

Capacity Building and Mentorship for the Establishment and Implementation of Monitoring & Evaluation Programmes on Experimental and Long-Term Pavement Performance (LTPP) Sections in Six African Countries and Myanmar

Meeting Report (August 2018)



Civil Design Solutions

GEN2132A

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Cover photo: Measuring the Drainage Factor in Myanmar.

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Abstract

The Research for Community Access Partnership (ReCAP) is providing support to Road Research Centres (RRC) in sub-Saharan Africa and Asia to collect performance-based data from existing trial/demonstration road sections. The data will provide evidence for the establishment of appropriate specifications for Low Volume Roads. The road sections are being monitored and evaluated in terms of the pavement design, materials and surfacing, drainage design, geometric design, road safety and performance under traffic. Monitoring is being carried out in accordance with existing guidelines for the establishment and monitoring of experimental and LTPP sections, which will be updated under the project.

A coordination meeting was held between experts engaged by ReCAP on capacity building projects for LTPP monitoring in Africa and Asia. The meeting was held in Johannesburg on 24th August 2018. The meeting enabled the experts to share their experiences on the LTPP programme, and to agree on key aspects of programme including responsibilities for collection and analysis of data and the format and content of the regional monitoring guidelines.

Key words

Performance Monitoring, Low Volume Roads, Capacity Building

Research for Community Access Partnership (ReCAP)

Safe and sustainable transport for rural communities

ReCAP is a research programme, funded by UK Aid, with the aim of promoting safe and sustainable transport for rural communities in Africa and Asia. ReCAP comprises the Africa Community Access Partnership (AfCAP) and the Asia Community Access Partnership (AsCAP). These partnerships support 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. The ReCAP programme is managed by Cardno Emerging Markets (UK) Ltd.

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Acronyms, Initialisms, Units and Currencies

AfCAP	Africa Community Access Partnership
AsCAP	Asia Community Access Partnership
CDS	Civil Design Solutions
CSIR	Council for Scientific and Industrial Research
DCP	Dynamic Cone Penetrometer
DF	Drainage Factor
DFID	Department for International Development
DR Congo	Democratic Republic of Congo
IRIM	Inter-Regional Implementation Meeting
LTPP	Long-Term Pavement Performance
LVR	Low Volume Road
LVSR	Low Volume Sealed Road
ReCAP	Research for Community Access Partnership
RRC	Road Research Centre
TRH	Technical Recommendations for Highways
TRL	Transport Research Laboratory
UK	United Kingdom (of Great Britain and Northern Ireland)
UKAid	United Kingdom Aid (Department for International Development, UK)

1 Introduction

1.1 Background

The Research for Community Access Partnership (ReCAP) is a six-year programme of applied research and knowledge dissemination funded by a grant from the UK Government through the Department for International Development (DFID). The overall aim of ReCAP is to promote safe and sustainable rural access in Africa and Asia through research and knowledge sharing between participating countries and the wider community.

In Africa and Myanmar ReCAP is providing support to Road Research Centres to collect performance-based data from existing trial/demonstration road sections. This data will provide evidence for the establishment of appropriate, cost-effective standards and specifications for Low Volume Roads. The road sections are being monitored and evaluated in terms of their performance related to pavement design, materials and surfacing, drainage design, geometric design and road safety, in accordance with existing guidelines for the establishment and monitoring of long-term pavement performance (LTPP) road sections.

Civil Design Solutions (CDS) is providing capacity building and mentorship support to the participating roads agencies and national consultants in Malawi, Kenya, Uganda, Ethiopia, South Sudan, DR Congo and Myanmar. CDS is also providing support to the RRC in Mozambique for the monitoring of trial sections. The Council for Scientific and Industrial Research (CSIR) is providing support to Tanzania. TRL is managing an AfCAP “Regional Back-Analysis Project” which involves the development of a regional database of performance data from a large number of road sections in Africa.

1.2 Purpose of the Report

This report covers the LTPP Coordination Meeting held at the City Lodge Barbara Road in Johannesburg on 24th August 2018. The meeting was convened to enable the experts that are providing technical support to the RRCs for trial section monitoring to share their experiences and to agree on key aspects of the LTPP monitoring guidelines. The report includes a summary of the presentations made by the experts and the main discussion points and agreements. The meeting attendance list is included as Annex 1.

The meeting agenda is included in Table 1.

Table 1: Meeting Agenda

Item	Time	Topic	Lead person
1	8:30	Introductions and purpose of the meeting	R Geddes
2	8:40	Summary of existing monitoring projects	
		Mozambique	P Paige-Green
		Tanzania	M Mgangira
		Kenya (Egis)	J Hongve
		Kenya (ReCAP)	F Dangare
		Ethiopia	F Dangare
		Malawi	F Dangare
		Uganda	F Dangare
		South Sudan	F Dangare
		DR Congo	F Dangare
		Myanmar	M Pinard
	11:00	Tea/Coffee	
3	11:30	Regional Back Analysis Project – progress and database requirements	K Mukura
4	12:00	Development of regional monitoring guideline	M Pinard
	13:30	Lunch	
4	14:15	Development of regional monitoring guideline (continued)	M Pinard
5	15:00	Streamlining the country reporting requirements	R Geddes
6	15:30	Use of the monitoring data – analysis of the data and capacity building for research centres	H Nkwanga
	16:00	Tea/Coffee	
7	16:30	General discussion and meeting resolutions	R Geddes

2 Presentations

2.1 Introductory Presentation

Nkululeko Leta made some opening remarks on behalf of the ReCAP PMU on the purpose of the meeting and emphasising its importance. Following this Robert Geddes of CDS made an introductory presentation summarising the current status of the LTPP monitoring programme in Africa and Asia. His presentation is included in Annex 2. He noted the following issues that have arisen through the CDS projects:

- There are some inconsistencies and lack of clarity in the data collection methodology, particularly for the Visual Condition Index;
- Some key data are not being collected (e.g. the Drainage Factor and moisture movements); and
- It is not always clear in the participating countries who is going to use the data to achieve the overall objective.

The purpose of the meeting was summarised as follows:

- To share experiences on the monitoring activities;
- To Achieve consensus on details of the monitoring guidelines;
- The understand mechanism for uploading data to the Regional Back-Analysis Database;
- To discuss and agree responsibilities for data analysis; and
- To discuss a strategy for capacity building at the country level to make good use of the data.

It was proposed that the outcome of the meeting, in particular the refined regional monitoring guideline and standard report format, should be shared with the wider stakeholder group at the country level and at the next ReCAP Inter Regional Implementation Meeting (IRIM).

2.2 Mozambique

Phil Paige-Green made a presentation of the LTPP monitoring project in Mozambique. His presentation is included in Annex 3.

The objectives of the Mozambique project were summarised as follows:

- To carry out a review of suitable existing trial sections;
- To ensure that data collected from existing and new sections are consistent with the regional protocols for establishment and monitoring of road trial sections;
- To develop a data base for capturing the monitoring data; and
- To provide support for capacity building and mentoring by working in close collaboration with researchers and technicians from the ANE RRC.

The project activities were summarised as follows:

- To review existing trial sections, inclusive of additional testing and back-analyses where required;
- To review and implement the existing regional guidelines/protocols for LTPP monitoring and produce a customised guideline for Mozambique;
- To carry out the systematic collection and recording of data during the monitoring period of the sections, including quality assurance of data;
- On-going monitoring of established and new trial sections – the sections are located in Inhambane and Zambezia Provinces;
- Development of an electronic database for storing data from the monitoring sites;
- Workshops on the regional monitoring guidelines, how to carry out a research project, and identifying priorities for further research under the RRC in Mozambique; and
- Presentation of papers at the SARF/PIARC Conference in Durban in October 2018.

2.3 Tanzania

Martin Mgangira made a presentation of the LTPP monitoring project in Tanzania. His presentation is included in Annex 4.

The objectives of the Tanzania project were summarised as follows:

- To evaluate the nature and quality of information available from the existing trial sections in Bagamoyo and Siha;
- To refine and implement existing regional guidelines and protocols to ensure that the establishment of road trials and collection of the information is standardised; and
- To establish LTPP monitoring sections on the two selected roads to collect data on a consistent and continuous basis over a number of years.

Activities that have been carried out include training workshop on experimental design, setting up test sections, research planning and reporting, monitoring and research during and after the construction phase, and monitoring climatic conditions and site demonstrations of monitoring tests and techniques.

The project participants are being individually assessed and have demonstrated a satisfactory level of competency to conduct field surveys. However, there are doubts about the availability of long-term funding allocations for monitoring.

2.4 Uganda, Kenya, Malawi, Ethiopia, South Sudan and DR Congo

Francis Dangare presented the project for capacity building support to six countries in Africa. His presentation is included in Annex 5. The key features of the project were outlined as follows:

- A number of road sections have been designated in each country for monitoring over a two-year period;
- Capacity will be developed within each RRC to independently manage the implementation of the monitoring programmes in the longer term; and
- Local consulting firms are assisting the RRCs with the field monitoring activities and to build capacity and interest in research in the local civil engineering consulting industry.

Of the six participating countries in the project, only Kenya and Ethiopia already had on-going LTPP monitoring programmes being implemented by local consulting firms under the management of the respective RRCs. New programmes were being established in Malawi, Uganda and South Sudan. DR Congo will participate in visits and workshops held in the other countries.

Key technical issues that have arisen during the implementation of the project include:

- There is a need to make use of existing national monitoring guidelines (Ethiopia and Kenya) and to update and harmonise them in line with the draft Regional Guidelines;
- The existing monitoring guidelines (Mozambique version) could be improved through the inclusion of photographs depicting each defect that must be monitored in the visual condition surveys;
- Clarity is needed on the materials testing standards and specification to be adopted on the LTPP monitoring projects (participating countries use different test methods interchangeably);
- Data on construction and maintenance costs on the project roads are seldom available;
- Moisture sensors should be installed on the monitoring sites and the Drainage Factor should be measured;
- Some sites selected for monitoring have already suffered significant deterioration;
- It is not always clear which agency is responsible for the interpretation of the monitoring data; and
- None of the participating RRCs currently has in-house capacity to manage the data and to analyse it to derive conclusions on the performance of the roads, but there are opportunities for strategic research to be carried out by the RRCs and other research organisations, for example universities, in the participating countries.

2.5 Myanmar

Mike Pinard presented the Myanmar component of the regional capacity building project. His presentation is included in Annex 6. The key features of the project were outlined as follows:

- Four trial sections are being established on the TG1 IA road in Shan State- they include penetration macadam, double bituminous surface dressing, unreinforced concrete slabs and concrete bricks;
- Monitoring is being carried out by staff from the Research and Development Unit (RDU) of the Department for Rural Road Development (DRRD);
- The TGI-1A road is not a low volume road- it was designed to conventional standards using ORN 31 and design traffic loading of 1.5 MESA – however it serves as a training facility for the research team;
- The road width of 4.5 m appears too narrow for the relatively high volume of motorised vehicles, leading to edge break and edge drop; and
- In Myanmar, language is a barrier to communication and there is a need to explain monitoring terms very carefully and to illustrate them with photos wherever possible.

2.6 Regional Guideline

Mike Pinard made a presentation on the draft regional guidelines for monitoring LTPP sites. His presentation is included in Annex 7.

The current guideline is based on TMH9 which provides inputs for road asset management at the strategic and tactical level. The guideline is compiled as one document comprising background information on planning, design and monitoring of trial sections, guidance on visual condition assessment of different types of pavements, and for miscellaneous measurements including roughness, gravel loss, reflection??, traffic counts, rut depth, etc.

It is proposed to restructure the guideline as follows:

- Part A: General/Background information on planning, design and monitoring of trial sections
- Raters Manuals:
 - Part B: Flexible pavements
 - Part C: Concrete pavements
 - Part D: Block pavements
 - Part E: Unpaved roads

The Raters Manuals will be reader-friendly and easy-to-use documents aimed at facilitating reliable monitoring by initially inexperienced raters and including supporting photographs to illustrate each type of distress.

Regarding the maintenance of the trial sections, there is a need for a maintenance protocol to highlight minimum maintenance interventions required to be undertaken by roads agencies and to report on what maintenance has been carried out. If maintenance is inadequate this should be reported to the road agency to facilitate action.

3 Discussion and Agreements

The following is a summary of the discussion and agreements reached at the meeting:

1. Permanent concrete markers should be installed for all monitoring sections. This requirement is to be included in the Monitoring Guideline.
2. It is important to maintain/repaint the road markings at the measurement locations.
3. When different degrees of a specific defect are found on a monitoring section, the visual condition assessment should record the degree which, when multiplied by its extend, gives the largest result.
4. All materials test results should state which testing standard was used.
5. The Drainage Factor measurement form needs to be included in the Monitoring Guideline and introduced to Tanzania and Mozambique.
6. The roads agency should alert the research team before carrying out on-carriageway maintenance, especially reseals. Information on maintenance inputs should be captured during each round of monitoring.
7. CSIR is developing a database for the Tanzania research centre. It needs to be compatible with the ReCAP regional back analysis database.
8. The primary responsibility for the monitoring of the research sections is with the RRCs. They may outsource the data collection to consultants. In some countries CDS is supporting the RRCs and the

consultants. In Tanzania CSIR is supporting the RRC. CDS/CSIR must report on the level of involvement and uptake by the RRCs.

9. ReCAP is providing impetus for the monitoring of the research sections but expects the research centres to take over this responsibility. Funding is likely to be a constraint, but the national road funds can be expected to contribute to research, as is the case in Tanzania.
10. CDS is preparing separate “Rater’s Manuals” for visual condition assessment of flexible, concrete, block and gravel pavements. Work done by A Beusch on cobblestone pavements in Zambia will be consulted as a possible Rater’s Manual for cobblestones. Each defect will be described in the Rater’s Manual and possible reasons given for its occurrence. The existing Appendix 3 of the Monitoring Guideline, which provides guidance on rating defects, will be extracted from the main document. CDS will set up a DropBox folder for photographs of defects which can be used in the Rater’s Manual – all participants to contribute. Phil Paige-Green will provide the MS Word versions of TMH9.
11. CDS will develop a draft standard format for reporting on each round of monitoring. Jon Hongve will provide a draft of a format he has developed for Kenya. The report format will allow for basic analysis of trends in the data and comments from the monitoring personnel. TRL will review the draft to ensure that all data required by the regional database are being recorded.
12. The RRCs are responsible for the analysis of the data to achieve the overall project objective (“to provide performance-based evidence which will contribute to the establishment of appropriate cost-effective standards and specifications for Low Volume Sealed Roads”). Some RRCs will require more support than others in this process. For example, the Uganda RRC already employs highly qualified staff (PhD) who know how to do research and Malawi is expecting to employ two researchers in the RDA. Kenya MTRD employs skilled and experienced staff but there seems to be a lack of incentive to carry out research. CDS will provide the required support to the RRCs and their local monitoring consultants, under the auspices of the regional LTPP project, to carry out preliminary analysis of the performance data to provide basic capacity for consolidation in future.
13. CDS will assist the RRCs in the six African countries and Myanmar to identify research projects that could be carried out using the monitoring data. The process of identifying research project and carrying out research could be included in a LTPP workshop at the ReCAP IRIM planned for early 2019.

Annex 1 : Attendance

Name	Organisation
Nkululeko Leta	ReCAP PMU
Henry Nkwanga	ReCAP PMU
Mike Pinard	CDS/Independent
Francis Dangare	CDS/IMC
Phil Paige-Green	CDS/Paige-Green Consulting
Kenneth Mukura	TRL
Martin Mgangira	CSIR
Jon Hongve	Independent
Robert Geddes	CDS

Annex 2 : Presentation R Geddes



Long Term Pavement Performance (LTPP) Monitoring

Coordination meeting

Johannesburg, 24th August 2018

Rob Geddes



Background to the meeting



LTPP Monitoring work in several countries:

- Mozambique
- Tanzania
- Kenya
- Ethiopia
- Uganda
- South Sudan
- Ghana?
- DRC?
- Myanmar



Development of Regional Monitoring Guideline for LTPP sites as a standard document.

Development of country databases and Regional Back Analysis Database.



Private and confidential

Monitoring Guideline



The Guideline includes:

- Setting out the monitoring section
- Procedures for taking measurements
- Standard forms.

Also have monitoring guidelines in

- Ethiopia
- Kenya
- TRH9 - Standard Visual Assessment Manual
- Jones, D. & Paige-Green, P. (2003). A Protocol for the Establishment and Operation of LTPP Sections including those associated with HVS tests.

Centro de Pesquisa
Rodoviária



Guia para a Monitoria de
Secções Experimentais e de
Pavimentos de Longo Termo de
Desempenho em Moçambique



2017



Private and confidential

Overall Objective of the LTPP Monitoring



***“To provide performance based evidence
which will contribute to the establishment of
appropriate cost effective standards and
specifications for Low Volume Sealed Roads”***



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Background to the meeting



It has been observed that:

- Inconsistencies and lack of clarity in the data collection methodology (VCI)
- Some key data not being collected (Drainage Factor, moisture movements)
- Not always clear who is going to use the data to achieve the overall objective.



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Purpose of the meeting



- To share experiences on the monitoring activities
- Achieve consensus on details of the monitoring guidelines
- Understand mechanism for uploading data to the Regional Database
- Agree responsibilities for data analysis
- Discuss a strategy for capacity building at the country level to make good use of the data.

The outcome of the meeting will be shared with the wider stakeholder group at a country level and at the next ReCAP IRIM.



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Meeting Agenda



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		Kenya (ReCAP)	F Dangare
		Ethiopia	F Dangare
		Malawi	F Dangare
		Uganda	F Dangare
		South Sudan	F Dangare
		DR Congo	F Dangare
		Myanmar	M Pinard
	11:00	Tea/Coffee	
3	11:30	Regional Back Analysis Project – progress and database requirements	K Mukura
4	12:00	Development of regional monitoring guideline	M Pinard
	13:30	Lunch	
4	14:15	Development of regional monitoring guideline (continued)	M Pinard
5	15:00	Streamlining the country reporting requirements	R Geddes
6	15:30	Use of the monitoring data – analysis of the data and capacity building for research centres	H Nkwanga
	16:00	Tea/Coffee	
7	16:30	General discussion and meeting resolutions	R Geddes



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Annex 3 : Presentation P Paige-Green



Long Term Pavement Performance Monitoring of Trial Sections in Mozambique incorporating Capacity Building of Road Research Centre Personnel

MOZ2093A



Project aim

- Objectives are to:
 - Carry out a review of suitable existing trial sections
 - Ensure that data collected from existing and new sections are consistent with the regional protocols for establishment and monitoring of road trial sections
 - Development of a data base for capturing the monitoring data
 - Capacity building and mentoring - close collaboration with researchers and technicians from the ANE RRC in order to enhance their capacity



Tasks

- 1: Review of existing trial sections, inclusive of additional testing and back-analyses where required

- 2: Review and implementation of existing regional guidelines/protocols). Output - updated standard guidelines/protocols for the establishment of the LTPP sections, systematic collection and recording of data during the monitoring period of the sections, including quality assurance of data – data base

- 3: On-going activities on established and new trial sections for monitoring (and updating) information for back-analysis



Task 1

- Numerous experiments over the years
- Mostly TRL but also ANE and others
- Old reports reviewed and experimental sections identified
- Most visited by ANE
- Some selected for implementation of protocol and capacity building



Review and develop guidelines

- No genuine regional guidelines
- Old set developed at CSIR for Gautrans HVS sites (Jones and Paige-Green, 2003)
- Slightly up-dated in Strategy document for Mozambique RRC (CSIR, 2014)
- Combined and updated with other relevant information – Draft Protocol (2016)



Develop data base

- Data base for storage of collected data developed in Maputo (Rhino)
- Data interchangeable between Rhino and Regional data base developed at the same time by TRL
- Up and running



Monitoring training

- **Various site visits**
 - Inhambane
 - Zambezia
- **Identified 3 roads and set up various LTPP monitoring sites**
 - *Cumbana to Chacane*
 - *Agostinho-Neto to Mutamba Road*
 - *Zero - Mopeia*



Monitoring training

- **Cumbana to Chacane**
 - Constructed from 2009 - 2013
 - Four monitoring sections
 - Penetration macadam
 - Sand seal (armoured base)
 - Otta seal
 - Unpaved (control)





Monitoring training

- **Agostinho-Neto to Mutamba Road**
 - Constructed in 2015
 - Two monitoring sections
 - Armoured base (50 mm calcrete chips rolled into local sand)
 - Blended base (50:50 sand calcrete)



Monitoring training

- **Zero - Mopeia**
 - Constructed in 2012
 - Single LTPP section to monitor Otta seal performance





Current Status

- Ongoing monitoring
- Additional sections to be added
- Workshop next week – training in research and identification of projects
- 2 papers at PIARC Conf in Durban – October
- Protocol open to revision - unify for region
- Must go hand-in-hand with suitable visual inspection manuals – country specific – adapt TMH9's



**Thank you for your
attention**

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Annex 4 : Presentation M Mgangira



AfCAP
Africa Community Access Partnership



Long Term Pavement Performance Monitoring of Existing Trial Sections and Implementation of Regional Guidelines for Establishing and Monitoring Trial Sections in Tanzania

LTPP Guideline Review Meeting
23 August 2018, Johannesburg
Dr M B Mgangira, Pr. Eng



AfCAP
Africa Community Access Partnership

Outline

- Project objective
- Project context
- Progress to date
- Concluding remarks



Project objectives

To evaluate the nature and quality of information available from the existing trial sections.

To refine and implement existing regional guidelines and protocols to ensure that the establishment of road trials and collection of the information is standardised .

To establish LTPP monitoring sections on the two selected roads to collect data on a consistent and continuous basis over a number of years

Effected through:

LVSr trial sections built in Bago to Talawanda road in the Bagamoyo District of the Pwani Region; and Lawate to Kibongoto road in the Siha District of the Kilimanjaro Region



Project context



Location of Bago - Talawanda Road



Location of Lawate - Kibongoto Road

Located on mostly flat terrain **Located in an area with steep terrain**

Project context

Length and percentage	Flat (0-3%)	Slight (3-5%)	Moderate (5-10%)	Steep (10-15%)	Very Steep (>15%)
Bagamoyo					
km	14.24	3.53	2.58	0.12	0.01
%	69.53	17.24	12.60	0.59	0.05
Siha					
km	2.98	2.69	4.15	2.62	1.04
%	22.11	19.96	30.79	19.44	7.72

Project context

Design basis

Bagamoyo sections:

- Tanzanian Pavement and Materials Design Manual

Siha sections:

- DCP method

Bagamoyo



Chainage (km)		Length	Surfacing Type
Start (km)	End (km)	(km)	
0.000	0.030	0.030	Engineered Natural Earth (Red Soil)
0.030	0.230	0.200	Single Otta Seal with a Sand Seal (26mm)
0.230	3.730	3.500	Engineered Natural Earth (Red Soil)
3.730	5.340	1.610	Engineered Natural Earth (Quartzitic Gravel)
5.340	5.560	0.220	Hand Packed Stone (150mm)
5.560	6.080	0.520	Concrete Strips (100mm - Reinforced)
6.080	6.740	0.660	Geocells (75mm)
8.000	8.240	0.240	Double Surface Dressing (20mm)
8.820	9.980	1.160	Gravel Wearing Course

Bagamoyo



Chainage (km)		Length	Surfacing Type
Start (km)	End (km)	(km)	
9.980	10.670	0.690	Concrete Strips (100mm - Unreinforced)
10.670	11.200	0.530	Engineered Natural Earth (Light Red Soil)
11.200	11.400	0.200	Double Sand Seal (20mm)
12.200	12.580	0.380	Gravel Wearing Course
13.520	14.180	0.660	Engineered Natural Earth (Marley Limestone)
16.240	17.100	0.860	Concrete Strips (100mm - Reinforced)
18.480	18.740	0.260	Concrete Strips (100mm - Reinforced)
19.000	19.200	0.200	Gravel Wearing Course
19.480	20.040	0.560	Gravel Wearing Course
20.040	20.260	0.220	Slurry Seal (8mm)

Siha



Chainage (km)		Length	Surfacing Type
Start (km)	End (km)	(km)	
0.020	0.200	0.180	Concrete Paving Blocks
0.200	1.360	1.160	Engineered Natural Earth (Natural Gravel)
1.360	1.500	0.140	Unreinforced Concrete Slab (100mm)
1.500	1.960	0.460	Engineered Natural Earth (Natural Gravel)
1.960	2.180	0.220	Geocells (75mm)
2.180	2.580	0.400	Unreinforced Concrete Slab (75mm)
2.580	2.780	0.200	Gravel Wearing Course
2.780	3.640	0.860	Concrete Strips (100mm - Unreinforced)
3.640	4.340	0.700	Gravel Wearing Course
4.340	4.540	0.200	Double Surface Dressing (20mm)
4.540	4.780	0.240	Concrete Strips (100mm - Unreinforced)
4.780	5.000	0.220	Unreinforced Concrete Slab (100mm)

Siha



Chainage (km)		Length	Surfacing Type
Start (km)	End (km)	(km)	
5.000	6.100	1.100	Concrete Strips (100mm - Unreinforced)
6.100	6.340	0.240	Gravel Wearing Course
6.340	6.620	0.280	Unreinforced Concrete Slab (100mm)
6.620	7.720	1.100	Gravel Wearing Course
7.720	8.260	0.540	Concrete Strips (100mm - Unreinforced)
8.260	9.670	1.410	Gravel Wearing Course
9.670	9.900	0.230	Unreinforced Concrete Slab (75mm)
9.900	10.100	0.200	Gravel Wearing Course
10.100	10.300	0.200	Concrete Strips (100mm - Unreinforced)

Siha



Chainage (km)		Length	Surfacing Type
Start (km)	End (km)	(km)	
10.300	10.680	0.380	Gravel Wearing Course
10.680	11.200	0.520	Concrete Strips (100mm - Unreinforced)
11.200	11.620	0.420	Gravel Wearing Course
11.620	11.820	0.200	Bituminous Penetration Macadam
11.820	12.120	0.300	Lightly Reinforced Concrete Slab (100mm)
12.120	12.280	0.160	Gravel Wearing Course
12.280	12.560	0.280	Lightly Reinforced Concrete Slab (75mm)
12.560	12.640	0.080	Gravel Wearing Course
12.640	13.070	0.430	Lightly Reinforced Concrete Slab (100mm)
13.070	13.480	0.410	Gravel Wearing Course

Training workshop 1

Phase	Module	Location	Date	Actual Date
Phase 1	Module 1: Experimental design/Experimental matrix	Dodoma	26 September 2017	26 September 2017
	Module 2: Setting up test sections – control section	Dodoma	27 September 2017	27 September 2017
	Module 3: Background to research planning and reporting	Dodoma	28 September 2017	28 September 2017
	Module 4: Monitoring and research during the construction phase	Dodoma	29 September 2017	29 September 2017
	Understanding monitoring of demonstration sites: Site visits	Siha Bagamoyo	2 – 3 October 2017 5 – 6 October 2017	2 – 3 October 2017 5 – 6 October 2017



Training workshop 2

Phase 2	Module 5: Monitoring and research after the construction phase Module 6: Monitoring of economic performance indicators	Siha	16 January 2018	16 January 2018
	Module 7: Monitoring of climatic conditions Module 8: Monitoring of in-service pavement performance	Siha	17 January 2018	17 January 2018
	Demonstrations: • Use of DCP and data analysis	Siha	18 January 2018	18 January 2018
	Demonstrations: • Use of the Merlin • Sand patch testing	Siha	19 January 2018	19 January 2018

Training workshop 3

Phase 3	Module 9: Drainage of the road surface, pavement layers	Siha	4 April 2018	11 April 2018
	Module 10: Analysis of the physical performance of road sections (using collected data in Phase 2)	Siha	5 April 2018	12 April 2018
	Module 11: Evaluation of appropriate construction methods Module 12: Economic analysis (life-cycle cost analysis)	Siha	6 April 2018	13 April 2018



Training workshop 4

Phase 4	Module 13: Materials sampling, field and laboratory measurements	Siha	12 June 2018	3 July 2018
	Module 14: Data collection management & linkage to pavement design	Siha	13 June 2018	4 July 2018
	Module 15: Individual presentation	Siha	14 June 2018	5 July 2018
	Module 16: Feedback and evaluation	Siha	15 June 2018	6 July 2018



Field survey (1)

Supervise and monitor the gathering of field data:

visual surveys,
roughness measurements,
DCP measurements,
rut depth measurements and
surface profiling.



Site conditions during field survey (1)



Field survey (1)

Collected field data being collated for analysis





Next training session is field survey (2)



- Scheduled week of 17 Sept



Concluding remarks

- Participants are being individually assessed
- Demonstrated a satisfactory level of competency to conduct field surveys
- DCP design method training requests
- Long-term funding allocation for monitoring could be an issue

Annex 5 : Presentation F Dangare





Capacity Building and Mentorship for the
Establishment and Implementation of Monitoring &
Evaluation Programmes on Experimental and Long-
Term Pavement Performance (LTPP) Sections in Six
AfCAP Countries

Status of Existing Monitoring Projects

Practitioners Meeting in Johannesburg 24 August 2018


Rob Geddes (Project Director)
Francis Dangare (Team Leader)
Mike Pinard (Materials Expert)






Project Concept

- Under the auspices of the existing Long-Term Pavement Performance (LTPP) monitoring programmes,
- a number of road sections in each country have been designated for monitoring over a two-year period with AfCAP support
- The objective is to develop sufficient capacity within each Road Research Centre (RRC) to independently manage the implementation of the monitoring programmes in the longer term
- Appointment of local consulting firms in each country to assist the RRCs with the field monitoring activities
- as well as to build the capacity and interest in research in the local civil engineering consulting industry
- Of the six participating countries in this project, only Kenya and Ethiopia already have on-going LTPP monitoring programmes being implemented by local consulting firms under the management of the respective RRCs




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Current Status of Monitoring Programme

Participating Country	Status of LTPP Programme	Monitoring Consultant	Remarks
Kenya	Started under AfCAP1	Across Africa	Continuation of monitoring programme
Ethiopia	Started under AfCAP1	Alert Engineers	Continuation of monitoring programme
Malawi	Sites constructed under WB- ASWAP Project	FN & Partners	Baseline Survey completed in July 2018
Uganda	Not yet commenced	Procurement in progress	Activities awaiting procurement of monitoring consultant




4




Current Status of Monitoring Programme

Participating Country	Status of LTPP Programme	Status of Monitoring Consultant	Remarks
Ethiopia	Started under AfCAP1	Procured	Continuation of monitoring programme
Kenya	Started under AfCAP1	Procured	Continuation of monitoring programme
Malawi	Sites constructed under WB-ASWAP Project	Procured	Identify and agree on monitoring sites
Uganda	Sites constructed under a Demonstration Project	Not yet procured	Identify and agree on monitoring sites
South Sudan	Sites constructed under AfCAP1	Not yet procured	Identify and agree on monitoring sites Procure monitoring consultant
Democratic Republic of Congo	Sites not yet constructed	Not yet procured	Construct monitoring sites Procure monitoring consultant



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Ethiopia


Monitoring programme is already ongoing as part of the continuation from where the TRL project ended under AfCAP1 in 2014.

TRL was providing assistance directly to the RRC.

Under AfCAP2, TRL provided a brief oversight to the monitoring consultant (AE) and this oversight ended in early 2017.




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Ethiopia Monitoring Sites

Road/Site Name	Location	Construction	Length (m)	Comments
Assosa - Kurmuk	700 km west of Addis Ababa	Laterite Crushed Stone	1600	Monitor 2 whole sections approx. 800m each and set up 2 LTPP sections of 200m each
Tulubolo - Kela	80 km south of Addis Ababa	Otta Seal	2100	Monitor whole section
Combolcha - Mekaneselem	Mid north – 700 km from Addis	Otta Seal	3000	Set up and monitor 4 LTPP sections of 200m each
Hawusewa - Abala	Upper North 900 km from Addis		900	Set up and monitor 4 LTPP sections of 200m each



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Ethiopia – First Monitoring Visit

compliance of existing monitoring sections with the regional protocol

the need for additional monitoring sections.

No data collection was carried out because this was a site familiarisation visit and did not form part of the routine monitoring programme



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Ethiopia – Insert Photos



a significant volume of heavy goods traffic uses the road

can no longer be categorised as a low volume road.

This will need to be substantiated by traffic surveys.



Ethiopia

: Ethiopia Site Visit – Otta Seal Section in Gerado Village




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Ethiopia – Tulubolo -Kela site



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Ethiopia – Observations and Conclusions



Last monitoring round in October

Opportunity for continuation under current ReCAP programme?

Host country to take over?



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Kenya Monitoring Sites



Road/Site Name	Location	Construction	Length (m)	Comments
D379 Wamwangi-Karatu	Kiambu	20mm CMA 160mm laterite 220mm granular	400	Whole section, including 200 m LTPP
E511 Kangari-Kinyona	Murang'a	20mm CMA 140mm laterite 260mm granular	900	Whole section, including 200 m LTPP
D382 Lord-Kona Bahati	Nyandarua	20mm CMA 140mm laterite 260mm granular	600	Whole section, including 200 m LTPP
D435 Muthuaini-Mununguaini	Nyeri	20mm CMA 150mm weathered basalt 250mm natural gravel	600	Whole section, including 200 m LTPP

CIVIL DESIGN SOLUTIONS


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Kenya





- This section was last monitored in June 2017 and the markings on the LTPP sections are still visible.
- Structural failures in the form of crocodile cracks and potholes are evident on the LTPP section.




CIVIL DESIGN SOLUTIONS


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Kenya





- The traffic volume (AADT) for the first monitoring survey was 853. This is almost three times the 300 AADT threshold for a low volume road. This may have contributed to the premature failures observed on the road.




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Kenya – D435 Muthuaini-Mununguaini



- The markings of the monitoring sections are no longer clearly visible and need to be re-marked.
- There are a range of surfacing and structural defects which include cracking, ravelling and potholes.




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- The markings of the monitoring sections are no longer clearly visible and need to be re-marked.
- There are a range of surfacing and structural defects which include cracking, raveling and potholes.




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Kenya



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Kenya - E511 Kangari – Kinyona Road


currently subjected to heavy construction traffic for a new water transfer tunnel

Total pavement failure is evident at the start of the research section, could be attributed to heavy traffic loading and inadequate drainage.


No detailed traffic survey was carried out during the baseline or first monitoring. road cannot be classified as low volume.

An axle load survey needs to be carried out to capture the influence of this traffic.


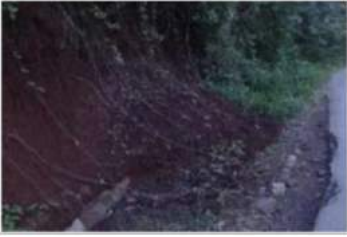
Opportunity for accelerated pavement failure research



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Kenya - E511 Kangari – Kinyona Road

The rock appears to be... there is no... being stored... use.

Discussion held with...

Poor routine maintenance practice... failures have occurred on steep cut slopes along the side of the road.



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Kenya E511 Kangari – Kinyona Road



- Drainage
- .

 CIVIL DESIGN SOLUTIONS

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Kenya E511 Kangari – Kinyona Road




- Drainage
- .

 CIVIL DESIGN SOLUTIONS


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 **ReCAP**
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Kenya E511 Kangari – Kinyona Road




- Drainage
- .

 CIVIL DESIGN SOLUTIONS


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Kenya D379 Wamwangi-Karatu




- The LTPP section markings are still visible.
- Crack Sealing carried out as part of maintenance
- The road is well drained with the drains well maintained and clear of overgrown vegetation.
- There are some pothole failures evident.

 CIVIL DESIGN SOLUTIONS


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**ReCAP**
Research for Community Access Partnership


Kenya D379 Wamwangi-Karatu



- The LTPP section markings are still visible.
- Crack Sealing carried out as part of maintenance
- The road is well drained with the drains well maintained and clear of overgrown vegetation.
- There are some pothole failures evident.




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Kenya: Observations and Conclusions

- AA is yet to carry out a full monitoring survey during the wet season
- next monitoring will be carried out in September/October
- The MTRD uses both BS and AASHTO standards for materials testing although most tests are carried out to British Standards.
- Concerns on the commitment of the monitoring consultants to execute their tasks.
- Their performance is expected to improve with the support of the CDS team
- It is recommended that the Kenya monitoring work should continue to refer to the TRL monitoring guideline to ensure that there is no confusion in the monitoring in Kenya and that the baseline data already collected does not become redundant.
- However, differences between the Kenya monitoring guidelines and the draft regional guidelines are not significant
- A drainage monitoring form, which has been identified as missing in the draft Regional Guidelines, has been developed and circulated for comments.



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Uganda


Procurement of local monitoring consultant in progress.

Matugga-Semuto-Kapeeka Pilot/Demonstration Project (PDP) selected.


This road was constructed in 2009 with funding from the Nordic Development Fund (NDF) under a Pilot Project for the Demonstration of Innovative Technologies for the Construction of Low Traffic Volume Bitumen Sealed Roads.

No formal monitoring has been carried out on this road since construction.

X



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Uganda

baseline and follow on monitoring phases cannot be accurately factored into the Regional Monitoring programme.


CDS will programme the next visit to Uganda to coincide with the baseline data collection activities

which will need to be aligned with the timing of the combined visit to the other participating countries.

Draft programme to be sent to PMU for approval on 28 August 2018



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Uganda


UNRA continues to benefit from participation in AfCAP projects,

with another project in the pipeline to investigate the geotechnical failures on roads and use of the road reserve.

UNRA staff have been involved in the training of trainers in the use of the DCP DN method of pavement design and desire that these staff form part of the capacity building team that works with the CDS team and the local consultant.




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Uganda

Kapeeka has been designated as an industrial park with industries that include quarrying, sand mining, car assembly and tiles manufacturing. This has subjected the road to heavy traffic which has accelerated the deterioration and failure of some sections. Patching is in progress and drainage works are planned for the new financial year.




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Uganda - Matugga-Semuto-Kapeeka Road



Drainage problems



Concrete block paving failure



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 **ReCAP**
Research for Community Access Partnership

Uganda Matugga-Semuto -Kapeeka Road




Kapeeka has been designated as an industrial park with industries that include quarrying, sand mining, car assembly and tiles manufacturing.






This has subjected the road to heavy traffic which has accelerated the deterioration and failure of some sections. Patching is in progress and drainage works are planned for the new financial year.




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Uganda: Kasiso-Lwogi Trial Section



- Not part of LTPP site
- Built as part of the DFID/EU funded CrossRoads/UNRA Mechanised Low Cost Seals Trial
- It is near the Matugga-Semuto-Kapeeka Road.
- There is currently no regular monitoring of these trials




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Uganda: - Observations and Conclusions

1. The appointment of the local monitoring consultant is a priority for Uganda.
2. Ideally, this should precede the monitoring work.
3. If there are further delays with the appointment of the monitoring consultant CDS will assist UNRA to carry out preparation and reconnaissance work including the selection of the research sections to be monitored.
4. However, it is expected that the monitoring consultant will be in place at the time of the next round of country visits.
5. The Uganda component of the project is not synchronised with activities in Malawi, Kenya and Ethiopia where baseline data collection has already been carried out.



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Uganda: - Observations and Conclusions

The LTPP sections previously established on the Matugga-Semuto-Kapeeka Road form part of the monitoring consultant's scope of works.

UNRA requested that the roads built under the Crossroads project in the vicinity be included in the monitoring programme.

This will require an addendum to the monitoring consultant's contract subject to PMU approval.



Malawi - Site work on T357 Parachute Battalion – Lifuwu Road



Timing of site visit with identification and marking of LTPP sections
The first site visited was the T357 Parachute Battalion – Lifuwu Road near Salima



Marking of the section on the CMA was carried out in accordance with the monitoring guidelines (Mozambique version) and training was provided for each of the required tests





Malawi - Site work on T357 Parachute Battalion – Lifuwu Road



- visual condition assessment
- rut depth measurements,
- one test pit (including layer density measurements, materials logging, sample extraction and bagging)
- Dynamic Cone Penetrometer (DCP).
- FWD and roughness measurements




Malawi S134 Kasinje - Kandeu Road in Ntcheu District




- Assisted the RA and FNP to select a section for monitoring
- Cape Seal on a natural gravel base.






Malawi – Key Observations and Recommendations

- There is a need to adopt consistent standards for materials testing on the project. The RA currently uses BS, AASHTO and TMH/SANS testing standards, but these give different results for the same material identification of dedicated researchers within the country team would contribute to the ownership of the project by the RRC and enhance the usefulness of the project outputs.
- post graduate students from the University of Blantyre could be involved through the T2 Centre to participate in the project as part of their academic research
- This would need to be organised by the RA. It is understood that the T2 Centre is currently short of resources, but the RA indicated that it might be able to mobilise resources to support two post graduate students




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Malawi – Key Observations and Recommendations

- Moisture sensors should be installed on each monitoring section to measure variations of in situ moisture content.
- A Rater's Manual is needed to facilitate the monitoring consultant's interpretation of degree and extent of visual assessments of the surfacing.
- The RA should make further efforts to obtain the as-constructed information from the design and supervision consultants for the trial sections.




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Malawi – Work Plan for Baseline Survey

Date	Activity
18-23 June 2018	D11 Kalenge Bridge-Misiku, at Chitipa
25-30 June 2018	T357 Parachute Battalion – Lifuwu at Salima.
2-7 July 2018	S134 Kasinje - Kandeu in Ntcheu District.
9-14 July 2018	S135 Mwanza - Kunenekude in Mwanza District
16-20 July	D387 Nsangwe-Dolo




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Malawi –Overall Monitoring Programme

Pavement Monitoring and Evaluation Tasks	Baseline	Year 1 (first 12 months)		Year 2 (second 12 months)	
	June/July-18	Sep/Oct-18	Mar/April-19	Sep/Oct-19	Mar/Apr-20
Review of Design Documents and Construction Records	ations these may be carried out in different months.				
Classified Traffic Counts	√*	√*	√*	√*	√*
Axle Load Survey	√*	√*			
Visual Condition Survey	√	√	√	√	√
Roughness Measurement	√		√		√
Rut Depth Measurement	√	√	√	√	√
Elastic Modulus/Deflection/FWD	√	√			
DCP Tests	√	√			
Base Layer Moisture Content	√	√	√	√	√
Trial Pits and Laboratory Testing	√	√			
Drainage Assessment	√	√	√	√	√
Reporting	√	√	√	√	√




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South Sudan

- Visit initially planned for the 12th to the 16th of May 2018.
- Not done as planned due to the delays by the partner institution to send invitation letters to facilitate the visa application process
- The days were utilised in Kenya to support the monitoring consultant to finalise their Baseline and First Monitoring reports.
- A visit to South Sudan will be included in the next round of country visits.
- CDS contract allows for a single visit to South Sudan
- CDS to obtain updated contact details of SSRA, Ministry of Transport, UNOPS and other consultees from Regional Technical Manager who completed a visit during early August 2018




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Democratic Republic of Congo

Representatives from DR Congo will participate in the project workshops




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General Conclusions and Recommendations - Malawi

- the monitoring consultants (FN & Partners) seem well prepared and motivated to undertake the project.
- They have mobilized the required equipment and staff for the project.
- They have previous experience with undertaking similar surveys for the RA in terms of rutting, roughness, deflections (using RA FWD), but not DCPs.
- They have limited experience in analysing monitoring data.




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General Conclusions and Recommendations - Kenya

- Quality of the monitoring by AA Consultants in Kenya needs significant improvement.
- Principal of the firm was available only for a limited time during the country visit and all the responsibilities relating to the project were delegated to the Project Engineer.
- The field work and materials testing, and reporting are being carried out by the MTRD who have the capacity and competency to undertake the tasks.
- AA needs to be more proactive in organising, coordinating and executing the various tasks and, ultimately, in assuming responsibility for the outcome of the project.
- If the performance of AA does not improve it may be necessary to engage a different consultant.
- Meanwhile CDS will continue to provide support to the AA team during the routine monitoring visits



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General Conclusions and Recommendations - Ethiopia

- Alert Engineers have been successfully carrying out the monitoring, with the final round scheduled for the period September- December 2018.
- The timeline for the monitoring is not aligned to the Regional Monitoring Programme. The monitoring consultant's final monitoring round is planned for December 2018.
- The reports that are produced are of good quality.
- ReCAP to support continuation to 2020?




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General Conclusions and Recommendations

Key technical issues that relate to the implementation of the project

- Need to make use of existing national monitoring guidelines, such as exist in Ethiopia and Kenya, and to update and harmonise them in line with international best practice contained in the draft Regional Guidelines.
- An initial review of the existing monitoring guidelines (Mozambique version) is that they could be improved through the inclusion of photographs depicting each defect that must be monitored in the visual condition surveys. It may be beneficial to produce a stand-alone "Raters' Manual" for this purpose, possibly in A5 format for easy use on site.
- Clarity is needed on the materials testing standards and specification to be adopted on the LTPP monitoring projects. Participating countries use either the BS or AASHTO test methods interchangeably and in most cases both of them depending on the test being carried out. This can result in different results for the same material tested by the two methods.




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General Conclusions and Recommendations

Key technical issues that relate to the implementation of the project

- The Regional Guidelines should allow flexibility in the use of different testing standards while stressing the importance of consistency in their use.
- A review of the project related documents shows that there is a data gap relating to construction and maintenance costs on the project roads. These costs will be sought from the RRCs and will also include the costs of other equivalent roads if available.
- It is recommended that moisture sensors should be installed on all monitoring sites and the Drainage Factor should be measured.
- Some sites selected for monitoring have already suffered significant deterioration. In some cases, this is due to much higher levels of traffic and heavier vehicles using the road than was expected. It may be advisable to abandon some of these sites if the data from the monitoring is no longer useful, though continued monitoring might be beneficial for training and capacity building purposes.




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General Conclusions and Recommendations

Key technical issues that relate to the implementation of the project

- The ToRs for the Research Consultant and the respective Monitoring Consultants are silent about the interpretation of data.
- The only indication given in the ToR for this requirement is for joint collection and analysis of data and report preparation.
- None of the RRCs that were visited has in-house capacity to manage the data being collected on the sites and to analyse it to derive any conclusions on the performance of the roads that could be used to verify or modify standards and specifications for low volume roads.
-




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General Conclusions and Recommendations

Key technical issues that relate to the implementation of the project

- It is expected that the RRCs will outsource some of the research responsibilities in the short and medium term. Support will be provided by the CDS team to researchers in the roads agencies, tertiary educational institutions or individual researchers in the project countries when requested.
- The CDS team is not aware of any strategic research projects being carried out on any of the experimental sections visited in any of the participating countries. The data could be used for a range of valuable research projects examining different aspects of the design and construction of LVRs. It is recommended that ReCAP management and the RRCs should engage with universities to identify post graduate students or other individuals and organisations that could make use of the data. CDS will assist the RRCs to identify relevant and useful research topics.




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Key Issues

- Sustainability post ReCAP
- Capacity Building
- .




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Work Plan




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Project Programme and Key Outputs


Schedule	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1. Launch Meeting	█																								
2. Assess on-going and planned LTPP monitoring schemes in participating countries	█	█	█																						
3. Organise Mission		█	█																						
4. Provide capacity building and mentorship to/counterpart training	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	
5. Accompany the local consultants and RRC site teams on their visits		█	█				█	█			█	█					█	█					█	█	
6. Identify and characterise field equipment		█	█				█	█				█	█					█	█					█	█
7. Review all data collected at the research sites				█				█				█						█	█					█	█
8. Develop a format for reporting of the results		█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
9. Review and analyse all available national and regional guidelines		█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
10. Organise a 2-day regional stakeholder workshop																									
11. Develop recommendations for modifications to the design standards and specifications for LVSDs																									
12. Completion of all construction and finance costs																									
Deliverables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1. Mission Report		●																							
2. Client Field Visit Reports			●				●				●			●			●						●		
3. Set of Monitoring Consultant Reports			●				●				●			●			●						●		
4. Workshop Report																									
5. Draft Regional Guidelines/Protocols																									
6. Project Report																									
Resources																									
1. Director	2	1	2				1	1	1			1	1	1				1	1	1			2	1	2
2. Senior Engineer	2	4	10	2	3		10	6	2	3		10	6	2	3			10	6	2	3		10	6	2
3. Site Expert	4	6		1	2				2				2												
4. Staff																									
Inputs provided in participating countries																									



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END



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Annex 6 : Presentation M Pinard (Myanmar)



Long Term Pavement Performance Monitoring of Trial Sections in Myanmar: *Monitoring Protocol*

RAF2132A



Mike Pinard
Sub-consultant: CDS



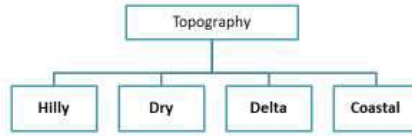
Myanmar in Perspective



Land Area	653,508 km ²
Water Area	23,070 km ²
Total Area	676,578km ² (#39)
Population	56,890,418 (#24)
Population Density	87.05/km ²

Background

Topography of Myanmar



Topography	Region	Condition of Soil
Hilly Area	Chin	Soft Soil
	Shan	Granular Soil
Dry Area	Bago, Magway, Sagaing, Mandalay	Hard Soil
Delta Area	Ayeyarwaddy	Clay
Coastal Area	Rakhine, Tanintharyi	Sandy Soil

➤ Because of different terrains, geographic conditions are different.

PERCENTAGE OF PAVED AND UNPAVED (LVRR)

Road Type	Mile/Furlong	%
Tar Road (Bitumen Road)	2153/7	5.5% Paved
Concrete Road	886/3	
Macadam Road	7580/0	94.5% Unpaved
Granular Road	4605/2	
Earth Road	34434/2	
Jeep/Motorbike/ Cart Road	5847/3	
Total	55507/0	

Details of Trial Sections

No.	Length of Sec	Road Width			Road Pavement		Road Surface
		Shoulder	Carriage way	Road Width	Macadam Sub Base	Macadam Base	
	m	m	m	m	mm	mm	
Trial A	500	1.00	4.50	6.50	200	150	Pen Mac SSD over penetration layer
Trial B	400	1.00	4.50	6.50	200	150	DBST over Prime Coat
Trial C	250	1.00	4.50	6.50	150	-	200mm thick 30MPa NRC
Trial D	200	1.00	4.50	6.50	200	-	70mm thick 25MPa concrete block on sand bedding layer
Trial E	400	1.00	4.50	6.50	200	150	Emulsion DBST over DBM
Trial A	359	1.00	4.50	6.50	200	150	Pen Mac SSD over penetration layer.

Non-Bituminous Surfacing Options



Visual Assessment Items

<p>A. Surfacing Assessment</p> <ul style="list-style-type: none"> • Texture • Voids • Surfacing failures • Surfacing patching • Surfacing cracks • Binder condition • Aggregate loss • Bleeding/flushing • Surface Deformation 	<p>B. Structural Assessment</p> <ul style="list-style-type: none"> • Cracks • Pumping • Deformation • Patching • Failure/Potholes <p>C. Functional Assessment</p> <ul style="list-style-type: none"> • Roughness (Riding Quality) • Skid Resistance • Drainage • Shoulders • Edge Defects
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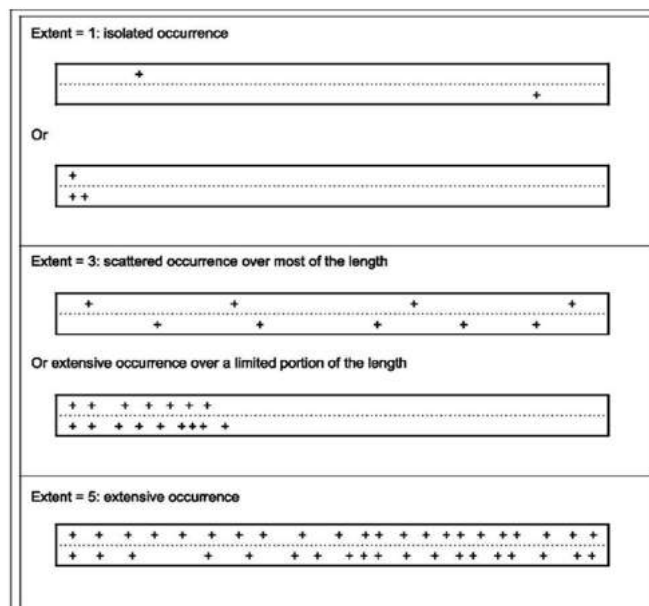
Classification of Degree of Distress

Degree	Severity	Description*
0	-	No distress visible.
1	Slight	Distress difficult to discern. Only the first signs of distress are visible.
2	Slight to warning	Distress clearly visible but not at degree 3
3	Warning	Start of secondary defects. (Distress notable with respect to possible consequences).
4	Warning to severe	Secondary defects clearly visible but no at degree 5 yet.
5	Severe	Secondary defects are well developed (high degree of secondary defects) and/or extreme severity of primary defect.

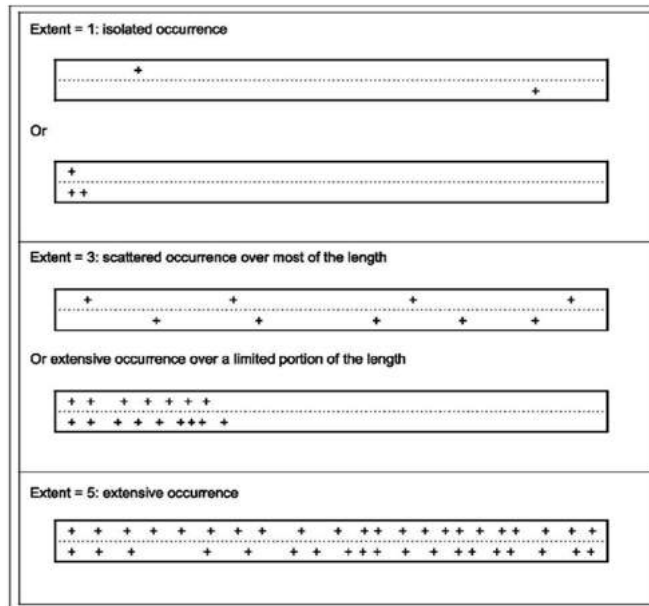
Classification of Extent of Distress

Extent	Description	Percentage of length
1	Isolated occurrence Not representative of the segment length being evaluated	< 5
2	Occurs over parts of the segment length More than isolated	5 – 10
3	Intermittent (scattered) occurrence over most of the segment length (general), or Extensive occurrence over a limited portion of the segment length.	10 - 25
4	More frequent occurrence over a major portion of the segment length.	25 - 50
5	Extensive occurrence over the entire segment.	> 50

Illustration of Extent



Determination of Extent



The Monitoring Team






Typical Defects Measured/Assessed



Degrees of Surfacing of Failures

Degree	Description
1	Failures difficult to discern from moving vehicle. Small areas of surfacing are lost (diameter < 50mm)
3	Significant failure is visible from a moving vehicle (diameter \approx 150mm)
5	Failure occurs over large areas and/or secondary defects have developed owing to the failure (diameter > 300mm)

Assessment of Degrees of Surfacing of Failures

SURFACING FAILURES					
	1				
	X	2	3	4	5
Small areas of surfacing are lost (diameter <50 mm) , difficult visible from moving vehicle					
	3				
	1	2	X	4	5
Significant failure visible from moving vehicle (diameter = 150mm).					
	5				
	1	2	3	4	X
Occur over large areas, failures > 300mm in diameter.					

Structural Assessment

Description of Degrees of Block Cracks

Degree	Description
1	Faint cracks.
3	Distinct, open cracks (≈ 3 mm) with slight spalling, deformation or secondary cracking at corners in the form of triangles.
5	Open cracks (> 3 mm) with significant spalling, secondary cracking or deformation evident around open cracks, or wide open cracks (> 10 mm) with little or no secondary defects.

Assessment of Degrees of Block Cracks

BLOCK CRACKS					
	1				
	X	2	3	4	5
Fail!					
	3				
	1	2	X	4	5
Distinct, open (> 3mm) with slight spalling					
	5				
	1	2	3	4	X
Open cracks (> 3mm) with significant spalling, or wide open cracks (> 10 mm)					

Structural Assessment

Description of Degrees of Rutting

Degree	Description
1	Difficult to discern unaided (< 5mm)
3	Just discernible (≈ 10 – 15mm)
5	Severe, dangerous. Very obvious from moving vehicle, even at high speed. Affects directional stability (> 30mm).

Typical Defects Measured/Assessed



Edge Break



Edge Drop

Typical Defects Measured/Assessed



Edge Break



Concrete Block Breakage

Typical Defects Measured/Assessed



Corner crack in concrete slab



Bleeding



Flaky aggregate

Measurement of Drainage Factor



Typical Traffic Using Trial Sections



Observations on Trial Sections

- The TGI-1A road is not a low volume road.
 - It was designed to conventional standards using ORN 31.
 - Design traffic loading of 1.5 MESA
- The base and sub-base comprise crushed rock as Dry Bound Macadam (DBM)
 - conventional pavement design used in Myanmar
 - Life typically 3-5 years.
- Rock is obtained from small privately-owned quarries along the road using single stage crushers
 - process is highly labour intensive.
- The use of DBM and Penetration Macadam leads to relatively high roughness levels.
- Road width of 4.5 m too narrow for relatively high volume motorized vehicles – leading to much edge break

Observations on Monitoring Exercise

- Language was a major barrier to communication.
 - Need to explain monitoring terms very carefully and to illustrate them with photos wherever possible
- Monitoring team very keen and willing to learn
- Need for user-friendly monitoring guides supported by illustrative photographs

Status of Project

- Further classroom training in assessment of unreinforced concrete and concrete blocks surfacings.
- Site monitoring of all four surfacing types .
- Programme for continuation of monitoring by DRRD team in Myanmar.
- Development of protocol for analysis and reporting of data.

Key Question

- Trial sections are NOT low volume, so what purpose do they serve?
 - Training/capacity building? Yes.
 - Replication on future roads? Hardly.

***Thank you
Questions?***



Inya Lake Yangon

Annex 7 : Presentation M Pinard (Monitoring Guideline)



Monitoring of LTPP Road Sections
Practitioners Meeting, Johannesburg,
24th August 2018



Development of Regional Monitoring Guideline

Mike Pinard
Sub-consultant: CDS

Some Fundamental Questions

What is the **purpose** of the *Capacity Building and Mentorship for the Establishment and Implementation of Monitoring & Evaluation Programmes on Experimental and Long-Term Pavement Performance (LTPP) Sections in Six Africa Countries and Myanmar?*

- *Research purposes*
- *Research and maintenance planning purposes?*
- *Other*

Some Fundamental Questions

What is the **purpose** of the *Capacity Building and Mentorship for the Establishment and Implementation of Monitoring & Evaluation Programmes on Experimental and Long-Term Pavement Performance (LTPP) Sections in Six Africa Countries and Myanmar?*

“To provide performance based evidence which will contribute to the establishment of appropriate cost effective standards and specifications for Low Volume Sealed Roads”

- *Research purposes*
- *Research and maintenance planning purposes?*
- *Input into country guidelines and manuals for LVRs?*
- *Other*

Some Fundamental Questions

What is the **level of competence** of the monitoring consultants/roads agencies involved in the Monitoring & Evaluation Programmes on Experimental and Long-Term Pavement Performance (LTPP) Sections?

- *Basic*
- *Intermediate?*
- *Advanced?*

Structure of Existing Guideline

- Based on TMH9
 - Provides inputs for RAMS at strategic and tactical level
- Compiled as one document comprising:
 - General/Background information on planning, design and monitoring of trial sections
 - Flexible pavements
 - Concrete pavements
 - Block pavements
 - Unpaved roads
 - Miscellaneous measurements (roughness, gravel loss, reflection, traffic counts, rut depths, etc.

Visual Assessment Items

A. Surfacing Assessment <ul style="list-style-type: none">• Texture• Voids• Surfacing failures• Surfacing patching• Surfacing cracks• Binder condition• Aggregate loss• Bleeding/flushing• Surface Deformation	B. Structural Assessment <ul style="list-style-type: none">• Cracks• Pumping• Deformation• Patching• Failure/Potholes C. Functional Assessment <ul style="list-style-type: none">• Roughness (Riding Quality)• Skid Resistance• Drainage• Shoulders• Edge Defects
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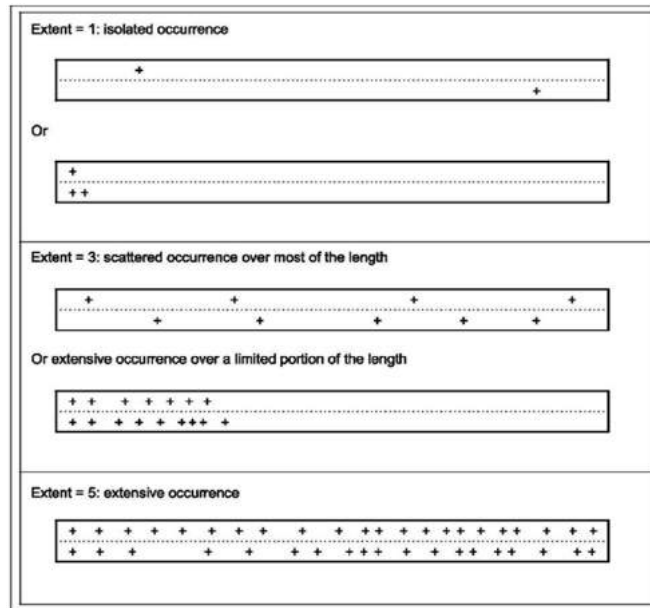
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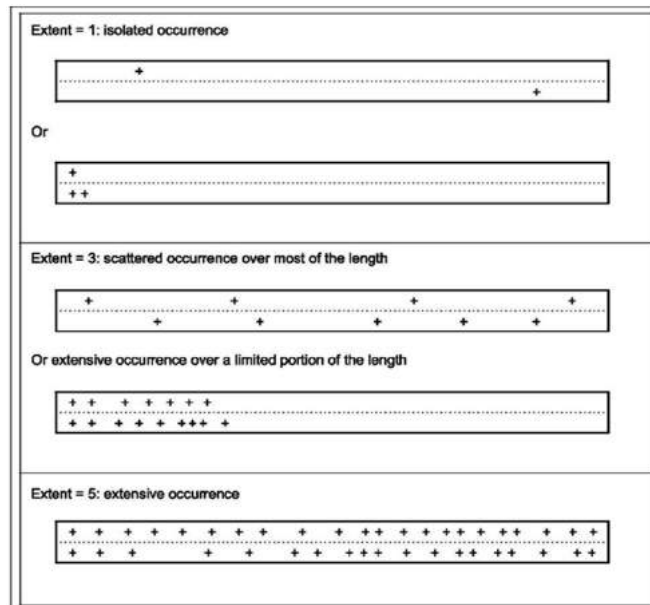
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5	Extensive occurrence over the entire segment.	> 50

Illustration of Extent



Determination of Extent



Proposed Restructuring/Unbundling

- Compile as separate, self-standing document comprising:
 - Part A: General/Background information on planning, design and monitoring of trial sections
Raters Manuals
 - Part B: Flexible pavements
 - Part C: Concrete pavements
 - Part D: Block pavements
 - Part E: Unpaved roads

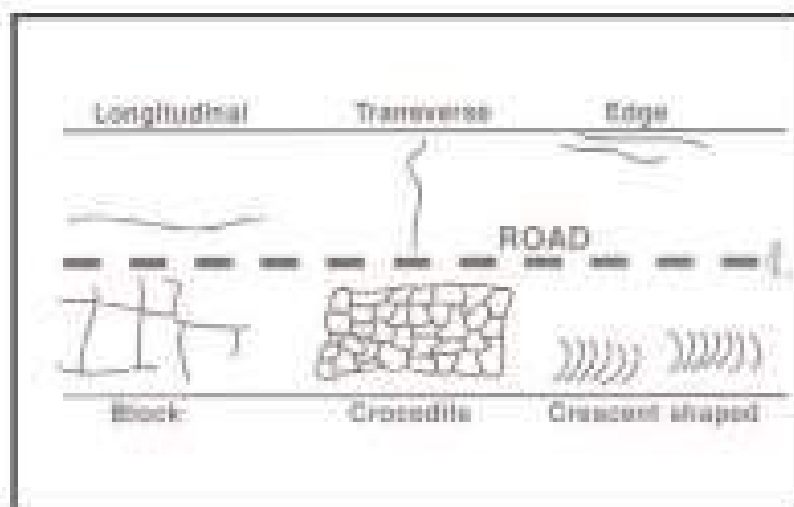
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Raters Manuals

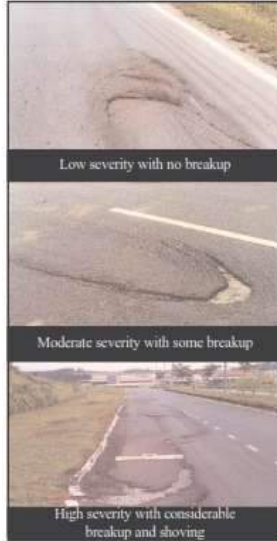
- Reader-friendly and easy-to-use document
- Aimed at facilitating reliable monitoring by initially inexperienced raters.
- Includes supporting photos to illustrate each type of distress

Types of Cracks



Crescent Shaped Cracks

CRESCENT SHAPED CRACKS



2.6. CRESCENT SHAPED CRACKS

SYNONYMS

Parabolic, slippage, shear cracks.

DESCRIPTION

This type of cracks are half moon or crescent shaped cracks, commonly associated with shoving, often occurring in closely spaced parallel group. It is mainly associated with bituminous layer only.

SEVERITY LEVELS

Low

Cracks with no breakup or shoving.

Moderate

Cracks with some breakup or shoving.

High

Cracks with considerable breakup or shoving.

MEASUREMENTS TO BE TAKEN

- a) predominant crack width.
- b) area affected.

Crocodile Cracks

CROCODILE CRACKS



2.1. CROCODILE CRACKS

DESCRIPTION

Crocodile cracks are interconnected or interlaced cracks which form a network of multi-sided blocks resembling the skin of a crocodile. The block size can range from 100 mm to about 300 mm.

Crocodile cracks is a consequence of the inability of the structure to support the repeated loads due to a "softening" of the material normally associated with increase in moisture content. The cracks in the subbase or subgrade tend to

spread rapidly under rain and traffic causing blocks of surfacing to be displaced and broken up.

SEVERITY LEVELS

Low

Interconnected or interlaced hairline cracks running parallel to each other, cracks not spalled.

Moderate

A pattern of articulated pieces formed by cracks that may be lightly spalled. Cracks may be sealed.

High

Pieces more severely spalled at edges and loosened; pieces rock under traffic; pumping may exist.

Block Cracks

BLOCK CRACKS



2.2. BLOCK CRACKS

SYNONYM

Ladder cracks.

DESCRIPTION

Block cracks are interconnected cracks forming a series of blocks, approximately rectangular in shape. Block sizes are usually greater than 300 mm and can exceed 3000 mm.

SEVERITY LEVELS

Low

Blocks defined by unspalled cracks with a mean width of 3 mm or less; cracks with sealant in good condition.

Moderate

Blocks defined by moderately spalled cracks; cracks with a mean width greater than 3 mm.

High

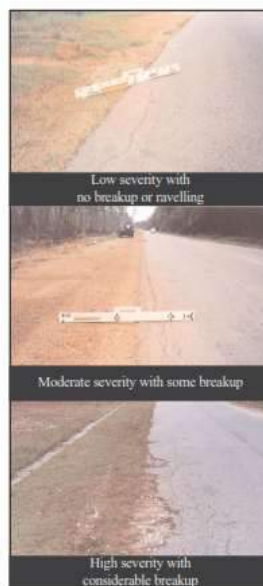
Blocks well defined by severely spalled cracks.

MEASUREMENTS TO BE TAKEN

- a) area affected.
- b) predominant crack width.
- c) predominant cell width.

Edge Cracks

EDGE CRACKS



2.5. EDGE CRACKS

DESCRIPTION

Edge cracks are crescent shaped or fairly continuous cracks, parallel to, and usually within 300 mm to 600 mm of the pavement edge. It usually occurs when paved shoulders do not exist.

SEVERITY LEVELS

Low

Cracks with no breakup or ravelling.

Moderate

Cracks with some breakup or ravelling.

High

Cracks with considerable breakup or ravelling along edge.

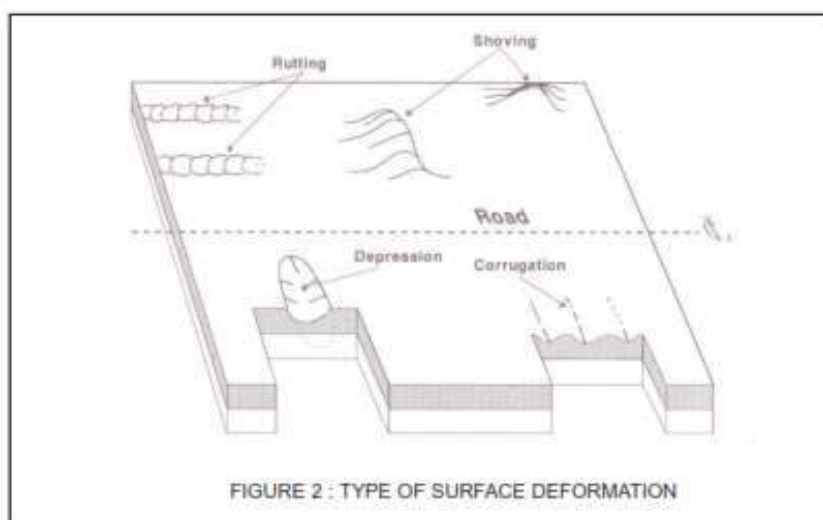
MEASUREMENTS TO BE TAKEN

- a) predominant crack width.
- b) area affected
- c) length

Review of Types of Cracks

- Block
- Longitudinal
- Transverse
- Crocodile
- Diagonal?
- Crescent?
- Meandering?

Type of Surface Deformation



Rutting

RUTTING



Low severity with rut depths < 12 mm



Moderate severity with rut depths between 12 mm to 25 mm



High severity with rut depths > 25 mm

3.1. RUTTING

SYNONYMS

Longitudinal rut.

DESCRIPTION

Rutting is longitudinal deformation or depression in the wheel paths which occur after repeated applications of axle loading. It may occur in one or both wheel paths of a lane. The length to width ratio would normally be greater than 4 to 1.

SEVERITY LEVELS

Low

Rut depths of less than 12 mm (measured under a transverse 1.2 m straight edge)

Moderate

Rut depths of between 12 mm to 25 mm (may include slight longitudinal cracks).

High

Rut depths of greater than 25 mm (may include multiple longitudinal or crocodile cracks).

MEASUREMENTS TO BE TAKEN

- maximum depth under a transverse 1.2 m straight edge.
- length.

Shoving

SHOVINGS



Low severity with noticeable swaying motion



Moderate severity resulting in rough ride



High severity resulting in severe ride

3.4. SHOVINGS

DESCRIPTION

Shoving is the bulging of the road surface generally parallel to the direction of traffic and/or horizontal displacement of surfacing materials, mainly in the direction of traffic where braking or acceleration movements occur, caused by traffic pushing against the pavement. Transverse shoving may arise with turning movements.

SEVERITY LEVELS

Low

Noticeable. (Based on observation of its appearance and its effect on riding quality).

Moderate

Rough ride.

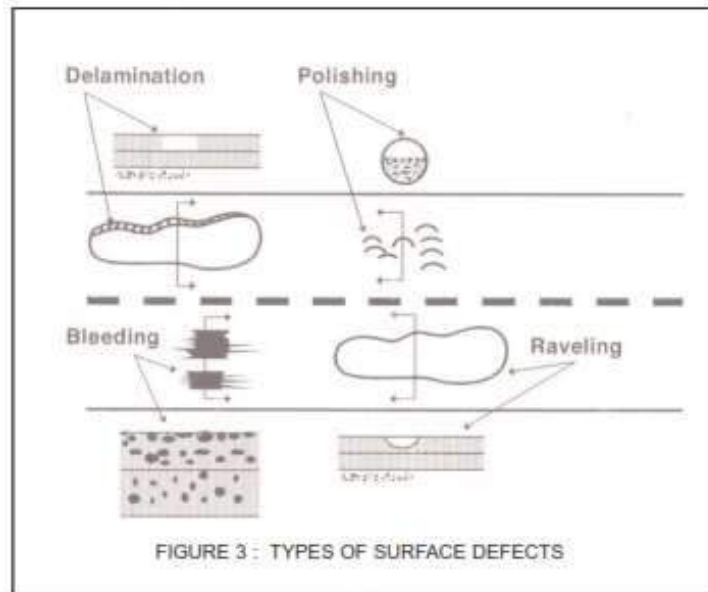
High

Very rough ride. Vehicle may lose control because of its presence.

MEASUREMENTS TO BE TAKEN

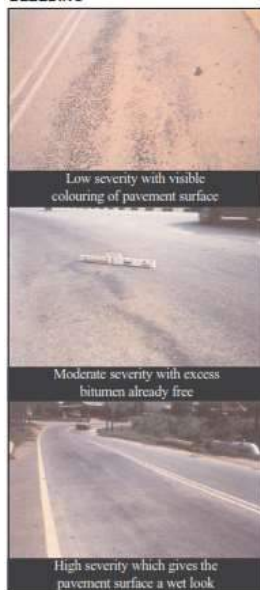
- maximum depth of bulge under 1.2 m straight edge from high point.
- area affected.

Types of Surface Defects



Bleeding

BLEEDING



4.1. BLEEDING

SYNONYMS

Flushing, fattig, slick, black spot.

DESCRIPTION

Bleeding is the presence of free bitumen binder on the surface resulting from upward migration of the binder, causing low texture depth and inadequate tyre to stone contact. It is most likely to occur in the wheel paths during hot weather.

SEVERITY LEVELS

Low

Colouring of pavement surface visible.

Moderate

Distinctive appearance with excess bitumen already free.

High

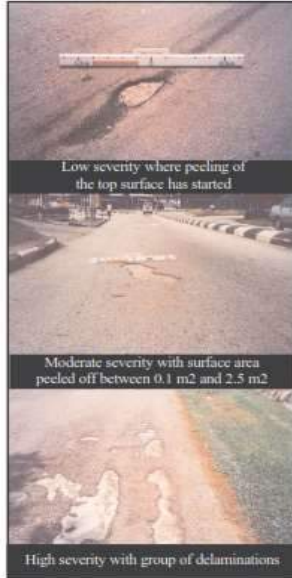
Free bitumen which gives the pavement surface a wet look. Tyre marks are evident.

MEASUREMENTS TO BE TAKEN

- area affected.
- percentage by area of stone immersed.

Delamination

DELAMINATION



4.4. DELAMINATION

SYNONYMS

Peeling, surface lifting, seal break, flaking

DESCRIPTION

Delamination is the loss of a discrete and large (minimum 0.01 square metre) area of the wearing course. Usually there is a clear delineation of the wearing course and the layer below.

SEVERITY LEVELS

Low

Peeling of the top layer has started but has not progressed significantly. Surface area peeled off is less than 0.1 m².

Moderate

Surface area peeled off is between 0.1 m² to 2.5 m². Severe crocodile cracks in and around the peeled off area.

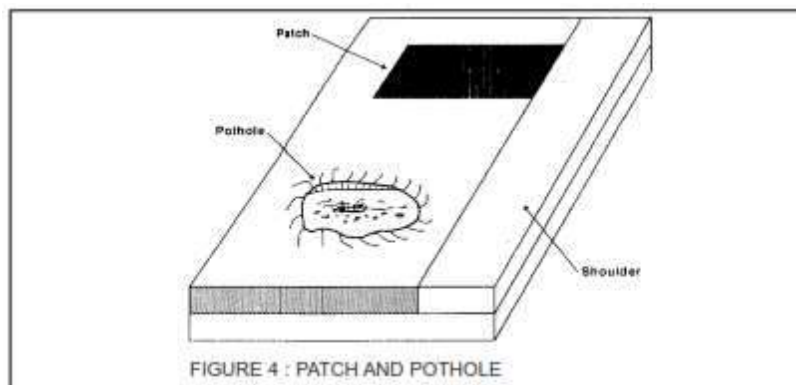
High

A group of more than two (2) moderate delaminations along a short stretch of road.

MEASUREMENTS TO BE TAKEN

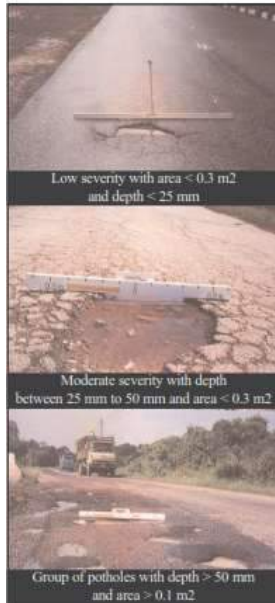
- thickness of layer(s) peeled off.
- area of individual delaminations.
- number of delaminations.

Patching and Potholes



Potholes

POTHOLE



6.0. POTHOLE

DESCRIPTION

Pothole is bowl shaped cavity in the pavement surface resulting from the loss of wearing course and binder course materials (see FIGURE 4). They are produced when traffic breaches small pieces of the pavement surface allowing the entry of water. These spots disintegrate because of the weakening of the base course or poor quality surfacing. Free water collecting in the hole and the underlying base accelerates its development.

SEVERITY LEVELS

MEASUREMENTS TO BE TAKEN

- a) depth of pothole.
- b) area of pothole.
- c) number of potholes at each severity level.

Edge Defects

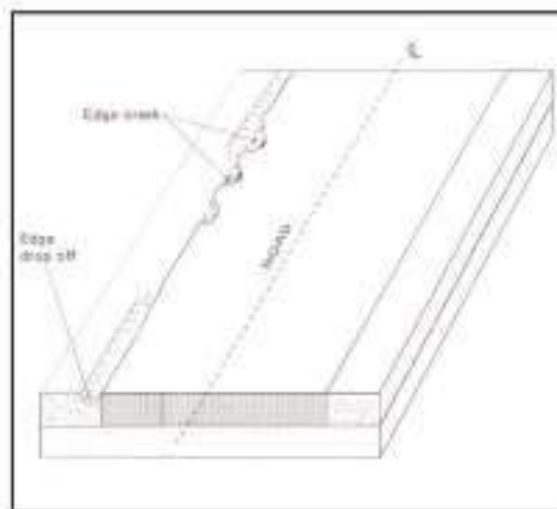
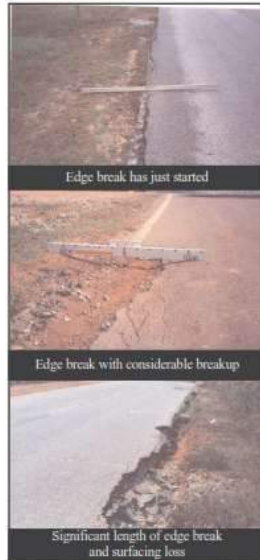


FIGURE 5 : TYPES OF EDGE DEFECTS

Edge Defects

EDGE BREAKS



7.0. EDGE DEFECTS

Edge defects occur along the interface of flexible pavement and the shoulder, and are most significant where the shoulder is unsealed. The detrimental effects of edge defects include :

- i) reduction of pavement width.
- ii) loss of quality of ride and possible loss of control of vehicle.
- iii) channelling of water at the edge of the pavement leading to erosion of shoulder.
- iv) entry of water into base.

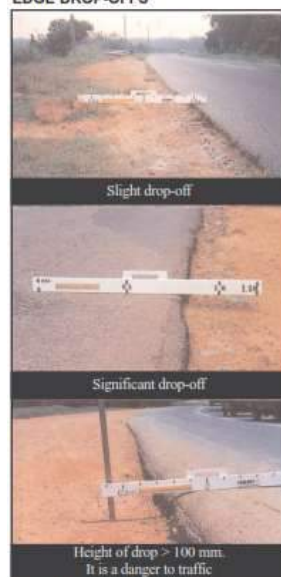
The defect types covered in this section are

- i) edge break.
- ii) edge drop-off.

The general form is illustrated in Figure 5.

Edge Drop-Off

EDGE DROP-OFFS



7.2. EDGE DROP-OFFS

DESCRIPTION

Edge drop-off is the difference in elevation between the traffic lane and outside shoulder; typically occurs when the outside shoulder settles or erodes. It is not usually considered a defect if the drop-off is less than 25 mm.

SEVERITY LEVEL

Not applicable. However, severity levels can be defined in relation to the height of drop.




MEASUREMENTS TO BE TAKEN

- a) height of drop.
- b) length affected.

Degrees of Surfacing of Failures

Degree	Description
1	Failures difficult to discern from moving vehicle. Small areas of surfacing are lost (diameter < 50mm)
3	Significant failure is visible from <i>a moving vehicle</i> (diameter ≈ 150mm) ????
5	Failure occurs over large areas and/or secondary defects have developed owing to the failure (diameter > 300mm)

Assessment of Degrees of Surfacing of Failures

SURFACING FAILURES					
	1				
	X	2	3	4	5
Small areas of surfacing are lost (diameter < 50 mm) . difficult visible from moving vehicle					
	3				
	1	2	X	4	5
Significant failure visible from moving vehicle (diameter = 150mm).					
	5				
	1	2	3	4	X
Occur over large areas, failures > 300mm in diameter.					

Proposed Restructuring/Unbundling

- Compile as separate, self-standing document comprising:
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Drainage Assessment Guideline

Drainage

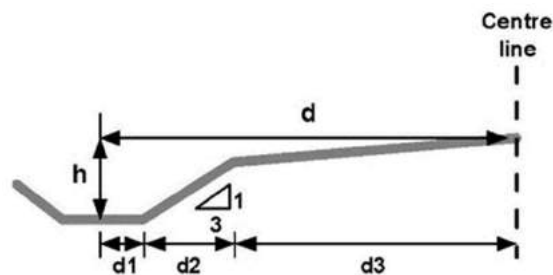
- Most influential factor affecting performance of a LVR
- Without an adequate, well-functioning drainage system, the pavement is likely to exhibit distress due to moisture ingress,
- Important to assess functionality of the drainage system in an objective manner during the performance monitoring of the road.
- The drainage system consists of:
 - Side drains and access culverts
 - Mitre drains
 - Cross culverts
- Need to measure Drainage Factor

Drainage



Influence of shoulder drainage on pavement performance

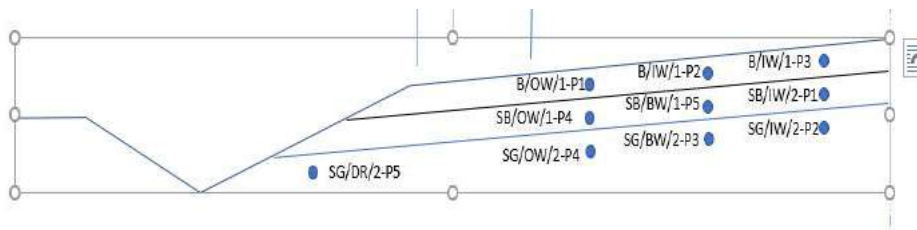
Drainage Factor



Drainage Factor $DF = d \times h$	Classification
$DF \geq 6.00$ or free draining	Very good
$4.5 \leq DF < 6$ or $H \geq 0.75$	Good
$3.5 \leq DF < 4.5$ or $H \geq 0.60$	Moderate
$2.5 \leq DF < 3.5$ or $H \geq 0.40$	Poor
$DF \leq 2.5$	Very poor

Notes: Classification can be moved up one class if:
 - gradient $\geq 1\%$ and/or
 - Lined drains where lining connects to edge of surfacing

Use of Moisture Sensors



Cost? Approx. USD 3000.00/set of 10 sensors

Maintenance

- Need for maintenance protocol to highlight minimum maintenance interventions required to be undertaken by roads agency on trial sections
- Need to ascertain and report on what maintenance has been carried on trial sections
- If inadequate maintenance, this to be reported to road agency to facilitate action

Collection and Analysis of Data

- Whose primary responsibility?
 - Monitoring consultant facilitated by ReCAP consultant?
 - ReCAP consultant supported by monitoring consultant?
- What is role of the roads agency in terms of following up of monitoring in absence of ReCAP consultants on site?

Establishment of Trial Section Locations

- Need for permanent concrete markers at beginning and end of each trial section with supplementary GPS coordinates

Thank you
Questions?