low Volume Rural Road Design Manual related to geometric design? | **Geometric Standards to be included:**<br>-a Road width by class, and traffic<br>-a Right of way for different terrain conditions<br>-a Standards for shoulder width, crossfall and superelevation, vertical and horizontal gradients<br>-a Design catalogue for pavement<br>**Attention to road safety aspects**:<br>-a Horizontal and vertical alignment fitting appropriate design speeds<br>-a Stopping and passing sight distances (in curves); this also relates to the road reserve, vegetation and objects that obstruct sight |
| 2.a Is the network tier (level in the hierarchy) sufficient to set the geometric design standard? (Class 1, 2 and 3 rural roads), or should there be a differentiation by terrain type, soil condition (road environment), road task / traffic? Any other considerations? | The design standards should differentiate in:<br>-a Traffic volumes and type of traffic<br>-a Terrain Type (steepness and Side Slope Cut and Fill)<br>-a Demography, and purpose of the road (Population and Social)<br>-a Climate (rainfall, temperature)<br>-a Soil Condition<br>-a Drainage system<br>-a Combination of Horizontal & Vertical Alignment |
| 3.a In addition to the geometric standards, should the future manual include a wider scope? | -a Planning and Functional Classification<br>-a Surveying (Alignment, Location and Detail)<br>-a Drainage system Design<br>-a Road Furniture<br>-a Road Safety Standards/ Traffic calming standards<br>-a Quantification & Costing<br>-a Maintenance Planning and costing and prioritisation |

**Table 8-3: Feedback on Pavement Standards**

| Questions on Pavement Standards | Feedback |
|---|---|
| 1.a In view of what is needed for your work as rural road design engineer, what subjects should be included in a Low Volume Rural Road Design Manual related to design? | -a In situ CBR<br>-a Material Assessment and Source of Road Materials<br>-a Traffic Condition (Traffic Volume and axle load), prediction<br>-a Existing Pavement Survey<br>-a Aerial Topography<br>-a Design Life |
| 2.a Should there be standard pavement types for the three rural road categories, or should there be differentiation in pavement even within the three categories? | Three categories in pavement types should be different because local conditions & materials sources vary. More differentiation is needed for different terrain and conditions |
| 3.a What pavement types could you think of? Which should be included in the LVRR manual? | Concrete pavements and Sealed Roads with stabilized layers to be designed, based on cost-benefit analyses and Gravel Roads should be included as options in areas where there are suitable local materials. Pavement designs for CBR subgrade less than 3% and classes of pavement design for in situ CBR of over 3% |
| 4.a What factors would influence the choice of pavement? How do these play a role in the different terrain and climatic environments in Myanmar | -a Road Alignment, Land Acquisition, Existing subgrade strength, Gradients & Axle (over) load (Timber transport evacuating from forest areas)<br>-a Availability of local materials |

**Table 8-4: Feedback on Drainage and Hydraulic Design**

| Questions on Drainage & Hydraulic design standards | Feedback |
|---|---|
| 1.a In view of what is needed for your work as rural road design engineer, what subjects should be included in a Low Volume Rural Road Design Manual related to hydrological analysis and hydraulic design? | -a Topographical (Scale) Map<br>-a Google Map and use of GIS tools<br>-a Meteorological (Rainfall) Data analyses<br>-a Survey / information gathering from local people<br>-a Use of and design of small dams<br>-a How to deal with spoil of unsuitable materials<br>-a Climate Change assessment and effects<br>-a Coordination with irrigation Department<br>-a Flow direction changes (Yearly)<br>-a Catchment analyses and setting of Return Period of floods or any disaster. |
| 2.a Provide feedback on the following subjects; should it be included and should it vary by road class?<br>-a How should climate change impact be accommodated in the manual?<br>-a Catchment assessments?<br>-a Hydraulic design of side drains and structures?<br>-a Hydraulic design of cross drainage (bridges, larger culverts, drifts, etc)<br>-a Construction standards for structures?<br>-a Other? | -a Guidance on setting of safe freeboard of bridges, taking account of climate changes & waterway transport<br>-a Catchment assessment can be calculated by contour map / Google map<br>-a Hydraulic design charts and standards needed<br>-a Standards for bridges, larger culverts, drifts, submersible bridges, submersible road, causeway, retaining wall<br>-a Quality Assurance and Control, Environmental Impact Assessment, road safety |

The workshop further discussed the way forward in the development of a full manual versus the development of technical design guidelines. The consensus seems to be to develop a manual in a staged approach, including standards and guidelines on design.

## 8.3 Summary of Stakeholder Input

The feedback from the stakeholders indicate a need for diversification in standards and specifications, taking account of the variations in geo-physical characteristics of the different regions. There is a need for clear design guidelines and for training. Emphasis is put on geometric standards, pavement standards, road safety and hydrology. A staged approach to the development of a design manual is preferred.

The stakeholders' priority is on improvement and refinement of geometric standards; particularly the refinement of road classification and further development of:

- Road width and drainage systems for different terrain types; discriminating in different local variations in terrain conditions, traffic type and volume and options to relax minimum width and road reserve
- A catalogue for pavement design in relation to traffic, subgrade strength and vertical alignment and availability of local construction materials.

Secondary priorities mentioned are:

- A design guideline for small structures, including hydrological and hydraulic assessments
- Bio-engineering and environmental management
- Standards and guidance on survey and design
- Guidance on soil testing and quality control
- A road maintenance planning and management guideline

An overarching demand mentioned is the need for practical training for district and state DRRD staff.

In terms of the development of the LVRR manual, the consensus from discussions with DRRD and from the workshop is that there is preference for an all-inclusive manual, with specific volumes that could be developed sequentially - starting with the geometric standards, followed by volumes or parts reflecting the priorities above.

# 9 Road Design Manual Assessment

## 9.1 Road Design Manual Objectives

In general, Low Volume Rural Roads manuals, design manuals or guidance documents should promote rational, appropriate and affordable designs for low volume roads for specific regions or countries. A review of existing documents indicates a range of approaches; from individual guidelines focussing on specific issues, such as pavement design, climate resilience or safety, to broadly based manuals covering a comprehensive spectrum of LVRR topics. To illustrate the range, Table 9-1 lists some typical relevant regional or recent AfCAP/ReCAP documents. To demonstrate the comparison, Table 9-2 list the contents of four typical LVRR design manuals.

## 9.2 Regional and International Experience

Lessons can be drawn from regional experience; SEACAP and other projects in Vietnam, Laos, Cambodia, Bangladesh, India, Nepal are useful references. Table 9-1 presents an overview of these manuals and guidelines.

Irrespective of the range / focus, recent experience has highlighted the following key principles on which to base an effective LVRR manual.

- (i) Provide guidance on fit-for-purpose roads that suit the road function and its traffic (the people as well as the vehicles) that will pass along them.
- (ii) Promote local resource based designs and be compatible with the road sector in Myanmar, taking into consideration the engineers and technicians who will design the roads, the contractors and labourers who will construct them, the communities and stakeholders who maintain them and the construction materials that are available.
- (iii) Facilitate the construction of roads with whole life asset costs that will not exhaust the provincial and district budgets or place excessive maintenance burdens on local communities.
- (iv) Reflect local experience and advances in low volume road technology gained in the region and elsewhere.
- (v) Be clear, succinct, concise as possible and capable of translation into local languages if required.

**Table 9-1: Typical Recent or Regional Low Volume Road Guides or Manuals**

| *Country, Year* | *Title* | *Focus* | *Volumes / Pages* | *Status* |
|---|---|---|---|---|
| *Bangladesh, 2005* | Road Design Standards, Rural Road | Road geometry, typical cross section, standard drainage and slope support options | 1 Volume / 115 pages | Official Government (LGED) publication |
| *Cambodia, 2009* | Rural Road Standards and Specifications: | Classification, geometric standards, and pavement options and technical specifications | 1 Volume / 65 pages | Research document for Government ministry. |
| *Cambodia, 2015* | Climate Resilient Roads | Climate strengthening option for rural roads (no bridges) | 1 Volume / 67 pages | Project output. Not official document |
| *Ethiopia, 2016* | Design Manual for Low Volume Roads | Comprehensive coverage of planning, investigation, design, construction and maintenance of LVRRs including low-level water crossing (small bridges) and trail bridges | 7 Volumes / 910 pages | Official Government publication |
| *Kenya, 2017* | Pavement Design Guidelines for Low Volume Sealed Roads | Design of low volume sealed road pavements and associated drainage. | 1 Volume / 154 pages | Official Government publication |
| *Lao PDR, 2009* | Low Volume Rural Road Standards and Specifications | Geometric standards, pavement design technical specifications | 3 Volumes / 154 pages | Research document for Government ministry. |
| *Malawi, 2013* | Design Manual for Low Volume Sealed Roads | Investigation and design of LVRR pavements, | 1 Volume / 185 pages | Official Government publication |
| *Malaysia, 2012* | Design Guide for Alternative Pavement Structures; Low Volume Road | Pavement structural design through series of catalogues. | 1 Volume / 17 pages | Official JKR (Public Works) document |
| *Nepal* | Nepal Rural Road Standards | Engineering standards, traffic and geometry | 1 Volume / 27 pages | Official Government publication |
| *South Sudan, 2013* | South Sudan Low Roads Design Manual | Comprehensive coverage of planning, investigation, design, construction and maintenance of LVRRs including low-level water crossing (small bridges). | 3 Volumes / 548 pages | Government supported document |
| *Tanzania, 2016* | Low Volume Roads Design Manual | Planning, investigation, design and construction of LVRR including safety, pavement, drainage and drainage structures. No bridges. | 1 Volume / 405 pages | Official Government publication |

## 9.3 Key Issues for a Myanmar a LVRR Design Manual

The review workshop on 24 January discussed the development of the LVRR design manual. The question that was put to the participants was: which aspects of design, standards and specifications should be considered for inclusion? As Table 9-1 shows, there is a great variation in the range of subjects featuring in the manuals.

The workshop report includes a comparison of three manuals, from Tanzania, Malawi and Lao PDR. The workshop recommended basic subjects for inclusion, but also listed some wider range of topics.

Table 9-2 below presents a comparison of four manuals, tabulated in order of their scope. The table only lists the main headings of the topics. The manuals include a range of annexes with design charts and specifications, and drawings.

The Ethiopia manual comprises different volumes of design manuals, each developed for a specific purpose. The actual LVRR design manual is one volume, which compares to the Tanzania Manual. The Ethiopian set further includes a small structure design manual, a construction manual, a maintenance management manual and a complementary infrastructure manual. The LVRR manual for Laos was developed for traffic axle loads of <4.5t, and the Nepal manual focuses on the most essential design criteria and charts.

A Myanmar LVRR Design Manual should be compatible with the objective and strategic aims of the NSRRA and the associated general classification.
The recommended ‘fit for purpose’ approach in the manual implies that this flexibility will apply particularly to issues such as:

- Application of appropriate geometric standards
- Pavement options, both sealed and unsealed
- Use of available materials
- Current and future climate impacts

The manual should be applicable to all terrain, geological and climatic zones in Myanmar, but with different design charts fitting the local road environments. For example, even though in Shan State in general the subgrades are firm and run through hilly terrain, there are locations with plastic and organic soil. Similarly, in the costal hills of west Ayeyarwady, granular subgrades are found. It is therefore better to make a subdivision based on a filter process as described in section 9 that allows the designer to choose the appropriate design based on the road environment rather than a subdivision of geographic location.

**Table 9-2: Comparison of LVRR manuals**

| **Ethiopia** | **Tanzania** | **Lao PDR** | **Nepal** |
|---|---|---|---|
| Low Volume Roads Design Manual;<br>6 Volumes and 1 maintenance guideline – 910 pages | Low Volume Roads Design Manual;<br>1 Volume (5 parts)– 405 pages | Low Volume Roads Environmental Optimised Design Manual;<br>1 Volume – 124 pages | Nepal Rural Road Standards<br>1 Volume -27 pages |
| **PART A**<br>**Introduction** -36 pages<br>▪a Context and scope of the LVRR Manual<br>▪a Policy and legislation<br>▪a Planning process and tools | | | |
| **PART B**<br>**Design of Low Volume Roads** -358 pages<br>Introduction<br>▪a Road environment<br>▪a Climate<br>▪a Terrain<br>▪a Hydrology<br>▪a Construction regime<br>▪a Maintenance regime<br>▪a Road safety regime<br>▪a Green Environment<br>▪a Environmental optimised design<br>▪a Principles of LVR pavement design | **Part A: Introduction**<br>▪a General,<br>▪a Low Volume Roads<br>▪a Physical Environment | **Introduction**<br>▪a Rural travel and infrastructure<br>▪a Environmentally Optimised Design (EOD) approach<br>▪a Structure and use of the manual | |
| **(Planning in PART A)** | **Part B: Planning**<br>▪a Rural Accessibility Planning | **Screening**<br>▪a Site visits and rapid survey<br>▪a Screening | **Rural Road Classification** |
| **Site Investigations and route selection**<br>▪a Stages of site investigation<br>▪a Considerations for route selection<br>▪a Ground investigation techniques<br>▪a Site investigation for design<br>▪a Subgrade investigations | **Part C: Investigations**<br>▪a Site Investigations<br>▪a Geotechnical Investigations and Design<br>▪a Construction Materials<br>▪a Traffic | **Investigations**<br>▪a Site visit and rapid survey<br>▪a Traffic assessment<br>▪a Terrain assessment<br>▪a Rainfall assessment<br>▪a Materials assessment<br>▪a Geotechnical investigations<br>▪a Construction and maintenance capacity | **Terrain Classification** |

| Ethiopia | Tanzania | Lao PDR | Nepal |
|---|---|---|---|
| **Design**<br>▪ Subgrade<br>▪ Construction materials<br>▪ Roadside slope stabilisation<br>o Drainage, Retaining wall, bio-engineering<br>▪ Traffic<br>▪ Geometric design<br>▪ Road safety, signage and road furniture<br>▪ Drainage design<br>o Hydrology, catchment /flow methods, drainage system, scour, erosion protection<br>▪ Pavement design<br>o Bituminous, earth, stones, cobblestone, brick, mortar, concrete, DCP-CRB, DCP-DN<br>▪ Surfacing<br>**Life Cycle Costing**<br>▪ Purpose, scope<br>▪ LC cost analyses<br>▪ Sensitivity analyses | **Part D: Design**<br>▪ Geometric Design (inclusive)<br>▪ Road Safety<br>▪ Hydrology and Drainage Structures<br>▪ Drainage and Erosion control<br>▪ Structural Design: Paved roads<br>▪ Structural Design: Unpaved roads<br>▪ Surfacing<br><br>**Costing**<br>▪ Life-cycle Costing | **Design**<br>▪ Geometric design (inclusive)<br>▪ Height of the subgrade above ground or flood water<br>▪ Subgrade strength<br>▪ Materials<br>▪ Pavement Design<br>▪ Erosion protection measures<br><br>**Costing**<br>▪ Estimation of costs<br>▪ Prioritisation<br>Contract documents | **Design**<br>▪ Traffic<br>▪ Geometric design<br>o Cross Section, Right of Way, stopping sight distance, Lateral & Vertical clearance, Horizontal Alignment, Vertical Alignment, Camber cross slope, Passing zone and lay-bys<br>▪ Carriageway width structures<br>▪ Embankment level<br>▪ Traffic signs and road safety<br>▪ Relaxation of rural road design standard |
| **PART D**<br>**Construction of Low Volume Roads** -146 pages<br><br>▪ Project Implementation<br>o procurement, tendering, supervision<br>▪ Road construction<br>o Strategy, equipment, issues, preparation, compaction, surfacing<br>▪ Borrow pit management<br>o Environment, preparation, extraction methods, stockpiling, processing, control, testing, management<br>▪ Construction of small structures<br>▪ Quality Assurance and control<br>▪ Technical Auditing | **Part F Construction**<br>▪ Construction, quality Assurance and Control<br>▪ Borrow Pit Management<br>▪ Technical Auditing | | |

| Ethiopia | Tanzania | Lao PDR | Nepal |
|---|---|---|---|
| **PART C**<br>**Complementary Interventions** -32 pages<br>▪a Context and application<br>▪a Planning, identification<br>▪a Employment and human resources<br>▪a Contract provisions<br>▪a Support to small scale contractors<br>▪a Supervision<br>▪a Management, M&E | | | |
| **PART E**<br>**Design standards for small structures** -206 pages<br>▪a Project Planning<br>▪a Design criteria<br>▪a Structural options<br>○a Drifts, culverts, fords, causeways, arch culverts, bridges<br>▪a Site selection and appraisal<br>▪a Water course characteristics<br>▪a Materials<br>▪a Structural Design | | | |
| **PART G**<br>**Road Maintenance -**94 pages<br>▪a Road Features<br>▪a Road surface types<br>▪a Purpose of maintenance<br>▪a Road maintenance tools<br>▪a Maintenance activities<br>○a Routine, Periodic, maintenance activities<br>▪a Priorities<br>▪a Work options<br>▪a Planning and productivity | | | |
| **Wereda Road Maintenance Guide**<br>**Practical guideline for community access** | | | |

# 10 Standards and Specification Recommendations

## 10.1 Gap/Problem Analysis

A Myanmar rural road classification has recently been adopted and is based on demographic and network functionality. There are broad geometric standards assigned to these classes which currently do not reflect the actual function of the road, or the type or volume of traffic. The road width is fixed by road class with no discrimination being made for differing vehicle types with an ADT is assumed to be 500 or less.

General design standards with respect to pavement type and outline pavement designs are linked to the three classes of rural road. No distinction is made for different subgrade strength or axle load (esa), which is assumed to be <300,000. A limited number of standard cross sections are also linked to the classes but with no variation for terrain.

Information and opinion gathered from the initial review, the fieldwork and the stakeholder workshop on the application of the current standards and specification and their development may be collated into a number of central points:

(i) Recognition that the current 3-fold classification requires expansion.
(ii) Standards and specification need to be relevant to the specific and varied road environments in Myanmar.
(iii) Geometric standards, in particular road widths, need to be able to be relaxed to suit specific requirements.
(iv) The number and variety road pavement and materials specifications need to be increased.
(v) Guidance on standards for climate resilience are required.
(vi) Standards need to be expanded to cover the range of geometric issues such as sight-lines, horizontal and vertical curves etc.
(vii) Safety issues should be an important part of Myanmar rural road standards.
(viii) Drainage and related hydraulic issues need to be covered by new standards, specifications and guidance.
(ix) Quality control standards and specification will be required.
(x) Technical specifications should include geotechnical and materials components
(xi) New standards and specification should be accompanied by a clear road design manual or guideline

## 10.2 Standards Recommendations - Roads

Bearing in mind the wide range of rural road environments within Myanmar, a flexible approach to standards is a logical way forward. The new surface and geometric standards contained within the current 3-fold classification to be applied by DRRD form the basis around which a flexible and cost-effective set of standards can be developed. Table 10-1 lists some key recommendations with respect to this development.

**Table 10-1: Summary of Recommendations for Road Standards**

| Standards | Recommendations |
|---|---|
| **Geometric** | The basic 3-fold standard should be developed with variations around the basic width depending on the relevant road environment factors, Table 9.2. Particular attention should be given to the use of equivalent traffic factors (PCUs) when using ADT information. Geometric standards, in addition to road widths, should cover a wide range of other factors such as cross-fall; horizontal and vertical alignments and sight lines; and the transverse profile or cross-section, for example Table 9.3. The cross-sectional profile including drainage ditches, embankment heights and side slopes is a vital part of geometric standards. |
| **Pavement** | The standards for pavement options should be expanded to give Myanmar LVRR practitioners the option of using standard designs that are compatible with the range of Myanmar conditions, Table 9.4. |
| **Hydraulic/drainage** | A set hydraulic hydrological standards suitable for LVRR related to the rain event return periods, flood levels and rainfall intensity need to be developed. This may be possible from existing high volume road documents. Hydraulic standards should be aware of the implication of future climate |
| **Safety** | No specific LVRR safety standards currently exist. Safety standards that are cross cutting and compatible with geometric, pavement design, and structural design are required. |
| **Climate Resilience** | Levels of climate resilience need to be set as targets for different road classifications within a network in order to balance climate threat adaption with the available budgets. Standards, usually in the form of performance levels, are cross cutting and impact on hydraulic design, geometric design, construction methods, environmental engineering and structural design |
| **Structural (construction)** | Structural standards define the minimum construction strengths and define quality criteria for materials used in construction |
| **Maintenance** | Levels of maintenance need to be set for LVRR networks as targets for the different classification levels as a guide to network managers. |

Table 10-2 recommends further variations in road width by road class, accounting for variations in traffic volume and composition. For constrained single lane roads that do not allow the larger vehicles to pass in opposite directions or to overtake, passing places are a geometric standard option. The increased width at passing places should allow two vehicles to pass at slow speed and hence depends on the design vehicle. For trucks or buses of 2.5m width, the safe minimum width of passing places is 6.0m. Passing places should normally be provided every 300m to 500m depending on the terrain and geometric conditions. The length of passing places is dictated by the maximum length of vehicles expected to use the road indicating the need to define a design vehicle. In most cases a length of 20m will be sufficient for rural roads.

**Table 10-2: Possible Variations in Road-width Geometry**

| Class | Basic Carriageway Width (m) | Variations on Carriageway Width (m) | Shoulder Width (m) | Comment |
|---|---|---|---|---|
| **A** | **5.50** | A1 5.50<br>A2 4.50<br>A3 3.60 | 1.00-3.00 | Narrower options for constrained locations. Also, where traffic may not justify the prescribed width.<br>Wider shoulders where higher % of Non-Motorised Transport and slower traffic |
| **B** | **3.60** | B0 4.50<br>B1 3.60<br>B2 3.00<br>B3 2.50 | 1.00-2.50 | Narrower options for constrained locations.<br>Wider option if traffic justifies.<br>Wider shoulders where higher % of Non-Motorised Transport and slower traffic. Possible use of passing places |
| **C** | **3.60** | C1 3.60<br>C2 2.50<br>C3 2.00 | 0.50-1.50 | Narrow options may be used for access for small vehicles or motorcycle only |

Combining the design considerations as presented in tables 10-1 and 10-2, a typical road design chart for a low volume class road could look like Table 10-3.

**Table 10-3: Typical Summary Geometry for a 3.60m Rural Road**

| Design Parameter | Comments | Definition | | |
|---|---|---|---|---|
| Carriageway width | | 3.6 m | | |
| Shoulder width | Depends on number of non 4-wheeled vehicles | > 300 **PCUs** 1.50 m<br>< 300 **PCU**s 1.00 m | | |
| Design speed | Defined by terrain | Flat | Rolling | Mountainous |
| | | 50 km/h | 40 km/h | 30 km/h |
| Maximum[1] gradient | Gravel | 6% | 10% | 10% |
| | DBST | 10% | 12% | 12% |
| | Concrete | 15% | 15% | 15% |
| Stopping sight distance (m) | Gravel | 70 | 50 | 35 |
| | Sealed | 55 | 40 | 30 |
| Minimum horizontal curve radius (m) SE=4% | Gravel (recommended) | 110 | 67 | 35 |
| | Sealed | 97 | 60 | 32 |
| Minimum horizontal curve radius (m) SE=7% | Gravel | 100 | 60 | 30 |
| | Sealed | 70 | 40 | 20 |
| Minimum value of L/G[2] for vertical curves | Gravel | 12 | 6 | 3 |
| | Sealed | 7 | 4 | 2 |
| Sag | Gravel or sealed | 2.2 | 1.3 | 0.7 |
| Cross-fall | Gravel | 5% | | |
| | Bituminous Sealed | 4% | | |
| | Concrete | 2% | | |

1: This will also be a function of vehicle type;
2: L is the length of the vertical curve and G is the tangent gradient in %.

Possible variations in pavement types that could be considered for low volumes rural roads are presented in Table 10-4.

Table 10-4: Range of Options for LVRR Pavement

| | Seals | Non-bituminous Surfaces | Unsealed Surfaces |
|---|---|---|---|
| **Running surface** | (i)a DBST<br>(ii)a DBST – emulsion<br>(iii)aPenetration macadam<br>(iv)aCold pre-mix | (v)a Non-reinforced concrete<br>(vi)a Concrete block<br>(vii)a Clay brick<br>(viii)a Stone setts/cobbles<br>(ix)a Hand-packed stone | (i)a Gravel wearing course<br>(ii)a Water bound macadam<br>(iii)aDry Macadam |
| **Base / Sub-base** | a.a Water-bound macadam<br>b.a Dry-bound macadam<br>c.a Cement stabilised local soil<br>d.a Lime stabilised local soil Mechanical stabilisation<br>e.a Graded crushed stone<br>f.a Natural gravel | | |

## 10.3 Standards: Small Structures

The current standards include 4 types of standard bridges and a range of culverts and a vented causeway. It is recommended to develop a specific Myanmar small structure manual, based on international or regional small structure manuals, catering for a greater variety of structures for different access service levels. This could include low level crossings such as drifts, but also structures for pedestrians, bicycle and motorcycle access or agricultural access only, such as small bridges, steps, etc.

The workshop identified the need for clear guidance on hydraulic assessments. The small structure manual should therefore include guidance on methods and techniques for hydrological catchment assessment, and for flood zones, and include hydraulic design charts for structures. Standards for small structures allows for standard construction, which simplifies the design and selection of appropriate structures. This further assist construction quality control.

Choice of structures depends on the hydrological and hydraulic characteristics of the streams or water body crossing the road and on the design vehicle. Design aspects include:

- Risk of flash floods and high energy flows, with risk of wash out and scouring
- Level of definition of stream channel (incised or shallow)
- Bed and invert levels of the structure, relative to the road level
- Meandering risks of water flow
- Structural strength, capable to withstand design loads
- Design life of the structure and related freeboard set above the design return period of Flood Water Level.
- Economic costs of structure
- Construction complexity and material use and availability
- Road user safety

In addition, the design should incorporate the “access service levels” of water crossings; this is the minimum acceptable level of access for the design vehicle. This should be appropriate and consistent with the level of access of the road itself, i.e. all sections of the road should be accessible for the same design vehicle under the same condition. The water crossings therefore should not form bottlenecks for the design traffic of the road, except if a lower level of access is chosen and accepting temporary restrictions of crossings for economic reasons. All crossings on the road should however have the same Access Service Level. Examples of access service levels are presented in Table 10-5. These can also be related to return periods and duration of high water level during which access is blocked.

**Table 10-5: Access Service Levels**

| ASL | Condition of access (for design vehicle) |
|---|---|
| **Level I:** | Access possible in all weather. |
| **Level II:** | Access possible in all but the worse weather conditions i.e. access likely but not guaranteed i.e. flash floods |
| **Level III:** | Access possible long periods of time but lost in bad weather/high water, with access blocked for hours to days. |
| **Level IV:** | Access lost for considerable periods (in rainy season), with access blocked for days to weeks. |
| **Level V:** | Access blocked during rains, up to several months. |

It is recommended to include in the standards access requirements for people with disabilities or those with special needs. This Includes easy on/off ramps, appropriate kerbs in built-up areas, protected or elevated walkways on bridges, side drain covers, etc.

## 10.4 Technical Specifications

Table 3-3 in section 3.5 listed key technical specifications required to effectively define the procedures and materials required to design, construct and maintain LVRRs to the accepted standards and section 7.7 outlined the principal sources of specifications currently available for use in Myanmar. Based on this it is a recommendation that a comprehensive upgrade of specifications is required, with an initial concentration on the following:

Construction: The existing MoC specifications for pavements and related materials, as adapted for use in the KfW RIP phases, are detailed but cater only for a very limited number of pavement options. Suitable specifications are available to be adapted from the trials research work in Vietnam and Laos, as well from the KfW trials in Taunggyi.

Earthworks and Drainage: There are limited specifications dedicated to LVRRs, although some may be adapted from MoC main roads specifications.

Quality Assurance: Specifications on the procedures to be adopted for quality control and quality assurance exist for some standard procedures but the extent of the specifications requires expansion. The use, for example, of the DCP as a quality control tool for earthworks and pavement layers needs to be defined.

Climate resilience. There is a lack of Myanmar specifications dealing with the identification, assessment and risks assessment of climate threats as well adaption measure to protect against these threats.

Section 5 (Table 5-2: Regionally Relevant Work on Technical Specifications) lists some initial sources for the above specifications.

## 10.5 Key Recommendations for a Myanmar LVRR Design Manual

This review demonstrates the justification for a development of an LVRR design manual for Myanmar

Considering the previous discussions and the stakeholder review, a LVRR design manual based on the Tanzanian model is likely to best suit the requirements of DRRD. This seems to be fitting the wish for a comprehensive manual with geometric standards and design at its core.

Further detailed discussion should be undertaken with the relevant technical committees, but a draft Table of Contents for initial drafting could look like:

**Part 1 (construction Methods / Design):**

1.a Scoping and Classification and sub-classification
2.a Surveys and investigations
3.a Geometric / pavement design,
4.a Road safety and road furniture
5.a Climate resilience and environmental protection
6.a Hydrology and hydraulics, with possibly a separate guideline on small structures and bridges
7.a Structural design and construction standards

**Part 2 (construction regime)**

8.a Costing, tenders and procurement
9.a Testing and quality control
10.a Supervision and quality control
11.a Environmental management

**Part 3 (maintenance)**

12.a Maintenance management

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# Annex 1 – Stakeholders Consulted

## People Met

)

| Name | Designation |
|---|---|
| **ReCAP** | |
| Maysam Abedin | Regional Technical Manager |
| Dr. Jasper Cook | Technical Team Leader ReCAP |
| Dr Nandar Kyaw | Country Manager AsCAP- Myanmar |
| **Department of Rural Road Development (MOC)** | |
| U Myint Oo | Deputy Director General |
| U Wanna Zaw | Deputy Director General |
| Daw Tin Moe Myint | Deputy Director General |
| Daw Kyi Kyi Thawe | Chief Engineer |
| U Soe Soe Oo | Deputy Director, Road and Bridge Division |
| Daw Hnin Pwint Wai | Sub-assistance Engineer |
| Daw Wut Hmone Win | Sub-assistance Engineer |
| Daw Nyen Thant Yi | Upper Clerk (GIS Specialist) |
| **Department of Rural Road Development – Ayeyarwady Division** | |
| U Lin Hteik | Deputy Chief Engineer, State Officer (Pathein) |
| U Khin Maung Win | Executive Engineer, District Engineer (Pathein) |
| U Moe Myint | Township Officer (Pathein) |
| U Thant Zin Min Tun | Executive Engineer, District Engineer (Maubin District Office) |
| Daw Than Than Win | SAE. Engineer (Maubin District Office) |
| Daw Htet Myat Mon | SAE. Engineer (Maubin District Office) |
| U Aung Htun | Township Officer, Taunggyi |
| U Maung Maung Kyaw | Assistant Director |
| U Khun Thein Win | Senior Clerk, Pinlaung |
| U Khun Tun Min Thant | SAE, Pinlaung |
| | |
| Daw Phyu Phyu | Director |
| Soe Thiha | Lab in charge |
| **JICA** | |
| Yoshifumi Tokushige | Project Formulation Advisor |
| Mi Mi Cho | Senior Program Officer |
| Myat Thazin | Assistant Program Officer |
| Thet Thet Zaw | Assistant Program Officer |

| **Name** | **Designation** |
|---|---|
| **KfW** | |
| Eva Schneider | Country Director |
| **Gauff Engineering** | |
| Mr André Drockur | RDP III Consultant Team Leader |
| **SWE Road** | ) |
| Dr. Geoff Edmonds | RRAP Consultant Team Leader |
| Mr Walter Illi | RRAP Road Engineer |
| **Myanmar Engineering Society** | |
| U Lin | Vice President |
| U Ko Ko Gyi , P.E | Vice President |
| Dr. Khin Sandar Tun | Vice President |
| **Myanmar Construction Entrepreneurs Association** | |
| U Kyaw Paing | Vice President (MCEA) |
| U Kyaw Soe Daniel | EC member (MCEA) |
| U Aung Win | Advisor (MCEA) |
| U Ne Lin | EC member (MCEA) |

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# Annex 2A – Selection from the Book of Standards

# ပြည်ထောင်စုသမ္မတမြန်မာနိုင်ငံတော်
# ဆောက်လုပ်ရေးဝန်ကြီးဌာန
# (ကျေးလက်လမ်းနှင့်တံတားဖွံ့ဖြိုးရေးဦးစီးဌာန)

MINISTRY OF CONSTRUCTION

Book Of Standard

Volume - 1

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## Book Of Standard
## မာတိကာ



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## Book Of Standard
## မာတိကာ



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Central Committee for the Development of Regional Roads and Bridges

## The Republic of The Union of Myanmar

### Rural Road Grades and right of way standards

| Rural road Grade (1) | Right of way ( width) | Remarks |
|---|---|---|
| Roads connect with MOC roads, roads connect with Town and Village | (100) ft | To make necessary Coordinate in the implementation process on the land availability |
| **Rural road Grade (2)** | | |
| Road connected with rural road grade (1) | (60) ft | |
| **Rural road Grade (3)** | | |
| Roads connect Village to Village | Width of Right of way should depend on the ground condition | |

---

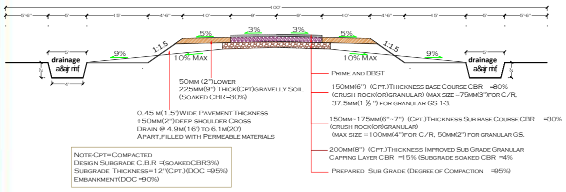
Central Committee for the Development of Regional Roads and Bridges

## The Republic of The Union of Myanmar

### Rural Road Grade (1) Design Standards

| | |
|---|---|
| Type Road | - Bitumen |
| Width | - 18 ft |
| Shoulder | - 10 ft (one side) |
| Cattle cart road | - 15 ft (one side) |
| Drainage | - 5 ft (one side) |
| Strength | - AASHTO HS20-44 36 tons |

| Traffic flow amount (Per day) | necessary lane width |
|---|---|
| Under 50 | - 12' ft |
| Under 500 | - 18' ft |




(Cumulative number of standard axle in one diredtion < 0.3 X )

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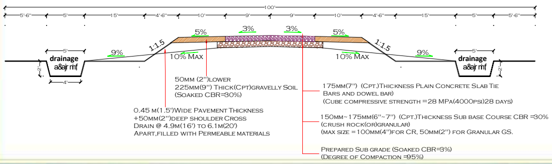
Central Committee for the Development of Regional Roads and Bridges

## The Republic of The Union of Myanmar

### Rural Road Grade (1) Design Standards

| | |
|---|---|
| Type Road | - concrete |
| Width | - 18 ft |
| Shoulder | - 10 ft (one side) |
| Cattle cart road | - 15 ft (one side) |
| Drainage | - 5 ft (one side) |
| Strength | - AASHTO HS20-44 36 tons |

| Traffic flow amount (Per day) | necessary lane width |
|---|---|
| Under 50 | - 12' ft |
| Under 500 | - 18' ft |



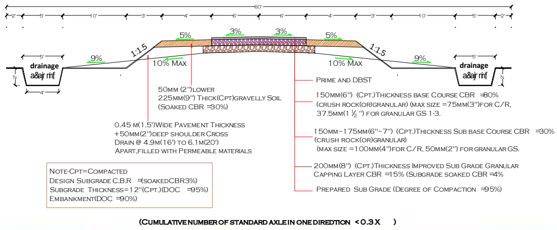

(Cumulative number of standard axle in one diredtion < 0.3 X )

Central Committee for the Development of Regional Roads and Bridges

## The Republic of The Union of Myanmar

### Rural Road Grade (2) Design Standards

| | |
|---|---|
| Type Road | - Bitumen |
| Width | - 12 ft |
| Shoulder | - 4 ft (one side) |
| Cattle cart road | - 10 ft (one side) |
| Drainage | - 5 ft (one side) |
| Strength | - 20 tons |

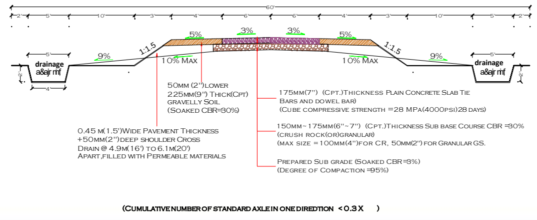



Central Committee for the Development of Regional Roads and Bridges

## The Republic of The Union of Myanmar

### Rural Road Grade (2) Design Standards

| | |
|---|---|
| Type Road | - concrete |
| Width | - 12 ft |
| Shoulder | - 4 ft (one side) |
| Cattle cart road | - 10 ft (one side) |
| Drainage | - 5 ft (one side) |
| Strength | - 20 tons |

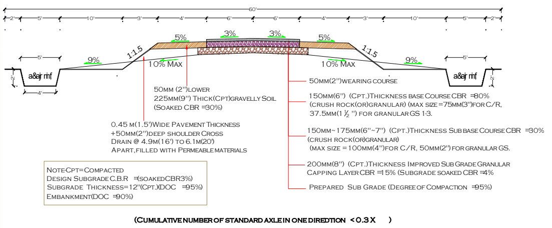



Central Committee for the Development of Regional Roads and Bridges

## The Republic of The Union of Myanmar

### Rural Road Grade (2) Design Standards

| | |
|---|---|
| Type Road | - Macadam |
| Width | - 12 ft |
| Shoulder | - 4 ft (one side) |
| Cattle cart road | - 10 ft (one side) |
| Drainage | - 5 ft (one side) |
| Strength | - 20 tons |

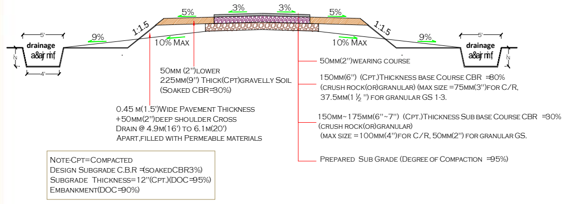



Central Committee for the Development of Regional Roads and Bridges

## The Republic of The Union of Myanmar

### Rural Road Grade (3) Design Standards

| | |
|---|---|
| Type Road | - Macadam |
| Width | - depend on the land availability |
| Strength | - 20 tons |

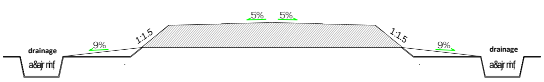



Central Committee for the Development of Regional Roads and Bridges

## The Republic of The Union of Myanmar

### Rural Road Grade (3) Design Standards

| | |
|---|---|
| Type Road | - earth road |
| Width | - depend on the land availability |
| Strength | - |




Central Committee for the Development of Regional Roads and Bridges

## The Republic of The Union of Myanmar

### Stages of Construction of each layer of Rural Roads

| Road Layer | Specification | Construction stage |
|---|---|---|
| Base Layer | Prepared Sub Grade (D.O.C. 95%) | Clear building and debris which causes any disturbance to the construction area |
| | | Land measurement to build the frame work for soil and preparation according to the depth and shape. |
| | | Under the construction area of earth frame, 6” thickness of the topsoil should be removed, grubbing soil and make 95%. compaction |
| | 8” thickness Improved subgrade Granular Capping Layer CBR | If there is weak soil under the construction area, dig and removed the weak soil until the necessary depth. Made Embankment with mixed soil |
| | | Moisture or water contain must be in the range of ± 1%. |
| | | To use the soil which have Liquid limit 40 and Plasticity index (max) 14 |
| | | Repair soil CBR of repaired soil shall not be more than 20 %. |
| **Remark: The construction of earth road can use the natural based soil.** | | |

Ref: Manual on Labour-Intensive-Type Pavement Work Low-Traffic-Volume Roads (MoC)

## THE REPUBLIC OF THE UNION OF MYANMAR

Central Committee for the Development of Regional Roads and Bridges

### Stages of Construction of each layer of Rural Roads

| Road Layer | Specification | Construction stage |
|---|---|---|
| 2nd – Sub Base Layer | 6: think sub base course CBR = 30% | During the time of carrying the requirements materials and spraying, to be serious caution of segregation of the layers |
| | Max C.R.Size 4"x 2" | To use Crush Size 4 MAX 4" x 2" . |
| | | To use suitable machines to have CBR between 20 % to 30% , (be cautious of the layer force index can change when CBR ismore than 30%) |
| | | If the local resources (or) Gravel road were not in standard quality, Lime or Cement can be reinforced . |

Ref: Manual on Labour-Intensive-Type Pavement Work Low-Traffic-Volume Roads (MoC)

## THE REPUBLIC OF THE UNION OF MYANMAR

Central Committee for the Development of Regional Roads and Bridges

### Stages of Construction of each layer of Rural Roads

| Road Layer | Specification | Construction stage |
|---|---|---|
| Base Layer | 6" thickness Sub Course CBR ≥ 80 % | To make sure the sub-base layers are in the standard heighta and depths before build the base layer |
| | Max: C.R size 3" x 1.5" | To use crush size not more than Maximum 3" x 11/2" |
| | | To use 8-10 tons of roller. To have density of consolidated; the roller should pass over and over again. |
| | | Should drive the roller 4-8 Km/hour |
| | | The roller passes should be more than 10 times |
| | | Must have CBR ≥ 80 % |

**Remark: to build the Macadam road, the standard building of 2nd base layer and base layer should be the same.**

Ref: Manual on Labour-Intensive-Type Pavement Work Low-Traffic-Volume Roads (MoC)

## THE REPUBLIC OF THE UNION OF MYANMAR

Central Committee for the Development of Regional Roads and Bridges

### Stages of Construction of each layer of Rural Roads

| Road Layer | Specification | Construction stage |
|---|---|---|
| surface | | |
| Bitumen – Prime coat | Prime Coat | Bitumen which has Penetrating level ( 80/100) must be used in the Prime coat |
| | | Penetration thickness should be 3-10 mm. |
| | | When spraying, Temperature must be 150-175 ˚C |
| | | Spray rate is 0.06-0.2 Gallons/yard |
| | | Bitumen mixed with water PK-3 (or) CRS-1 can also be used in the prime cost. |

Ref: Manual on Labour-Intensive-Type Pavement Work Low-Traffic-Volume Roads (MoC)

## THE REPUBLIC OF THE UNION OF MYANMAR

Central Committee for the Development of Regional Roads and Bridges

### Stages of Construction of each layer of Rural Roads

| Road Layer | Specification | Construction stage |
|---|---|---|
| surface | | |
| Bitumen – Prime coat ( Closed surfaced) | DBST | After Bitumen has sprayed, the same size of crush stones should be chipped and rolled again |
| | | The thickness should not be more than 25mm |
| | | If normal bitumen would be used , the temperature should under 15˚C of temperature |
| | | If bitumen mixed with water would be used , the temperature should above 50 ˚C |
| | | 5-2.5 mm crushed stone : 0.6 $m^3$ for 1st sub Base Layer |
| | | Straight Asphalt ; 60-80 L |
| | | 5-13 mm crushed stone : 1.1 $m^3$ for 2nd sub Base Layer |
| | | Straight Asphalt ; 80-100 L |

Ref: Manual on Labour-Intensive-Type Pavement Work Low-Traffic-Volume Roads (MoC)

## THE REPUBLIC OF THE UNION OF MYANMAR

Central Committee for the Development of Regional Roads and Bridges

### Stages of Construction of each layer of Rural Roads

| Road Layer | Specification | Construction stage |
|---|---|---|
| Concrete Surface | 175 mm (7")Thickness Plain Concrete slab with Tie Bar and Dowel Bar | Concrete Join expansion should place in each 20 ft |
| | | Should use Dowel bar with 1.25" Ø and 18' long in each 12" c/c |
| | | To ensure 4000 psi of concrete stress |
| | | Make sure to be in the given specific designs |
| | | to make sure of concrete curing |

Ref: Manual on Labour-Intensive-Type Pavement Work Low-Traffic-Volume Roads (MoC)

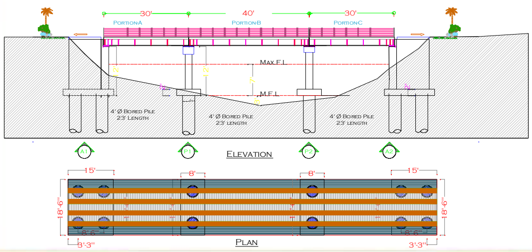
## THE REPUBLIC OF THE UNION OF MYANMAR

Central Committee for the Development of Regional Roads and Bridges

### Rural Bridge type standards

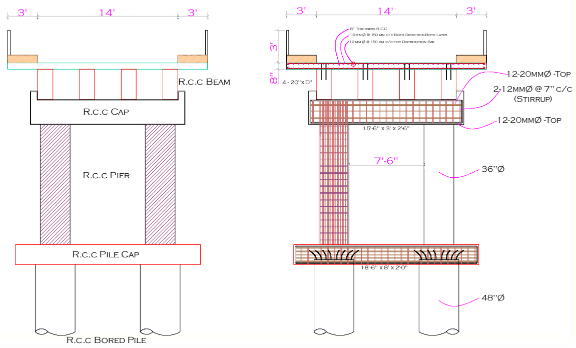
**Rural Bridge Type (1)**

Type of Bridge - Concrete Bridge
Width - 14 ft (Pavement for Pedestrian 3 ft (oneside))
Strength - AASHTO , HS 20-44 20 tons



Central Committee for the Development of Regional Roads and Bridges

## THE REPUBLIC OF THE UNION OF MYANMAR

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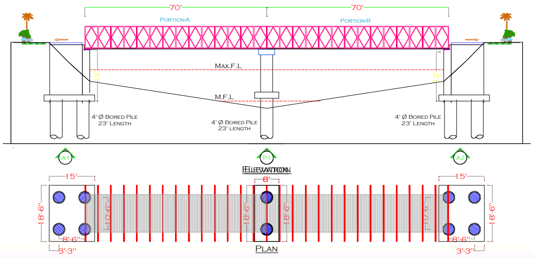
## THE REPUBLIC OF THE UNION OF MYANMAR

### Rural Bridge type standards

**Rural Bridge Type (2)**

| | |
|---|---|
| Type of Bridge | - Bally Bridge |
| Width | - 12 ft (Pavement for Pedestrian 3 ft (one side)) |
| Strength | - 13 tons |




Central Committee for the Development of Regional Roads and Bridges

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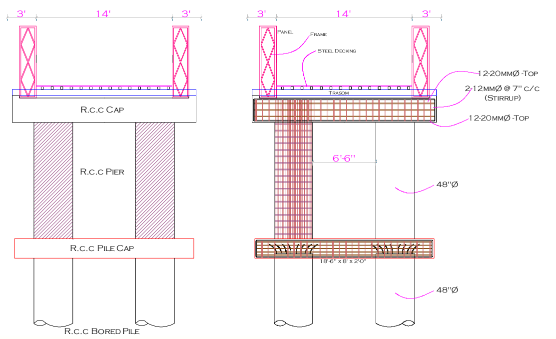


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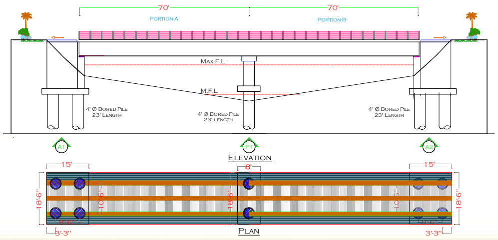
## THE REPUBLIC OF THE UNION OF MYANMAR

### Rural Bridge type standards

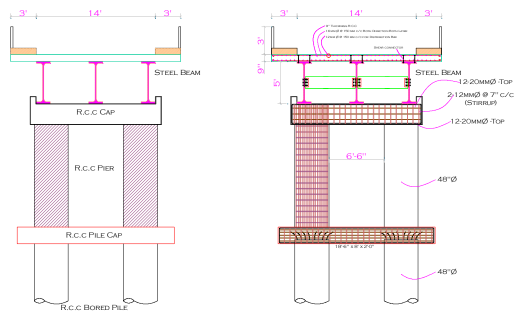
**Rural Bridge Type (3)**

| | |
|---|---|
| Type of Bridge | - Steel Plate Girder |
| Width | - 14 ft (Pavement for Pedestrian 3 ft (one side)) |
| Strength | - AASHTO , HS 20-44 36 tons |




Central Committee for the Development of Regional Roads and Bridges

## THE REPUBLIC OF THE UNION OF MYANMAR



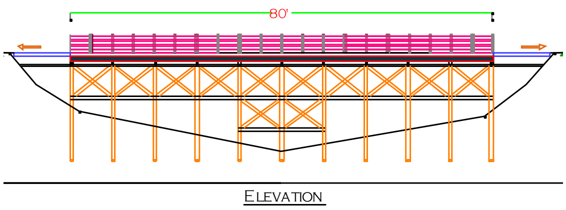

Central Committee for the Development of Regional Roads and Bridges

## THE REPUBLIC OF THE UNION OF MYANMAR

### Rural Bridge type standards

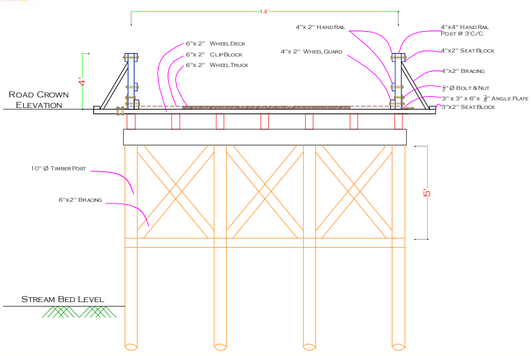
**Rural Bridge Type (3)**

| | |
|---|---|
| Type of Bridge | - Timber Bridge |
| Width | - 14 ft |
| Strength | - 13 tons |



Central Committee for the Development of Regional Roads and Bridges

## The Republic of The Union of Myanmar




STANDARD DRAWING

| SR. NO. | SPAN (ft) | | WIDTH (ft) | BRIDGE TYPE | REMARK |
|---|---|---|---|---|---|
| 1 | Box Culvert | 3 x 3 | 30' | R.C | |
| 2 | Box Culvert | 3 x 5 | 30' | R.C | |
| 3 | Box Culvert | 5 x 3 | 30' | R.C | |
| 4 | Box Culvert | 5 x 4 | 30' | R.C | |
| 5 | Box Culvert | 5 x 5 | 30' | R.C | |
| 6 | Box Culvert | 5 x 8 | 30' | R.C | |
| 7 | Box Culvert | 8 x 8 | 30' | R.C | |
| 8 | Box Culvert | 10 x 5 | 30' | R.C | |
| 9 | Box Culvert | 10 x 8 | 30' | R.C | |
| 10 | Box Culvert | 10 x 10 | 30' | R.C | |
| 11 | Box Culvert | 10 x 12 | 30' | R.C | |
| 12 | Box Culvert | 12 x 12 | 30' | R.C | |
| 13 | Box Culvert | 20 x 12 | 30' | R.C | |
| 14 | Bridge | 30 | 30' | R.C | |
| 15 | Bridge | 40 | 30' | R.C | |
| 16 | Bridge | 50 | 30' | R.C | |

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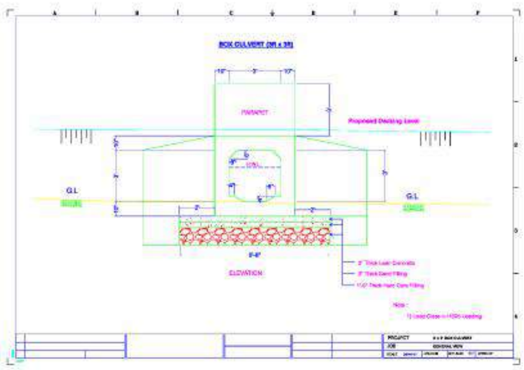


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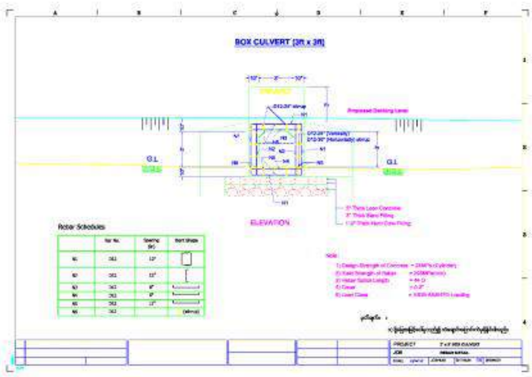


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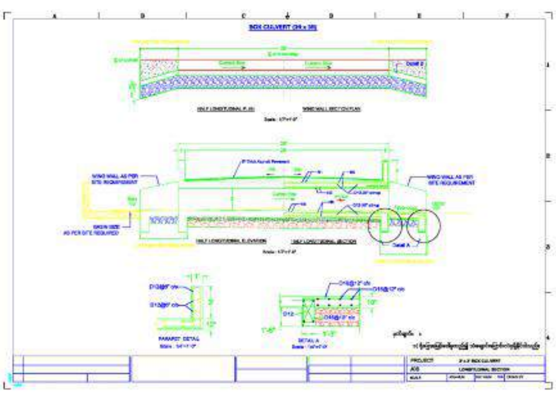


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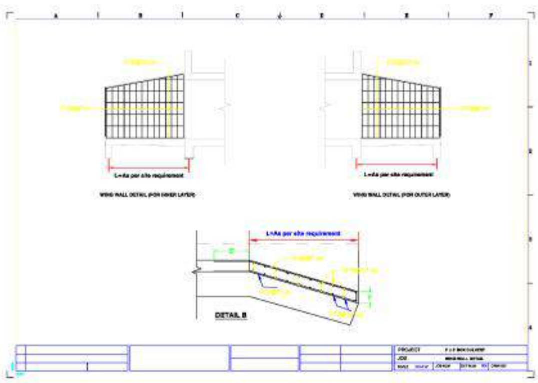


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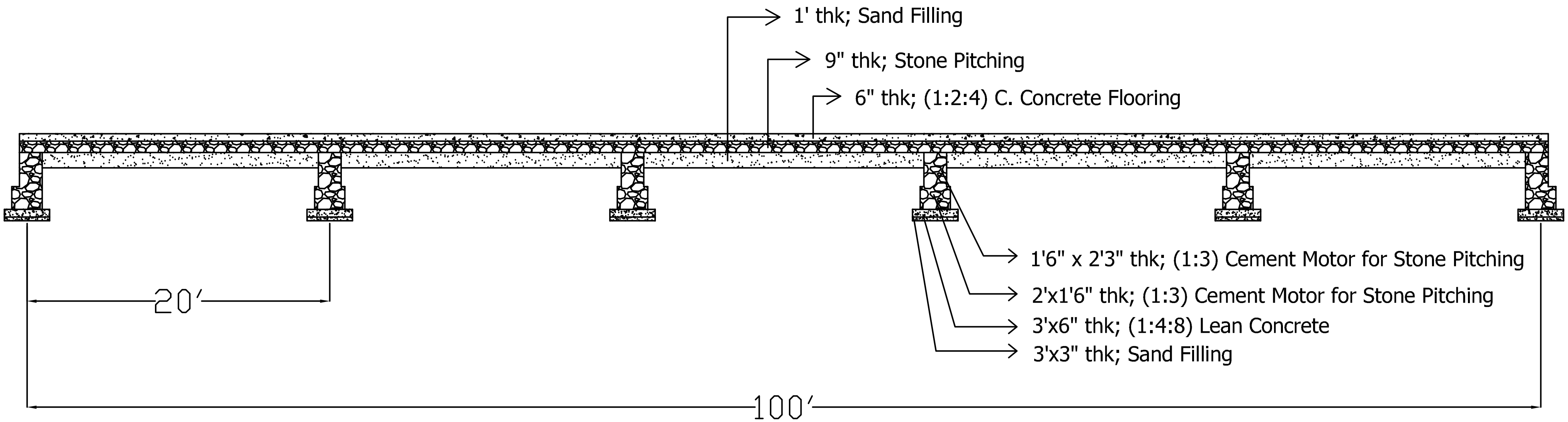
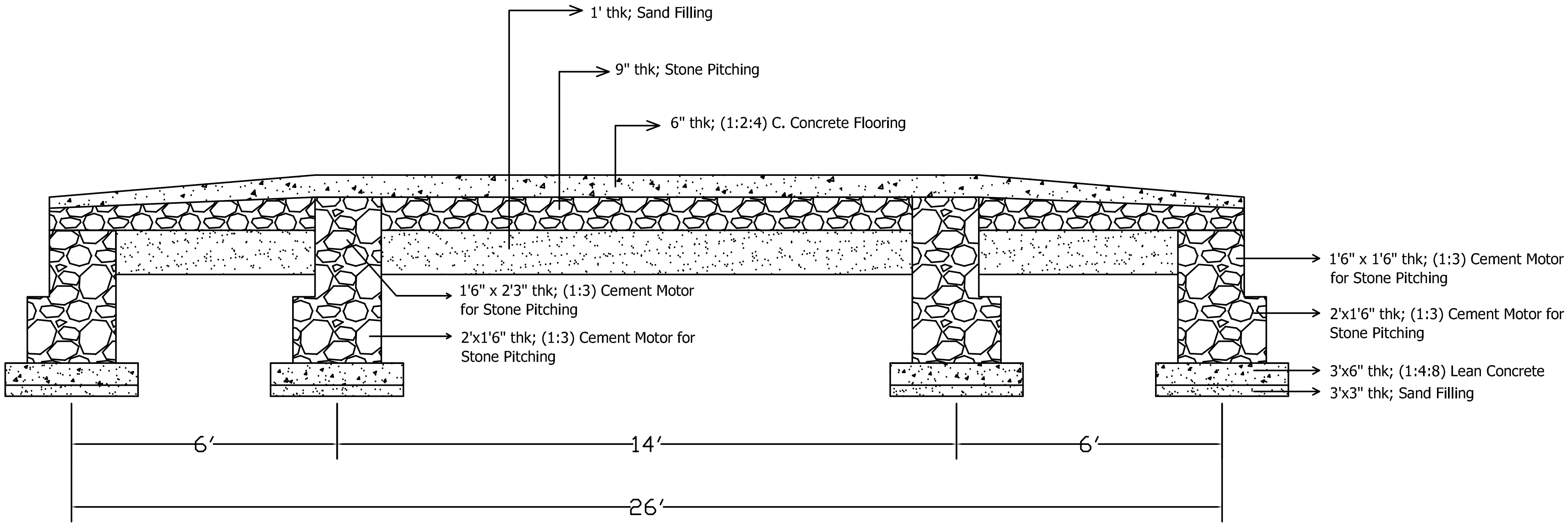


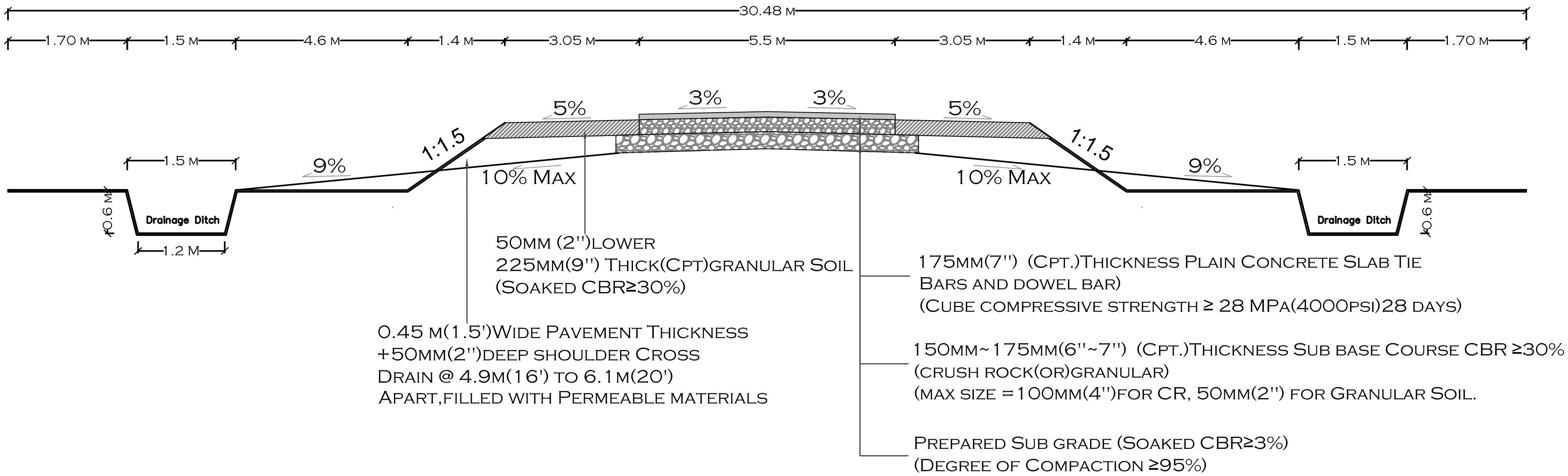

# LONGITUDINAL SECTION



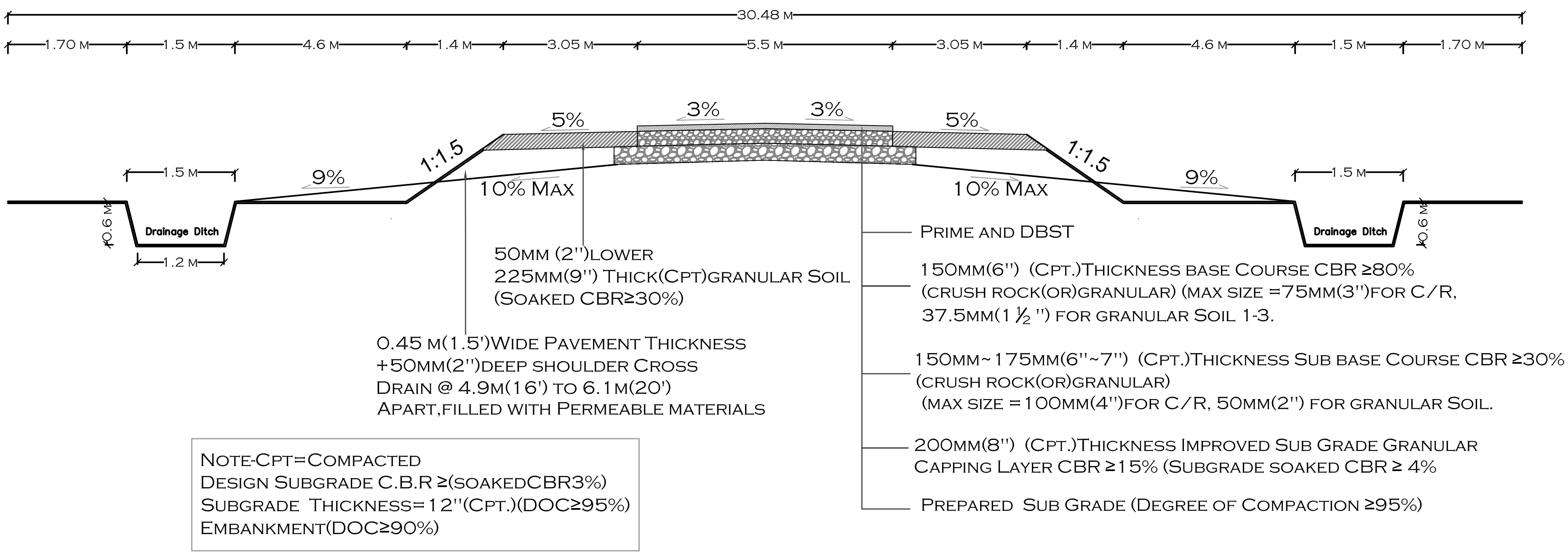

# CROSS SECTION

# Annex 2B – Current Rural Road Standard Drawings

# Rural Road Design Standard - Class (A) -concrete ROAD

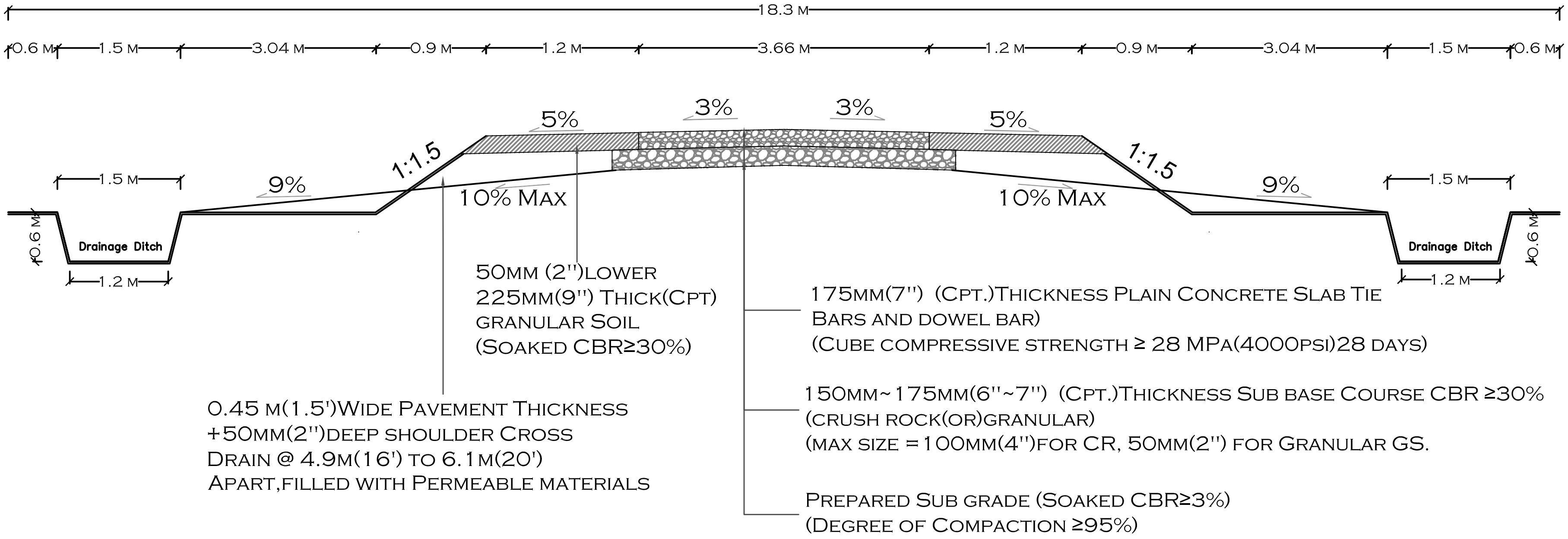


# Rural Road Design Standard - Class (A) -BITUMINOUS ROAD



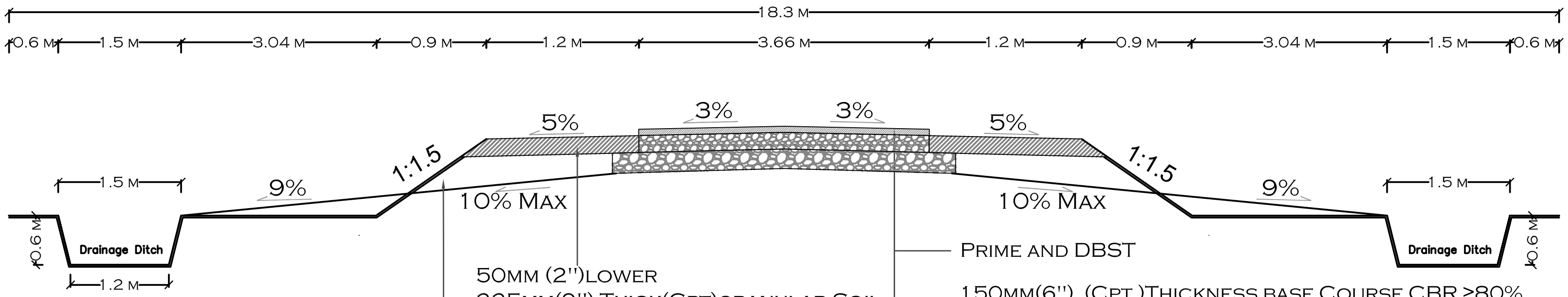

Typical Design Cross Section of Rigid Pavement (Rural Road)
(Cumulative number of standard axles in one direction <0.3x10$^{6}$)

# Rural Road Design Standard - Class (B) -concrete ROAD




(Cumulative number of standard axles in one direction <$0.3x10^6$)

# Rural Road Design Standard - Class (B) -BITUMINOUS ROAD




50mm (2'')lower
225mm(9'') Thick(Cpt)granular Soil
(Soaked CBR≥30%)

0.45 m(1.5')Wide Pavement Thickness
+50mm(2'')deep shoulder Cross
Drain @ 4.9m(16') to 6.1m(20')
Apart,filled with Permeable materials

Prime and DBST

150mm(6'') (Cpt.)Thickness base Course CBR ≥80%
(crush rock(or)granular) (max size =75mm(3'')for C/R,
37.5mm(1 ½ '') for granular Soil1-3.

150mm~175mm(6''~7'') (Cpt.)Thickness Sub base Course CBR ≥30%
(crush rock(or)granular)
(max size =100mm(4'')for C/R, 50mm(2'') for granular Soil.

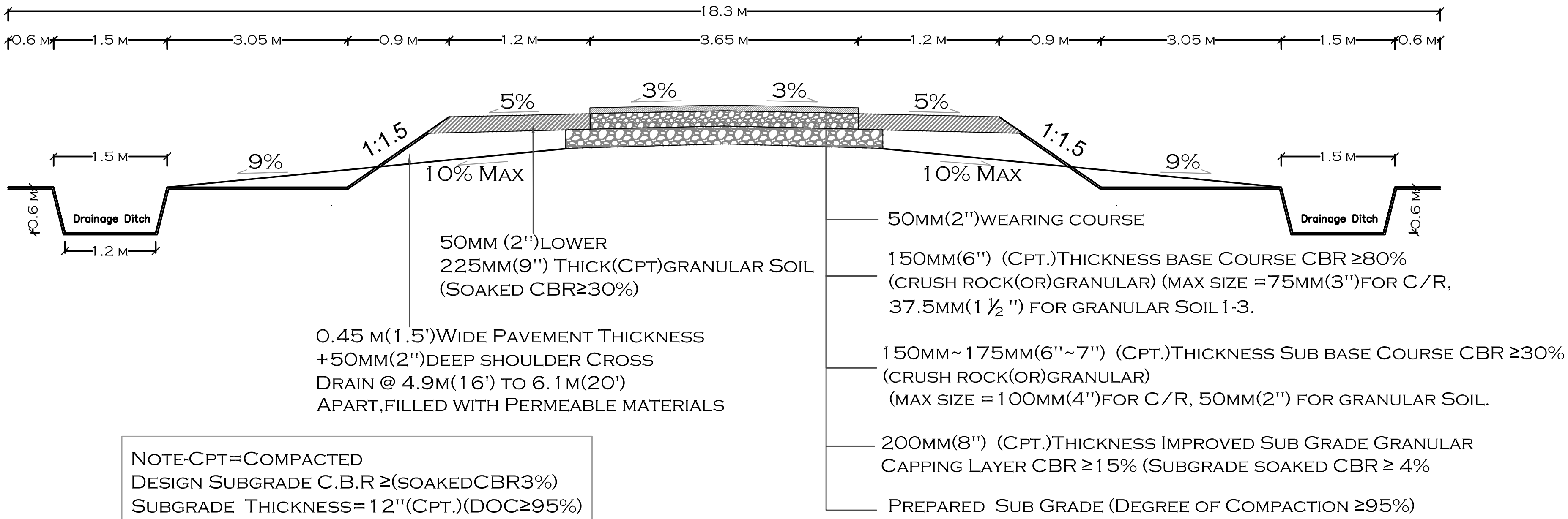
200mm(8'') (Cpt.)Thickness Improved Sub Grade Granular
Capping Layer CBR ≥15% (Subgrade soaked CBR ≥ 4%

Prepared Sub Grade (Degree of Compaction ≥95%)

Note-Cpt=Compacted
Design Subgrade C.B.R ≥(soakedCBR3%)
Subgrade Thickness=12''(Cpt.)(DOC≥95%)
Embankment(DOC≥90%)

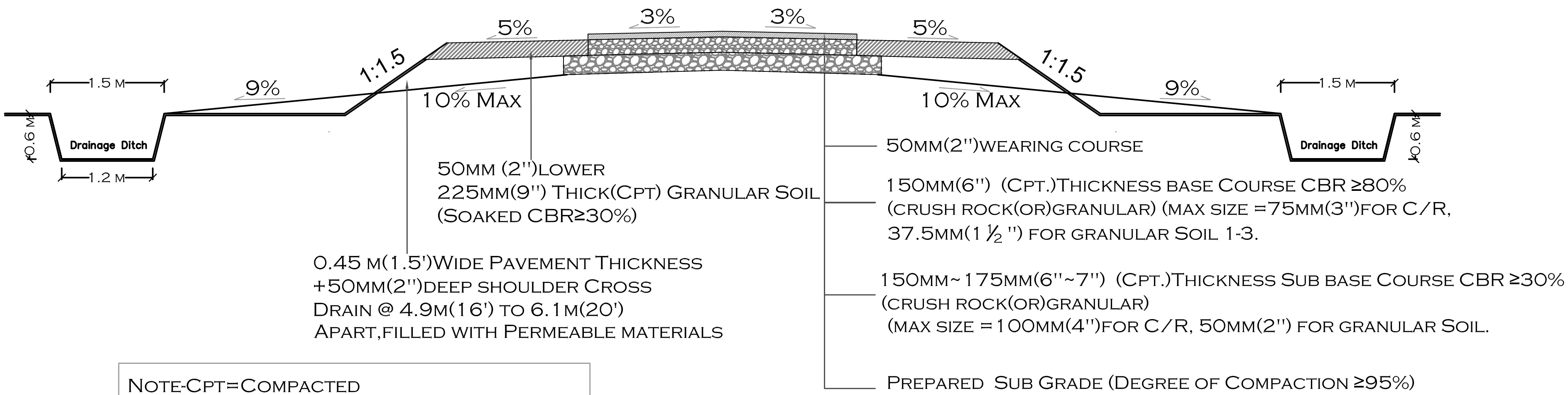
(Cumulative number of standard axles in one direction $<0.3 \times 10^6$)

# Rural Road Design Standard - Class (B) -Macadam ROAD



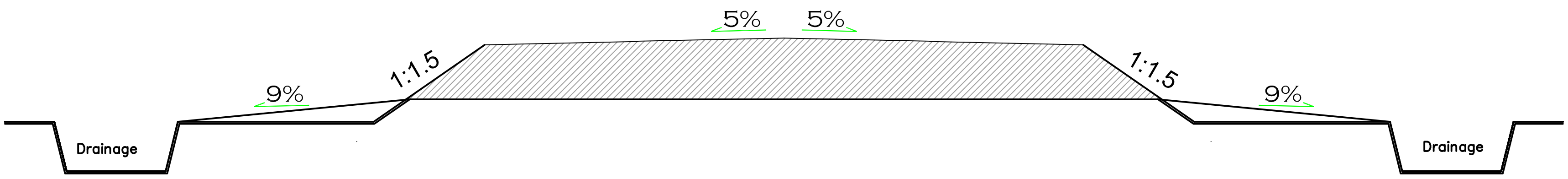

Note-Cpt=Compacted
Design Subgrade C.B.R ≥(soakedCBR3%)
Subgrade Thickness=12"(Cpt.)(DOC≥95%)
Embankment(DOC≥90%)

# Rural Road Design Standard - Class (C)- Macadam ROAD




Note-Cpt=Compacted
Design Subgrade C.B.R ≥(soakedCBR3%)
Subgrade Thickness=12"(Cpt.)(DOC≥95%)
Embankment(DOC≥90%)

# Rural Road Design Standard - Class (C) -Earth ROAD




Existing Eartmh

Width of road varies, depending on space