Study On Quality Of Bank Financed Road Projects

Transport, Urban Development & ICT Department

AFRICAN DEVELOPMENT BANK GROUP

Department of Transport and ICT, OITC

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FOREWORD

The African Development Bank has over the years supported the Regional Member Countries in their efforts in improving accessibility and livelihoods of people, through the execution of road transport projects. We can proudly talk of the many kilometres of road improvements through maintenance interventions, rehabilitation, new construction or upgrading that we have supported across the continent. The focus has in many instances been paved (bituminous) roads, but we have also supported the improvement of unpaved roads.

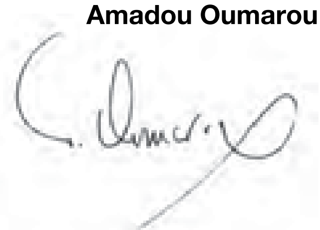
The Bank reflected on the outputs in the road sub-sector, taking cognisance of the fact that we have promoted and supported the improvement of over 10,000 km of road in the continent since 2006, with 4,000 km of these since 2010. We considered it prudent that we take stock of what we have been doing, to establish that we have not been doing the wrong thing to the detriment of the Bank's overarching mission of sustainable development; and what do we need to do to avoid doing the wrong thing. Are the roads we are supporting to build of the right quality? Are these roads sustainable? These are some of the questions that we asked ourselves, and we believe these are questions that many road users would also ask us.

The Bank has a well-defined project cycle, one stage of which is the post-evaluation of projects following completion. This is undertaken by the Independent Evaluation Department (IDEV), which would typically consider the development impact and effectiveness of the projects in relation to the defined outcomes as well as the strategic issues. Other internal organs also progressively look at the fiduciary aspects as relate to the execution of the projects. Our intention at this stage was to focus on the technical aspects of the projects delivery and hence the formulation of the Study.

The Study looked at technical parameters to provide answers to the question of whether the standards and specifications adopted in Bank financed projects are of international best practice, and further more if these are indeed adhered to. The Study was therefore akin to a technical audit of Bank financed road projects, based on the sampling of recently completed projects in eight selected countries across the continent.

Whereas we have obtained a sense of satisfaction in the findings from the Study, we are quick to point out that we need to keenly pursue the matter of ensuring quality and sustainability. We are glad to note that some stakeholders promptly responded to the early findings from the Study and undertook further investigations to address the issues pointed out. Collective responsibility is required at all levels by each of the stakeholders to ensure that our contribution to addressing the accessibility issue in Africa through good quality well maintained roads is sustained. This is what the continent should continue to strive for. We owe it to the people – across the age, gender and geographical, in the spirit of the Bank's Inclusive Growth.

Amadou Oumarou



DIRECTOR, TRANSPORT, URBAN DEVELOPMENT & ICT DEPARTMENT
THE AFRICAN DEVELOPMENT BANK

ACKNOWLEDGEMENTS

The Study was undertaken on behalf of the Bank by M/s Intercontinental Consultants and Technocrats Pvt. Ltd of India. The Bank is grateful for their input and efforts in ensuring the completion of the Study and overcoming the various challenges in conducting the Study.

The Study was initiated by Mr Gilbert Mbesherubusa (retired Vice President, Infrastructure, Private Sector & Regional Integration) when he was Director of the Transport and ICT Department. He was always keen on the progress of the Study in reflection of his vast contribution to the Bank's transport sector work in his time at the Bank.

The Report was prepared under the overall leadership of Mr. Amadou Oumarou, Director of the Transport and ICT Department, and the two Division Managers in the Department, Mr. Jean Kizito Kabanguka and Dr. Abayomi Babalola. The Study was coordinated Mr. Richard Malinga (Transport Engineer) who was Task Manager for the Study.

The Study received the support of the staff members of the Transport and ICT Department of the Bank, at the various review as well as from other departments, notably the Results and Quality Assurance Department (ORQR), specifically the Quality Assurance Division.

The Study would not have been possible without the cooperation of the Governments and Road Authorities/ Agencies in the Study Countries of Benin, Cameroon, Democratic Republic of Congo, Ghana, Kenya, Tanzania, Tunisia and Uganda. The various authorities provided valuable information for the Study. The full support of the Bank's staff in the field offices in some of the Study Countries - Cameroon, Democratic Republic of Congo, Ghana, Kenya, Tanzania and Uganda is also recognised. These provided assistance in the coordination of the in-country activities and have continued to follow up with the various agencies to ensure that specific findings from the Study are followed up.

The Bank's Senior Management is also acknowledged for the keen interest in the Study and providing the resources that enabled the Study to be undertaken.

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ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
AfDB	African Development Bank
AFNOR	Association Francaise de Normalisation
ARP	Aménagement des Routes Principal
ASTM	American Society for the Testing of Materials
BLI	Base Layer Index
BSI	British Standards Institute
CAR	Central African Republic
CBR	California Bearing Ratio
CCGT	Les Cahiers des Clauses Techniques Generales
CPC	Cahiers des Communes
DBM	Dense Bituminous Macadam
DBST	Double Bituminous Surface Dressing
DFR	Draft Final Report
DRC	Democratic Republic of Congo

ECOWAS	Economic Community of West African States
EIRR	Economic Internal Rate of Return
FIDIC	The International Federation of Consulting Engineers
FWD	Falling Weight Deflectometer
GoC	Government of Camroon
GoG	Government of Ghana
GoZ	Government of Zanzibar
HDM	Highway Development and Management Model
ICT	Intercontinental Consultants and Technocrats Pvt. Ltd.
IDA	International Development Association
ILO	International Labour Organization
IRI	International Roughness Index
JICA	Japan International Cooperation Agency
KenHA	Kenya Highways Authority
Ksh	Kenya Shillings
LCPC	Laboratoire d'Etudes Techniques des Ponts et Chausees
LLI	Lower Layer Index
MDB	Multilateral Development Bank
MECCO	Mwanainchi Engineering and Contracting Company Ltd.
MESA	Millions of Equivalent Standard Axles
MLI	Middle Layer Index
MMS	Maintenance Management System
MSN	Modified Structural Number
MTS	Medium Term Strategy
NORAD	Norwegian Agency for International Development
NTF	Nigeria Trust Fund
OPEC	Organization of Petroleum Exporting Countries
PCR	Pavement Condition Rating
PMU	Project Management Unit
PSI	Present Serviceability Index
QAP	Quality Assurance Plan
RAs	Road Administrations
RFP	Request for Proposal
RMCs	Regional Member Countries
ROMDAS	Road Measurement Data Acquisition System
SETRA	Service d'Etudes Techniques des Routes et Autoroutes
TANROADS	Tanzania national Roads Agency
TOR	Terms of Reference
TRL	Transport and Research Laboratory
UCS	Unconfined Compressive Strength
UNDP	United Nations Development Programme
US$	United States Dollar
VO	Variation Order

1.0
INTRODUCTION

1.0 INTRODUCTION

1.1 Background

The African Development Bank in December 2012 engaged Intercontinental Consultants and Technocrats Pvt. Ltd. (ICT) of India to conduct a Study on the Quality of Bank Financed Road Projects on its behalf. The Study initially covered five countries but was later expanded, in November 2013, to cover three additional countries.

The African Development Bank is a multilateral development institution involved in the financing of development projects, including infrastructure, in its 54 Regional Member Countries (RMCs) in Africa. It is recognized that infrastructure plays a significant role in achieving sustainable economic growth and poverty reduction in RMCs. The Bank therefore places infrastructure development as one of the core priority areas in its operations.

Considerable resources have been invested by the Bank on infrastructure development. Out of the total of UA 4.52 billion (approximately equivalent to US$ 6.87 billion) approved in 2012, infrastructure accounted for UA 1.76 billion representing 38.9% of the total Bank approvals in 2012. The investment in infrastructure is much higher than this figure if infrastructure related interventions in other sectors are considered. The transport sector accounted for 16.8% of total Bank approvals for 2012. With the recognition by governments of member countries of the importance of infrastructure development in socio-economic development, there has been a rising demand for infrastructure support from RMCs.

The Bank has supported road sub-sector projects in almost all of its RMCs, spread across the continent's five sub-regions – North Africa, West Africa, East Africa, Southern Africa and Central Africa. The Bank's RMCs have different and very diverse levels of financial and technical capacities within the roads sub-sector. This has its implications in terms of the nature of Bank's involvement and level of standards and specifications applied. Whilst the broad project design and implementation in different RMCs may share similarities as far as the Bank's procedures and processes may influence, the road projects in the different RMCs invariably present unique characteristics depending on local conditions.

Road projects financed by the Bank in the RMCs include new construction, upgrading (mainly from gravel to paved), rehabilitation and capacity improvement. The projects have also included standalone bridges (with limited approach roads), or have been in the form of a nation-wide program.

With socio-economic development being the main mandate of the African Development Bank, the Bank needs to ensure that all the projects it finances achieve their economic and social developmental objectives. To achieve this overarching objective, the Bank has put in place various procedures and safeguards with the aim of ensuring that these projects fulfill various criteria, amongst which are the adequacy, suitability

and sustainability of the physical structures put in place. In the case of road projects, physical quality, safety and sustainability play a major role in meeting the said criteria.
With the Bank having financed and supported numerous transport sector projects, and specifically road transport operations, there is the need to verify whether or not that the technical standards and specifications adopted in various Bank financed road projects are of internationally accepted quality, reflecting best practice. There is also the need to verify if these standards and specifications are adhered to during project implementation.
This Study carried out by ICT on behalf of the Bank, therefore, aimed at establishing the above noted aspects. The Study is also to help develop recommendations for any changes in the Bank's operations and implementation of projects that would ensure that Bank financed road projects are robustly sustainable.

1.2 Objectives of the assignment

The overall objective of the study is to assess the sustainability as deduced from the quality of Bank financed road projects and based on the findings develop recommendations on improvements, if any, for future investments in the road sector.

The specific objectives of the study are:

a. To assess whether the technical standards and specifications adopted in Bank financed road projects are of internationally acceptable best practice;
b. To assess whether the adopted standards and specifications are fully adhered to during project implementation; and
c. To provide recommendations on changes or improvements, in the Bank's approach in the project design as they affect the quality of road projects at implementation and impact sustainability.

It was noted that any recommendations to be made were to be within the context of the Bank's projects general objectives in terms of social and economic development; development of the domestic construction industry; and national and local employment.

1.3 Organization of the report

This Final Report is presented in nine (9) chapters and five appendices. The information contained in each chapter has been aggregated to provide a logical approach towards producing the assignment outputs for the realization of the objectives of the assignment.

Chapter 1: INTRODUCTION - gives a background to the assignment.
Chapter 2: THE ASSIGNMENT - defines the assignment, discusses the scope, its management, the approach to conducting the assignment, the expected outcomes and the challenges faced in conducting the assignment.
Chapter 3: THE STUDY ROADS - provides brief background information on the roads

selected for the Study. The study roads have also been assessed to see how they provide a spread in terms of climate, location, type of finishing and the type of works carried out as intended by the Bank.

Chapter 4: ASSESSMENT OF THE QUALITY OF SELECTED ROADS -presents the results generated through the field studies and laboratory testing and provides the Consultant's interpretation of the results of the field studies and laboratory tests and the inferences drawn from them.

Chapter 5: PERFORMANCE OF THE CONTRACTS FOR THE STUDY ROADS - examines the performance of the contracts under which the selected roads were constructed, the reasons for any challenges faced and how these could be avoided in future projects.

Chapter 6: STANDARDS AND SPECIFICATIONS OF STUDY ROADS AND BEST PRACTICE AND COMPARISON WITH OTHER INTERNATIONALLY FUNDED ROAD PROJECTS - compares the standards, specifications and performance of the selected roads in the Study countries with those of other projects funded from other sources for assessing whether or not the standards and specifications of Bank road projects meet best practice.

Chapter 7: USER PERCEPTIONS AND SOCIO-ECONOMIC ASSESSMENT OF STUDY ROADS - presents the results and analysis of user surveys carried out for the Study roads.

Chapter 8: SUSTAINABILITY OF BANK PROJECTS - discusses the sustainability of Bank funded road projects based on current practices in the Study countries and reflects on what needs to be done to make them robustly sustainable.

Chapter 9: FINDINGS AND RECOMMENDATIONS - presents the findings of the Study and the consultant's recommendations.

The Terms of Reference for the Study are reproduced as Appendix 1; Appendix 2 is a summary of the field and laboratory test results; Appendix 3 is a summary of relevant information, characteristics and study findings for each road section; Appendix 4 is a check list of measures/good practices to ensure the quality of Bank financed road projects; while Appendix 5 is a summary of the road network information, road management systems, maintenance funding arrangements and the sustainability risk for each Study Country.

2.0
THE ASSIGNMENT

2.0 THE ASSIGNMENT

2.1 Scope of the assignment

The scope of work as understood from a careful study of the Terms of Reference (ToR) and discussions with the representatives of the Bank includes, but not limited to the following:

- Refining the quality parameters and indicators to be used in the Study as appropriate for the specific road projects selected for evaluation. The quality parameters were expected to include both technical (engineering) and other perspectives and were to comprise:
  - Riding Surface Quality as measured by Road Roughness or such other parameters as proxy;
  - Pavement Condition Rating;
  - Present Serviceability Index (PSI);
  - Conformity of construction (as-built) with technical specifications;
  - Time for actual implementation against planned implementation time;
  - How well the issues of Road Safety have been addressed; and
  - Ease of maintenance with regard to the required technology and available capacity.
- Evaluation of selected road projects in eight representative countries which have been selected for the Study. The specific projects have been chosen considering such aspects as:
  - Climatic conditions of the project area (for example high precipitation versus arid/ dry);
  - Project planned implementation time (duration), and the period when the project was commenced; and
  - Road project type and classification (new construction, rehabilitation, upgrading, expansion), and road surfacing type/material (surface dressing, Asphalt Concrete, or other);

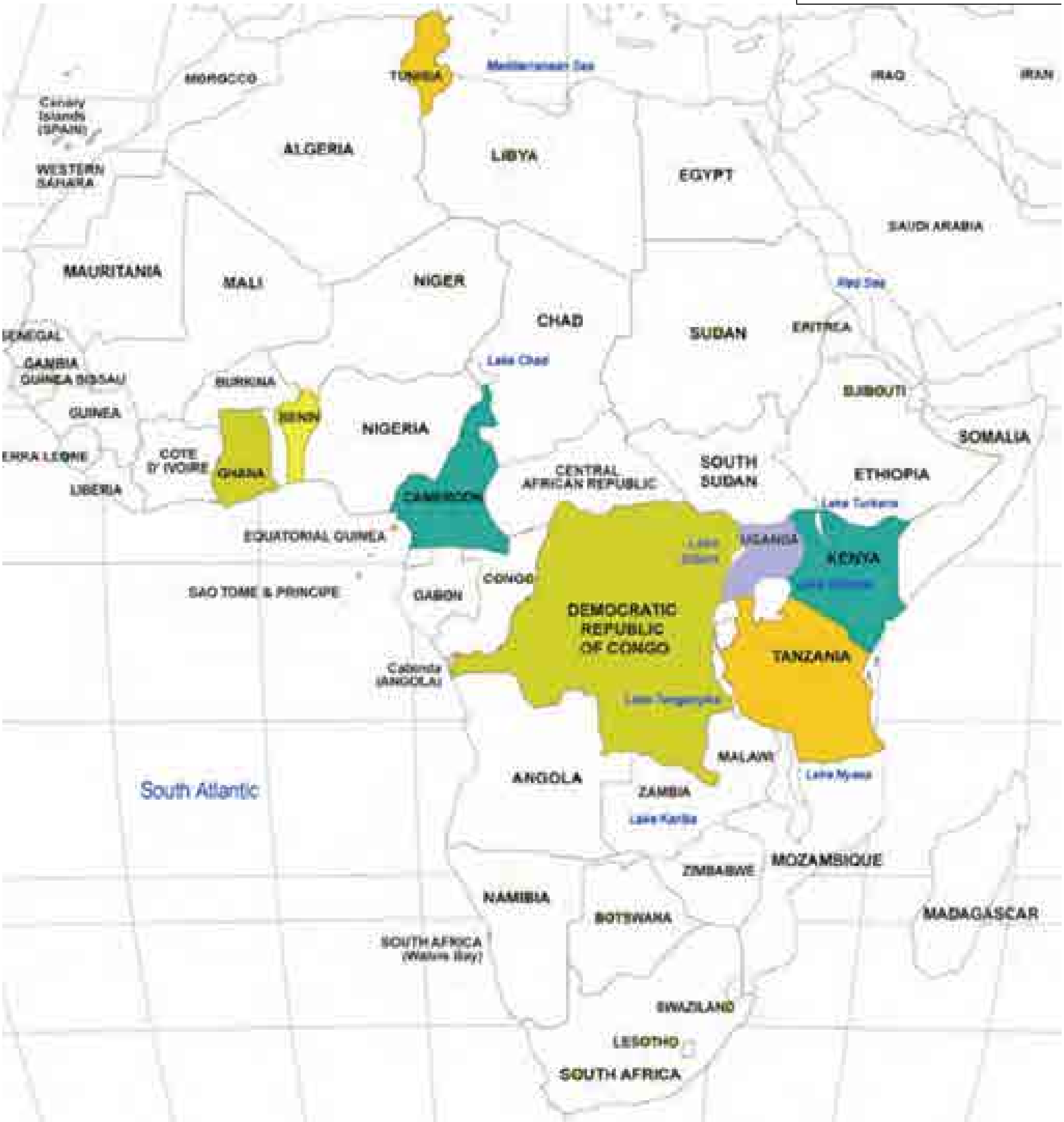
  The chosen projects are located in the eight selected countries of:
  - Benin;
  - Cameroon;
  - Democratic Republic of Congo (DRC);
  - Ghana;
  - Kenya;
  - Tanzania;
  - Tunisia; and
  - Uganda.

  The study countries are shown on a map of Africa in Figure 2.1.

- Review of any critical key variances in road construction specifications and technical standards used in the selected projects, and their potential influence on quality of road projects. Make any recommendations for replication or transfer as may be deemed appropriate for the broad improvement of the quality of road projects.

- Review of the quality assurance system put in place and the relevant quality assurance manuals used in the projects and accordingly draw any pertinent conclusions.

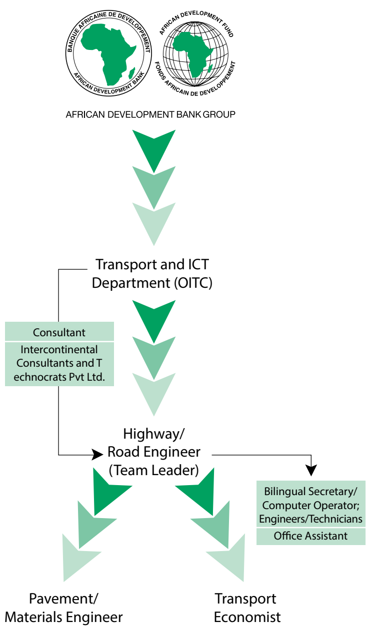
Figure 2.1: Map of Africa Showing Study Countries



2.2 Organization and management of the project

The Study was conducted by a team comprising a Highway/Road Engineer who was also the Team Leader, a Pavement and Materials Engineer and a Transport Economist. The team was supported by a group of engineers and technicians and other ancillary staff. Coordination on the Consultant's side necessary for realization of the objectives of the assignment was carried out by the consultant's Team Leader. The Team Leader liaised with the Bank`s Project Manager for the Study. The organization structure for managing the assignment is illustrated in the chart in Figure 2.2.

Figure 2.2: Project Organization Chart



2.3 Approach to assignment

General

The Terms of Reference are detailed and clearly defined what was to be done by the Consultant.

The Consultant initially carried out a thorough review of the project documents provided by the Bank and by the respective Road Administrations in the Study countries. The Consultant's Team also carried out consultations/communications with the Bank staff associated with the project and other relevant agencies as the Study progressed. The parties which were consulted were mainly Road Authorities/Administrations in the Study countries. The Consultant also undertook consultations with some private sector stakeholders, who were essentially the consultants, and the contractors for the specific projects and regarded as relevant to the study.

The initial consultations were followed by field investigations for each Study road section. The field investigations comprised visual surveys, non-destructive and destructive testing of the pavements. Samples recovered from the destructive testing of the pavements were subjected to various laboratory tests. Bridges and other drainage structures were also visually inspected. The different facets of the field investigations are described in the following sections.

Visual Surveys

The entire length of each Study road section was subjected to a visual survey. The visual surveys were carried out from a vehicle traveling at a relatively slow speed. Wherever any hint of surface distress was detected, the affected area, including a short length of approximately 30 m preceding and beyond the affected area was surveyed on foot. The extent of various distresses, such as cracking (longitudinal, transverse, alligator), flushing, rutting, ravelling, patching, corrugations and potholing were recorded. The width of the carriageway and shoulders at several points for each road were also measured. For bridges and other drainage structures, the inspections were used to identify and collect information on any visible cracks in the abutments, piers and decks and the extent and orientation of such distress. Information on accessories, such as railings, and the state of such accessories were also noted.

The visual survey was also used to assess the safety aspects of the roads. The assessment involved an evaluation of the geometry of the roads comprising the adequacy of off-set distances, radii of curves, the layout of junctions, and other safety features, such as road signs and speed calming devices in built-up areas to enable recommendations to be given, where necessary, for appropriate remedial measures.

Field Surveys

Roughness Measurements

Roughness measurements were carried out for the entire length of each Study road in both directions using a vehicle mounted Road Measurement Data Acquisition System (ROMDAS) after due calibration, except for the roads in the Democratic Republic of Congo where the Consultant's engineers with their equipment were not allowed to enter the country. The riding quality of the Project Roads was assessed in terms of pavement roughness using the ROMDAS. The system can be run at highway speeds, but needs to be calibrated for the desired running speed; say 30, 45, or 60 km/hr. For the project roads the recording speed was set at 30 km/hr.

Calibration of ROMDAS

The ROMDAS equipment, attached to the test vehicle, used for the riding quality assessment was calibrated at the standard running conditions of tyre pressure and running speed using the Z – 250 Reference Profiler.

For purposes of calibration, 13 typical road sections representing a good range of surface unevenness from very smooth to somewhat rough conditions, to cover the spectrum of roughness levels seen during the visual surveys were selected. Surface roughness levels of these typical locations were recorded in terms of deviations from a flat surface, in mm/km, using the ROMDAS attached to the test vehicle running at 30 km/hr. Subsequently, the same stretches were assessed for their roughness levels in International Roughness Index (IRI) values in m/km using the Z – 250 Reference Profiler. Table 2.1 presents an example of the data obtained using the two different types of equipment at the identified locations.

Table 2.1: Roughness of Typical Road Section Measured using ROMDAS and Reference Profiler

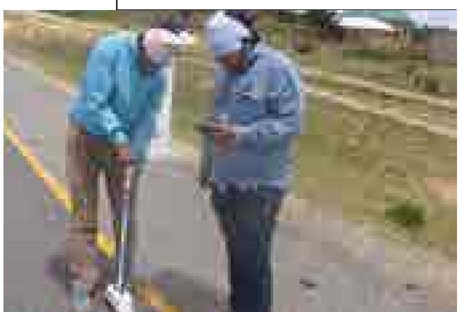
Section No.	IRI (m/km)	ROMDAS Response (mm/km)
1	1.55	180
2	1.99	238
3	2.09	250
4	2.43	325
5	3.42	484
6	3.97	580
7	4.13	648
8	5.34	878
9	6.13	960
10	8.17	1223
11	9.09	1356
12	10.23	1514
13	11.76	1824

Picture 2.1: The Test Vehicle used in Tanzania and Kenya

Picture 2.2: Monitor and Data Recording

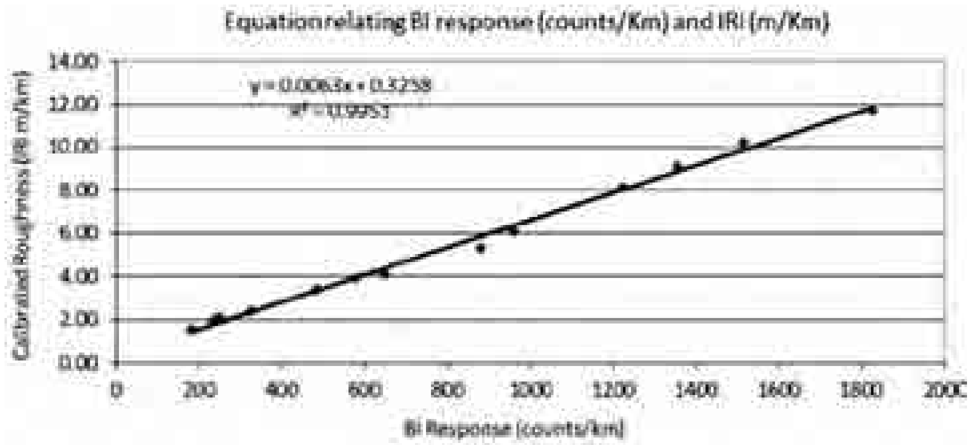
Picture 2.3: A View of ROMDAS Equipment

Picture 2.4: The Reference Profiler



The data presented in graphical manner, with the ROMDAS roughness values in counts/km along the x-axis and the Z - 250 Reference Profiler assessed roughness values in m/km along the y-axis, indicates a straight line relationship, y = 0.0063x + 0.3258 with a coefficient of correlation, r, of 0.9951, indicating a very high correlation between the results of the two equipment. Figure 2.3 shows the calibration between ROMDAS Bump Integrator counts and IRI.

Figure 2.3: Calibration Graph between BI response and Roughness in m/km



This calibration was used to convert the roughness measurements of the Study roads in mm/km obtained using the ROMDAS equipment to IRI.

Deflection Testing

Based on the analysis of the visual surveys and the roughness measurements, a minimum of 10% of each road was selected for deflection testing for evaluating the current structural capacity of the roads.

The Falling Weight Deflectometer (FWD) was used where available. In the absence of the Falling Weight Deflectometer, the Benkelman Beam and the Lacroix Deflectograph were used for the deflection testing. The Falling Weight Deflectometer was used in Benin, Ghana, Kenya and Uganda, the La Croix Deflectograph in Tunisia and the Benkelman Beam in Cameroon, Tanzania and DRC.

The FWD is a device that drops a controlled weight on to a load plate positioned on the pavement surface and measures the deflection of the pavement with seven sensors located in series. The vehicle that tows the test device is equipped with a computer system that is used to control the load and record the deflections. The deflection bowl can be determined from the deflections. The pavement properties can be back-calculated from the observed response.

The La Croix Deflectograph is a device used for the continuous automatic measurement of the elastic deflection of a pavement under a specified load. Measurements are taken in the wheel paths of the lane being tested. The deflections are recorded at approximately 6m intervals. The data obtained can be used to assess the load carrying capacity of the pavement and for overlay or strengthening design.

The Benkelman Beam technique uses the elastic rebound deflection of the pavement under a dual wheel axle load of 8,200 kg and tire pressure of 5.9 kg/cm2 of a slowly moving vehicle. Temperature correction is not required for surface dressed roads, but is required for asphaltic concrete roads. However, since the information is meant for assessing the capacity of the road sections and not for designing an overlay, the deflection values as obtained have been utilized as measured for further analysis.

Test Pits

For each Study road section, between one and three test pits, depending on the length, was sunk to help assess the composition of the pavement and the characteristics of the component layers. The locations of the test pits were selected after carefully studying the results of the visual survey, the roughness measurements and the deflection surveys. The pits, in general, measured about 0.5m x 0.5m in plan and were sunk to depths in the order of 1m from the pavement surface. Prior to sinking of the pits the in-situ densities of the asphalt layers were measured and cores taken from any asphalt layers. The densities of the pavement layers were measured using the sand replacement method and where available the nuclear densometer. The thickness of each layer was checked and samples from each layer taken for laboratory analyses. The test pits were reinstated by filling back in layers of no more than 200 mm and compacted using manual compactors and rammers until the further action of the compactors could not dent the surface of the layer. Where necessary, additional material, mainly crushed rock was, added to ensure adequate thicknesses of the unbound layers. The bound layers were replaced with compacted layers of asphaltic concrete and leveled to ensure that surfaces flushed with the original pavement and shoulder surfaces. Where the roads had been surface dressed, the patches were finished in surface dressing.

Picture 2.5: Deflection Testing in Kenya

Laboratory Analysis

Cores taken from asphalt layers were tested in the laboratory for the asphalt content and grading of the aggregate component. The recovered aggregate have been tested for those properties that had been specified in the project specifications, such as particle shape, strength in terms of Abrasion Value or Impact Value, water absorption and stripping.

Roads with surface treatments would have samples taken from the surface treatment and the aggregates tested for grading and the bitumen coverage. Samples recovered from aggregate layers, such as for crushed rock base, were tested for grading, Aggregate Crushing Value or Los Angeles Abrasion Value and particle shape in terms of flakiness and elongation index. The filler material have been tested for its plasticity characteristics
The soil layers were tested for natural moisture content, grading and Atterberg Limits and the maximum dry density and the optimum moisture content based on the compaction standards specified in the project documents.

Picture 2.6: Sand Replacement on Athi River-Namanga Road, Kenya

Compliance with Standards and Specifications

The results of the field and laboratory analysis have been compared with project specifications to enable the Consultant assess to what extent the implementation had met the specifications and what actions, if any, would be required for the projects to meet their intended objectives.

Assessment of the Performance of the Construction Contracts

The performance of the construction contracts for the projects have been assessed and the reasons for unsatisfactory or poor performance and the responsibility discussed and recommendations given for improving the quality and sustainability of Bank's projects.

Other Investigations

Review of Projects' Technical Standards and Specifications against International Best Practice; and Comparison of Project Standards, Specifications and Performance with Other Projects

The technical standards and specifications of the Study road sections were reviewed against international best practice. The standards and specifications used for the Study roads were also compared with those employed on other internationally funded in-country projects to assess whether or not Bank funded road projects followed practices similar to those used for other internationally funded projects. The performance of the Study roads was also compared with that of the selected roads funded from other sources to assess whether or not these were comparable. The roads chosen for comparison, in general, had similar classifications and similar post-construction ages as those being studied. Another consideration was for the chosen projects to provide as wide a mix of funding agencies as possible.

Visual surveys were carried out on these other projects to assess whether or not the Bank's projects are performing as well as those funded by other financiers. The standards have also been compared with some regional standards in Africa

The standards adopted in different countries for similar roads have also been discussed to help initiate debate and assist the Bank in developing a policy on Standards and Specifications for Bank financed projects.

Review of Quality Assurance Systems

It was intended to review the quality assurance system established for each of the road sections for compliance with the contract documents; with each document being examined for the following:

- Procedures for sampling of materials:
- Procedures for, and frequency of various tests (including calibration of testing equipment) and approval of materials;
- Standard forms for the approval of tested materials and work items;
- Procedures for the approval of the Contractor's construction methodology;
- Procedures for approval of the permanent works;
- Procedures for dealing with substandard work and its rectification; and
- Records management system for quality control.

However, only the Administration in Cameroon was able to produce documents detailing the quality assurance plans for the selected projects in that country. There were indications in progress reports for the Nairobi - Thika road section in Kenya; and another in Tanzania for the Singida - Katesh road section that these were prepared though. In the absence of these documents the Consultant reviewed the quality control records as found in the progress reports, where available, to assess how well quality had been controlled, especially how substandard work had been dealt with.

Obtain Users' Perspectives on the Quality and Impact of Study Roads

The Consultant obtained road users' perspectives on the quality, standards and impact of each road. This was done through road side surveys using a pre-structured questionnaire. The survey questions were formulated to provide information, among others, on:

- Assessment of quality and safety; and
- Whether or not the improvement of the road has reduced travel time and/or enhanced capacity.

A minimum of ten respondents were interviewed for each road. The surveys were conducted by trained and qualified enumerators who were fluent in the relevant local languages. The age, sex and the occupation of each respondent was captured during each interview. The selection of the respondents, though random, covered interviewees representing all sections of society - different age brackets, gender and occupation groups - to make the coverage as broad-based and as representative as possible.

Analysis of the answers to the questionnaire have been made to allow the perspective of users on the quality and impact of the roads to be evaluated.

Verification of Project's Initial Economic Assumptions

The Consultant has compared available traffic data for the project roads before and after the improvements supplemented with limited traffic surveys where necessary to be able to provide a qualitative assessment of the economic benefits of the project. Feasibility reports for most of the projects were unavailable to allow a comparison of the current attributes with the initial assumptions for a more comprehensive or quantitative assessment.

Assessment of Study Road's Contribution to the Development of the Local Construction Industry

The contribution made by the Study road to the development of the local construction industry was evaluated by obtaining information on the extent local consultants were involved in project feasibility, detailed design and supervision in terms of man-months of professional time. The extent of the involvement of local contractors in the project as sub-contractors and as suppliers was also assessed, though this proved difficult since the construction contractors were unavailable for interviews and discussions.

Assessment of Project's Contribution to Employment Generation

The contribution of each of the projects to direct employment was assessed from project monthly and quarterly reports. The assessment of indirect employment was difficult given the duration of the assignment. This was done through the examination of available secondary data and stakeholder consultations.

Evaluation of Axle Load Control in Study Countries

As part of the process for the assessment of the sustainability of Bank's Projects, the axle load control regime in the Study Countries were interrogated and recommendations made based on the level of effectiveness in the particular country.

Evaluation of the Institutional Arrangements for the Management of Roads and Funding of Maintenance

The institutional arrangements within which the road networks are managed including the management of projects; and the funding for road maintenance has been reviewed for each of the Study countries as part of the assessment of the sustainability of the Bank's projects and where necessary recommendations given.

2.4 Assignment outputs

The main outputs of the study were, as per the ToR, expected to include:

- A critical assessment of the quality of Bank financed road projects in respect of technical standards and specifications in reference to sustainability.
- Recommendations on approaches to defining technical standards and specifications that would improve quality and sustainability of road projects; whilst taking due cognisance of the climate of the local construction industry.

Other outputs could be proposed by the Consultant in line with the objectives of the Study.

2.5 Challenges faced in the conduct of the assignment

The Bank have been very helpful in providing background material for the assignment, informing the various Road Administrations (RAs) in the Study countries, and assisting with our travel arrangements. The Consultant has nevertheless faced a number of challenges in the conduct of the assignment.

It appeared most of the RAs did not appreciate their roles in the Study or were not adequately prepared for the Study. There were a few exceptions though where the RAs showed enthusiasm and were very cooperative. Some RAs indicated that they had not received any letters or electronic mails from the Bank introducing the Study and the Consultant and that the only indication they had was our communication to them requesting for meetings and documents.

Consequently, obtaining relevant documents from the RAs was a major challenge. While some were very helpful, acquiring the necessary documents in some countries proved to be very daunting. Despite repeated visits to some of the countries, and letters announcing the Consultant's impending visits, the Consultant was not able to access all the information deemed necessary for the Study. None of the RAs was able to provide all the documents required by the Consultant for the Study. In particular, none of the RAs was able to provide the Quality Assurance Plan for any of the projects in any of the countries. Either they did not exist or they could not be traced.

Recommending projects financed by other development partners to be used for the purposes of comparison did also not receive the attention the Consultant felt it deserved. In some cases the recommended projects had different characteristics compared with the study roads in terms of carriageway cross-section and the type of wearing course used. This was realized only after such projects had been visited.

Travelling to some of the Study countries proved to be more difficult than had been anticipated. The Consultant's team was stuck in Nairobi for a week waiting for visas for the Democratic Republic of Congo for the Team Leader and an interpreter. Two support engineers who were to carry out roughness tests in DRC after their work in Tanzania and Kenya were refused entry at Kinshasa airport even though they had visas obtained with the support of the Banks's Field Office in Nairobi. The reason given by immigration officials in Kinshasa was that the visas had been obtained in Nairobi where they were not resident. Roughness tests could therefore not be carried out in DRC since there was inadequate time for alternative arrangements to be made after the Consultant was unable to source suitable equipment in the DRC or nearby Brazzaville. Importing testing equipment into some countries was also a huge challenge. Testing was delayed in Tanzania and Kenya because of customs procedures. The team leader with some support engineers spent two days at the Togo/Benin border just to be able to enter Benin with a Falling Weight Deflectograph for deflection testing.

Another challenge was the non-availability of suitable and/or adequate field and laboratory testing equipment in the Study countries. There were virtually no private testing laboratories in the Study countries. Most of the government laboratories did not appear sufficiently equipped for the tests required. Laboratory testing also took much longer due to the lack of adequate numbers of equipment and in some cases the non-availability of the required equipment. Some tests, such as determining the penetration of bitumen recovered from extraction tests, which were not regarded as very critical therefore had to be skipped because of the lack of appropriate equipment. The effect of not carrying out such tests was mitigated through inferences made from other tests carried out and especially from the assessment of the performance of the roads since all of them had been in service for some time.

The Consultant would, however, like to point out that the foregoing challenges do in no way detract from the quality of the findings/observations and recommendations provided through the Study.

3.0
THE STUDY ROADS

3.0 THE STUDY ROADS

3.1 Introduction

A total of thirty (30) road sections from eight countries were selected for the Study. Two (2) of these sections are in Benin, two (2) in Cameroon, two (2) in the Democratic Republic of Congo, six (6) in Ghana, three (3) in Kenya, , six (6) in the United Republic of Tanzania - three (3) on the main land and three (3) on Zanzibar Island, eight (8) in Tunisia and one in Uganda. The Study road sections have been examined against the criteria set by the Bank for their selection. The selected roads do provide the desired spread across climatic regions, type of construction, type of surfacing and implementation period. Geographical spread does not appear to have been fully satisfied since there are no projects in Southern Africa. This was however explained at the commencement meeting to be attributable to the non-availability of recently completed projects in the region. The details of the Study road sections were obtained from documents provided to the Consultant by the Bank. The details and the actual implementation schedules were verified or obtained during the country visits for the field investigations; and through contract documents for the projects and construction progress reports. Details of the Study road sections are provided below.

3.2 Benin

The two road sections studied in Benin are the Pobe - Ketou and the Ketou - Illara roads. The Pobe - Ketou and Ketou - Illara road sections form part of the link from Cotonou to the town of Imeko in the Ogun State of Nigeria. The location of the roads is shown on a map of Benin in Figure 3.1 while the two road sections are presented in Figure 3.2.

Pobe - Ketou Road Section

The Pobe - Ketou road section forms part of RN 3. The 42.8 km long road section has a 7m wide carriageway and 1.5m wide shoulders. It comprised two sections with different characteristics prior to the implementation of the rehabilitation project which is the subject of the study. The two sections are the 19.4 km Pobe - Onigbolo and the 23.4 km long Onigbolo - Ketou sections which had previously been upgraded, paved and commissioned in 1983.

The Pobe - Onigbolo section had been built on expansive soils sensitive to variations in water content and prior to the recent rehabilitation was in an advanced state of deterioration to the point where for over 99% of its length showed characteristics of an earth road in a very poor condition. The Onigbolo - Ketou section on the other hand, showed less surface distress than the Pobe - Onigbolo section and the carriageway structure also showed very little distortion. Under the recent rehabilitation, the two distinct sections were therefore provided with different pavement structures.
The pavement structure for the 19.4 km Pobe - Onigbolo Section comprises a 60mm asphalt wearing course, a 150 mm thick base and a 150 mm thick lateritic gravel sub-base. A geo-membrane to limit shrinkage and expansion of the formation soils and prevent

contamination of the sub-base placed on top of the formation.The 23.4 km long Onigbolo - Ketou section, under the rehabilitation project, has been provided with a 60mm thick asphalt overlay placed after grinding of the surface of the then existing pavement. The 45.6 km Pobe - Ketou section including a 2.5 km section in Ketou town was executed by Sogea-Satom of France at a cost of 17.444 billion FCFA (equivalent to approximately US$ 53.1 million) for a construction period of 36 months. A Variation Order (VO) for an amount of 596.185.000 F CFA was signed with the contractor for improvements to drainage in Ketou. Supervision was carried out by Cowi A/S of Denmark. The project was completed in early 2009. There was no funding support from AfDB for the construction of this road section.

Figure 3.1: Map of Benin Showing Location of Study Roads

Ketou - Illara Section

The 16.5 km long Ketou - Illara road, which is a section of RNIE 4, was an earth road with irregular longitudinal and cross-sectional profiles and a carriageway with distortions and deterioration in several places which has been upgraded.

The upgraded road has a 7m wide carriageway and 1.5m wide shoulders; and has a pavement made up of a 150 mm thick lateritic gravel sub-base layer, a 200 mm thick cement stabilized laterite base layer which is finished with double surface dressing.

The pavement provided under the upgrading project is a 150 mm lateritic gravel sub-base layer, a 200 mm of cement stabilized laterite layer and finished with double surface dressing.

Figure 3.2: Pobe - Ketou and Ketou - Illara Road Sections in Benin

The works for the 16.5 km Ketou - Illara section was constructed by Colas of France and supervised by Scet Tunisie of Tunisia. The contract sum for the works was 3.346.818.769 F CFA (including taxes); that is approximately US$6.5 million. AfDB's contribution out of this was 2.958.877.104 F CFA which was 88% of the total cost.

The Government of Benin provided the remaining 387.941.665 F CFA or 12% of the total cost. The project was commenced around May, 2006 and was completed around November, 2007.

3.3 CAMEROON

The two road sections studied in Cameroon are the Bamenda - Batibo - Numba and the Nandeke - Mbere roads. The locations of the road sections have been indicated in Figure 3.3 with the road sections presented in Figures 3.4 and 3.5. The two road sections are described below.

Figure 3.3: *Map of Cameroon Showing Locations of Study Roads*

Bamenda - Batibo and Batibo - Numba Roads Section

The 43.240 km Bamenda - Batibo and the 20 km Batibo - Numba road sections form part of the multinational Bamenda - Ekok/Mfum - Abakaliki - Enugu corridor linking Cameroon and Nigeria. The Bamenda- Batibo section was largely rehabilitated. The Batibo - Numba road section was however upgraded.

The road section lies in a tropical forest zone with high rainfall in southwestern Cameroon. Average annual rainfall values are above 2,000 mm. The road sections pass through an area with a hilly to mountainous topography. The sections are currently under construction with over 95% complete. A design speed of 80 km/h was used for the design of the rural portions of the road sections. The mountainous portions were however designed for a speed of 60 km/h and in settlements.

While the greater portion of the Bamenda - Batibo section received a 50 mm overlay, about 5 km received a 70 mm overlay.

Approximately 15 km of the section was however partially reconstructed with the provision of a 200 mm pit run crushed stone base and finished with a 50mm asphaltic concrete wearing course.

Figure 3.4: Bamenda - Batibo - Numba Road Section

The section has been provided with a 7 m wide carriageway with 1.5 m wide shoulders on each side. The shoulders have been finished with double surface dressing.

The Batibo - Numba section has been provided with a 7 m wide carriageway with 1.5 m wide shoulders on either side. The pavement for this section comprises a 250 mm natural gravel/lateritic sub-base, a 200 mm pit run crushed stone base and finished with a 50 mm asphaltic concrete wearing course with the shoulders receiving double surface dressing.

The project also involved the construction of some social infrastructure within the road corridor. These include the construction of a school, an agro-processing building, and a parking lot in Widikum; five market stalls, one youth center, and ten drying bays for agricultural products.
The project also included the construction of a vehicle axle load weighing station.

Construction of the sections is being undertaken by China Communications Construction Company of Beijing with supervision by SNC-Lavalin International Inc. of Montreal, Quebec, Canada.

Construction commenced on 3rd February, 2010 for a construction period of 36 months and an initial completion date of 2nd February, 2013. The construction period has been extended twice - first to June 2013, then to August 2013 with a variation order for the construction of a 450 m road to Bali clinic and a 900 m road to Batibo hospital. With the addition of a 700m extension in Bamenda from the Presbyterian Church of Aziri, the original start of the project, to the center of the City, the construction is expected to be completed on 30th June, 2014.

The original contract sum for the construction of the road sections was 28, 276, 438, 939 Francs CFA (approximately US$ 60.2 million) without taxes with AfDB contributing 91.40% and the Government of Cameroon providing the remaining 8.60%. The cost to completion is now projected to be 31,645,291,141Francs CFA.

Figure 3.5: Nandeke - Mbere Road Section

Nandeke - Mbere Road Section

The Nandeke - Mbere road section is 72 km long and lies in central Cameroon. The road section forms part of the 253 km Garoua Boulai - Ngaoundere road which is in turn part of the N'Djamena (Chad) - Bangui (in Central African Republic (CAR)) highway.
The road section starts at Nandeke village and ends at the entry into Mbere village. As part of the project, a 9.9 km road from Nandeke to Meidougou has been constructed. About 4 km of urban roads in Meiganga were also constructed as part

of the project. Some social infrastructure has also been provided as part of the project. The social infrastructure provided includes perimeter walls for 12 schools which are within 100m of the road; 30 units of drying bays, each 50m2; the provision of equipment for agro-processing and the rehabilitation of access roads connected to the project road.

The Nandeke - Mbere road section has been designed for a speed of 80 km/hr. and has been provided with a 7 m wide carriageway with 1.5 m wide shoulders on either side.

The pavement for the main Nandeke - Mbere road section was provided with a 50 mm thick asphalt Concrete wearing course, a 200 mm thick crushed rock base over a 300 mm thick natural gravel sub-base. The shoulders were finished with double surface dressing. The spur to Meidougou and the urban roads in Meiganga were provided with the same materials and thicknesses for base and sub-base but while the Meidougou spur was provided with three layers of surface dressing as wearing course, the roads in Meiganga were provided with two layers of surface dressing. The shoulders for these roads were also finished in double surface dressing.

Construction was undertaken by DTP Terrassement of the Bouygues Group of France while supervision is carried out by Studi International of Tunisia.

Upgrading of the road section commenced on 16th June, 2009 for a construction period of 24 months with an expected completion date of 16th June, 2011 for an original contract sum of 32.402.734.517 FCFA (approximately US$ 69.4 million) without taxes. The construction period was extended to 31st December, 2013 with a cost to completion of 39.650.358.169 FCFA. AfDB contributed 88% of the cost while GoC made available the remaining 12%.

3.4 Democratic Republic of Congo (DRC)

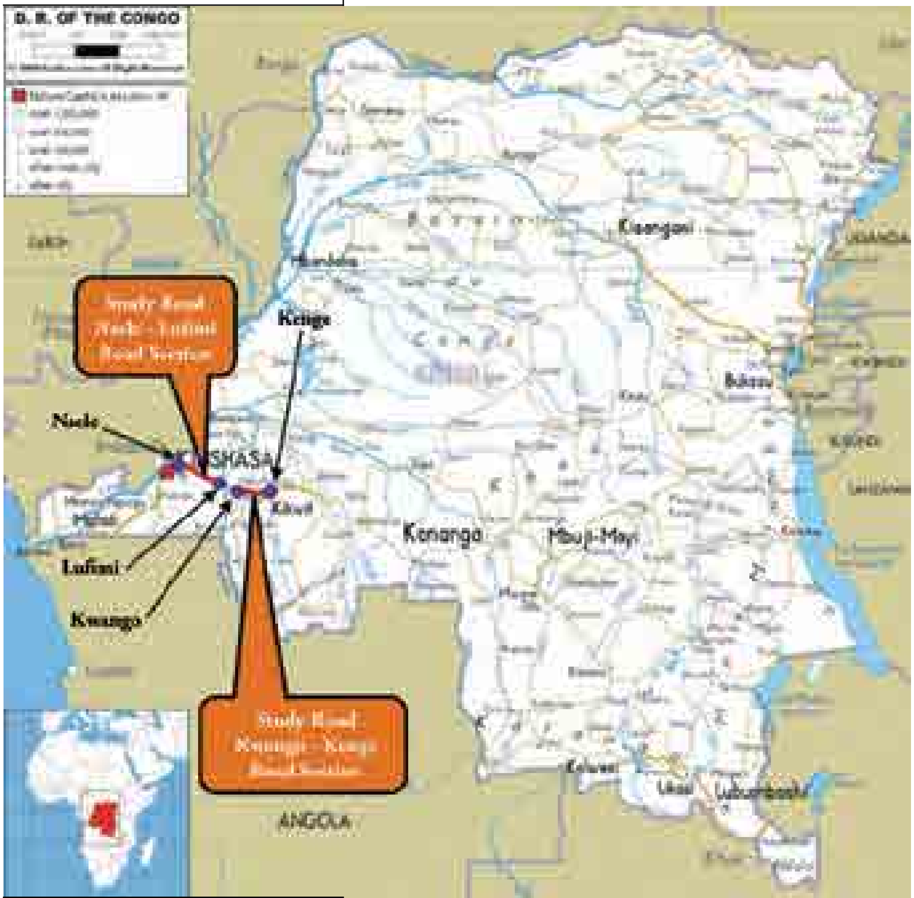
Two roads were selected for study in the DRC. These are the 93.58 km of the rehabilitated road between Nsele and Lufimi; and the 72.8 km of rehabilitated road from Kwango to Kenge. Both sections of road form part of National Route 1 (RN 1) which links Banana in Bas Province to Lubumbashi in Katanga Province. The location of the roads is shown on a map of DRC in Figure 3.6. The roads are presented in Figure 3.7.

Nsele - Lufimi Road Section

The works for the 93.58 km Nsele - Lufimi Road comprised:

I. Rehabilitation of the 90 m long and 33.90 m wide Nsele Bridge. The rehabilitation of the bridge involved the repair of the portals, the raising of the decks and the laying of riprap injected with concrete slurry to protect the piers and the foot of the left hand abutment.
II. Overlaying the 4.8 km four lane dual carriageway from Nsele Bridge to Nsele junction with a 40 mm thick asphalt concrete surfacing.

Figure 3.6: Map of DRC Showing Location of Study Roads



III. The rehabilitation of the 88.78 km long Carrefour Nsele - Mutiene - Lufimi section, which involved the widening of the carriageway from 6 to 7 m, and the construction of one meter wide shoulders on each side. The pavement for the widening was constructed of selected sand overlain by a 280 mm thick recycled existing pavement mixed with selected material as sub-base. The existing carriageway together with the widened sections received a 120 mm thick bitumen injected base layer and a 40mm thick asphaltic concrete surfacing.

The Nsele - Lufimi project was constructed by Sinohydro of China for a contract sum of US$ 41.738 million over twenty four (24 months). The African Development Bank contributed 75% of the cost of the project with the remaining 25% paid by the DRC Government. The project was supervised by Studi International of Tunisia.
The project also included the construction of a market, a school with five classrooms, fence walls for three schools, development of seven parking lots and four water supply points.

Figure 3.7: Nsele - Lumfimi and Kwango - Kenge Road Sections

A total of 1,600 fruit trees were also planted as part of the project. The project commenced on the 18th of December, 2008; was completed in December, 2010 and the Defects Liability Certificate issued on the 6th January, 2012.

Kwango - Kenge Road Section

The Kwango - Kenge Road which is 70.3 km long was rehabilitated with a pavement structure comprising a 150 mm thick cement stabilized lateritic gravel sub-base; a 150 mm thick cement stabilized base with a 200% CBR; and finished with a 40 mm thick asphalt concrete surfacing. The road was provided with a 7 m wide carriageway and 1 m wide shoulders on either side.
As part of the project, three markets, two school fence walls were constructed and two parking lots and two water sources developed. As part of the project, the right abutment of the bridge over River Wamba was repaired and 140 km of rural roads connected to the project road were developed. A total of 3,220 fruit trees in four villages were also planted; and bamboo and vertivers were also planted to check debris and erosion. Construction for this road was carried out by Sinohydro of China for a construction

period of 24 months for a contract sum of US$52.824 million. AfDB's Contribution was 76.02% with the DRC Government contributing the remaining 23.98%. Project supervision was carried out by AIC Progetti of Italy. The project commenced on 18th December 2008 and completed in January, 2011 after being granted a 1 month extension of time. The Defects Liability Certificate was issued on 6th January, 2012.

3.5 Ghana

The road sections selected for study in Ghana are the:

- Agbozume - Aflao road;
- Akatsi - Dzodze - Akanu road;
- Akatsi - Agbozume road;
- Nsawam Bypass;
- Techiman - Apaaso road; and
- Apaaso - Techiman road.

The location of the roads has been indicated on a map of Ghana in Figure 3.8 while the road sections have been illustrated in Figures 3.9 to 3.11. A brief description of each road section has been given below:

Agbozume - Aflao (and Akatsi By-pass) Road Section

The Agbozume - Aflao road section and the Akatsi Bypass are sections of the Accra - Aflao road which forms part of the National Route 1 (N1) in Ghana and which is in turn a part of the Trans-West African Coastal Highway that links Ghana with its neighboring countries of Cote d'Ivoire and Togo; and other countries in the West African Sub-region such as Nigeria, Liberia and Sierra Leone.

The Agbozume - Aflao section which is 19.9 km and the 7.20 km Akatsi Bypass are separated by the Akatsi - Agbozume road section. The two components of the road section lie in the south-east of Ghana and generally run in an easterly direction.

Figure 3.8: Map of Ghana Showing Location of Study Roads

Figure 3.9: Akatsi - Dodze - Akanu, Akatsi - Agbozume and Agbozume - Aflao Road Sections

The component sections traverse coastal savannah plains with flat to rolling terrain lying between 2 and 50 m above mean sea level. Rainfall is low with annual an average between 750 and 1000 mm. About 40% of the road section passes through marshes from Nogopko, just outside Agbozume, to Akame and from Tokor to Denu.

The road section was designed to a speed of 80 km/hr. and has been provided with a 7.3m single carriageway of two (2) lanes - each 3.65m wide; with two shoulders on either side of the carriageway. Each shoulder is 2.5 m wide. The carriageway has been finished with a 40 mm of asphaltic concrete wearing course which overlies 125 mm of Dense Bituminous Macadam (DBM) which is in turn underlain by a 200 mm crushed rock base and 200 mm of natural gravel sub-base. The shoulders have been finished in bituminous double surface dressing.

The contract for the construction of the road section was awarded to China Geo-Engineering Corporation for a contract sum of GH¢8,156,544.83 & US$20,293,735.55 (equivalent to US$ 25.3 million) and a construction period of 24 months. Construction commenced on 1st January, 2009 and was expected to be completed on 15th January, 2011. The construction period was revised to 44 months with an approved completion date of 1st December, 2013. The project is, however, ongoing with about 90% complete with an expected completion period of 1st August, 2014 and at a projected cost of GH¢18,846,979.29 and US$21,207,914.87. Construction supervision is being carried out by Conterra Limited of Accra, Ghana.

The AfDB is providing 90% of the cost of the project while GoG provides the remaining 10%. The GOG portion included rates, compensation payment and relocation costs.

Akatsi - Agbozume Road Section

The Akatsi - Agbozume road is contiguous with the Agbozume - Aflao section and the Akatsi Bypass and therefore forms part of the National Route 1 (N1) which is in turn a part of the Trans-West African Coastal Highway that links Ghana with its neighboring countries of Cote d'Ivoire and Togo; and other countries in the West African Sub-region such as Nigeria, Liberia and Sierra Leone.

The 31.6 km road lies in the south-east of Ghana and generally runs in an easterly direction from Akatsi to Agbozume. The road traverses coastal savannah plains with flat to rolling terrain lying between 2 and 50 m above mean sea level. Rainfall is low with annual an average between 750 and 1000 mm. A substantial section of around 40% of the length of the section passes through coastal swamps.

The road section was designed to a speed of 80 km/hr. and has been provided with a 7.3m single carriageway of two (2) lanes - each 3.65m wide; with two shoulders on either side of the carriageway. Each shoulder is 2.5 m wide. The pavement for the carriageway has a 40 mm thick asphalt concrete wearing course, a 125 mm thick DBM and a 200 mm thick crushed rock base. The crushed rock base is underlain by a 200 mm thick sub-base of natural gravel. The shoulders have been finished in bituminous double surface dressing.

The contract for the construction of the road section was awarded to China Geo-Engineering Corporation for a contract sum of GH¢17,472,078.00 & US$14,253,611.40

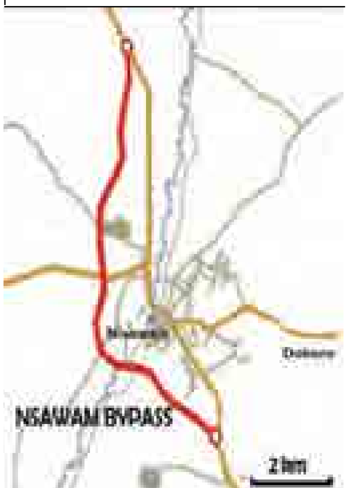
(equivalent to US$ 31.7 million). Construction commenced on 1st January, 2009 and was expected to be completed on 15th January, 2011. The project was substantially completed on 15 October, 2011 at a cost of GH¢13,592,218.65 and US$19,219,771.71. Construction supervision was undertaken by Conterra Limited of Accra, Ghana.
Funding was from AfDB A 65.05%, EBID - 22.06% and GOG - 12.89%. The GOG portion included compensation payments and utility `relocation costs.

Akatsi - Dzodze - Akanu Road Section

The Akatsi - Dzodze - Akanu road section which is 30 km long is part of the coastal Trans-ECOWAS highway. The road, located in the south-east of Ghana starts from Akatsi town on the Accra - Aflao/Lome road, crosses Dzodze Township on the Ho - Denu road and ends at Akanu on the border with Togo. The border at Noepe on the Togo side is approximately 20 km north of Lome. The road is to allow transit traffic to by-pass the center of Lome in Togo.
The road section trends east-north-east from Akatsi towards Akanu and crosses coastal scrub and grass land with average annual rainfall in the order of 750 - 1,000 mm.
The Akatsi - Dzodze - Akanu road section was constructed under two contracts. The first contract involved the rehabilitation of the 25 km Akatsi - Dodze road section. The section has been provided with a 7.3 m single carriageway of two (2) lanes each 3.65 m wide; with two shoulders on either side of the carriageway, each 2.5 m wide. The pavement structure comprised a 300 mm thick natural sub-base, a 200 mm thick graded crushed stone base and initially finished with a primer seal with 10 mm chippings. The road was designed to a speed of 80km/hr.
The construction of the road section was undertaken by M/S China Jiangxi Corporation for International Economic and Technical for a contract sum of GH¢ 13,125,534.71 and € 6.977, 855.88 (equivalent to approximately US$ 25 million). Construction for the road section commenced on 2nd February, 2009 and was scheduled to be completed on 1st February, 2011. The completion was however extended to 1st May, 2011. The project was completed at a cost of GH¢ 12,963,780.03 and € 6,544,242.60. Construction supervision was carried out by M/S Twum Boafo and Partners of Accra, Ghana. The AfDB contributed 97% of the cost while GoG provided the remaining 3%.

The second project involved the upgrading of the 5 km Dodze - Akanu road, the overlay of the 25 km Akatsi - Dzodze road section and the construction of a bridge over River Aka. The pavement for the upgraded Dzodze - Akanu sub-section consists of a 300 mm natural sub-base; a 200 mm graded crushed stone base, a 50 mm asphaltic concrete binder course and a 50 mm asphaltic concrete wearing course. A 7.3 m carriageway with 2.5 m shoulders on either side has also been provided for the sub-section. The Akasti - Dzodze sub-section was provided with a 100mm overlay of asphaltic overlay in two layers - a 50 mm binder course and a 50 mm wearing course. The shoulders for the entire section have been provided with double surface dressing. The construction of the works was awarded to M/S China Jiangxi Corporation for International Economic and Technical Cooperation at a sum of GH¢9,499,365.17 and US$13,509,581.46 (approximately US$20.3 million). Construction commenced on 1st June, 2010 and was scheduled to be completed on 30th November, 2011. The pro-

Figure 3.10: Nsawam Bypass in Ghana



ject was substantially completed on 29th February, 2012 at a completed cost of GH¢ 10,482,313.90 and US$ 12,329,522.78. Construction supervision was carried out by M/S Twum Boafo and Partners of Accra. The AfDB contributed 97% of the cost while GoG provided the remaining 3%.

Nsawam Bypass

The Nsawam by-Pass is part of National Route 6 (N6) which connects Accra and Kumasi; the two largest cities in Ghana, and links Ouagadougou in Burkina Faso to Accra through the Kumasi - Paga road (N10). The road starts at the end of the Ofankor - Nsawam dual carriageway at Atwerebuanda to the south-east of Nsawam which is about 35 km from the center of Accra and joins the Nsawam - Apedwa road at Kwafokrom. The bypass has a length of 9.3 km. The construction of the bypass also included the construction of four bridges over a railway line, the Densu River and its associated flood plain, the Adeiso - Nsawam road and the Kraboa-Coaltar road, the longest being the bridge over River Densu. The road lies within an area with relatively flat to rolling topography and traverses a moist semi-deciduous forest zone with annual rainfall in the order of 750 mm to 1,000 mm.

Figure 3.11: Techiman - Apaaso and Apaaso - Kintampo Road Sections

The road was originally planned as a single carriageway road. With the Government's decision to make the Accra - Kumasi road a dual carriageway, a second carriageway was added and the road is now the Kumasi bound carriageway along the by-pass.
The road has been designed to a speed of 80km/hr. and has a 7.3 m carriageway, a 2.5 m wide outer shoulder and a 1.5 m wide inner shoulder.
The pavement structure provided comprise a 40 mm wearing course, a 60 mm binder course, an 80 mm dense bituminous macadam, a 200 mm crushed rock base and a 200 mm cement-stabilized sub-base.
The contract for the construction of the Nsawan Bypass was awarded to M/S China Railway Wuju Corporation for an initial contract sum of US$17,198,144.32 and GH¢11,446,744.55 for a total of GH¢28,297,485.34 equivalent to US$28. 83 million; for completion in 24 calendar months. Construction commenced on 17th June 2008. The project was substantially completed on 31st September 2012 for a sum of US$19,629,620.61 and GH¢14,497,935.74 (GH¢33,731,038.02). Construction supervision was carried out by Comptran Engineering and Planning Associates of Accra. The AfDB contributed 71.19% of the cost, Nigeria Trust Fund (NTF) - 12.59%, Organization of Petroleum Exporting Countries (OPEC) - 6.34% with GoG providing 11.14%.

Techiman - Apaaso Road Section

The 53.7 km Techiman - Apaaso road section forms part of the 60 km Techiman - Kintampo road rehabilitation project. The Techiman - Kintampo road is part of National Route 10 (N10) in Ghana which begins in Kumasi and runs northwards through Techiman, Kintampo, Tamale and Bolgatanga and finally terminates at Paga at the border with Burkina Faso. The route forms part of the ECOWAS network of highways. The Techiman - Kintampo road section is located in the central part of Ghana and traverses generally rolling topography with altitude between 150 and 300m above mean sea level. The road lies in the transition zone of Ghana with wooded savannah vegetation.

The road has been provided with a single 7.3 m wide carriageway of two (2) 3.65 m wide lanes and a 2.5 m wide shoulder on either side of the carriageway.
The pavement structure comprises a 40 mm thick asphaltic concrete wearing course, a 60 mm thick asphalt binder course, a 200 mm thick crushed rock base and a 200 mm thick natural gravel sub-base. The shoulders were also finished in asphalt concrete.

The contract for construction of the road section was awarded to M/S Shinsung Engineering and Construction Company Ltd of China for a sum of GH¢28,084,534.00 and US$8,107,000.00 (equivalent to US$36.7 million) with commencement on 1st October, 2008 and an original completion date of 1st March, 2011. The project was substantially completed on 30th June, 2012. Construction supervision was carried out by Conterra Limited of Accra.
The AfDB contributed 82.6% of the project cost with GoG providing the balance of 17.4%.

Apaaso-Kintampo Road Section

The construction of the 6.3 km Apaaso - Kintampo section of the Techiman - Kintampo road rehabilitation project was awarded as an addendum to the construction of the Techiman - Apaaso road section at a sum of GH¢7,533,588.77 (GH¢5,784,094.01 + US$1,778,664.86 for a total of US$7.56 million).
The road section was provided with a single carriageway of 7.3 m width with 2.5 m wide shoulders on either side. The pavement structure comprise an asphalt wearing course of 40 mm, a binder course of 60 mm, 200 mm crushed rock base and a 200 mm natural gravel sub-base.
Construction commenced on 16th October, 2010 for a 9 month construction period and a completion date of 16th July, 2011.
AfDB contributed 92.3% and GoG the remaining 7.7%.

3.6 Kenya

Three roads were studied in Kenya are the Athi River - Namanga, the Isiolo - Merille, and the Nairobi - Thika road sections. The locations of the roads are shown on a map of Kenya in Figure 3.12 while the road sections are presented in Figures 3.13 to 3.15.

The 136 km long Athi River - Namanga Road Section

The rehabilitation of the Athi River - Namanga road section was part of the Multinational Arusha - Namanga - Athi River Road Project in Tanzania and Kenya.
The road part of the route designated as A104. The project involved rehabilitation and reconstruction, and included the construction of a one-stop border post at Namanga. The Pavement structure for the Namanga - Athi River road section consisted of 50 mm thick asphalt wearing course, a 150 mm thick Dense Bitumen Macadam (DBM) overlying 200 mm of crushed rock base and 200 mm of cement stabilized sub-base. The shoulders were finished with a single layer of surface dressing. The road has been constructed with a 7 m wide carriageway and 2 m wide shoulders.

The construction of the road was undertaken by China National Engineering Corporation for a sum of Ksh 6,208,705,229.80 (equivalent to US$ 100.03 million) for a contract period of 36 months. Construction started in November 2007 and was substantially completed on 27th February 2012. Supervision was undertaken by Gibb (East Africa) Limited.

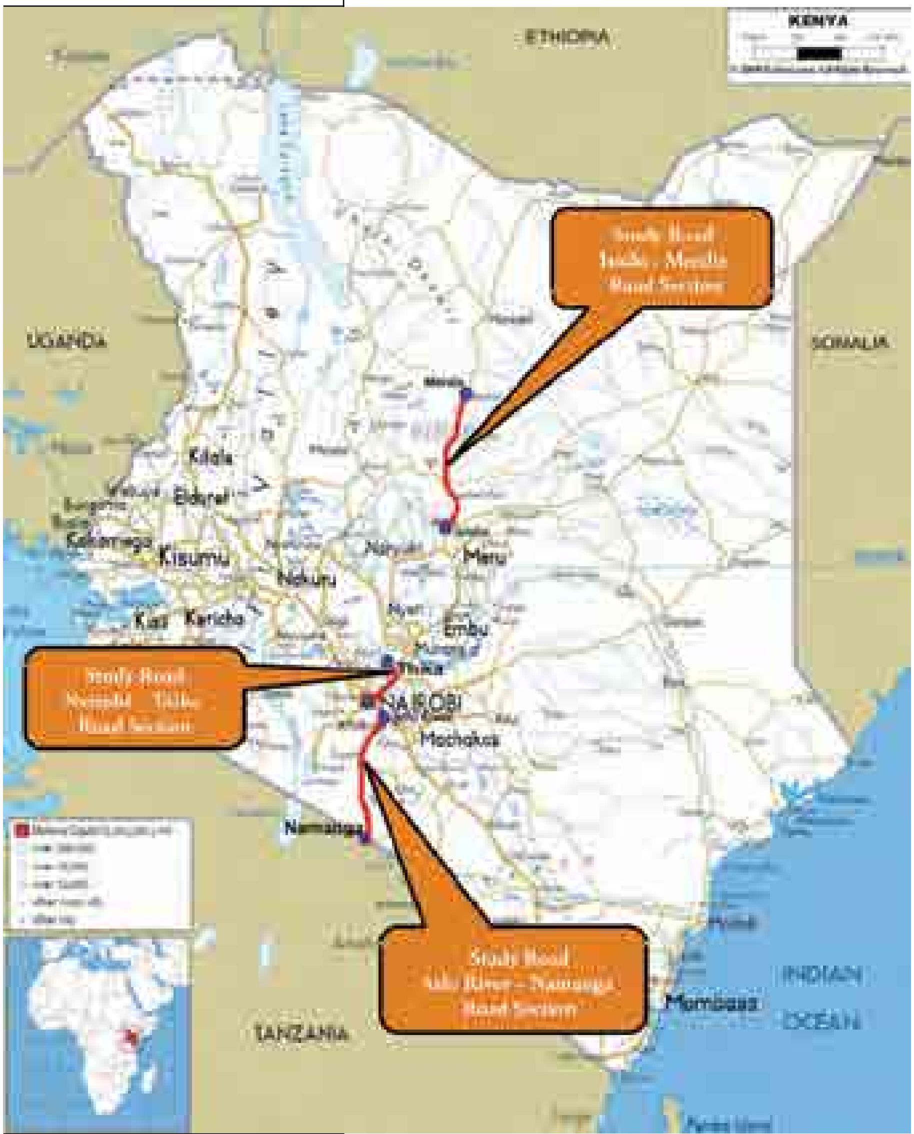


Figure 3.12: Map of Kenya Showing Locations of Study Roads

The 136 km long Isiolo - Merille Road Section

The Isiolo - Merille road section is part of route A2 is also part of the Mombasa - Nairobi - Addis Ababa (Ethiopia) highway. The road, originally a gravel road, has been upgraded and finished in asphalt concrete. The pavement comprised a 50mm asphaltic concrete wearing course, a 200 mm thick cement stabilized base over a 200 mm thick natural gravel sub-base. The road has been constructed with a 7 m carriageway with 2 m wide surface dressed shoulders.

The construction for the road commenced in November 2007 and was carried out by China Wu Yi Company Ltd. of Fouzhon City, Fujian, China. The contract value was 4,875,409,271.00 Kenyan Shillings (Ksh) equivalent to approximately US$78.6 million; with a completion time of 30 months. The project was substantially completed on 30th September, 2010. Supervision was undertaken by Gibb (East Africa) Limited.

Figure 3.13: Isiolo - Merille Road Section

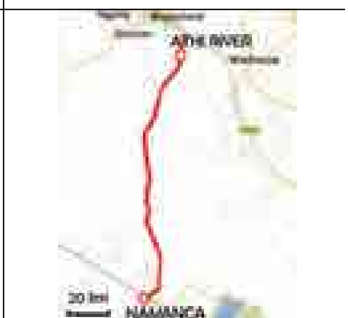


Figure 3.14: Athi River - Namanga Road Section

The Nairobi - Thika Road Section

The improvement project for the 45 km long Nairobi - Thika road, which is part of route A2, involved:

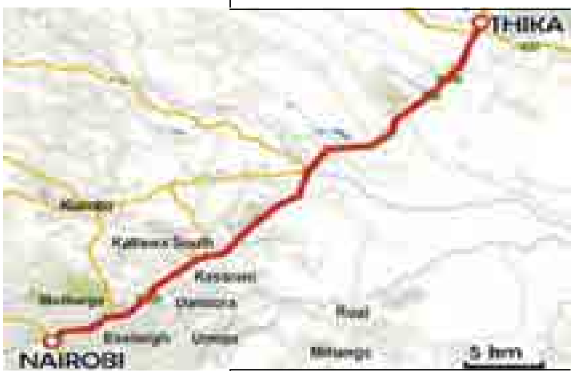
- The provision of additional capacity through construction of additional lanes (from four lanes to six/eight lanes) and reconstruction of the existing carriageway pavement;

- The construction of service roads to separate through traffic from local traffic;
- The construction of traffic interchanges at six (6) locations to replace the existing roundabouts at Pangani, Muthaiga, GSU, Kasarani, Githurai and the Eastern By-pass; and
- The rehabilitation of some existing bridges, the provision of drainage structures, road safety features, and environmental and social mitigation measures.

The contract for the construction of the Nairobi - Thika road was let in three lots.
The first lot (Lot1) comprised the rehabilitation and upgrading of three Nairobi City Arterial Connectors to the Nairobi - Thika Road (A2) for a total of 12.4 km. The components were:

- Forest Road from Pangani to A104 Museum Roundabout (3.6 km);
- Muranga Road from Muthaiga to A104 at University Way Roundabout (4.5 km); and
- Kariakor Road from Pangani to A104 at Haile Selasse Road Roundabout (4.3 km).

Figure 3.15: Nairobi - Thika Road Section



Construction was carried out by China WU YI Co Ltd of Fuzhou City, Fujian, China for a contract amount of Ksh. 8,030,386,596.64, equivalent to US$ 129.4 million (7,697,632,227.00 which is approximately US$ 122.83 million net of taxes and duties). The Bank contributed 76% of the total cost net of taxes and duties with the remaining paid by the Government of Kenya. The original contract period was 30months with a commencement date of 28th January, 2009 and a scheduled completion date of 27th July, 2011. The construction period was later extended to 37months with a revised completion date of 29th February, 2012; due among other reasons for additional works instructed by the client.
The project is in the Defects Liability Period which under the contract is 24 month.
The second lot (Lot 2) covered the rehabilitation and expansion of the 14.1 km Muthaiga - Kenyatta University stretch on the Nairobi - Thika road (km 3+900 - km 18 + 00). The contract was awarded to Sinohydro Corporation of Beijing, China for a contract sum of Ksh 8,690,568,489.73 (equivalent to US$ 140.02 million) for a contract period of 30 months with a commencement date of 26th January, 2009. The scheduled completion date was 25th July 2011 but this was later extended to 30th June 2012. The Bank's contribution to the cost of the project was 76% net of taxes and duties; that is 70% of the total cost including taxes and duties. This section also has a 24 month Defects Liability period which is yet to end.
The third lot (Lot 3) involved the rehabilitation and upgrading of the 23.88 km Kenyatta University (km 18+000) to Thika (km 41+880) section of the road. The contract for a total of Ksh 9,441,732,008.29 which is approximately US$ 152.1 million (Ksh 9,053,864,811.09 {US$ 145.9 million} net of taxes and duties) was awarded to SHENGLI Engineering Construction (Group) Co. Ltd of Dong Yang City, Shandong, China. The project was financed fully by the Government of China. This lot commenced on the 22nd January, 2009 for a construction period of 30 months and therefore scheduled completion date of 21st July, 2011. The construction period was extended to 11th February, 2012, then later to 11th April, 2012 and eventually to 11th October, 2012. The lot is under defects liability which under the contract is 24 months.

All the three lots were supervised by CES Pvt Ltd of India in Association with APEC Ltd of Kenya.

3.7 Tanzania

Six roads were selected for study in Tanzania. Three of the roads are in Zanzibar while the other three are on the mainland.

Figure 3.16: Manzizini - Fumba, Amani - Dunga and Mfenesini - Bumbwini Road Sections in Zanzibar

The three roads studied in Zanzibar formed part of the upgrading of six (6) roads to asphaltic concrete standards totalling 87.43 km. The roads are the 17.81 km Zanzibar Town (Manzizini) - Fumba road, the 12.75 km Zanzibar Town (Amani) - Dunga road and the 13.10 km Mfenesini - Bumbwini road. The roads are presented on a map of Zanzibar in Figure 3.16. The roads generally followed the existing alignments requiring only short horizontal adjustments without any major changes; except for sections at the beginning of the Manzizini - Fumba Road where a 2.5 km long stretch from the existing dual carriageway; and relatively longer sections of the Amani - Dunga Road were re-aligned.

The roads were provided with carriageway widths of 6.0 m with 1.0 m - 1.5 m shoulders without any major widening. The roads were designed with a design speed of 80 km/hr. in the flat terrain open country and 50 km/h through established villages. Improvements to horizontal and vertical alignments were made to meet the selected design speeds consistent with traffic safety requirements.

The road foundations were protected by paved side drains where the gradients exceeded 4%. The road pavements were designed to be provided with a 50 mm asphaltic concrete surfacing placed on 125 mm thick crushed stone base over a natural gravel sub-base layer of varying thickness between 125 and 200 mm. The shoulders were to be sealed with surface dressing. However the carriageway and shoulders for the three roads were provided with the same thickness of 40 mm of asphalt concrete surfacing during the implementation. The contract for the three roads including the construction of four bridges between Mahonda and Mkokotoni was awarded to M/s COGEL S.p.A/PRISMO of Italy on 22nd May, 2006. The work commenced on 22ndJuly, 2006 for duration of 18 months; with an initial completion date of 21st August, 2007. The contractor however terminated the contract on 1st February, 2008 citing non-payment of certificates for works on the Mazizini - Fumba Road, by then completed to sub-base level. The contract was repackaged to exclude the Manzizini - Fumba road which was completed with funds from the Government of Zanzibar (GoZ) on 4th November, 2009, by M/s Mwanainchi Engineering and Contracting Company Ltd (MECCO) of Tanzania. The new repackaged contract was awarded to MECCO on 31st August, 2009 for a contract sum of Tsh19,990,608,530 (approximately US$ 15.4 million). The Bank financed 85% of the works contract while GoZ financed the remaining 15%. Works commenced on 1st October, 2009 with a 15 month duration and a completion date of 31st December, 2010. A total of 13.1 months extension of time was awarded and the revised completion date was set as 3rd February 2012. The works were finally completed on 30th June , 2012. Black & Veatch of South Africa supervised all the works.

The other three roads in Tanzania were the three lots of the 223.5 km Singida - Babati

- Minjingu road which was upgraded to bituminous standard. The Singida - Babati road is a link between the Central corridor and the Great North Road which extends from Cape Town in South Africa to Cairo in Egypt. The Babati - Minjingu section of the road is part of the Great North Road.

The location of the road sections is shown on a map of Mainland Tanzania in Figure 3.17. The road sections are illustrated in Figure 3.18.

The three lots were all constructed with a carriageway width of 6.5 m with 1.5 m wide shoulders on each side of the carriageway. There were however localized variations in the width of the shoulders at sections where the road crossed populated areas. The three lots are:-

- Lot 1: the 65.1 km Singida - Katesh road section,
- Lot 2: the 73.8 km Katesh - Dareda section, and
- Lot 3: the 84.6 km Dareda - Babati - Minjingu road section.

Lot 1: Singida - Katesh Road

The Singida - Katesh road section forms part of route T14. The project comprised the 63.6 km long Singida - Katesh road, originally a gravel road and the 2.4 km long Singida by-pass.

The constructed pavement comprises a double bituminous surface dressing, 150 mm cement stabilized gravel base course, 250 mm cement improved sub-base in two layers, and an improved subgrade. The shoulders were sealed with a single layer of surface dressing.

The road generally follows the existing alignment on this rolling to hilly section of the project. A design speed of 100 km/hr. was used for flat terrain which was reduced to 50 km/hr. in mountainous sections and through the towns and villages of Singida, Makungu, Kinyammudo, Sagara, Mougitu and Katesh. Climbing lanes have been provided at sections where the vertical gradients were higher than 5%.

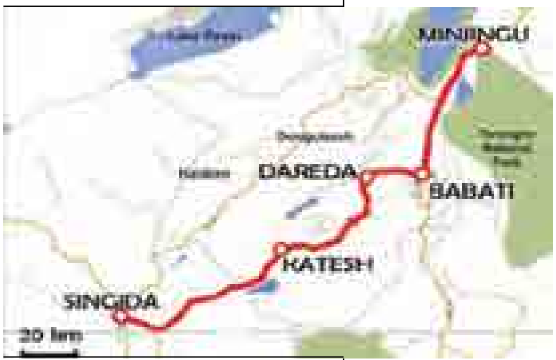
All drainage structures were replaced due to limitations of width and hydraulic capacity.

Three major reinforced concrete box culverts including one at the Singida bypass, another across the Mwanitera Stream; and a number of concrete pipe culverts were installed along the road.

Figure 3.8: Map of Ghana Showing Location of Study Roads

Figure 3.18: Singida - Katesh, Katesh - Dareda and Dareda - Dabati - Minjingu Road Sections

There are 25 bus bays which are spread along the road especially at villages and designed to provide rest and conveniences for heavy long distance freight; and passenger traffic over this section.



Construction for this lot was carried out by Sinohydro of Beijing, China for a contract sum of Tsh 51, 626,214,569.00 which is approximately US$ 43 million, with supervision by Africon (now Aurecon) of South Africa. Construction commenced on the 11th of March, 2009 and was expected to be completed after 30 months; that is on 10th September, 2011. The project was substantially completed in January, 2012 by which time no extension of time had been granted. Incidentally, the contract for the supervision consultancy was signed on June 8th, 2009 with the commencement of services on 27th June, 2009 - more than three months after the commencement of the works.

The employer also by a letter in September 2009 changed the status of the supervising consultant from Engineer's Representative to Engineer. The Consultant has been unable to ascertain the reasons for this change but the change could have been made to improve the decision making process for better management of the project. The project was completed with no cost overrun.

Lot 2: Katesh - Dareda Road

The 73.8 km road which is also part of route T14 has been constructed to the same geometric and structural standards as for the Singida - Katesh section. The road generally follows the existing alignment, with a high embankment almost throughout its length because of poor alignment soils and drainage system. This road section passes through a rolling to flat terrain at the bottom of the great East African Rift Valley and posed a challenge with drainage. A reinforced concrete bridge at Bubu River and 16 major reinforced concrete box culverts and a number of concrete pipe culverts were constructed. A total of 26 bus bays were provided throughout the road section.

The constructed pavement was provided with double bituminous surface dressing as a wearing course, 150 mm thick cement stabilized gravel base course, 250 mm thick cement improved sub-base in two layers, and an improved subgrade. The shoulders were sealed with a single layer of surface dressing.

Construction started on 11th March, 2009 for a construction period of 33 calendar months and at a Contract sum of Tsh 64,145,236,879 equivalent to approximately US$ 53.5 million with AfDB contributing 46.36% and the Government of Tanzania paying 53.64%.

An extension of time of 234 days was granted for delays in payment by the government, additional work quantities, and inclement weather; and for relatively extensive design revisions.

The Taking-Over Certificate was issued on 1st August, 2012 with the total cost to completion estimated as Tsh 66,023,554,890; that is 2.9% above the contract sum.

Supervision was undertaken by COWI A/S of Kogens Lyngby, Denmark and construction undertaken by Sinohydro Corporation of Beijing, China.

Lot 3: Dareda - Babati - Minjingu Road

The Dareda - Babati - Minjingu includes a 1.46 km section of the Babati-Dodoma road which was incorporated to take care of serious flooding problems at Babati town. Another 500m of road in Babati was constructed with a pavement comprising 50mm asphalt concrete surfacing, 150 mm crushed rock base course, 300mm cement stabilized sub-base in two layers on top of natural or improved subgrade.

The Dareda - Babati portion of the road section is part of route T14 while the Babati - Minjingu portion is part of route T5.

The road follows the existing alignment along the bottom of the Great Rift Valley posing serious drainage problems. Two bridges, one of them across the Kiongozi River and 24 major box culverts (twelve of them in the flood prone Mdori basin) were therefore provided along the road. Eighteen (18) lay byes spread out throughout the road at convenient locations were provided.

The last 10 km of the road cuts across the Lake Manyara and the Tarangire National Parks. A 7.3 km animal migration route has been provided over this stretch of road. Provision has been made for prominent road signs, rumble strips and speed reducing humps at 500 m intervals throughout the 7.3 km corridor. These facilities are expected to slow down vehicles to allow animal crossings without compromising the safety of traffic on the road, as well as that of the animals.

There are 3 main carriageway cross sections in this lot. The differences are in the width of the shoulders - 2 m shoulders in suburban and urban and 1.5 m in rural sections. In Babati town, both pedestrian and bicycle paths have been provided. The existing road in Babati town was reconstructed with a new pavement which incorporated bus bays and parking lots.

The 1.6 km section of the Dodoma - Babati road which was incorporated in the project included a large box culvert which replaced the existing low capacity culverts. The road level was raised to prevent cross flooding that frequently occurred in Babati town. The culverts are expected to direct water to River Kiongozi.

The pavement structure for the road section comprised 50 mm thick asphalt concrete surfacing, 150 mm thick crushed rock base, a 300 mm thick cement stabilized sub-base in two layers of 150 mm thick over improved subgrade; while the shoulders received a single layer of surface dressing.

Construction for this lot started on 11th March, 2009 for a construction period of 36 months and a Contract sum of Tsh 84,919,693,728 (US$ 68.82 million at an exchange rate of 1US$=1,223.94 Tsh) with 54.88% of this paid by AfDB while the Government of Tanzania paid the remaining 45.12%.

A 4.75 month extension of time was granted revising the completion time to 1st August 2012. The Taking-Over Certificate was issued on 1st August 2012.

The cost to completion was valued at Tsh 84,878,733,020.95 which is 99.5% of the contract sum.

Construction was carried out by China Henan International Cooperation Group Ltd of Zengzhou, China. Supervision was carried out by Crown-TECH Consult Ltd of Dar es Salaam, Tanzania.

3.8 Tunisia

Eight road sections were selected for the Study in Tunisia. The roads form part of a program to:

- rehabilitate 374.1 km of classified roads in 10 Governorates; and
- strengthen 640.4 km of classified roads in 16 Governorates.

The rehabilitation projects involved

- widening of the carriageways to 7.6 m or more;
- providing shoulders for the widened roads and the carriageways with 250 mm or 350 mm thick bituminous gravel and/or crushed gravel or humidified reconstituted crushed gravel, at sections where the structure was weak;
- providing an asphalt concrete surfacing of appropriate thickness with an average thickness of around 80 mm
- reinforcement of drainage structures; and
- provision of safety features including road signs.

To accommodate the widening, provision of shoulders and realignment, the works at some locations included the shifting of utility networks. The realignment, to improve safety, was, as far as possible carried out within the right-of-way. The selected roads which were rehabilitated are the 19 km Grombalia - Limite Gouvernorat de Ben Arous road section (RVE573) located in Nabeul Governorate. The others are Mornag - Jbel Rsas (MC35) which is 10.2 km long and the 11.1 km long Khlidia - Jbel Rsas road section (RVE565), both located in Ben Arous.

Roads which were part of the network strengthening scheme received treatments which primarily consisted of:

a strengthening the pavement structure by providing a new base for the carriageways. The base provided was a 250 mm or 350 mm thick bituminous gravel, crushed gravel or humidified reconstituted crushed gravel at sections depending on the assessed strength of the pavement.

b providing an asphalt concrete surfacing with an average thickness of around 80 mm;

c reinforcement of drainage structures; and

d provision of safety features including road signs.

The roads under this scheme were not widened since the carriageways were already 7.6 m or wider. The selected roads which were strengthened include Bab El Khadra - Station Metro road section (MC135) - 7 km; Ben Arous - Stade Rades (GP 1) - 6.5 km; and the Ben Arous - Mornag road section (MC34) - 4.4km. These roads are located in Tunis and Ben Arous. The other two strengthening projects are Carrefour Hopital Ariana - RR 31 road section (X20) - 8.3 km; and the Jdaida - Tebourba road section (RVE511) - 8.8 km; both located in Tunis and Manouba.

The location of the roads sections is shown in Figure 3.19 while the road sections are presented in Figures 3.20 to 3.22.

The works on the eight roads were grouped into four lots and signed under the following four contracts:

I.RVE 573 for a sum of DT 7,803,005.00 (approximately US$ 5.8 million) for a period of 18 months. The works were awarded to Enterprise Souroubat of Tunisia and commenced on 4th January 2010. The projects were substantially completed on 12th of

April 2011. The final completion certificate was issued on the 23rd of June 2012. The final cost of the project was DT 8,765,296,213 or 112.3% of the initial contract sum. The extra payment was for Variation in prices.

II. MC35 and, RVE 565 for a sum of DT 12,296,700.00 (approximately US$ 8.8 million) and a construction period of 20 months. The contractor for the works was Enterprise K. Kobbi of Tunisia, who commenced the works on 6th July, 2010. The projects were substantially completed on 15th of July, 2012 for a total cost of DT 13,343,200,488; that is 8.5% above the original contract sum. The additional cost was for developing one street and a parking lot at the north entrance of the town of Mornag. These works were initially not anticipated in the tender.

Figure 3.19: Map of Tunisia Showing Location of Study Roads

Figure 3.20: RVE573, MC35 and RVE565 Road Sections in Tunisia

Figure 3.21: MC135, GP1 and MC34 Road Sections in Tunisia

III. MC135, GP1 and MC34 for a sum of DT 8,382,190.00 (approximately US$ 5.98 million) and a construction period of 7 months. The projects were awarded to Enterprise K. Kobbi of Tunisia.

Figure 3.22: RV11 and X20 Road Sections in Tunisia

The works were commenced on the 1st July, 2010 and were substantially completed on 26th February, 2011 for a total cost of DT 8,336, 671. 863, 0.5% less than the contract sum. The final completion certificate was issued on 4th May, 2012.

IV.RVE 511 and X20 were awarded to Enterprise ETEP of Tunisia for a contract sum of DT 3,935,679.00 (about US$ 2.2 million) and a contract period of 5 months. The works were started on the 11th of July, 2011 and were substantially completed on the 8th of January 2012 at a total cost of DT 3,626,011.161 which is 92.1% of the contract sum.

3.9 Uganda

The Kabale - Kisoro road section in Uganda has been studied. The location of the Kabale - Kisoro road section has been shown on a map of Uganda in Figure 3.23. The road section has been presented in Figure 3.24. A description of this road section is provided below.

Figure 3.22: RV11 and X20 Road Sections in Tunisia

Kabale - Kisoro - Bunangana/Kyanika Road Section

The Kabale - Kisoro - Bunagana/Kyanika road section is 100.136 km long and lies in the south-west of Uganda. The road traverses an area with rolling to mountainous topography. The road was a gravel road which has been upgraded to a bituminous road. The road starts at Kabale town and runs to Kisoro town and on to the Ugandan border with the Democratic Republic of Congo (DRC) at Bunagana for a length of 88.520 km. At Kisoro town, a 6.302 km spur connects the road to Kyanika at the Border with the Republic of Rwanda. The road therefore connects Uganda to the road networks of DRC and Rwanda. A component of the road section is a 5.314 km bypass at the southern side of the Kisoro airstrip to enhance safety.

The road was designed for a speed of 70 km/hr. This was reduced to 50km/hr., generally, in the mountainous sections and through settlements.

Lower design speeds were however used in very steep sections and down to 20km/hr at three hairpin bends. The road has a 6 m wide single carriageway with 1.5 m wide shoulders in the flat sections for 27.743 km and 1 m wide shoulders in the mountainous sections for 39.400 km. The last 11.31 km to Bunagana, the 5.314 km southern by-pass and the 6.302 km Kyanika spur were provided with 1 m wide shoulders. In curves with radii less than 300m in flat sections, and 50m for the mountainous sections, the width of the inner lane varied from 3.25 to 4 m with a corresponding decrease in the width of the shoulder. The shoulders were finished in asphaltic concrete; the surfaces of which flush with that of the carriageway.

The pavement surfacing provided was a 50 mm thick asphaltic concrete wearing course over a 10 mm aggregate single layer of surface dressing for 77.25 km to Kisoro while the remaining length covering the Kisoro - Bunagana sub-section, the southern bypass and the Kyanika spur were provided with double surface dressing.

Figure 3.24: : Kabale - Kisoro - Bunangana/Kyanika Road Section

The rest of the pavement for all the sub-sections comprised 125 mm thick crushed stone base, 275 mm thick crushed stone sub-base, 150 mm thick upper improved subgrade and 150mm thick lower improved subgrade overlying natural subgrade. The sub-sections which have been completed in double surface dressing are planned to be provided with an asphalt concrete overlay under a different contract.

The road was constructed by SBI International Holdings, AG of Switzerland with construction supervision carried out by Mott Macdonald of the United Kingdom in association with Kagga and Partners of Uganda.
Construction commenced on the 22nd of March, 2007 for a construction period of three years (1096 days). The construction period was later extended by 924 days to 2020 days. The contract was awarded for an initial sum of Ush 147,067,121,956 (approximately US$ 80.37 million) and was completed at a cost of Ush 195,445,535,968.
Funding was provided by AfDB and the Government of Uganda with AfDB contributing 89.5% and the Government of Uganda providing the remaining 10.5%.

3.10 Assessment of selected roads against bank's criteria

The selected roads have been examined against the criteria set by the Bank for their selection. A matrix in Table 3.1 shows how the selected roads meet the criteria in terms of regional, climatic and topographical spread; and the type of construction and surface finish. The selected roads are typical of the Bank's operations in Africa and do provide the desired spread across climatic regions, type of construction, type of surfacing and implementation period. Geographical spread does not appear to have been fully satisfied since there are no projects in Southern Africa. This was however explained at the commencement meeting to be attributable to the non-availability of recently completed projects in the region.

Table 3.1 (1/2): Assessment of selected roads against

Country/ Project	Length (km)	Region	Project Commen-cement	Original Construction Period	Date Completed
BENIN					
1. Pobe - Ketou	42.8	West	2005	36 Months	2009
2. Ketou - Illara	16.5		2006		2007
CAMEROON					
3. Bamenda - Batibo - Numba	63.2	Central	Feb 2010	36 Months	Jun 2014
4. Nandeke - Mbere Road	82.0		Jun 2009	24 Months	Dec 2013
DRC					
5. N'sele - Lufimi	93.58	Central	Dec 2008	24 Months	Dec 2010
6. Kwango - Kenge	70.3		Dec 2008	24 Months	Jan 2011
GHANA					
7. Agbozume - Aflao (Including Akatsi Bypass)	27.1		Jan 2009	24 Months	Dec 2013
8. Akatsi - Dzodze - Akanu	30.0		Jun 2009	17 Months	Feb 2012
9. Akatsi - Agbozume	31.6	West	Jan 2009	24 Months	Oct 2011
10. Nsawam Bypass;	9.3		Jun 2008	24 Months	Sep 2012
11. Techiman - Apaaso	53.7		Oct 2010	29 Months	Jun 2012
12. Apaaso - Kintampo	6.3		Oct 2010	9 Months	Jul 2010
KENYA					
13. Nairobi - Thika	45		Jan 2009	30 Months	Oct 2012
14. Athi River - Namanga	136	East	Nov 2007	30 Months	Sept 2010
15. Isiolo - Merille	136		Nov 2007	30 Months	June 2012
TANZANIA - ZANZIBAR					
16. Manzizini - Fumba	17.81		2006	18 Months	Nov 2009
17. Amani - Dunga	12.75	East	2009	15 Months	June 2012
18. Mfensini - Bumbwini	13.1		2009	15 Months	June 2012
TANZANIA - MAINLAND					
19. Singda - Katesh	65.1		March 2009	30 Months	Jan 2012
20. Katesh - Dareda	73.8	East	March 2009	30 Months	Aug 2012
21. Dareda - Minjingu	84.6		March 2009	30 Months	Aug 2012

SOURCE: STUDY TEAM

Bank's criteria

Climate	Topography	Urban/ Suburban/ Rural	Construction Type	Surface Type
Hot & Wet	Rolling	Rural/urban	Rehabilitation	Asphalt Concrete
Hot & Wet	Flat	Rural	Upgrading	Surface Dressing
Hot & Wet	Rolling	Rural	Rehab / Upgrading	Asphalt Concrete
Hot & Wet	Rolling	Rural	Upgrading	Asphalt Concrete
Hot & Wet	Hilly / Rolling	Rural	Rehab./ widening	Asphalt Concrete
Hot & Wet	Hilly / Rolling	Rural	Rehabilitation	Asphalt Concrete
Hot & Wet	Flat	Rural	Rehabilitation	Asphalt Concrete
Hot & Wet	Flat	Rural	Rehabilitation	Asphalt Concrete
Hot & Wet	Flat	Rural	Rehabilitation	Asphalt Concrete
Hot & Wet	Rolling	Rural	New Construction	Asphalt Concrete
Hot & Wet	Rolling	Rural	Rehabilitation	Asphalt Concrete
Hot & Wet	Rolling	Rural	Rehabilitation	Asphalt Concrete
Mild & Wet	Rolling	Urban/Suburban	Rehab./ Widening	Asphalt Concrete
Semi-arid	Rolling	Rural	Rehabilitation	Asphalt Concrete
Arid	Upland Plain	Rural	Upgrading	Asphalt Concrete
Wet & Humid	Flat (Coastal)	Urban / Rural	Upgrading	Asphalt Concrete
Wet & Humid	Rolling	Urban / Rural	Upgrading	Asphalt Concrete
Wet & Humid	Flat	Rural	Upgrading	Asphalt Concrete
Hot & Dry	Rolling / Hilly	Rural	Upgrading	Surface Dressing
Hot & Dry	Rolling / Flat	Rural	Upgrading	Surface Dressing
Hot & Dry	Upland / Flat	Rural	Upgrading	Asphalt Concrete

Table 3.1 (2/2): Assessment of selected roads against b

Country/ Project	Length (km)	Region	Project Commen-cement	Original Construction Period	Date Completed
TUNISIA					
22. Grombalia - Limite Gouvernorat de Ben Arous - (RVE 573)	19		April 2011	18 Months	June 2012
23. Mornag - Jbel Rsas (MC 35)	10.2		July 2010	20 Months	July 2012
24. Khlidia - Jbel Rsas (RVE 565)	11		July 2010	20 Months	July 2012
25. Bab El Khadra - Station Metro (MC 135)	7	North	July 2010	7 Months	Feb 2011
26. Ben Arous - Mornag (MC 34)	4.4		July 2010	7 Months	Feb 2011
27. Ben Arous - Stade Rades (GP1)	6.5		July 2010	7 Months	Feb 2011
28. Jdaida - Tebourba (RVE511)	8.8		July 2011	5 Months	Jan 2012
29. Carrefour Hopital Ariana (RR31 (X 20))	8.3		July 2011	5 Months	Jan 2012
UGANDA					
30. Kabale - Kisoro - Bunangana / Kyanika	100.14	East	Mar 2007	36 Months	Sep 2012

SOURCE: STUDY TEAM

ank's criteria

Climate	Topography	Urban/ Suburban/ Rural	Construction Type	Surface Type
Temperate/ Mediterranean	Rolling	Rural	Rehab./ Widening	Asphalt Concrete
Temperate/ Mediterranean	Flat	Sub Urban	Rehab./ Widening	Asphalt Concrete
Temperate/ Mediterranean	Flat	Rural	Rehab./ Widening	Asphalt Concrete
Temperate/ Mediterranean	Rolling	Urban	Rehabilitation	Asphalt Concrete
Temperate/ Mediterranean	Rolling	Rural	Rehabilitation	Asphalt Concrete
Temperate/ Mediterranean	Hilly	Rural	Rehabilitation	Asphalt Concrete
Temperate/ Mediterranean	Hilly	Rural	Rehabilitation	Asphalt Concrete
Temperate/ Mediterranean	Hilly	Urban	Rehabilitation	Asphalt Concrete
Mild & Wet	Rolling/ Mountainous	Rural	Upgrading	Asphalt Concrete

4.0
ASSESSMENT OF THE QUALITY OF SELECTED ROADS

4.0 ASSESSMENT OF THE QUALITY OF SELECTED ROADS

4.1 Introduction

4.1.1 General

The Study roads have been assessed for their quality by:

- Evaluating the finished road, as the end product, in terms of the user utility and traffic carrying potential; and
- Evaluating the individual component layers of the pavements in terms of the thickness, the quality of the material utilized, the level of compaction and other requirements; in compliance or otherwise with the specifications.

The evaluation of the finished road has been undertaken using the following three investigations:-

- A Visual Survey;
- Measurement of the riding quality of the pavement using roughness as a proxy; and
- An assessment of the structural capacity of the pavement through the measurement of pavement deflections.

The evaluation of the component layers of the pavement was carried out through the laboratory testing of the materials recovered from the field investigations and comparing the test results with those indicated in the project specifications.

4.1.2 Assessment of quality through visual survey

A visual survey was undertaken to assess the general condition of the road as a precursor to the more mechanistic procedures of pavement evaluation in terms of surface roughness of the road using ROMDAS and deflection response. These techniques can be used to assess the cumulative effect of the various distresses and the quality of finished work. Besides assessing the roads through the visual survey and the use of the mechanistic procedures, note was taken of other general conditions within the road environment that can affect the quality of the road as a whole.

A visual survey was generally carried out while travelling in a vehicle moving at relatively slow speeds of around 30 km/hr. Wherever there was any indication of surface distress, the affected area, including short lengths of about 30 m before and beyond the affected area, was surveyed on foot.

Road failures/distresses are basically a traffic loading and environment related phenomenon, but especially during the early service life, are often related to either poor construction or the use of poor quality materials. The failures could be exhibited through a number of manifestations. These include:

- cracking - generally a material related distress of different types and severity; potholes developing out of block cracking;
- edge failure due to lack of sufficient lateral support;

- rutting - the surface depression in the wheel-path(s) which is an indicator of insufficient structural strength of one or more layers for the traffic loading, unstable asphalt mix or post construction consolidation of the pavement layer(s) leading to settlements and depressions making the surface uneven for travel;
- ravelling - the result of the progressive loss of surface aggregate;
- flushing or bleeding - signifying the presence of excess bitumen on the surface; and
- shoving - a manifestation of the lack of adhesion between two bituminous layers, especially in the case of strengthening works, or the surfacing and the base.

Rectification of any of these localized failures by patching after removing the distressed material was also taken account of in the detailed analysis.
A Pavement Condition Rating (PCR) has been derived for each road section based on an analysis of the visible signs of distress for the entire stretch and using the criteria in Table 4.1 developed by the United States Federal Highway Administration (USFHA). The USFHA pavement condition rating has been adopted because it has been developed after extensive research involving road users and has widespread use globally.

Table 4.1: Pavement Condition Rating Based on Different Types of Defects

Defects	Range of Distress, Percent of Area Affected				
Description	**Very Severe**	**Severe**	**Moderate**	**Slight**	**None to Very slight**
Cracking (%)	>30	21 to 30	11 to 20	5 to 10	<5
Raveling (%)	>30	11 to 30	6 to 20	1 to 5	0
Pothole (%)	>1	0.6 to 1.0	0.1 to 0.5	0.10	0
Shoving (%)	>1	0.6 to 1.0	0.1 to 0.5	0.10	0
Patching (%)	>30	16 to 30	6 to 15	2 to 5	<2
Settlement and Depression (%)	>5	3 to 5	up to 2	Up to 1	0
Rutting (mm)	>50	21 to 50	11 to 20	5 to 10	<5
Rating	1	2	3	4	5
Condition	Very poor	Poor	Fair	Good	Very Good

Source: United States Federal Highway Administration (Modified by Study Team)

Roads hardly exhibit a single distress manifestation. There is usually a combination of distress manifestations and in rating the roads, this has been borne in mind. A road regarded as very good would have a Present Serviceability Index (PSI) of 4.5 to 5, a good road from 3.5 to 4.5, a road in fair condition from 2.5 to 3.5, a poor road from 2 to 2.5 and a very poor road below 2.

In rating the condition of a pavement and inferring the PSI of the roads, the Consultant has used the “deduct method” where a perfect road is given a value of 100. Deductions are made for each distress manifestation depending on how the type of distress and its degree of severity affect the riding quality. The deduct values for the various types of distress are shown in Table 4.2. The assessment of the distresses used for the deductions has been based on the percent of the pavement area showing a particular distress as presented in Table 4.1.

Table 4.2: Deduct Values for Different Pavement Distresses for Condition Rating

Description	Very Severe	Severe	Moderate	Slight	None to Very slight
Cracking	40	20	7.5	2.5	0-2.5
Raveling	40	20	7.5	2.5	0-2.5
Potholing	50	30	15	10	0-10
Shoving	50	30	15	5	0-5
Patching	40	20	10	5	0-5
Settlement and Depression	40	20	10	5	0-5
Rutting	40	20	10	5	0-5

Source: Study Team

A pavement rating based on the 'Pavement Score' after the deductions for the various distresses is shown in Table 4.3. The PSI and condition rating of the road sections were derived based on Tables 4.2 and 4.3.

Table 4.3: Relationship between Pavement Score and Pavement condition Rating

Pavement Condition Rating	Net Value	PSI
Very Good	>85	4.5 - 5.0
Good	70 - 85	3.5 - 4.5
Fair	55 - 70	2.5 - 3.5
Poor	40 - 55	2.0 - 2.5
Very Poor	<40	<2.0

Source: Study Team

4.1.3 Assessment of quality in terms of riding quality

The Riding Quality of the Project Roads has been assessed by using roughness as a proxy. The roughness measurements were designated in the units of the International Roughness Index (IRI). The IRI is defined as the accumulation of the vertical movements of a vehicle on a road and is expressed in meters per kilometer (m/km). It is a measure of the "bumpiness" of the road which normally is an indication of the combined effect of distresses of an in-service road. In the case of a newly constructed road the roughness value normally is an indicator of the quality of the construction. The IRI for newly paved surfaces typically would range from 1.5 to 3.5 m/km. For older paved roads the IRI would range from 2.5 to 5.5 m/km. and damaged roads can have IRIs as high as 10 m/km. The IRI is an open ended scale.

The Study roads have been in service for some time, though for relatively short durations. The visual surveys did not indicate the deterioration of any sections of the roads for such sections to have excessively higher roughness values than for the rest of the roads suggesting that the higher values were mainly contributed by speed humps and rumble strips. In analyzing the data, the average roughness and standard deviation for all measurements for each lane was calculated. With the presence of many speed humps, rumble strips and other speed calming devices contributing to the calculated roughness, road roughness values which were higher than the average plus one standard deviation, referred to as outliers, were eliminated and the average IRI recalculated to give a normalized roughness value for the lane, which in the opinion of the Consultant was a more realistic estimate.

Each road lane was rated using the normalized roughness values based on the guidelines of the Federal Highway Administration, USA, for roads other than the Interstate, for the Highway Performance Monitoring System which is shown in Table 4.4. The use of this assessment is because of its widespread use globally and backed by research, such as the UNDP Brazil Study which has been validated in other countries across the globe including Africa, linking the condition and the rate of deterioration of a road pavement with its roughness.

Table 4.4: Pavement Condition Rating Based on Roughness

Pavement Condition	IRI (m/km)
Very Good	0 - 1
Good	1.0 - 1.5
Fair	1.5 - 2.7
Mediocre	2.7 - 3.5
Poor	>3.5

Source: United States Federal Highway Administration

Despite the realization that roughness provides a good indication of the condition of a pavement, the use of roughness in road specifications is yet to be adopted. Most Road Administrations, such as in Uganda and in Ghana, still use a limit on the deviation beneath a 3m straight edge as an acceptance criterion for completed pavements. With the use of the straight edge, it is possible for pavements with high initial roughness to be accepted since the bar only provides information on the degree of surface evenness over a small area. On the other hand, the use of roughness measurements provides an overall picture of how even the finished pavement is. There may be the need to examine the possibility of using roughness as an acceptance criterion in future specifications.

For this study, an analysis for each road lane was carried out for all intervals over which measurements of roughness were made, normally 50 or 100 m. This was to allow the assessment of the proportions of the road lane with different condition ratings. A review of the results showed that using the mean plus one standard deviation to eliminate results (outliners) contributed by the speed calming devices still left some contributions mainly from low rumble strips. The results showed that the lanes therefore had relatively short sections, in the order of 3%, rated as poor, except for a few of the roads which crossed a few large urban settlements and had series of rumble strips. Where the proportion of a road rated as poor exceeded 8% of the length, the results were more of an indication of the quality of finish for the particular road. Graphs of roughness measurements for the Study roads are presented in Appendix 2.1.

4.1.4 Assessment of quality of construction in terms of structural capacity

The quality of construction in terms of the structural capacity of the roads has been assessed as an estimate of the projected service life of the pavement in terms of the number of equivalent standard axle load of 8,200 kg that the road can sustain with the existing component layers without any major strengthening works.

The assessment was done using the Falling Weight Deflectometer (FWD), the Benkelman Beam, or the La Croix Deflectograph depending on availability in a particular country.

The FWD is one of the best non-destructive tools for the structural evaluation of pavements. The structural behavior of a pavement layer, in mechanistic analysis, is denoted by the elastic moduli and Poisson's ratios of its component layers.

Where the FWD was used, the evaluation of the pavements for the Study Roads was made by determining the maximum deflection under the load, the Radius of Curvature (ROC) for the deflection bowl, the Base Layer Index (BLI), the Middle Layer Index (MLI) and the Lower Layer Index (LLI). The RoC and BLI correlate with the properties of the wearing course and base layer of the pavement while the MLI correlates with that of the sub-base layer with the LLI correlating with that of the subgrade layer. The deflection data obtained using the FWD is utilized for back-calculating the effective pavement layer moduli and other parameters which are then used to estimate the residual life of the pavement in millions of equivalent standard axles (MESA).

In using the Benkelman Beam and the La Croix Deflectogragh, the evaluation has been undertaken by measuring the elastic rebound deflection of the pavement under a dual wheel axle load of 8,200 kg and tire pressure of 5.9 kg/cm2.

The Benkelman Beam and the La Croix Deflectogragh use the same principle in the analysis of the measured deflection data. The maximum deflections measured in both wheel tracks for a lane, and where both lanes are tested, from all four wheel tracks, are used to determine the characteristic deflections of homogeneous sections. The characteristic deflections are used to derive the residual lives of the pavement. In assessing the residual life of the pavement, a characteristic deflection equal to the 90th percentile deflection value for the test sections were used. This ensures that there is a 90% probability that the estimated life would be achieved.

For this Study, the Consultant has carried out the evaluation by using the characteristic deflections to estimate the Modified Structural Number (MSN) of the pavement sections tested based on the relationship derived from UNDP's Brazil Study between rebound deflection and Modified Structural Number and which is shown in Figure 4.1. The relationship has been found to be generally applicable in a large number of situations. The residual strength is then estimated by using the World Bank's Aggregate Model which is a relationship between MSN load carrying capacity of a pavement. The relationship which has been validated in a number of countries in South America, Asia and Africa is shown in Figure 4.2.

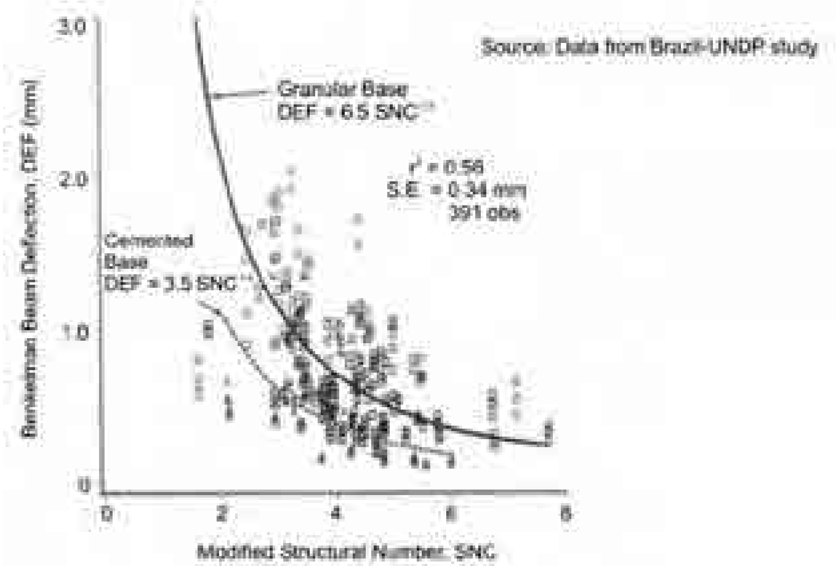
The deflection data obtained through the use of the FWD was corrected for temperature. The data from the Benkelman Beam or the La Croix Deflectograph were however not corrected for temperature. Temperature corrections for measured deflections are not necessary for surface dressed roads, but are usually required for pavements with thick asphalt layers.

The information gathered in this study was meant for assessing the capacity of the sections tested and not for designing overlays. Moreover, the roads on which the Benkelman Beam or the La Croix Deflectograph was used had thin asphalt layers and the effect of temperature would be minimal. The deflections, as measured by these two types of equipment, were therefore utilized for the analysis.

4.1.5 Assessment of quality in terms of pavement layer characteristics

Assessment of the quality of the pavement as constructed has been determined based on a comparison of the layer characteristics of the as-built pavement with the design requirements and specifications, in terms of layer thicknesses, the properties of the materials used and their treatment. The laboratory test results obtained from materials recovered from the pavements have therefore been compared with those specified in the contract documents for compliance. The thicknesses of the various layers as measured in the field were also compared with the specified thicknesses.

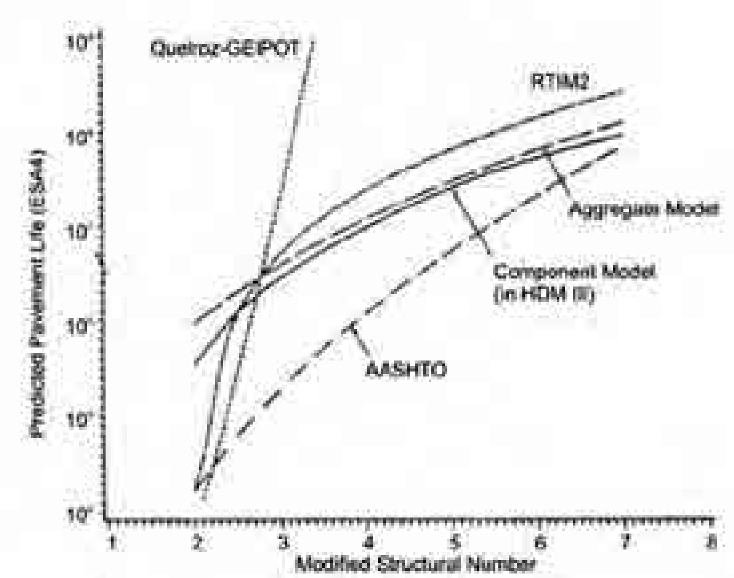
Figure 4.1: Relationship between the Benkelman beam surface rebound deflection and modified structural number in the Brazil - UNDP study



4.2 Assessment of road sections in benin

The study road sections were Pobe to Ketou and Ketou to Illara on the Benin - Nigeria border. Pobe is 75 kilometers from Port Novo. The 59.3 km long Pobe - Ketou - Illara road is in two well-defined segments. While the north bound Pobe - Ketou is a part of the major north - south road going north from Cotonou to the border of Benin with Burkina Faso, the Ketou - Illara section goes eastwards to the border with Nigeria.

Figure 4.2: Pavement life in cumulative equivalent standard axles as predicted by various models for common performance limits of 2 to 6 m/km IRI



4.2.1 Assessment of quality through visual survey

Pobe - Ketou Road Section

General

The Pobe - Ketou road section is 42 km long. The road is a 7 m two lane undivided carriageway with 1.5 m paved shoulders. The shoulders are at a level slightly lower than the level of the carriageway, the drop being the difference of the thickness of the asphalt layer on the carriageway and the single surface dressing on the shoulder.

Drainage

The road is for a greater part on an embankment of height averaging a meter to a meter and a half. Natural drainage of the road is therefore good. Very few cross-drainage works were noticed. Wherever the road goes through a built up area or through a cut, good side drains have been provided. While some of the drains are lined, others are unlined earth drains.

Safety
Warning signs regarding speed breakers and other potential hazards are few on the Pobe - Ketou section. It is inconceivable that the road would have been finished without the installation of road signs. It is therefore most likely that the absence of road signs is the result of vandalism. There were also no kilometer posts.
Pavement Distress
The surfacing, though looking hungry, experienced slight bleeding at some places about 2 to 5 kilometers from Pobe. Though the road is otherwise free from any distress, a lone pot hole of size 30 cm x 60 cm, which must have grown over a period, right in the middle of the carriageway is an ominous sign of the lack of maintenance.
Pavement Condition Rating
The road shows no other distress in terms of raveling, shoving, rutting or patching.
The pavement score is estimated as 93. The pavement condition is therefore rerated as Very Good and a PSI of 4.77. Riding quality of the road in general is very good, except for the sections with speed humps and rumble strips. One speed breaker, about 20 - 25 kilometers from Pobe has been so very badly constructed, probably after the completion of the project, so much so that travelling over it, even at crawling speed, is uncomfortable.

4.2.2 Assessment of quality in terms of riding quality

A summary of the roughness measurements for the Pobe - Ketou and Ketou - Illara road sections have been provided in Table 4.5. Also provided in Table 4.5 is the overall rating of the road sections and the proportions of the length of the roads with various ratings.
The results show that about 25% of both lanes can be rated as very good, another 30% as good, approximately 35% as fair, about 5% as mediocre and around 6% as poor. The overall rating of both road sections is Good.

Table 4.5: Summary of Roughness Data for Benin Roads

Pobe - Ketou - Illara Road Section			Average IRI	Standard Deviation	Average IRI without Outliers	% Section Very Good	% Section Good	% Section Fair	% Section Mediocre	% Section Poor	Rating
Direction of Travel	Chainage (km) Start	End									
Illara - Pobe	0.800	58.500	1.95	1.77	1.28	25.46	29.28	34.14	5.04	6.08	Good
Pobe- Illara	0.000	58.500	1.83	1.27	1.26	20.89	32.53	35.70	4.54	6.34	Good

4.2.3 Assessment of quality of construction in terms of structural capacity

A total length of 25 lane-kilometers of the road sections in sub-sections of 2.5 and 5 km lengths was tested for the two road sections in Benin using the FWD. The software provided with the equipment only provided the layer moduli. The residual capacity was estimated using elastic layer analysis by considering the limits of vertical and tensile strain at the top of the subgrade. A cement stabilized base was used for the sections that required partial reconstruction or upgrading. There is the likelihood of the cement stabilized layers cracking over time and making it difficult to achieve the calculated residual capacities. The calculated residual capacities have been modified by a factor of 0.6 to arrive at realistic residual capacities. The factor of 0.6 was used since a number of studies has shown that if two pavements, one with a non-cemented base and the other with a cement stabilized base, have the same deflection under the same standard load, the pavement strength of the cement stabilized pavement would be about only 60% of that of the pavement with the non-cemented base. The derived layer moduli and other relevant parameters derived for the sub-sections tested, and the calculated residual capacity in MESA and the estimated number of years to reach this capacity are also provided in Table 4.6.

Table 4.6: Elastic Moduli (E) Values and Residual Life for Pobe - Illara Road Sections

Test Section			Elastic Modulus of the Layers (MPa)				Layer Thickness (mm)			Tensile strain (Micro strain)	Vertical strain (Micro strain)	Residual Life	
Direction of Travel	Chainage (km) Start	End	Wearing Course	Base	Granular Sub-base	Sub-Grade	Wearing Course	Base	Granular Sub-base			MESA	Time (Years)
Illara - Pobe	3.000	5.500	3789	1508	833	372	60	150	150	90.4	497	20	>20
	23.000	28.000	5897	1288	711	300	60	150	150	80.9	343	40	>20
	33.000	38.000	3226	2075	1146	350	60	150	150	54.7	275	60	>20
Pobe - Illara	5.000	10.000	2636	1425	787	373	60	150	150	92.7	307	60	>20
	20.000	25.000	3999	1577	871	344	60	150	150	68.9	158	60	>20
	35.000	37.500	2341	1746	965	397	60	150	150	68.8	278	60	>20

4.2.4 Assessment of quality in terms of pavement layer characteristics

Assessment of the quality of the pavement as constructed has been carried out based on a comparison of the pavement as provided with the design requirements, in terms of layer thicknesses, materials utilised with regard to material properties and strength characteristics. The selected road sections have been divided into five homogeneous sections for this analysis, as follows:

- Pobe - Junction with main road to Nigeria,
- Junction with main road to Nigeria - Cement factory at Onigbolo,
- Cement factory at Onigbolo - 5.5 km north of the factory,
- 5.5 km north of the factory - Ketou, and
- Ketou - Illara.

Historic Data from Available Reports

Design traffic, design sub-grade CBR, pavement composition details and specifications to be adopted for the pavement layers have been collected from the available reports for the road sections. The design pavement composition for the road sections given in the report is presented in Table 4.7 while the details of the pavements as constructed are given in Table 4.8.

Data Obtained from Field Test Observations and Laboratory Testing

The pavement composition was sought to be verified at two locations, but at both locations the pits could not be opened due to the very high strength of the cement stabilized base course. At these locations cores were then sought to be cut for taking samples of base and sub-base course for assessing the Unconfined Compressive Strength (UCS) for the materials. The core cutting machine also broke down. The Asphalt concrete layer thickness was measured by cutting small sections near the edge of the carriageway. The continued good performance and the relatively high residual traffic carrying capacity of the roads indicate that the pavements met specifications.

Table 4.7: Design Traffic and Design CBR as per Design Requirements

S. No.	Section	From	To	Length (km)	Design Traffic (ESA) 106	CBR of Alignment Soil (%)
1	Pobe-Junction with main road to Nigeria	0.000	2.400	2.400	25	9
2	Junction with main road to Nigeria - Cement factory at Origbolo	2.400	19.000	16.600	38	1
3	Cement factory at Origbolo -5.5 km north of the factory	19.000	24.500	5.500	11.8	7
4	5.5 km north of the factory-Ketou	24.500	43.200	18.700	11.8	14
5	Ketou-Illara	43.200	59.800	16.600	1.05	15

4.2.5 Summary

The assessment of the two road sections in Benin has revealed that the roads which have been in service for between 5 and 6 years are performing well. The pavements are rated as Good. The riding quality of both sections is rated as Good. The residual capacity of the pavement for the two the Pobe - Illara road section is in the order of 20MESA while for the Pobe - Ketou section, it is estimated between 40 and 60 million equivalent standard axles. These exceed the design requirements of between 1.5 and 38 MESA. At present traffic levels, the roads should be expected to last for over 20 years if the roads are adequately maintained and there is not an a higher than anticipated traffic growth in the order of 7% due to a boom in the economy.

4.3 Assessment of roads in cameroon

4.3.1 Assessment of quality through visual survey

The Bamenda - Batibo - Numba and the Nandeke - Mbere road sections were studied in Cameroon.

Bamenda - Batibo - Numba Road Section

General

The Bamenda - Batibo - Numba section was constructed in two sub-sections. These were the 42.5 km and Bamenda - Batibo section and the 20 km Batibo - Numba section. The contractor is still on site and work is about 95% complete. The road section which has a carriageway width of 7 m and 1.5 m wide shoulders is in a rolling to mountainous terrain. Landslides had occurred in four areas on the Batibo - Numba portion of the road section and were being repaired by the contractor. The verges were overgrown with tall grass.

Drainage

Over the Bamenda - Batibo portion of the road section, natural drainage is good for a substantial length. Stone pitched side drains however have been constructed on both sides wherever the roadside conditions required provision of drains. Most of the drains are existing drains which have not been attended to and cleaned properly. At a few places, especially in the cut areas, some concrete lined drains have been provided. In the villages, drains have, in general, not been provided with slabs, and where provided, the numbers are inadequate. These drains are likely to be eventually filled up with gravel to be used as pedestrian crossings. The contractor indicated that this issue was been looked at with the supervision team.

On the Batibo - Numba section, the terrain is such that natural drainage is good. Concrete lined side drains have however been provided where necessary.

Safety

Over the Bamenda - Batibo stretch road line markings, including zebra crossings, have been provided adequately. The road humps are however yet to be marked which could make night driving dangerous. Vertical signs including warning signs at turns and at speed humps are missing or are yet to be installed many places. Where they have been installed, they are not easily visible due to the growth of tall grass around them. The supervision team and the contractor indicated that this aspect is still being worked on.

Beyond Bali the road is winding and some signage has been provided over this stretch but the numbers are inadequate. Speed limit signs are very few in numbers. This portion has been provided with climbing lanes at two areas where the gradients are higher than 7%. At one place, about 16 km from Batibo, where road signs indicate the gradient to be 7% over a significant length, a climbing lane has not been provided.

In Bali town, a long straight stretch has not been provided with any speed calming intervention and drivers were observed driving at speeds much higher than 50 km/hr. This could lead to accidents if appropriate measures are not taken. Locals may also take upon themselves the responsibility of constructing speed humps which tend not to be properly constructed.

On the Batibo - Numba stretch, the alignment has been widened as part of the upgrading works resulting in some recent cut slopes which are yet to stabilize. Therefore Minor slides and slope slippages have therefore been taking place. These are being corrected by the contractor. Locations at Pk 8, 12, 16 and 19 are some of the areas that have experienced minor slides. As a result of the unstable situation along the cut slopes, debris and loose boulders also are falling on to the road surface creating a safety hazard. The contractor is cutting the slopes back at these places to create a buffer to accommodate future mass movements until the slopes stabilize. The road administration would need to pay attention to this stretch of road after it has been handed over to ensure the safety of road users.

In stretches with tight curves the shoulders have been finished in asphalt concrete at the same level as the carriageway improving safety. Guard rails have been provided where necessary and reinforced safety walls provided at the location of high cliffs. Well-constructed speed humps have been provided at the entries and exits of settlements. Three climbing lanes have also been provided over stretches where the vertical gradient exceeds 7%. The beginning and end of each climbing lane would however need to be signed.

Pavement Distress

There were no signs of distress on the Bamenda - Batibo portion. The Batibo - Numba sub-section has also shown no distress except between km 7+400 and 7+500 where two small areas each covering about 8 m2 has shown some alligator cracking in the Batibo bound lane. These areas thought to have exhibited the cracking due to a high ground water regime had been marked for investigation and repair by the contractor at the time of the visual inspection. Three patches were also noticed between km 7 and km 8. The construction joints over this stretch were visible and slightly rough.

The riding quality for both sub-sections was judged to be Good.

Pavement Condition Rating

Based on the distresses exhibited by the road section, a condition score of 92 and 90 is estimated for the Bamenda - Batibo and the Batibo - Numba stretches respectively. Both stretches are rated as Very Good. The sections have derived PSI values of 4.73 and 4.66.

Nandeke - Mbere Road Section

General

The Nandeke - Mbere road project comprised the upgrading of the 72.8 km Nandeke - Mbere road, a 9.9 km spur to Meidougou and 4.4 km of urban roads in Meiganga.

The Nandeke - Mbere road is a two lane undivided road of 7.0 meter width and 1.0 to 1.5 m wide paved shoulders on either side. The reduction of the shoulder width in some stretches of the road was presumably to avoid extensive earthworks and thereby control cost. While the carriageway is finished with asphaltic concrete, the shoulders are surface dressed. The shoulders surfaces flush with that of the carriageway.

The Meidougou spur and the Meiganga urban roads are finished with triple and double surface dressing respectively. The shoulders for both components are provided with double surface dressing.

Drainage

The road passes through an upland plain terrain, though a small length is in rolling terrain. Natural drainage of the pavement is good due to the road being provided with an embankment of sufficient height for the stretch traversing the plain. Wherever the road passes through built up areas, good masonry or concrete lined side drains have been provided. The drains serve as a good barrier to the spread of vegetation on to the shoulders. The drains are being kept clean.

Safety

Road markings are good and vertical signage is also adequately provided. Some of the information signs, especially the names of towns, are however losing letters. An

example is presented in Picture 4.1. Wherever the road has been surface dressed again or patch repaired, the road markings have not been done. Kilometer marker posts have been provided at 5 km intervals over the length of the road.
Painted road edge markers have been provided on the outer edge of curves providing guidance to drivers especially at night. At sharp bends and at locations where the level difference between ground and road surface is significant, guard rails have been provided. Since gradients are quite convenient and embankment height is moderate over most parts of the road, no guard rails have been provided along embankments.

Speed breakers are being provided using paver blocks in trapezoidal shape, which is not a good alternative to the conventional speed breakers built in bituminous material finished in parabolic shape.

Picture 4.1: Well-Marked Section of Road with Letters Missing in Town Name

Pavement Distress

Some 10 kilometers beyond Meiganga, a substantial length has seen a recent application of a single application of surface dressing as shown in Picture 4.2. The cover aggregates for the surface dressing have been whipped off by traffic in places, exposing tack-coated carriageway.
Closer examination of the surface shows cracking of the surface. Discussions with representatives of the project administration indicated that the stretch covered with the surface dressing was the first to be asphalted on the project. The asphalt mix had aggregates with 19 mm as the maximum size. Once the problem of cracking arose, the mix design was changed with a reduction in the maximum size of aggregate to 12 mm. The remedial action being taken was a recommendation from the (Cameroon) National Central Laboratory.
A little beyond this stretch, a length of about 500 meter of the North bound lane has been extensively patched. At about 20 km north of Meiganga, another stretch of the road, mostly along the North bound lane, and sometimes both lanes, has been recently surface dressed.

Picture 4.2: Recently Sealed Nandeke Section on Nandeke - Mbere Road Section

These small patches of surface dressing and patch repairs are quite well spread over a large part of the length. Some of the patch repairs are older than most others of recent origin. Enquiries with the local people revealed that the surfacing had been cracking and the sections that had got badly cracked were being patch repaired as shown in Picture 4.3, whereas sections with moderate cracking were being surface dressed. The sealing of the cracks would prevent the ingress of surface water and delay the deterioration of the road. Some other sections which show cracking, but have not been surface dressed, do not show any distress other than cracking.

Pavement Condition Rating

The road, other than cracking shows no distress such as raveling, potholing, rutting. The pavement condition score is deduced as 60 giving a condition rating of Fair; and PSI of 2.83. Riding quality of the road is generally good, even in the sections which are showing signs of distress and the road has been patch repaired or surface dressed.

4.3.2 Assessment of quality in terms of riding quality

The analysis of roughness measurements for the two Study roads in Cameroon have been produced in Table 4.9.
Based on the analysis, the Bamenda - Batibo - Numba road section is rated as Fair, while the Nandeke - Mbere road section is rated as Good. The Nandeke - Meigougou spur is rated as Fair.

Picture 4.3: Patching on Nandeke - Mbere Road Section

4.3.3 Assessment of quality in terms of structural capacity

The structural capacity of the road sections in Cameroon has been assessed using the Benkelman Beam.
The stretches tested for the two road sections, the relevant deflection values including the 90th percentile values of the maximum deflections and the derived residual lives have been summarized in Table 4.10.

Table 4.9: Summary of Roughness Data for Road Sections in Cameroon

Sub Section Direction	Chainage (km)		Average	Standard	Number of
	Starting	Ending	IRI (m/km)	Deviation (m/km)	Outliers
BAMENDA - BATIBO					
Bamenda - Batibo	0	45	1.75	0.52	100
Batibo - Bamanda	45	0	1.8	0.73	41
BATIBO - NUMBA					
Batibo - Numba	0	25	1.59	0.53	21
Numba - Batibo	25	0	1.62	0.46	42
NANDEKE - MBERE					
Nandeke - Mbere	86.014	158.863	1.29	0.39	26
Mbere - Nandeke	158.863	86.014	1.36	0.45	27
Meidougou - Nandeke	0	10	1.57	0.06	34
Nandeke - Meidougou	10	0	1.57	0.07	27

Table 4.10: Maximum Deflection Values and Residual Life for Cameroon Roads

Sub Section Direction	Chainage (km)		No. of	Maximum	Minimum
	Starting	Ending	observations	deflection (mm)	deflection (mm)
BAMANDA - BATIBO	10	12	21	0.54	0.1
(TO BATIBO)	30	32	21	0.64	0.08
	37	39	21	0.7	0.2
BAMANDA - BATIBO	43	41	21	0.58	0.24
(TO BAMANDA)	28	26	21	0.7	0.2
	24	22	21	0.6	0.08
BATIBO - NUMBA					
(TO NUMBA)	2	4	21	0.6	0.16
BATIBO - NUMBA					
(TO BATIBO)	19	17	21	0.6	0.08
NANDEKE – MBERE	91	93	21	0.5	0.3
(TO MBERE)	110	112	21	0.96	0.22
	124	126	21	0.36	0.24
	135	137	21	0.62	0.32
	147	149	21	0.54	0.3
NANDEKE – MBERE	158	156	21	1.06	0.2
(TO NANDEKE)	121	119	21	0.56	0.32
	114	112	21	0.82	0.08
	104	102	21	0.96	0.22
	90	88	21	0.5	0.3

Average IRI without Outliers (m/km)	% Section Very Good	% Section Good	%Section Fair	% Section Mediocre	% Section Poor	Rating
1.68	0	31.11	65.78	2	1.11	Fair
1.64	0	36.56	58.44	3.33	2.67	
1.48	0	53.2	44.4	1.2	1.2	Fair
1.51	0	46	50.4	2.4	1.2	
1.23	0.7	91.35	6.42	0.42	1.12	Good
1.29	6.53	79.53	11.39	0.69	1.81	
1.55	0	16	84	0	0	Fair
1.56	0	15	85	0	0	

Mean deflection (mm)	Standard deviation	90th percentile deflection (mm)	Modified structural number	Residual pavement life Mediocre	Residual pavement life Poor
0.19	0.1	0.27	6.4	79	>20
0.38	0.18	0.58	4.5	18	>20
0.39	0.14	0.6	4.3	16	>20
0.43	0.11	0.52	4.8	25	>20
0.38	0.14	0.5	5	32	>20
0.22	0.15	0.53	4.6	19	>20
0.43	0.11	0.52	4.8	25	>20
0.32	0.16	0.52	4.8	25	>20
0.39	0.05	0.44	5.6	28	>20
0.51	0.14	0.65	4.2	14	>20
0.31	0.03	0.36	5.8	63	>20
0.44	0.1	0.58	4.5	18	>20
0.42	0.07	0.52	4.8	25	>20
0.48	0.14	0.71	4.1	13	>20
0.45	0.06	0.55	4.7	22	>20
0.35	0.18	0.58	4.5	18	>20
0.51	0.14	0.65	4.2	14	>20
0.39	0.05	0.43	5.7	50	>20

4.3.4 Assessment of quality in terms of pavement layer characteristics

The characteristics of the materials used for the pavement layers have been determined through laboratory tests on samples recovered from the field. The laboratory tests carried out on the layer samples include gradation, the California Bearing Ratio (CBR) and Atterberg Limits. The thicknesses and field densities of the various layers were also determined. The results showed that for all two road sections, the constructed layers met the specifications. The laboratory test results are provided in Appendix 2.3.

4.3.5 Summary

Construction for the two Study roads in Cameroon is ongoing. Both roads are at advanced stages of construction with over 95% completed.

The investigations have indicated that while the pavement for the Bamenda -Batibo - Numba road section is rated as good, the pavement for the Nandeke - Mbere road section is rated only as fair. The Nandeke - Mbere road section has shown some distresses, mainly cracking, which are being corrected. On the other hand, the riding quality of the Nandeke - Mbere road is rated as good while that of the Bamenda = Batibo - Numba road is rated as fair.

Both roads have residual traffic carrying capacities which exceed the design values and should meet the expected lives if maintenance is sustained.

4.4 Assessment of roads in DRC

4.4.1 Assessment of quality through visual survey

Two roads were studied in the Democratic Republic of Congo. The roads are the 93.58km N'sele - Lufimi and the 70.3 km Kwango - Kenge roads.

Nsele - Lufimi Road

General

The road starts from the N'sele Bridge which is about 45 km to the east of Kinshasa. The road passes through rolling to mountainous terrain mainly used for agricultural production. The carriageway is 7 m wide with 1 m shoulders on either side. The road passes through a gorge around km 47. There are no shoulders over this section and around km 53, near Pema, which also is in a mountainous area. The shoulder width was also found to be less than 1m (approximately 0.6m), for a length of about 1 km in the vicinity of km 83.6. Shoulders were again absent around km 89 for a stretch of about 200m.

Routine maintenance has not been carried out allowing the verges to overgrow and cover parts of the shoulders.

Drainage

Drainage on the road is good. Concrete drains and kerbs have been provided in the mountainous areas or at areas with high gradients, estimated to be in excess of 4%.

Safety

The geometric design of the road is adequate for the terrain and should not raise any safety concerns. The road has been well marked and road signs are adequate

Signage at the section through the gorge at around km 47 could however be improved. The road passes through or close to a number of settlements. Speed bumps have been provided at the entries in both directions to these settlements to slow down vehicles and prevent accidents.

However, the numbers of bus bays provided in the settlements are inadequate. Vehicles therefore tend to stop on the carriageway and shoulders in these settlements to pick-up or drop passengers creating a safety hazard.

Around km 7, that is near Nsele Bambou, part of the Nsele bound carriageway is being used as a market. This a serious safety hazard as shown in Picture 4.4.

The settlement of Mankao (around km 23) also raises some safety concerns. There is inadequate separation of pedestrians, hawkers selling at a nearby market and through traffic. There is therefore a melee of moving vehicles, pedestrians, parked vehicles, vehicles being repaired on the shoulders resulting in chaos. This is a serious safety hazard that needs to be investigated and resolved to avoid accidents in the future. The user conflict is illustrated in Picture 4.5.

Picture 4.4: Market on Part of Carriageway and Shoulder at Nsele Bambou

Pavement Distress

The riding surface was generally good but a few minor manifestations of distress were noticed.

The distress manifestations include:-

- A shallow depression across the carriageway at km 3.3;
- A Lean surface at km 13.9 and km 16 as a result of vehicles that got burnt on the carriageway;
- Shallow potholes at km 32.5, km 33, km 50 and km 50.7. The potholes appear to have been initiated or were the result of the bases of hydraulic jacks used to raise vehicles which were repaired on the carriageway;
- Shallow short tears across the carriageway at km 37.6, km 67.4 and km 89; These appear to have been caused by vehicle tyre rims making contact with the pavement surface after tyre bursts;
- Some rippling around km 59 over a section where the road has a gradient of about 10%; and
- Some micro-cracking around km 50.

The riding quality has not been impaired by these minor manifestations of distress for now and the road offers a good riding quality.

Pavement Condition Rating

Based on the pavement distresses, a condition score of 83 and a PSI of 4.36 are estimated for this road section. The road is therefore rated as Good.

Picture 4.5: Road User Conflict in Mankao

Kwango - Kenge Road

General

The road passes through a rolling to a mountainous terrain. Agriculture is the mainstay of the inhabitants in the project's catchment area.

The carriageway is 7 m wide with 1 m shoulders on either side.

Picture 4.6: Sand from Adjacent Higher Ground Covering Carriageway

Drainage

The drainage for the road is regarded as adequate. Line drains have been provided as and where necessary.

Safety

The geometric has been properly carried out for the design speed of 80 km/hr. which is appropriate for the terrain. Road line markings and relevant road signs have been provided. There are speed humps at the entry of all settlements from both directions slowing down vehicles crossing these settlements. Most of the settlements were not provided with drains and in settlements where the surrounding ground is higher than the road level, a lot of sand has been transported across the carriageway, sometimes almost covering the entire carriageway and creating a safety hazard, especially at night. An example is shown in Picture 4.6.

Pavement Distress

The road has shown a network of thin longitudinal cracks connected by transverse cracks - the building blocks of ultimately exhibiting alligator cracking. The cracking is predominant in the outer wheel paths in both lanes.

Picture 4.7: Longitudinal Cracks in Outer Wheel Path of Kwango - Kenge Road Section

This type of cracking is typical of cement stabilized pavements with thin wearing courses. The cracking exhibited is shown in Pictures 4.7 and 4.8. The road is covered with a number of intermittent patches, an indication that the cracking had progressed to alligator cracking in locations. Some of these patches cover considerable lengths. Some of the patching is shown in Picture 4.9. Except for a few locations, the patching has been well done and the riding quality has not been seriously impaired. The cracking is extensive in coverage, though the cracks are for now thin.

They therefore do not affect the riding quality but if the necessary intervention is not carried out soon the road could deteriorate very quickly.

Picture 4.8: Cracks in the Pavement for Kwango - Kenge Road Section

A pothole was noticed at km 51.2 in the Kenge bound lane. There was severe tearing and shoving at km 58.3 and at km 62.4. These are shown in Pictures 4.10 and 4.11. Depressions and rippling over approximately a half kilometer stretch was noticed around km 68.

A number of vehicles were found to have broken down on the road and were being repaired on the carriageway causing a safety hazard. A similar phenomenon was also seen on the N'sele - Lufimi road and the other roads visited. A typical example is shown in Picture 4.12.

Pavement condition Rating
From an assessment of the distresses, a condition score of 60 and a PSI of 2.83 are deduced for the road. The road is therefore rated as Fair. The riding quality is also rated as fair.

Picture 4.9: : *Patching on Kwango - Kenge Road Section*

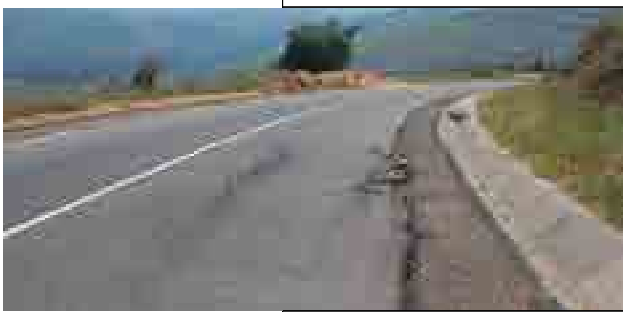
4.4.2 Assessment of quality of construction in terms of structural capacity

The Benkelman Beam was used to assess the structural capacity of the roads in DRC. Two sections, km 10.000 to km 20.000 and km 60 - 70.000 were tested on this section. For km 10.000 t0 20.000, the mean deflection was calculated as 0.09 mm with a standard deviation of 0.03 mm and a characteristic deflection of 0.13 mm; while for the section from km 60.000 to km 70.000, the 90th percentile deflection was calculated as 0.23 mm.

Picture 4.10: *Tearing on Kwango-Kenge Road*

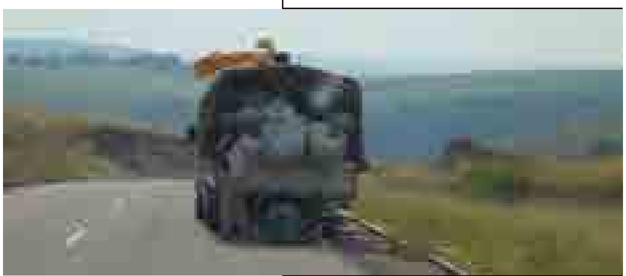
The modified structural numbers for the two sections are derived as 5.3 and 6.3 respectively giving estimated residual lives as 12 and 20 MESA respectively equivalent to between 12 and 20 years at current traffic levels of around MESA per year.
Two sections were tested on the Kwango - Kenge road section. The sections are from km 10.00 to km 17.500 and km 37.500 to km 45.000.
The maximum deflections varied from 0.02 mm to 0.10 mm with a mean value of 0.05 mm and a standard deviation of 0.02 mm.
The calculated characteristic deflection of 0.075 mm was therefore used in estimating the residual life as discussed in Section 4.1. Based on the characteristic deflection, the type of base layer which is cement stabilized, the MSN was estimated as 5.3 which gave the residual strength for this section as 30 million equivalent standard axles (MESA).
For km 37.500 section to km 45, the maximum deflection values gave a mean value of 0.06 mm and a standard deviation of 0.02 mm and a characteristic deflection of 0.075 mm. The derived MSN was 5.8 based on which the residual strength is estimated at 40 MESA.
The residual capacity of the Kwango - Kenge road is therefore estimated at around 40 MESA.

Picture 4.11: *Shoving on Kwango - Kenge Road*



This translates into a life of more than 20 years at an estimated annual traffic of around 0.75 MESA. This life would only be achieved if regular maintenance is carried out.
The details of the deflections measured and the residual traffic carrying capacities of the two sections of road are summarized in Table 4.11.

Picture 4.12: *Vehicle Being Repaired on Carriageway*



4.4.3 Assessment of quality in terms of pavement layer characteristics

The quality of the pavement as constructed has been assessed based on a comparison of the pavement as provided, with the design requirements. Laboratory tests have been carried out on samples of materials recovered from the field. This has primarily involved the determination of the particle size distribution of the aggregates used for the bituminous layers. The tests show that the aggregate grading largely met the project specifications. The layer thicknesses also met the specified values. The very low deflections obtained in the field are also indicative of the roads having met the specifications. The test results are provided in Appendix 2.3.

4.4.4 Summary

The two roads in the Democratic Republic of Congo are rated to be in fair to good condition. The current riding quality of both roads is relatively good. Whereas the N'sele - Lufimi road is rated as good, the Consultant could only rate the Kwango - Kenge road as fair. This is because of the extensive network of longitudinal and lateral cracks in the outer wheel paths of the road; and the extensive patches on the road. The patches may be indicative of some of the cracks having progressed to alligator cracking. The cracks are thin now but they are bound to grow and widen if some intervention is not applied quickly.

This brings up the question of using cement stabilized bases under thin wearing courses in areas of wet and dry seasons. The maintenance of such pavements poses a lot of difficulties. Over time, the cracks become extensive. Shrinkage of the cement stabilized base creates gaps between blocks of the base making riding uncomfortable. At the same time cutting the blocks out for repairs is difficult and the only alternative is usually to rehabilitate the road by removing the surfacing and base.

It may be worthwhile noting that the Lufimi - Kwango and the Kenge - Kikwit roads, contiguous with the Kwango - Kenge road section and all of similar construction have shown similar behavior and reinforces this observation.

Experiences with this method of construction have made a number of countries shy away from the use of cement stabilized bases after the initial enthusiasm of the late 60s and early 70s. Its use seems to be returning with probable serious consequences for countries which are already unable to cope with the maintenance of their roads. It may be prudent for such roads to, as quickly as possible, be given a relatively thick bituminous overlays which can resist the cracking. A geo-fabric such as Tensar-Grid or Glass-Grid may be introduced between the existing surface and the new overlay to attenuate the cracking.

Another issue which requires serious attention is the number of vehicles which had broken down and were being repaired on the carriageway for both roads and the other roads travelled on in the country. Apart from the damage such practice does to the pavements it is also a safety hazard. There may therefore be the need to have a vehicle inspection system established to ensure vehicles that use the road are road-worthy.

Table 4.11: Deflection Details and Residual Pavement Life for Roads in DRC

Test Section			Max deflection	Minimum Deflection	Mean Deflection	Standard Deviation	90th Percentile Deflection	Residual Pavement Life (MESA)	
Direction	Chainage (km)								
	Start	End	(mm)	(mm)	(mm)		(mm)	MESA	Time
Nsele - Lufimi	10.000	20.000	0.2	0.04	0.09	0.03	0.13	64	>20
Nsele - Lufimi	60.000	70.000	0.28	0.10	0.19	0.04	0.23	40	>20
Kwango - Kenge	10.000	17.500	0.10	0.02	0.05	0.02	0.75	30	>20
Kwango - Kenge	37.500	45.000	0.14	0.02	0.06	0.02	0.75	30	>20

4.5 Assessment of Roads in Ghana

4.5.1 Assessment of quality through visual survey

General

Six road sections were studied in Ghana. These sections are the:

1. Agbozume- Aflao road and Akatsi Bypass (27.1 km);
2. Akatsi - Agbozume road (30 km);
3. Akasti - Dzodze - Akanu road (30 km);
4. Nsawam Bypass (9.3 km);
5. Techiman - Apaaso road (53.7 km); and
6. Apaaso - Kintampo road (2.5 km).

Agbozume - Aflao Road Section and Akatsi Bypass

General

The road section has two discrete stretches - the 19.9 km Aflao stretch and the 7.2 km Akatsi Bypass. Both stretches are part of the Trans - West African Coastal Highway and have been provided with a 7.3 m wide single carriageway and 2.5 m wide shoulders. The carriageway has an asphaltic concrete wearing course while the shoulders are surface dressed. This was confirmed through field measurements which showed that in some areas the carriageway is 7.6 m wide. Construction is ongoing with about 90% of the project complete. The last 4 approximately 4 km to Aflao is at various levels of pavement construction.

Drainage

Adequate drainage has been provided for both stretches. The road is in general on a low embankment of between 1 and 1.5 m. Embankments higher than 1.5m have been provided with stone pitching. Lined drains have been provided in the major settlements along the road section.

Safety

The completed portions of the road section have been adequately marked. Adequate, warning, advisory and information signs have also been provided. Zebra crossings and marked speed humps; and rumble strips have been provided in settlements. Guard rails have been provided where necessary and especially on embankments higher than 3 m. Kilometer posts have also been provided.

Pavement Distress

The pavement has shown no distress except for some minor general unevenness, slight raveling at paces and some slight flushing.

Pavement condition Rating

The pavement score for the road section is estimated as 90 with a corresponding PSI of 4.66. The condition is therefore rated as Very Good. The ride quality is Very Good and only slightly impaired by the speed humps and rumble strips.

Akatsi - Agbozume

General

The Akatsi - Agbozume road section is also part of the Trans-West African Coastal Highway. Field measurements indicated that the road has a 7.3 m wide carriageway with 2.5 m wide shoulders as designed. The carriageway has an asphaltic concrete wearing course while the shoulders are surface dressed.

Drainage

Drainage for the road is adequate. A greater part of the road is on a shallow embankment. In the shallow cuts traversed by the road, the Akatsi bound lane has been provided with stone-pitched drains. Concrete drains have also been provided in the towns crossed by the road.

Safety

The road section has been adequately marked. Adequate, warning, advisory and information signs have also been provided. Zebra crossings and marked speed humps; and rumble strips have been provided in settlements. Bus bays have been constructed in settlements. Picture 4.13 some of the safety features on the road section. Guard rails have been provided where necessary and especially on embankments higher than 3 m. Kilometer posts have also been provided.

Picture 4.13: Safety Features on Akatsi - Agbozume Road Section in Ghana

Pavement Distress

The road has shown little distress. The distresses manifested are general unevenness, slight flushing, depressions at the speed humps and minor rutting.

Pavement Condition Rating

The pavement condition score for the road section is estimated as 87 and a PSI of 4.56. The condition is therefore rated as Very Good. The ride quality is Very Good and only slightly impaired by the speed humps and rumble strips.

Akatsi - Dzodze - Akanu

General

The 30 km Akasti - Dzodze - Akanu road section will allow vehicles with no business in Aflao to bypass city through Noefe about 20 km to the north of Lome. It is part of the ECOWAS road network. The carriageway width as measured during the study varied between 7.1 m and 7.6 m with the average of 7.3 m and the shoulder width measured as 2.5 m.

Drainage

Drainage for the road section is adequate. Concrete drains have been provided in the settlements crossed by the road.

Safety

The road section has been adequately marked. Adequate, warning, advisory and information signs have also been provided. Well-designed speed humps; and rumble strips have been provided in settlements. Bus bays have also been provided in the relatively large settlements. Guard rails have been provided where necessary. Kilometer posts were seen over the fifteen kilometer stretch from Akatsi. They were however absent for the remaining 15 or so kilometers believed to be most likely the result of vandalism.

Pavement Distress

The road section has exhibited some minor distresses. These are very slight alligator cracking, very slight longitudinal cracking on the shoulders, slight rutting, slight raveling and very slight flushing. Some patches were noticed, mainly on the Dzodze - Akanu stretch.

Pavement Condition Rating
A pavement condition score of 82 and a PSI of 4.3 have been estimated for the road section indicating a condition rating of Good and the ride quality - Good.

Nsawam Bypass
General
The 9.3 km Nsawam Bypass is a new construction which bypasses the congested town of Nsawam. It is part of the main Accra - Kumasi road and links Accra to Burkina Faso, Mali, Northern Togo and Niger. The Study road is now the north bound carriageway of the bypass with the dualization of the bypass. It has a 7.3 m wide carriageway with a 1.5 m inner shoulder and a 2.5 m outer shoulder.
Drainage
The bypass crosses the Densu flood pain south of Nsawam. Over this stretch, the road is formed on an embankment the rest of the road section crosses an area with a rolling topography. Drainage is therefore good.

Picture 4.14: : School Children Crossing Nsawam Bypass in Ghana

Safety
The road section has been adequately marked. Adequate, warning, advisory and information signs have also been provided. Guard rails have been provided where necessary. There are some isolated communities located to the south of the road. These communities access social services in Nsawam mainly by foot necessitating the crossing of the high speed bypass. There is a high potential for vehicular - pedestrian accidents. This has been exacerbated by the dualization. There are no U- turns and motorists have created unauthorized turns through the median. This also poses a serious threat to safety. Pictures 4.14 and 4.15 illustrate the safety challenges described above which would need to be addressed.
Pavement distress
The Nsawam bypass has shown little distress. The distresses noticed are very slight flushing and very slight ravelling.
Pavement Condition Rating
A pavement condition score of 93 is deduced for the road section with an estimated PSI of 4.77. The condition is rated as Very Good. Ride quality is also Very Good.

Picture 4.15: Unauthorized U-Turn on Nsawam Bypass

Techiman - Apaaso road (53.7 km)
General
The Apaaso - Kintampo road section is part of the Kumasi - Paga road that links southern Ghana to Burkina Faso, Mali, Northern Togo and Niger. The road has been provided with a 7.3 m wide carriageway and 2.5 m wide shoulders.
Drainage
The road traverses an area with a rolling topography. Natural drainage is therefore good. Concrete drains have been provided in the settlements crossed by the road.

Safety

Considerable attention has been given to safety on the road section. Speed humps and rumble strips have been provided to slow down vehicles in the settlements. Guard rails have also been provided where necessary.

Picture 4.16: Paved Walkway for Pedestrians on Techiman - Apaaso Road Section in Ghana

Climbing lanes have been provided at three areas where the road has long stretches with gradients higher than 7%. Raised walkways which are paved have also been provided in the larger settlements to minimize vehicular-pedestrian conflicts. Picture 4.16 shows a raised walkway in a settlement along the road section. There are adequate, warning, advisory and information signs. Kilometer posts have also been provided. The design is adequate for the design speed of 80 km/hr.

Pavement Distress

The pavement has shown some distress, though this is not extensive. The distresses are mainly slight alligator cracking, slight transverse cracking at two main locations, slight to moderate raveling and very slight flushing.

The supervision team indicates that these distresses have been included in the snag list to be rectified by the contractor before the road is handed over.

Pavement condition Rating

A pavement condition score of 80 and a PSI of 4.16 have been derived for the road section. The condition is rated as Good with a Good ride quality.

Apaaso - Kintampo road (6.3 km)

General

The Techiman - Apaaso road section is also part of the Kumasi - Paga road that links southern Ghana to Burkina Faso, Mali, Northern Togo and Niger. The road has been provided with a 7.3 m wide carriageway and 2.5 m wide shoulders.

Table 4.12: Summary of Roughness Data on Study Roads in Ghana

Sub Section Direction	Chainage (km)		Average	Standard	Number of
	Starting	Ending	IRI (m/km)	Deviation (m/km)	Outliers
AGBOZUME -AFLAO ROAD					
Agbozume -Aflao (Agbozume Bound)	0.000	15.000	2.03	0.59	12
Agbozume -Aflao (Aflao Bound)	0.000	15.000	1.98	0.57	12
AKATSI - AGBOZUME ROAD					
Akatsi - Agbozume (Agbozume Bound)	0.200	30.820	2.85	3.63	54
Akatsxi - Agbozume (Akasti Bound)	0.050	30.830	3.00	3.77	55
AKATSI - DZODZE - AKANU ROAD					
Akatsi - Dzodze - Akanu (Akanu Bound)	0.100	29.200	2.55	3.00	49
Akatsi - Dzodze - Akanu (Akatsi Bound)	0.050	29.150	2.68	3.27	54
AKATSI BYPASS					
Akatsi Bypass (Akatsi Bound)	0.050	6.604	1.85	0.59	29
Akatsi Bypass (Sogakope Bound)	0.050	6.629	1.95	1.01	09

Drainage

The road traverses an area with a rolling topography. Natural drainage is therefore good. Concrete drains have been provided in the settlements crossed by the road.

Safety

Considerable attention has been given to safety on the road section. Speed humps and rumble strips have been provided to slow down vehicles in the settlements. Guard rails have also been provided where necessary. There are adequate, warning, advisory and information signs. Kilometer posts have also been provided. The design is adequate for the design speed of 80 km/hr.

Pavement Distress

The pavement has shown little distress. The distresses are mainly slight to moderate raveling and very slight flushing.

Pavement condition Rating

A pavement condition score of 80 and a PSI of 4.16 have been derived for the road section. The condition is rated as Good with a Good ride quality.

4.5.2 Assessment of quality in terms of riding quality

Roughness measurements used for the assessment of riding quality for the roads in Ghana have been analyzed and summarized in Table 4.12.

From the study of the results, the rating of the riding quality for the roads in Ghana is assessed as follows:

Agbozume - Aflao road & Akatsi Bypass	-	Fair
Akatsi - Agbozume road	-	Fair
Akasti - Dzodze - Akanu road	-	Fair
Nsawam Bypass	-	Good
Techiman - Apaaso road	-	Fair
Apaaso - Kintampo roaad	-	Fair

Average IRI without Outliers (m/km)	% Section Very Good	% Section Good	%Section Fair	% Section Mediocre	% Section Poor	Rating
1.91	0.00	6.85	83.56	5.48	4.11	FAIR
1.92	0.00	16.67	77.78	2.78	2.78	
1.84	1.31	34.80	49.18	2.78	11.93	FAIR
1.93	2.44	30.36	49.03	4.38	13.80	
1.71	2.06	42.37	40.65	3.77	11.15	FAIR
1.74	3.95	36.71	44.94	2.06	12.35	
1.72	0.76	35.61	55.30	6.82	1.52	Fair
1.79	2.00	24.00	69.00	3.00	2.00	

Table 4.12: Summary of Roughness Data on Study Roads in Ghana (suit)

Sub Section Direction	Chainage (km)		Average	Standard	Number of
	Starting	Ending	IRI (m/km)	Deviation (m/km)	Outliers
NSAWAM BYPASS					
Nsawam Bypass, North Bound Carriageway - Inner lane	0.050	9.350	1.57	0.92	21
Nsawam Bypass, North Bound Carriageway - Outer lane	0.050	9.25	1.62	0.82	25
TECHIMAN - APAASO					
Techiman- Apaaso Road	0.0	52.698	1.61	0.85	52
Apaaso -Techiman Road	2.5	56.014	1.69	0.84	60
APAASO - KINTAMPO					
Apaaso-Kintampo Road	52.748	54.971	1.78	0.59	7
Kintampo-Apaaso Road	0.0	2.5	1.59	0.43	0.00

4.5.3 Assessment of quality in terms of structural capacity

The falling weight deflectometer (FWD) was used to evaluate the structural capability of the roads in Ghana. The homogenous sections tested, the derived Elastic Moduli and the residual life in terms of traffic carrying capacity have been summarized in Table 4.13.

Table 4.13: Summary of E Values and Residual Life for Ghana road sections

Road/Test Section	From	To	Elastic Modulus (MPa)				Residual Life	
(Km)	(km)	(km)	AC	Base	Subbase	Subgrade	MESA	Years
Agbozume - Aflao (Aflao Bound)	3.000	7.900	2200	266	251	340	15.86	31.7
Agbozume - Aflao (Agbozume Bound)	10.000	15.000	3556	296	279	240	13.62	27.1
Akatsi Bypass (Agbozume Bound)	0.000	2.000	2268	389	367	240	15 .92	31.8
Akatsi Bypass (Agbozume Bound)	5.000	6.650	2499	382	360	187	12.55.	25.1
Akatsi Bypass (Akatsi Bound)	2.000	5.000	2130	415	391	221	14.85	29.7
Akatsi - Agbozume (Akatsi Bound)	0.000	3.000	3410	394	371	283	17.34	34.7
Akatsi - Agbozume (Akatsi Bound)	16.000	19.000	2653	379	357	238	17.94	35.9
Akatsi - Agbozume (Akatsi Bound)	22.000	25.000	2640	332	313	238	17.25	34.5
Akatsi - Agbozume (Akatsi Bound)	28.000	30.950	2494	396	374	272	18.35	36.7
Akatsi - Agbozume (Agbozume Bound)	5.000	9.000	2403	332	313	274	18.26	36.5
Akatsi - Agbozume (Agbozume Bound)	11.000	14.000	2074	314	296	275	17.85	35.7
Akatsi - Agbozume (Agbozume Bound)	24.000	27.950	1810	364	343	281	17.34	34.7
Akatsi-Dzodze-Akanu (Akastsi Bound)	1.000	3.000	2980	417	394	271	15.43	25.3
Akatsi-Dzodze-Akanu (Akatsi Bound)	6.000	9.000	2147	331	312	240	10.19	16.7
Akatsi-Dzodze-Akanu (Akatsi Bound)	14.000	16.000	2154	355	334	281	11	18.3
Akatsi-Dzodze-Akanu (Akatsi Bound)	22.000	25.000	1926	332	313	303	8.36	13.7
Akatsi-Dzodze-Akanu (Akanu Bound)	4.000	8.000	1422	301	284	254	5.62	9.2
Akatsi-Dzodze-Akanu (Akanu Bound)	14.000	17.000	1597	343	323	295	6.54	10.7
Akatsi-Dzodze-Akanu (Akanu Bound)	19.000	24.000	1425	316	298	282	5.93	9.7

Average IRI without Outliers (m/km)	% Section Very Good	% Section Good	%Section Fair	% Section Mediocre	% Section Poor	Rating
1.38	26.00	35.00	33.00	4.00	2.00	Good
1.47	24.00	31.00	40.00	3.00	3.00	
1.51	8.00	48.00	42.00	1.00	1.00	Good
1.56	6.00	45.00	45.00	2.00	2.00	
1.57	0.00	41.00	50.00	7.0	2.0	Fair
1.59	6.00	49.00	45.00	0.00	0.00	

Table 4.13: Summary of E Values and Residual Life for Ghana road sections (suit)

Road/Test Section (Km)	From (km)	To (km)	Elastic Modulus (MPa) AC	Base	Subbase	Subgrade	Residual Life MESA	Years
Nsawam Bypass (Outer Lane)	0.000	9.250	1877	418	394	194	14.14	8
Nsawam Bypass (Inner Lane)	0.000	9.200	1999	394	372	186	13.78	7
Techiman - Kintampo (Techiman Bound)	1.000	4.000	2062	364	343	182	15.22	15
Techiman - Kintampo (Techiman Bound)	20.000	24.000	2137	343	324	188	16.45	16
Techiman - Kintampo (Techiman Bound)	26.000	30.000	1915	400	377	244	15.45	15
Techiman - Kintampo (Kintampo Bound)	2.000	4.000	2544	412	389	295	18.67	18
Techiman - Kintampo (Kintampo Bound)	5.000	8.000	1930	365	344	268	11.58	11
Techiman - Kintampo (Kintampo Bound)	15.000	18.000	1578	374	353	197	9.85	9
Techiman - Kintampo (Kintampo Bound)	23.000	26.000	1583	368	347	285	10.45	10
Techiman - Kintampo (Kintampo Bound)	38.000	42.000	1349	318	300	197	7.22	7
Apaaso - Kintampo (Apaaso Bound)	0.6	3.6	1598	383	361	327	12.45	12
Apaaso - Kintampo (Kintampo Bound)	0.6	3.6	1227	329	310	240	5.22	5

4.5.4 Assessment of quality in terms of pavement layer characteristics

The quality of the pavement as constructed has been assessed based on a comparison of the characteristics of the pavement layers as provided, with the specified requirements. Laboratory tests have been carried out on samples of materials recovered from the field. This has involved the determination of the thicknesses, field densities of the layer; the bitumen content and the particle size distribution of the aggregates used for the bituminous layers, the characteristics of the aggregates used in the bases and the CBR, particle size distribution and the Atterberg limits of the natural gravel subbases. The tests show that in general the layers met the specifications. The percentage of air voids in the wearing courses for the Akatsi - Agbozume (9.97%), Nsawam Bypass (5.91%) and Apaaso - Kintampo (6.62%) were higher than the specified 3 - 5%. The percentage of voids measured as 10.91 % for the DBM for Nsawam Bypass was higher than the specified 4 - 8%. Also the voids for the asphaltic concrete base course for the Techiman - Apaaso road of 9.92%, 7.88% for the Apaaso - Kintampo and 8.23% for the Akatsi - Agbozume road sections were higher than the specified 3 - 5%. The plasticity index for a sub-base sample from the Akatsi - Dzodze road at 18.9% was slightly beyond the specified limit of 15%. The thickness of the sub-base layer of the Techiman - Apaaso and the Apaaso - Kintampo measured as 90 mm and 100 mm in the pits dug was lower than the specified 200 mm. The supervision team has however indicated that sections of the road were in relative good condition and varying thicknesses of sub-base were applied to make up any strength deficit. The test results are provided in Appendix 2.3.

4.5.5 Summary

Six road sections have been studied in Ghana. The pavement condition was rated as very good for three of them and good for the other three. The riding quality as measured by roughness was rated as good for the Nsawam Bypass and fair for the five other road sections. The structural capacity was rated as good or very good for four of the road sections except for the Techiman - Apaaso and Apaaso - Kintampo sections which were rated as mediocre.

The overall quality was rated as good for the Nsawam Bypass, fair for the Agbozume - Aflao, Akatsi - Agbozume and the Akasti - Dzodze - Akanu road sections and mediocre for the Techiman - Apaaso and Apaaso - Kintampo road sections. It may be necessary to carry out further investigations to confirm the adequacy or otherwise of the pavement for the Techiman - Apaaso and Apaaso - Kintampo road sections for the anticipated traffic loading; and to make recommendations for remedial action if found necessary.

4.6 Assessment of Roads in Kenya

4.6.1 Assessment of quality through visual survey

The three Study roads assessed in Kenya as part of the assignment are:

- Athi River - Namanga Road (136 km);
- Isiolo - Merillie Road (136 km); and
- Nairobi - Thika Road (45 km).

Athi River - Namanga Road

General

Athi River - Namanga Road is an important arterial road connecting Kenya with Tanzania. At Athi River it takes off from the Mombasa - Nairobi highway. From Tanzania come maize, onion and other agricultural produce. From Kenya industrial produce goes to Tanzania.

Though most of the road passes through open grass lands, there are a number of small towns traversed by it. Within the towns, for short distances, the road has a divided carriageway with 4 lanes. Outside the towns, it is a two lane undivided 7 m wide carriageway road with 2 m wide paved shoulders.

Drainage

At most locations, the road is on an embankment of average height of one meter with good natural drainage. Wherever side drains have been provided, these are earth drains. Part of the length of the road passes through rolling terrain and had been provided with good cross drainage.

Safety

The road passes through mostly plain terrain with small lengths passing through rolling terrain. No higher level safety provisions appear to be warranted. There are not enough warning, advisory and information signs. At some places, the harmonization of vertical and horizontal curves has not been properly done creating a potentially hazardous situation, such as at Km 62 from Athi River. Kilometer markers are regularly provided. A level railway crossing just outside Kajiado poses a serious hazard. There are no barriers at this crossing. Speed humps have been provided at both sides of the crossing but motorists speed across this even with trains approaching the crossing. This phenomenon was observed during the visual survey. Barriers would need to be provided for the avoidance of a serious accident in the future. Discussions with the Road Administration indicated that action was being taken on this issue. There were occasional herds of cattle but there were no warning signs - a potentially hazardous situation for motorists as shown in Picture 4. 17.

Picture 4.17: *Cattle Crossing the Athi River - Namanga Road Section*

Pavement Distress

Though the road, in general is, in a comparatively good condition, at places, especially around km 83 to km 85, there are signs of edge failure and shoving; and lifting of bituminous material at other places. Some patch repairs are also seen. There are also shoulder edge breaks at new entries to the road created by newly established farms and industrial estates.

Pavement Condition Rating

The road shows no other distress such as raveling, potholing, rutting or cracking. The road however shows slight unevenness of long wavelengths over the pavement area which have resulted from settlements or depressions.

The pavement condition score is estimated as 84 and the PSI as 4.42 giving a pavement condition rating of Good. Before the improvement, the road was part a bituminous surfaced road and part gravel road. It used to take a full day to cover the 136 km length. The road now has a fairly good riding quality and it takes about 3 hours to complete the journey. Being a through route connecting Kenya with Tanzania, there is considerably more traffic on it. As a result large a number of rumble strips, mostly in built-up areas, have been provided which have reduced the otherwise reasonably good ride quality of the road. Besides these narrow rumble strips, there are properly designed speed humps of 4 to 5 meter width, which beside serving the intended purpose of reducing vehicle speeds do not deteriorate the quality of ride.

Isiolo - Merille Road

General

The road passes through a very gently rolling terrain, mostly through rural area and agricultural fields. A small length of the road passes through built-up areas.

The road in its entirety is a two lane undivided road with a 7m wide carriageway and 2 m wide surface treated shoulders.

Picture 4.18: *A Herd of Cattle and Sheep Crossing the Isiolo - Merille Road Section*

Drainage

The road is on an embankment for a large part of the length and has good natural drainage. Wherever side drains have been provided, these are in the form of earth drains.

Safety

The road generally passes through plain terrain. The geometric design is adequate for the design speed. In the rural sections there is inadequate advance directional signs Provision of road signage for the sections passing through built-up areas has, however, been adequately made. Metal crash barriers have been provided at the location of relatively high embankments. In the larger settlements along the road, lay-byes have been provided with separators removing any possible conflict with through traffic. The area traversed by the road is inhabited mainly by pastoralists. Animal crossings were rampant. There were no signs warning motorists of possible animal crossings.

This could be potentially hazardous for travelers not familiar with the area. Picture 4.18 shows a herd of cattle and sheep crossing the road.

Pavement Distress

The road is generally good. It shows no distress, except between km 8 and 15, where a number of longitudinal cracks have opened up mainly in the north bound carriageway, but with some shorter sections in the south bound lane.

There were also some transverse cracking associated with the longitudinal cracking in places.

The cracks were shallow and restricted to the upper part of the asphalt layer.

Pavement Condition Rating

The road shows no distress in terms of raveling, potholing, shoving, rutting or patching. The road however shows slight unevenness of long wavelengths resulting from shallow settlements or depressions especially at the Isiolo end of the road, but which covers less than 1% of the pavement area.

A condition score of 82 has been estimated for the road section giving a condition rating of Good and a PSI of 4.3. The road has a good riding quality in spite of the cracking that the road has suffered. With the passage of time, if the situation is not rectified properly, these cracks, by allowing water to percolate down to the lower layers during the wet season, will lead to deterioration that will adversely affect the riding quality of the road.

The rumble strips provided at different locations, from considerations of safety, and though properly executed, tend to reduce the ride quality of the road.

Nairobi - Thika Road

General

The 42 km long, multi-lane divided carriageway road, designated as A2 super highway is an access controlled fast-connecting road between the capital city of Nairobi and the town of Thika. It was opened to traffic in November 2012.

The road is a divided multi-lane facility. Within the urban section, it is an eight lane divided dual carriageway facility flanked on either side with a 5.5/7.5 m wide service road, a 2/3 m bicycle track and a 2 m pedestrian walkway. The rural section is a 6-lane divided dual carriageway road with 1.5 m wide shoulders. The shoulders are finished with the same materials as the carriageway and flush with the main carriageway.

Drainage

The road is mostly in very gently rolling terrain and is in generally on an embankment with an average height of one meter. There are not many large cuttings or fillings along the alignment. Due to good natural drainage there are not many drains provided along the road, but wherever drains have been provided these are shallow lined drains only. There is a small number of medium sized cross drainage structures.

Safety

There are sufficient road edge surface markings. With the shoulders finished to the same level and standard as the carriageway, the road markings which are in good condition now may get obliterated with the passage of time, blurring the distinction between the carriageway and shoulders. Periodic re-marking would therefore be necessary for safety.

Guard rails have been provided along the median throughout the length of the road. Along the outer edge of the pavement, guard rails are again provided wherever the road level is considerably higher than the surrounding ground level; and at drainage structures. Guard rails are also provided wherever the road passes through a built up area.

A good number of high capacity aesthetically designed pedestrian bridges have been provided. In spite of the presence of these pedestrian bridges, at-grade crossings have been created. The crossings are preceded by marked speed breakers which do not seem to deter speeding motorists creating a serious safety hazard for pedestrians, a good number of who use these at-grade crossings.

Pavement Distress

There are no apparent signs of any damage or distress on the road.

Pavement Condition Rating

The road shows no distress in terms of raveling, potholing, shoving, rutting or patching except for very slight unevenness, resulting from settlements or depressions with long wavelengths. A condition score of 93 and a PSI of 4.77 have been estimated for the road section giving a condition rating of Very Good. Riding quality of the road is good and vehicles often tend to exceed the specified speed limit of 100kph.

4.6.2 Assessment of quality in terms of riding quality

The analyses of roughness measurements used for the assessment of the riding quality of the three road sections in Kenya have been summarized in Table 4.14. Also presented in Table 4.15 are the ratings for each lane tested and the proportions of each lane with different ratings. From the results, the Athi River -- Namanga road is rated as Fair, the Isiolo - Merille road as Fair and the Nairobi -Thika road as Good.

Table 4.14: Summary of Roughness Data on Study Roads in Kenya

Sub Section Direction	Chainage (km)		Average	Standard	Number of
	Starting	Ending	IRI (m/km)	Deviation (m/km)	Outliers
Athi River - Namanga Road (To Namanga)	0.000	136.300	2.17	0.78	93
Athi River - Namanga Road (To Athi River)	136.300	0.000	2.22	0.73	88
Isiolo- Merillie Road (To Merillie)	0.000	138.500	1.83	0.74	125
Isiolo- Merillie Road (To Isiolo)	138.500	0.000	1.69	0.67	129
Nairobi Thika Road (To Thika Inner lane)	0.000	40.650	1.86	0.96	30
Nairobi Thika Road (To Nairobi Inner lane)	40.000	0.000	1.76	0.90	24
Nairobi Thika Road (To Thika middle lane)	0.000	40.650	1.59	0.66	30
Nairobi Thika Road (To Nairobi middle lane)	40.000	0.000	1.61	0.68	31
Nairobi Thika Road (To Thika outer lane)	0.000	38.800	1.55	0.62	29
Nairobi Thika Road (To Nairobi outer lane	38.800	0.000	1.56	0.62	26

4.6.3 Assessment of quality of construction in terms of structural capacity

The Falling Weight Deflectometer (FWD) was used to evaluate the structural capacity of the project roads in Kenya. The Study roads evaluated are:-

- Athi River - Namanga Road (136 km);
- Isiolo - Merillie Road (136 km); and
- Nairobi - Thika Road (45 km)

The homogenous sections tested on these road sections, the elastic moduli and the residual pavement strengths have been summarized in Table 4.15.

4.6.4 Assessment of quality in terms of pavement layer characteristics

The quality of the pavement as constructed has been assessed based on a comparison of the pavement as provided, with the design requirements. The characteristics of the materials used for the pavement layers have been determined through laboratory tests on samples recovered from the field. The laboratory tests carried out on the layer samples include gradation, the California Bearing Ratio (CBR) and Atterberg Limits. The thicknesses and field densities of the various layers were also determined. The results showed that for all three road sections, the construction met the specifications. The laboratory test results are provided in Appendix 2.3;

4.6.5 Summary

The three road sections studied in Kenya are rated as good for the Nairobi- Thika Road and fair for the Athi River - Namaga and Isiolo- Merille road.

Average IRI without Outliers (m/km)	% Section Very Good	% Section Good	%Section Fair	% Section Mediocre	% Section Poor	Rating
2.01	0.00	8.14	81.14	7.19	3.52	Fair
2.08	0.00	1.03	89.58	6.16	3.23	
1.67	0.00	33.43	59.49	4.19	2.89	Fair
1.53	0.00	50.04	44.77	2.96	2.24	
1.66	0.98	38.33	52.58	4.91	3.19	Good
1.61	0.00	43.39	50.69	3.24	2.74	
1.44	0.00	62.16	33.66	1.97	2.21	
1.46	0.00	58.85	36.91	1.50	2.74	
1.41	0.00	66.75	28.61	2.32	2.32	
1.42	0.00	66.58	28.98	1.83	2.61	

Table 4.15: Summary of E Values and Residual Life

Length (Km)	Elastic Modulus (MPa)				Residual Life	
	Surfacing	Base	Sub-base	Subgrade	MESA	Years
SECTION : ATHI RIVER - NAMANGA SECTION						
Km 21+000 - km 23+000	5381	4534	-	112	96	>20
Km 23+000 - km 25+300	4831	2030	-	89	96	>20
Km 25+300 - km 26+700	2794	2247	-	86	88	>20
Km 26+700 - km 28+000	3960	4778	-	110	39	>20
SECTION: ISIOLO - MERILLE SECTION						
Km 9+000 - km 10+000	4434	159	85	48	0.02	0.1
Km 10+000 - km 11+000	4278	366	196	111	0.87	4.5
Km 75+000 - km 80+000	3718	484	200	148	0.90	4.5
SECTION: NAIROBI - THIKA SECTION						
Km 30+550 - km 32+850	3672	1530	922	193	135	>20
Km 32+850 - km 35+650	4535	1756	1058	286	174	>20

The Nairobi - Thika and the Athi River road sections have adequate residual strengths and should be able to provide the expected service over the next twenty years given adequate and timely maintenance
The Isiolo - Merille road however has exhibited cracking which was visible over approximately a 10 Km stretch. The estimated residual strengths for the sections tested ran-

ged from 0.02 to 0.9 MESA suggesting that some intervention would be required soon if the road is to provide the expected service.

4.6.4 Assessment of quality in terms of pavement layer characteristics

The quality of the pavement as constructed has been assessed based on a comparison of the pavement as provided, with the design requirements. The characteristics of the materials used for the pavement layers have been determined through laboratory tests on samples recovered from the field. The laboratory tests carried out on the layer samples include gradation, the California Bearing Ratio (CBR) and Atterberg Limits. The thicknesses and field densities of the various layers were also determined. The results showed that for all three road sections, the construction met the specifications. The laboratory test results are provided in Appendix 2.3.

4.6.5 Summary

The three road sections studied in Kenya are rated as good for the Nairobi- Thika Road and fair for the Athi River - Namaga and Isiolo- Merille road.
The Nairobi - Thika and the Athi River road sections have adequate residual strengths and should be able to provide the expected service over the next twenty years given adequate and timely maintenance
The Isiolo - Merille road however has exhibited cracking which was visible over approximately a 10 Km stretch. The estimated residual strengths for the sections tested ranged from 0.02 to 0.9 MESA suggesting that some intervention would be required soon if the road is to provide the expected service.
Further and more detailed investigations would therefore be required for the Isiolo-Merille road to assess the causes of the cracking and the lower than expected residual strength.

4.7 Tanzania - Zanzibar

4.7.1 Assessment of quality through visual surveys

The three roads on Zanzibar island which were evaluated as part of the assignment are:
- Amani - Dunga Road, 12.75 km;
- Manzizini - Fumba Road, 17.81 km; and
- Mfenisini - Bumbwini Road, 13.10 km

Zanzibar is a small island and therefore the Study roads, as also the other roads, are of short lengths and since the roads take off from the outskirts of Zanzibar town, the roads tend to have the character of local roads. Traffic tends to be mainly composed of light vehicles with very little heavy commercial traffic.

Amani - Dunga Road Section

General

The road, takes off from the Amani town runs eastward. Though a major length of the road passes through built-up areas or agricultural fields, part of the road before the intersection with the Kinyasini - Chawaka road passes through a wooded stretch.

Within the Amani town, for about a kilometer, the road has 4-lanes, with a divided carriageway. Outside the town area it is a two lane undivided 6.5 meter wide carriageway road with 1.5 meter wide paved shoulders.

Drainage

Part of the road is in flat terrain with some length in rolling terrain. The road is therefore mostly on an embankment. The embankment, on an average is of one meter height. There aren't any large cuttings or fillings along the alignment. Due to good natural drainage there are not many drains provided along the road, but wherever drains have been provided these are shallow earth drains. There are no lined drains provided. The terrain being flat there aren't any large cross drainage provisions.

Safety

The road passes through mostly plain terrain with small lengths passing through rolling terrain. Though no special safety provisions are warranted, for the one location where guard rails have been provided, it has been provided only on one side while both sides were assessed to require rails. Road signage was deemed to be inadequate. The information signs, warning signs and advisory signs were fewer than desirable.

Pavement Distress

No surface distress in any form, except some minor settlements, was observed on the road.

Pavement Condition Rating

The road shows no distress in terms of raveling, potholing, shoving, rutting or patching. The road however shows some slight unevenness, resulting from settlements or depressions with long wavelengths. A condition score of 95 with a PSI of 4.83 has been derived for the road section giving a condition rating of Very Good.

The road has a fairly good riding quality. The road ends at the junction with the Kinyasini - Chawaka road which being a through route has considerably more traffic on it. To slow down vehicles from the study road entering the Kinyasini - Chawaka road, a large number of rumble strips, mostly in the built-up areas, have been provided which reduce the otherwise very good riding quality of the road. Besides these rumble strips, there is one properly designed speed hump of 4 to 5 meter width, which despite serving the intended purpose of reducing vehicle speeds does not impair the ride quality.

Manzizini - Fumba Road Section

General

The 17.81 km long Manzizini - Fumba Road goes from the outskirts of Zanzibar town in a southerly direction and ends at Fumba at the sea shore. The beach has not been developed and there is very little tourist traffic there as of now. Some fishing activity however is flourishing. The traffic therefore appears light. The road is an undivided two lane facility with 6.5 meter wide carriageway and 1.5 meter wide shoulders. The shoulders are paved with the same materials as the main carriageway and the levels flush.

Drainage

At most locations, the road is in embankment of average height of one meter with good natural drainage. Wherever side drains have been provided, these are earth drains. The drain in one of the settlements along the road has been filled by residents to allow vehicles to enter the road or no drain was provided in the first place as shown in Picture 4.19.

Safety

The road was completed about four years ago. Under four years of traffic the road surface markings have faded in many places. Edge markings were limited to a few stretches. Road signs are inadequate but it was difficult to tell whether the signs have been vandalized or were not provided with the construction.

Riding Quality

The road section has a very good riding quality.

Pavement Distress

There are no visible signs of any distress except around km 7 where a crack has opened in the shoulder and is extending into the carriageway as shown in Picture 4.20.

Picture 4.19: *Blocked Drain on Manzizini - Fumba Road Section , Zanzibar*

Pavement Condition Rating

The road shows no distress in terms of raveling, potholing, shoving, rutting or patching. The road however shows considerable unevenness, over up to 1% of the pavement area, resulting from settlements or depressions of long wavelengths. A pavement score of 92 and a PSI of 4.73 have been assessed for this road section. The pavement condition is therefore rated as Very Good. The road has been under traffic, which though is light, for nearly four years, the road still has a good riding quality.

Mfenisini - Bumbwini Road

General

The 13.1 km long road takes off from Zanzibar town at Mohonda road and is largely north bound. It is not a through road but ends in the village of Makoba, about 2.5 km after Bumbwini.

Being an internal road, the traffic is rather low. Besides the passenger traffic, comprising mostly of light commercial vehicles, with one or two large size buses and cars, a few large commercial vehicles, mostly carrying sand and other building materials were seen plying on the road. Local agricultural produce was also being carried on light commercial vehicles.

Picture 4.20: *Longitudinal Crack on Manzizini - Fumba Road Section, Zanzibar*

The road is an undivided two lane facility with a 6.5 meter wide carriageway and 1.5 meter wide shoulders. The shoulders are paved to the same level and with the same materials as the main carriageway. As a result the carriageway and the shoulders are flush at the same level.

The carriageway beyond Bumbwini to Makoba gets reduced to total 5.0 meters for the two lanes, with 30 cm wide shoulders. The road was completed in June 2012.

Drainage

The road is mostly on an embankment of average height of one meter. There aren't any large cuts or fills along the alignment. Due to good natural drainage there are not many drains provided along the road, but wherever drains have been provided these are shallow earthen drains. There are no lined drains provided. The terrain being flat and with agricultural fields on both sides, there aren't any large cross drainage provisions. There is one minor bridge at Mekundu.

Safety

There are sufficient edge markings and road surface markings and road signs. The shoulder, being finished to the same standard as the carriageway, the surface road markings which are now in good condition are fading with the passage of time. Distinction between the carriageway and shoulders would start to get lost over time and the road would need to be re-marked.

No guard rails were provided but since the road is in flat terrain and embankment heights are small, there was no need for guard rails and similar safety provisions.

Pavement Distress

There are no apparent signs of any damage or distress on the road.

Pavement Condition Rating

The road shows no distress in terms of raveling, potholing, shoving, rutting or patching. The road however shows slight unevenness in places. A pavement condition score of 95 and a PSI of 4.83 have been assessed for the road section. A pavement condition rating based on an evaluation of the pavement distress is indicated to be Very Good. The riding quality of the road is good.

4.7.2 Assessment of quality in terms of riding quality

The analyses of roughness measurements for the three roads in Zanzibar including the rating of the riding quality have been presented in Table 4.16. From the analyses, all three roads are rated as Good.

Table 4.16: Summary of Roughness Data for Study Roads in Zanzibar

Sub-Section/ Direction	Chainage (km) Start	End	Average IRI	Standard deviation	Number of outliers	Average IRI without outliers	% Section very good	% Section good	% Section Fair	% Section Mediocre	% Section Poor	Rating
Amani - Dunga	0.00	13.00	1.76	1.25	10	1.43	0.00	62.31	29.23	1.54	6.92	Good
Dunga- Amani	13.00	0.00	1.76	1.07	12	1.47	0.00	59.23	30.00	4.62	6.15	
Manzizini - Fumba	0.00	18.30	1.33	0.27	9	1.28	0.00	87.98	11.48	0.55	0.00	Good
Fumba - Manzizini	18.30	0.00	1.30	0.18	26	1.25	0.00	89.07	10.93	0.00	0.00	
Mfenisini - Bumbwini	0.00	12.10	1.55	1.08	8	1.30	0.00	84.30	9.09	1.65	4.96	Good
Bumbwini -Mfenisini	12.10	0.00	1.59	1.20	7	1.31	0.00	80.99	13.22	0.00	5.79	

4.7.3 Assessment of quality in terms of structural capacity

The structural capacity of the road sections in Zanzibar has been assessed using the Benkelman Beam.

The stretches tested for the three road sections, the relevant deflection values including the 90th percentile values of the maximum deflections and the derived residual lives have been summarized in Table 4.17.

Table 4.17: Deflection Details and Residual Pavement Life for Roads in Zanzibar

Test Section / Direction	Chainage (km) Start	Chainage (km) End	Max. Deflection (mm)	Min. Deflection (mm)	Mean Deflection (mm)	Standard Deviation	90th Percentile Deflection	MSN	Residual Life MESA	Residual Life Years
Amani - Dunga	0.00	6.00	1.28	0.1	0.36	1.19	0.61	4.3	16	>20
Dunga - Amani	6.00	0.00	0.66	0.12	0.37	0.12	0.51	5.8	32	>20
Manzizini - Fumba	0.00	10.20	0.84	0.08	0.35	0.15	0.53	5.6	30	>20
Fumba Manzizini)	10.20	0.00	0.76	0.06	0.33	0.14	0.51	5.8	32	>20
Mfenesini - Bumbwini	0.00	6.00	0.60	0.08	0.28	0.12	0.40	6.0	62	>20
Bumbwini Mfenesini	6.00	0.00	0.60	0.10	0.35	0.12	0.50	5.9	56	>20

4.7.4 Assessment of quality in terms of pavement layer characteristics

Assessment of the quality of the pavement as constructed has been carried out based on a comparison of the pavement as provided with the design requirements, in terms of layer thicknesses, materials utilised with regard to material properties and their strength characteristics. The tests show that the materials utilized and the thicknesses met the specifications. The CBR for the base layers for the Amani - Dunga and the Mfensini - Bumbwini road sections however did not meet the specifications. This is likely related to the nature of the materials utilised and the processes it had to pass through in determining the properties for this study. Crushed coral stone was used for the base/sub-base layers. This type of material has cementitious properties which can be destroyed through compaction but can be re-established with time in the presence of the appropriate amounts of water, usually the quantities used for compaction. The materials had gone through the earlier compaction during construction when they must have met the specifications. Samples of such materials removed from the road and re-compacted in the laboratory would further have destroyed the fabric giving lower than expected CBRs. A study of the construction test results from progress reports indicated compliance with the specifications for use. The high residual strengths and the current performance of the roads further reinforce this argument. It is concluded that the materials as incorporated in the pavements for the road sections meet the specifications and should provide the required performance.

4.7.5 Summary

All the three road sections studied in Zanzibar were rated as good. The residual strengths for the road sections ranged from 15 MESA to over 60 MESA. These exceed the design values. The roads should therefore be able to provide reasonable service over the next twenty years if they are regularly maintained.

The higher than anticipated residual strengths of the roads in Zanzibar may be linked to the type of materials used and the type of sub-grade for the roads. The roads were built on the underlying coral bedrock. The base layers were also constructed of aggregates from the coral rock. This type of rock has natural cementatious characteristics and over time hardens without becoming brittle and thus providing increased strength. This may explain the high residual pavement strengths. Further investigations would be required to ascertain the causes of the cracking on the Manzizini - Fumba road; and what remedial actions need to be taken.

4.8 Tanzania - Mainland

4.8.1 Assessment of quality through visual survey

The three lots of the 223.6 km Singida - Babati - Minjingu Road upgrading project on Mainland Tanzania namely:-

- Singida - Katesh Road (91.2 km) - Lot 1;
- Katesh - Dareda Road (70.3 km) - Lot 2; and
- Dareda - Babati - Minjingu Road (60.9 km) - Lot 3;

have been studied as part of the assignment.

While the Singida - Katesh - Dareda - Babati is a link road joining Singida on the Manyoni - Nzega Road to Babati on the Arusha - Dodoma road, the Babati - Minjingu section is a part of the Arusha - Dodoma Road. The Singida - Babati road was a gravel road which has been upgraded to a surface dressed road from Singida to Dareda and finished with bituminous concrete surfacing from Dareda to Babati. The Babati - Minjingu section which was originally paved, but had deteriorated to the level of a gravel road due to the lack of proper maintenance, has been finished with bituminous concrete surfacing.

Though the three road sections are contiguous, the Babati - Minjingu section being part of the Dodoma - Arusha Road has considerably a higher level of commercial and total traffic compared to the the Singida - Babati section.

Singida - Katesh Road Section

General

The Singida - Katesh road section takes off from a rotary before the road coming from Manyoni enters the town of Singida.The road section traverses an area with a rolling topography.

The road section is in an area with a rolling topography. Both the horizontal and vertical components of the road alignment have been improved, one or two abrupt changes in the alignment had however not been completely removed. Further improvement of the alignment would have involved considerable land acquisition and perhaps was the reason it was allowed to remain that way. The sight distances and curvatures are however adequate

Carriageway and Shoulders

The 2.5 km long bypass to the Singida town is a four lane divided carriageway road with 1.5 meter wide paved shoulders in an urban environment. The pavement and the shoulders are finished in bituminous concrete.

Coming out of the inhabited area to the rural area, the road becomes an undivided two lane single carriageway road of 6.5 meter width, with shoulders of 1.5 meter width on either side. Beyond the town area the carriageway has been finished in double bituminous surface dressing (DBST) and the shoulders have been sealed with a single coat of surface treatment.

The drop in level between the carriageway and the shoulder is minimal, so much so that at the turnings vehicles were seen partly using the shoulder. Being new, and with little traffic on it, the bitumen has not yet worked its way up. The road therefore looks light grey with a rough open texture and gives a hungry impression.

Drainage

The 2.5 km long road section at the beginning, passing through the outskirts of Singida has covered, lined drains that also serve as footpaths for pedestrians.

Outside the built-up areas, the road is formed over an embankment of height ranging from1.0 to 1.5 meters. It therefore has good natural drainage. Wherever the road passes through built up areas, trapezoidal shaped side drains of large capacity, lined with concrete panels have been provided. The road has also been provided with lined drains in cut sections. At places, where the embankment width is relatively small, the embankment slopes have been stone pitched and in places extended to accommodate the lined side drains.

Safety

Signage and road markings in the town area are very good. Adequate safety provisions in terms of long lengths of guard rails or guard posts have been made with adequate signage. Also to slow down vehicles near inhabited areas rumble strips and properly designed and constructed speed humps have been provided over the full width of the carriageway and shoulders. There are sufficient signage and road markings to warn the drivers of their presence. The road also has a large number of bus bays near the inhabited areas. The signage quality is good and the road markings have been done in good quality thermoplastic paint. Kilometer posts were completely missing during the period of the investigation.

In sections with relatively long stretches of steep gradients (estimated to be higher than 6%), climbing lanes have been provided.

Riding Quality

Riding quality of the road section in the town area, which has been finished in asphaltic concrete, is good.

The ride quality of the section in the area beyond Singida Township, which has been finished in DBST, is not very smooth and besides more pronounced vehicle vibration, there is considerable more traffic noise. With time and under traffic, the aggregates will settle deeper into the bitumen layer and consequently with the bitumen working its way up, the road surface will become smoother without impairing skid resistance, ride quality will improve and traffic noise will reduce.

Pavement Distress

A part of the road has developed some transverse cracks of short lengths and another stretch shows intermittent longitudinal cracking along the outer wheel path over approximately a ten kilometer stretch. The cracks have been properly sealed. No further action is required at this stage, but it is important to investigate the underlying reason for this phenomenon. The site is about 15 km away from Singida. Since the road did not have kilometer posts, it was not possible to indicate a more precise location. A pit was dug within this stretch during the field work, across the cracks, to investigate the possible cause(s) of the cracking.

Transverse cracks that extend at right angles to the central line of the pavement almost always result from environmental factors and may deteriorate under traffic during unfavorable conditions like moisture ingress.

These are generally the result of natural shrinkage of stabilized lower layers. The road under study has cement-stabilized sub-base and base courses. Besides the transverse cracks, the road section suffers some longitudinal cracks also that run parallel to the shoulder along the wheel paths, almost parallel to the center-line of the pavement. The cracks that have appeared on the DBST surfacing are the result of shrinkage cracks in the base layer. Picture 4.21 shows the cracking between km 2 and 11.

Pavement Condition Rating

The pavement shows some cracks over a short stretch. The cracks are thin (< 3mm) and show no signs of spalling and have been properly sealed with bitumen to prevent rain water from going down in to the lower layers. Besides these cracks, the road shows no other distress in terms of raveling, potholing, shoving, rutting or patching.

The road however shows considerable unevenness, estimated to cover 1 to 2 percent of the pavement area, the result of settlements or depressions of long wavelengths. A pavement condition score of 67 and a PSI of 3.30 are estimated for the road section giving a pavement condition rating of Fair.

Picture 4.21: Sealed Cracks on Singida- Katesh Road Section Between km 2 and 11

Katesh - Dareda Road Section

General

The Katesh - Dareda section is contiguous with the Singida - Katesh section and has been constructed to the same geometric and structural standard. The road generally follows the existing alignment. There are certain other similarities too. Since the section is in continuation of the earlier section and no new road joins or takes off, the traffic on this section more or less remains the same. Heavy commercial traffic on the road section is not heavy. Being a continuation of the Singida - Katesh road, the Katesh - Dareda Road too has a 6.5 meter wide carriageway and 1.5 meter wide shoulders, but the road strikes as being of a different genre. The switch over is unmistakable for more than one reason. The pavement surfacing, though also two coats of surface treatment like the previous section with a single layer of surface dressing on the shoulders, does not look hungry. It has a more closed texture and therefore the riding quality is psychologically felt to be smoother and traffic noise is low. In terms of appurtenances such as guard rails, this section is seen to be a little wanting compared to the Singida - Katesh section. At many places, where the road passes through built-up areas, short stretches of around 25 m of unpaved approach roads which would normally be sealed, have not been sealed with the result that vehicles joining the road at these places during the wet season bring dirt onto the study road destroying the aesthetics.

Drainage

The road passes through a rolling terrain and is on an embankment and, therefore has good natural drainage in the rural areas. However, in the built-up areas, unlike the previous section, a good part of the side drains are unlined. A number of culverts were provided for the road.

Safety

Though the road section scores higher on account of lesser traffic noise, it lags behind the Singida - Katesh section in certain other aspects. The signage and safety devices of guard rails and guard posts are not as adequately provided as for the previous section, but wherever these are provided, the quality is good. Like the previous section, good quality thermoplastic paint has been used for road markings. Climbing lanes have been provided where the gradient exceeds 5% and bus bays have been provided in the settlements.

Pavement Distress

There are no distresses of any kind, like raveling, potholing, shoving, rutting or patching at this stage, except general unevenness resulting in higher levels of roughness.

Pavement Condition Rating

The road shows no distress in terms of raveling, potholing, shoving, rutting or patching. It however shows considerable unevenness, resulting from settlements or depressions of long wavelengths.

A pavement condition score of 69 and a PSI of 3.43 have been derived for the road section giving a pavement condition rating of Fair. Due to a general unevenness of the surface, however the ride quality of the road is not very good.

Dareda - Babati - Minjingu Road Section

General

The Dareda - Babati - Minjingu road section comprises of two sub-sections. The Dareda - Babati sub-section is the extended part of the Singida - Katesh - Dareda road and, with this sub-section, completes the Singida - Babati road link.

The other sub-section, that is, the Babati - Minjingu link is the part of the Dodoma - Arusha highway which carries a reasonable level of commercial traffic. The traffic on the Dareda - Babati sub-section is largely the same as that plying on the earlier two sections. There is, as of now, very little heavy commercial traffic. The carriageway width, with 1.5 meter wide shoulders, remains 6.5 meters and the pavement has been finished with bituminous concrete. Technically, there appears to be no reason why when the Singida - Katesh - Dareda road sections have been finished with two coats of surface treatment, the Dareda - Babati sub-section, which carries similar traffic has however been finished with bituminous concrete as part of the Arusha - Dodoma Road, would receive heavier traffic loading, and being a part of the same contract, the Dareda - Babati sub-section has also been provided with a bituminous concrete surfacing.

The Babati - Minjingu sub-section, being part of the Arusha - Dodoma road which has a higher class designation has higher geometric standards. It also has an undivided carriageway of 7 m width with 1.5 m wide shoulders.

Drainage

Outside built-up areas the road is on an embankment. It therefore has good natural drainage. Wherever the road passes through built up areas, trapezoidal shaped side drains of large capacity, lined with concrete panels have been provided. Wherever the road passes through a cutting, the road has been provided with lined drains. In built-up areas, side drains lined in pre-cast concrete panels have been provided.

Safety

In the Dareda - Babati sub-section there are very few road signs and the road markings are completely missing as at the time of the visual assessment. Speed humps have been provided using paving blocks and because there are no markings on the speed breakers vehicles, especially during night time and periods of low visibility, would reach these locations at the normal traffic speed. The situation, besides resulting in discomfort to the passengers could cause damage to vehicles or create a safety hazard. The road administration has however indicated that the installation of signs on this road section were yet to be affected at the time of the Study. The consultant strongly recommends the expeditious installation of warning signs on both sides, at proper distances ahead of the location. The speed breakers should also be suitably painted to forewarn the drivers about their presence.

The speed humps, constructed with paving blocks, are of trapezoidal shape in cross-section, rather than the parabolic section that the conventional bituminous concrete speed humps have. Even after the provision of warning signs and road markings on these, therefore, a vehicle will not be able to negotiate these speed humps without a jerk. The paving blocks have been set in coarse sand as is the normal practice, without any binding material. Thus, whenever a paver block gets dislodged for one reason or the other, the other blocks would also tend to get progressively dislodged. This will create a very grave situation. The speed breakers constructed with paving blocks should be replaced with conventional parabolic speed breakers constructed with bituminous material.

Proper road markings are also seen. Road signs, guard rails and guard posts appear to have remained as these were prior to the improvement works. At one place while the guard rail posts are standing, the guard rails are missing perhaps removed for replacement or through vandalism. As has been the seen on the other study roads in Tanzania, there are no distance (kilometer) posts; specific locations are thus difficult to indicate.

For a good part of the rehabilitated road section, the edge markings of the carriageway, done in thermoplastic paint, have been provided in broken lines. The use of broken lines for edge markings were observed in Cameroon, DRC and on one Study road in Tanzania. Whereas some counties continue to use broken lines for edge markings, this standard is gradually giving way to the use of solid edge lines. Over another relatively long stretch, the edge markings have not been done.

Though traffic on the Babati - Minjingu stretch is higher than for the Singida - Katesh - Dareda - Babati stretch, heavy commercial traffic is still quite low. Enquiries with the local people revealed that during the maize cultivation season the road experiences large heavy commercial traffic. There are not many speed humps on this stretch. A speed breaker using paver blocks was seen being constructed during the survey. The hump was being constructed in trapezoidal section with the straight sides being divided by thin concrete sections and paving blocks being set in coarse sand.

Pavement Distress

The road has experienced extensive longitudinal cracking along the edge of the carriageway as shown in Picture 4.22. The longitudinal cracks are typical of pavements with cement-stabilized bases and sub-bases with thin surfacings of thicknesses less than 150 mm. In the particular case of the Dareda - Babati - Minjingu road section, the pavement has a thin (50 mm thick) asphalt surfacing and a relatively thick layer of 300 mm of cement-stabilized sub-base separated by 150 mm of crushed rock base. Any cracks initiated in the sub-base layer were expected to have been absorbed by the crushed rock base. However the thickness of the base was not thick enough such that the larger cracks could not be absorbed and ended up being transmitted to the asphalt wearing course. A thicker base, of say 225 mm or higher could probably have mitigated the migration of the cracks to the wearing course. The performance should be compared with that of the Nsawam by-pass in Ghana which also has a cement stabilized sub-base but a 200 mm thick crushed rock base and a total of 180 mm in bituminous layers on top of the crushed rock; and has shown no cracking. The cracking may be mitigated by applying a relatively thick overlay of thickness in the order of 100 mm or the application of a geotextile/glass grid and the deepening of the side drains to improve the dissipation of runoff from the adjacent ground.

Picture 4.22: *Typical Longitudinal Cracking along Carriageway on Babati - Minjingu Road Section, Tanzania.*

There are no other manifestations of distresses at this stage, except general unevenness resulting in higher levels of roughness.

Pavement Condition Rating

The carriageway shows no distress in terms of raveling, potholing, shoving, rutting or patching, except the cracking along the edges. It however shows moderate unevenness of long wavelengths, resulting from settlements or depressions.

A pavement condition score of 69 and PSI of 3.43 are obtained for this road section giving a condition rating of Fair. The road is newly constructed and despite the distresses described above, the ride quality of the road is good.

4.8.2 Assessment of quality in terms of riding quality

The analyses of roughness measurements on the three road sections have been presented in Table 4.18. From the analyses, the Singida - Katesh road section is rated as fair, the Katesh - Dareda section as Poor and the Dareda - Babati - Minjingu section as Fair.

Table 4.18: *Distribution of Road Length in Various Categories of Roughness*

Section/ Direction of Test	Chainage (km) Start	End	Length (km)	Mean IRI	Standard Deviation	Average IRI Without Outliers	% Total Section Very Good	% Total Section Good	% Total Section Fair	% Total Section Mediocre	% Total Section Poor	Rating
Singida-Katesh	0.00	77.80	77.80	2.00	1.14	1.55	0.00	32.90	56.56	3.08	7.46	Fair
Katesh-Singida	77.80	0.00	77.80	2.13	1.23	1.81	0.00	24.94	0.00	66.45	8.61	
Katesh-Dareda	77.80	122.90	45.10	4.17	1.67	3.78	0.00	0.00	0.67	34.50	65.19	Poor
Dareda-Katesh	122.90	77.80	45.10	4.26	1.72	3.87	0.00	0.00	1.55	29.93	68.51	
Dareda-Babati	122.90	147.90	25.00	2.00	1.40	1.46	0.00	40.00	50.00	2.00	9.00	Fair
Babati-Dareda	147.90	122.90	25.00	2.02	1.33	1.49	0.00	27.00	63.00	1.00	10.00	
Babati-Minjingu	0.00	59.00	59.00	1.9	0.56	1.82	0.00	11.56	85.93	1.17	1.34	
Minjingu -Babati	59.00	0.00	59.00	1.9	1	1.71	0.00	11.93	85.88	0.84	1.34	

4.8.3 Assessment of quality of construction in terms of structural capability

The structural capacity of the road sections on Mainland Tanzania has been assessed using the Benkelman Beam. Data collection and analysis were carried out separately for the three road sections. The sub-sections tested for the three lots, the relevant deflection values including the 90th percentile values of the maximum deflections and the derived residual lives have been summarized in Table 4.19.

The results show that the Singida - Katesh road section has a residual strength of between 22 and 40 MESA which exceed the design strength of 7 to 8 MESA. The residual strength of the Katesh - Babati section has an estimated residual strength of between 3.5 and 10 MESA.

This means some sections would not have the anticipated pavement strength of between 7 and 8 MESA. The residual strength of the Babati - Minjingu section has been estimated as varying between 3 and 17 MESA suggesting that sections have a current traffic carrying capacity much lower than the design strength of 17 MESA. Further investigations would have to be carried out to ascertain the causes and the remedial measures to be taken to ensure the road performs as intended.

4.8.4 Assessment of quality in terms of pavement layer characteristics

The characteristics of the materials used for the pavement layers have been determined through laboratory tests on samples recovered from the field. The laboratory tests carried out on the layer samples include gradation, the California Bearing Ratio (CBR) and Atterberg Limits and the unconfined compressive strength of the cement stabilized layers.

The thicknesses and field densities of the various layers were also determined. The results showed that for all three road sections, the construction met the specifications. The laboratory test results are provided in Appendix 2.3

4.8.5 Summary

Two of the road sections studied in Tanzania, the Singida-Katesh and the Dareda-Babati-Minjingu sections are rated as fair while the Katesh- Dareda section is rated as medicore.

The Singida-Katesh and the Dareda- Babati-Minjingu sections have developed cracking, which in the opinion of the consultant may be linked to the type of materials used in the pavement layers.

The residual strengths for the road sections range from 3 to 40 MESA indicating that sections have traffic carrying capacities less than the anticipated 7 to 17 MESA and are unlikely to provide the required service over the anticipated lives. The consultant would suggest that the road sections are investigated for the causes of the cracking and the low residual strengths and the appropriate remedial steps taken if the investment in the roads sections is to be realized.

Table 4.19: Deflection Details and Residual Pavement Life

Section Direction	Chainage (km)		No. of	Maximum	Minimum
	Starting	Ending	observations	deflection (mm)	deflection (mm)
Singida-Katesh (To katesh)	10.000	16.000	61	0.54	0.10
	45.000	52.000	71	1.08	0.10
	58.000	65.000	71	0.44	0.10
Singida-Katesh (To Singida)	10.000	16.000	61	0.36	0.10
	45.000	52.000	71	0.40	0.08
	58.000	65.000	71	0.38	0.12
Katesh-Babati (To Babati)	101.600	107.600	61	0.86	0.14
	117.600	124.400	69	1.20	0.10
	134.600	141.600	71	0.84	0.14
Katesh-Babati (To Katesh)	101.600	107.600	61	0.82	0.08
	117.600	124.600	71	0.66	0.08
	134.600	141.600	71	0.78	0.10
Babati-Minjingu (To Minjingu)	10.800	17.800	71	0.50	0.14
	26.800	33.800	71	1.06	0.20
	45.000	51.100	60	0.62	0.16
Babati-Minjingu (To Babati)	10.800	17.800	71	0.44	0.12
	26.800	33.800	71	0.96	0.22
	45.800	51.900	60	0.82	0.08

4.9 Tunisia

4.9.1 Assessment of quality through visual survey

Eight road sections that have been studied in Tunisia are:

- Bab El Khadra - Station Metro (MC 135);
- Ben Arous - Stade Rades (GP 1);
- Ben Arous - Mornag (MC 34);
- Carrefour Hopital Ariana - RR 31 (X 20);
- Jdaida - Tebourba (RVE 511);
- Grombalia - Limite Gouvernorat de Ben Arous (RVE 573) ;
- Mornag - Jbel Rsas (MC 35);
- Khlidia - Jbel Rsas (RVE 565).

Bab El Khadra - Station Metro (MC -135) Road

General

The road, from km 0 to km 7 was reinforced, work commencing in July, 2010 and ending after about 7 months. The road is totally in an urban setting and is highly trafficked as was observed during the investigations. The road is a six-lane divided carriageway road with a wide, raised central divider paved with interlocking paver blocks. Being an urban road, the shoulders have been raised and meant for the use of pedestrians.

Mean deflection (mm)	Standard deviation	90 percentile deflection (mm)	Modified Structural Number	Residual pavement life	
				MESA	Years
0.20	0.07	0.27	5.2	25	>20
0.23	0.13	0.25	5.4	30	>20
0.20	0.07	0.26	5.3	22	>20
0.19	0.06	0.27	5.2	25	>20
0.19	0.04	0.23	5.8	40	>20
0.20	0.05	0.24	5.6	38	>20
0.37	0.17	0.58	3.2	4	8
0.27	0.14	0.35	4.2	10	20
0.27	0.12	0.43	3.8	6	12
0.34	0.17	0.60	3.0	3.5	7
0.26	0.10	0.38	4.0	6	12
0.25	0.12	0.35	4.2	10	20
0.29	0.08	0.36	4.1	9	10
0.48	0.14	0.71	2.8	3.2	4
0.29	0.12	0.42	3.9	6.2	7.5
0.27	0.07	0.33	4.4	17	20
0.51	0.14	0.65	2.9	3	4
0.35	0.18	0.58	3.2	4	5

Drainage
There are no open side drains, but surface drainage has been provided for through a covered drainage system which was judged to be adequate.
Safety
Adequate road signage for urban traffic control has been provided.
Pavement Distress
Being an urban road, in order to control road levels, the existing surfacing of the road was completely removed and the surfacing renewed in two layers. Due to the wide carriageway width of 10.5 m, the surfacing layer had to be constructed in two segments. The construction joint is visible at places. The road surface is characterized by moderate to severe unevenness as a result of very shallow depressions and settlements. The road shows no signs of distress after two years of traffic.
Pavement Condition Rating
A pavement condition score of 58 is assessed for the road section based on the observed defects. A corresponding PSI of 2.7 is derived for the road, giving a pavement condition rating of Fair. The riding quality of the road is Fair.

Ben Arous - Stade Rades (GP 1)
General
The 6.4 km long road from PK4 to PK 10.5 is an urban road which goes to the outskirts of Tunis. It serves an industrial area over some distance and ends at Road 22 and serves as the Southern entrance of Tunis.

At its starting point it is an undivided road, which at approximately 15 m is wider than the standard four lane road of 13 m. After about a kilometer and beyond a round-about on the road, it has been provided with a central divider. The road has paved shoulders in the built-up area. After a second round-about, a service road has been provided. Beyond the intersection with Road No. 560 the road passes through a residential area and is a four lane divided road. The shoulders for this section are not paved. The last approximately two kilometer stretch has been provided with a paved pedestrian walkway, the condition of the surface of which is uneven and rough.

Drainage

Within the built up area there are side drains which are lined for some length and unlined for short lengths. Outside the city limits, the road is on an embankment and has good natural drainage.

Safety

There are practically no road signs, except where the road meets other roads. The signage is almost entirely to announce the names of the roads and streets that this road meets. No other safety challenges were observed.

Pavement Distress

At the intersection of GP1 with Road Number 560, under the flyover the road is in a bad condition with a poor riding quality. The road also shows general unevenness with intermittent shallow depressions.

Pavement Condition Rating

The pavement is given a condition score of 68, a corresponding PSI of 3.36 and the pavement condition rated as Fair. Riding quality of the road is generally fair.

Ben Arous - Mornag (MC 34)

General

The road starts after the intersection with the Autoroute at PK 7 and is practically entirely in a rural setting, with fields on both sides. Traffic on the road is relatively low. The road has been in service for about three years since the improvement.

The Project ends at Sebel at Mornag at PK 11.4.

It is a two lane undivided road with paved shoulders. The right hand side shoulder, for some reason is wider than the shoulder on the left hand side.

Drainage

The road is in a rural setting and is on embankment of moderate height. The natural drainage of the road is good.

Safety

There were no road markings seen during the survey. Road signage was assessed as adequate though the signs were mainly informational announcing names of the roads and streets that the road crosses.

Pavement Distress

There are no visible signs of any distress except slight to moderate unevenness and some shallow depressions.

Pavement Condition Rating
Based on the recorded distresses a pavement condition score of 84 and a PSI of 4.42 are derived for this road section. The pavement condition is therefore rated as Good. Riding quality of the road was judged as good.

Carrefour Hopital Ariana - RR 31 (X 20)
General
The road is a four lane divided urban facility with a planted central separator. Traffic is heavy and mostly of fast moving urban traffic.
It is four lane divided road with 1.5 meter wide shoulders. At the beginning of the road the shoulders are not paved for a kilometer or so, but afterwards it is paved throughout.
Drainage
There is no open drainage system. Drains are all covered and are adequate.
Safety
Road signs and markings were regarded as adequate.
Pavement Distress
There were no visible signs of any distress or indications of bad workmanship except for some unevenness as a result of settlements and depressions along the road section.
Pavement Condition Rating
Based on the pavement distresses shown, a pavement condition score of 84 and a PSI of 4.42 have been derived for the road section. The pavement condition is rated as Good. The road has a good riding quality.

Jdaida - Tebourba (RVE 511)
General
The road is a two lane undivided facility. Traffic is low as observed from the survey.
The road shoulders are unpaved.
Drainage
The road is mostly in the rural setting and is over an embankment of moderate height with good natural drainage.
Safety
The road markings that must have been provided with the road improvement have faded.
There were very few advisory and informational road signs which were regarded as those necessary for this section.
Pavement Distress
No distresses were seen except some slight to moderate unevenness and some wide depressions.
Pavement Condition Rating
A pavement condition score of 83 and a PSI of 4.36 are assessed for the road section giving a pavement condition rating of Good.

The road surface looks good and the riding quality is also good.

Grombalia - Limite Gouvernorat De Ben Arous (RVE 573)

General

The 19 km long road takes off from the road connecting Mornag with Belhsen and goes to Grombalia. It passes through rolling terrain. The road passes over the Expressway about 1.5 km short of the end of the Project road. It is a two lane undivided road. The carriageway is in asphaltic concrete and the shoulders are finished with surface treatment. Traffic on the road is generally low, till the road reaches the town of Tebournek, where there is a stone quarry. From here, there is some commercial traffic plying on the road from this link to the highway.

Drainage

Due to the rolling terrain the road has good natural drainage. Wherever it passes through cutting, which is mostly on one side only, a side drain in earth has been provided

Safety

The road has good markings, road signage and kilometer posts. Speed humps are also provided in the settlements along the road. The terrain being rolling, the road has guard rails and guard posts provided at many places, enhancing safety on the road.

Pavement Distress

The road shows no sign of distress except for moderate unevenness resulting from settlements and depressions.

Pavement Condition Rating

A pavement score of 70 and a PSI of 3.5 are assessed for the road section. The pavement condition is rated as Good. The road generally has a good riding quality.

Mornag - Jbel Rsas (MC35)

General

The road, starting from Mornag at PK 0, passes through the built-up area as an undivided four lane facility with raised walkways on both sides. The road ends at Jbel Rsas at PK 10.5. Traffic on the road is mostly non-commercial. Project Road RVE 565 takes off from this road. The road ends at Mont Rsas where a big stone quarry exists. A cement plant is also located nearby. Around this area the traffic in terms of commercial vehicles is quite substantial.

The road starts as an undivided road, but after about 1.5 km and then transforms into a divided highway with paved shoulders at carriageway level and being used for the parking of vehicles. After another approximately 2 km, the shoulder, though paved, is at a level lower than the carriageway, as is the norm generally. The last approximately 4km of the road section is a two lane undivided facility.

Drainage

The drainage through the built up area is entirely lined. Along the road, for about 1 km, the land use is residential on one side and agricultural on the other side. While a lined drain has been provided on the residential side, on the side used for agriculture, natural drainage due to the moderate embankment height of the road is being utilized to drain the road. The last 4 km has agricultural fields on both sides with good natural drainage.

Safety

The road signs provided on this road are adequate. Road edge markings which can enhance safety have been provided. The speed breakers provided on this road have

been very nicely done with good design and well-marked in yellow paint.
Riding quality of the road as a whole is quite good.

Pavement Distress

The road shows no distress in terms of raveling, potholing, rutting and other forms of distress except for moderate unevenness resulting from settlements and shallow depressions. Some settlements at the approaches to culverts were observed.

Pavement Condition Rating

A pavement condition score of 76 and a PSI of 3.90 are assessed for this road section. The pavement condition is therefore rated as Good.

Khlidia - Jbel Rsas (RVE 565)

General

The road is a two lane undivided road with a length of 11.1 km
The road is a two lane road with 1.5 meter wide shoulders.

Drainage

The road is largely on an embankment and therefore has good natural drainage.

Safety

At the start of the project road markings are good, but after about 4km, there are no markings. Essential road signs have also been provided over the entire length of the road.

Distress

The road shows no distress in terms of raveling, potholing and rutting. The road however shows moderate to severe unevenness most probably from inadequate surface control during construction. The vegetation growing alongside the carriageway has come up to the road. It is not being removed. Shoulders are missing at quite a few places.

Pavement Condition Rating

A pavement score of 70 and a PSI of 3.5 are assessed for this road section. The pavement condition is rated as Good. The road is bumpy in places but riding quality as a whole is regarded as fair.

4.9.2 Assessment of quality in terms of riding quality

The analyses of roughness measurements for the roads in Tunisia including the rating of the riding quality have been presented in Table 4.20. From the analyses, all eight roads are rated as Fair.

4.9.3 Assessment of quality of construction in terms of structural capability

The structural capacity of the roads in Tunisia was assessed using the La Croix Deflectograph. Even though the road lengths were comparatively short, the evaluation has been undertaken generally for 2 Km length for each road, except for RVE 573 where a 5 Km length was investigated. Evaluation using the Deflectograph is similar to the use of the Benkelman Beam except that the La Croix Deflectograph records deflection responses continuously at 4 m intervals. Data collection and analyses were carried out separately for each of the eight road sections. The calculated parameters and the derived residual lives for the pavements are presented in Table 4.21.

Table 4.20: Summary of Roughness Data on Study Roads in Tunisia

S. No.	Road Section	Sub Section Direction	Chainage (km) Starting	Chainage (km) Ending	Average IRI	Standard Deviation
1	MC 135	Bab El khadra - Station Metro	1.00	6.80	3.21	0. 79
		Station Metro - Bab El khadra	7.00	1.00	3.71	0.99
2	GP-1	Ben Arous - Stade rades	4.00	10.40	3.43	0.97
		Stade rades- Ben Arous	10.70	4.00	3.24	0.8
3	MC 34	Ben Arous - Mornag	7.00	11.40	2.70	0.97
		Mornag - Ben Arous	11.80	7.40	2.87	0.97
4	X 20	Carrefour Hopital Ariana - RR 31	1.80	8.20	2.39	0.58
		RR 31 - Carrefour Hopital Ariana	8.20	1.80	2.36	0.64
		Carrefour Hopital Ariana - RR 31	1.80	8.20	2.51	0.48
		RR 31 - Carrefour Hopital Ariana	8.20	1.80	2.42	0.72
5	RVE 511	Jdaida - Tebourba	0.200	9.600	2.39	0.83
		Tebourba - Jdaida	9.800	0.200	2.64	1.43
6	RVE 573	Grombalia - Limite Gouvernorat de Ben Arous	0.000	20.400	2.56	1.05
		Limite Gouvernorat de Ben Arous - Grombalia	20.500	0.000	2.75	1.12
7	MC 35	Mornag - Jbel Rsas	0.300	10.500	2.75	0.87
		Jbel Rsas - Mornag	10.500	0.300	2.81	0.83
8	RVE 565	Khlidia - Jbel Rsas	22.700	11.300	2.80	0.59
		Jbel Rsas - Khlidia	11.200	22.600	2.33	0.53

Table 4.21: Deflection Details and Residual Pavement Life

S. No.	Route	Section/ Direction	Chainage (km)Maximum Starting	Ending	Minimum Deflection (mm)
1	MC 135	Bab El Khadra - Station Metro	3.100	5.131	2.60
2	GP-1	Stade Rades- Ben arous	6.097	4.064	3.40
3	MC 34	Ben Arous - Mornag	9.000	11.040	2.92
4	X 20	Carrefour Hopital Ariana - RR 31	1.800	3.800	0.76
5	RVE 511	Jdaida - Tebourba	1.300	3.360	0.80
6	RVE 573	Limite Gouvernorat de Ben Arous - Grombalia	6.700	11.700	2.16
7	MC 35	Jbel Rsas - Mornag	9.000	6.988	1.12
8	RVE 565	Khlidia - Jbel Rsas	22.600	20.590	1.24

4.9.4 Summary

Six of the road sections in Tunisia were rated as fair with the remaining two roads sections rated as mediocre. The road section rated as fair were MC 34, X20, RVE 511, RVE 573, MC 35 and RVE 565. Road sections MC 135 and GP1 were rated as mediocre. The residual pavements strengths range from 4 MESA for RVE 575 to 68 MESA for X20 which should allow the roads to provide the intended service for between 10 and 15 years. However, with a residual pavement strength of around 6MESA, the heavily trafficked GP1 - albeit mostly light traffic, may require some intervention before the 10 years horizon. The roads should be monitored to allow any necessary intervention to be carried out timeously.

Average IRI without Outliers	% Section Very Good	% Section Good	% Section Fair	% Section Mediocre	% Section Poor	Rating
2.99	0.00	0.00	26.67	43.33	30.00	Fair
3.45	0.00	0.00	13.33	30.00	56.67	
3.05	0.00	0.00	18.18	48.48	33.33	Fair
2.92	0.00	0.00	23.53	44.12	32.35	
2.26	0.00	4.35	60.87	13.04	21.74	Fair
2.36	0.00	0.00	56.52	17.39	26.09	
2.19	0.00	3.13	75.00	12.50	9.38	Fair
2.19	0.00	3.13	81.25	6.25	9.38	
2.31	0.00	0.00	71.88	25.00	3.13	
2.27	0.00	6.25	78.13	9.38	6.25	Fair
2.19	0.00	4.26	68.09	19.15	8.51	Fair
2.14	0.00	0.00	79.17	4.17	16.67	
2.3	0.00	12.75	44.12	30.39	12.75	Fair
2.48	0.00	2.94	56.86	26.47	13.73	
2.46	0.00	0.00	63.46	19.23	17.31	Fair
2.54	0.00	0.00	50.00	34.62	15.38	
2.61	0.00	0.00	56.14	33.33	10.53	Fair
2.15	0.00	0.00	80.70	15.79	3.51	

Mean Deflection (mm)	Standard Deflection (mm)	90th percentile deviation	Modified deflection (mm)	Residual Structural Number	Pavement Life	
					MESA	Years
0.08	0.19	0.27	0.35	7.2	40	>20
0.04	0.30	0.30	0.78	3.9	6	10
0.04	0.37	0.28	0.62	4.4	15	>0
0.04	0.12	0.06	0.18	8.0	68	>20
0.08	0.30	0.12	0.37	6.3	20	>20
0.08	0.59	0.23	0.87	3.6	4	10
0.20	0.50	0.17	0.70	4.2	10	20
0.08	0.55	0.24	0.87	3.6	4.5	12

4.10 Uganda

4.10.1 ASSESSMENT THROUGH VISUAL SURVEY

General

The Kabale - Kisoro - BunaganaKynika road was studied in Uganda. The Bunagana road link connects Uganda to the Democratic Republic of Congo while the Kyanika link connects Uganda to Rwanda. The road caters to significant commercial traffic mostly coming from Kampala - Masaka - Mbarara going across to Democratic Republic of Congo and Rwanda through the border posts near Kisoro. Some of this heavy commercial traffic, as deciphered from the vehicle number plates, originate from Kenya - perhaps from Mombasa Port - carrying imports coming by sea, and other goods for the two countries.

The road has a 6 m wide carriageway; and 1 m wide shoulders in mountainous areas. A shoulder width of 1.5 m was provided in the other stretches of the road. The carriageway and shoulders are finished in asphalt concrete. The surfaces of the shoulders are flushed with the surface of the carriageway.

Drainage

The road section crosses an area with rolling to mountainous topography. Natural drainage is therefore generally good. Along the cut slopes, concrete lined drains have been provided. Wherever unlined drains have been provided, the drains have been covered with vegetation, needing more frequent cleaning and removal of vegetation. The road however crosses swamps in two valleys. Drainage in these areas poses some challenges which would need to be resolved.

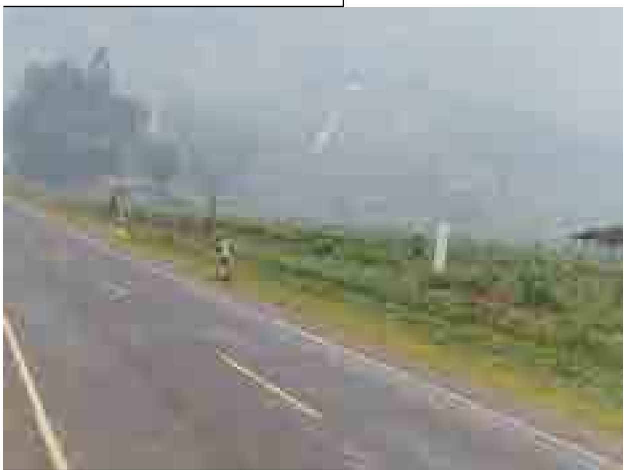
Picture 4.23: Market Posing a Safety Hazard on Kabale - Kisoro Road Section

Safety

The road has a good longitudinal profile and other geometric features. Well-designed and clearly marked speed humps and rumble strips have been provided along the road section at the entry and exit of the settlements crossed by the road. The humps have been constructed across the carriageway and shoulders. Bus bays have been constructed in the settlements. Adequate signs have been provided for schools, and where necessary, both on and above ground. Cat's eyes have been laid along the center of the carriageway for improved night vision. Chevron signs have been provided in tight curves. In general, signage is adequate. Warning signs were however absent.

Road edge markers have been provided in curves and in stretches where the adjacent land drops for up to about 4 m. Where the ground drops for more than about 4 m, guard rails have generally been provided. There are areas which require guard rails but these have not been provided. Two markets were seen operating very close to the road posing a safety hazard as shown in Picture 4.23.

Picture 4.24: R-O-W Marker on Kabale-Kisoro Road Section



The right-of-way is clearly marked through concrete posts with UNRA - Uganda National Road Authority - imprinted on them and planted at regular intervals along the route as shown in Picture 4.24. Kilometer posts have also been installed at regular intervals and are clearly visible. Short stretches of adjoining unpaved roads have been paved to prevent soil being transported to the road; there are a few which remain unpaved.

The side slopes are generally well stabilized, but slippages on new cut slopes are occurring at places. Rock falls were also observable at locations. There were no warnings however. Besides the cut slope slippages, slides, both on the hillside and the valley side were seen at a few places. At some of these places, warning signs provided were not adequate.

The condition of debris lying across the Kisoro bound lane at around km 38 gave the impression that the damages have remained unattended to for long durations. A slide is developing near km 49+500. Some patch repairs have been carried out on the carriageway edge on the valley side. This spot should be watched for incipient slide. At km 62 boulders rolling down from the hillside and resting on the carriageway are not being cleared, becoming a safety hazard. These and other spot damages need to be attended to rather more expeditiously.
The surfacing over stable sections comprises asphaltic concrete and is of very good riding quality. Joints between previous day's construction works at many places are not very well done and could be felt riding over them.

Pavement Distress

The road has exhibited various forms of distress. These include depressions and cracks at the two major swamp crossings at around Ihanga (km 11) and around Akagyezi (km18) which have been surface dressed; patches between km 22 and 23 km 32 and 33 and 27 and 28 and a sealed crack around km 48+500 indicative of underlying ground movement. The road has also shown some general depressions between km 21 and 23. The road has also some raveling in the Kabale bound lane at Idundi village. There were also signs of excessive bleeding west of Idundi village.

Pavement Condition Rating

The pavement condition score based on the distresses recorded has been estimated as 68 and a PSI of 3.63 giving a pavement rating of Fair. The riding quality was judged to be fair

4.10.2 Assessment of quality in terms of riding quality

The analyses of roughness measurements for the road in Uganda including the rating of the riding quality have been presented in Table 4.22. From the analyses, the riding quality of the road is rated as Mediocre.

Table 4.22: Summary of Roughness Data on Study Roads in Uganda

Sub section Direction	Chainage (km) Starting	Ending	Average IRI (m/km)	Standard deviation (m/km)	Average IRI without outliers (m/km)	% Section very good	% Section good	% Section Fair	% Section Mediocre	% Section Poor	Rating
Kabale to Bunagana	0.000	88.000	3.82	1.98	3.23	0.00	0.00	33.95	25.31	40.74	Mediocre
Bunagana to Kabale	88.000	0.000	3.78	1.94	3.07	0.56	0.00	33.90	35.59	29.94	

Table 4.23: Stiffness Modulus Details and Residual Pavement Life

Section	Stiffness Modulus (MPa)	Std Deviation	Coefficient of Variation	Residual Life (MESA)	Residual Life (Yrs)
Km 5+000 - 10+000	152.33	24.75	6.15	6	24
Km 10+000 - 15+000	148.99	28.75	5.18	5	20
Km 75+000 - 80+000	126.58	30.7	4.12	4*	16
Km 80+000 - 85+000	102.71	22.21	4.63	3.6*	14

4.10.3 Assessment of quality of construction in terms of structural capability

The structural capacity of the road Kabale - Kisoro - Bunaga/Kyanika in Uganda was assessed using the Light Falling Weight Deflectometer. The calculated parameters and the derived residual lives for the pavements are presented in Table 4.23.

4.10.4 Assessment of quality in terms of pavement layer characteristics

The quality of the pavement as constructed has been assessed based on a comparison of the pavement as provided, with the design requirements. The characteristics of the materials used for the pavement layers have been determined through laboratory tests on samples recovered from the field. The laboratory tests carried out on the layer samples include gradation, the California Bearing Ratio (CBR) and Atterberg Limits. The thicknesses and field densities of the various layers were also determined. The results showed that for the road section, the construction met the specifications. The laboratory test results are provided in Appendix 2.3

4.10.5 Summary

The Kabale - Kisoro - Bunagana/ Kyanika road section has been studied in Uganda. The road has been constructed in mainly mountainous terrain. Stretches of the road section pass through areas of active earth movements. This has affected the riding quality of the road. Some of the stretches which have exhibited distresses would require monitoring whereas others would need to be repaired quickly for the safety and comfort of motorists.

4.11 Overall rating of study roads

An overall assessment of the quality of each study road has been derived considering the various components of the evaluation methodology. The components considered are the pavement condition rating, the riding quality as measured by roughness in IRI, the residual structural capacity in relation to the design traffic carrying capacity and the degree of compliance of the pavement layers with the projects' specifications. Each assessment component is graded on a scale of 1 to 5; 5 being very good, 4 - good, 3 - fair, 2 - mediocre and 1 - poor. The overall quality assessment has been taken as the average of the four assessment components.

The pavement condition rating derived from the visual survey as summarized in Table 4.3 has been used in this assessment while for riding quality the assessment obtained based on Table 4.4 has been used.

For the structural assessment, a road section with the minimum residual strength exceeding the design traffic is classified as very good. An assessed residual strength of between 80 and 100% of the design traffic is rated as good, between 60 and 80% is rated as fair, between 50 and 60% is rated as mediocre and below 50% rated as poor.

For compliance of the pavement layers with the specifications, a pavement with the layers meeting all specified requirements is rated as very good. Where there are deviations but these are not expected to affect performance such as minor deviations for Atterberg limits for a pavement with good drainage, the pavement is rated as good. Pavements with deviations of up to 10% on significant requirements such as CBR or aggregate crushing value are rated as fair, and mediocre for deviations of between 10 and 20%. Where a deviation of the significant requirements was more than 20% below the specified requirement, a rating of poor was given. The assessment has been done bearing in mind that the materials have been compacted during construction, dug out and taken through the testing process again; and mindful of inter-laboratory testing differences which could account for up to a 20% difference in test results for some parameters.

These assessments have been made with the knowledge that road characteristics such as drainage and safety which have implications for sustainability were at least satisfactory for all the road sections studied, though improvements to these are warranted for some of the road sections. The ratings for drainage and safety for the road sections are summarized in Table 4.24.

Table 4.24: Rating of Road Section Characteristics Revealed through Visual Survey

Country	Road Section	Rating for Drainage	Safety Rating
Benin	Pobe-Ketou Section	Satisfactory	Satisfactory
	Ketou-Illara- Section	Satisfactory	Satisfactory
Cameroon	Bamenda - Batibo - Numba Road	Good	Satisfactory
	Nandeke - Mbere Road Section	Good	Satisfactory
DR Congo	Kwango - Kenge	Good	Satisfactory
	Nsele - Lufimi	Good	Satisfactory
Ghana	Agbozume - Aflao		
(and Akatsi Bypass)	Very Good	Very Good	
	Akatsi - Agbozume	Very Good	Very Good
	Akatsi -Dzodze - Akanu	Very Good	Good
	Nsawam Bypass	Good	Satisfactory
	Techiman - Apaaso	Good	Very Good
	Apaaso - Kintampo	Good	Very Good
Kenya	Athi River - Namanga	Very Good	Satisfactory
	Isiolo - Merille	Good	Good
	Nairobi - Thika	Good	Satisfactory
Tanzania - Zanzibar	Amani - Dunga	Good	Satisfactory
	Manzizini - Fumba	Good	Satisfactory
	Mfensini - Bumbwini	Good	Good
Tanzania - Mainland	Singjda - Katesh	Very Good	Very Good
	Katesh - Dareda	Good	Good
	Dareda - Minjingu	Good	Satisfactory
Tunisia	Bab El Khadra - Station Metro (MC 135)	Good	Good
	Ben Arous - Stade Rades (GP1)	Good	Satisfactory
	Ben Arous - Mornag (MC 34)	Good	Good
	Carrefour Hopital Ariana - RR 31 (X 20)	Very Good	Good
	Jdaida - Tebourba (RVE511)	Good	Satisfactory
	Grombalia - Limite Gouvernorat		
	de Ben Arous (RVE 573)	Good	Very Good
	Mornag - Jbel Rsas (MC 35)	Very Good	Very Good
	Khlidia - Jbel Rsas (RVE 565)	Very Good	Very Good
Uganda	Kabale - Kisoro - Bunangana / Kyanika	Good	Satisfactory

Based on the average score from the four assessment components, each road section has bee graded as shown in Table 4.25.

Table 4.25: Overall Quality Rating of Study Roads

Quality Assessment	Quality Rating
Very Good	4.5 - 5.0
Good	3.5 - 4.4
Fair	2.5 - 3.4
Mediocre	1.5 - 2.4
Poor	0 -1.4

All the Study roads have been rated for their overall quality as described in Section 4.1.6. Table 4.26 summarizes the overall rating. The details for each Study road with other relevant information such as the length and other construction details are presented in Appendix 3. The rating indicates that, overall seven (7) of the Study Sections were very good, fifteen (15) Good and eight (8) fair.
All the Study Roads continue to provide the service for which they were intended.

The Study has demonstrated that currently twenty six (26) of the thirty (30) road sections studied have traffic carrying capacities which are equal to or higher than antici-

Table 4.26: Overall Rating of Study Roads (1/2)

Country	Road Section	Length (km)	Commenced	Completed
Benin	Pobe - Ketou	42.80	2005	2009
	Ketou - Illara	16.50	2006	2007
Cameroon	Bamenda - Batibo - Numba	63.20	Feb-10	6/2014
	Nandeke - Mbere Road	82.00	Jun-09	12/2013
DRC	Nsele - Lufimi	93.58	Dec-08	12/2010
	Kwango - Kenge	70.30	Dec-08	01/2011
Ghana	Agbozume - Aflao	27.10	Jan-09	12/2013
	Akatsi - Dzodze - Akanu	30.00	Jun-09	02/2012
	Akatsi - Agbozume	31.60	Jan-09	10/2011
	Nsawam Bypass	9.30	Jun-08	09/2012
	Techiman - Apaaso	53.70	Oct-10	06/2012
	Apaaso - Kintampo	6.30	Oct-10	07/2013
Kenya	Nairobi - Thika	45.00	Jan-09	10/2012
	Athi River - Namanga	136.00	Nov-07	09/2010
	Isiolo - Merille	136.00	Nov-07	06/2012
Tanzania - Zanzibar	Manzizini - Fumba	17.81	2006	11/2009
	Amani - Dunga	12.75	2009	06/2012
	Mfensini - Bumbwini	13.10	2009	06/2012
Tanzania - Mainland	Singda - Katesh	65.10	Mar-09	01/2012
	Katesh - Dareda	73.80	Mar-09	08/2012
	Dareda - Minjingu	84.60	Mar-09	08/2012
Tunisia	Grombalia - Limite Gouvernorat de Ben Arous (RVE 573)	19.00	Apr-11	06/2012
	Mornag - Jbel Rsas (MC 35)	10.20	Jul-10	07/2012
	Khlidia - Jbel Rsas RVE 565	11.00	Jul-10	07/2012
	Bab El Khadra - Station Metro (MC 135)	7.00	Jul-10	02/2012
	Ben Arous - Mornag (MC 34)	4.40	Jul-10	02/2012
	Ben Arous - Stade Rades (GP1)	6.50	Jul-10	02/2012
	Jdaida - Tebourba (RVE511)	8.80	Jul-11	01/2012
	Carrefour Hopital Ariana - RR 31(X 20)	8.30	Jul-11	01/2012
Uganda	Kabale - Kisoro - Bunangana / Kyanika	100.14	Mar-07	09/2012

pated in their planning. The four (4) road sections, which were among the eight rated as fair, could have sections which may not have the anticipated pavement strength as intended. The road sections are the Techiman - Apaaso and the Apaaso - Kintampo road sections in Ghana, the Isiolo - Merille in Kenya and the Dareda - Minjingu road section in Tanzania. These roads, however, continue to have riding surfaces which are regarded as fair or good.

One road section in the Democratic Republic of Congo and two road sections in Tanzania (Mainland) have shown cracking which is extensive in the case of the road in the Democratic Republic of Congo and their long term performance may be in doubt. Two of the roads, the one in DRC and the other in Tanzania were provided with cement stabilized bases while the other in Tanzania has a thick layer of cement stabilized sub-base (300 mm thick) and a thin (150 mm thick) layer of crushed rock base. All three roads were provided with a thin asphalt wearing course of 50 mm thick. These and the performance of other roads with similar pavement structures seen in the course of the study raise concern on use of cement stabilized bases under thin wearing courses of less than 150 mm thick.

Pavement Condition Rating	Riding Quality Rating	Structural Capacity Rating	Pavement Layer Rating	Overall Quality Rating
Very Good	Good	Very Good	Very Good	V Good (4.8)
Very Good	Good	Very Good	Very Good	V Good (4.8)
Very Good	Fair	Good	Very Good	Good (4.3)
Fair	Good	Good	Very Good	Good (4)
Very Good	Good	Very Good	Very Good	V Good(4.8)
Fair	Fair	Very Good	Very Good	Good (4)
Very Good	Fair	Very Good	Good	Good (4.3)
Good	Fair	Very Good	Good	Good (4)
Very Good	Fair	Very Good	Good	Good (4.3)
Very Good	Good	Good	Very Good	Very Good (4.5)
Good	Fair	Mediocre	Fair	Fair (3)
Good	Fair	Mediocre	Fair	Fair (3)
Very Good	Good	Good	Good	Good (4.3)
Good	Fair	Good	Good	Good (3.8)
Good	Fair	Mediocre	Good	Fair (3.3)
Very Good	Good	Very Good	Good	V Good (4.5)
Very Good	Good	Very Good	Good	V Good (4.5)
Very Good	Good	Very Good	Good	V Good (4.5)
Fair	Fair	Good	Good	Good (3.5)
Fair	Mediocre	Good	Good	Fair (3.3)
Fair	Fair	Mediocre	Good	Fair (3)
Good	Fair	Good	Good	Good (3.8)
Good	Fair	Good	Good	Good (3.8)
Fair	Fair	Fair	Good	Fair (3.3)
Fair	Mediocre	Very Good	Good	Good (3.5)
Good	Fair	Very Good	Good	Good (4)
Fair	Mediocre	Good	Good	Fair (3.3)
Good	Fair	Very Good	Good	Good (4)
Good	Fair	Very Good	Good	Good (4)
Fair	Mediocre	Good	Good	Fair (3.3)

The level of service and riding quality for the Study roads was negatively affected by the numerous speed calming interventions in settlements. The quality of some of these speed calming devices, constructed after the completion of the roads, are less than satisfactory and could pose safety hazards.

5.0 PERFORMANCE OF THE CONTRACTS FOR THE STUDY ROADS

5.0 PERFORMANCE OF THE CONTRACTS FOR THE STUDY ROADS

5.1 General

This chapter deals with the performance of the contracts for the construction of the Study road sections with respect to cost control and construction period. The performance of any road contract with respect to the control of cost and the execution period depends on a number of factors. These factors include the quality of the feasibility studies, the robustness of detailed engineering studies, the quality of contractor's management, and the quality of the supervision. The client's management of the project including his or her general responsiveness to issues referred to him/her for decisions can also have a serious impact on the success or otherwise of the project.

5.2 Cost control

The nature of road contracts, with a likely number of unforeseen events and issues, is such that a contract may be deemed to have performed satisfactorily if the original contract sum is not exceeded by 15%. This limit has been chosen since most contract forms allow the "Engineer" to vary the contract within this limit either with or without the express approval of the client to reflect the complex nature of road projects which usually make it difficult for all conditions along the alignment to be revealed or anticipated through the studies prior to construction. The Conditions of Contract used for Bank Financed projects are based on the Multilateral Development Bank (MDB) Harmonized Conditions of Contract derived from the FIDIC Conditions of Contract. The MDB Harmonized Conditions of Contract limit variations that can be issued by the Engineer, though this limit is left open to be determined by the client. The limit specified in the contract data is usually 15%.

With a cost increase beyond 25% the contract would be deemed as poor and most clients would prefer a new contract for the additional works except under exceptional conditions. It is assumed that adequate provision would have been made for price escalation in the original contract sum especially for countries which experience rapid depreciation of their currencies.

From a cost control point of view, the performance of a contract may be rated as follows:-

Satisfactory	-	cost exceeds the original contract sum but is no more than 15% above the contract sum.
Moderately Satisfactory	-	cost exceeds the original contract sum by more than 15% but does not exceed the original sum by more than 25%.
Unsatisfactory	-	cost is in excess of 25% more than the contract sum.

5.3 Control of execution period

A contract whose period of execution exceeds the original contract period by no more than 15% would be regarded as having performed satisfactorily. Where the time of execution exceeds the original contract period by more than 15%, this may be symptomatic of a number of variation orders having been issued, due to inadequate design or as after-thought from the client, or the tardiness of the contractor. A project would generally be viewed as problem project where the construction period exceeds the original contract period by more than 25%; unless when the reasons for the time extension could be attributable to a natural disaster or other unanticipated occurrences which could be classified under force majeure in the contract conditions.

The projects may therefore be rated based on the actual construction time as:-

Satisfactory	-	Construction time exceeds the contract period by no more than 25%.
Moderately Satisfactory	-	The execution period exceeds the original contract period by 25% but not more than 35%.
Unsatisfactory	-	The construction period exceeds the original contract period by more than 35%.

5.4 Assessment of performance

The performances of the contracts for the Study road sections have been assessed using a two-dimensional approach for each of the contracts. This is because though an increase in cost is usually associated with a longer execution time, this may however not always be the case. Conversely, a longer execution time may not necessarily be associated with an increase in cost.

Based on the foregoing, a project is judged as:

- Satisfactory where the cost does not exceed the contract sum by more than 15% and the contract period is not exceeded by 25%,
- Moderately Satisfactory where the cost does not exceed the contract sum by 15% and the contract period is not exceeded by more than 50% or the cost exceeds 15% but not 25% of the contract sum and the contract period is not exceeded by more than 35%; and
- Unsatisfactory where the cost exceeds the contract sum by 25% and the contract period is exceeded by more than 35% or the contract sum is not exceeded by 15% but contract period is exceeded by more than 50%.

The reasons for those performing unsatisfactorily or poorly have been discussed and where possible an indication of the party seen as responsible has been given.

A matrix showing the performance of the contracts for each of the projects is presented in Table 5.1.

The Thirty (30) road sections studied were constructed under twenty seven (27) contracts. The Benin roads were under two (2) contracts; Cameroon - two (2), DRC - two (2); Ghana - six (6), Kenya - five (5), Three (3) for Nairobi - Thika);

Tanzania Mainland - three (3); Zanzibar - two (2) Tunisia - four (4) and Uganda - one (1).

Out of the twenty seven contracts, two had funding from other sources - DANIDA for the Pobe - Ketou Road in Benin and China for Lot 3 of the Nairobi - Thika Road project in Kenya. Of the remaining twenty five contracts under which Bank funded road projects were executed, the performance of eleven was regarded as satisfactory, six as moderately satisfactory and eight as unsatisfactory. The eight for which performance was

Table 5.1: Performance of Contracts for Selected Road Projects

Country Name	Project Road	Contract Sum	Actual Cost
Benin	Pobe-Ketou Section	17.444 billion FCFA	18.040 billion FCFA
	Ketou-Illara- Section	3,346,818,769 FCFA	3,346,818,769 FCFA
Cameroon	Bamenda - Batibo - Numba Road	FCFA 28,276,438,939	FCFA 31,645,291,141
	Nandeke - Mbere Road Section	FCFA 32,402,734,517	FCFA 39,650,358,169
DR Congo	Lot 1 - Rehabilitation / reconstruction of the Kwango - Kenge (72.8 km):	US$ 52.824 Million	US$ 52.824 Million
	Lot 2 - Rehabilitation of Nsele Bridge - Lufimi (94.6 km)	US$ 41.738 Million	US$ 41.738 Million
Ghana	Akatsi - Aflao (and Akatsi Bypass)	GH¢ 38,597,148.16	GH¢ 50,658,851.60
	Akatsi - Dzodze - Akanu	GH¢ 28,364,144.72	GH¢ 27,699,259.51
	Akatsi - Agbozume	GH¢ 38,852,495.10	GH¢ 42,421,876.22
	Nsawam Bypass	GH¢ 28,297,485.34	GH¢ 33,731,038.02
	Techiman - Apaaso	GH¢ 36,058,579.20	GH¢ 54,658,060.00
	Apaaso - Kintampo	GH¢ 7,533,588.77	GH¢ 17,486,030.63
Kenya	Nairobi - Thika	8,030,386,596.64 KSHs (Lot - 1)	9,230,902,053.61 Kshs
		8,690,568,489.73 KSHs (Lot - 2)	
		9,441,732,008.29 KSHs (Lot - 3)	9,988,166,743.00 Kshs
	Athi River - Namanga	6,208,705,229.80 KSHs	-*
	Isiolo - Merille	4,875,409,271.00 KSHs	4,875,409,271.00
Tanzania - Mainland	Singjda - Katesh	51,626,214,569 TSHs	51,626,214,569 TSHs
	Katesh - Dareda	64,145,236,879 TSHs	66,023,554,890 TSHs
	Dareda - Minjingu	84,919,693,728 TSHs	84,878,733,020.95 TSHs
Tanzania - Zanzibar	Manzizini - Fumba	4,821,293,060 TSHs	*
	Amani - Dunga	19,990,680,530 TSHs	20,779,291,097 TSHs
	Mfensini - Bumbwini		
Tunisia	RVE 573	7,803,005.000 Dinars	8,765,296.213 Dinars*
	MC 35	12,296,700 Dinars	13,343,200.488 Dinars
	RVE 565		
	MC 135	8,382,190,000 Dinars	8,336,671,863 Dinars
	MC 34		
	GP1		
	RVE511	3,935,679,000 Dinars	3,626,011,161 Dinars
	X 20		
Uganda	Kabale - Kisoro - Bunangana / Kyanika	Ush 147,067,121,956	Ush 195,445,535,968

regarded as unsatisfactory was on account of cost increases of more than 25% beyond the contract sum and the execution periods of more than 35% beyond the contract periods; or where the increase in cost was below 15% of the contract sum, project execution was delayed beyond 50% of the contract period. The contracts which were regarded as having performed unsatisfactorily were for one contract in Cameroon, four of the contracts in Ghana, the two for the three roads in Zanzibar and for the one contract in Uganda.

% of actual cost above contract sum	Original Construction Period (OCP)	Actual period for completion (APC)	% of APC above OCP	Rating
3.4	18 Months	18 Months	0	Satisfactory
0	36 Months	36 Months	0	Satisfactory
12%	36 Months	53 Months	47%	Mod. Satisfactory
22%	24 Months	42 Months	75%	Unsatisfactory
0	24 Months	25 Months	4.16	Satisfactory
0	24 Months	24 Months	0	Satisfactory
31%	24 Months	44 Months	83%	Unsatisfactory
-2%	17 Months	20 Months	18%	Satisfactory
9%	24 Months	33 Months	38%	Mod. Satisfactory
19%	24 Months	44.5 Months	85	Unsatisfactory
51.6%	29 Months	44 Months	52	Unsatisfactory
132.1%	9 Months	9 Months	0	Unsatisfactory
14.95	30 Months (Lot - 1)	38.5 Months (Lot - 1)	28.33 (Lot - 1)	Mod. Satisfactory
14.35	30 Months (Lot - 2)	41 Months (Lot - 2)	36.67 (Lot - 2)	Mod. Satisfactory
5.79	30 Months (Lot - 3)	40 Months (Lot - 3)	33.3 (Lot - 3)	Mod. Satisfactory
-*	30 Months	40.5 Months	35	Mod. Satisfactory
0	30 Months	34 Months	13.33	Satisfactory
0	30 Months	34 Months	13.33	Satisfactory
2.9	30 Months	38 Months	26.67	Mod. Satisfactory
-0.5	30 Months	34.75 Months	15.83	Satisfactory
*	18 Months	36 Months	100	Unsatisfactory
3.9	15 Months	28.1 Months	87.33	Unsatisfactory
				Unsatisfactory
12.3	18 Months	17.5 Months	-2.77	Satisfactory
8.5	20 Months	24.5 Months	22.5	Satisfactory
				Satisfactory
-0.5	7 Months	7 Months	0	Satisfactory
				Satisfactory
				Satisfactory
-7.9	5 Months	5.5 Months	10	Satisfactory
				Satisfactory
33	1096 days	2020 days	84	Unsatisfactory

The Nairobi - Thika road contracts suffered delays and cost increases due to additional works and also to problems with delays in the relocation of utilities and also in paying compensation for structures appropriated for the road widening. The Athi River - Namanga road also suffered delays due to additional works and also on account of the slow start up of the contractor. The Consultant was not able to verify whether or not the additional works were necessitated by shortcomings in the design, which would be the responsibility of the design consultants and partly shared by the client for not adequately supervising the consultant; or entirely from the client requiring additional facilities after project commencement. It is the opinion of the Consultant that both were contributory factors.

With the Katesh - Babati road in Mainland Tanzania, the delays resulted from design changes necessitated during construction due to inadequacies in the original design. The contractor's startup was also slower than programmed. Delays in payment of the local component by the government also contributed to the delays.

Picture 5.1: Section of Kabale - Kisoro Road in Uganda in a Mountainous Area

With the Manzizini - Fumba road the project was completed under two contracts. The initial contract was terminated by the original contractor for non-payment of certified work - two certificates were to be paid for by the Bank and a number of certificates by the Government of Zanzibar.

Before this event, the performance of the contractor had been called into question. The supervision consultant was also found to be weak in enforcing the conditions of the contract. However in view of the delays in payment for certified work, a non-performing contractor was able to get out of the contract without any penalties.

A second Contract, fully funded by the Government of Zanzibar, was later awarded for the completion of the project.

The performance of the contracts for the Kabale - Kisoro - Bunagana/Kyanika road project in Uganda and for the Bamenda - Batibo - Numba road project in Cameroon was affected by engineering challenges in rather difficult environments as indicated in Pictures 5.1 and 5.2.

The Consultant's interviews with personnel from the Road Administrations indicated that the tardiness of contractors was, in general, related to the lack of experience of key personnel in the region and an inadequate understanding of the language of the contract by such key personnel. In some cases, the delays were caused by the contractors failing to quickly establish their operations usually due to challenges in their management of the projects.

Picture 5.2: Repair of one of the Recurrent Landslides on the Bamenda - Batibo -Numba Road Section, Cameroon

A practice was found in the DRC, and could be replicated where applicable, in the opinion of the Consultant to improve quality and the cost and time performance of Bank funded road projects. For the projects in the DRC, a Project Management Unit (PMU) was set up as a technical assistance component of the project. The PMU was staffed with qualified and experienced project management personnel who provided technical support for the implementing agency during project execution.

This undoubtedly must have helped in the performance of the contracts in the DRC. For the wider application of this practice, the Bank could assess the capacity of an implementing agency at the project identification/appraisal stage and if the capacity for engineering reviews and project management is found to be less than satisfactory, then a PMU; or other forms of technical assistance such as the engagement of technical experts; could be set up to assist the implementing agency in the review of the detailed designs, analyzing contractual issues, overseeing the supervision consultants; and also in training counterparts staff in the implementing agencies for knowledge transfer as part of capacity building. The Consultant appreciates that this is part of the Bank's appraisal system. Based on the performance of the most of the road sections studied, however, a deepening of this system could be of tremendous help in ensuring that Bank funded road projects perform satisfactorily. Another reason cited for changes in scope of works during construction was inadequate time sometimes given for studies.

5.5 Actions required for improving performance of future contracts

The foregoing brings out a number of issues for consideration in future projects if they are to perform well and ensure overall quality and sustainability of Bank funded road projects. The identified issues are:

- All parties, especially the client, should as much as possible ensure that designs are well done and are adequate for the intended purpose. This would require the careful selection of study/design and supervision consultants with a strong emphasis on the qualification and the proven experience of consultants' staff to ensure they are fully capable of carrying out the required services satisfactorily. Discussions with Bank staff indicated that higher attention is being given to these attributes in Request for Proposals and in evaluation. Efforts in this direction nevertheless need to continue.
- A thorough assessment of the capacity of implementing agencies should be made at project identification/appraisal stage and where deemed to be less than satisfactory and depending on the degree of capacity deficit, a Project Management Unit be set up or Technical Assistant(s)/Experts could be engaged to assist the implementing agencies in the review of designs, analyses of contractual issues, overseeing supervision consultants; and in the training of counterpart staff from the agency for capacity building. This, it is understood, is an integral part of Bank operations but it may need to be deepened.
- Contractors' key personnel should have experience in the region and must have adequate knowledge and understanding of the language of the contract.
- There should be adequate funding available to cover the required counterpart funding for the project from the recipient's governments.
- The recipient Government's share of the project cost is as low as possible and where ever possible the Bank considers fully funding the project. The issue of counterpart funding, or rather the lack of it, was a contributory cause of many a delay to projects.

The Bank may also encourage the Governments to set up infrastructure funds either through bonds or some form of tax to ensure counterpart funds are available for projects RMCs jointly finance with development partners to fund,

- As much as possible, all utility lines in the construction corridor are removed and the necessary compensation for projects to be appropriated paid prior to contract effectiveness,
- Governments should be encouraged to come out with guidelines for the sharing of the right of way between the utility agencies and the road agency to avoid encountering unexpected utility facilities during construction which not only delays projects but can increase construction costs significantly.

5.6 Quality control on study roads

Picture 5.3: : Part of Asphalt Laboratory for Nandeke - Mbere Road Project

Another area was the issue of quality assurance on the projects. As has been noted in Chapter 2, the Consultant was unable to obtain the Quality Assurance Plan (QAP) for most of the projects for the construction of the Study roads. Quality Assurance Plans were obtained for the projects for the two road sections in Cameroon. In Uganda a summarized Quality Assurance Plan was seen in the Project Completion Report prepared by the supervisor. On the Agbozume - Aflao road project discussions with the Engineer's Representative indicated that the site had a system for ensuring quality, though it was not contained in a single document.

There was evidence from a study of the progress reports, however, that this has been prepared for some of the projects.

The non-availability of the document does not infer that quality control of the projects had been neglected. In the absence of the documents relating to the quality assurance plans used for the projects, the Consultant scrutinized the sections on quality control as contained in the progress reports for the construction of the various Study roads.

Picture 5.4: Part of Soils Laboratory for Nandeke - Mbere Road Project

In Benin and Tunisia where the Consultant did not have access to Progress Reports; since these were not available from the executing agencies as in Benin or were not prepared in Tunisia because supervision was carried out in house; Quality Control files were examined.

The quality control procedures adopted were the same for all the Study Countries. Laboratories were established on each of the construction projects and provided with the necessary equipment as per contract conditions. Pictures 5.3 and 5.4 show the laboratory set up on the Nandeke - Mbere road section in Cameroon. The study of the progress reports and the files for Quality Control suggests that quality control was adequately carried out on the projects.

Materials were, where appropriate tested before being incorporated or, where the contracts permitted, test certificates from certified laboratories accompanied materials that were to be incorporated in the works. The various layers of the pavement were subjected to the tests prescribed in the project specifications prior to being accepted for works to continue or for acceptance of the completed pavement. Concrete for drainage structures and bus bays was also tested for strength as prescribed in the project specifications. Materials or sections of constructed works that initially did not meet project specifications were rejected or removed and retested for compliance.

The largely satisfactory quality of the as built roads as evidenced from the Consultant's investigations confirms that quality control had indeed been carried out for the Study roads during their construction. The Consultant cannot stress enough the importance of the QAP and it would be necessary for Bank Supervision Missions to insist on this document. This document is a requirement under the conditions of contract for Bank financed road projects and must be filed on site for reference during the currency of the contract with copies properly archived at the offices of the Road Administrations.

6.0
STANDARDS AND SPECIFICATIONS OF STUDY ROADS AND BEST PRACTICE AND COMPARISON WITH OTHER INTERNA-

6.0 STANDARDS AND SPECIFICATIONS OF STUDY ROADS AND BEST PRACTICE AND COMPARISON WITH OTHER INTERNATIONALLY FUNDED ROAD PROJECTS

6.1 Standards and specifications used in bank funded projects and best practice

As part of the requirements of the ToR, the Consultant has assessed whether the technical standards and specifications adopted in Bank financed road projects are of internationally acceptable best practice.
Best practice refers to a technique or methodology that has consistently shown results superior to other means and that is used as a benchmark. It may also refer to practices that have produced outstanding results in one or more situations and may be adapted for other situations. The standards and specifications have been reviewed in relation to best practice to enable an assessment of whether or not these follow best practices. The standards and specifications used for the Study roads in the various countries are discussed in the ensuing sections.

6.1.1 Benin

In Benin, the design standards used for the Study roads followed the recommendations of the Aménagement des Routes Principal (ARP); that is Technical Guidelines for the Design of Main Roads published by the Road and Motorway Division of Service d'Etudes Techniques des Routes et Autoroutes (SETRA) in France. The road standards also conformed to standards issued for the Economic Community of West African States (ECOWAS) community roads in 1996. The specifications for the projects were based on Les Cahiers des Clauses Techniques Generales (CCGT) of France. Testing of construction materials was based on testing standards set by the Association Francaise de Normalisation (AFNOR) and Laboratoire d'Etudes Techniques des Ponts et Chausees (LCPC) of France.

6.1.2 Cameroon

The design standards used for the study roads followed the recommendations of the Aménagement des Routes Principal Division of Service d'Etudes Techniques des Routes et Autoroutes (SETRA) in France. The specifications for the projects were based on Les Cahiers des Clauses Techniques Generales (CCGT) of France. Testing of construction materials was based on testing standards set by the Association Francaise de Normalisation (AFNOR) and Laboratoire d'Etudes Techniques des Ponts et Chausees (LCPC) of France. These standards and specifications have been used extensively in former French colonies especially in French speaking West Africa such as Togo and Benin with satisfactory results.

6.1.3 DRC

The roads in DRC followed the design standards contained in Les Fascicules de la Conception Routiere ex-Zairoise (Congolaise) which is largely based on the technical guidelines published by SETRA of France. The specifications for the roads followed those in Les Cahiers des Clauses Techniques Generales (CCGT) of France and the Les Specifications Techniques de l'Ancien Direction Congolaise des Ponts et Chausee. Testing of construction materials was based on testing standards set by AFNOR/LCPC of France, CRR of Belgium, BSI of the United Kingdom and ASTM in the United States.

6.1.4 Ghana

The designs of the Study road sections in Ghana were based on the Road Design Guide issued by the Ghana Highway Authority. The Road Design Guide was largely based on the American Association of State Highway and Transportation Officials (AASHTO) Design Guides. The specifications were based on Specifications for Roads and Bridges issued by Ghana's Ministry of Roads and Highways initially published in 1991 and revised in 2007. Material Testing was based on Ghana Highway Authority's Material Testing Manual developed in 1992.

The specifications and the testing manual were developed based on specifications and testing standards from AASHTO, the American Society for the Testing of Materials (ASTM), and British Standards and Specifications for Roads and Bridges; and adapted for local conditions.

6.1.5 Kenya

The designs of the Study roads in Kenya were based on the Kenyan Manual for Road Design. The specifications used for the roads were the Kenya Standard Specifications for Road and Bridge construction issued by the Permanent Secretary, Ministry of Roads and Public Works in 1986. The development of the Kenyan standards and specifications were based on standards and specifications from the American Association of State Highway and Transportation Officials (AASHTO) and the American Society for the Testing of Materials (ASTM) in the United States of America; and British Standards and Specifications for Roads and Bridges and adapted for local conditions. The Kenyan standards and specifications incorporate best practices from the British and American standards and specifications which have the widest use in the world. After their application for a quarter of a century and with the experience obtained from their application, the documents are currently being reviewed.

6.1.6 Tanzania

The design of the pavements for the Study roads in Tanzania was based on the Tanzania Pavement and Materials Design Manual issued by Tanzania's Ministry of Works in 1999. The manual was developed in collaboration with the Norwegian Public Roads Administration and incorporates best practices from SADC, the Transport and Research Laboratory (TRL) of the United Kingdom; and from Norway. The geometric design of the roads followed the guidelines issued by SADC while the specifications for the projects were based on the "Standard Specification for Road Works" issued by the Ministry of Works in year 2000. The specifications which were developed in collaboration with the Norwegian Public Roads Administration under a cooperation agreement with the Norwegian Agency for International Development (NORAD) largely follow the guidelines issued by SADC and incorporate best practices from Norway.

6.1.7 Tunisia

In Tunisia, the design standards used for the study roads followed the recommendations of the General Technical Guidelines for Design of Roads for the Construction of Main Roads published by the Road and Motorway Division of Service d'Etudes Techniques des Routes et Autoroutes (SETRA) in France. The specifications used were based on those issued by the Prime Minister on 6th July, 1999. These are Terrassements Generaux, Granulats Routiers and Execution des Enduits Superficiels. These specifications are based on the French Cahiers des Communes (CPC), the Cahiers des Clauses Techniques Générales (CCPT and recommendations from Laboratoire d'Etudes Techniques des Ponts et Chaussées (LCPC) of France. The testing methods were based on testing standards issued by AFNOR and LCPC of France. For tests not covered by AFNOR and LCPC, standards from AASHTO or ASTM were used.

6.1.8 Uganda

The design of the Study road in Uganda was based on the Uganda Road Design Manuals published by the Ministry of Works and Transport of the Republic of Uganda. The manuals have been developed from AASHTO and the British design guides for road and bridges. The specifications for the Study road were the General Specifications for Road and Bridge works published by the Ministry of Works and Transport of the Republic of Uganda in November 1992. The specifications were developed based on internationally accepted specifications from AASHTO, ASTM and the British Standards Specifications for Roads and Bridges.

6.2 Comparison of standards, specifications and performance of study roads with those of other internationally funded roads

6.2.1 Introduction

The performance of projects funded by the Bank in the various Study countries have been compared with those of other projects funded from other sources. The other projects were proposed by the Road Administrations after carefully explaining to them the objective of this comparison. The intention was to get as wide a funding source spread as possible. The projects proposed were:-

Benin	-	Godomey - Calavi Road (Funded by the EU)
Cameroon	-	Garoua Bolai - Nandeke Road (Funded by the EU), and Mbere - Ngouandere Road (Funded by IDA)
D. R. Congo	-	Lufimi - Kwango Road (Funded by the EU) and, Kenge - Kikwit Road (Funded by IDA)

Figure 6.1: Location of Godomey - Calavi Road in Benin

Ghana	-	Anwiankwanta (Ayaase) - Assin Praso Road (Funded by JICA)
Kenya	-	Machakos - Sultan Hamood Section of the Nairobi - Mombasa Road (Funded by the IDA)
Tanzania	-	Chalinze - Tanga Road (Funded by DANIDA) and, Singida - Shelui Road (Funded by IDA); and
Tunisia	-	Grombalia Bypass (Funded by the EU)
Uganda	-	Jinja - Bugiri Road (Funded by the EU) and Masaka - Mbarara Road (Funded by the EU)

The roads were visually inspected to provide an appreciation of the performance of each one of them.

6.2.2 Benin

The Godomey - Calavi road in Benin is a 3.5 km multi-lane sub-urban road on the outskirts of Cotonou.

It is a dual carriage way with three lanes on each side. The lane widths are 3.25 m with two outer shoulders, each 1.5 m wide. The carriageways are finished in asphalt concrete with surface dressed shoulders.

Discussions with the Road Administration staff indicated that the pavement consists of asphalt layers, crushed rock base and natural sub-base of various thicknesses.

The inspection showed that the road was performing well with little or no distress exhibited. The visual inspection of the two roads indicates that both roads are performing well.

It is therefore concluded that the performance of the Pobe - Ketou and the Ketou - Illara road sections is comparable to that of the Godomey - Kalavi road section. The location of the Godomey - Kalavi road in relation to the Study roads is shown in Figure 6.1.

6.2.3 Cameroon

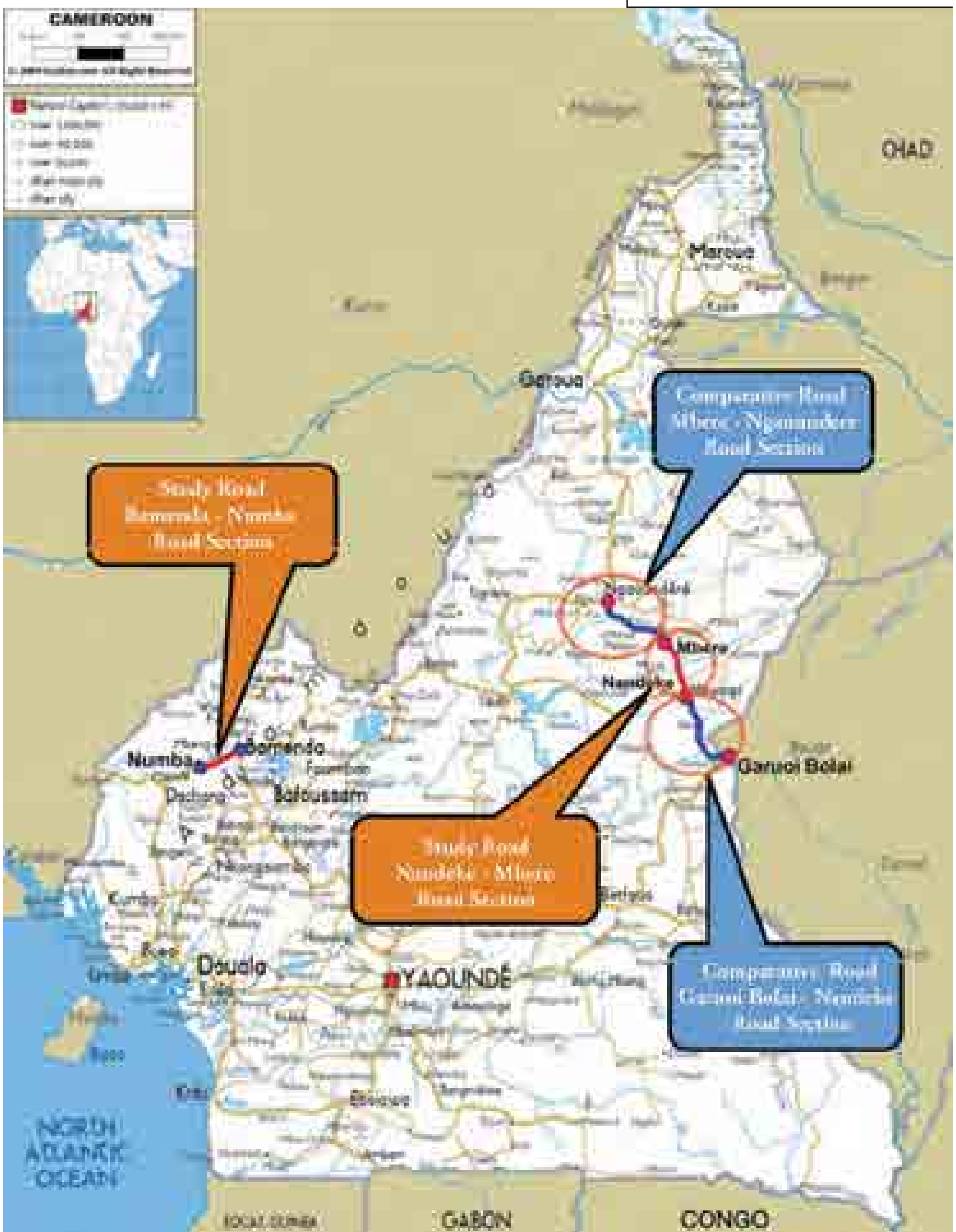
The Garoua Bolai - Nandeke road section is approximately 94 km long and is contiguous with the Nandeke - Mbere road. It has a 7m wide carriageway with 1.5 m shoulders on either side of the carriageway. Construction was carried out by DTP Terrassement/Razel of France and supervised by Egis/BCEOM International also of France. The pavement structure has a 50 mm asphalt concrete wearing course, a 200 mm crushed rock base and a 300 mm thick natural sub-base. Costruction for this road section commenced on 21st September, 2010 and was substantially completed in June, 2013. The project was funded by the EU. (Figure 6.2).

The visual survey showed that the road has shown no distress except for a few patches in three cut sections.

A poor construction joint and a pothole were also observed around 13 km and at around 25 km north of Garoua Boulai respectively. The road has been properly marked and adequate safety features provided.

The Mbere - Ngaoundere road section lies to the north of the Nandeke - Mbere section and is part of the Garoua Boulai - Ngaoundere road. The road section is 86 km long. The pavement structure is the same as provided for the Garoua Boulai -Nandeke and the Nandeke - Mbere sections. The carriageway is 7m wide with 1.5 m shoulders. Construction was undertaken by Groupement Constructura Andrade Gutierrez, S. A. /Zagope Construcões Engenharia S. A. of Brazil and supervised by Egis/BCEOM International of France. Funding was provided by IDA. The visual survey showed a relatively open-textured wearing course. Some transverse cracking was observed mainly in the north bound lane.There was also moderate bleeding over sections.

Figure 6.2: Location of Garuoi Bolai - Nandeke and Mbere - Ngaoundere Roads in Cameroon



Construction started in august 2009 for a 24 month contract period. The project is yet to be handed over to the client because of the observed defects.

The Study roads and these other roads used the same specifications. Roughness measurements carried out on the last 10 km of the Garoua Boulai - Nadeke and the first 10 km of the Mbere - Ngaoundere sections gave average values of 2.45 and 2.02 IRI respectively. These values may be compared with average values of around 1.6 IRI for the two Study roads in Cameroon.

The foregoing suggests that the standards used for Bank funded road projects in Cameroon are the same as standards used for road projects funded from other sources; and that the performance of Bank funded road projects in Cameroon is at leat comparable to those funded from other sources. The locations of the roads used for comparison in relation to those of the Study roads are shown in Figure 6.2.

6.2.4 DRC

The Lufimi - Kwango road in DRC is a single carriageway road which connects the Nsele - Lufimi and Kwango - Kenge roads. It is a 57 km long road with a 7m wide carriageway and 1m wide shoulders. The carriageway is surfaced in asphalt with surface dressed shoulders. The pavement has a cement stabilized base overlying natural subbase and improved subgrade.

The project was completed in December, 2008 and construction was undertaken by Sogea-Satom of France. The road has shown moderate longitudinal cracking with intermittent transverse cracking. There is also extensive patching of the road. The frequency of cracking and patching increases towards Kwango. The road has also shown moderate tearing and shoving in the hilly sections. The lack of drains has led to the carriageway being covered with sand in the section before the Kwango Bridge.

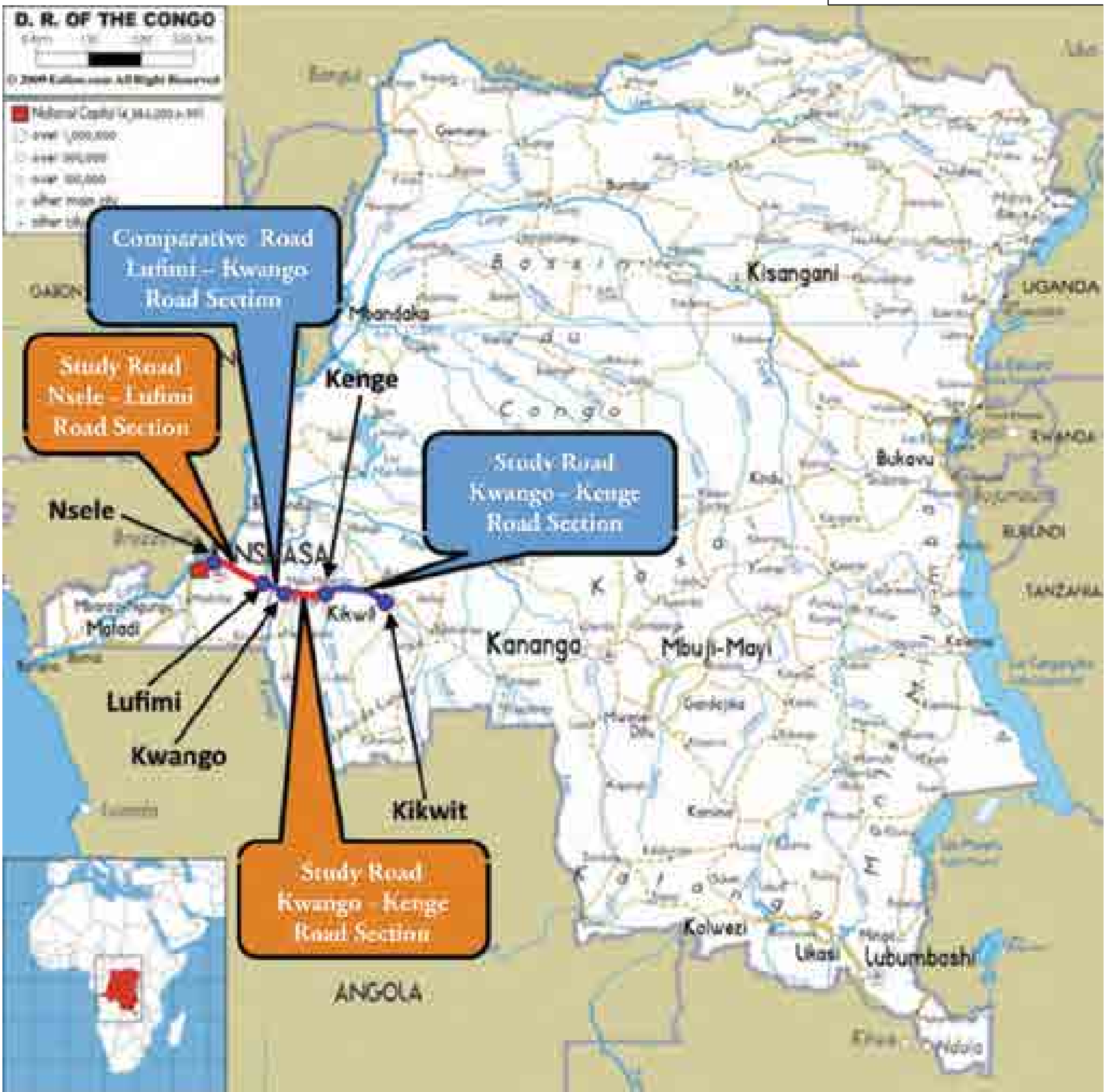
The performance of the road is similar to that of the Kwango - Kenge road which also has cement stabilized base. The geometric design standards and the specifications used for this road were the same standards and specifications used for the Nsele - Lufimi and the Kwango - Kenge roads.

The road has shown moderate longitudinal cracks mainly in the outer wheel paths with transverse connectors, similar to those exhibited by the Lufimi - Kwango and the Kwango - Kenge roads. There is slight to moderate edge breakage. There are intermittent patches. There was also the occasional pothole and alligator cracking in places. Subsidence was also noticed at two places in the Kenge-bound lane from Kikwit close to Kenge. The geometric design standards are the same as those used for the Nsele - Lufimi and the Kwango - Kenge roads, except for the difference in shoulder width. The specifications used for this road were also the same as used for the two study roads. The location of the Lufimi - Kwango and Kenge - Kikwit roads are shown in Figure 6.3.

The foregoing suggests that the Bank funded projects in the DRC have equal or superior standards to those funded from other sources.

The specifications and materials used are similar and the performance of Bank funded projects are not worse than that of projects funded from the other sources.

Figure 6.3: Location of Lufimi - Kwango and Kenge -Kikwit Roads in DRC



6.2.5 Ghana

The Anwiankwanta (Ayaase) - Assin Praso road in Ghana which is 60 km long has a carriageway width of 7.3 m and shoulders of 2.5 m wide on either side.

The road funded by the Japan International Cooperation Agency (JICA) was constructed by Tokura Limited of Japan and supervised by Ingerosec also of Japan.

Construction commenced in April 2013 and was substantially completed on 31st December 2013. Parts of the road section received an overlay comprising a 40 mm thick wearing course and two layers of asphaltic concrete base, each 50 mm thick, after minor repairs such as pothole repairs. Other parts were partially reconstructed. The reconstructed sub-sections received a total of 140 mm of asphaltic concrete layers just like those which received overlays; a 200 mm thick crushed rock base and a 200 mm thick natural gravel sub-base.

Figure 6.4: Location of Anwiankwanta (Ayaase) - Assin Praso Road in Ghana

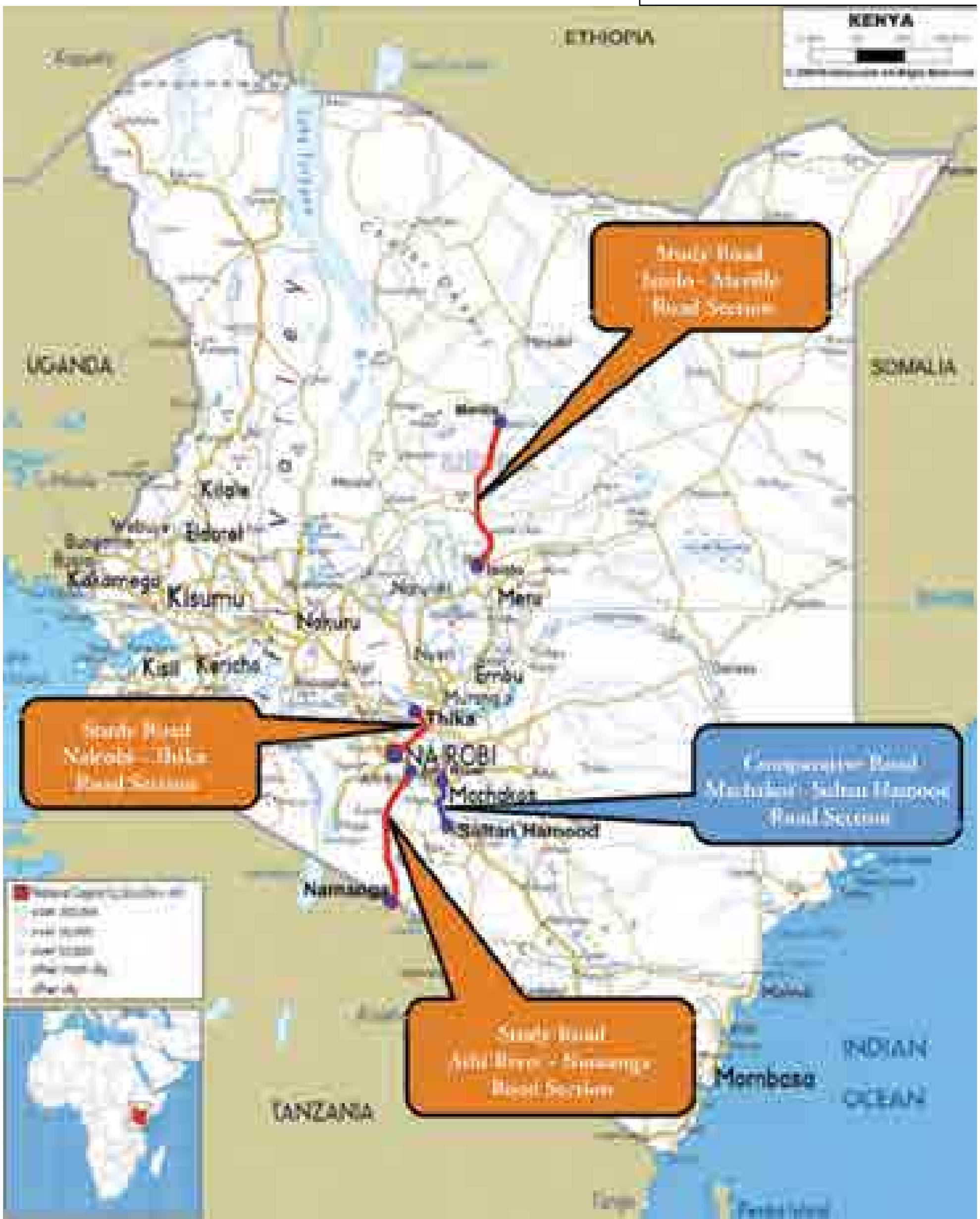
The visual survey showed that the road has not exhibited any distresses except some minor bleeding over a short section. Adequate provisions have also been made for safety especially through settlements.

The standards and specifications used for the construction of this road section were the same as those used for the roads studied in Ghana. The performance of the Study roads is comparable to the performance of this road section funded by JICA. The location of the Anwiankwanta - Assin praso road is shown in Figure 6.4

6.2.6 Kenya

The Machakos - Sultan Hamood section of the Nairobi - Mombassa road is an originally single carriageway being expanded into a dual carriageway for the first 12.5 km with two service roads on each side of the carriageway for 7.5 km. The original two lane two-way road to Mombassa has been rehabilitated while a new carriageway has been constructed for the Nairobi bound traffic for the dual carriageway section.

Figure 6.5: Location of Machakos - Sultan Hamood Road in Kenya



The construction, undertaken by SBI international of Israel, was supervised by Nicholas O'Dwyer of Ireland. The carriageways have a width of 7 m with an outer shoulder width of 1.5 m and an inner shoulder width of 1 m. The service roads have 1.5 m wide shoulders on each side. (Figure 6.5)

The road has an asphalt concrete surfacing over dense bituminous base on graded crushed rock base which is further underlain by natural sub-base. The asphalt concrete surfacing has been further surfaced with a single layer of surface dressing.

The road which has recently been completed has shown little or no defects. The visual inspection revealed some minor rutting and flushing in the Nairobi-bound lane on the section with a single carriageway. There was also a minor depression and cracking over a limited section in the Nairobi-bound lane over this section.

The standards and specifications of the Study roads are the same as used for the Machakos - Sultan Hamood road section.

The location of the the Machakos - Sultan Hamood road section has been shown in Figure 6.5.

The performance of the Nairobi - Thika road is comparable to that of this road. In terms of current performance, the other Study roads funded by the Bank, that is the Athi River - Namanga and the Isiolo - Merille roads are no worse than that of the Machakos - Sultan Hamood road.

6.2.7 Tanzania

The Singida - Shelui road, which is 110 km, was constructed in three lots. The three lots were:

Lot 1	-	Singida - Igugno (34 km);
Lot 2	-	Igugono - Misigiri/Sekenke (42 km) and;
Lot 3	-	Misigiri/Sekenke - Shelui (33 km).

All the three lots were constructed by CHICO of China. The supervisors were Roughton International for Lot 1, Dar al-Handassah of Egypt for Lot 2 and BCEOM of France for Lot 3. The projects were completed in November, 2007 for Lot 2, November, 2008 for Lot 1 and January, 2009 for Lot 3. Current traffic is in the order of 800 ADT for Lots 1 and 2, and 650 for Lot 3.

All lots have a carriageway width of 6.5 m and 1.5 m shoulders. The pavement structures were similar.

Figure 6.6: Location of Singida - Shelui and Chalinze - Tanga Roads in Tanzania

The carriageways were finished in double surface dressing, over a base of crushed stone blended with natural gravel. The sub-base for all the lots was cement stabilized natural gravel and placed over improved subgrade.

The performance of all three lots is generally good except that a short section of Lot 1 has been washed away as shown in Picture 6.1. A short section of Lot 2 has also seen some cracking and patching as shown in Picture 6.2.

The design and construction of the Singida - Minjingu road were based on the same standards and specifications used for the Singida - Shelui road. The Singida - Katesh section of the singida - Babati -- Minjingu road has seen some cracking between km 2 and km 11. Its performance cannot be said to be worse than that of the Singida -Shelui road. It may be concluded that the standards and specification of the Bank funded projects are comparable to those of the three lots of the Singida - Shelui road funded from another source. Construction of the 125 km Chalinze - Kitumbi road project was started on 21st April, 2008 and completed on 7th October, 2010. Construction was carried out by China Geo-Engineering Corporation and supervised by Roughton International Ltd of the United Kingdom. The carriageway has a 6m width with two 1m wide shoulders. The pavement structure comprises an asphalt concrete wearing course, crushed rock base, natural gravel sub-base over improved sub-base. The average daily traffic is around 2,200 vehicles per day. The Consultant's inspection revealed that the performance of the road can be considered good. There are however a few manifestations of distress. Rutting was observed between km 52 and 65. Some patching has also been carried out around km 62. At 6 m, the carriageway is a bit narrower than that used on the Singida - Minjingu road.

The design and specifications for the Study roads and those of the Singida - Shelui and the Chalinze - Tanga roads were based on the Tanzania Pavement and Materials Design Manual and Standard Specifications for Road Works.

It may be concluded that the specifications used on the Singida - Minjingu road, and its performance are comparable, if not superior, to those of the Chalinze - Tanga and the Singida - Shelui road projects. The Chalinze - Tanga and Singida - Shelui road sections are shown in relation to the Study roads in Figure 6.6.

Picture 6.1: Singida-Shelui (Lot 1: Singida-Iguguno Section Washed away road at Chainage 16+700km

6.2.8 Tunisia

The Grombalia By-pass is a 7 km dual carriageway. The two carriageways, each 8m wide with two 2.75 m shoulders, are separated by a 3 m divider. The shoulders are unpaved.

The road is finished in asphalt concrete. Our inspection indicated that the project was yet to be officially handed over.

Some traffic is however using the road. There were no defects noticed on the road. The standards are comparable to those used in the Study roads, in particular, the lack of paving on the shoulders. The same standard specifications were used for the construction of the Grombalia Bypass and the Study roads.

Figure 6.7 shows the location of the Grombalia By-pass on a map of Tunisia.

Picture 6.2: Singida-Shelui Lot 2: Iguguno-Misigiri Section, km 39+000

6.2.9 Uganda

The two roads sections used for comparison in Uganda were the 149 km Masaka - Mbarara and the 72.8 km Jinja - Bugiri roads. Both roads were funded by the EU.

The design of both roads was based on the Uganda Road Design Manuals. The specifications used for the Masaka - Mbarara road section was the January, 2005 General Specifications for Road and Bridge Works published by the Ministry of Works and Transport while that used for the Jinja - Bugiri road was the General Specifications for Road and Bridge Works published by the same Ministry in 1992.

Both roads were reconstructed and have a 7 m wide carriageway and 1.5 m wide shoulders. The pavement structure provided for the Masaka - Mbarara road section was a 50 mm thick asphaltic concrete wearing course, dense bituminous macadam with thickness varying between 110 and 150 mm, a crushed stone base with thickness varying between 225 and 250 mm and a crushed stone sub-base with thichness varying between 100 and 175 mm. The Jinja - Bugiri road had a 60 mm asphaltic concrete wearing course, a 150 mm thick dense bituminous macadam, a 175 mm thick crushed rock base and a 200 mm thick crushed stone sub-base.

Figure 6.7: Location of Grombalia Bypass in Tunisia

Construction of the Masaka - Mbarara road section started on 8th January, 2008 and was completed on 13th August, 2012. Construction of the Jinja - Bugiri road commenced on 1st July, 2006 and was completed on 13th October, 2009. The specifications employed for the projects being used for comparison and that for the Study road were found to be the same or similar. The Kabale - Kisoro - Bunagana/Kyanika, the Masaka - Mbarara and the Jinja - Bugiri road sections form part of the DRC/Rwanda - Uganda - Kenya link. The Masaka - Mbarara and the Jinja - Bugiri road sections have a higher classification than that of the Study road and accounts for the different standard for the Kabale - Kisoro - Bunagana/Kyanika road section. The study road has a 6 m wide carriageway with 1 m wide shoulders. It must be understood that even if the classification for all three roads were the same, the mountainous terrain through which a large portion of the Kabale - Kisoro road traverses would have necessitated a lower standard. A more liberal standard would have increased the cost of the project and made it uneconomical to construct in addition to the possibility of triggering rock and land slides which could make the road unsafe. The standards are seen as adequate for the level of traffic using the road now and predicted over the expected life of the road section

Picture 6.3: A View of the Masaka - Mbarara Road Section

The Masaka - Mbarara road section has shown no distress. The Jinga - Bugiri road has however exhibited a variety of distresses. Among the distresses shown are ravelling; and bleeding which is extensive. Picture 6.3 is a typical view of the Masaka - Mbarara road while Picture 6.4 shows a portion of the Jinja - Bugiri road section which has exhibited some distress.

The discussion above suggests that compared to the two roads both funded by the EU; the Study road has performed better than the Jinja - Bugiri road but has not performed as well as the Masaka - Mbarara road section.

The road administration indicates that the asphaltic concrete mix design for the Masaka - Mbarara road section was modified based on the lessons learnt from the performance of the Jinja - Bugiri road section. The locations of the Masaka - Mbarara and the Jinja - Bugiri road sections in relation to the Kabale - Kisoro road section are illustrated in Figure 6.8.

Picture 6.4: Pavement Distress on the Jinja - Bugiri Road Section

6.3 Summary

The Standards and Specifications used for Bank funded road projects have been reviewed, especially, with respect to their genesis. The review has indicated that the specifications and standards have been based on national, regional or international standards and specifications. The international standards and specifications utilized for the development of the standards and specifications were mainly AASHTO and ASTM from the United States of America, the British Standards and Specifications from the British Standards Institute (BSI) and AFNOR from France which have proven to provide satisfactory results in different situations over time.

The standards and specifications have however been adapted to suit local conditions. Where local and national standards have been utilized, these have been developed based largely on the above named proven international standards. It may therefore be concluded that the Bank financed road projects in Regional Member Countries are based on standards and specifications which follow international best practice.

The specifications for all the Study countries were found to be prescriptive rather than performance-based. The prescriptive specifications set forth in detail the materials to be utilized and the manner in which the work is to be performed and the contractor would be expected to follow them without deviation. On the other hand, performance specifications describe the end result or a standard to be achieved and leave the determination of how the result is to be achieved by the contractor. While it is thought that performance specifications encourage innovation, it also carries a higher risk. On ther other hand, prescriptive specifications are presumed to carry a lower risk of achieving project objectives but do not engender innovation. Mixing performance and prescriptive specifications for the same project has been found to dilute responsibility and can lead to serious legal disputes. It is conceivable that performance specifications will become more prevalent in the future; the current capacity levels of most implementing agencies however require that a shift to performance specifications is pursued with caution.

A review of the spcifications from the Study countries showed little or no differences. This is because all of them have developed from the same standards – AASHTO, ASTM and the British specifications for English speaking member countries; and AFNOR, LCPC and CCPT for the French speaking member countries. There is also a growing trend towards cross fertilization from these standards in member country specifications thereby blurring any differences.

Figure 6.8: Location of Jinja - Bugiri and Masaka - Mbarara Roads in Uganda Masaka -l Road in Uganda

Despite that the standards for the Study countries have, to a large extent, followed proven international standards, differences were observed in carriageway and shoulder widths from country to country for roads of similar classes and in similar terrain. Whereas very conservative dimensions may impair safety on roads, excessively liberal dimensions can increase the cost of projects significantly and increase the burden of maintenance. The most desirable dimensions are the ones that provide adequate safety without unduly increasing the cost of the facility. As much as it is recognized that the Bank does not hold specifications, the Bank may provide guidelines for these geometric standards. This could be done after studying regional standards to help with the harmonization of these standards on the continent, and to ensure cost-effective road development while providing adequate safety.

The comparison of the standards and specifications used for Bank funded road projects with those funded from other sources has also shown that in a particular country, the same standards and specifications have been used both for Bank funded road projects and those funded from other sources.

The Study has revealed that, for any country, it is the country's adopted standards and specifications that are followed for the development of road infrastructure for both locally funded and foreign funded projects; except in exceptional circumstances where a compromise on the standards may be made due to financial constraints without unduly impairing safety on the facility.

The standards and specifications used for projects in a particular country are therefore independent of the source of funding. What varies from project to project, and rightly so, is the structure of the pavement – that is the thicknesses of the the various layers. This is because the pavement structure is largely a function of the traffic expected to use the road section over the design life; and the environment within which the road section is located.

Most of the Study countries have been using their national or regional specifications over the last two to three decades. The Tanzania Standards and Specifications were developed taking into account the SADC guidelines. Benin has also adopted Standards issued by ECOWAS. Pavement performance records are becoming available and it may be time for these specifications to be reviewed taking into account pavement performance using different materials. There may also be the need to take advantage of new technologies that may have become available over the last two or so decades.

A comparison of the performances of Bank funded road projects with those of other projects funded from other sources also shows that the performances of the Study roads were comparable to those of other internationally funded road projects. Distresses were observed on some Bank funded road projects just as distresses were observed on road projects funded from other sources. The Study has shown that the performance of a road is unrelated to the source of funding; but rather is a function of the design, the construction, the adequacy or otherwise of the supervision or a combination of these factors.

7.0
USER PERCEPTIONS AND SOCIO-ECONOMIC ASSESSMENT OF STUDY ROADS

7.0 USER PERCEPTIONS AND SOCIO-ECONOMIC ASSESSMENT OF STUDY ROADS

7.1 General

Road User Perception Surveys were conducted on all the selected Study roads in the eight countries of Benin, Cameroon, Democratic Republic of Congo (DRC), Ghana, Kenya, Tanzania and Tunisia and Uganda. The surveys aimed at a target sample size of ten respondents for each road section. The target sample was exceeded on some roads while on some fast roads in urban areas this was not always achieved. The number of roads on which the target number of respondents was not achieved was however few. The respondents were randomly selected but covered all sections of users in terms of age, sex and professions.

The distribution of respondents in terms of age, sex and profession for the various countries and for all the eight countries in the Study is shown in Table 7.1. A total of 382 respondents were interviewed out of which 15% were women.

The relatively fewer number of women was because women, especially in the rural areas, tended to shy away from being interviewed. The survey questionnaire with the expected responses is reproduced in Table 7.2.

Table 7.1: Summary of Respondents' Attributes (%)

Respondent's Attribute	Country								All Countries
	Benin	Cameroon	DRC	Ghana	Kenya	Tanzania	Tunisia	Uganda	
Age (years)									
15 To 25	22.2	15.4	27.3	30.5	5.3	15.6	6.3	25.0	15.8
25 To 50	72.2	57.7	45.5	61.0	68.4	59.4	71.9	50.0	62.7
Greater Than 50	5.6	26.9	27.3	8.5	26.3	25.0	21.9	25.0	21.5
Sex									
Male	100	80.8	83.3	85.4	90.3	79.5	90.5	50.0	85.1
Female	0	19.2	16.7	14.6	9.7	20.5	9.5	50.0	14.9
Skill									
Professional/ Skilled	8.3	23.1	50	19.5	48.3	22.1	27.0	50.0	25.1
Semi-Skilled	75	46.2	27.8	46.3	38.7	50.8	39.2	37.5	47.4
Un-skilled	16.7	30.8	22.2	34.1	13.0	27.1	33.8	12.5	27.5

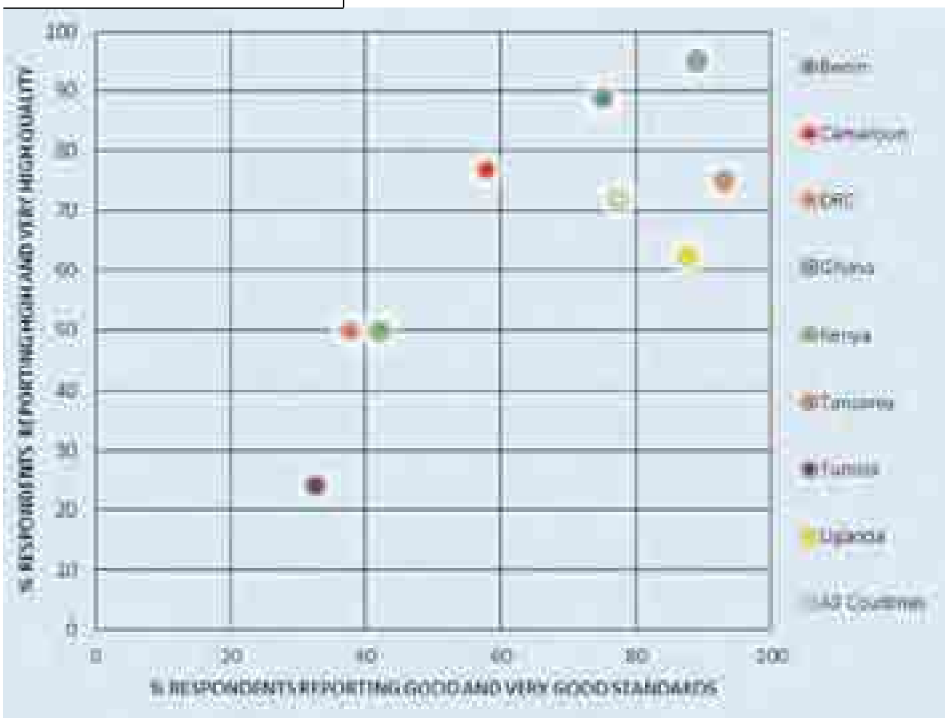
7.2 Analysis of survey data

For carrying out the analysis of the data obtained through the Questionnaire, a data-input format has been prepared, which could accommodate all the information and feedback given during the surveys. Accordingly, all the survey information was migrated to populate the data-input format. For the analysis of the data collected through the survey, MS-Access based software was developed, so that it could analyze a number of queries, whenever required. The software developed brings out the analysis for the parameters by specific road, and also summarizes the analysis at the country level by aggregating the data obtained for different roads in a specific country. Thus, the results were analyzed for each Study road and country as a whole.

In order to provide a better appreciation of the user perceptions through the information obtained from the survey, the responses have been re-categorized as presented in Table 7.3. For an appreciation of the positive perceptions of the users, the responses have been grouped into broader categories. The categories used in summarizing the results are shown in Table 7.4.

7.3 Survey findings

Figure 7.1: Percentage of Respondents Reporting Good and Very Good Standards; And High and Very High Quality for the Study Countries

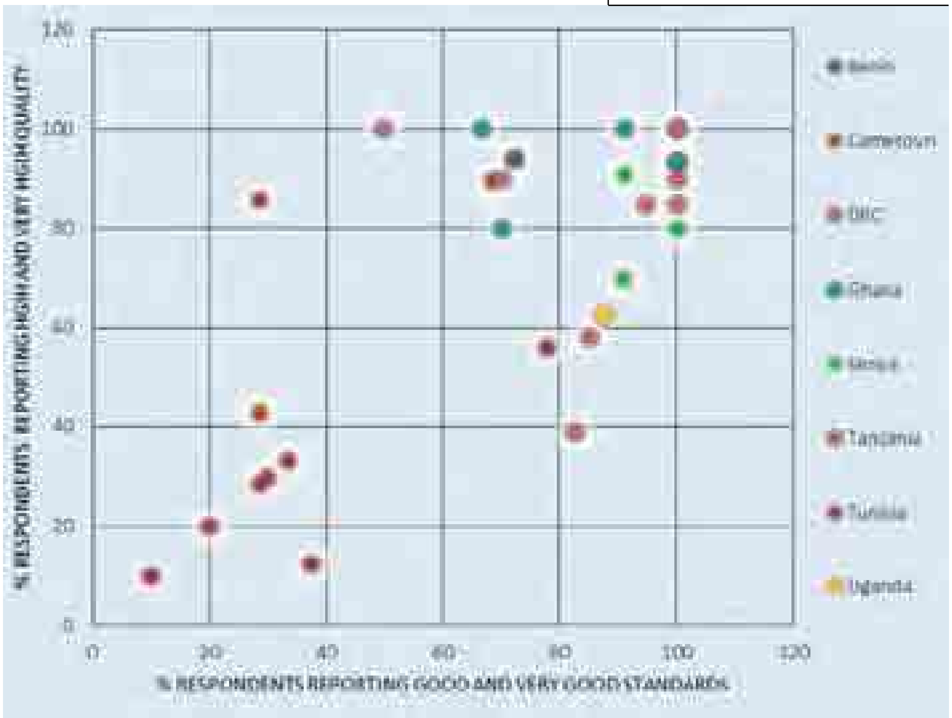


The results of the analysis of the data based on the broad categories shown in Table 7.5 understandably varied from project to project and from country to country. The results are summarized in Table 7.5. The results have been shown for each country and as aggregated for all the eight Study countries.

The analysis of the data collected through the Questionnaire show that about three quarters (74.9%) of the total number of respondents (382) have been using the project roads for more than three years. The responses can therefore be considered as significant.

As purpose of road use, "Business" has been selected one of the important functions, which signifies in brief the level of economic activities. About 6 out of ten (57.1%) of the respondents from all eight countries reveal their purpose of road use as for business purposes; Most of the respondents, about eight out of ten (77.4%), agreed that the project roads were in poor condition before the investment. Nearly three quarters, (72.3%), of all respondents indicated that the quality of the finished roads were either high or very high.

Figure 7.2: Percentage of Respondents Reporting Good and Very Good Standards; And High and Very High Quality for All Study Road Sections



The roads which were thought to have the highest quality were roads which had been upgraded or have been rehabilitated after they have badly deteriorated. The roads in Tunisia received the lowest scores. This, in our opinion, could be due to the fact that the roads did not receive the massive overhaul that the users had expected. More than three quarters, (77.1%), were of the view that the standards of the completed roads were good or very good. The percentage of respondents in each country reporting that the quality of the Study roads as either high or very high and the standards as very good or good have been illustrated in Figures 7.1 and 7.2.

Table 7.2: Questionnaire for Road User Perception Survey

For How Long Have You Been Using this Road?	Less than one (1) year	Between 1 and 3 yrs	More than 3 yrs	
What Do You Use The Road For?	Business	Leisure	Social	other
What Was The State Of The Road Before Recent Rehabilitation?	Good	Fair	Poor	Don't Remember
What is Your Assessment of the Quality of the Rehabilitated Road?	Very High	High	Fair	Poor
What is Your Impression of the Road Standard (Width, curves, etc.)	Very Good	Good	Fair	Poor
What Are The Benefits Of The Rehabilitated Road To You And The Community?				
a. Savings In Travel Time?	<30mins	30min-1hr	>1hr	
b. (1) Positive Impact On Safety Measured As A Reduction In Accidents	Low	Moderate	High	No Change
b. (2) Negative Impact On Safety Measured As An Increase In Accidents (if increase, indicate if immediately after construction or it is continuing and reasons)	Low	Moderate	High	
c. Employment Generated Measured As The Number Of People Employed As A Result of the Road being Built	Low	Moderate	High	No Change
d. Businesses Developed Measured As The Numbers Of New Businesses Springing Up and/or More Activities At Older Ones	Low	Moderate	High	No Change

Table 7.2: Questionnaire for Road User Perception Survey (suit)

For How Long Have You Been Using this Road?	Less than one (1) year	Between 1 and 3 yrs	More than 3 yrs	
e. Communities Along Road Developed Measured By The Number Of New Houses, And Other Structures Such As For Commerce And Offices; Areas Along Road Cleaner, Aesthetically More Pleasing	Low	Moderate	High	No Change
Comments: Age:	Sex:	Profession/ Trade:	Other:	

Table 7.3: Questions Asked and Parameters Used for Analysis

Details of the Questions Asked	Parameter Used for Assessing User's Perception
For how long have you been using this road?	Period of Road Usage
What do you use the road for?	Purpose of Road Use
What was the state of the road before recent rehabilitation?	Condition Before Investment
What is your assessment of the quality of the rehabilitated road?	Quality of Road
What is your impression of the road standard (width, curves, etc.)?	Comfort & convenience
Has there been savings in travel time?	Time Savings
Has there been any positive impact on safety measured as a reduction in accidents?	Road Safety (Reduction. In Accidents)
Has there been any negative impact on safety measured as an increase in accidents?	Road Safety (Increase. In Accidents)
Has there been any impact on employment generation measured as the number of people employed as a result of the road being built?	Employment Generation
Has there been any economic growth measured as the numbers of new business springing up and/or more activities at older ones?	Growth in Economic Activities
Has there been any development as measured by the number of new houses, and other structures, such as for commerce and offices; areas along road cleaner, aesthetically more pleasing?	Development along the Road

Table 7.4: Parameters and Indicators Used for Assessing User's Perspectives

Parameter	Indicator
Period of Road Usage	> 3 years
Purpose of Road Use	Business
Condition Before Investment	Poor
Quality of Road	High +Very High
Comfort & Convenience	Good + Very Good
Time Savings	>30 mins.

Table 7.4: Parameters and Indicators Used for Assessing User's Perspectives (suit)

Parameter	Indicator
Road Safety (Reduction In Accident)	Moderate + High
Road Safety (Incr. In Accident)	Low
Employment Generation	Moderate + High
Growth in Economic Activities	Moderate + High
Development along the Road	Moderate + High

Table 7.5: Results of Road User Perception Survey

Parameter / Indicator	Benin	Cameroon	DRC	Ghana	Kenya	Tanzania	Tunisia	Uganda	All Countries
	% of Respondents								
Respondents Who Have Used The Road For More Than 3 Years	60.0	80.8	83.3	55.6	61.1	80.0	91.9	100.0	74.9
Respondents Using Road For Business	86.1	69.2	61.1	93.8	66.7	31.4	33.8	75.0	57.1
% of Respondents Indicating Road Condition was Poor Before Intervention	86.1	57.7	83.3	70.4	76.7	87.7	68.5	87.5	77.4
% Of Respondents Reporting Very High & High Quality Of Finished Road	88.9	77.0	50.0	62.5	50.0	75.0	24.3	62.5	72.3
% Of Respondents Reporting Very Good & Good Standards	75.0	57.7	37.5	87.5	41.9	93.0	32.4	87.5	77.1
% Of Respondents Reporting Time Savings More Than 30Mins.	28.6	88.5	66.7	100.0	66.7	100	4.0	100.0	65.1
% Of Respondents Reporting Higher Accident Rate After Construction	28.6	34.6	38.9	37.5	38.7	51.0	36.5	37.5	10.3
% Of Respondents Reporting Lower Accident Rate After Construction	100	15.4	44.4	0	32.3	100	43.4	0	45.2
% Of Respondents Reporting Moderate & High Employment Generated After Construction	2.8	88.5	94.4	87.5	45.2	51.0	4.1	87.5	70.7
% Of Respondents Reporting Moderate & High Economic Growth After Construction	2.8	73.1	38.9	87.5	45.2	59.0	2.7	87.5	66.4
% Of Respondents Reporting Moderate & High Development Along The Road After Construction	25.0	77.0	22.2	100.0	51.6	53.0	4.1	100.0	62.9

SOURCE: STUDY TEAM

The high scores for quality and standards are refreshing since the Consultant is aware that the judgment of the public on standards and quality can be very harsh, especially in developing countries. A good road finished in surface dressing to the highest standards may still be judged as of poor quality because users expected an asphalt road or they would have preferred wider lanes.

Users tend to be very sensitive to visible manifestations of distress if these occur shortly after construction; and may rate roads which experience this phenomenon as poor in terms of quality. This may explain the relatively low scores for the Singida - Katesh and the Dareda - Minjingu roads in Tanzania, the Isiolo - Merille road in Kenya and the Kwango - Kenge road in DRC which have experienced some highly visible cracking.

Due to improvement of the project roads, savings in travel time have been considered as one of the most important benefit parameters, particularly for marketing of perishable commodities and, in general, agricultural, farm and dairy produce. Travel time savings are also significant for passenger movement for higher labor mobility and productivity. The results show that about two thirds of all respondents (65.1%) reported saving more than half an hour for journeys on the study roads. A third of the respondents reported saving more than one hour on their journeys. The results for the individual countries varied widely. Higher proportions of respondents in countries with longer rural roads among the study roads reported longer time savings; while countries such as Tunisia with almost all the roads in an urban setting; and Zanzibar and Benin with shorter stretches of roads had smaller proportions reporting time savings over half an hour.

The responses collected show that 45.2% of respondents believe there has been a moderate to high reduction in accidents through the realization of the projects. On the other hand, about a tenth (10.3%) of respondents thought there has been a an increase in the number of accidents as a result of the improvements to the roads. The respondents citing an increase in the number of accidents indicated that excessive speeding was usually to blame. Occasionally, road improvements may initially lead to an increase in accidents due to higher speeds. This tends to taper off with time. The results would therefore have been affected by the timing of the surveys which was for most of the road sections not too long after completion of the road improvements.

It may nevertheless be surmised that overall, the users perceive that the improvements to the roads have had some positive impact on road safety.

The investments in the project roads appear to have played a positive role in employment generation through various activities in different sectors, particularly in the informal sector. More than seven out of ten (70.7%) of all respondents indicated that the roads have created moderate to high employment to the catchment areas. The figures varied from as high as 94% in Congo to a low of 2.8% in Benin. Tunisia also had a low score of 4.1% with over 80% of respondents from Cameroon, Ghana and Uganda; and around 50% for Kenya and Tanzania reporting moderate to high employment generated by the roads. The higher figures appear to be related to projects which included social components such as the construction of markets. Whereas road construction is seen as creating transient jobs such social structures tend to create permanent jobs which are what stick in the minds of the populations.

The concept that improved transport infrastructure can attract investments for several economic activities was tested in the user surveys through asking respondents there had been any developments along the road corridor after the construction. More than a third of all respondents suggested there had been moderate to high economic activities since the road construction. The scores ranged from around 2.7% for Tunisia and Benin to between 39 and 88% for the rest of the Study countries. The figure for Tunisia is understandable since most of the projects were in heavily built urban and suburban areas. These perceptions may also reflect the general economic health of a country as perceived by the citizenry.

With regard to development activities generated by the roads, about two thirds of all respondents replied that there has been moderate to high developments along the road corridors. The country scores ranged from around 25% for Benin and DRC to 100% for Uganda with a score of 4.1% recorded for Tunisia.

The results of the road user surveys have indicated that that the majority of users, about three quarters, perceive the quality and standards as high or very high. Nearly two thirds of all respondents reported time savings of more than thirty minutes with a third reporting savings of over an hour.

Around two thirds of respondents perceive there has been moderate generation of employment. This figure was much higher for projects which had social components. Again, nearly two thirds- of all respondents perceived that the roads had generated moderate to high economic activities and development.

7.4 Socio- economic evaluation

7.4.1 Economic assessment

A very simplified assessment has been carried out by comparing the traffic on some of the Study roads before and after the interventions to provide an indication of the economic viability of the road projects.

Information gathered during the Study showed that there have been considerable increases in traffic on the Study roads since their improvement. Data made available to the Consultant by the Road Administrations showed that traffic on the Ketou - Illara road in Benin increased from an ADT of around 370 and no motorcycles in 2005 to an ADT of 650 and 2890 motorcycles in 2010. In the DRC traffic at the Lufimi Bridge increased from an ADT of 324 in year 2005 at project identification to 940 in year 2011. A limited traffic survey undertaken by the Consultant on the Katesh- Dareda road in Tanzania gave an ADT of around 450 which is in the case of the Katesh - Dareda road is comparable to the projected traffic of 400 vehicles per day at the time of design. Another example is the Nandeke - Mbere road section where traffic measured in August, 2009 at the north of Meiganga and at Babongo gave ADTs of 195 and 98 vehicles per day. Traffic counts at the same two points in September/October 2012 gave ADT values of 658 and 361. Interviews with road administration staff, the general public and available limited information point to a similar phenomenon in all the study countries.

The phenomenon is exemplified by the Zanzibar case where information obtained from the Bank's Project Completion Report for the Zanzibar Roads Upgrading Project showed that ADTs increased from 339 to 6,342 vehicles per day from 2001 to 2011 for the Mfenisini - Bumbwini; from 3,238 for the Amani - Dunga road and from 753 to

16,234 for the Manzizini - Fumba road over the same period indicating increases of between 4.5 times and over 20 times for the three roads studied on the island. The increases cannot be attributable solely to normal growth. The Economic Internal Rate of Return (EIRR) values estimated for the three roads at appraisal were for the Mfenisini - Bumbwini road - 12.6%, 33.4% for the Amani - Dunga road and 24.1% for the Manzizini - Fumba road. A re-assessment by the Bank in September 2012 showed EIRRs of 27% for the Mfenisini - Bumbwini road, 112.6% for the Amani - Dunga road and 87.7% for the Manzizini - Fumba road.

Our interactions with respondents in the Study countries indicated that access of the populations to markets for their produce and for inputs has improved. There were also indications that access to social services such as schools and health facilities have also improved.

This is indicative of the selected projects having produced the desired returns and impact. This conclusion was largely supported by the users through the user perception surveys.

Picture 7.1: A New Housing Estate on Athi River Namanga Road, Kenya

7.4.2 Employment creation

An indicative assessment has been made for the likely number of jobs generated by the Study roads. The assessment was based on information gathered from the progress reports; and did not involve a more rigorous study of the employment generated by the construction of the Study roads.

There is no doubt that the construction of the projects created employment in the catchment areas of the projects. Infrastructure development and maintenance has been seen as one of the traditional means of generating employment while producing useful assets for a number of countries. Studies by the International Labour Organization (ILO) also indicate that each direct job generates another 1.6 to 2 indirect jobs. Information gleaned from the progress reports, where available, and supported by the Consultant's experience suggests that between 200 and 780 skilled and non-skilled personnel were employed each month on the projects with an average of around 350 persons per month per contract. The projects lasted for between eighteen and forty four months with an average of around 24 months with the exception of two of the contracts in Tunisia which lasted for only five and half and seven months.

Picture 7.2: A New Horticultural Farm on Athi River -Namanga Road, Kenya

With the exception of these two contracts, each of the study roads is conservatively estimated to have generated around 8,400 person-months of direct employment over the construction period for the skilled and unskilled. Another approximately 13,440 indirect person-months of employment would also have been generated during the period of construction.

Some permanent employment has also been generated indirectly as a consequence of the improvements to the Study roads. A clear example is the boom in activities along the Athi River- Namanga road in Kenya where new housing estates,

horticultural farms, industrial estates and educational institutions seem to be flourishing as a result of the road improvement.
Pictures 7.1 and 7.2 show some of the housing estates and horticultural farms established since the completion of the project.

It can thus be said that the improvement to the Study roads have generated employment in the project catchment areas.

7.4.3 Development of the local construction industry

The Study has shown that in Tunisia and in Zanzibar, all the contracts were carried out by local contractors. Evidence gathered from the progress reports and obtained from talking to Road Administration personnel and some of the contractors' personnel confirms that in the other three countries and in Mainland Tanzania local contractors participated in the projects as sub-contractors For projects which had social components, most of the social infrastructure was provided by local sub-contractors. The local contractors who participated in the project as sub-contractors, nevertheless, would have benefitted from the availability of work enhancing their experiences and providing them work for their continued development. This is particularly important since the non-availability of work for local contractors has been found to be one of the issues that hamper the development of the local construction industries in Sub-Sahara Africa.
With regard to project supervision, it was found out that the majority of the professional staff employed by the consultants for all the projects were local - either employed directly by the foreign supervision consultants or through their local associates. Two of the projects in Kenya, the Athi River – Namanga and Isiolo – Merille road projects were fully supervised by a local consultant. In Tanzania also, one of projects on the mainland was also handled by a local consultant. In Ghana, the supervision of all the projects selected for study was carried out by local consultants.
The projects can therefore be said to have supported the development of the local construction industry by providing work and possibly technology transfer to local consultants and contractors.

7.4 Summary

A road users' perception survey on the quality and standards of the roads indicated that nearly three quarters of users in all the Study countries rated the quality of Bank funded projects as high or very high with over three quarters of users interviewed rating the standards of Bank funded road projects as high or very high.
The surveys also showed that about two thirds of all respondents (65.1%) reported time savings of more than half an hour for journeys on the study roads. More than a third of the respondents reported saving more than one hour on their journeys.
The responses also show that about half (45.2%) of respondents believe there has been a moderate to high reduction in accidents through the realization of the projects.
There were indications that the investments in the project roads have played a positive role in employment generation through various activities in different sectors, particularly

in the informal sector. Over two thirds of all respondents indicated that the roads have created moderate to high employment in the catchment areas. This figure was much higher for projects which had social components.

The Study has established that conservatively each road project would have generated an estimated 8,400 person-months of direct employment over the construction period for the skilled and unskilled. Another approximately 13,440 indirect person-months of employment would also have been generated during the period of construction.

Approximately two thirds of all respondents suggested there had been moderate to high economic activities since the road construction. This was evident on some of the roads.

There was every indication that the investments in the roads have yielded the desired impacts on the populations served. Traffic on all the roads have significantly increased. Residents have had improved access to markets and inputs for their daily activities and also to social services such as health facilities and schools.

The construction of the road sections also supported the local construction industry by providing work for local contractors as main contractors or as sub-contractors and to consultants.

8.0
SUSTAINABILITY OF BANK FINANCED ROAD PROJECTS

8.0 SUSTAINABILITY OF BANK FINANCED ROAD PROJECTS

8.1 Introduction

Sustainability requires the reconciliation of economic, environmental and social equity. Sustainability has a number of benefits including empowering people to meet their own needs, which is what any aid or support ultimately seeks to achieve.

For this Study the Consultant has understood sustainability in Bank operations to mean operations that continue to help drive the Bank's overarching objective of economic growth and poverty reduction. Thus road projects supported by the Bank should continue to provide the intended services for them to be able to act as catalysts for economic growth and poverty reduction.

For road projects to be sustainable there is the need to ensure that the roads are:

a. Appropriately selected based on acceptable/agreed economic and social factors;
b. Well designed (fit for the purpose) with adequate safeguards for road safety;
c. Well-constructed;
d. Adequately maintained;
e. Blends with the environment and avoids social dislocation as much as possible.

The Consultant has had the opportunity to interrogate the environmental and social safeguards incorporated in the projects studied. The study showed that appropriate mitigation measures and resettlement action plans have been developed to ensure sustainability. There were occasions, however, where compensation payments to project affected persons were delayed such as in DRC. The compensation payments are, nevertheless, eventually paid.

Some of the requirements for the seemingly separate demands listed above are inter-related. If initial designs are inadequate, then even if construction is done to specifications, the project objectives are unlikely to be achieved. On the other hand, if designs are adequate but construction is done poorly, the objectives would not be achieved.

For appropriate and continued maintenance to ensure that projects are sustainable, strong and capable Road Administrations to plan and supervise maintenance, and protect the road infrastructure (mainly from overloading), are required. Incidentally, strong and capable RAs are also required to plan and supervise the initial construction. Even when project designs and supervision are carried out by consultants it is important that that the RAs are capable of adequately supervising these consultants. An efficient and capable RA is necessary to ensure that client decisions are taken quickly based on a sound appreciation of the contractual and technical issues to avoid delays to a project and ensure quality of the completed facility. There should also be adequate financing for objectively assessed maintenance. There should also be adequate capacity for the local construction industry to be able to effectively carry out maintenance when required. The state of the roads in any country is a window to the interplay of all the factors discussed above; and can therefore provide a quick assessment of how sustainable any project can be.

8.2 Good governance and sustainability

Good governance has a role to play in achieving quality and sustainability. Good governance is the process whereby public institutions conduct public affairs, manage public resources and guarantee the realization of society's aspirations in a manner essentially free of abuse and corruption, and with due regard for the rule of law.

Good governance in the road sector encompasses the following attributes:

- Discipline - Road Administrations must rigorously apply discipline in pursuing approved programs;
- Transparency - sufficient and adequate information must be available in the public domain for stakeholders to fully understand the reasons behind investment decisions;
- Responsibility - Road Administrations' personnel take full responsibility for their decisions and are prepared to discuss these with stakeholders;
- Accountability - necessary in fighting corruption to ensure that decisions benefit the whole rather than a few individuals and would ultimately yield desired results. Good governance relies on principles such as transparency and participation to shape anti-corruption measures. There should be mechanisms for information sharing and for monitoring the formulation and implementation of the Road Administration's infrastructure development plans, the use of public funds and the implementation of road sector policies;
- Independence - the road agency and road fund carry out their duties and responsibilities without any external pressures;
- Fairness - ensuring that all levels of society have adequate access;
- Participation - Road Administrations recognize their social responsibilities and create avenues for the public to participate in policymaking and planning, either through formal institutions or informal consultations; and
- Responsiveness (to the needs of users) - Road Administrations establish mechanisms for identifying road user needs and responding in a timely manner in order to minimize total transportation costs.

Good governance in the road sector can therefore advance social integration by improving a Road Administration's capacity to fulfill its responsibility in providing public services which are essential if communities are not to be excluded from social and economic activities such as the right to education, health and food.

It also ensures that services are accessible and acceptable to all, and paths for public participation in decision-making are available. Good governance therefore guides Road Administrations to act in the best interest of society by allocating available resources to preserving and developing the road network on the basis of economic and social efficiency decision criteria for sustainability; rather than allocating resources to the road sector based on subjective or unquantifiable criteria.

8.3 Road authorities and sustainability in africa

By the mid-80s the substantial portions of the road networks in most countries in Africa were in poor condition. Vehicle operating costs were, therefore, high and travel times longer. The poor condition of the networks contributed significantly to making transport costs in Sub-Sahara Africa the highest in the world. It was found out that roads had not been managed as part of the market economy, but as a social service. The institutional frameworks within which roads were being managed were also largely inadequate. Roads were managed as part of Ministries. With the usual bureaucratic posture of the Ministries, there was usually a lack of clearly defined responsibilities with the result that management structures were weak and ineffective. Through dialogue between development partners in the road sub-sector and African Governments, reforms were embarked on. The objectives of the reforms were:

- To ultimately provide the road user value for money through good governance and better management of resources by:
  - Strengthening sub-sector administration through appropriate institutional set-ups and human resource development policies.
  - Rationalizing programming and budgeting.
  - Clearly defining responsibilities between road agencies, their parent ministries and road boards.
- To bring roads to the market place and put them on the basis of fee-for-service through cost recovery policies. This was to be supported by appropriate legislation and administrative frameworks for sustainability.
- To redefine the role of the private sector in road delivery by increasing its role in the management of the road sub-sector to engender ownership.

By the early 1990s, after extensive discussions between Sub-Sahara African Governments and Development Partners there was general agreement that among the major reforms required were:

a The setting up of autonomous road agencies with effective structures and clearly defined responsibilities. The agencies were to run as commercial entities while parent ministries remained with the responsibility for policy and oversight, that is “Eyes on - Hands off”; and
b That funding for road maintenance needed to be increased and predictable for effective planning through benign earmarking by the setting up of “Road Funds”.

A number of countries have set up autonomous road authorities or semi-autonomous road agencies. Performance varies from agency to agency but, in general, there have been a number of positive impacts with the setting up of these road agencies. Some of the positive impacts include:

i. The establishment of clear lines of authority thereby creating accountability,
ii. Improvements in operational efficiency and transparency,
iii. Better human resource management improving staff retention,
iv. Increased absorptive capacity for available funds, and
v. Reduction in vehicle overloading.

The reduction in overloading may not seem obvious but accountability for maintaining a network with inadequate resources motivates the road agencies to aggressively pursue all actions which can help minimize road deterioration. The reduction in overloading associated with the setting up of road agencies has been documented in Tanzania. Another example is Ghana; and the new main road administration in Kenya is taking serious and concrete steps to control overloading.

Whereas road authorities should not be looked as the only viable alternative for managing roads, they have role to play in the sustainability of road projects in Africa looking at the present state of development and governance where political considerations seem to have a large impact on a number of national issues without adequate checks and balances. The accountability expected from these agencies and the independence that is given them improves governance in the road sector and leads to improved management of the networks.

8.4 Road funds, road maintenance and sustainability

Another major outcome of the reforms in the road sub-sector has been the setting up of Road Funds. This was premised on the basis that funding for road maintenance needed to be increased and predictable for effective planning.

There were initial reservations expressed by the International Monetary Fund and the Ministries of Finance against the setting up of Roads Funds. Road Funds were regarded as earmarking. The arguments were that earmarking did not allow for the most efficient allocation of funds and effective budgetary controls. The arguments against the setting up of these funds were overcome by the compelling arguments that the inflows into the funds would be fee-for-service; that African countries were yet to attain good and transparent budgetary systems; and the importance of preserving the individual countries' road assets for socio-economic development.

It must be noted that road funds were not entirely new to Sub-Sahara Africa. Road Funds had been set up in some countries earlier. These "first generation" funds however suffered from poor financial management, the absence of independent audits, the use of funds for unauthorized expenditures, diversion of funds and weak oversight.

The new or "second generation" road funds had to have:

- A strong legal basis ensuring a separate road fund administration with clear rules and regulations;
- Strong oversight with a broad based management board, the members of which are from both the private and public sectors;
- Sound financial management systems and lean but efficient administrative structures;
- Regular technical and financial audits; and
- Revenues which are incremental to the budget and derived from user charges.

In the advocacy for reforms, it was always understood that there could not be "a one size fits all" prescription for all the Sub-Sahara African countries. The principles were nevertheless largely applicable to all African countries.

Road Funds have been set up in about 30 African countries so far with mixed operational results. With the 30 or so road funds which have been established only eleven (11) countries receive user charges directly into their bank accounts. There are thus still a number of the funds that receive revenue through the treasuries. The channel through which revenue is received by the funds is an important consideration as it can affect the ready availability of funds for the execution of works. For funds where channeling is through treasuries this has been known to cause delays.

The present collections by the funds are inadequate to meet the maintenance needs of the countries. Only half of the countries which have road funds collect sufficient revenue to meet more than 50% of their maintenance needs. In any case, none of the funds collects adequate revenue to meet the total maintenance needs of the country's network.

Though fuel levy is the most important single contributor to the revenues of most of the funds, there is no robust mechanism for adjusting this levy in relation to inflation, exchange rate depreciation and network needs. It may be prudent to look at ways of broadening the revenue base of the funds. Broadening of the revenue base may be necessary to avoid a crisis should the use of non-hydrocarbon based fuels increase or the use of electric cars become pervasive in the region. For example, additional revenue could accrue to the funds if a charge is introduced for road use for all vehicles. This charge could be graduated to reflect the relative damaging effect various classes of vehicles have on roads.

Other road user charges that may be introduced must provide a reliable revenue stream with low evasion rates. Such charges should also not be affected by the method of vehicle propulsion.

There are other issues which would also need to be addressed if the reforms are to have a greater impact on the networks in the region to enable them to act as catalyst for socio-economic development. Reliable statistics on the size of the vehicle fleet which are required for proper strategic planning seem to be absent in most of the countries. There are also indications that the revenues from the funds are not always used for maintenance.

Despite these issues with road funds, there is no doubt that their establishment has improved road maintenance in countries where they exist.
While there is the need to ensure sufficient financing for road maintenance, to achieve cost-effective maintenance would also require appropriate planning tools such as the establishment of a Maintenance Management System (MMS). Achieving cost-effective and timely maintenance would also require an adequate local construction capacity in the countries.

8.5 Axle load control and sustainability

Roads are the largest asset of any country. Apart from this, roads facilitate socio-economic growth. Vehicle overloading destroys roads prematurely. The consequence is that huge financial outlays are required for maintenance and rehabilitation - funds which are unavailable to African countries. Overloading also compromises road safety. Overloading must therefore be controlled if road projects are to be sustainable.

Picture 8.1: : Pothole Developing on Ketou - Pobe Road

8.6 Assessment of sustainability of projects in study countries

a. The study countries have therefore been assessed for the sustainability of their road projects based on;
b. The management regime for roads,
c. Capacity of the Road Administrations,
d. Robustness of funding for maintenance,
e. The effectiveness of axle load control in the country, and
f. The local contracting capacity.

8.6.1 Benin

The management of roads in Benin is through the Directorate of Public Works in the Ministry of Public Works and Transport. The consultant's assessment indicated that there may be capacity challenges within the Directorate of Public Works. The consultant's investigations suggested that there was no effective maintenance management system in place.
Benin set up a Road Fund in 1996 by law. The fund's revenue comes from fuel levy, road tolls and international transit fees. Fuel levy contributes about 53% of the funds income while road and bridge tolls contribute 42% with the remaining 5%

Picture 8.2: Inadequate Maintenance on Lome - Cotonou Route

coming from international transit fees. The current fuel levy is eight (8) United States Cents for gasoline and six (6) cents for diesel. The operations of the fund are supervised by a Board of (nine) 9 persons. Five of the board members are from the private sector with the other four from the public sector. The minister of Public Works chairs the board.

The fund's income is estimated to fully cover routine maintenance and 60% of periodic maintenance of the classified network. There does not appear to be any Government budgetary support for maintenance. Gaps in periodic maintenance build up over time as a backlog which becomes difficult to eliminate. The net effect is that eventually more rehabilitation and maintenance has to be carried out at three to four times the cost of periodic maintenance. Eventually the condition of the network deteriorates suppressing socio-economic growth. The Consultant's assessment showed that Benin does not have a strong local construction industry.
Benin has no axle load control program.
The foregoing indicates a high risk for sustainability of road projects in Benin. Pictures 8.1 and 8.2 show the lack of timely attention to a pothole developing on the Pobe - Ketou road; and the lack of maintenance on the Lome - Cotonou road. These are symptomatic of the risks to sustainability.

The Government should be encouraged to reform road management in the country, build capacity for road management institutions, find ways to increase road maintenance funding, ensure the establishment of a maintenance management system and institute an effective axle load control system for sustainability.

8.6.2 Cameroon

Roads are managed through the Ministry of Public Works in Cameroon. There is no road agency but a cell has been created with some degree of autonomy to oversee the implementation of projects funded by the AfDB and the World Bank. The Consultant's assessment is that capacity enhancement in the ministry would be helpful. There is no effective maintenance management system in place.

Picture 8.3: Vehicle Repair on Nsele Lufimi - Road

A road fund was established in 1998. The fund does not have its own independent sources of funding. Road User Charges are chanelled through the government budget. There is therefore the risk that not all collections are directed to the fund for its purposes or that transfers to the fund are delayed. The fund receives only about 50% of the maintenance needs of the network. The challenges with road maintenance are therefore visible when travelling on the roads in the country.

Cameroon has adopted appropriate policies and has adequate equipment for axle load control. The effectiveness of the implementation of axle load control may however need to be improved. The local contracting capacity in Cameroon is weak and this poses risks to sustainability. Another risk is the concentaration of the award of government contracts, including road maintenance, in one ministry. Contract award for maintenance projects thererefore tend to be delayed.

Picture 8.4: : Overgrown Verges on N'sele - Lufimi Road

The foregoing suggest a moderately high risk to the sustainability of road projects in Cameroon. Cameroon may therefore have to sustain reforms in the road sub-sector to minimize the risks to the sustainability of their road projects.

8.6.3 DRC

The Democratic Republic of Congo manages roads through the Roads Department in the Ministry of Public Works.
A Project Management Unit (PMU), the Cellule Infrastructure, manages all external funded projects through feasibility to commissioning. Commissioned projects are taken over by the Roads Department for management and maintenance. The PMU unit is efficient and well organized. However, this arrangement can only be transitional. There are indications of a capacity deficit in the Roads Department which could have been one of the reasons for establishing the PMU.

DRC has a road fund but the fund is only able to collect funds to cover only about 50% of the maintenance needs of the road network. There is also no axle load control system in place. The Consultant assessed the local road construction industry as weak.

Picture 8.5 Inadequate Maintenance on Lome - Cotonou Route

Another phenomenon which was noticed on roads in DRC was the rampant breakdown of freight vehicles and their subsequent repair on the carriageway, damaging the road through fuel spillage and jacking. A typical example is shown in Picture 8.3. This would need to be controlled to preserve the investments made in the roads. Pictures 8.4 and 8.5 show the general lack of timely maintenance and a typical vehicle repair on a road carriageway.

The foregoing suggests a relative high sustainability risk for projects in the DRC. The Government should be encouraged to reform the administration of roads, build capacity in the institutions that emerge, increase funding for road maintenance, set up an operational maintenance management system. An effective axle load control system should also be established. The government should also look at strengthening the local contracting capacity.

8.6.4 Ghana

Ghana set up a road agency in 1974. Some of the independence of the agency has been eroded over time. Capacity support in the road agency would be helpful. Ghana also set up a road fund in 1985 which was later reformed in 1997. The fund however does not meet the criteria for a second generation fund. The board has representation from the private sector but is chaired by the minister of Roads and Highways and has the Chief Director (Permanent Secretary) as secretary. The board has in recent times taken over the payment of contractors. The fund collects revenue which is estimated to cover about two thirds of the maintenance needs of the network. Currently the board has a backlog of unpaid invoices to contractors covering approximately nine months of work which the government is trying to find a solution to.

Ghana, however, has a comprehensive axle load control system in place. It cannot be said to be totally effective with an estimated 20% of vehicles weighed currently being overloaded. An action plan has been developed for reducing and eventually eliminating overloading. This includes:

- Educational & awareness campaign;
- Control at the ports of entry;
- Operations at permanent weighbridge stations;
- Monitoring with mobile weighing vans and mobile weigh pads;

Currently, fourteen 14 permanent weigh bridges are installed; and five Weigh-In-Motion scales installed for screening vehicles for weighing at permanent weighbridges. Additionally, six (6) Mobile Weigh Vans and four (4) Weigh Pads are being operated. There are also five (5) weigh bridges installed at the port of Tema and two at the Takoradi Port to help control vehicles loaded at the ports. There are plans to ultimately install twenty eight (28) permanent axle load weigh stations countrywide, twenty (20) High Speed Weigh-in-Motion stations to be supported by the use of ten (10) Mobile Weigh Vans and 12 Portable Weigh Pads.

The management of permanent weigh stations is also been privatized while a new legal framework for axle load control is under preparation.

The action plan when fully implemented should support the sustainability of road projects undertaken in the country.

Picture 8.6: Broken-up Surface of Nanyuki- Isiolo Road

There is a vibrant local contracting industry. There are currently around four hundred and fifty (450) indigenous road contracting firms registered with the Ministry of Roads and Highways in Ghana, in the four classes of 1 to 4; class 1 being the most capable. There are currently twenty five (25) class 1 contractors capable of competing with international contractors and a number of major projects have been undertaken by local contractors over the last two or so decades. The development of the industry followed deliberate actions by the government starting from the late 1970s initially to be able to carry out the maintenance of roads. Other initiatives such as providing guaranteed loans and projects helped to develop some contracting firms to be able to take on major road construction works. Almost all road maintenance works in the country are now undertaken by local contractors. The non-prompt payment of invoices for work done is, nevertheless, gradually undermining the local contracting industry.

Picture 8.7 : Overgrown Verges on Isiolo - Merille Road

The risk to the sustainability of road projects is rated as moderate. The reforms which have taken place in the sector over the last one and half or so decades need to be revisited and strengthened to ensure road projects are sustainable.

8.6.5 Kenya

Kenya is at the tail end of road management reforms instituted a few years ago. Three autonomous institutions have been created for road management which was until recently carried out through the Ministry of Works. These are the Kenya Highways Authority, The Kenya Rural Roads Authority and the Kenya Urban Roads Authority. The Kenya Highways Authority (KenHA) which the Consultant visited in the course of the Study gives the impression of being professionally run and to be moving in the right direction. Our discussions with the officials indicated that support for capacity building would help grow the organization. The consultant learnt through discussions in Kenya that the Government is mulling merging the three road agencies into a Kenya Roads Authority. Our opinion is that while this could ultimately be a good idea for the long term, the newly formed institutions should for now be allowed to grow and remove the bottlenecks in the road transport system for which they were set up. The current setup would also ensure that adequate attention is given to national, rural and urban roads to ensure a fully functioning road network.

Kenya has a well performing road fund. However, discussions with KenHA suggest that moneys received from the Kenya Roads Fund can cover only about 60% of their maintenance requirements. The lack of adequate maintenance was visible on some of the roads travelled on in the country is shown in Pictures 8.6 and 8.7. Kenya also has a reasonably strong local contracting industry.

KenHA is aggressively pursuing axle load control in the country. New axle load stations are being installed and the few which are in place are monitoring axle loads on the roads on which they are installed. The consultant noticed a long queue of vehicles waiting to be monitored. Steps should be taken to make operations more streamlined in order not to invite the disaffection of road users which may undermine the acceptance of axle load control in the country.

Whereas there are risks to sustainability of road projects in Kenya, these are progressively being tackled and the Government should be encouraged to continue on this path. Capacity should be enhanced in KenHa, and additional sources of funds for road maintenance found.

8.6.6 Tanzania

Mainland Tanzania set up a road agency in year 2000 and is now fully autonomous with every indication of a professionally run road administration. The Consultant's assessment is that some capacity building would be required, though. The road agency, Tanzania national Roads Agency (TANROADS) has a functioning maintenance management system. Tanzania's Road's Fund meets the requirements of a second generation fund.

It has a relatively independent board, receives money directly into its accounts and is not involved in the payment of contractors. It interrogates the programs of the implementation agencies and carries out annual technical audits of maintenance projects in addition to the financial audit of its own operations. It is however unable to raise all the funds required for the full maintenance of the road network in the country. Discussions with TANROADS indicated that disbursements from the Roads Fund are able to cover about 70% of their maintenance needs.

The axle load control in mainland Tanzania is effective and among the best, if not the best, in Africa. There is a network of fixed weigh stations distributed in the country and supported by mobile weigh bridges. Axle load control is backed by law which is largely unambiguous. The penalties are punitive and reflect the damaging effect of the overloaded vehicles have on the roads. There is also virtually no interference in the operations of axle load operations. This has led to a decline in overloading which is estimated at around 4% of all vehicles weighed.

The Government has, through the Contractor's Registration Board also embarked on the development of the local contracting industry to, among other objectives, support road maintenance.

The risk for sustainability, though present, in mainland Tanzania is low. The Government should be encouraged to strengthen the autonomy of TANROADS and built capacity within the institution. The Government should also find ways to increase maintenance funding.

Zanzibar, on the other hand manages roads through the Ministry of Transport. There is an ongoing study for reforms in the management of roads. Zanzibar has a road fund which is not able to collect funds to cover the maintenance of its network. Road Fund receipts are estimated to cover only about 50% of the network needs. There is no axle load control on the island. The local contracting capacity is underdeveloped.

There appears to be a relatively high risk to sustainability in Zanzibar. The size of Zanzibar however would make the risk manageable with the appropriate intervention. The Government should be encouraged to fully pursue the reforms in road management which it has started. A system for controlling axle loads should be instituted and the base of the road fund widened.

8.6.7 Tunisia

Tunisia manages roads through the Directorate of Bridges and Roads in the Ministry of Equipment, Housing and Planning. There have been recent discussions on the possibility of forming an autonomous agency for managing roads. The country has no road fund but receives its budget for maintenance from the central government. Approved budgets are released and these are regular. Tunisia appears to have a well-developed local contracting industry. There does not appear to be any axle load control in Tunisia on the national roads except for highways under concessions. The risk to sustainability in Tunisia is regarded as moderate. The Government should be encouraged to continue the reforms in road management; reform road maintenance funding and establish an axle load control system on the national network outside those under concession.

8.6.8 Uganda

Uganda set up a road agency, the Uganda National Road Authority, in 2008. The agency has embraced its mandate and there are indications that road management has improved. Uganda also set up a road fund in 2010. The fund does not have its own independent sources of funding. Road User Charges are chanelled through the government budget. There is thus the risk that not all collections are directed to the fund for its purposes or that transfers to the fund are delayed. The fund currently receives only about 40% of the maintenance needs of the network. A maintenance management system is yet to be established. There are consequently challenges with road maintenance.

A backlog of maintenance has built up which the government is tackling through a number of initiatives and programs such as the Backlog Road Maintenance Program supported by the European Union.. Uganda has adopted the necessary policies and are in the process of improving the infrastructure for axle load control. The current inadequate spread of weigh stations undermines the effectiveness of axle load control. The spread is nevertheless expected to improve over time with new weigh stations being intalled including weighbridges under the Bank's Road Sector Support Programs.

The local contracting capacity in Uganda is weak and this poses risks to sustainability. The risk to the sustainability of road projects in Uganda is therefore assessed as moderate. The reforms in the road sub-sector should be deepened with a view to eliminating the risks discussed to make road projects in Uganda sustainable.

8.6.9 Summary

The factors and their associated risks to the sustainability of road projects in the eight Study countries have been discussed. The overall risk of each country to the sustainability of road projects in the country have also been estimated. The factors which include the type of road management, maintenance funding, maintenace funding, axle load control regime and the estimated overall risk to sustainability are summarized in Table 8.1.

Table 4.9: Sustainability and Country Risk Factors

No.	ROAD SUB-SECTION INFORMATION	
1	Network Statistics	
		a. Total Length of Network (km)
		b. Classified Network (km)
		c. Paved Network (km)
		d. Paved as % of Classified Network (%)
		e. Current Network in Good or Fair Condition
2	Road Management	
		a. Road Agency
		b. Department in Ministry
3	Source of Maintenance Funding	
		a. Road Fund
		b. Government Budget
		c. Road Fund through Government Budget
		d. % of Maintenance Needs Covered
4	Maintenance Planning	
		a. Does Country Have a Maintenance Management System?
5	Protection of Road Infrastructure	
		a. Is there an Axle Load Control System?
		b. Effectiveness Rating
6	Capacity of Implementing Agencies	
		a. Capacity Rating
7	Local Contracting capacity	
		a. Capacity Rating
		Overall risk to sustainability

8.7 Sustainability as deduced from the quality of bank financed road projects

The study on the quality of Bank Financed projects has shown that all the road sections studied have been appropriately selected and would yield the returns expected returns on investment if they are properly maintained. The roads have had minimal impact on the environment and where necessary mitigation measures have been instituted. Social dislocation has been minimized and where required adequate compensation has been paid. The physical tests carried out suggest that, by and large and with the exception of eight out of the thirty road sections studied, for which further investigations have been recommended, the roads have been adequately designed and construction has met the set specifications. The roads sections, as implemented, can be said to provide the necessary contributions to the sustainability of Bank financed road projects.

There have been recent discussions on whether or not the use of longer Defects Liability Periods could enhance quality by making the contractor conscious of the fact that if the road is not built to specification he or she would have to carry out repairs that are

COUNTRY							
Benin	Cameroon	DRC	Ghana	Kenya	Tanzania	Tunisia	Uganda
15,500	50,000	171,250	109,515	160,886	90,807	19,418	70,746
8,300	28,857	42,250	67,450	63,575	86,472	19,418	35,800
2,100	5,250	2,250	12,442	9,273	6,578	14,757	8,360
25.30	18.19	5.33	18.45	14.59	7.61	76.00	23.35
66.00	58.00	44.00	69.00	70.00	83.0	71.50	50.00
No	No	No	Yes	Yes	Yes	No	Yes
Yes	Yes	Yes	No	No	No	Yes	No
Yes	No	Yes	Yes	Yes	Yes	No	No
No	No	No	No	No	No	Yes	No
No	Yes	No	No	No	No	No	Yes
50%	50%	50%	70%	60%	70%	70%	40%
No	No	No	Yes	No	Yes	No	No
No	Yes	No	Yes	Yes	Yes	No	Yes
N/A	Moderate	NA	Moderate	Moderate	High	N/A	Moderate
Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Low	Low	Low	Moderate	Moderate	Moderate	High	Moderate
High	High	High	Moderate	Moderate	Low	Moderate	Moderate

likely to arise. In principle this seems plausible. However it must be understood that not all failures may be attributable to poor construction; and road administrations are likely to see more disputes as to the causes of failures. It should also be understood that this option is likely to raise the costs of projects since contractors would have to keep at least part of their establishment for the construction of the road for much longer, the cost of which would be factored into their unit rates or the General Items of the Bills of Quantities. It should also be borne in mind that most road failures do not tend to appear within the initial third period of its design life. Since any extended defects liability period is likely to end within the initial third period of the design life, the usefulness of an extension of the Defects Liability Period is doubtful while it has the potential of increasing the cost of the project.

Another issue which has become topical is whether the use of Performance Based or Output Based Contracts could also ensure the quality of roads that are constructed. Performance Based contracts identify the required outcomes without prescribing the methods for achieving the outcomes; but specifying how the outcomes would be assessed. Payments for this type of contract are contingent on the delivery of the specified outcomes. This contract form allows the contractor to devise the most efficient and effective way to carry out the work and deliver the specified outcomes. The contractor has the opportunity to propose innovative solutions and the flexibility to adopt new technologies which, in a competitive setting, can create significant cost savings to be passed on to the client. The maximization of his/her knowledge and practices can lead to greater certainty of performance; and can result in higher service levels. The client can also benefit from the reduced risk by defining the required outcome instead of technical specifications. Communication between client and contractor is simplified since their respective roles are clearly defined. The client can specify the type of information that is periodically specified.

To avoid disputes, the expected outcomes and the methods for their assessment would need to be clearly defined. Under such contracts deflection response and roughness could be used to judge the quality of the completed road before the maintenance period starts.

Performance-Based contracts have begun to be used in maintenance contracts as a way of ensuring there is innovation and that the roads under such contracts continue to receive maintenance throughout the contract periods which are usually longer with durations in the order of 5 years. The use of such contracts may contribute to sustainability while ensuring due care is taken by the contractor during the construction phase to ensure he/she is not saddled with the maintenance of a badly constructed road for 5 or so years. Contractors, in order to ensure that designs are adequate may want to be involved in the designs. If such a system is to be used, only a preliminary design may be necessary and the design made the responsibility of the contractor. These would then become Design-Build Contracts with extended maintenance periods. The Bank could pay fully for the initial construction costs while the member country pays for the annual maintenance costs under such a contract. This could help with sustainability by ensuring that Bank financed roads are initially built to expected quality standards and are maintained. The contract period of around 5 years used for such contracts is informed by the need for the contractor to get reasonable use of his/her equipment since the investment required for equipment used such a contract are necessarily higher than for normal contracts. Again, most roads tend to require major periodic maintenance between seven (7) and ten (10) years depending on the structure and surface type. Extending the period much longer than five years may require the contractor to plan for the probability of a major periodic maintenance intervention which raises a risk which may not be easily quantifiable at the time of the bidding.

Another issue which was found to undermine the proper management of Bank financed road projects with possible consequences on quality was the inability of RMCs to pay compensation to project affected persons, for relocation of utilities and counterpart funds on time. RMCs would therefore have to find innovative ways of funding infrastructure. Infrastructure bonds and Infrastructure Development Funds may be alternative financing schemes worth considering.

Infrastructure bonds are long term bonds through which the issuer, in this case a government, owes the holders a debt and depending on the terms of the issue may be required to pay interest and/or repay the principal at a later date, termed maturity. The proceeds are used to finance public infrastructure. These bonds can provide governments much needed funds to finance much needed infrastructure. Thus in the face of mounting public debts for many countries, it can be a viable alternative for financing infrastructure.

A number of governments have therefore used and continue to use this as a funding mechanism for public infrastructure. A total of US$15.8 billion in infrastructure bonds had been issued up to the middle of December for the 2013 year with the United Kingdom accounting for US$1.5 billion out of this. India also continues to use infrastructure bonds for financing public infrastructure. A notable example is the Rural Electrification Company Limited of India which finances all aspects of rural power generation through infrastructure bonds and other financial instruments.

The United States of America and its states have used infrastructure bonds for financing public infrastructure. A prime example is the Mello-Roos Act of 1982 which allowed the state of California to establish the "Community Facilities Districts" for financing improvements to public services including roads, electricity, schools, parks and public protection. The 2006 State of California US$40 billion infrastructure bond issue is another example.

Infrastructure bonds tend to attract institutional subscribers such as pension funds and insurance companies which require a steady stream of income to fund long term liabilities. Infrastructure bonds are usually more attractive compared to sovereign and corporate debt and volatile equity markets since yields tend to be higher. Infrastructure bonds may also come with some tax incentives.

To ensure their use for the intended purposes in RMCs, it may be necessary for such funds to be managed by an independent board which is backed by legislation.

As has been discussed above, however, the proper selection, design, construction, sensitivity to the physical environment and mitigation of any social impacts are only part of the process for making Bank funded road projects sustainable. The other factors which include the road management regime, the provision of adequate maintenance, and the protection of the road infrastructure would need to be dealt with in RMCs to ensure the robust sustainability of Bank financed road projects.

8.8 Required actions for sustainability

The Bank aims at making the road projects robustly sustainable. The discussions in the previous sections of this chapter suggest that a number of actions would need to be pursued if Bank funded road projects are to be robustly sustainable.

Most of the actions cannot be taken directly by the Bank, but by Regional Member Country Governments and by the Road Administrations or implementing agencies for Bank financed road projects. The Bank may however be able to play a role even for such actions that need to be taken by RMC Governments or its implementing agencies through support and/or leverage.

The actions required to be taken by RMC Governments and their RAs include:

- The continued reform of road management for a more efficient and commercial approach towards managing roads. Countries which do not have road agencies/authorities should consider setting up such agencies. Where such agencies have been formed, they should be given more autonomy and made more accountable.

- Improving funding for maintenance and for development projects. Countries that do not have Road Funds should consider setting up such funds. Those with established funds should find ways to widen the base of the instruments contributing to the fund. RMC Governments should consider setting up Infrastructure Bonds for supporting counterpart or co-financing requirements for projects supported externally; and for accelerating infrastructure development.
- Setting up effective axle load control systems. The Road Administrations should prepare master plans for axle load operations to enable development partners including the Bank support the setting up of such systems.
- Setting up effective vehicle and driver inspection systems where these do not exist to avoid the frequent breakdown and repair of vehicles on road pavements.
- RMCs should develop their local contracting capacities for timely and cost-effective maintenance; and for employment generation and economic growth. This may be done through better regulation, targeted procurement and deliberate actions within the country laws.
- Road Administrations should strengthen their capacities, especially in the areas of planning and contract management. This could be done through a combination of training and education. Emphasis should nevertheless be placed on training.
- Training could be through combination of short–term professional courses and attachment to professional offices known for their professional excellence. The training courses could be tailor made to suit the needs of RAs and given by local academic institutions or provided by internationally known trainers. Technical Assistants may be used to help build capacity but their use should be mainly for specific short term assignments and for knowledge transfer with measureable outputs. Specialist training for staff, where necessary, may be pursued through higher education both in local institutions and those elsewhere as appropriate.

9.0
FINDINGS AND RECOMMENDATIONS

9.0 Findings and recommendations

9.1 Introduction

A study on quality of road projects funded by the African Development Bank has been carried for thirty (30) recently completed road projects in eight (8) Regional Member Countries.
The eight countries are:
- Benin;
- Cameroon;
- Democratic Republic of Congo;
- Ghana;
- Kenya;
- Tanzania;
- Tunisia; and
- Uganda.

The roads were chosen to provide a spread across climatic regions, types of construction, type of surfacing and implementation period.

The study was undertaken to assess the sustainability of Bank financed road projects as deduced from their quality; and based on the findings of the study, develop recommendations for improvements, if any, for future investments in the road sector.
The specific objectives of the Study were:
- To assess whether the technical standards and specifications adopted in Bank financed road projects are of internationally acceptable best practice;
- To assess whether the adopted standards and specifications are fully adhered to during project implementation; and
- To provide recommendations on changes or improvements, in the Bank's approach in the project design as they affect the quality of road projects at implementation and impact sustainability.

The recommendations, if any, were to be made within the context of the Bank's projects general objectives in terms of social and economic development; domestic construction industry development; and national and local employment generation.

9.2 Findings

9.2.1 General

The findings of the Study has been put under two categories. These are findings related to the overall quality of construction; and findings on sustainability. It should be noted that quality of construction affects sustainability and that the separation of findings on overall quality from that of sustainability is only for convenience.

9.2.2 Overall quality

- The road sections have been rated based on the pavement condition rating, the riding quality as measured through roughness, and the residual traffic carrying capacity as assessed through the deflection response of the road pavements and also the level of compliance of the pavement layers with the specified requirements of the construction contracts. Based on the assessment for overall quality;
  - o Seven (7) of the Study Sections were rated as Very Good;
  - o Fifteen (15) as Good; and
  - o Eight as (8) Fair.

All the Study Roads continue to provide the service for which they were intended.

- The Study has demonstrated that currently twenty six (26) of the thirty (30) road sections studied have traffic carrying capacities which are equal to or higher than anticipated in their planning. The four (4) road sections, which were among the eight rated as fair, could have sections which may not have the anticipated pavement strength as intended. The road sections are the Techiman - Apaaso and the Apaaso - Kintampo road sections in Ghana, the Isiolo - Merille in Kenya and the Dareda - Minjingu road section in Tanzania. These roads, however, continue to have riding surfaces which are regarded as fair or good.
- One road section in the Democratic Republic of Congo and two road sections in Tanzania (Mainland) have shown cracking which is extensive in the case of the road in the Democratic Republic of Congo and their long term performance may be in doubt. Two of the roads, the one in DRC and the other in Tanzania were provided with cement stabilized bases while the other in Tanzania has a thick layer of cement stabilized sub-base (150 mm thick) and a thin (150 mm thick) layer of crushed rock base. All three roads were provided with a thin asphalt wearing course of 50 mm thick. These and the performance of other roads with similar pavement structures seen in the course of the study raise concern on use of cement stabilized bases under thin wearing courses.
- The level of service and riding quality for the Study roads was negatively affected by the numerous speed calming interventions in settlements. The quality of some of these speed calming devices, constructed after the completion of the roads, are less than satisfactory and could pose safety hazards.
- Road safety was assessed as satisfactory for all the Study road sections. There are still a few of the road sections which could benefit from some road safety interventions for sustainability. The interventions required are mainly for signage, the installation of speed calming devices in built up areas and the removal and replacement of badly constructed (by road users) speed humps with ones that have been properly designed.
- Some of the safety concerns could have been foreseen as part of the design or during construction while others are regarded as maintenance related. The foregoing, coupled with the use of materials which have shown to be inappropriate for some of the pavement structures built; such as the use of cement stabilized bases under surface dressing for the Singida - Katesh and the Katesh - Dareda roads in Mainland Tanzania, and under a thin asphaltic concrete surfacing for the Kwango - Kenge road; suggest the need for technical and safety audits prior to construction.

These audits may take the form of design reviews by parties not involved in the original design. Technical audits during construction would also ensure that project specifications are being followed. Post-construction safety inspections would also ensure that the roads continue to be safe since improvements to roads can affect settlement and land use patterns.

- The study has also revealed that the standards, specifications and performance of Bank funded projects are comparable to those funded from other sources. The standards and specifications of Bank funded road projects in Regional Member countries also follow international best practice. These are supported by the results of a road users' perception surveys on the quality and standards of the roads which indicated that three-quarters of users in all the study countries rated the quality of Bank funded projects as high or very high with three quarters of users interviewed rating the standards of Bank funded road projects as high or very high.
- The Thirty (30) road sections studied were constructed under twenty seven (27) contracts. The Benin roads were under two (2) contracts; Cameroon - two (2), DRC - two (2); Ghana - eight (6), Kenya - five (5 - three (3) for Nairobi - Thika); Tanzania Mainland - three (3); Zanzibar - two (2), Tunisia - four (4) and one (1) for Uganda. Out of the twenty seven contracts, two had funding from other sources - DANIDA for the Pobe - Ketou Road in Benin and China for Lot 3 of the Nairobi - Thika Road project in Kenya.
- Of the remaining twenty five contracts under which Bank funded road projects were executed, the performance of eleven was regarded as satisfactory, six as moderately satisfactory and eight as unsatisfactory. The eight for which performance was regarded as unsatisfactory was on account of cost increases of more than 25% beyond the contract sum and the execution periods of more than 35% beyond the contract periods; or where the increase in cost was below 15% of the contract sum, project execution was delayed beyond 50% of the contract period. The contracts which were regarded as having performed unsatisfactorily were for one contract in Cameroon, four of the contracts in Ghana, the two for the three roads in Zanzibar and for the one contract in Uganda.
- The unsatisfactory or poor performance was attributable to inadequate designs necessitating sometimes extensive design changes or additional works with the related increases in cost and/or construction period. Another major issue was the inability of recipient Governments to meet their co-financing/counterpart fund obligations on time. Some delays were also attributable to the tardiness of contractors which result mainly from the lack of experience of their key personnel in the region and an inadequate understanding of the language of the contract by such key personnel.
- Delays in the relocation of utilities for projects in urban and sub-urban areas also affected the performance of some of the projects.
- The Study has shown that selected road sections are producing the desired returns and impact. Access of the populations to markets for their produce and for inputs has improved. There were also indications that access to social services such as schools and health facilities has also improved.

- The selected projects have and continue to generate employment and support the domestic construction industry especially where the projects had social components. The Study estimates that on average each study road conservatively generated over 8,000 person-months of direct skilled and unskilled jobs and more than 13,000 person-months of indirect jobs. Some permanent employment has also been generated indirectly as a consequence of the improvements to the Study roads through the establishment of new small and medium scale, and in cases, relatively large enterprises that have sprung up since the road improvements.

9.2.3 Sustainability

The study has shown that all the road sections studied have been appropriately selected and would yield the expected returns on investment if they are properly maintained. The roads have had minimal impact on the environment and where necessary mitigation measures have been instituted. Social dislocation has been minimized and where required adequate compensation has been paid. The physical tests carried out suggest that, with the exception of eight out of the thirty road sections studied, for which further investigations have been recommended, the roads have been adequately designed and construction has met the set specifications. The roads sections, as implemented, can be said to provide the necessary contributions to the sustainability of Bank financed road projects.

- It was found out that risks to the sustainability of Bank funded road projects beyond design and construction exist in all the countries studied. The degree of risk, however, varies from country to country. The risks are related to the management regime for roads, the capacity of road administrations, the lack of adequate funding for maintenance, the lack of effective axle control mechanisms and weak local contracting capacities.
- None of the study countries is able to fully fund maintenance. Most of them lack effective road maintenance management systems.
- Four out of the eight countries are managing the roads through Ministries and Departments which does not allow the road administrations to operate as effectively as needed for the efficient management of their networks.
- The difficulty in accessing data, which is routinely required for planning purposes; in obtaining relevant reports for the Study; and the high degree of changes in scope of works during construction are symptomatic of capacity issues in the Road Administrations.
- The laboratories of the Road Administrations were not always as well equipped as would be desirable to enable them to play a significant role in project monitoring and also for supporting required pavement management systems.
- In, at least, one of the countries, the frequency of broken down vehicles and the repair of these vehicles in the carriageway raises concern for the sustainability of the completed projects and for safety. This phenomenon is not unique to the particular Study country but has been observed in other Regional Member Countries.
- Of the Study countries, the three countries of Benin, Cameroon and DRC were rated to have a high risk with respect to sustainability of road projects. Ghana, Kenya,

Tunisia and Uganda were rated as moderate risk countries with Tanzania rated as having a low risk to the sustainability of road projects, including bank funded road projects.

9.3 Recommendations

9.3.1 General

The Bank is desirous of ensuring the overall quality of road projects it funds and that they are robustly sustainable. The study has revealed that, by and large, the Bank funded road sections studied have been judged to have met the desired objective. Further investigations have, however been recommended for eight of the road sections to preclude premature failure or to determine if and what remedial measures would be required in the short to medium term. Risks beyond the physical quality of the roads for the continued achievement of this objective do, however, exist in all the Study countries, though to different degrees. A number of actions would need to be pursued if Bank funded road projects are to always meet the required quality and be robustly sustainable.

While a few of the actions can be taken directly by the Bank, most of the actions cannot be taken directly by the Bank, but by Regional Member Country Governments and by their Road Administrations or implementing agencies for Bank financed road projects. The Bank may however be able to play a role even for such actions that need to be taken by RMC Governments or their implementing agencies through support and/or leverage.

Based on the findings of the Study, a number of recommendations have been given. The recommendations have been put in three groups - those that can be directly implemented by the Bank; and those that would need to be carried out by RMC Governments and by their implementing agencies with Bank support and/or leverage.

9.3.2 Actions to be taken by bank

- The Bank may consider, in as much as it is possible, minimizing the contributions of Regional Member Governments for co-financing projects to avoid project delays and costly interest payments for the Governments resulting from delayed payments for work executed on road projects.
- The Bank may consider introducing Output Based or Performance Based Contracting with an extended maintenance period in the order of 5years to ensure that contractors become committed to producing quality roads at competitive costs; and ensure the maintenance of Bank funded roads at least in the short to medium term. Extending the Defects Liability Period under the current form of contract as used for the Study roads, however, is unlikely to yield any real benefits.
- The Bank should deepen its practice of assessing the capacity of implementing agencies at project identification or at appraisal. Where capacity is deemed unsatisfactory, the Bank may set up a Project Management Unit (PMU) or employ experts as part of the project to assist the implementing agency in reviewing studies, designs and for construction supervision. The Bank may also require that safety and

technical reviews of designs by third parties are carried out prior to construction.

- Periodic technical Audits should be carried out on selected Bank funded road projects. At least one audit should be carried out for each road funded in the second trimester of the contract. Post-construction technical audits should also be conducted within the Defects Liability Period; but these should be limited to the use of non-destructive testing.
- The Bank should ensure that implementing agencies pay serious attention to the qualification and experience of consultants' and contractors' key staff in the selection of consultants and contractors.
- Bank Missions, during project implementation, should ensure that all mandatory documents are prepared and properly filed/archived for reference and for audits.

9.3.3 Actions to be taken by rmcs

- RMCs should reform road management for a more efficient and commercial approach towards managing roads.
- RMCs should improve maintenance funding. Those who do not have Road Funds should consider setting up such funds. Those with established funds should find ways to widen the base of the instruments contributing to the fund.
- RMCs should consider setting up Infrastructure Bonds for supporting counterpart funds and co-financing responsibilities for projects supported externally to avoid costly delays to projects.
- RMCs should consider setting up effective vehicle and driver inspection systems in countries where these do not exist to avoid the frequent breakdown and repair of vehicles on road pavements which increase the road maintenance burden compromises safety.
- RMCs should establish guidelines for the sharing of road corridors among the Road Administrations and the utility agencies to avoid costly re-location of utilities during the implementation of road projects; and which always ends up as additional costs to the road projects.
- RMCs should take steps to develop their local contracting capacities, and their construction industries in general, to ensure cost-effective construction and maintenance of road projects. This may be done through better regulation, targeted procurement and deliberate actions within the country laws.

9.3.4 Actions to be taken by road administrations

- RAs should set up effective axle load control systems. The Road Administrations should prepare master plans for axle load control operations to enable development partners, including the Bank, support the setting up of such systems.
- RAs should strengthen capacity especially in the areas of planning and contract management. Capacity should be built through a combination of training and education but with more emphasis on training. Technical Assistants may be used but should be mainly for specific short term assignments and for knowledge transfer with measureable outputs.
- The Administrations should be encouraged to collect road data on a routine basis for effective network planning.

- RAs should establish effective Maintenance Management Systems (MMS) where they are not yet set up.
- RAs should set up document management systems to help with the efficient storage and retrieval of project related and other needed information.
- RAs should strengthen their laboratories for them to be able to monitor roads on a routine basis to support road management systems.
- RAs examine critically the use of cement stabilized base layers under thin wearing courses (surfacings) since the long term performance of such pavements may be such that the full return on investment may not be realized due to high maintenance costs.
- RAs should, as much as possible, seal the shoulders of sealed roads to reduce the burden of frequent maintenance for paved roads with unsealed shoulders for better road asset management.
- RAs should, as much as possible, avoid major settlements in planning road projects to avoid the excessive numbers of speed calming devices which are becoming common place on national roads and which tend to reduce the benefits of road improvements, and may sometimes impair safety.
- RAs should carry out periodic safety audits on completed roads to ensure the safety safeguards incorporated in projects are still effective.
- The relevant RAs should carry out further investigations into the Techiman - Apaaso - Kintampo road sections in Ghana, the Isiolo - Merille road in Kenya; the Singida - Katesh and Dareda - Babati - Minjingu roads in Tanzania and the Kwango - Kenge road in the Democratic Republic of Congo to ensure the maximization of the return on investment made in these roads. The current state of the roads cited for further investigations in DRC and Tanzania may not be related to poor construction but could be related to the inappropriate use of otherwise competent material in the base and sub-base layers for these road sections.

APPENDIX

APPENDIX 1 : TERMS OF REFERENCE (TOR)

1. Introduction

1.1 Background

1.1.1. The African Development Bank (AfDB) is a multilateral development institution involved in the financing of development projects, including infrastructure, in its 54 Regional Member Countries (RMCs) in Africa. The role infrastructure plays in achieving sustainable economic growth and poverty reduction in RMCs is widely recognized. Accordingly, the Bank places Infrastructure development as one of the priority areas in its Medium Term Strategy (MTS, 2008 - 2012).

1.1.2. Considerable resources have been invested by the Bank on infrastructure development; with a total of UA 2.60 billion (approximately equivalent to US$ 4.0 billion) approved in 2010, representing 70.9% of the total Bank approvals in 2010. There has been a rising demand for infrastructure support from RMCs.

1.1.3. The Bank has supported road sub-sector projects in almost all of its RMCs, spread across the continent's five sub-regions - North Africa, West Africa, East Africa, Southern Africa and Central Africa. The Bank's RMCs enjoy different and very diverse levels of financial and technical capacities within the roads sub-sector. This has its implications in terms of the nature of Bank's involvement and level of standards and specifications applied. Whilst the broad project design and implementation in the different RMCs may share similarities as far as the Bank's procedures and processes may influence, the road projects in the different RMCs invariably present unique characteristics as related to local conditions.

1.1.4. Road projects financed by the Bank in the RMCs include either new construction, upgrading (mainly from gravel to paved), rehabilitation and capacity improvement. The projects can also include standalone bridges (with limited approach roads), or can be in the form of a nation-wide program.

1.1.5. With socio-economic development being the main mandate of the African Development Bank, the Bank needs to ensure that all the projects it finances achieve their economic and social developmental impacts. To this end, the Bank has put in place various procedures and safeguards with the aim of ensuring that these projects fulfill various indicators, amongst which is the adequacy, suitability and sustainability of the physical structures put in place. In the case of road projects, physical quality, safety and sustainability play a major role in achieving the said indicators.

1.1.6. With the Bank having financed and supported numerous transport sector projects, and specifically road transport operations there is need to verify that the technical standards and specifications adopted in the various Bank financed road projects are of internationally accepted quality, reflecting best practice; and correspondingly if these are adhered to during project implementation.

1.1.7. The subject study, to be undertaken by the Bank, aims at establishing the above noted aspects and accordingly develop recommendations for any changes in the Bank's operations and implementation of projects that would ensure that Bank financed road projects are robustly sustainable.

1.2. Objectives of the Study

1.2.1. The overall objective of the study is to assess the sustainability as deduced from the quality of Bank financed road projects and accordingly develop recommendations on any improvements for future investments in the road sector.

1.2.2. The specific objectives of the study are:

- To assess whether the technical standards and specifications adopted in Bank financed road projects are of internationally acceptable best practice.
- To assess whether the adopted standards and specifications are fully adhered to during project implementation.
- To provide recommendations on changes or improvements, in the Bank's approach in the project design as they affect the quality of road projects at implementation and impact sustainability.

1.2.3. While pursuing these objectives, the consultant will also keep in mind that the recommendations must respect the Bank's projects general objectives in terms of: (i) social and economic development; (ii) development of domestic construction industry; and (iii) national and local employment.

1.3. Outline of Study Outputs

1.3.1. The main outputs of the study would include:

i- A critical assessment of the quality of Bank financed road projects in respect of technical standards and specifications in reference to sustainability.

ii- Recommendations on approaches to defining technical standards and specifications that would improve quality and sustainability of road projects, whilst taking due cognisance of the local construction industry climate.

1.3.2. The Consultant shall be at liberty to propose any further outputs.

2. Scope of services

2.1 General

2.1.1. The Consultant shall perform all necessary activities that may encompass planning, engineering, and related tasks as described herein with due care and diligence to attain the objectives of the study.

2.1.2. The overall responsibility for administration and coordination of the study rests with the Bank through the Transport and ICT Department (OITC).

2.1.3. In the conduct of his work, the Consultant shall regularly communicate with the Bank and other agencies as the Study may require and as agreed with the Bank. This may include Road Authorities, Ministries responsible for Works, Transport, Finance, and other Government Departments/ Agencies responsible for roads. The Consultant will also be expected to undertake comprehensive consultation with the private sector (consultants, and contractors) as relevant to the study.

2.1.4. The Consultant shall be solely responsible for collecting the data required to execute the study. The Bank will assist the Consultant in obtaining data and services appropriate to achieving the objectives of the study, as much as practicable. The consultants shall be responsible, however, for the analysis and interpretation of all data received and the conclusions and recommendations derived from the data.

2.2 Detailed Scope of Work

The scope of work will include, but not be limited to the following:

2.2.1. The Consultant shall refine the quality parameters and indicators to be used in the Study as shall be appropriate for the specific road projects selected in accordance with provisions made in paragraph 2.2.2 below. The quality parameters shall include both technical (engineering) and other perspectives and may include:

- Riding Surface Quality (Road roughness or such other as proxy).
- Pavement Condition Rating.
- Present Serviceability Index (PSI).
- Conformity of construction (as-built) with technical specifications.
- Time for actual implementation against planned implementation time.
- Addressing of Road Safety.
- Ease of maintenance vis-à-vis required technology and available capacity.

2.2.2. The Consultant shall accordingly carry out field visits to the following five representative countries that have been preliminarily selected for the study. The sampling criteria for specific projects shall consider such aspects as:

- Climatic conditions of the project area (for example high precipitation versus arid/ dry).
- Project planned implementation time (duration), and the period when the project was commenced.
- Road project type and classification (new construction, rehabilitation, upgrading, expansion), and road surfacing type/ material (gravel road, surface dressing, Asphalt Concrete, or other).

2.2.3. The countries to be visited for the purpose of the study shall include:

- Tunisia
- Benin
- Ghana
- Democratic Republic of Congo
- Tanzania

2.2.4. The Bank may require that the representative countries for the purpose of the Study are modified/ altered prior to commencement, or during implementation of the assignment; and as such the Consultant shall clearly indicate the planned travel costs in accordance with the sub-regions (North Africa, West Africa, East Africa, Southern Africa and Central Africa).

2.2.5. In agreement with the Bank, the Consultant shall select the specific projects to be included in the Study, on the basis of attaining a balanced mix of project types / conditions such that a representative detailed study may be undertaken.

2.2.6. The Consultant shall review any critical key variances in road construction specifications and technical standards in use in the selected projects, and their potential influence on quality of road projects. The Consultant shall accordingly make any recommendations for replication or transfer as may be deemed appropriate for the broad improvement of road projects quality.

2.2.7. The consultant should review the quality assurance system put in place and relevant quality assurance manuals in use in the projects and accordingly draw any pertinent conclusions.

3. Additional responsibilities of the consultant

Documents

Apart from data obtained by the Consultant, he shall be furnished with additional documents by the Bank. The Consultant shall take stock of all documents made available to him for the purpose of this assignment, which shall include Project Completion Reports, Project Quarterly Progress Reports, and Project Appraisal Reports, as well as Contract Documents. These documents in his custody shall be returned at the completion of the study. The consultant shall be entirely responsible for the analysis and interpretation of data obtained from these documents and from the other sources. These documents shall be considered confidential and treated as such.

Personnel

The consultant shall provide at his own expense all personnel and labour necessary for the execution of the study.

Offices

The consultant shall be responsible for providing offices for the execution of the assignment in their home country, however the Bank shall provide to a reasonable extent office space at the Temporary Relocation Agency (Tunis) and in the Bank's Field Offices (where present) during the field visits for execution of the Study, upon request by the Consultant.

Testing Equipment

The consultant shall be responsible for the provision of the requisite testing equipment for the purposes of the study. The consultant shall also make all necessary arrangement for use of laboratories for the testing of any materials or specimens obtained as part of the study activities. A clear scheme for restoration should be provided for any proposed destructive testing.

4. Services and facilities to be provided by the client

The Bank shall assist the Consultant in obtaining immigration authorization for staff and custom clearance for instruments and other equipment imported for the study. The Bank shall ensures that the Consultant is accorded the best cooperation from all Bank Departments, Units and Field offices as may be required for the purposes of conducting the Study.

5. Key professionals for the services

5.1 Key professionals for the study shall at least consist of

- Highway/ Road Engineer (Team Leader)
- Pavement/ Materials Engineer

5.2 The team will have the following professional skills and expertise to carry out the study

- Highway/ Road engineer with extensive roads sector experience in management and construction of roads, and road performance evaluation with mixed exposure to projects in both developed and developing countries;
- Pavement/ Materials Engineer with extensive experience in the evaluation of pavements, and road construction materials for both paved and unpaved roads;

5.3

The team should possess extensive exposure to the international development institutions procedures, and knowledge of the development of domestic consultants and contractors

5.4

5.4.All the key professionals are to be at least holders of a Master's degree or equivalent in their respective fields of specialization with not less than 20 years of experience for the Team leader, and 15 years of experience for the other experts in work of a similar nature. The key professionals should have an ability to communicate effectively in English or French (together with sound working knowledge of the other language).

5.5

All experts should have the ability to present their views clearly, both orally and in written form, and the ability to work with national counterpart staff. Experience in Sub-Saharan Africa will be an added advantage.

5.6

The time input for the study is expected to be approximately 12 man-months. The consultant shall provide a schedule to indicate the key tasks for each of the key professionals.

5.7

The Consultant shall include any additional key personnel and support staff as shall be necessary to successfully execute the assignment.

6. Implementation schedule and reporting

6.1 Implementation Schedule

The Study shall be conducted over a period of six months from the Commencement Date. It is expected that the Draft Report shall be submitted four months after the commencement of the assignment and it shall be presented and discussed at a Validation Workshop.

6.2 Reporting

The Consultant shall submit the following Reports to the Bank:

6.2.1 Inception Report

The Inception Report shall be submitted to the Bank one month after commencement of the Study. The Inception Report shall include the following:

- Consultant's mobilization status and setup.
- Consultant's proposed refined quality parameters and indicators; and sampling criteria for the selection of Bank funded road projects that are to be included in the study analysis.
- Consultant's recommended specific projects to be included in the Study.
- Update on the methodology and work-plan for the execution of the Study.
- Any other pertinent issues for the execution of the assignment.

6.2.2 Progress Report

The Progress Report shall be submitted to the Bank two months after commencement of the Study. The Progress Report shall catalogue the work done by the Consultant, including Reports reviewed, data obtained, data to be obtained, any challenges encountered and how they were resolved, analysis being carried out and any recommendations to the Bank to achieve the objectives of the study and activities to be done in the coming months.

6.2.3 Draft Final Report

The Draft Final Report shall be submitted to the Bank four months after commencement of the Study. The Draft Final Report shall address all aspects of the Study, providing clear and concise findings and recommendations as per the Terms of Reference. The Draft Report shall include the Consultant's findings and recommendations of the Study.

6.2.4 Final Report

The Final Report shall be submitted to the Bank one month after receipt of the Bank's comments to the Draft Final Report and validation workshop. The Final Report shall incorporate the Bank's comments to the Draft Final Report and relate the validation workshop's discussions.

All the Reports shall be submitted in the two Bank languages; English and French. The Consultants provision for translation of Reports should be explicitly stated. Similarly, the need for interpretation services, if any, during site visits should also be explicitly stated for the specific country.

6.3 Validation workshop

A validation workshop will be organized by the consultant in the Temporary Relocation Agency of the Bank in Tunis at the end of the fourth month of the Study, following submission of the Draft Report. In this workshop attended by OITC task managers and management, the consultant will present his findings and recommendations as per Draft Final report.

Contract No. OITC0/2013/10/20

Preamble

A Service Contract was entered into by and between the AFRICAN DEVELOPMENT BANK (hereinafter called the «Bank»), of the one part, and INTERCONTINENTAL CONSULTANTS AND TECHNOCRATS PVT. LTD. of the other part on 06th December 2012.

The Contract was for the Study on Quality of Bank Financed Road Projects – Contract N° OITC0/2012/11/32. The scope of the Study under that commenced on 17th December 2012 covered Five Study Countries. It is desirous that the Study scope covers an additional Three Study Countries. This Services Contract, Contract N° OITC0/2013/10/20 (the "Contract") is prepared in respect of the Additional Scope as defined herein and the outstanding scope from aforementioned Contract N° OITC0/2012/11/32.

The Terms of Reference as contained in Annex I of this Contract N° OITC0/2013/10/20 are similar to those contained in Contract N° OITC0/2012/11/32, with modifications to Clause 2.2 (Detailed Scope of Work) and Clause 6.2 (Reporting).

The Deliverables under this Contract No. OITC0/2013/10/20 shall encompass the outputs from Contract No. OITC0/2012/11/32 as defined in the Terms of Reference herein.

1. Introduction

1.1 Background

1.1.1. The African Development Bank (AfDB) is a multilateral development institution involved in the financing of development projects, including infrastructure, in its 54 Regional Member Countries (RMCs) in Africa. The role infrastructure plays in achieving sustainable economic growth and poverty reduction in RMCs is widely recognized. Accordingly, the Bank places Infrastructure development as one of the priority areas in its Medium Term Strategy (MTS, 2008 – 2012).

1.1.2. Considerable resources have been invested by the Bank on infrastructure development; with a total of UA 2.60 billion (approximately equivalent to US$ 4.0 billion) approved in 2010, representing 70.9% of the total Bank approvals in 2010. There has been a rising demand for infrastructure support from RMCs.

1.1.3. The Bank has supported road sub-sector projects in almost all of its RMCs, spread across the continent's five sub-regions – North Africa, West Africa, East Africa, Southern Africa and Central Africa. The Bank's RMCs enjoy different and very diverse levels of financial and technical capacities within the roads sub-sector. This has its implications in terms of the nature of Bank's involvement and level of standards and specifications applied.

Whilst the broad project design and implementation in the different RMCs may share similarities as far as the Bank's procedures and processes may influence, the road projects in the different RMCs invariably present unique characteristics as related to local conditions.

1.1.4. Road projects financed by the Bank in the RMCs include either new construction, upgrading (mainly from gravel to paved), rehabilitation and capacity improvement. The projects can also include standalone bridges (with limited approach roads), or can be in the form of a nation-wide program.

1.1.5. With socio-economic development being the main mandate of the African Development Bank, the Bank needs to ensure that all the projects it finances achieve their economic and social developmental impacts. To this end, the Bank has put in place various procedures and safeguards with the aim of ensuring that these projects fulfill various indicators, amongst which is the adequacy, suitability and sustainability of the physical structures put in place. In the case of road projects, physical quality, safety and sustainability play a major role in achieving the said indicators.

1.1.6. With the Bank having financed and supported numerous transport sector projects, and specifically road transport operations there is need to verify that the technical standards and specifications adopted in the various Bank financed road projects are of internationally accepted quality, reflecting best practice; and correspondingly if these are adhered to during project implementation.

1.1.7. The subject study, to be undertaken by the Bank, aims at establishing the above noted aspects and accordingly develop recommendations for any changes in the Bank's operations and implementation of projects that would ensure that Bank financed road projects are robustly sustainable.

1.2 Objectives of the Study

1.2.1. The overall objective of the study is to assess the sustainability as deduced from the quality of Bank financed road projects and accordingly develop recommendations on any improvements for future investments in the road sector.

1.2.2. The specific objectives of the study are:

- To assess whether the technical standards and specifications adopted in Bank financed road projects are of internationally acceptable best practice.
- To assess whether the adopted standards and specifications are fully adhered to during project implementation.
- To provide recommendations on changes or improvements, in the Bank's approach in the project design as they affect the quality of road projects at implementation and impact sustainability.

1.2.3. While pursuing these objectives, the consultant will also keep in mind that the recommendations must respect the Bank's projects general objectives in terms of: (i) social and economic development; (ii) development of domestic construction industry; and (iii) national and local employment.

1.3. Outline of Study Outputs

1.3.1. The main outputs of the study would include:

i- A critical assessment of the quality of Bank financed road projects in respect of technical standards and specifications in reference to sustainability.

ii- Recommendations on approaches to defining technical standards and specifications that would improve quality and sustainability of road projects, whilst taking due cognisance of the local construction industry climate.

1.3.2. The Consultant shall be at liberty to propose any further outputs.

2. Scope of services

2.1. General

2.1.1. The Consultant shall perform all necessary activities that may encompass planning, engineering, and related tasks as described herein with due care and diligence to attain the objectives of the study.

2.1.2. The overall responsibility for administration and coordination of the study rests with the Bank through the Transport and ICT Department (OITC).

2.1.3. In the conduct of his work, the Consultant shall regularly communicate with the Bank and other agencies as the Study may require and as agreed with the Bank. This may include Road Authorities, Ministries responsible for Works, Transport, Finance, and other Government Departments/ Agencies responsible for roads. The Consultant will also be expected to undertake comprehensive consultation with the private sector (consultants, and contractors) as relevant to the study.

2.1.4. The Consultant shall be solely responsible for collecting the data required to execute the study. The Bank will assist the Consultant in obtaining data and services appropriate to achieving the objectives of the study, as much as practicable. The consultants shall be responsible, however, for the analysis and interpretation of all data received and the conclusions and recommendations derived from the data.

2.2. Detailed Scope of Work

The scope of work will include, but not be limited to the following:

2.2.1. The Consultant shall refine the quality parameters and indicators to be used in the Study as shall be appropriate for the specific road projects selected in accordance with provisions made in paragraph 2.2.2 below. The quality parameters shall include both technical (engineering) and other perspectives and may include:

- Riding Surface Quality (Road roughness or such other as proxy).
- Pavement Condition Rating.
- Present Serviceability Index (PSI).
- Conformity of construction (as-built) with technical specifications.
- Time for actual implementation against planned implementation time.
- Addressing of Road Safety.
- Ease of maintenance vis-à-vis required technology and available capacity.

2.2.2. The Consultant shall accordingly carry out field visits to the following three representative countries that have been preliminarily selected for the study. The sampling criteria for specific projects shall consider such aspects as:

- Climatic conditions of the project area (for example high precipitation versus arid/ dry).
- Project planned implementation time (duration), and the period when the project was commenced.
- Road project type and classification (new construction, rehabilitation, upgrading, expansion), and road surfacing type/ material (gravel road, surface dressing, Asphalt Concrete, or other).

2.2.3. The countries to be visited for the purpose of the study shall include:

- Cameroon
- Ghana
- Uganda

2.2.4. The Bank may require that the representative countries for the purpose of the Study are modified/ altered prior to commencement, or during implementation of the assignment; and as such the Consultant shall clearly indicate the planned travel costs in accordance with the sub-regions (North Africa, West Africa, East Africa, Southern Africa and Central Africa).

2.2.5. In agreement with the Bank, the Consultant shall select the specific projects to be included in the Study, on the basis of attaining a balanced mix of project types / conditions such that a representative detailed study may be undertaken.

2.2.6. The Consultant shall review any critical key variances in road construction specifications and technical standards in use in the selected projects, and their potential influence on quality of road projects. The Consultant shall accordingly make any recommendations for replication or transfer as may be deemed appropriate for the broad improvement of road projects quality.

2.2.7. The consultant should review the quality assurance system put in place and relevant quality assurance manuals in use in the projects and accordingly draw any pertinent conclusions.

3. Additional responsibilities Of the consultant

Documents

Apart from data obtained by the Consultant, he shall be furnished with additional documents by the Bank. The Consultant shall take stock of all documents made available to him for the purpose of this assignment, which shall include Project Completion Reports, Project Quarterly Progress Reports, and Project Appraisal Reports, as well as Contract Documents. These documents in his custody shall be returned at the completion of the study. The consultant shall be entirely responsible for the analysis and interpretation of data obtained from these documents and from the other sources. These documents shall be considered confidential and treated as such.

Personnel

The consultant shall provide at his own expense all personnel and labour necessary for the execution of the study.

Offices

The consultant shall be responsible for providing offices for the execution of the assignment in their home country, however the Bank shall provide to a reasonable extent office space at the Temporary Relocation Agency (Tunis) and in the Bank's Field Offices (where present) during the field visits for execution of the Study, upon request by the Consultant.

Testing Equipment

The consultant shall be responsible for the provision of the requisite testing equipment for the purposes of the study. The consultant shall also make all necessary arrangement for use of laboratories for the testing of any materials or specimens obtained as part of the study activities. A clear scheme for restoration should be provided for any proposed destructive testing.

4. Additional responsibilities of the consultant

The Bank shall assist the Consultant in obtaining immigration authorization for staff and custom clearance for instruments and other equipment imported for the study. The Bank shall ensures that the Consultant is accorded the best cooperation from all Bank Departments, Units and Field offices as may be required for the purposes of conducting the Study.

5. Key professionals for the services

5.1. Key professionals for the study shall at least consist of:
(iii) Highway/ Road Engineer (Team Leader)
(iv) Pavement/ Materials Engineer

5.2. The team will have the following professional skills and expertise to carry out the study:

- Highway/ Road engineer with extensive roads sector experience in management and construction of roads, and road performance evaluation with mixed exposure to projects in both developed and developing countries;
- Pavement/ Materials Engineer with extensive experience in the evaluation of pavements, and road construction materials for both paved and unpaved roads;

5.3. The team should possess extensive exposure to the international development institutions procedures, and knowledge of the development of domestic consultants and contractors

5.4. All the key professionals are to be at least holders of a Master's degree or equivalent in their respective fields of specialization with not less than 20 years of experience for the Team leader, and 15 years of experience for the other experts in work of a similar nature. The key professionals should have an ability to communicate effectively in English or French (together with sound working knowledge of the other language).

5.5. All experts should have the ability to present their views clearly, both orally and in written form, and the ability to work with national counterpart staff. Experience in Sub-Saharan Africa will be an added advantage.

5.6. The time input for the study is expected to be approximately 08 man-months. The consultant shall provide a schedule to indicate the key tasks for each of the key professionals.

5.7. The Consultant shall include any additional key personnel and support staff as shall be necessary to successfully execute the assignment.

6. Implementation schedule and reporting

6.1. Implementation Schedule

The Additional Countries Scope of the Study shall be conducted over a period of 3.5 months from the Commencement Date.

6.2. Reporting

The Consultant shall submit the following Reports to the Bank:

6.2.1a Progress Report (Additional Countries)

A Progress Report shall be submitted to the Bank four weeks after the date of commencement of the Contract. The Progress Report shall catalogue the work done by the Consultant, including Reports reviewed, data obtained, data to be obtained, any challenges encountered and how they were resolved, analysis being carried out and any recommendations to the Bank to achieve the objectives of the study and activities to be done in the following period. The Progress Report shall also include interim test results from the Additional countries, and any updates on the countries under the original scope (under contract No. OITC0/2012/11/32).

6.2.2a Updated Revised Draft Final Report

The Updated Revised Draft Final Report shall be submitted to the Bank 2.5 months after commencement of the Contract. The Updated Revised Draft Final Report shall address all aspects of the Study, incorporating the Bank's comments on the Revised Draft Final

Report (covering the scope of five countries under Contract OITC0/2012/11/32) and integrating the Study aspects from the Additional countries. The Updated Revised Draft Final Report shall provide clear and concise findings and recommendations as per the Terms of Reference.

6.2.3a Final Report

The Final Report shall be submitted to the Bank two weeks after receipt of the Bank's comments to the Updated Revised Draft Final Report. The Final Report shall incorporate the Bank's comments to the Updated Revised Draft Final Report. The Consultant shall also submit an electronic version of the Final Report, including the native files of insertions in the Final Report (pictures, charts, tables, maps and other such material included in the Report).

All the Reports shall be submitted in the two Bank languages; English and French. The Consultants provision for translation of Reports should be explicitly stated. Similarly, the need for interpretation services, if any, during site visits should also be explicitly stated for the specific country.

The Addendum to the Request for Proposals (RFP) is issued in accordance with Article 2.3 of the Letter of Invitation.

The Terms of Reference are amended as follows:

Para 2.2.5 of the ToR is modified as:

2.2.5. A schedule indicating specific projects pre-selected to be included in the Study, is provided as Annex 1, as a guide for the Consultant. The objective in the selection of the projects is attaining a balanced mix of project types / conditions such that a representative detailed study may be undertaken. The Bank may if deemed necessary, amend the projects selection in the course of the execution of the Study. The Consultant shall provide in the Inception Report a view on the selection of projects vis-à-vis conducting a fully representative Study.

The following are added under Section 2.2 (Detailed Scope of Works) of the ToR

2.2.8 The Consultant shall make reference to road projects implemented through other financing (by the respective Governments or other Financiers); making cross-comparisons and drawing any pertinent conclusions in the modalities and procedures as far as they affect and influence the quality of the roads, and related sustainability aspects.

2.2.9 The Consultant shall examine and analyze the governance and institutional set up for the road sector in the Study countries, and critically discuss how it could influence the quality of roads. Recommendations in this regard should clearly indicate what the best practice would be, and the specific elements that would need to be addressed.

2.2.10 In the execution of the Study, the Consultant shall also obtain Road Users' perspective on the quality of the road. Various issues may be examined in this regard for both Bank financed roads and those by others, in a broad range of factors including technical, governance, institutional among others.

APPENDIX 2 :
FIELD AND LABORTORY TEST RESULTS

Appendix 2.1: Rough test results

A. Illara - Pobe Road

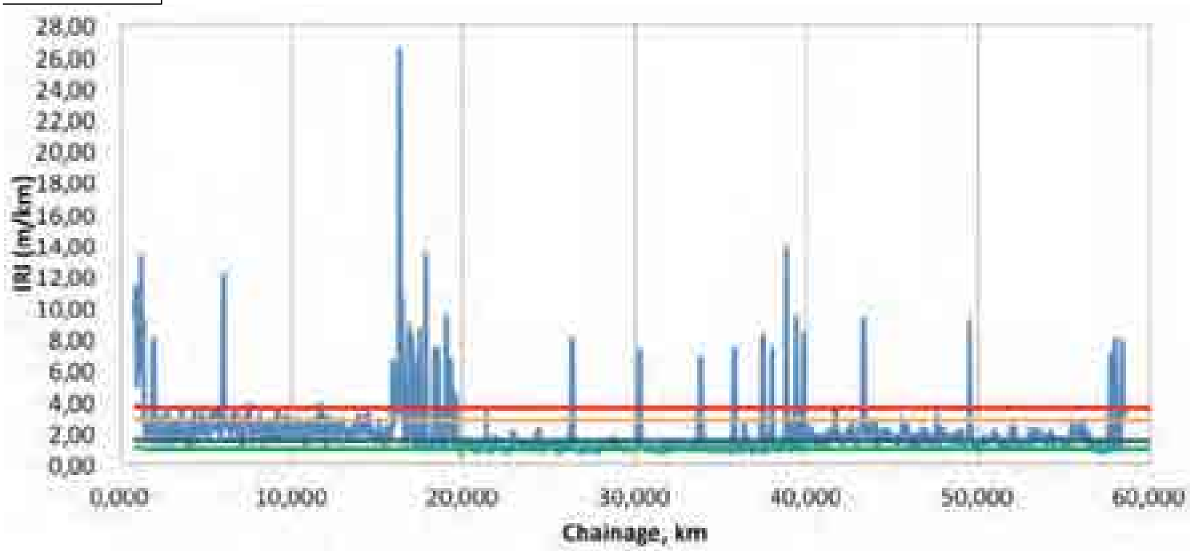


Figure A2.1.1-1: Roughness Levels along Illara - Pobe Road, Illara - Pobe Direction

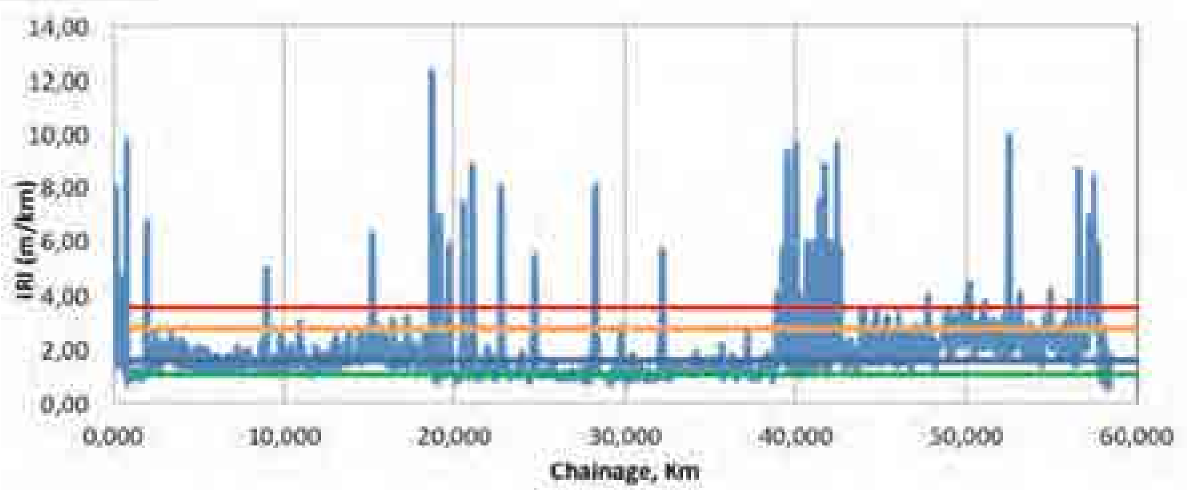


Figure A2.1.1-2: Roughness Levels along Illara - Pobe Road, Pobe - Illara Direction

Bamenda - Batibo - Numba Road
Bamenda - Batibo Section

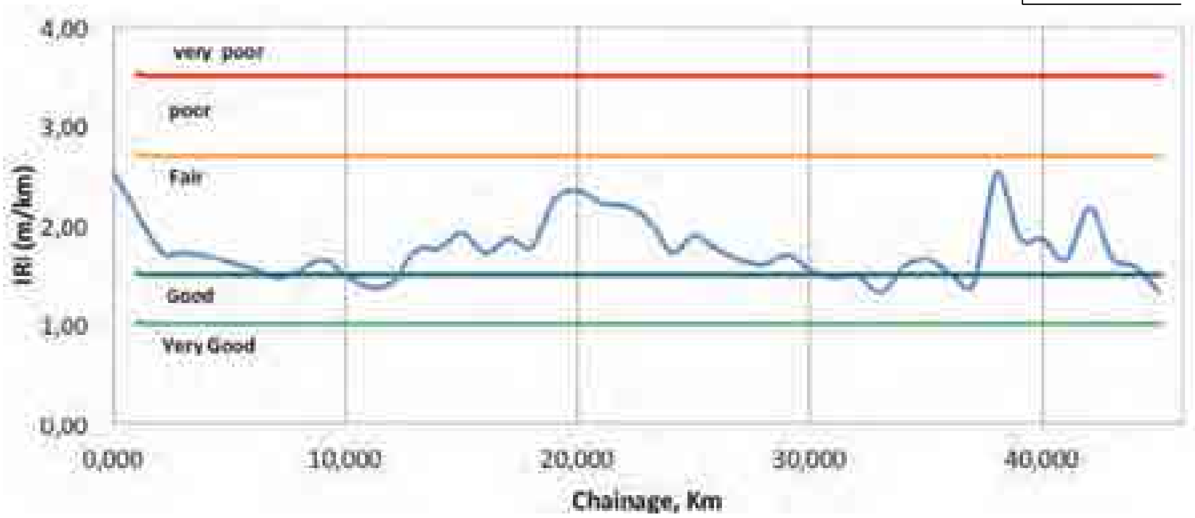


Figure A2.1.2-1: Roughness Levels along Bamenda - Batibo Road, Bamenda - Batibo Direction

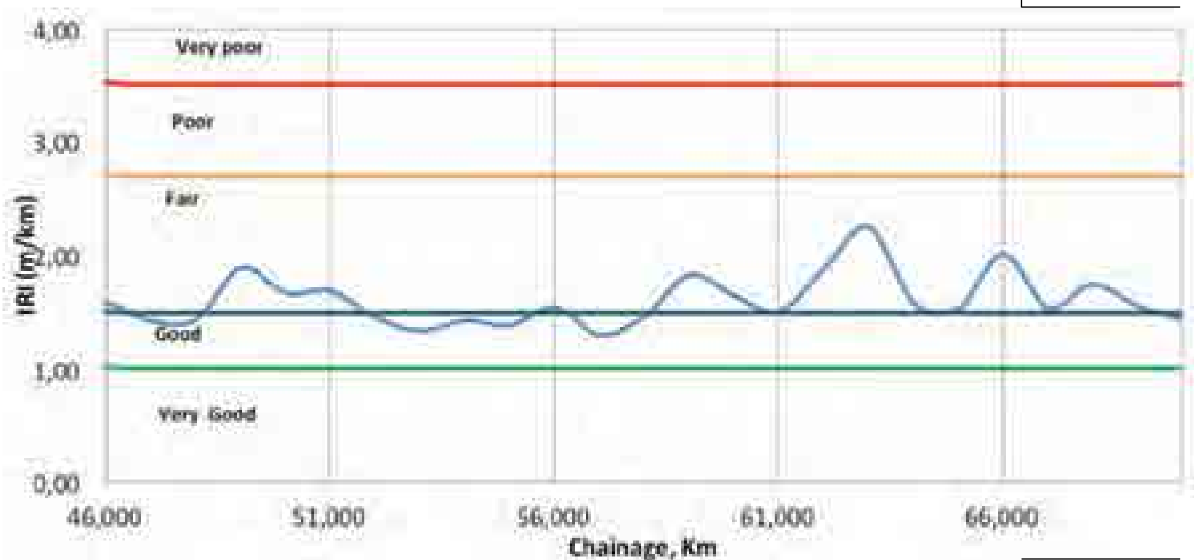


Figure A2.1.2-2: Roughness Levels along Bamenda - Batibo Road, Batibo - Numba Direction

Batibo - Numba Section

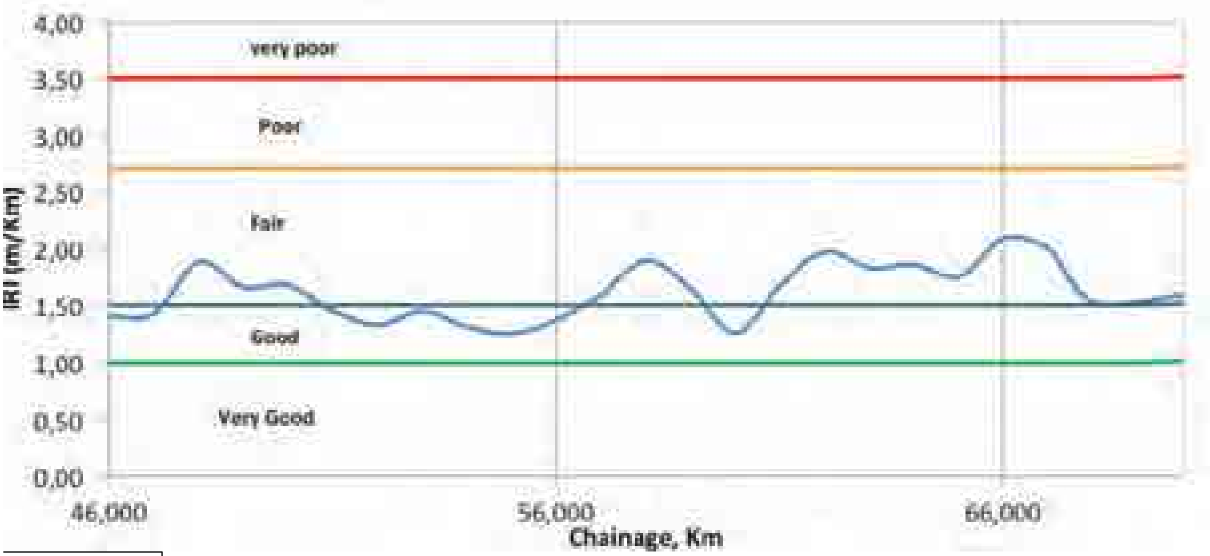


Figure A2.1.2-3: Roughness Levels along Batibo - Numba Road, Batibo - Numba Direction

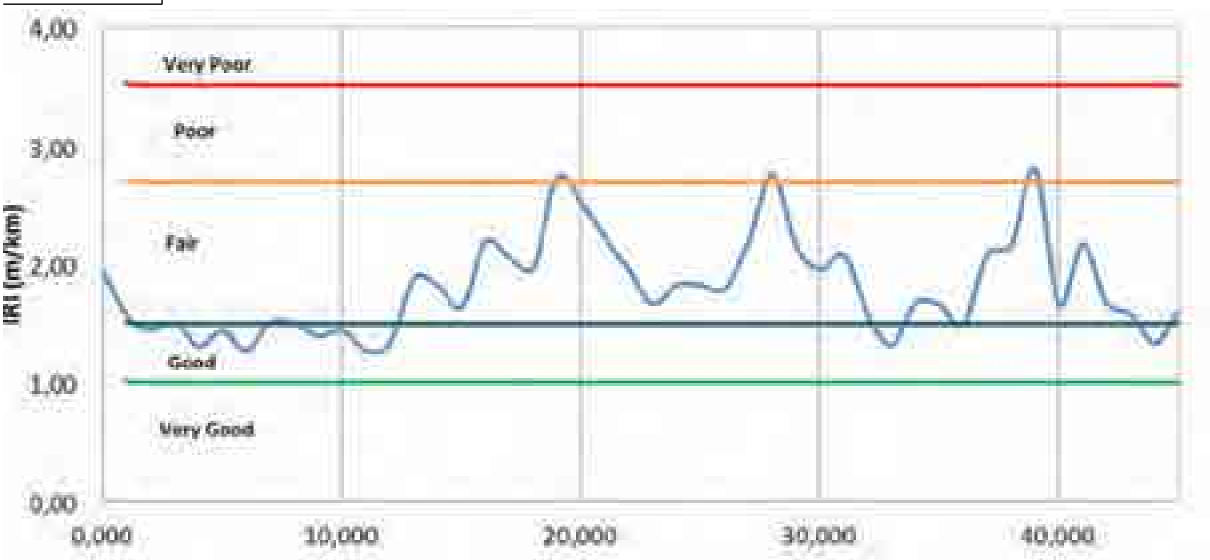


Figure A2.1.2-4: Roughness Levels along Batibo - Numba Road, Numba - Batibo Direction

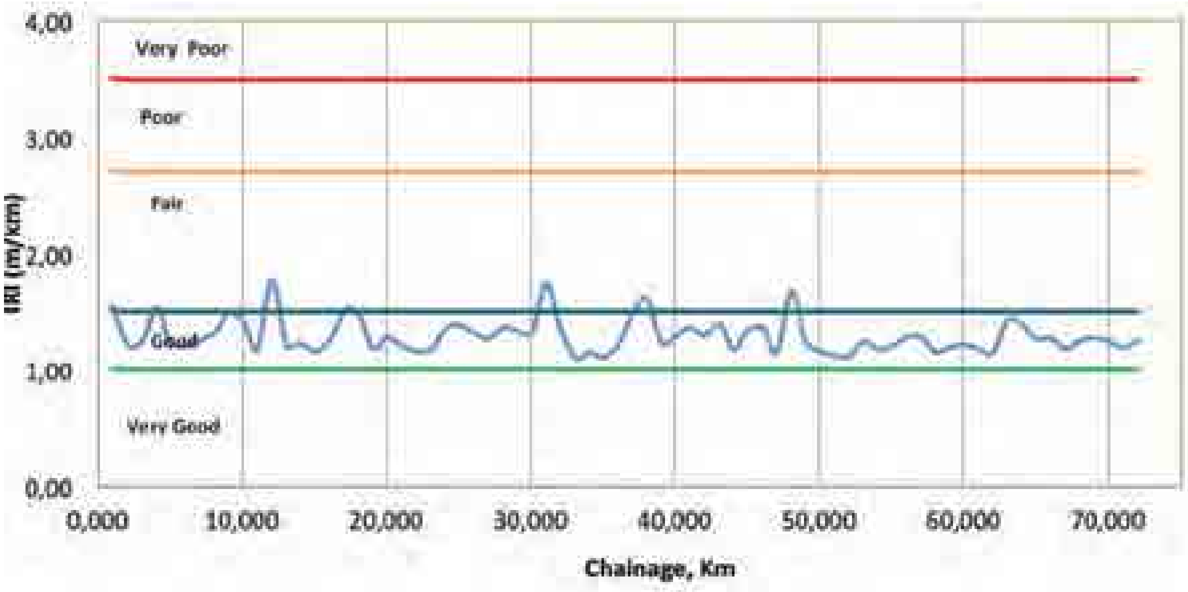


Figure A2.1.2-5: Roughness Levels along Nandeke - Mbere Road, Nandeke - Mbere Direction

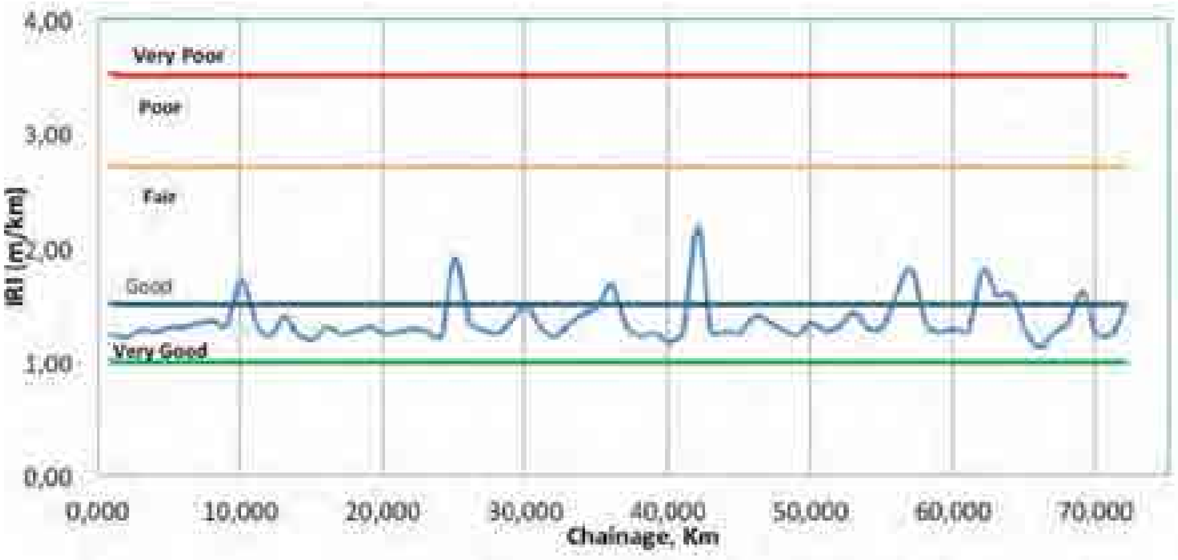


Figure A2.1.2-6: Roughness Levels along Nandeke - Mbere Road, Mbere – Nandeke Direction

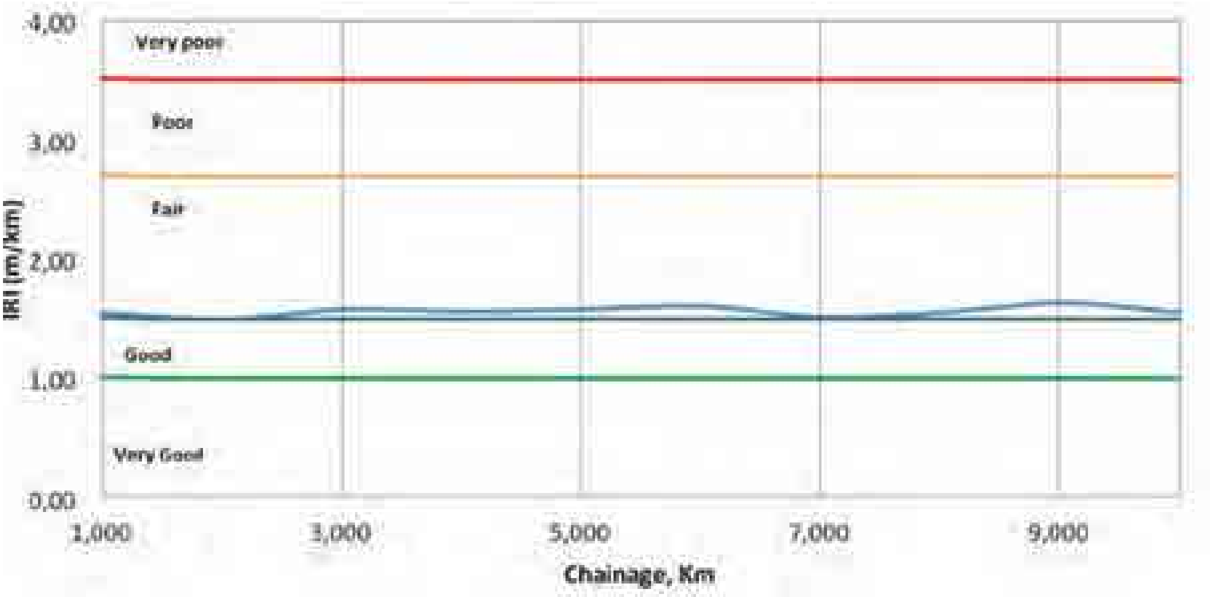


Figure A2.1.2-7: Roughness Levels along Junction Nandeke Road, Meidougou - Nandeke Direction

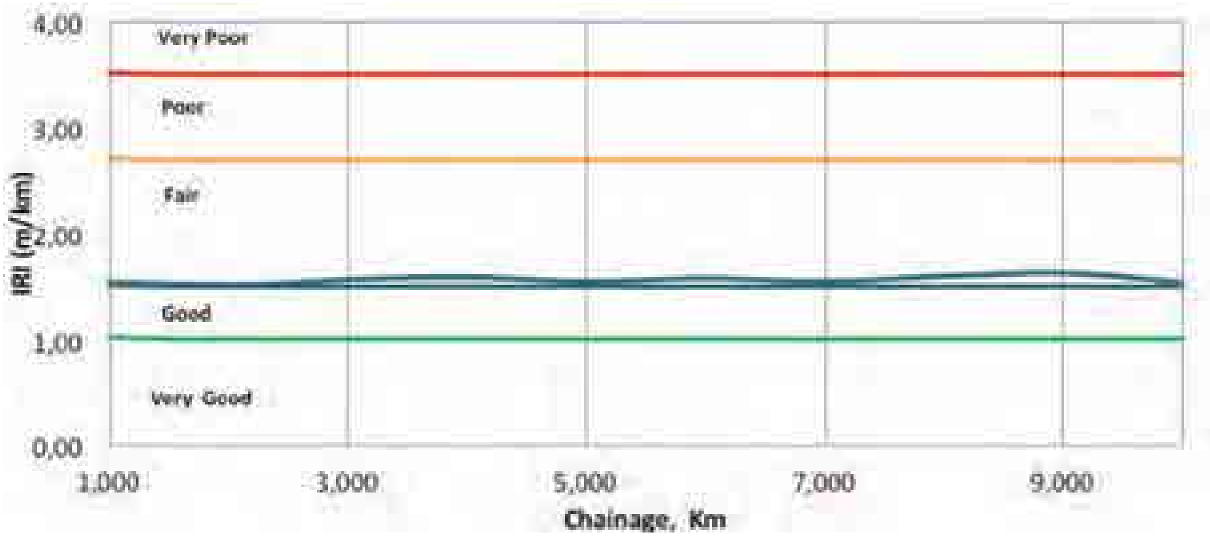


Figure A2.1.2-8: Roughness Levels along Junction - Nandeke Road, Nandeke - Meidougou Direction

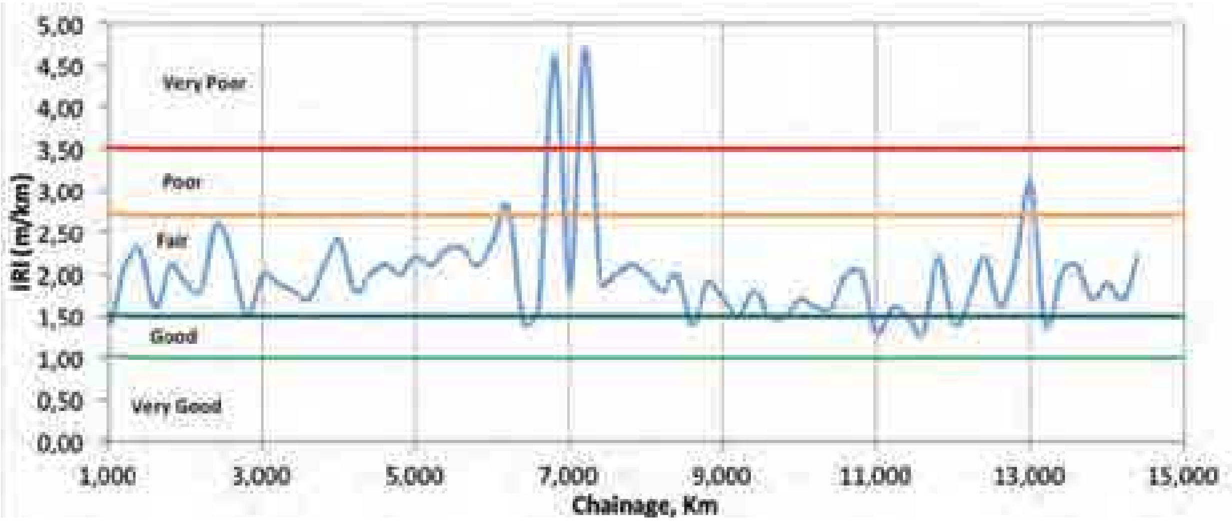


Figure A2.1.3-1: Roughness Levels along Agbozume - Aflao Road, Agbozume - Aflao Direction

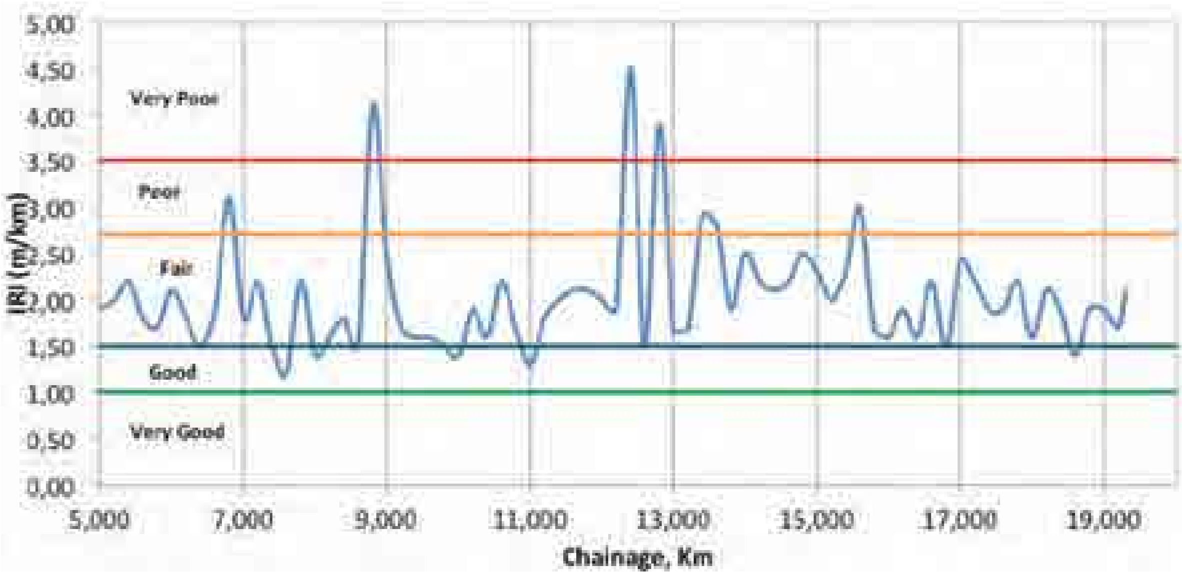


Figure A2.1.3-2: Roughness Levels along Aflao - Agbozume Road, Aflao - Agbozume Direction

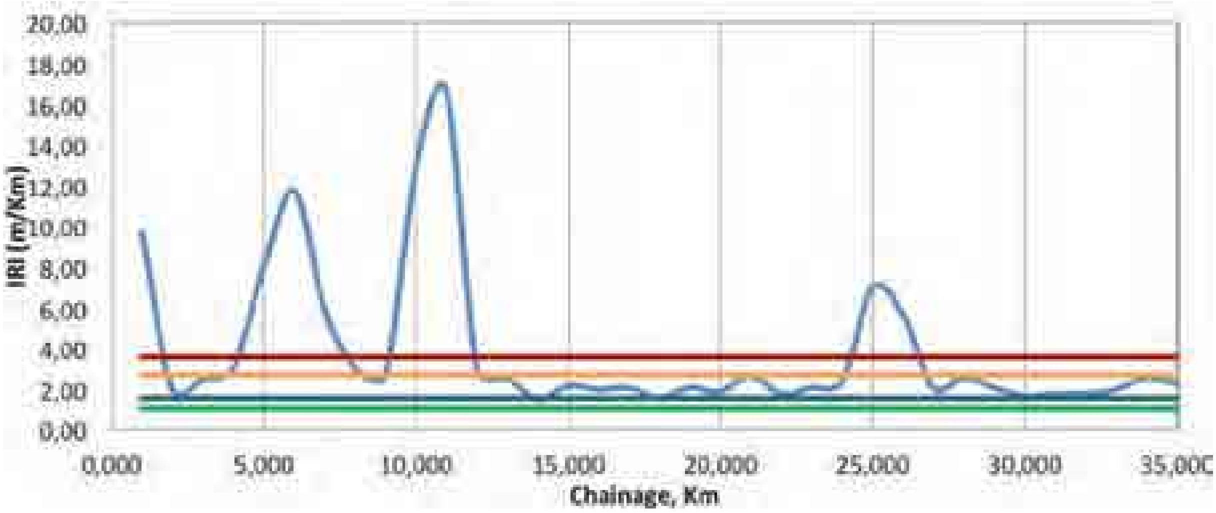


Figure A2.1.3-3: Roughness Levels along Akatsi - Agbozume Road Section

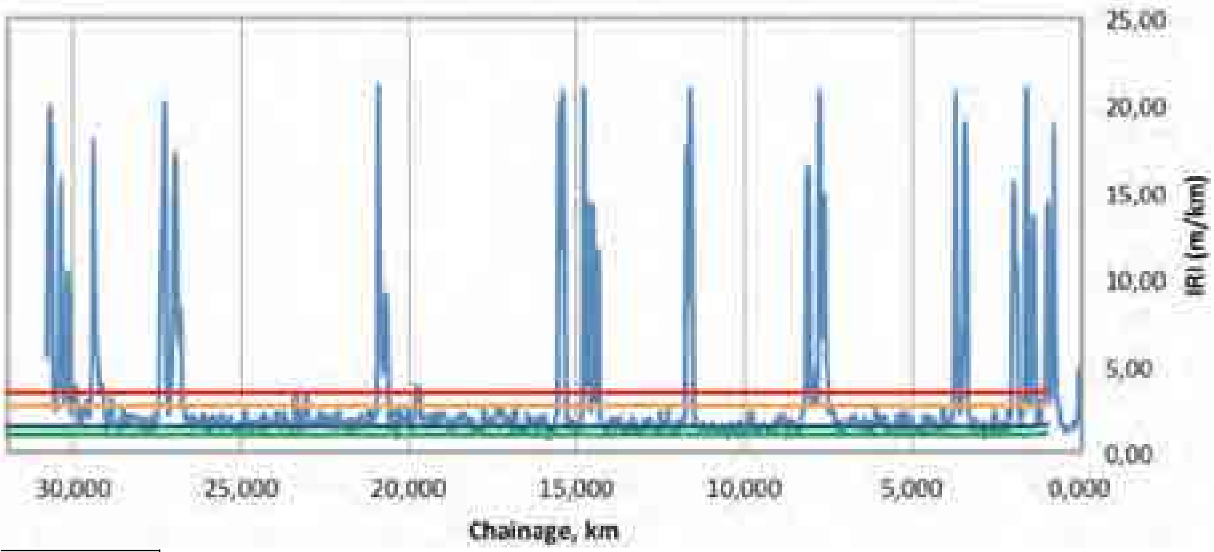


Figure A2.1.3-4: Roughness Levels along Akatsi - Agbozume Road Section

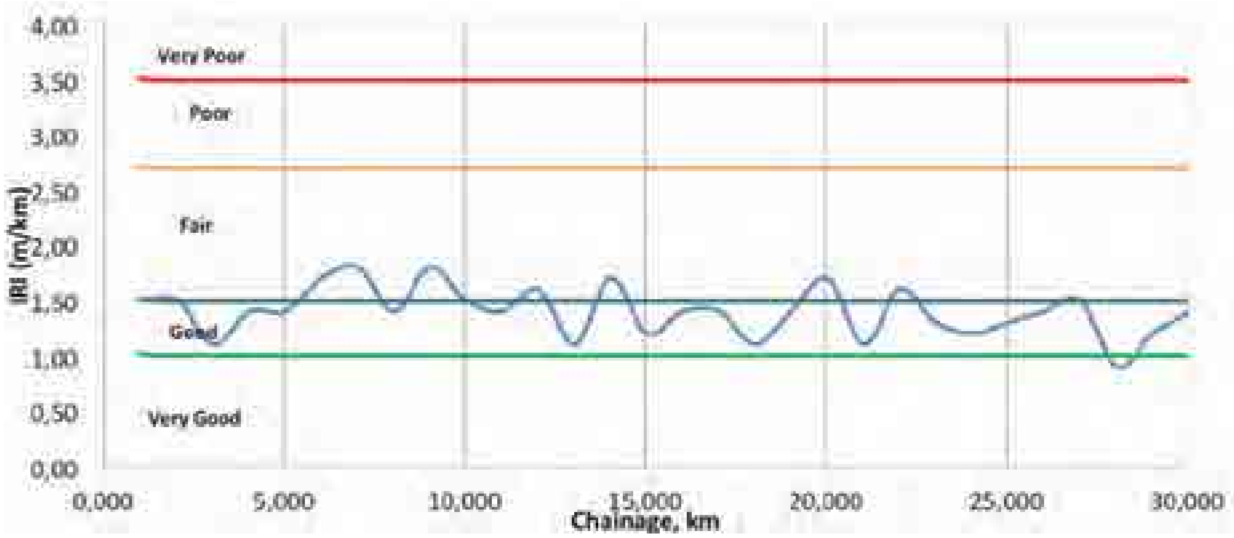


Figure A2.1.3-5: *Roughness Levels along Akatsi - Dzodze - Akanu Road Section*

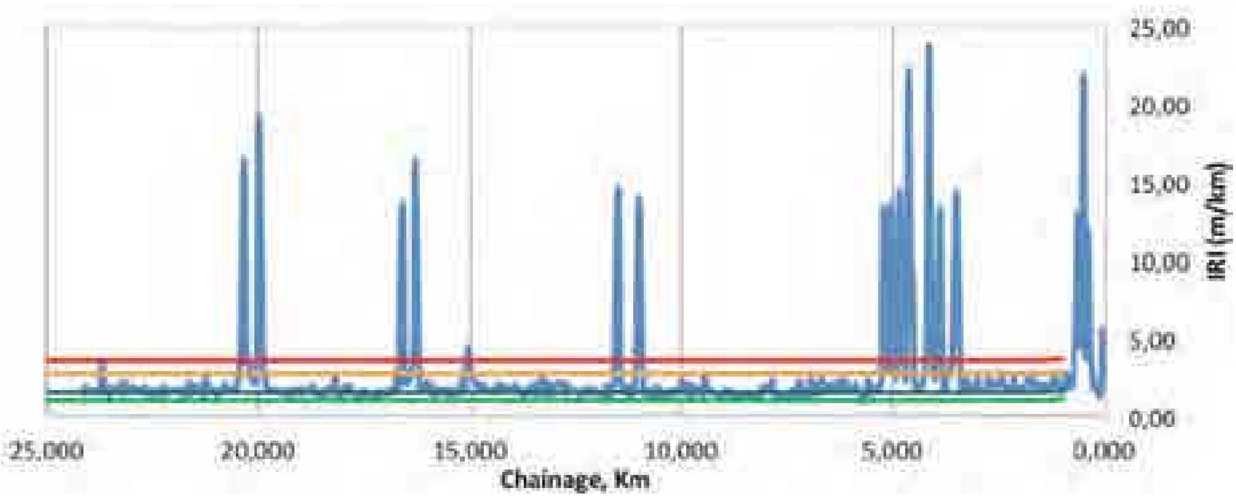


Figure A2.1.3-6: *Roughness Levels along Akatsi - Dzodze - Akanu Road Section*

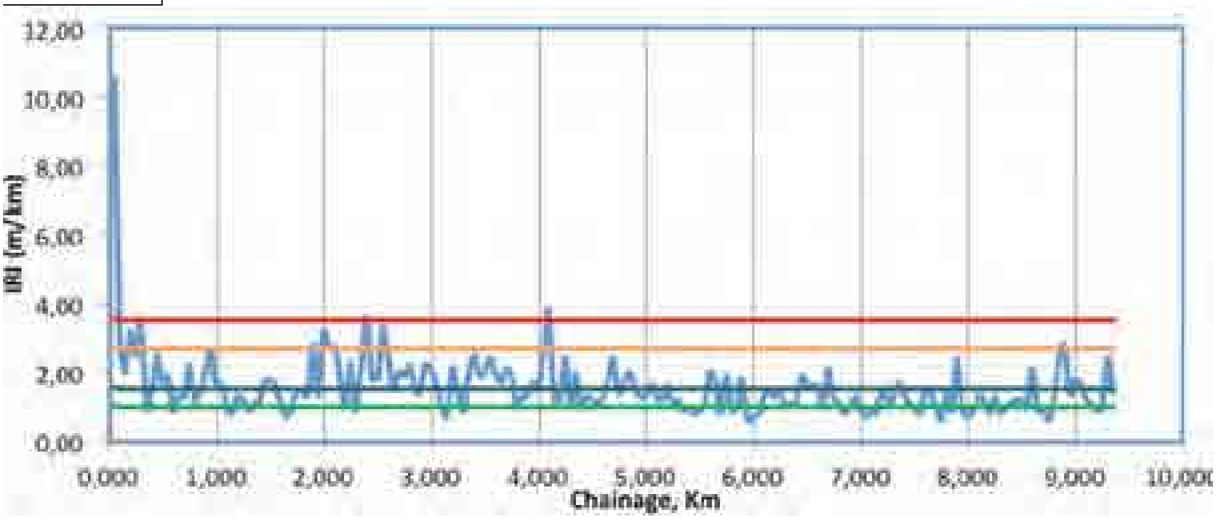


Figure A2.1.3-7: Roughness Levels along Nsawam Bypass Road Section

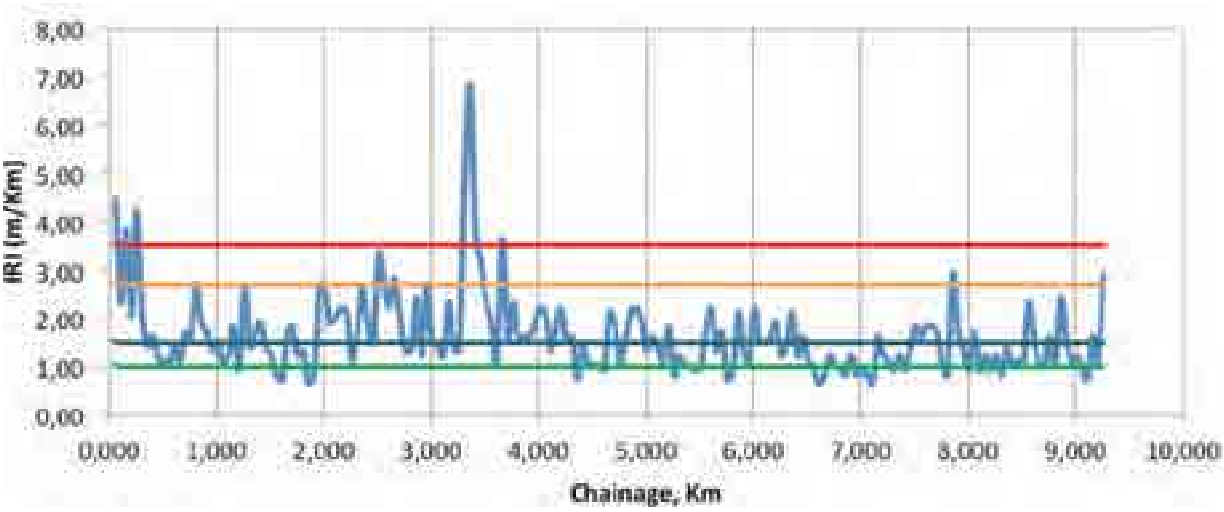


Figure A2.1.3-8: Roughness Levels along Nsawam Bypass Road Section

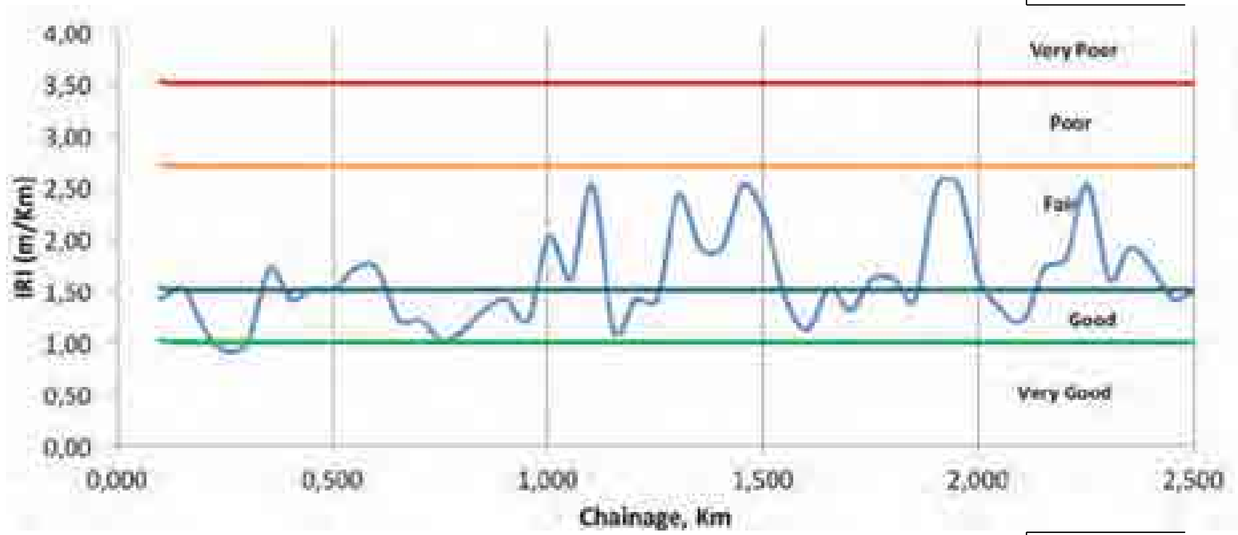


Figure A2.1.3-9: *Roughness Levels along Kintampo - Apaaso Road Section*

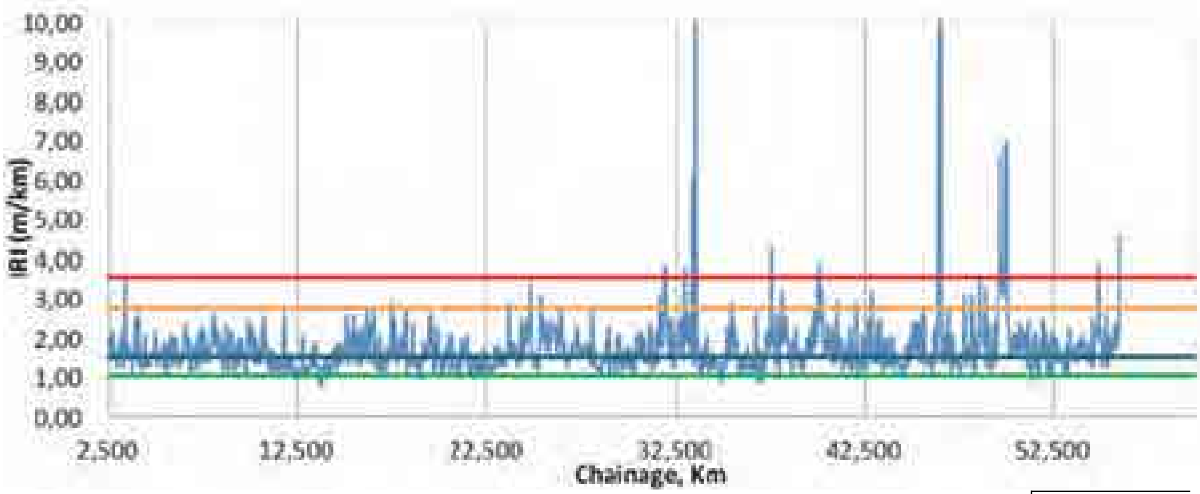


Figure A2.1.3-10: *Roughness Levels along Apaaso - Techiman Road Section*

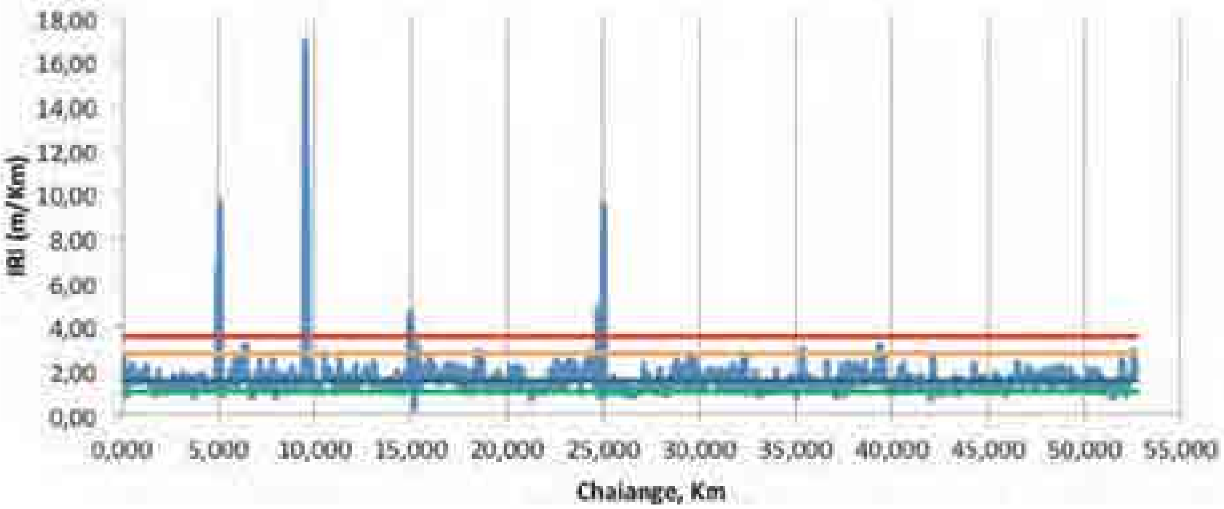


Figure A2.1.3-11: *Roughness Levels along Techiman - Apaaso Road Section*

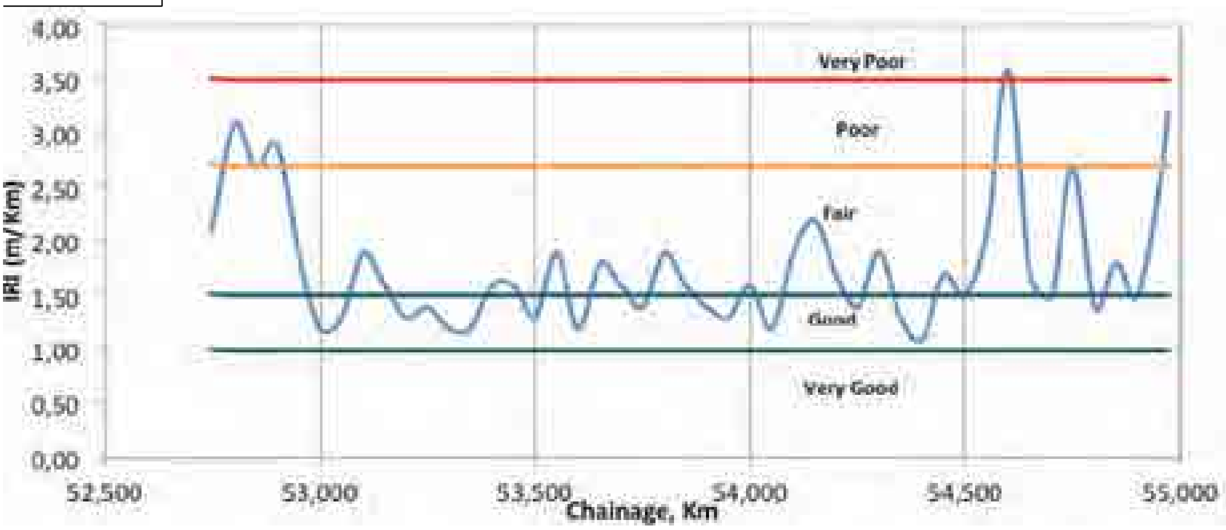


Figure A2.1.3-12: *Roughness Levels along Apaaso - Kintampo Road Section*

B. Athi River - Namanga Road

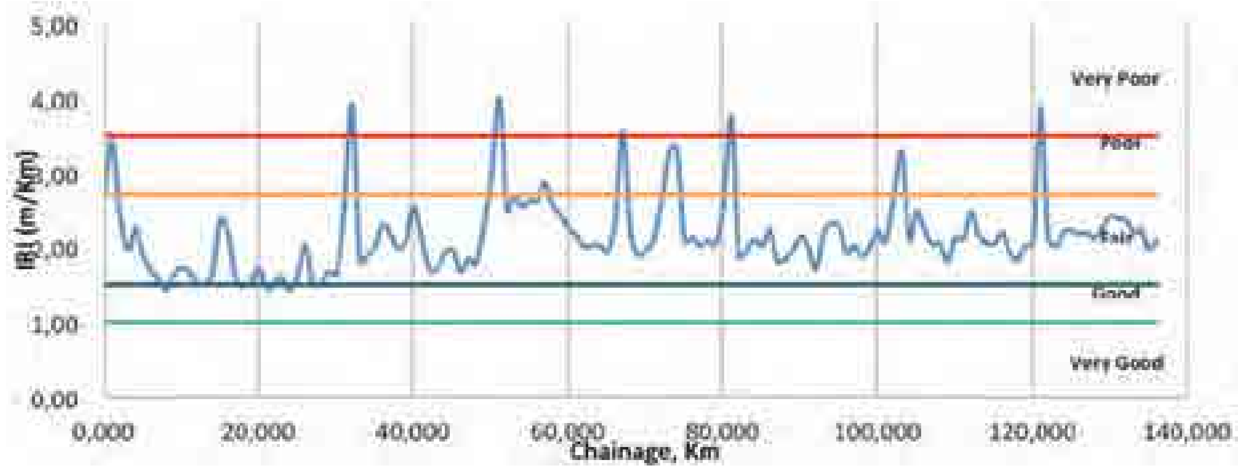


Figure A2.1.4-1: Roughness Levels along Athi River Namanga Road, Athi River - Namanga Direction

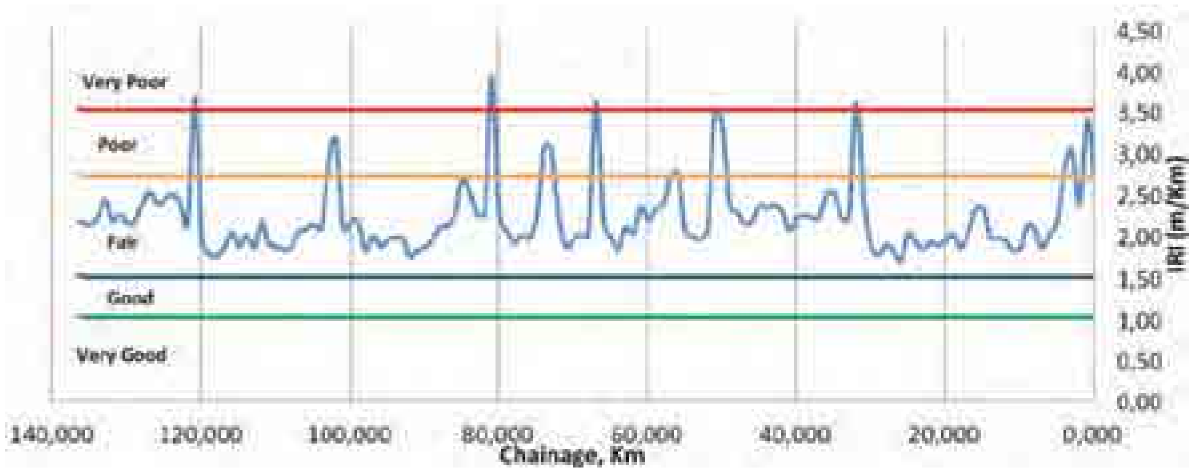


Figure A2.1.4-2: Roughness Levels along Athi River - Namanga Road, Namanga - Athi River Direction

C. Isiolo - Merille Road

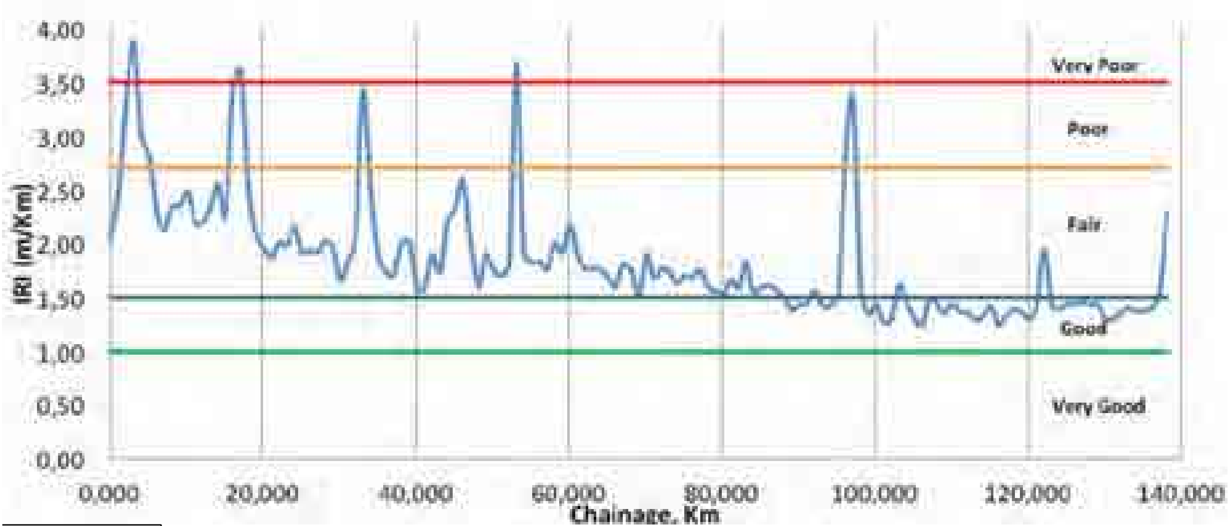


Figure A2.1.4-3: Roughness Levels along Isiolo - Merille Road, Isiolo - Merille Direction

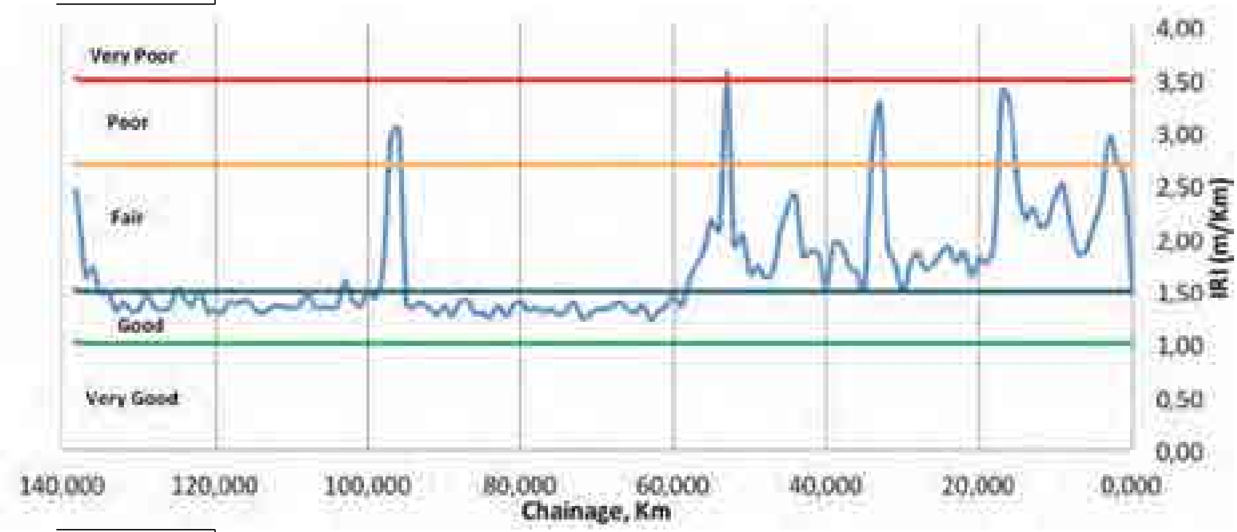


Figure A2.1.4-4: Roughness Levels along Isiolo - Merille Road, Merille - Isiolo Direction

D. Nairobi - Thika Road

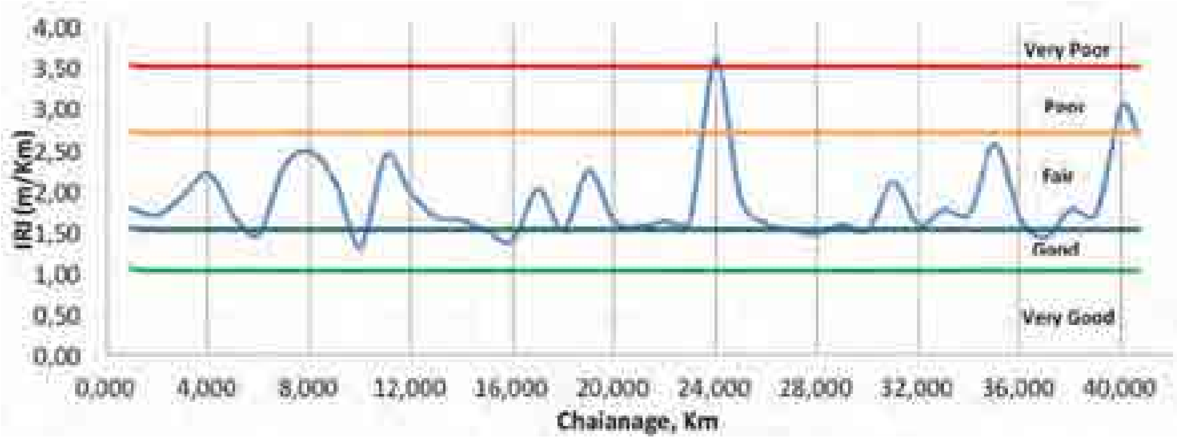


Figure A2.1.4-5: Roughness Levels along Nairobi - Thika Road, Nairobi - Thika Direction (Inner Lane)

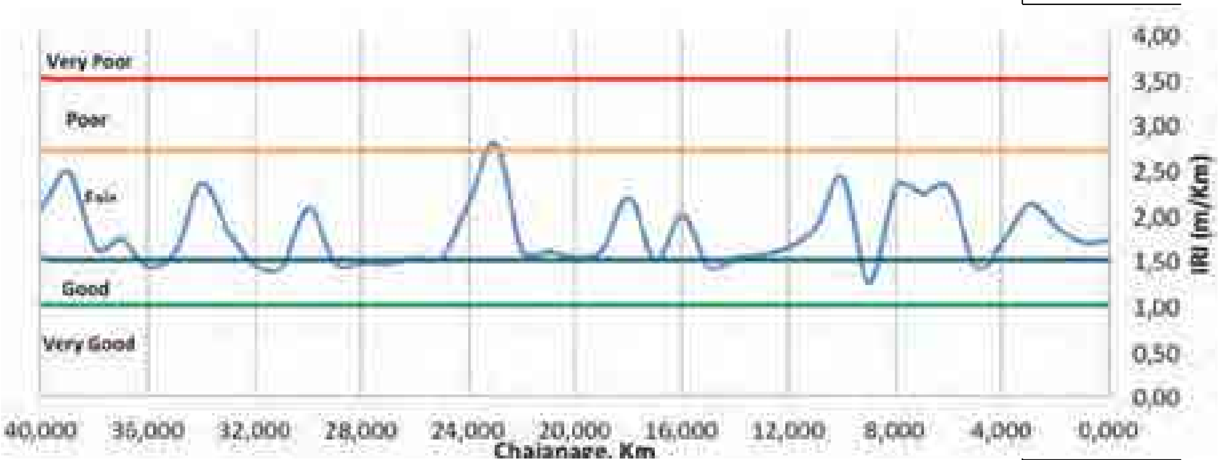


Figure A2.1.4-6: Roughness Levels along Nairobi - Thika Road, Thika - Nairobi Direction (Inner Lane)

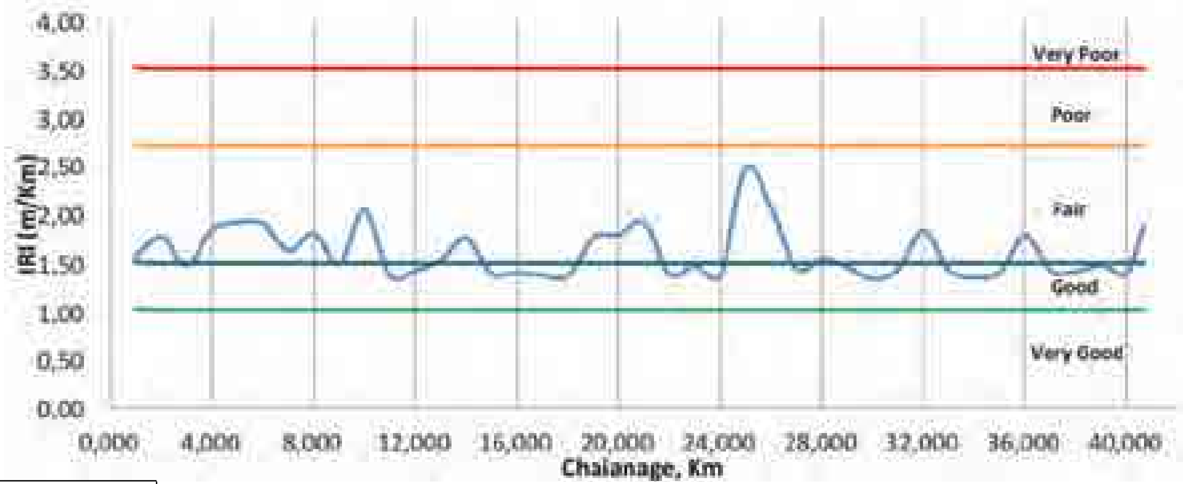


*Figure A2.1.4-7: Roughness Levels along
Nairobi - Thika Road, Nairobi - Thika Direction (Middle Lane)*

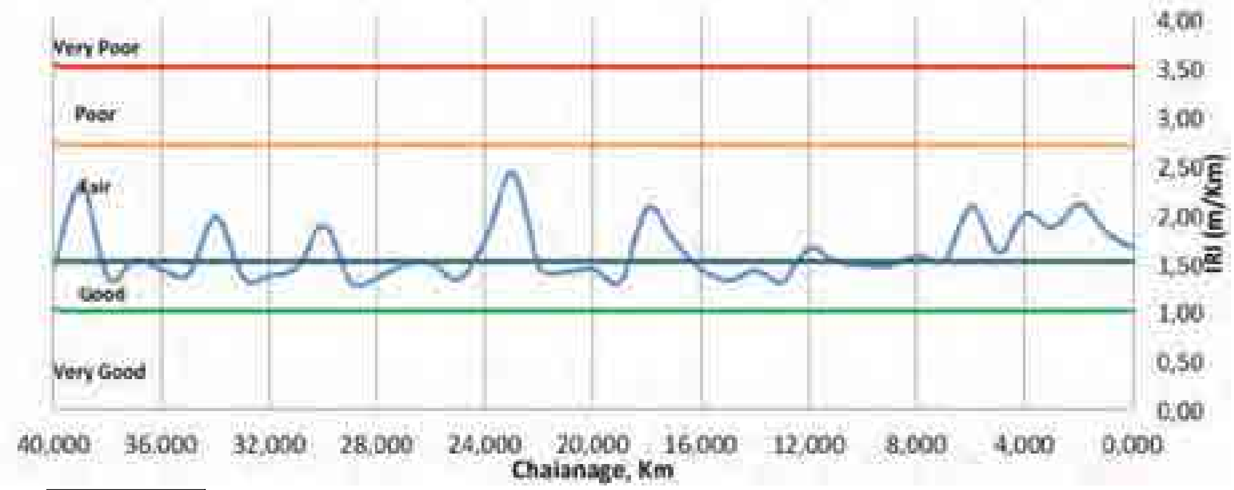


*Figure A2.1.4-8: Roughness Levels along
Nairobi - Thika Road, Thika - Nairobi Direction (Middle Lane)*

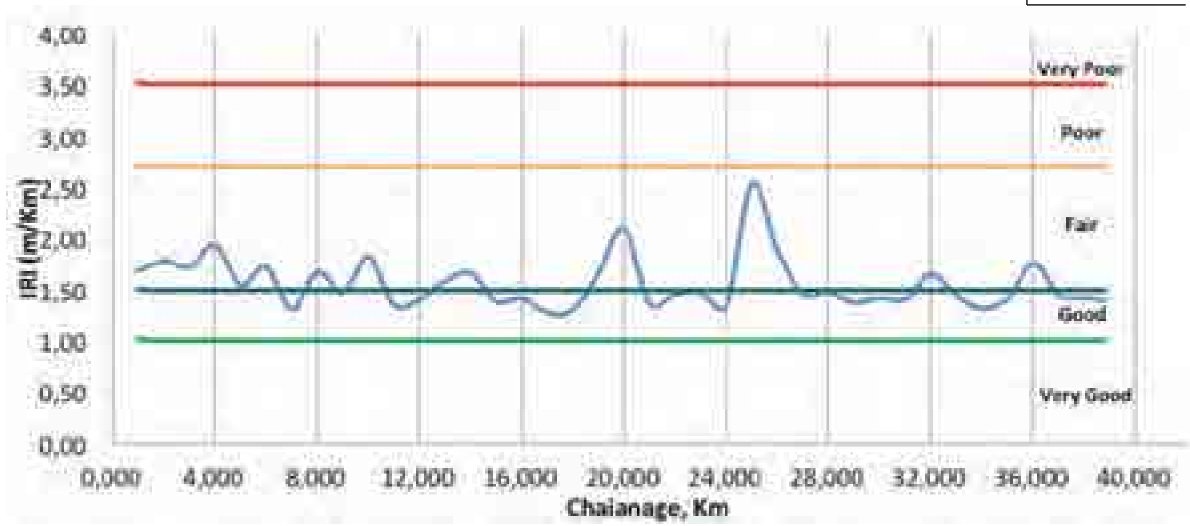


Figure A2.1.4-9: Roughness Levels along
Nairobi - Thika Road, Nairobi - Thika Direction (Outer Lane)

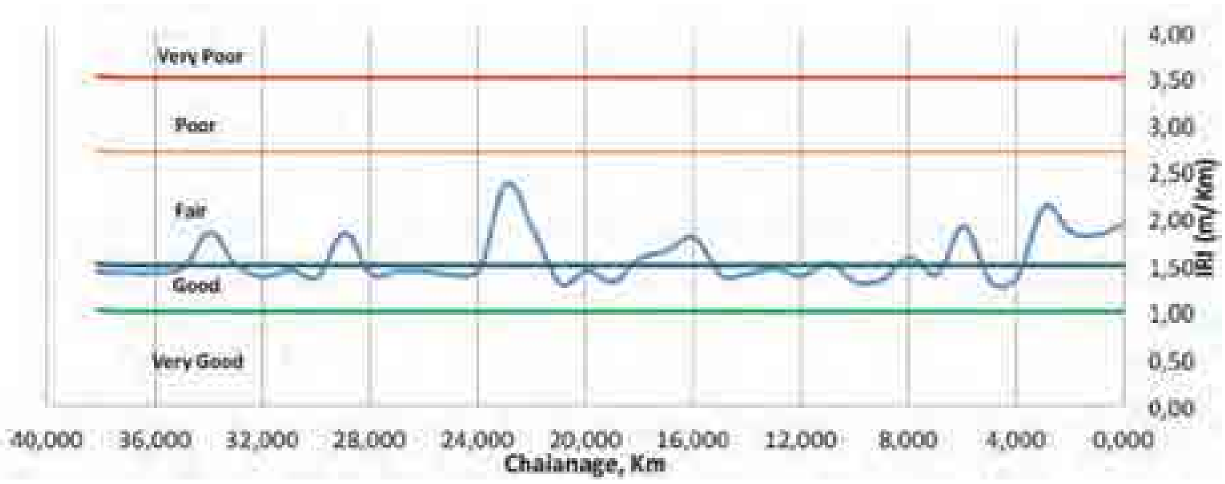


Figure A2.1.4-10: Roughness Levels along
Nairobi - Thika Road, Thika - Nairobi Direction (Outer Lane)

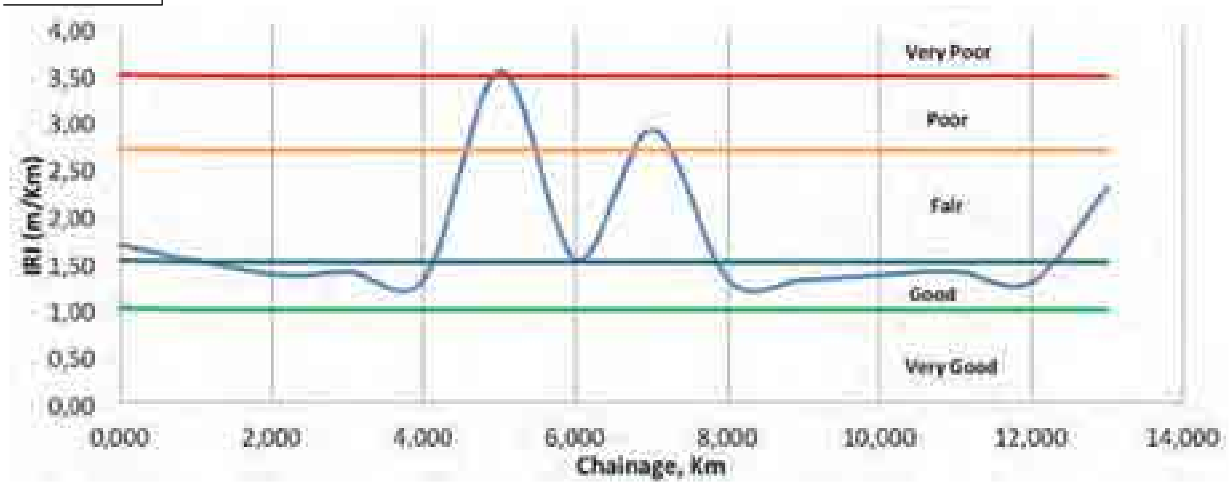


Figure A2.1.5a-1: Roughness Levels along Amani - Dunga Road, Amani - Dunga Direction

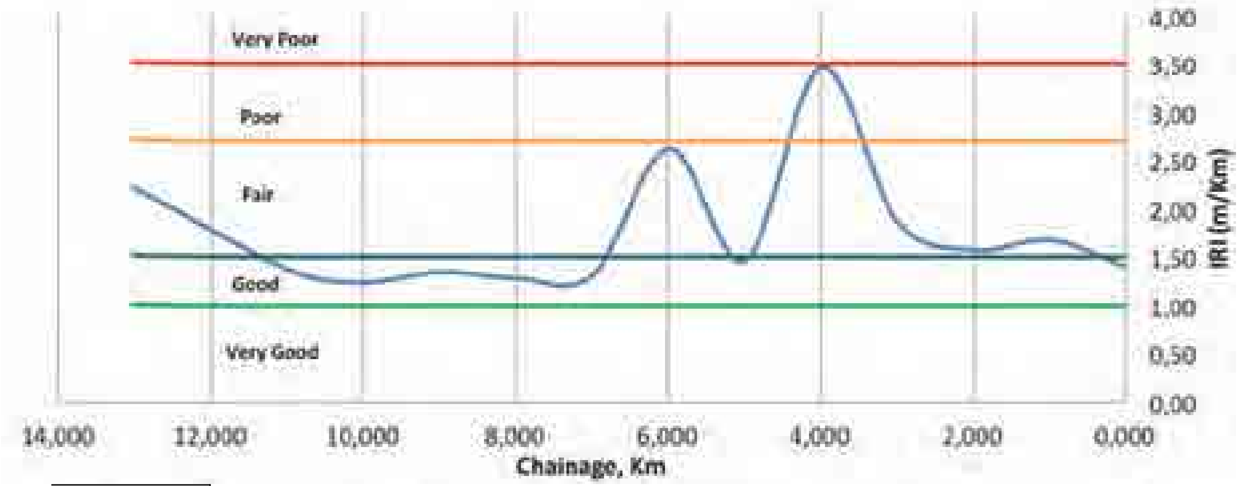


Figure A2.1.5a-2: Roughness Levels along Amani - Dunga Road, Dunga - Amani Direction

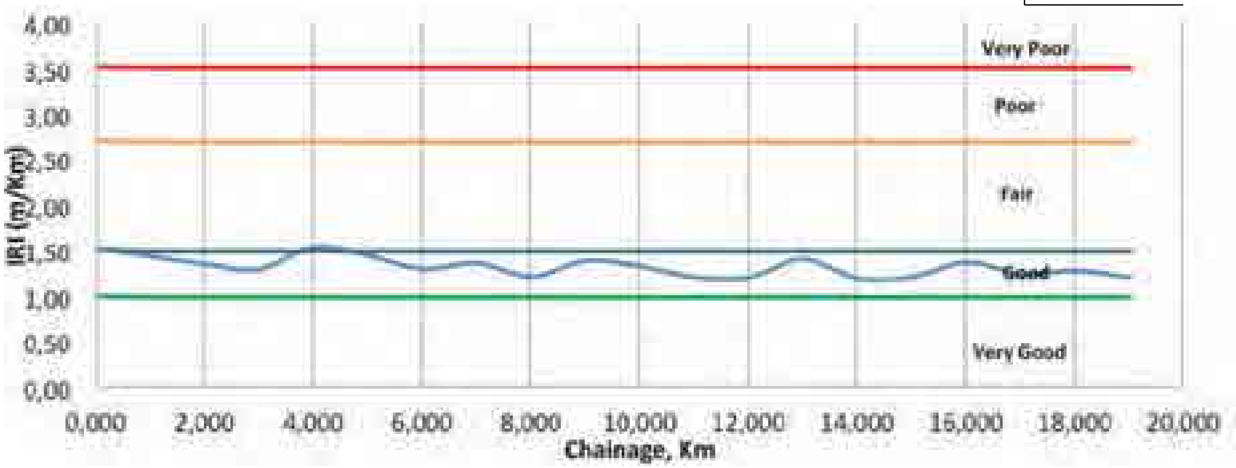


Figure A2.1.5a-3: Roughness Levels along Manzizinni - Fumba Road, Manzizinni - Fumba Direction

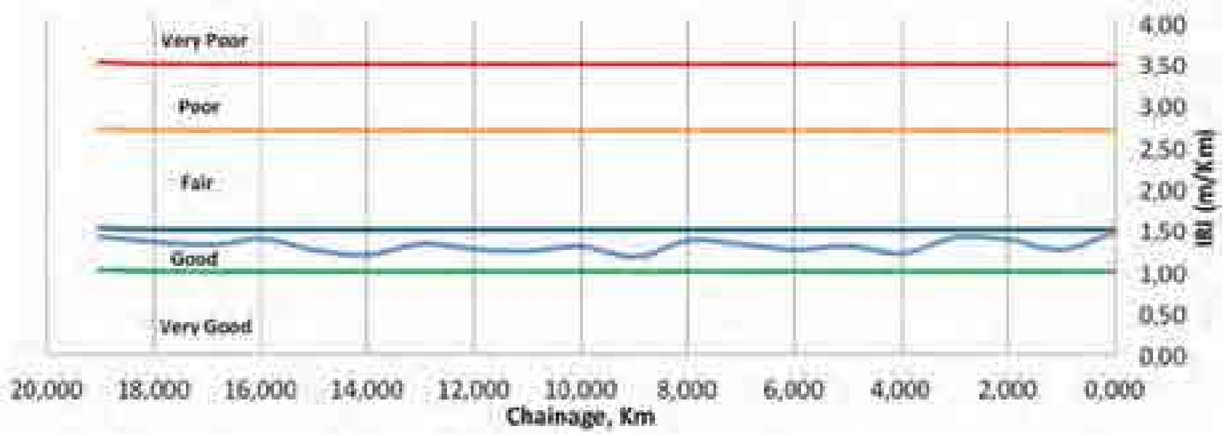


Figure A2.1.5a-4: Roughness Levels along Manzizinni Fumba Road, Fumba - Manzizinni Direction

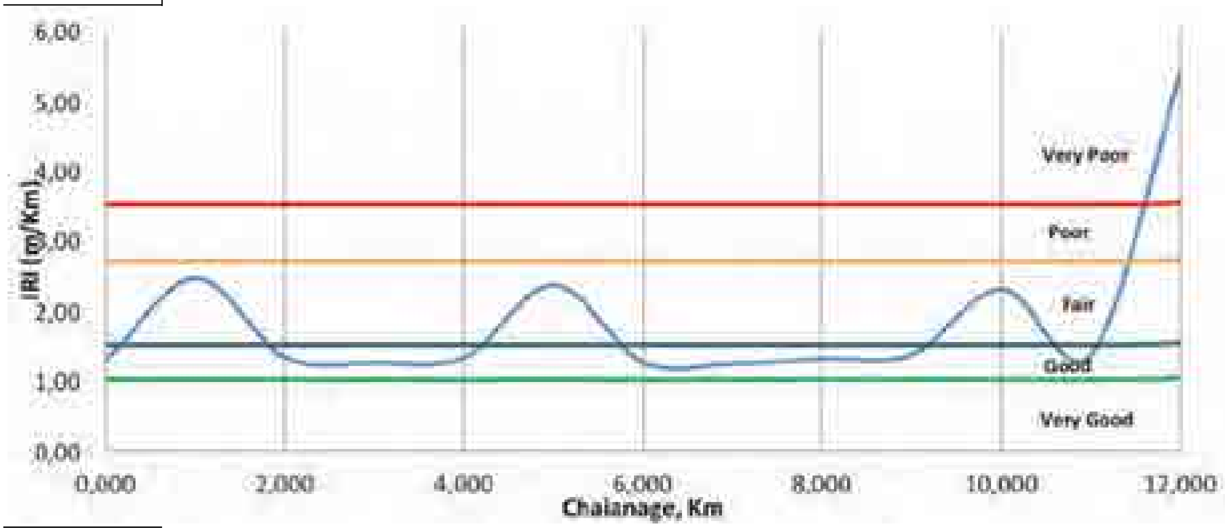


*Figure A2.1.5a-5: Roughness Levels along
Mfenisini - Bumbwinini Road, Mfenisini - Bumbwinini Direction*

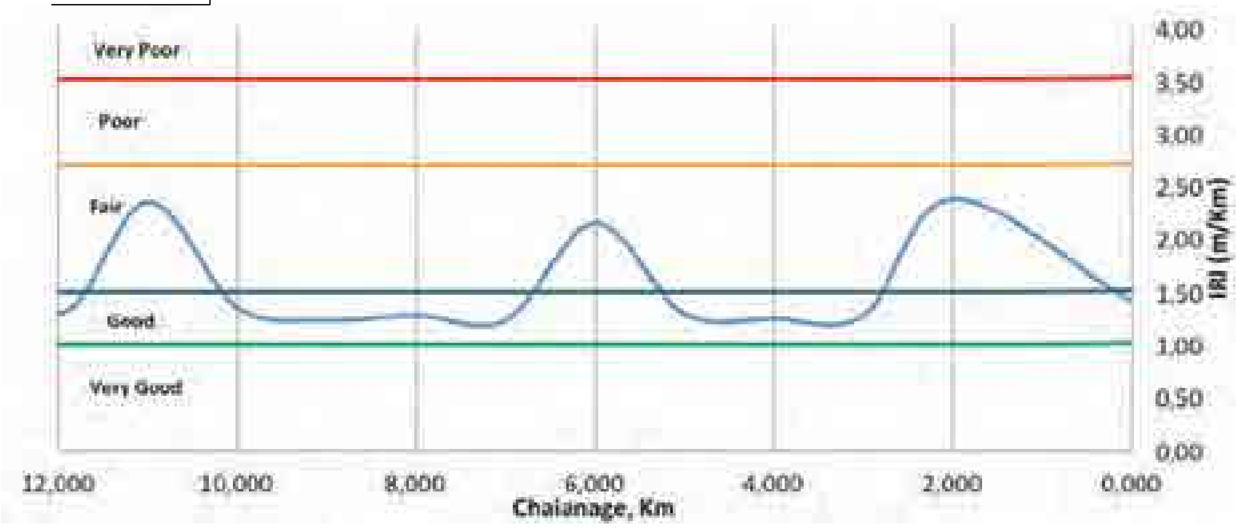


*Figure A2.1.5a-6: Roughness Levels along
Mfenisini - Bumbwinini Road, Bumbwinini - Mfenisini Direction*

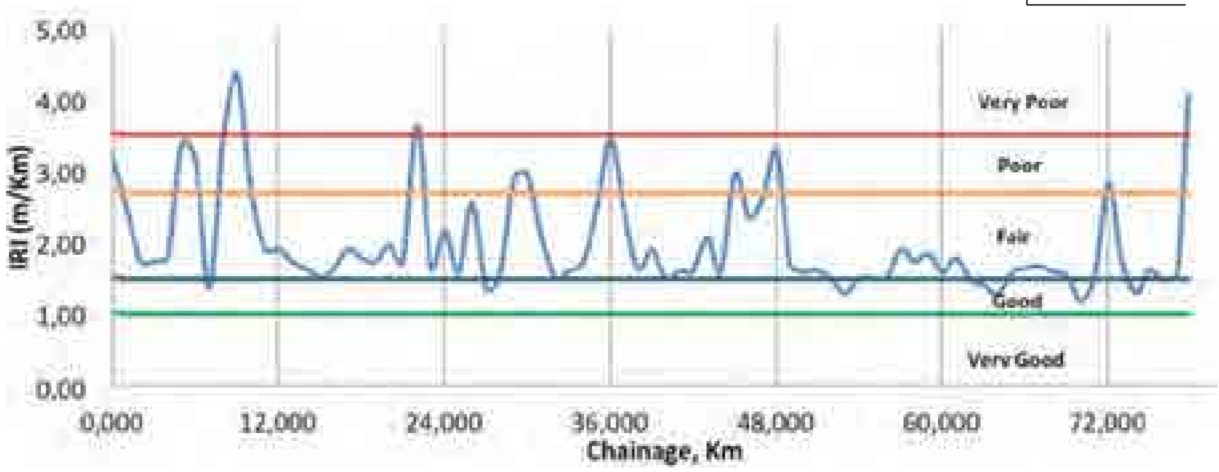


Figure A2.1.5b-1: Roughness Levels along Singida - Katesh Road, Singida - Katesh Direction

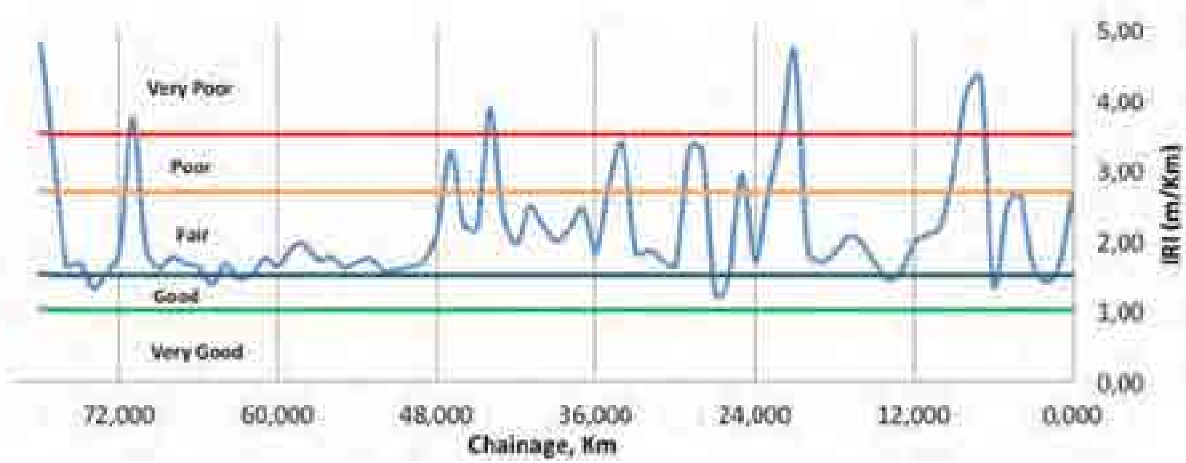


Figure A2.1.5b-2: Roughness Levels along Singida - Katesh Road, Katesh - Singida Direction

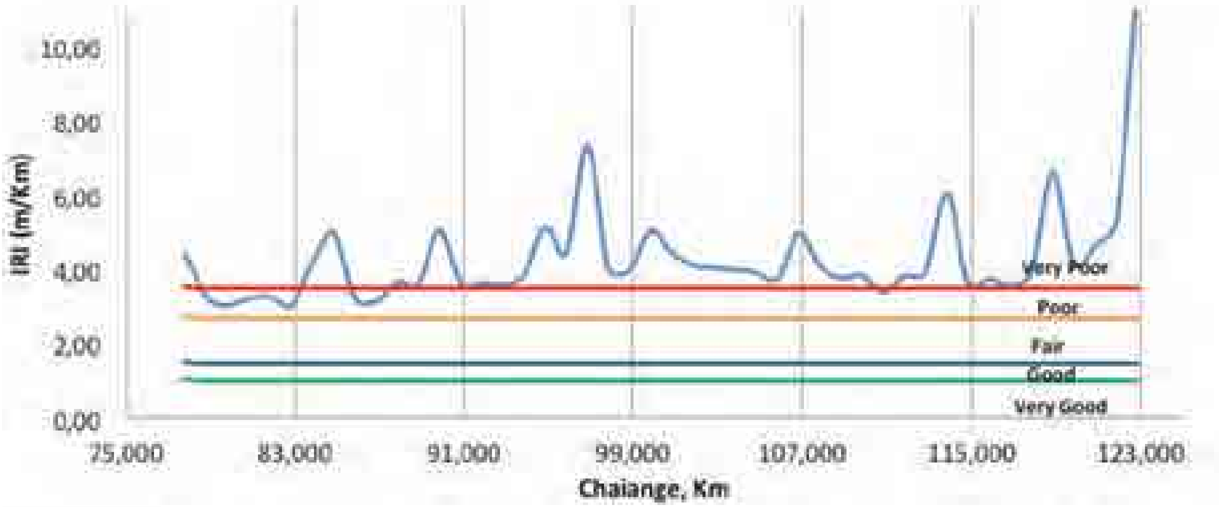


Figure A2.1.5b-3: Roughness Levels along Katesh - Dareda Road, Katesh - Dareda Direction

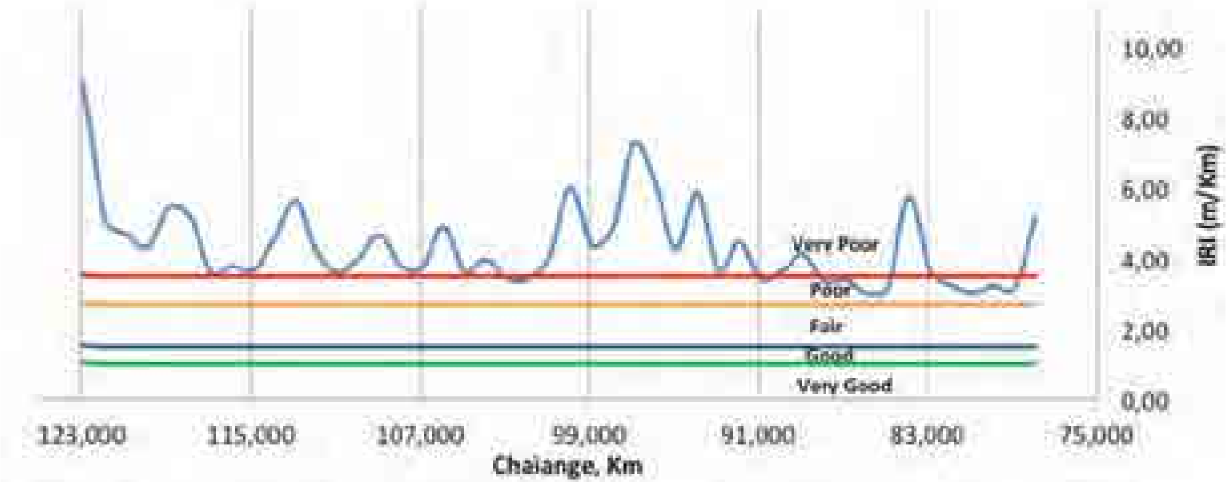


Figure A2.1.5b-4: Roughness Levels along Katesh - Dareda Road, Dareda - Katesh Direction

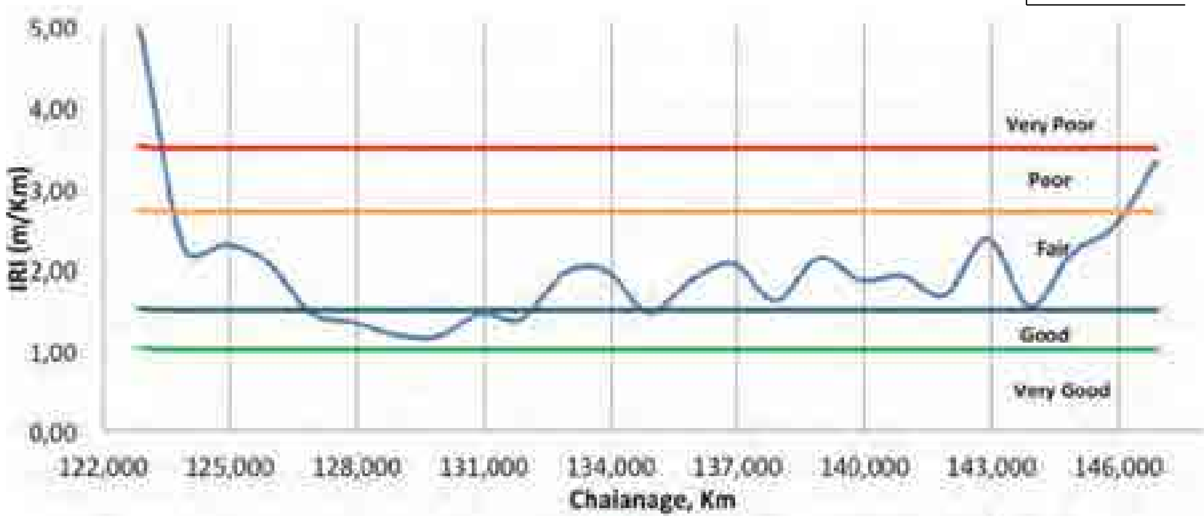


Figure A2.1.5b-5: *Roughness Levels along Dareda - Babati Road, Dareda - Babati Direction*

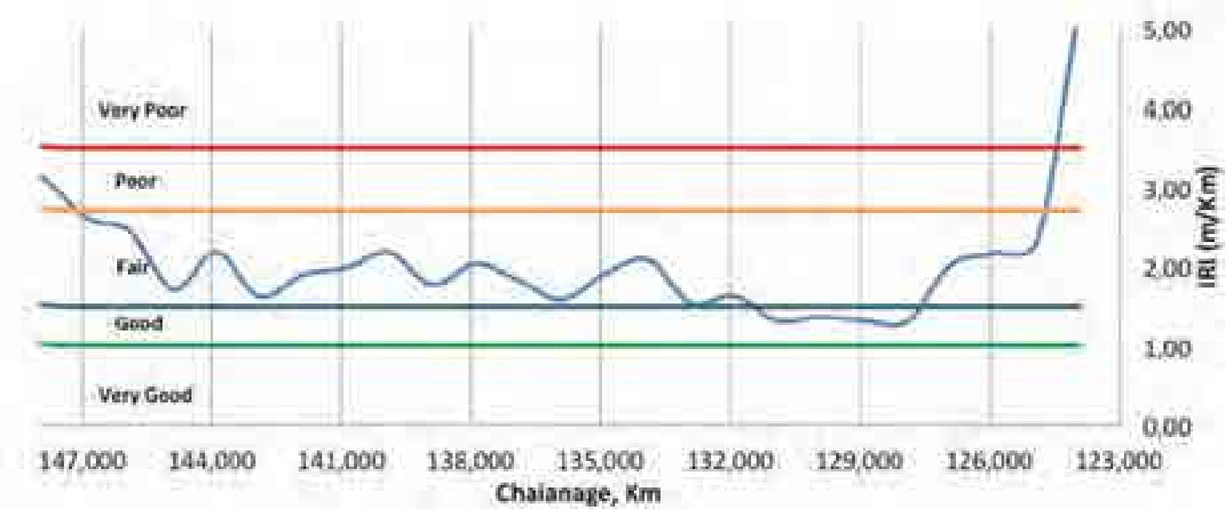


Figure A2.1.5b-6: *Roughness Levels along Dareda - Babati Road, Babati - Dareda Direction*

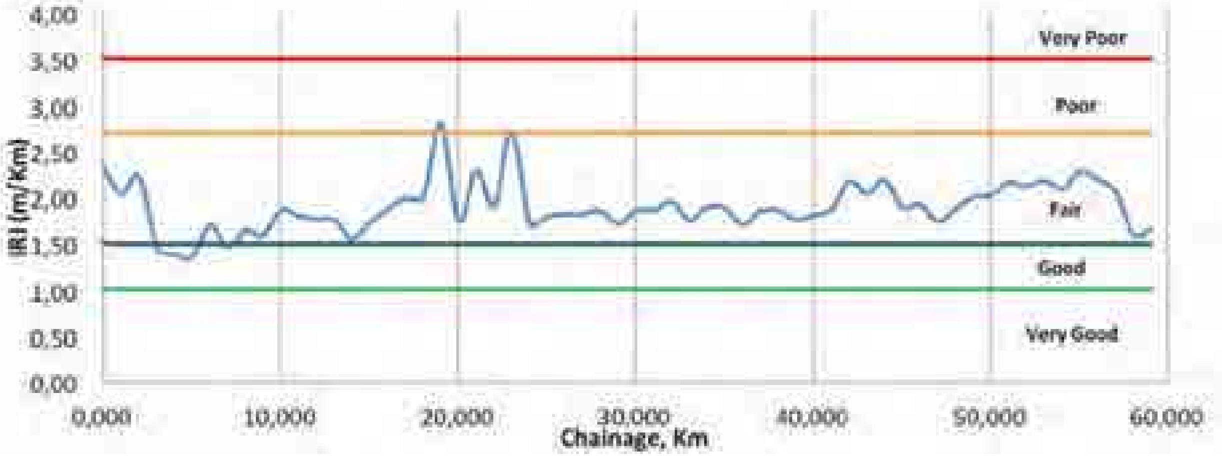


Figure A2.1.5b-7: Roughness Levels along Babati - Minjingu Road, Babati - Minjingu Direction

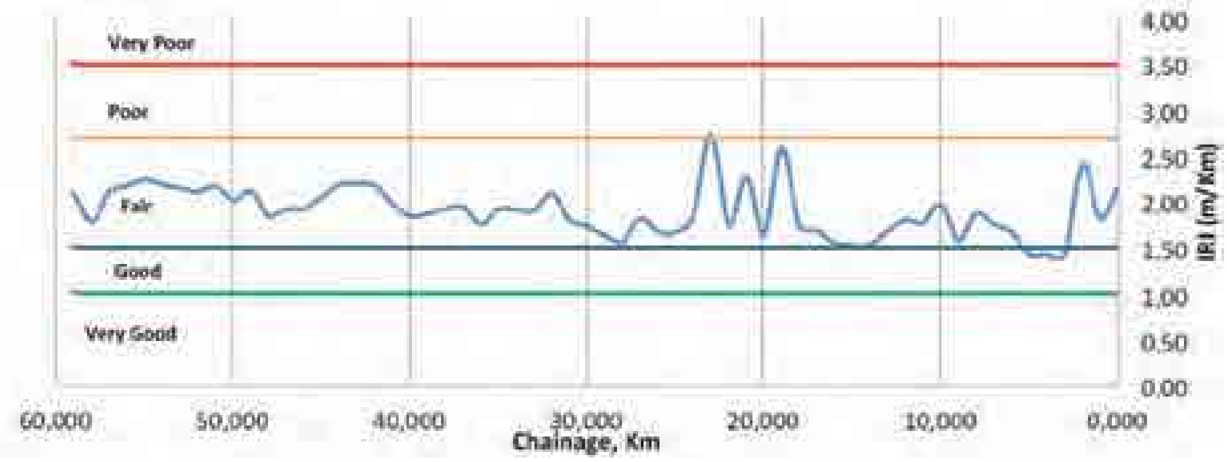


Figure A2.1.5b-8: Roughness Levels along Babati - Minjingu Road, Minjingu - Babati Direction

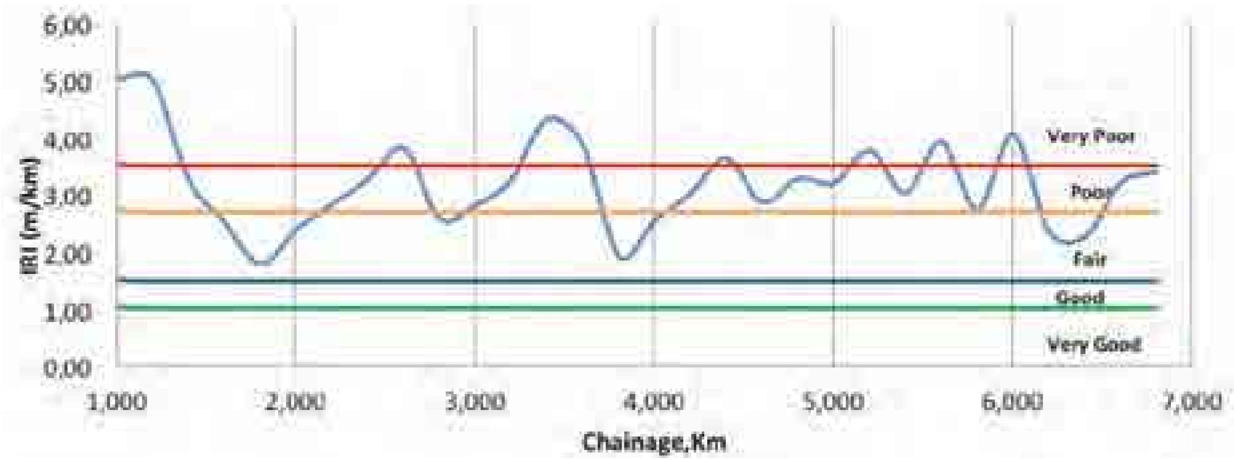


Figure A2.1.6-1: Roughness Levels along
Bab El Khadra - Station Metro Road, Bab El Khadra to Station Metro Directio

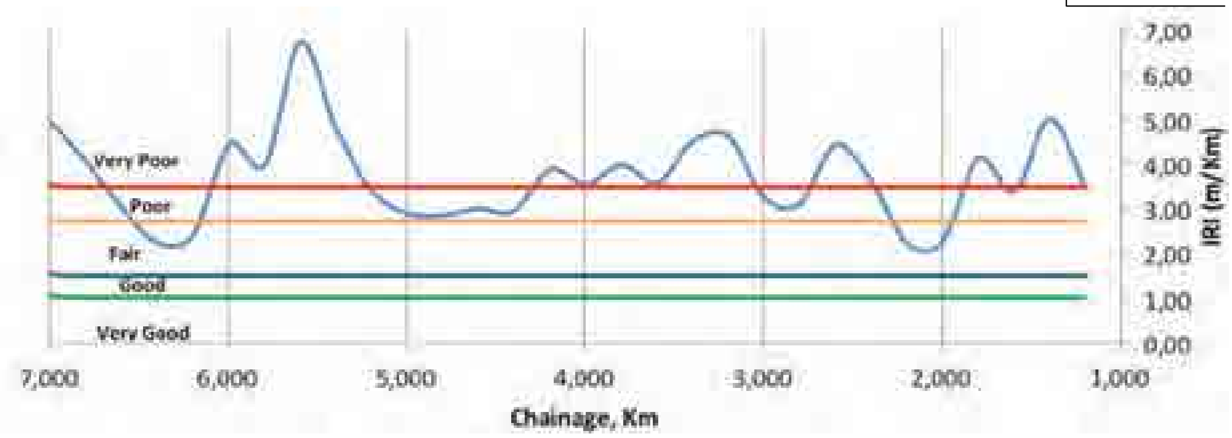


Figure A2.1.6-2: Roughness Levels along
Bab El Khadra - Station Metro Road, Station Metro Road to Bab El Khadra Direction

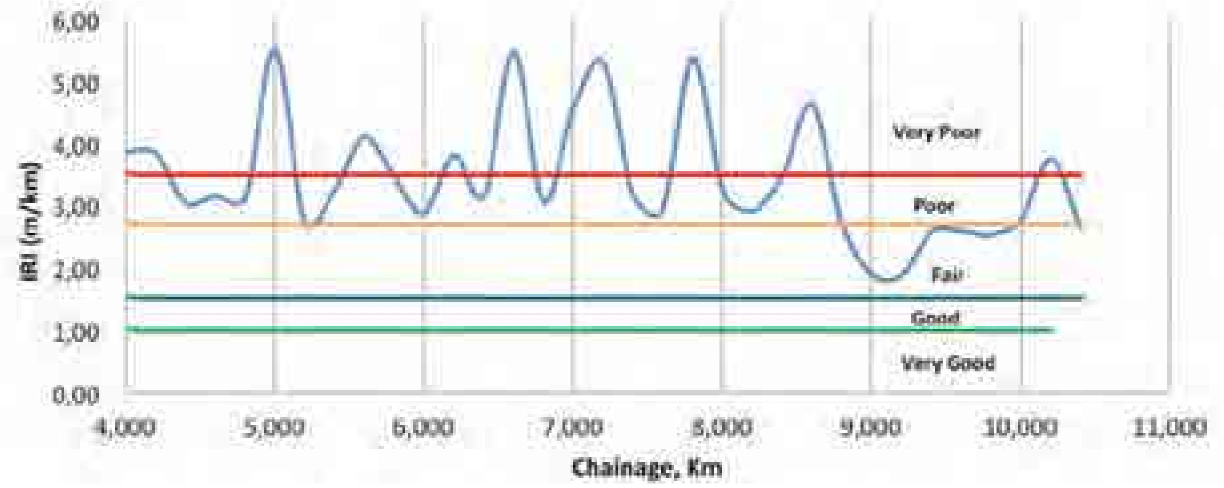


*Figure A2.1.6-3: Roughness Levels along
Ben Arous - Stade Rades Road, Ben Arous to Stade Rades Direction*

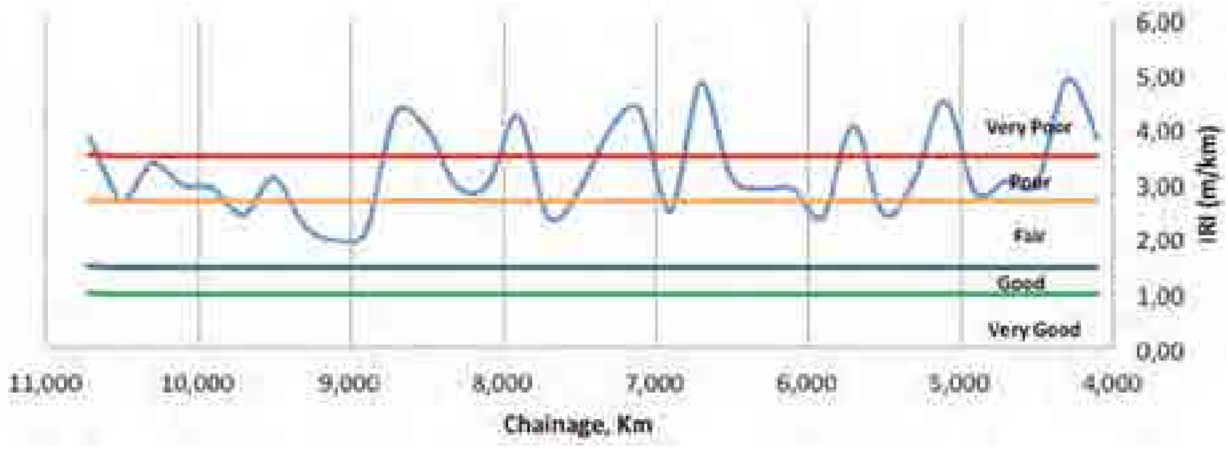


*Figure A2.1.6-4: Roughness Levels along
Ben Arous - Stade Rades Road, Stade Rades to Ben Arous Direction*

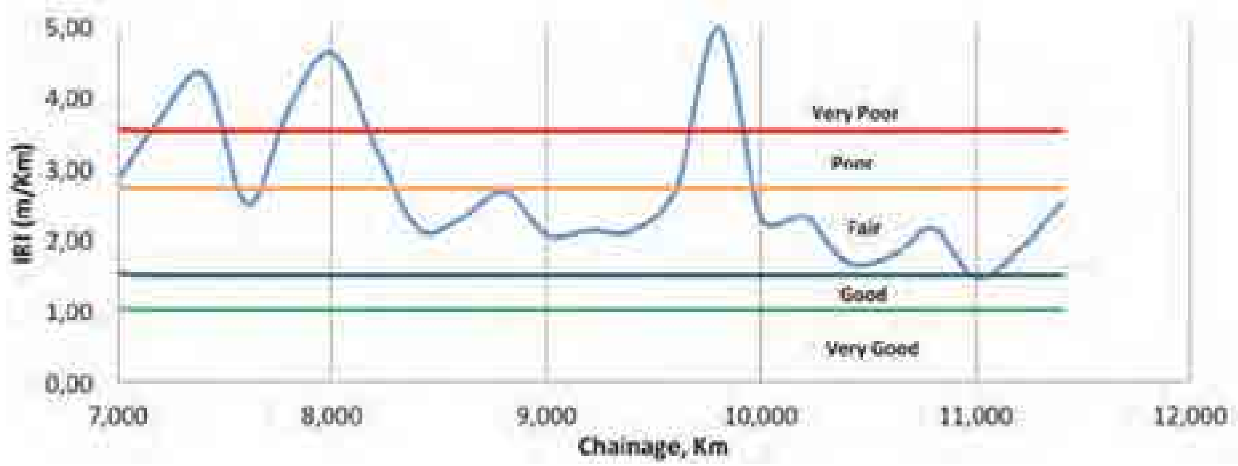


Figure A2.1.6-5: Roughness Levels along
Ben Arous - Mornag Road, Ben Arous to Mornag Direction

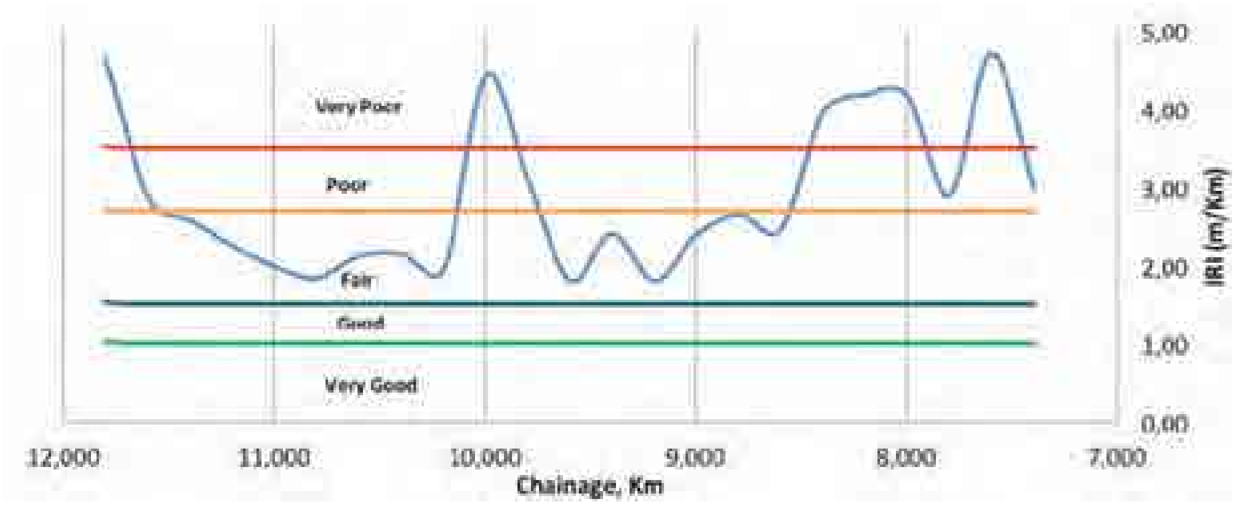


Figure A2.1.6-6: Roughness Levels along
Ben Arous - Mornag Road, Mornag to Ben Arous Direction

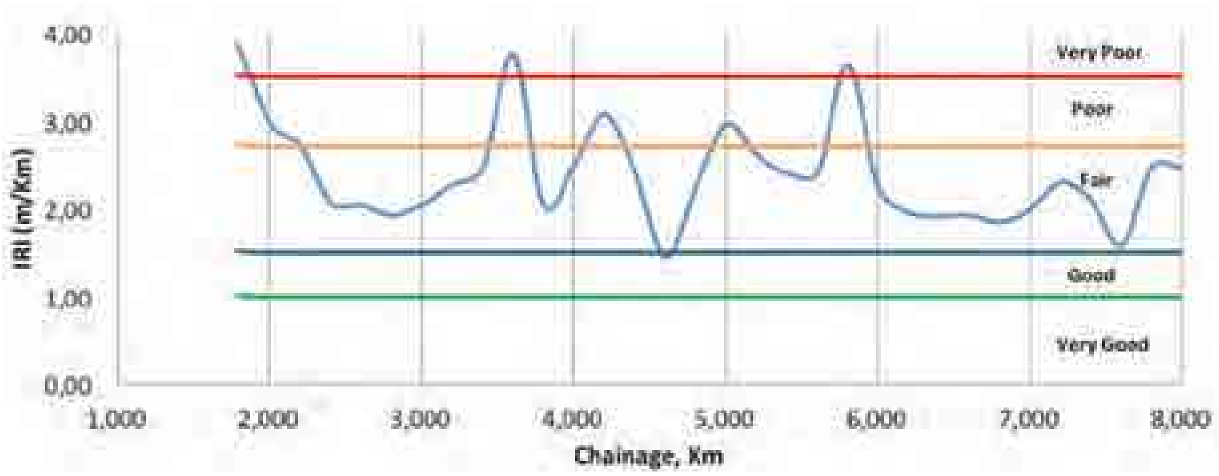


*Figure A2.1.6-7: Roughness Levels along
Carrefour Hopital Ariana - RR 31 Road, Carrefour Hopital Ariana to RR 31 Direction*

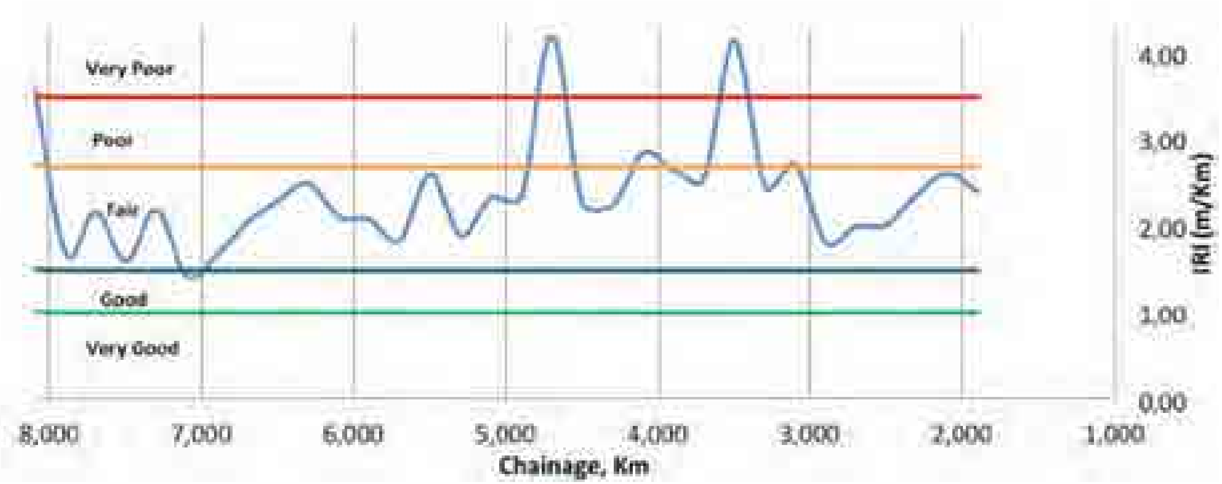


*Figure A2.1.6-8: Roughness Levels along
Carrefour Hopital Ariana - RR 31 Road, RR 31 to Carrefour Hopital Ariana Direction*

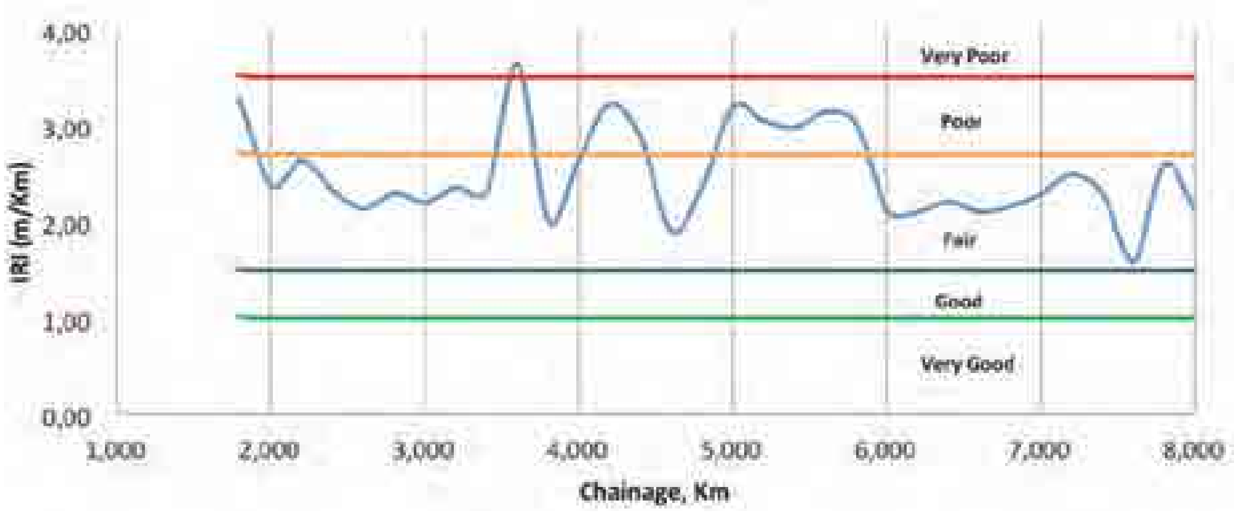


Figure A2.1.6-9: Roughness Levels along
Carrefour Hopital Ariana - RR 31 Road, Carrefour Hopital Ariana - ImRR 31 to Direction

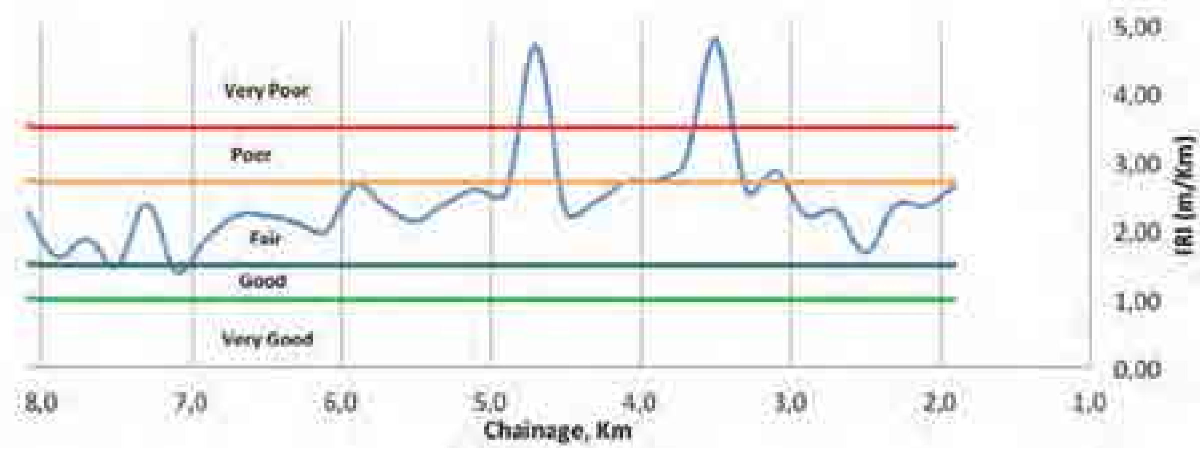


Figure A2.1.6-10: Roughness Levels along
Carrefour Hopital Ariana - RR 31 Road, RR 31 - Carrefour Hopital Ariana Direction

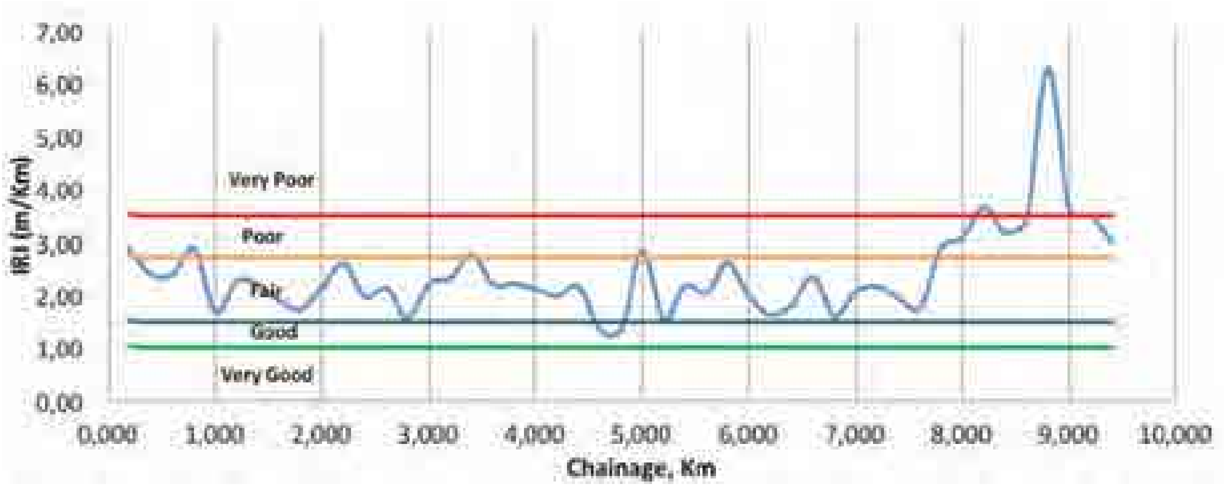


Figure A2.1.6-11: Roughness Levels along Jdaida - Tebourba Road, Jdaida - Tebourba Direction

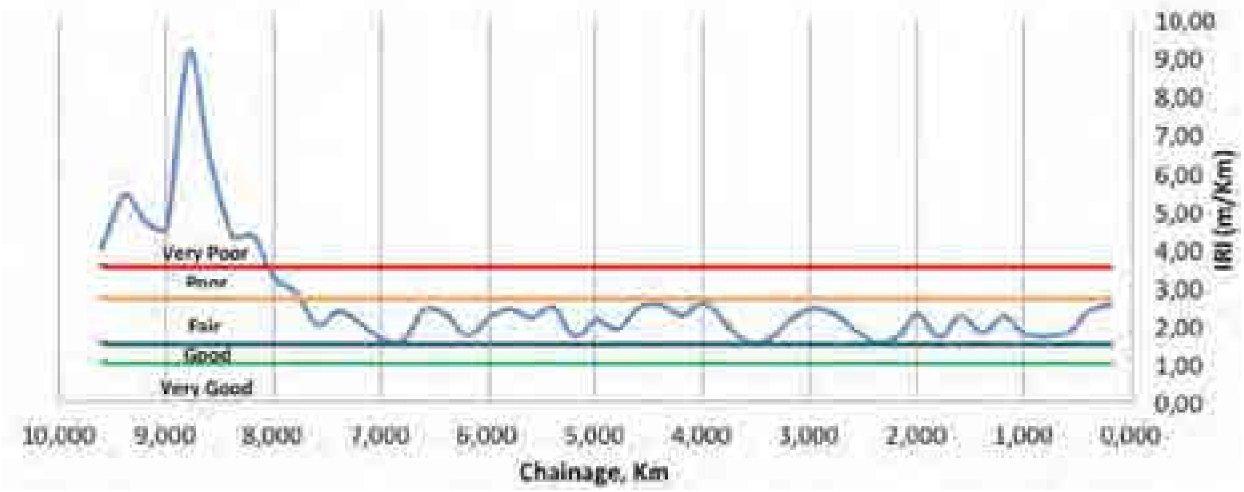


Figure A2.1.6-12: Roughness Levels along Jdaida - Tebourba Road, Tebourba - Jdaida Direction

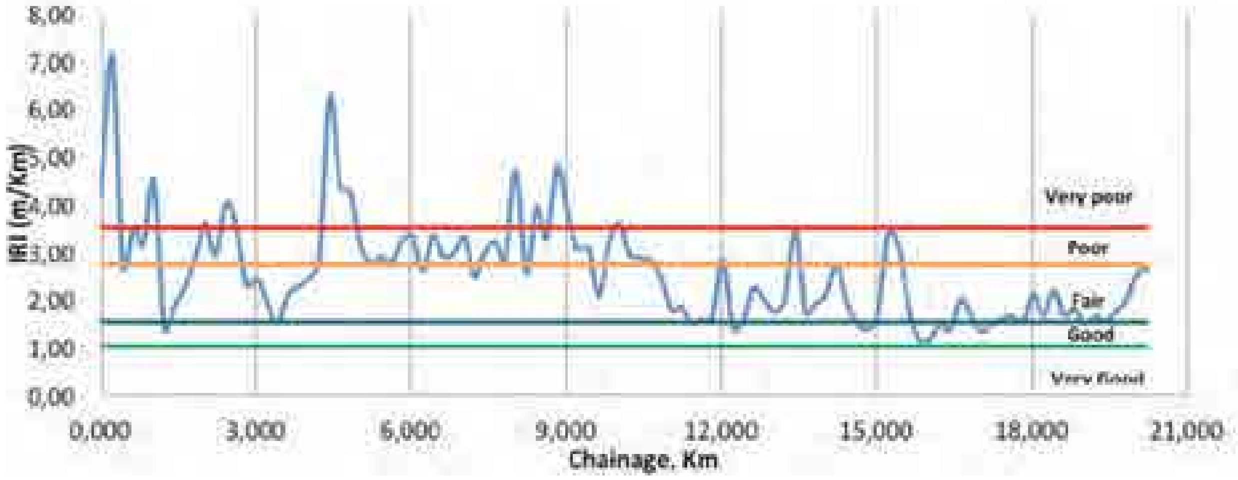


Figure A2.1.6-13: Roughness Levels along Grombalia - Limite Gouvernorat de Ben Arous Road, Grombalia - Limite Gouvernorat de Ben Arous Direction

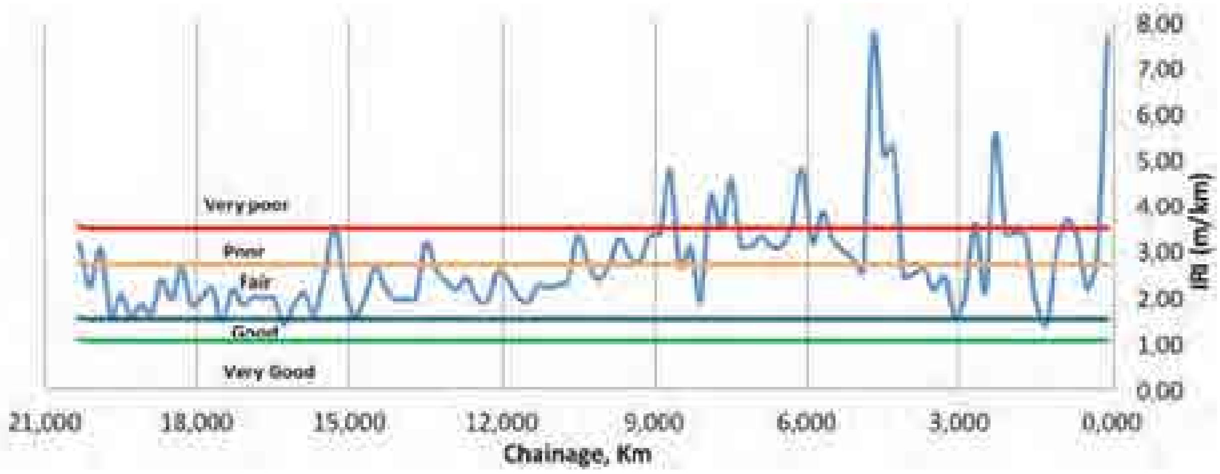


Figure A2.1.6-14: Roughness Levels along Grombalia - Limite Gouvernorat de Ben Arous Road, Limite Gouvernorat de Ben Arous - Grombalia Direction

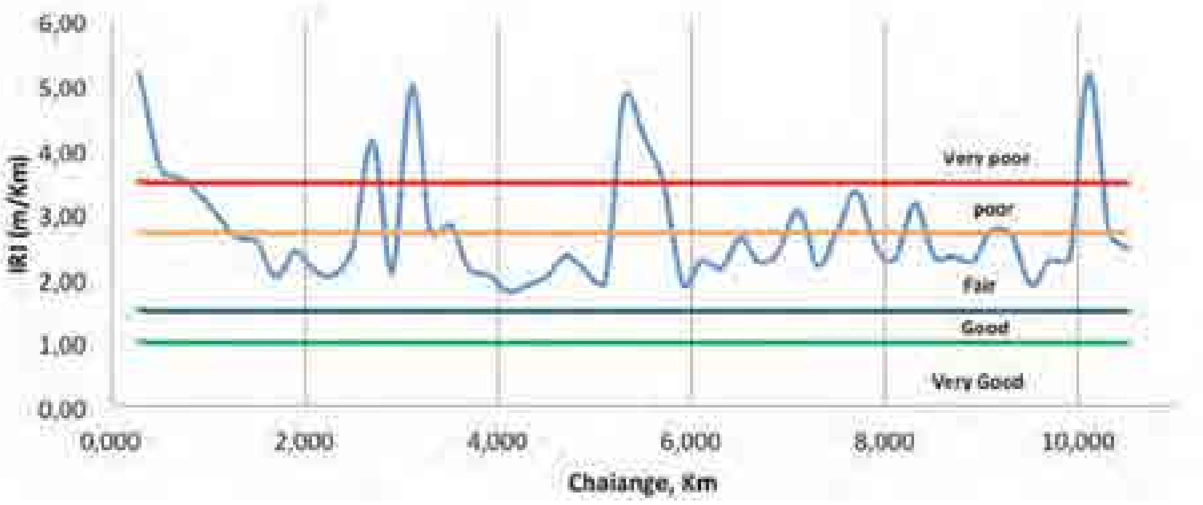


Figure A2.1.6-15: Roughness Levels along Mornag - Jbel Rsas Road, Mornag - Jbel Rsas Direction

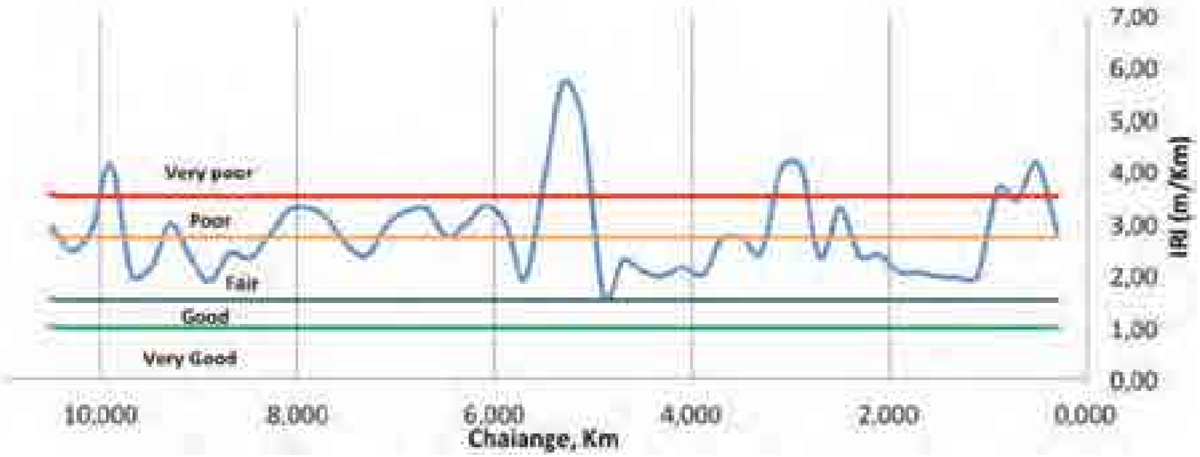


Figure A2.1.6-16: Roughness Levels along Mornag - Jbel Rsas Road, Jbel Rsas - Mornag - Direction

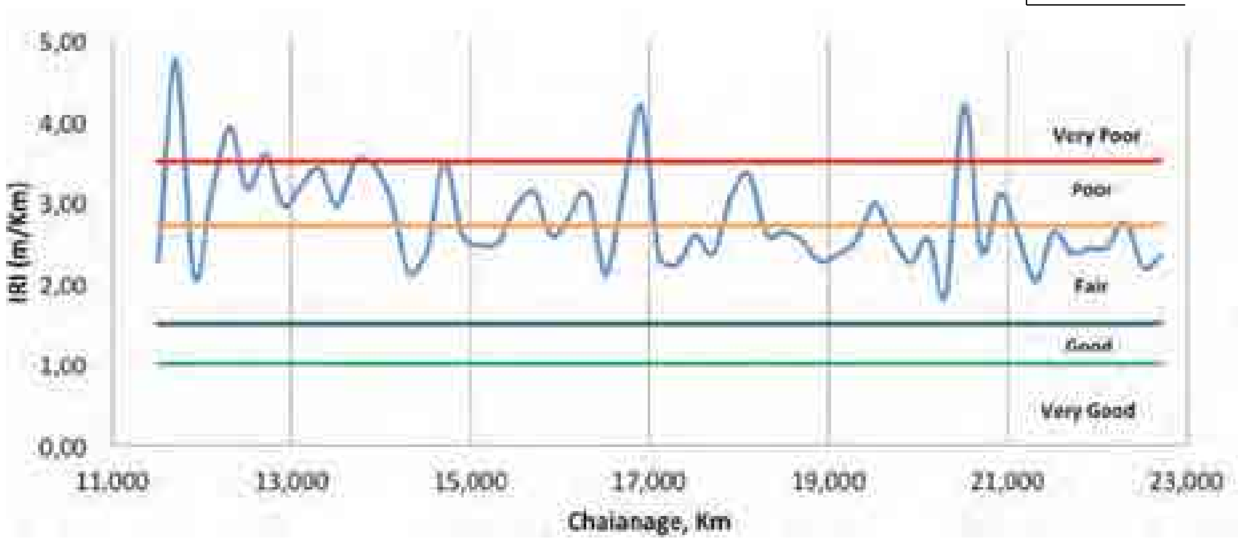


Figure A2.1.6-17: Roughness Levels along Khlida - Jbel Rsas Road, Khlida - Jbel Rsas Direction

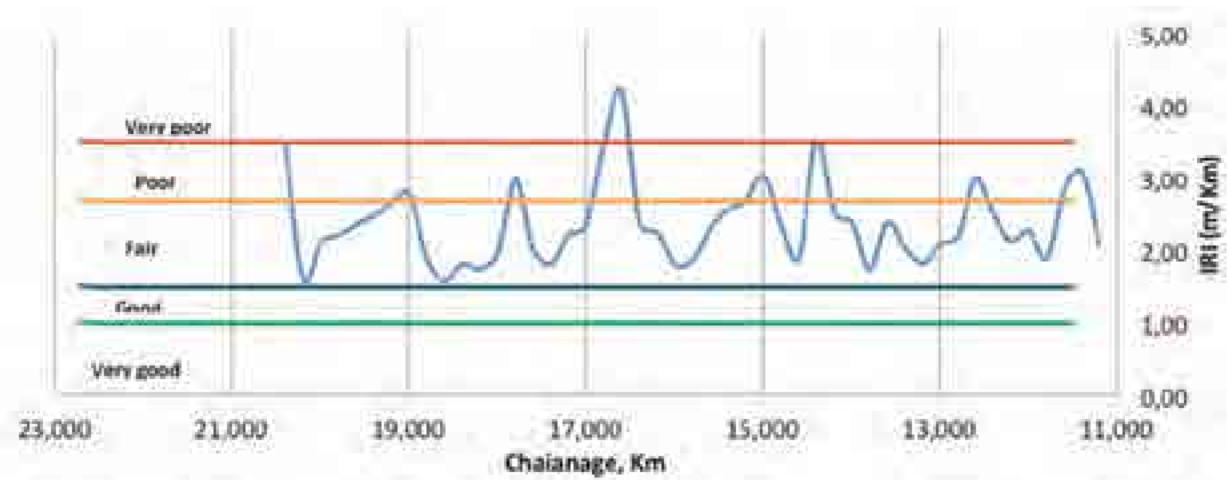


Figure A2.1.6-18: Roughness Levels along Khlida - Jbel Rsas Road, Jbel Rsas - Khlida - Direction

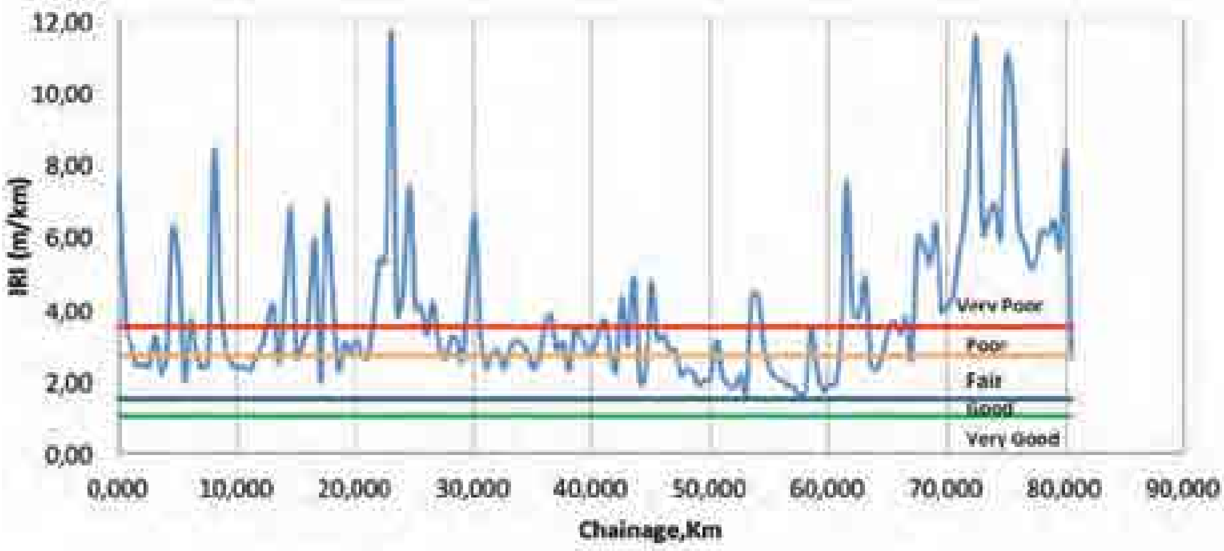


Figure A2.1.7-1: *Roughness Levels along Kabale - Bunagana Road, Kabale - Bunagana Direction*

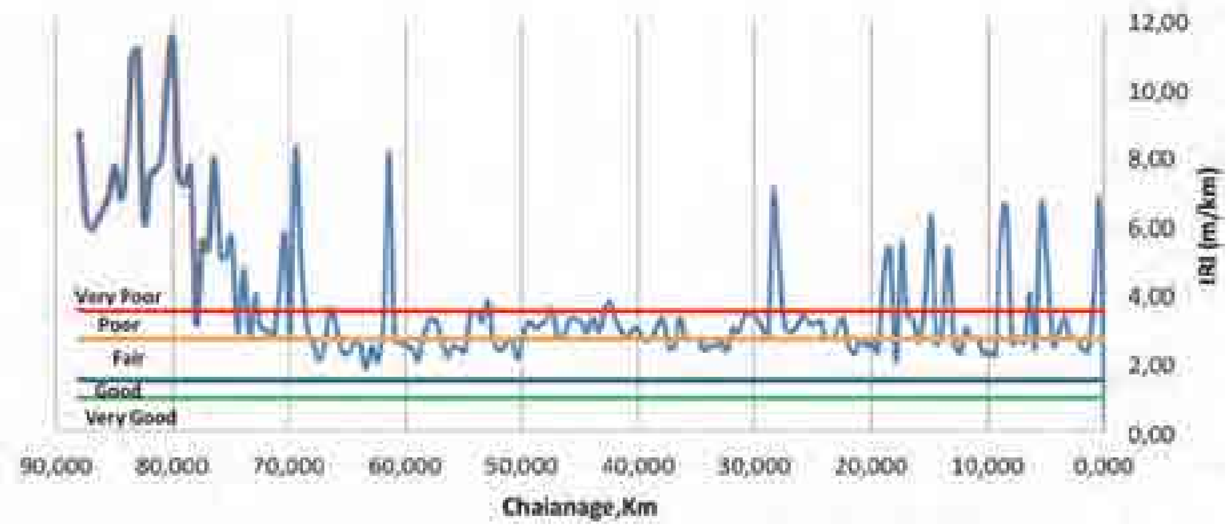


Figure A2.1.7-2: *Roughness Levels along Kabale - Bunagana Road, Bunagana - Direction*

Appendix 2.2: Deflection test results

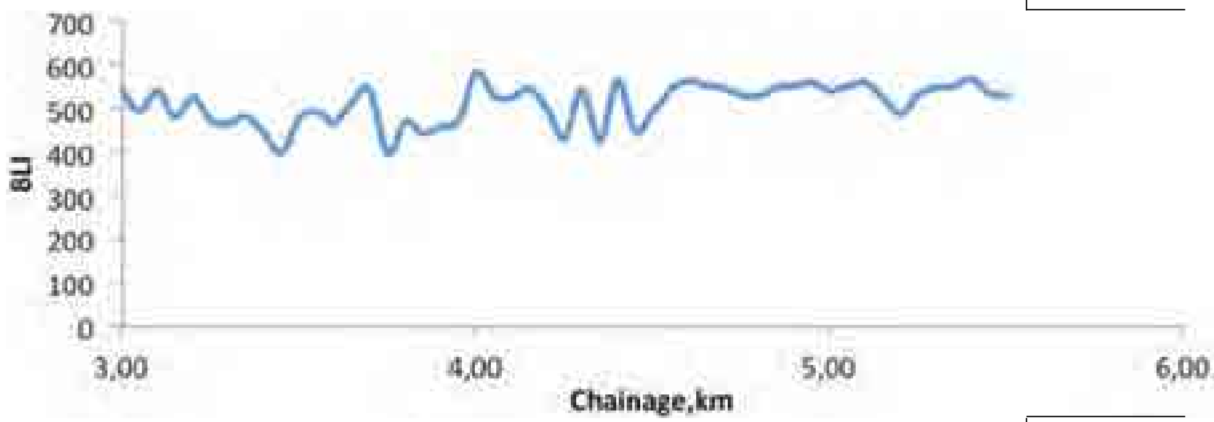


Figure A2.2.1-1: Base Layer Index (BLI) Values for Illara -Pobe Lane, km 3.000 to 5.500

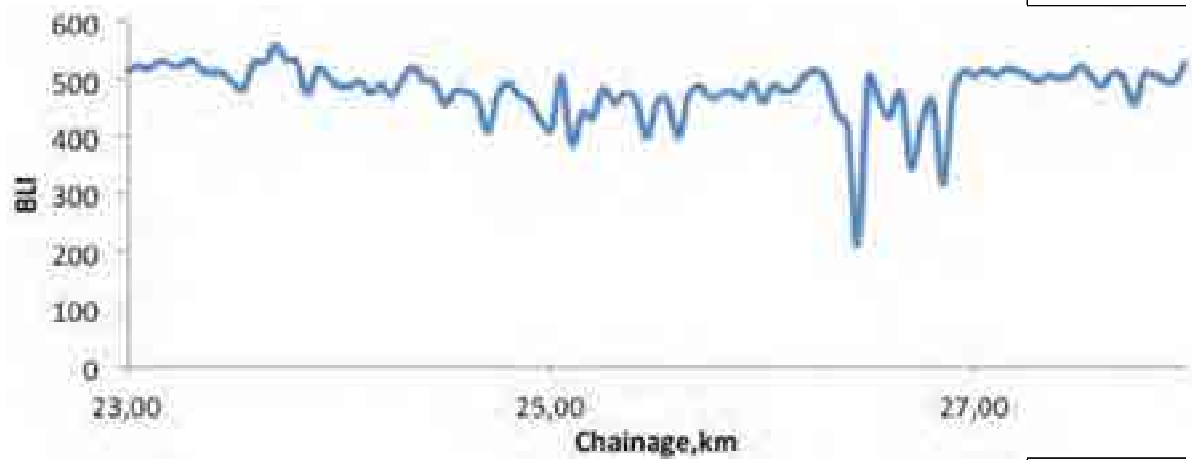


Figure A2.2.1-2: Base Layer Index (BLI) Values for Illara -Pobe Lane, km 23.000 to 28.000

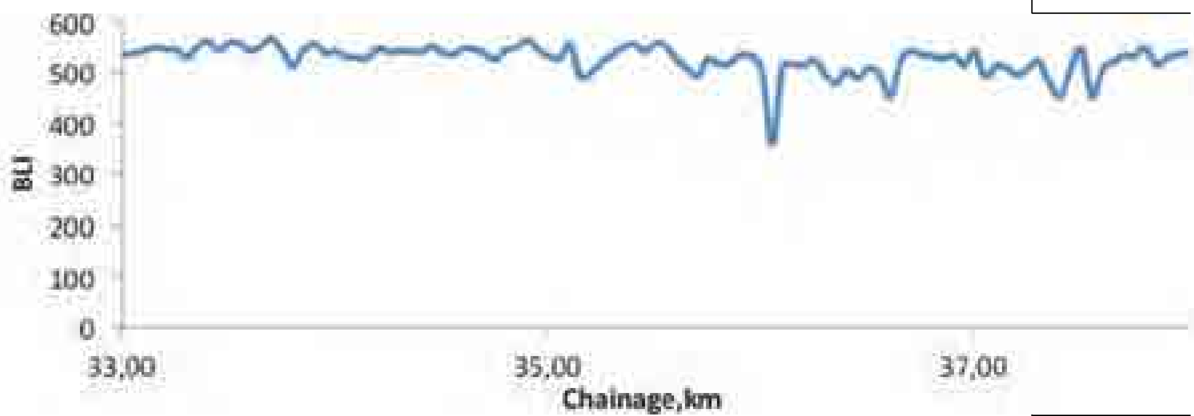


Figure A2.2.1-3: Base Layer Index (BLI) Values for Illara -Pobe Lane, km 33.000 to 38.000

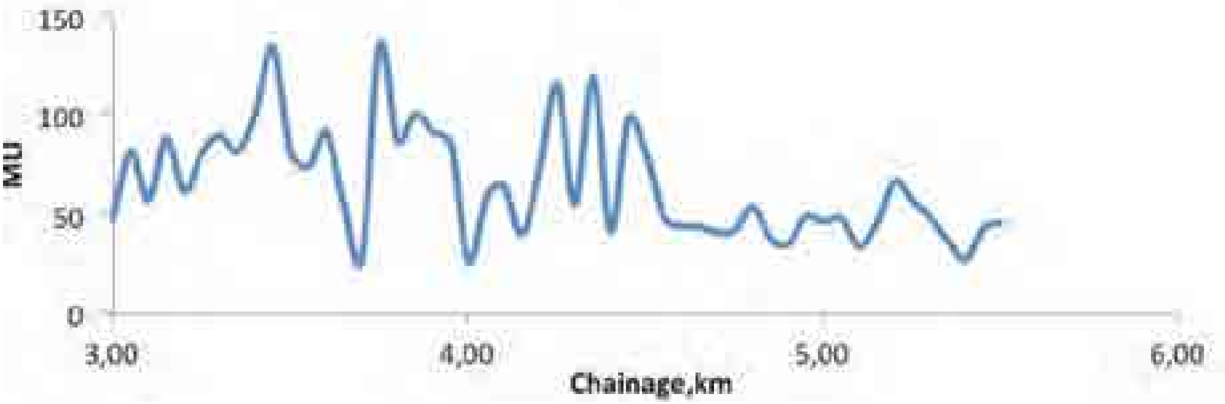


Figure A2.2.1-4: Middle Layer Index (MLI) Values for Illara – Pobe Lane, km 3.000 to 5.500

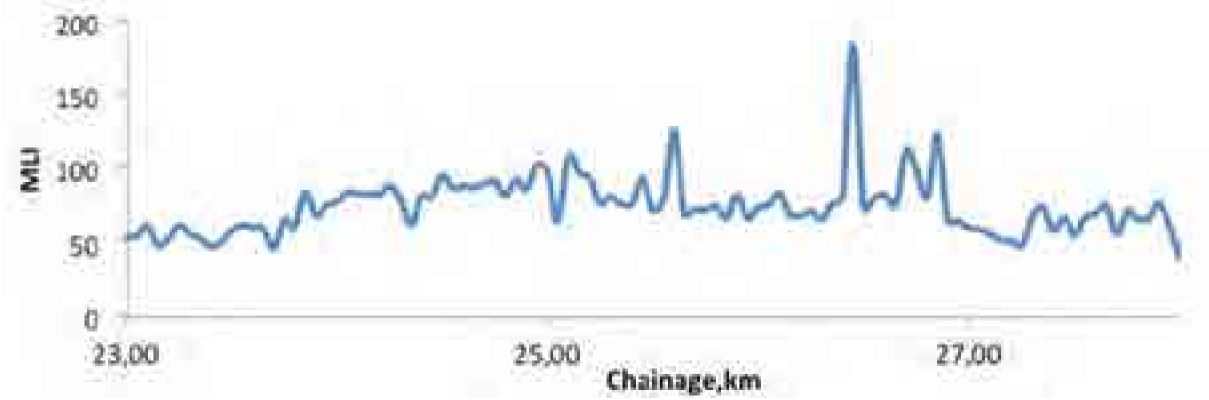


Figure A2.2.1-5: Middle Layer Index (MLI) Values for Illara – Pobe Lane, km 23.000 to 28.000

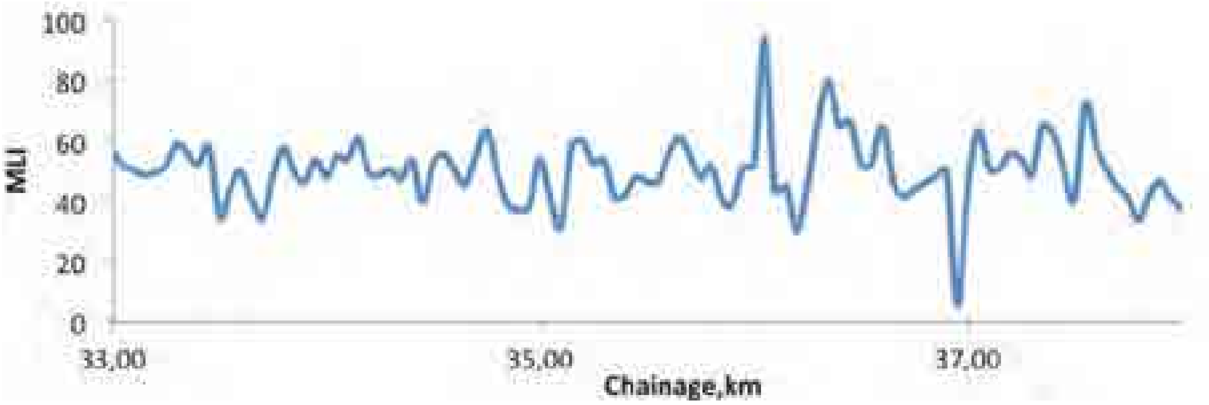


Figure A2.2.1-6: Middle Layer Index (MLI) Values for Illara-Pobe Lane, km 33.000 to 38.000

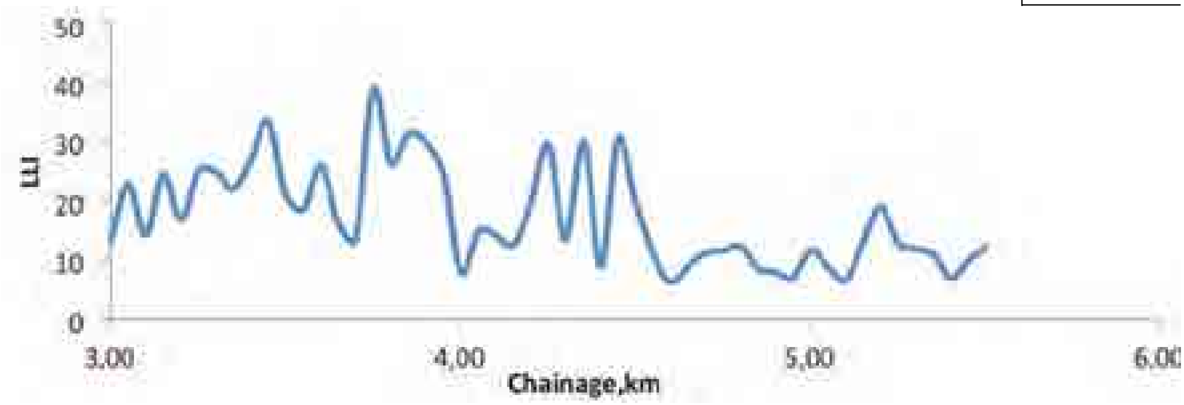


Figure A2.2.1-7: Lower Layer Index (LLI) Values for Illara -Pobe Lane, km 3.000 to 5.500

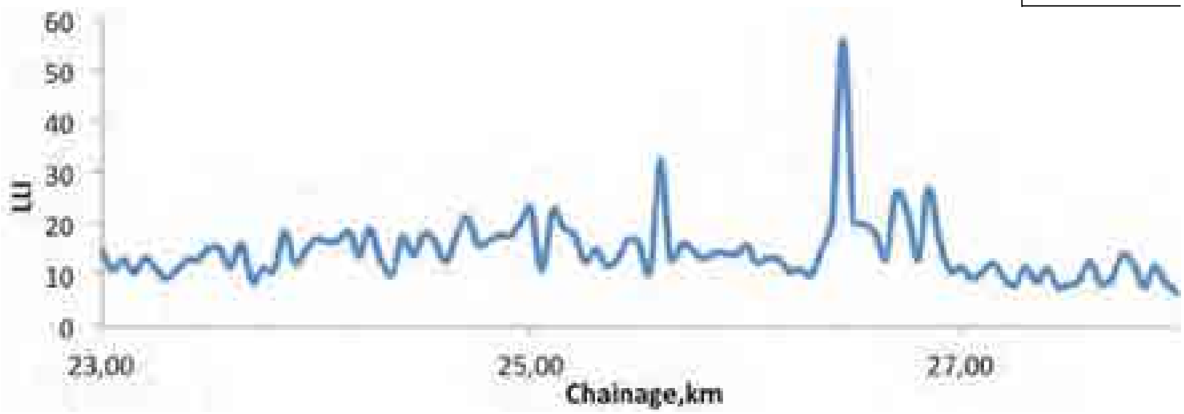


Figure A2.2.1-8: Lower Layer Index (LLI) Values for Illara -Pobe Lane, km 23.000 to 28.000

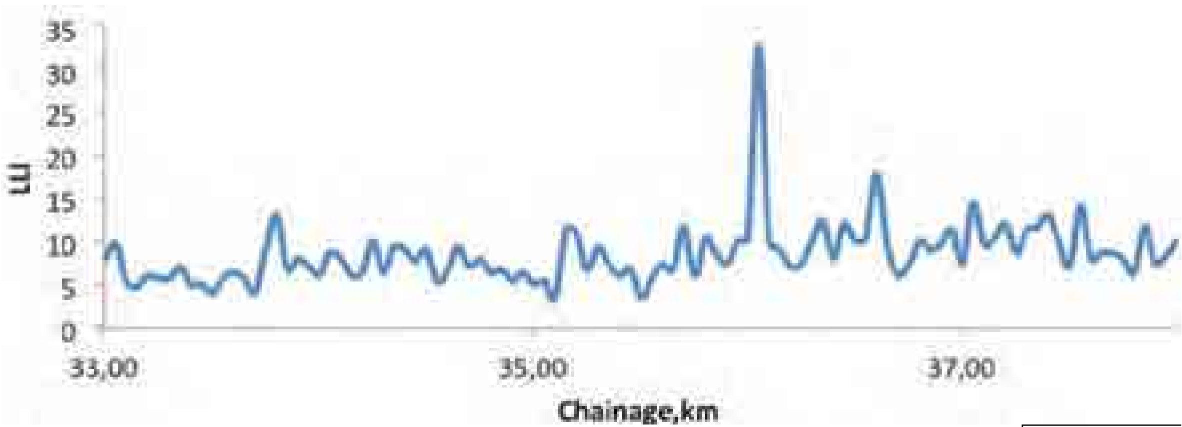


Figure A2.2.1-9: Lower Layer Index (LLI) Values for Illara -Pobe Lane, km 33.000 to 38.000

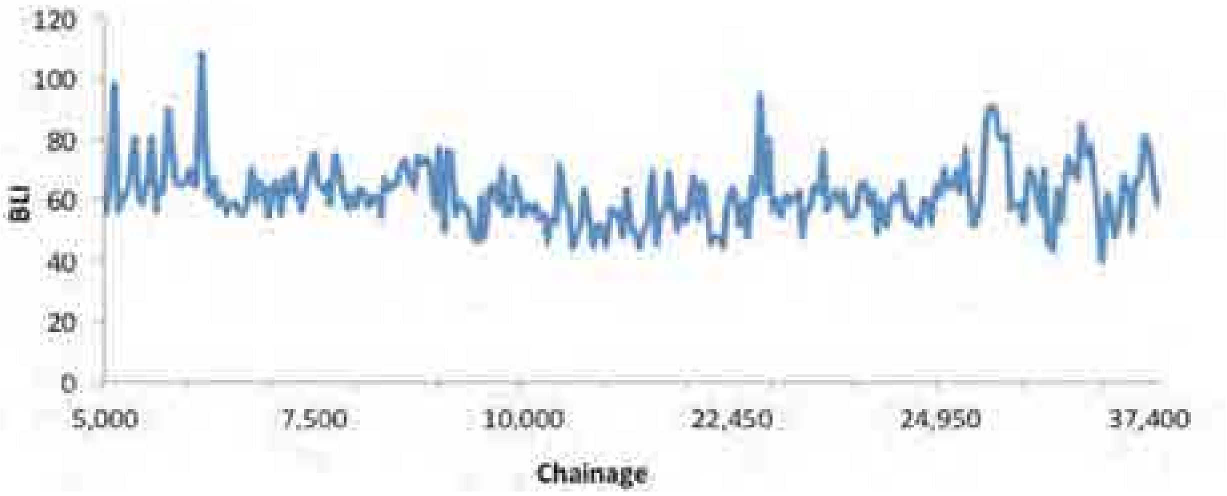


Figure A2.2.1-10: Base Layer Index (BLI) Values for Pobe - Illara Lane

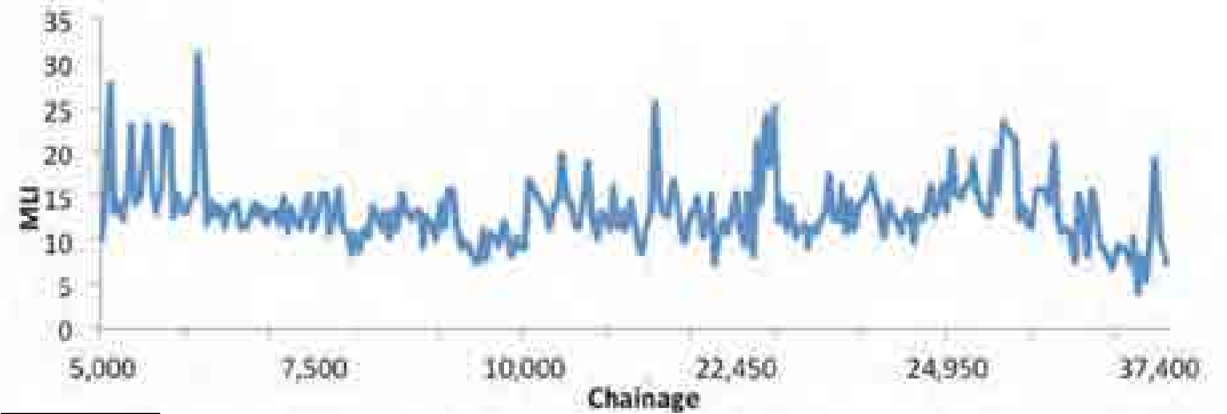


Figure A2.2.1-11: Middle Layer Index (MLI) Values for Pobe - Illara Lane

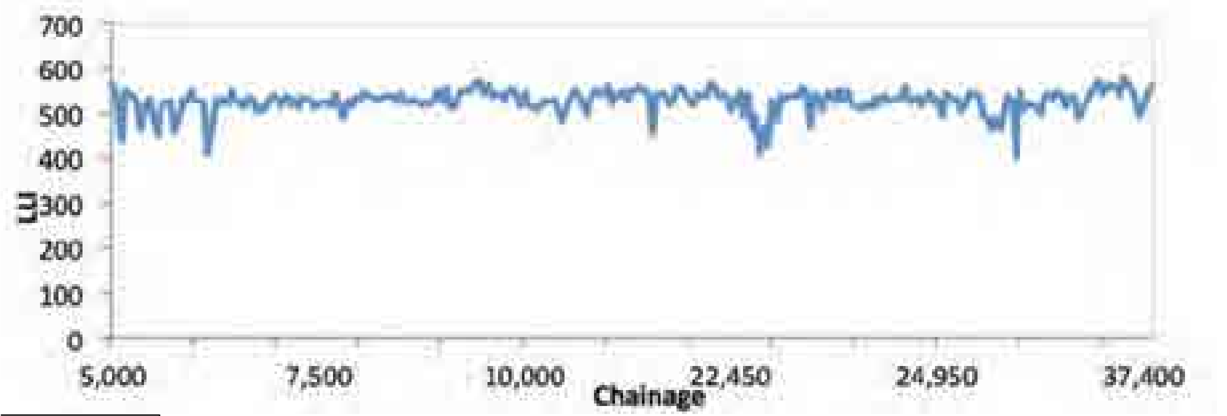


Figure A2.2.1-12: Lower Layer Index (LLI) Values for Pobe - Illara Lane

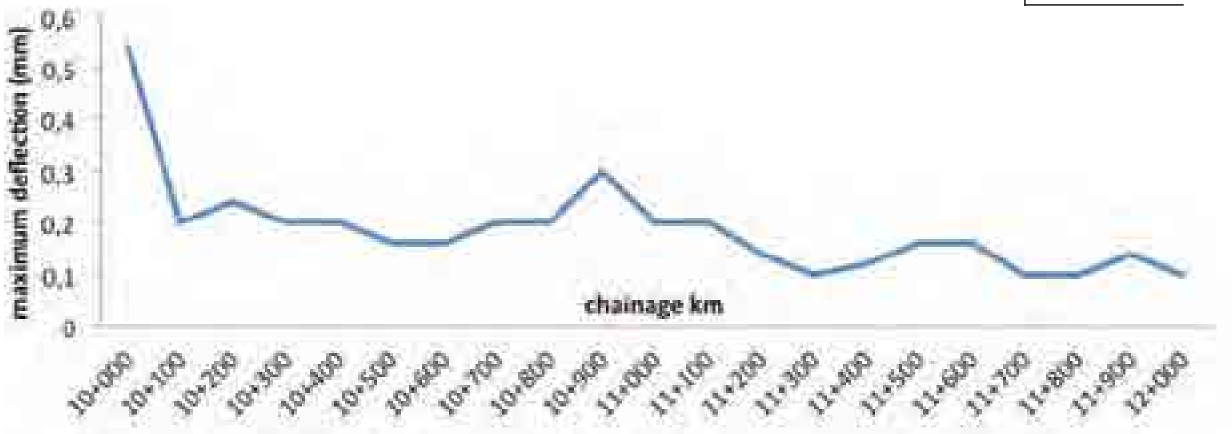


Figure A2.2.2-1: Maximum Deflections for Bamenda - Batibo Road Section

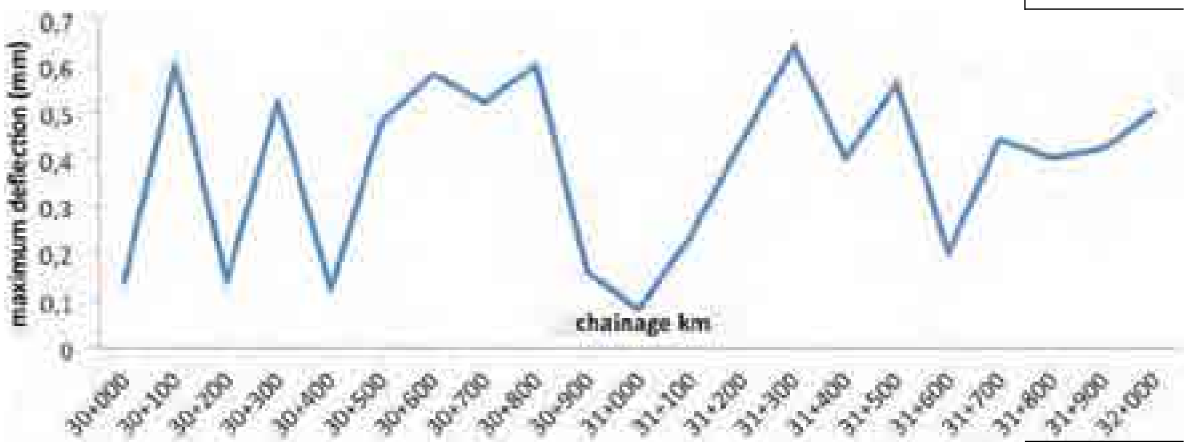


Figure A2.2.2-2: Maximum Deflections for Bamenda - Batibo Road Section

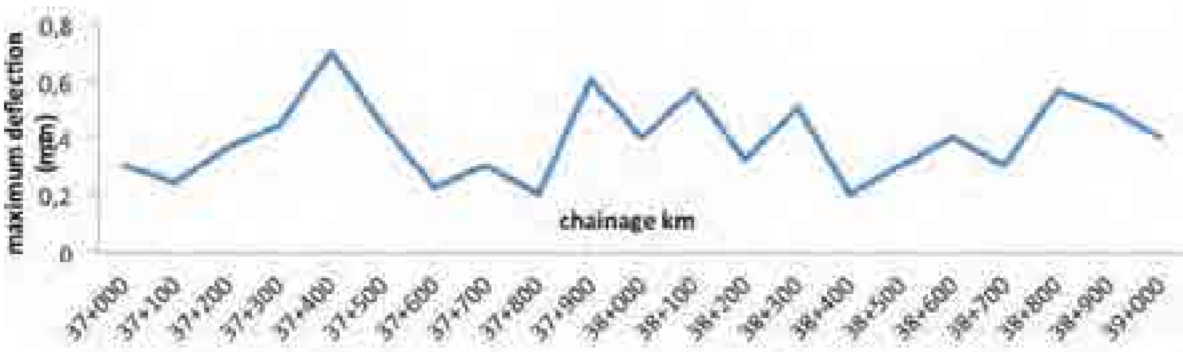


Figure A2.2.2-3: Maximum Deflections for Bamenda - Batibo Road Section

Figure A2.2.2-4: Maximum Deflections for Bamenda - Batibo Road Section

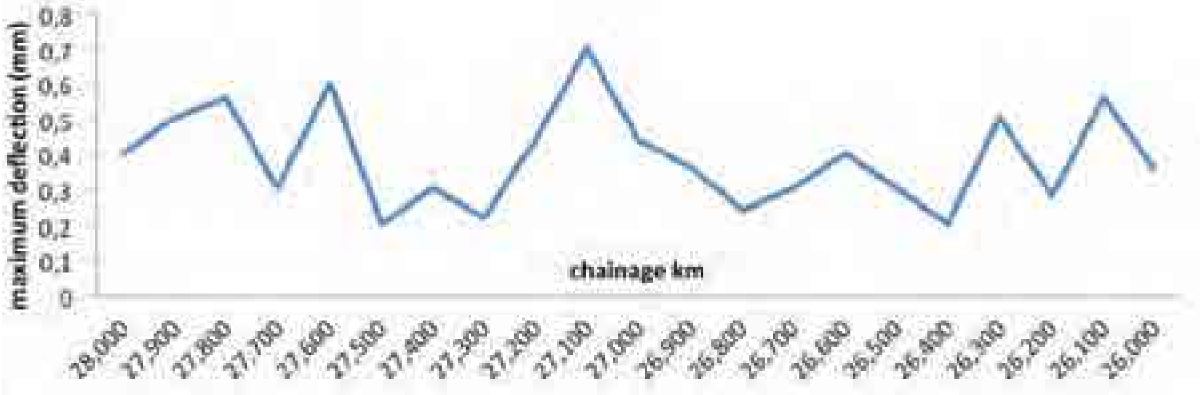


Figure A2.2.2-5: Maximum Deflections for Bamenda - Batibo Road Section

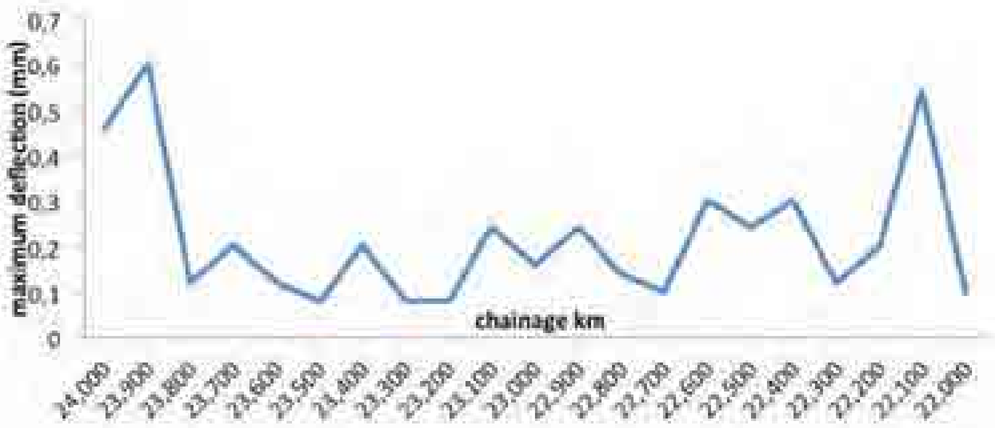


Figure A2.2.2-6: Maximum Deflections for Bamenda - Batibo Road Section

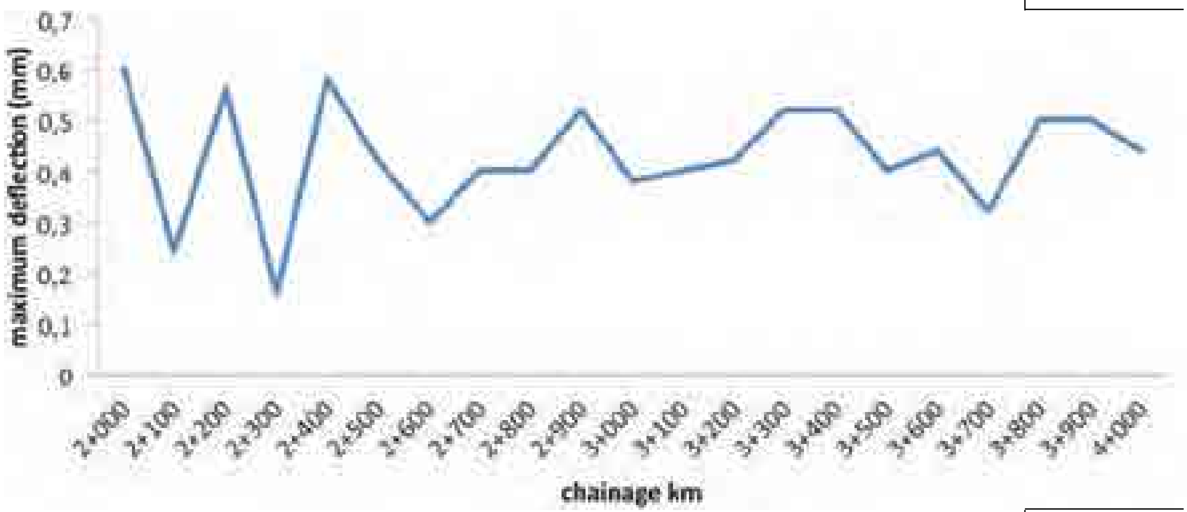


Figure A2.2.2-7: *Maximum Deflections for Batibo - Numba Road Section*

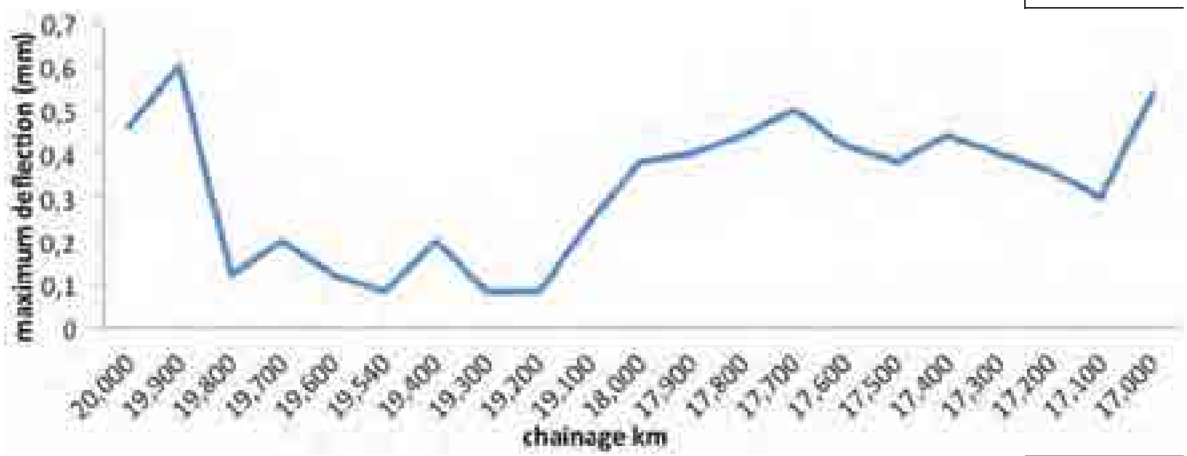


Figure A2.2.2-8: *Maximum Deflections for Batibo - Numba Road Section*

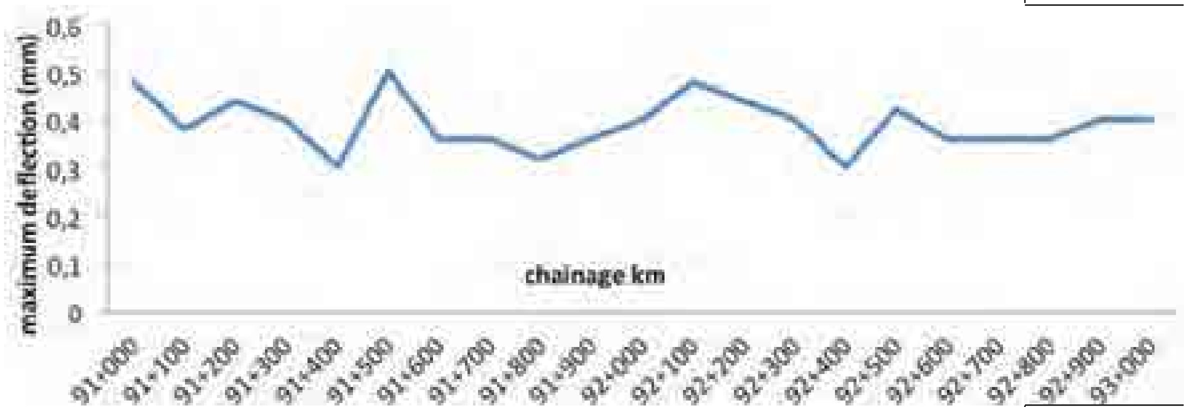


Figure A2.2.2-9: *Maximum Deflection for Nandeke - Mbere Road Section*

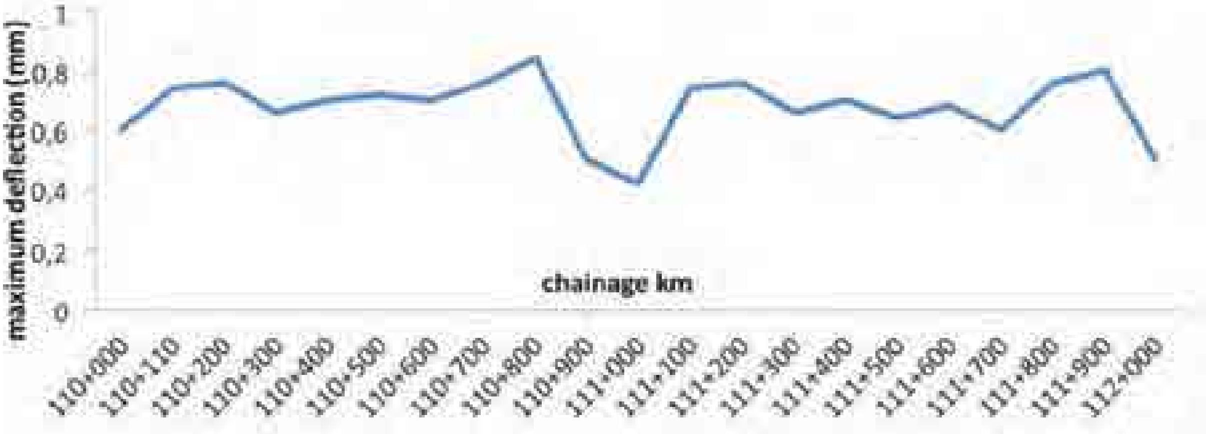


Figure A2.2.2-10: Maximum Deflection for Nandeke - Mbere Road Section

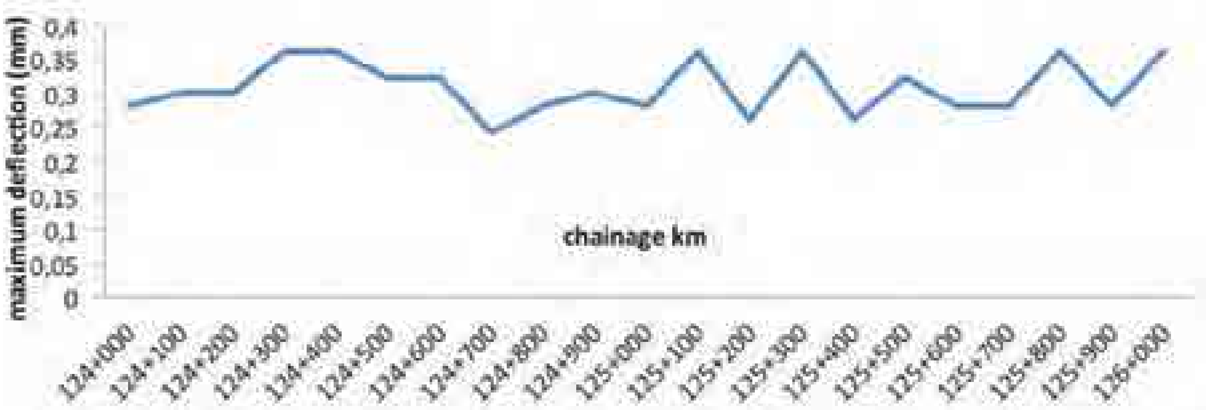


Figure A2.2.2-11: Maximum Deflection for Nandeke - Mbere Road Section

Figure A2.2.2-12: Maximum Deflection for Nandeke - Mbere Road Section

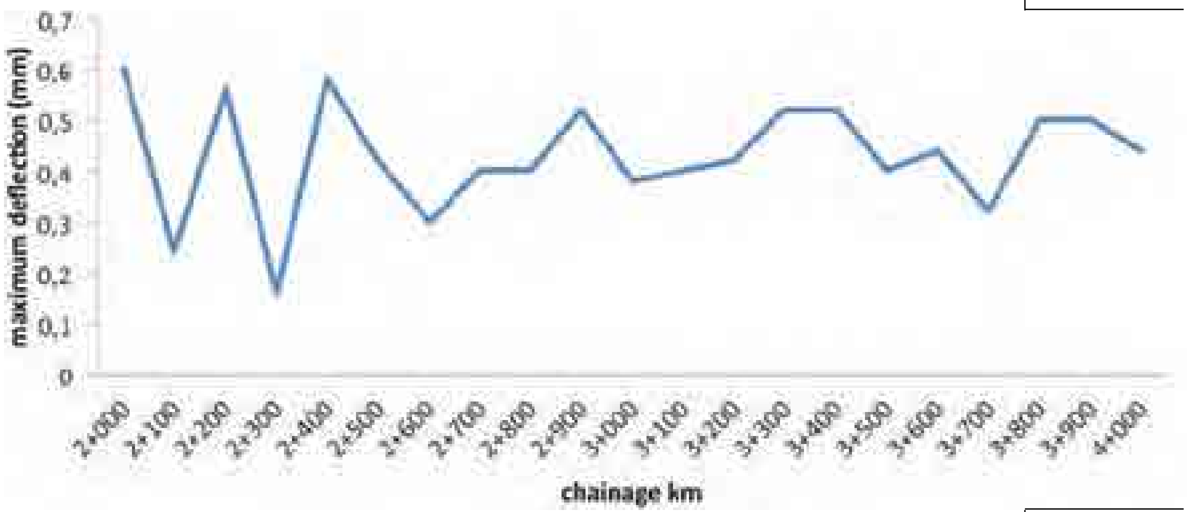


Figure A2.2.2-13: *Maximum Deflection for Nandeke - Mbere Road Section*

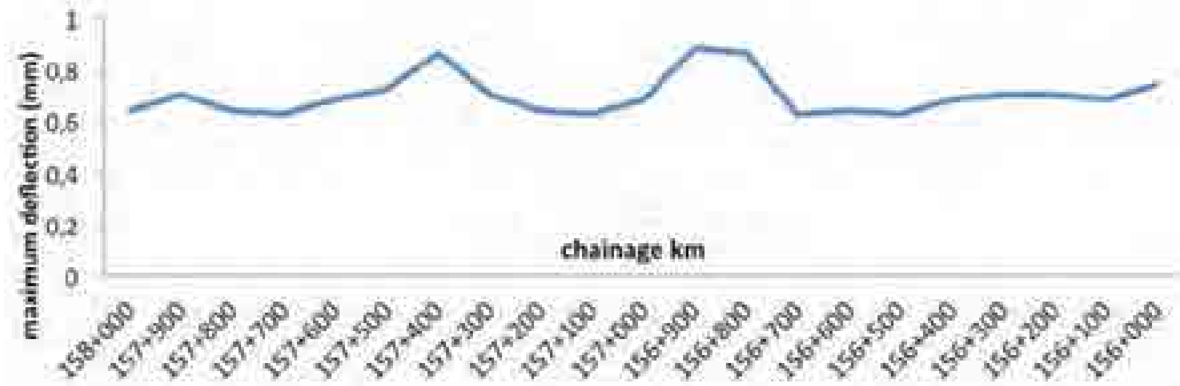


Figure A2.2.2-14: *Maximum Deflection for Nandeke - Mbere Road Section*

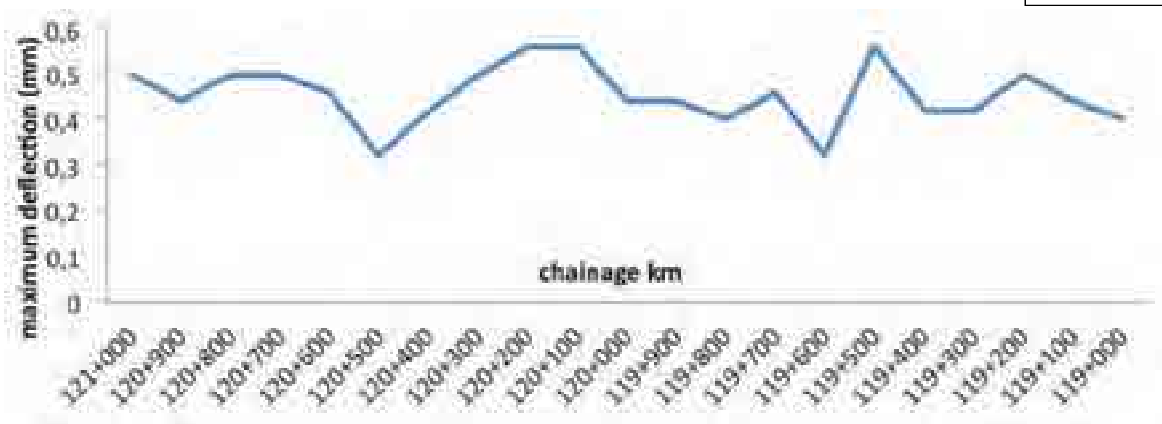


Figure A2.2.2-15: *Maximum Deflection for Nandeke - Mbere Road Section*

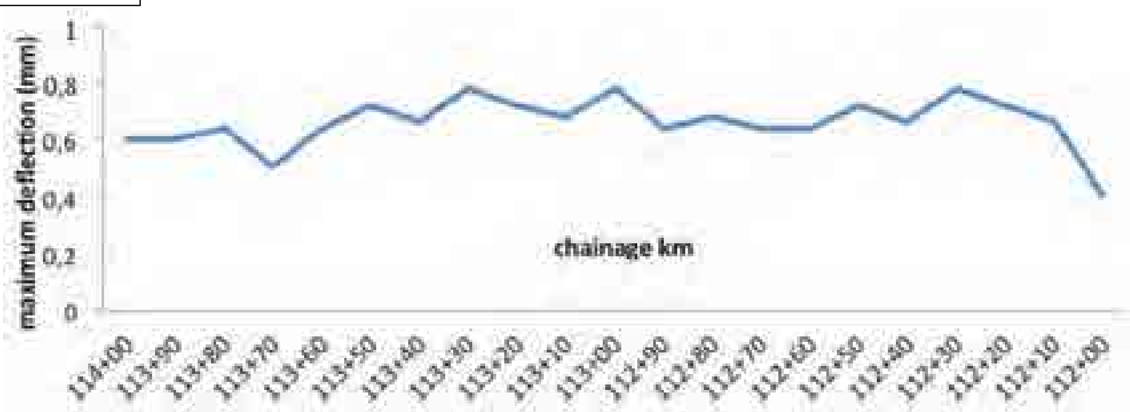


Figure A2.2.2-16: Maximum Deflection for Nandeke - Mbere Road Section

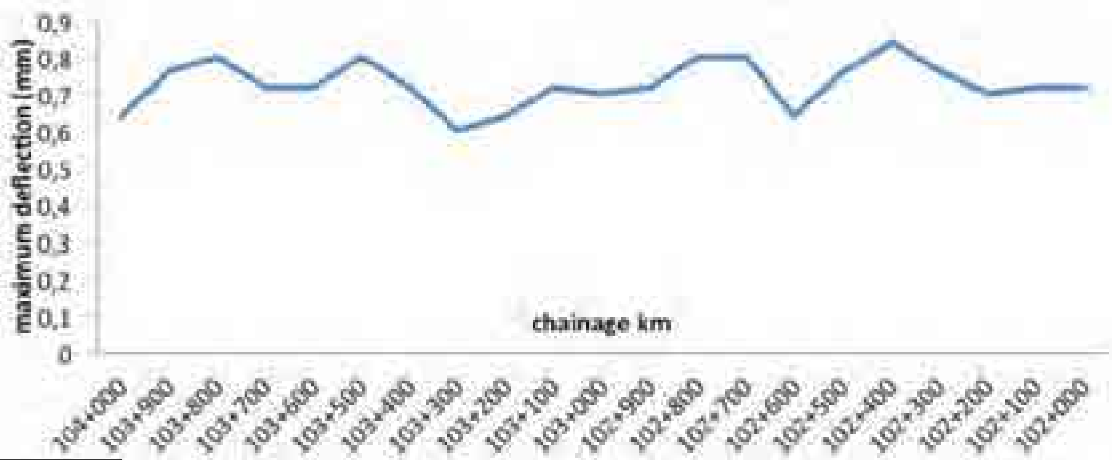


Figure A2.2.2-17: Maximum Deflection for Nandeke - Mbere Road Section

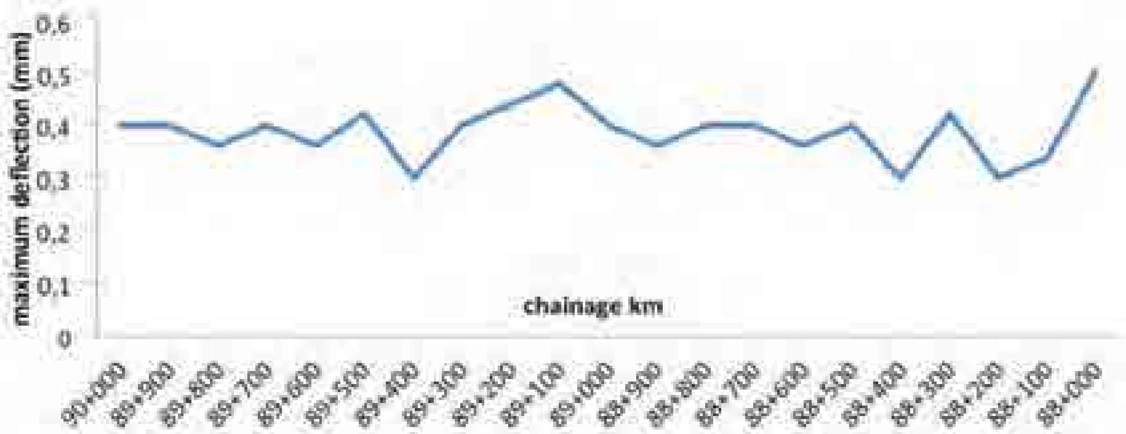


Figure A2.2.2-18: Maximum Deflection for Nandeke - Mbere Road Section

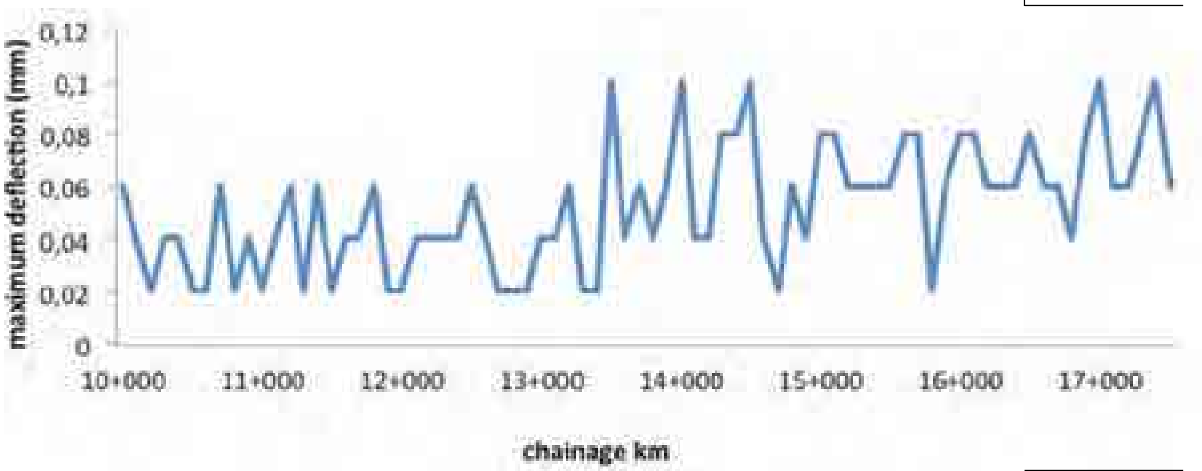


Figure A2.2.3-1: Maximum Deflection for Kwango - Kenge

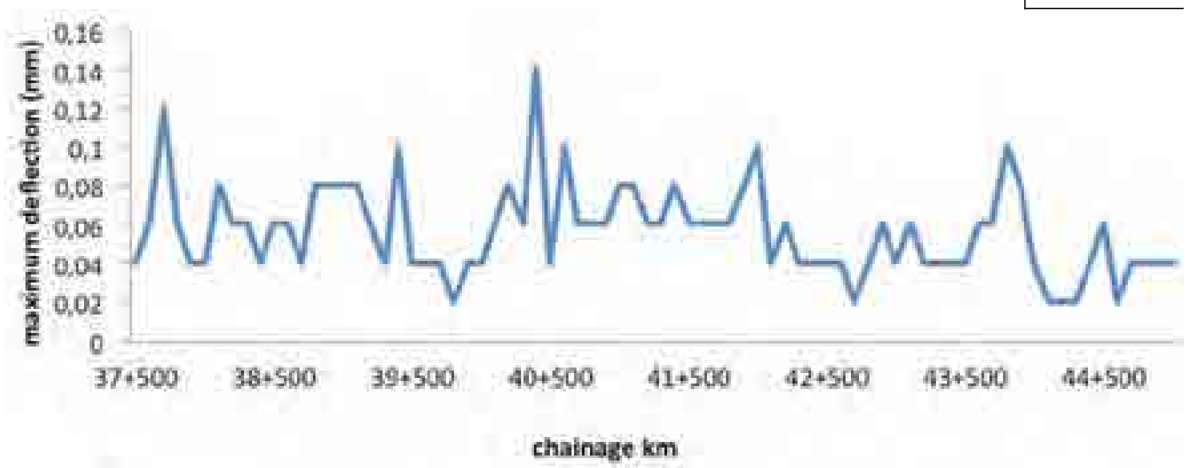


Figure A2.2.3-2: Maximum Deflection for Kwango - Kenge

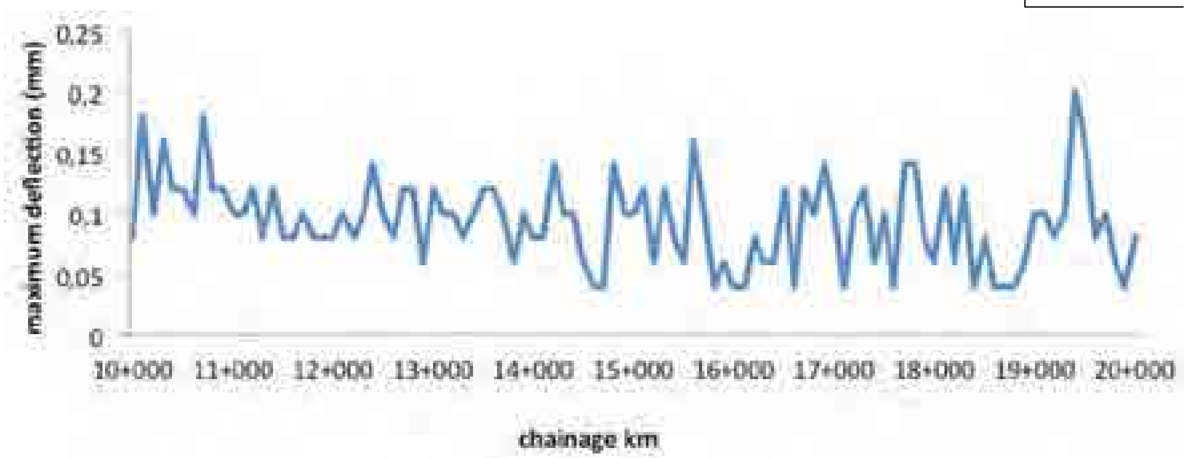


Figure A2.2.3-3: Maximum Deflection for Nandeke - Mbere Road Section

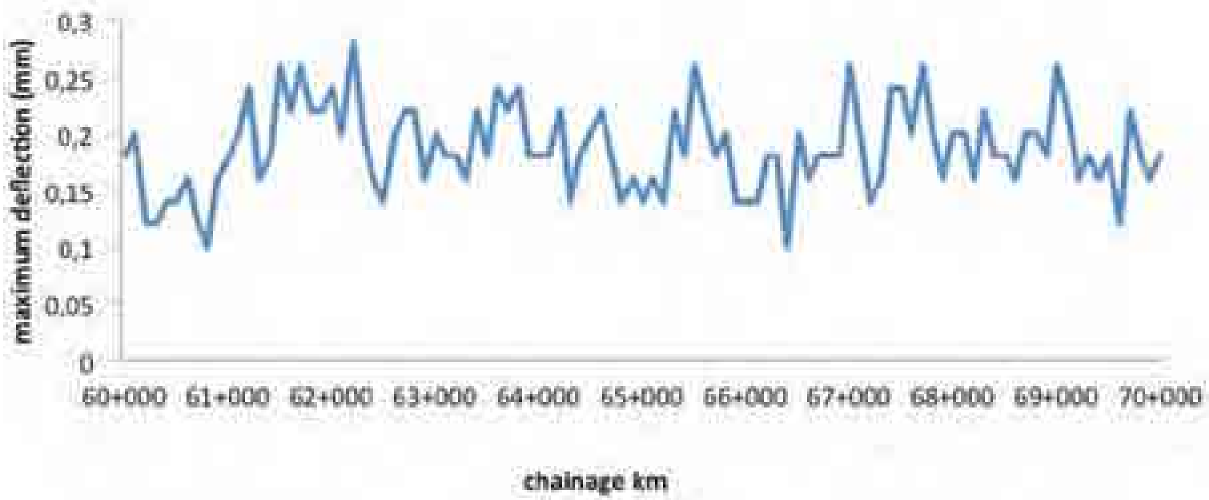


Figure A2.2.3-4: Maximum Deflection for N'sele - Lufimi

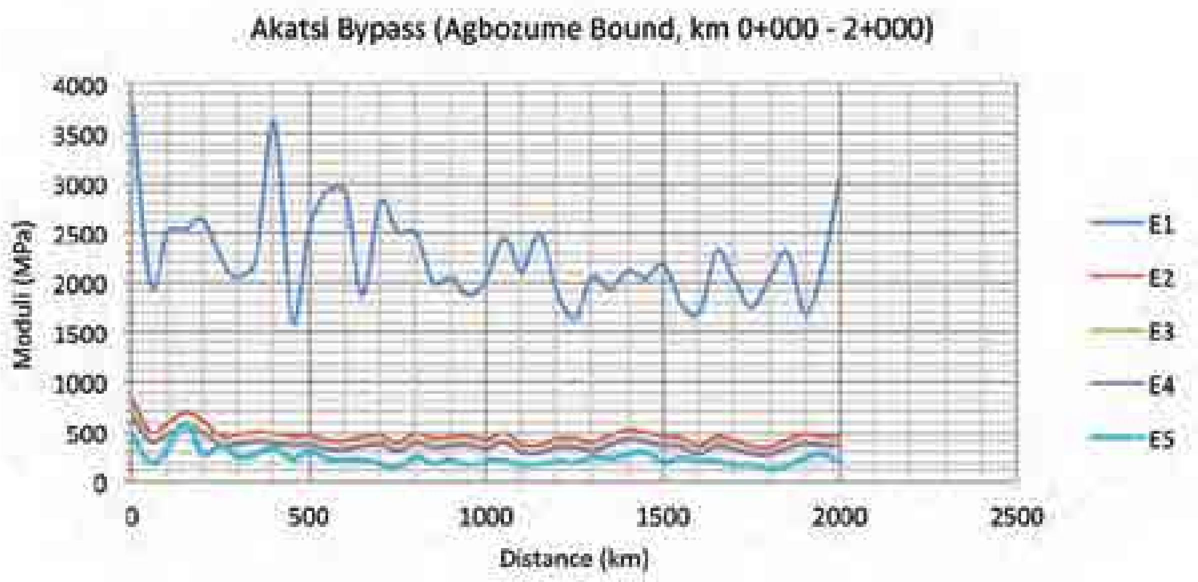


Figure A2.2.4-1: Falling Weight Deflection Test Results for Akatsi Bypass (Agbozume Bound, km 0+000 - 2+000)

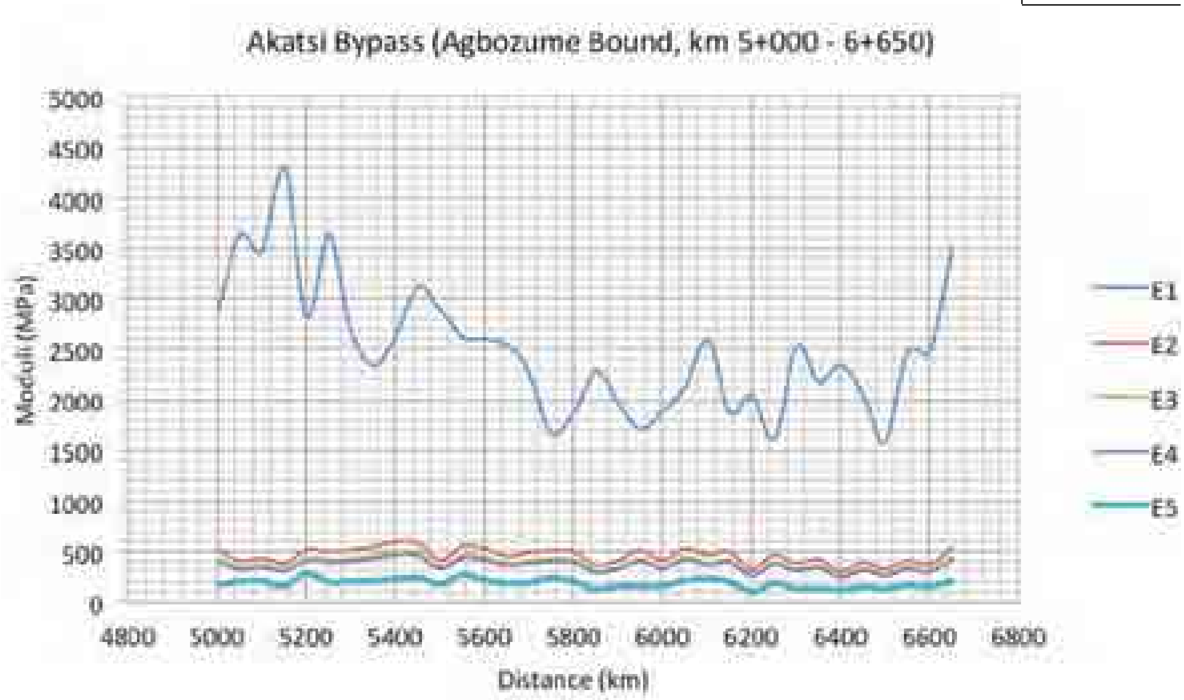


Figure A2.2.4-2: Falling Weight Deflection Test Results for Akatsi Bypass (Agbozume Bound, km 5+000 - 5+650)

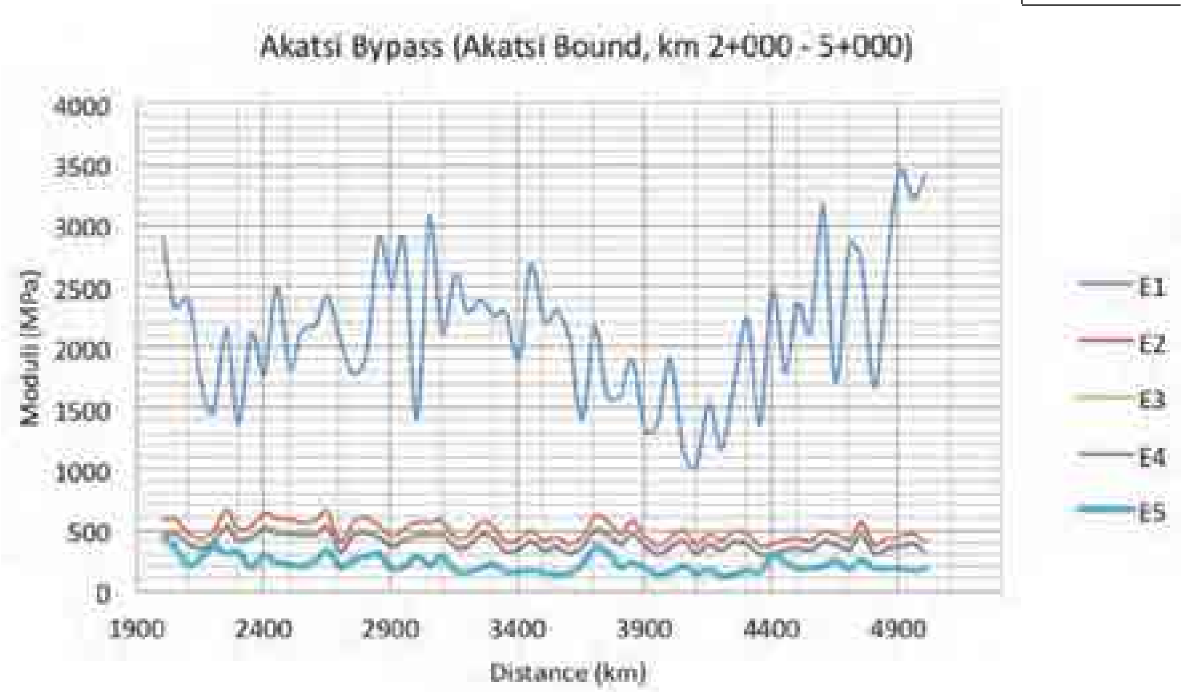


Figure A2.2.4-3: Falling Weight Deflection Test Results for Akatsi Bypass (Akatsi Bound, km 2+000 - 5+000)

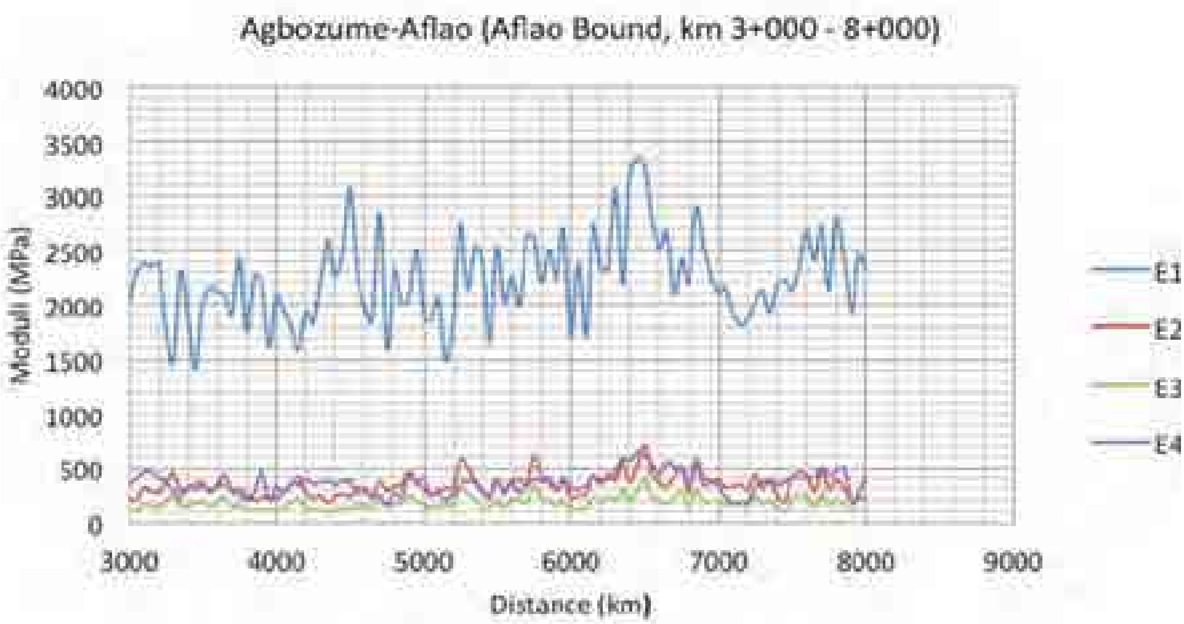


Figure A2.2.4-4: Falling Weight Deflection Test Results for Agbozume - Aflao (Aflao Bound, km 3+000 - 8+000)

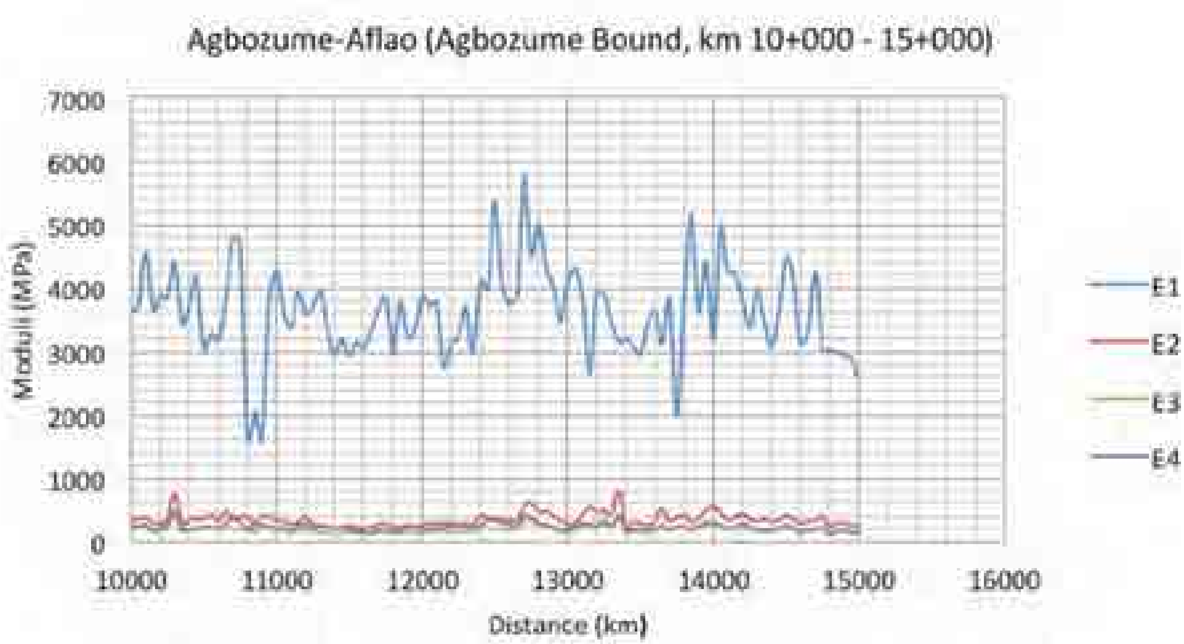


Figure A2.2.4-5: Falling Weight Deflection Test Results for Agbozume - Aflao (Agbozume Bound, km 10+000 - 15+000)

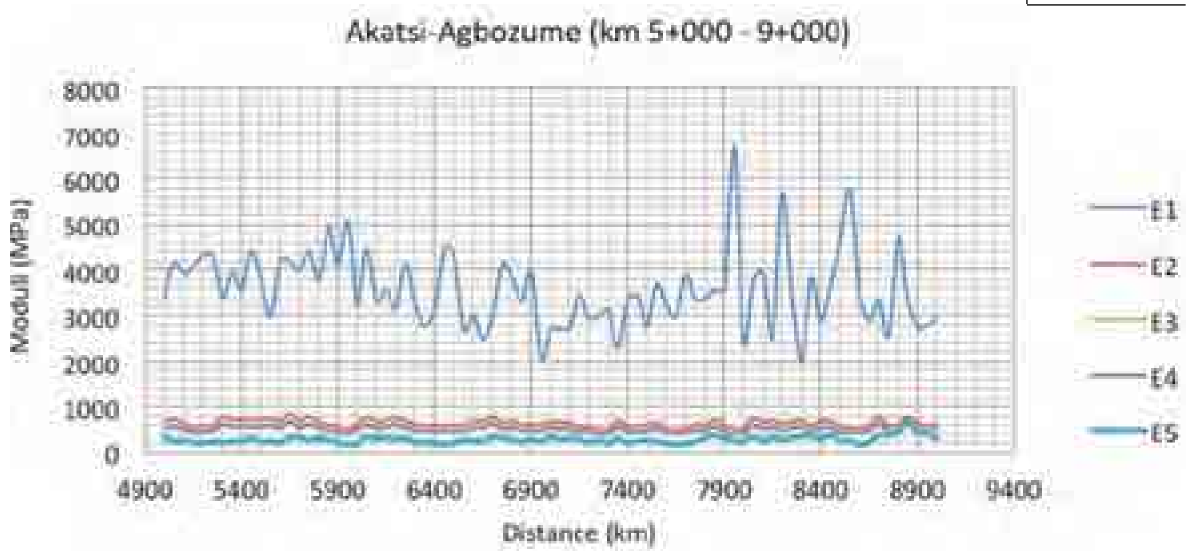


Figure A2.2.4-6: Falling Weight Deflection Test Results for Akatsi - Agbozume (Agbozume Bound, km 5+000 - 9+000)

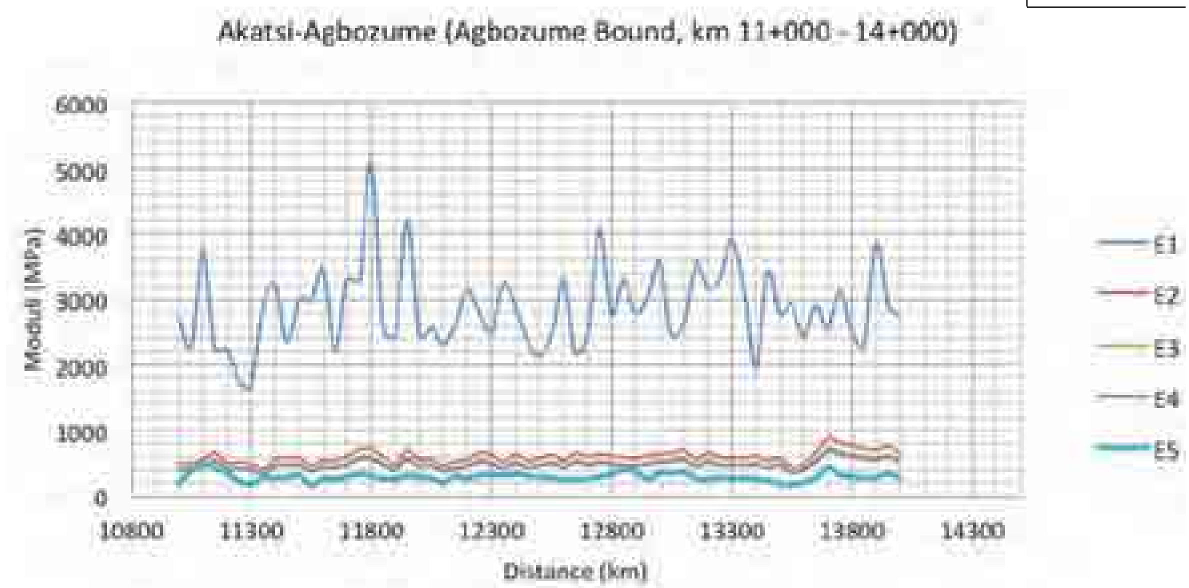


Figure A2.2.4-7: Falling Weight Deflection Test Results for Akatsi - Agbozume (Agbozume Bound, km 11+000 - 14+000)

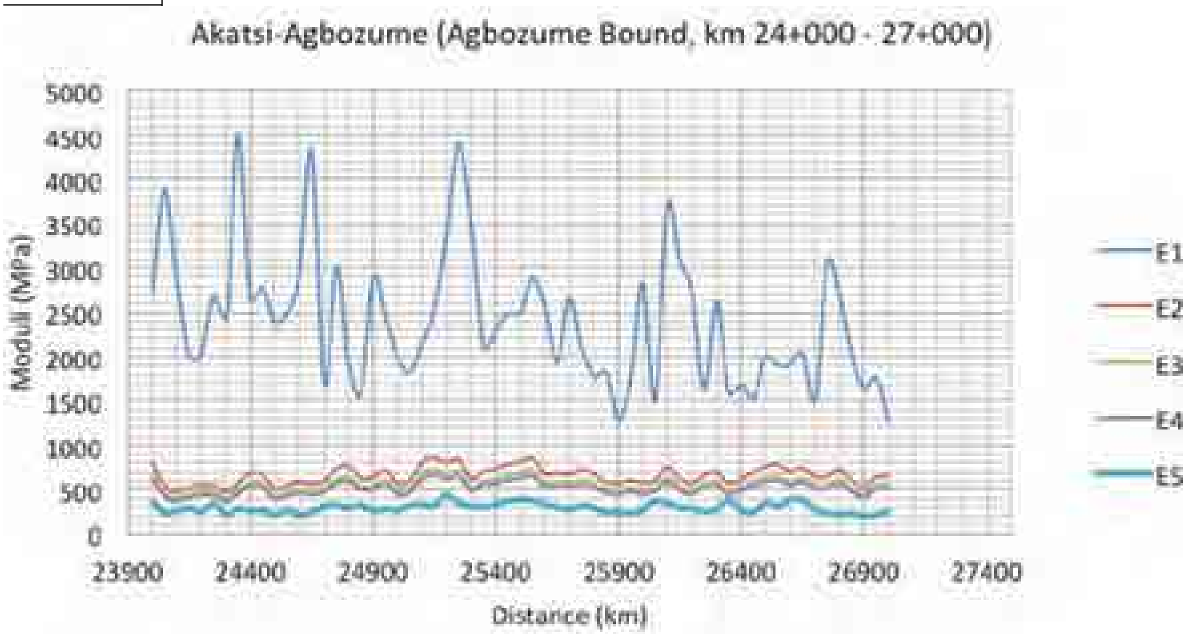


Figure A2.2.4-8: Falling Weight Deflection Test Results for Akatsi - Agbozume (Agbozume Bound, km 24+000 - 27+000)

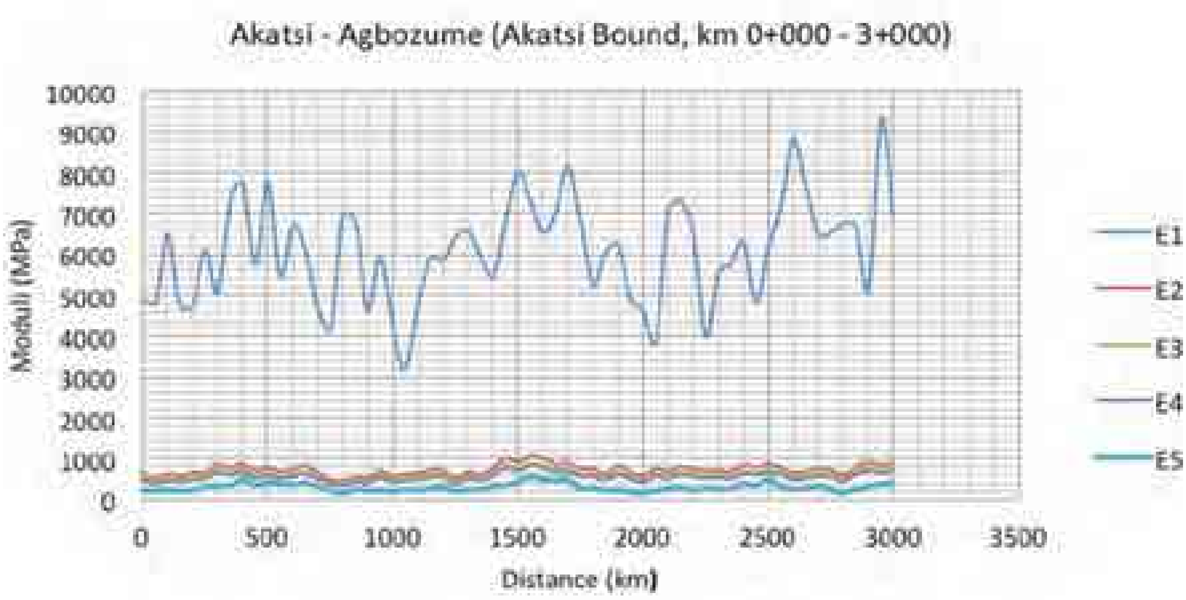


Figure A2.2.4-9: Falling Weight Deflection Test Results for Akatsi - Agbozume (Akatsi Bound, km 0+000 - 3+000)

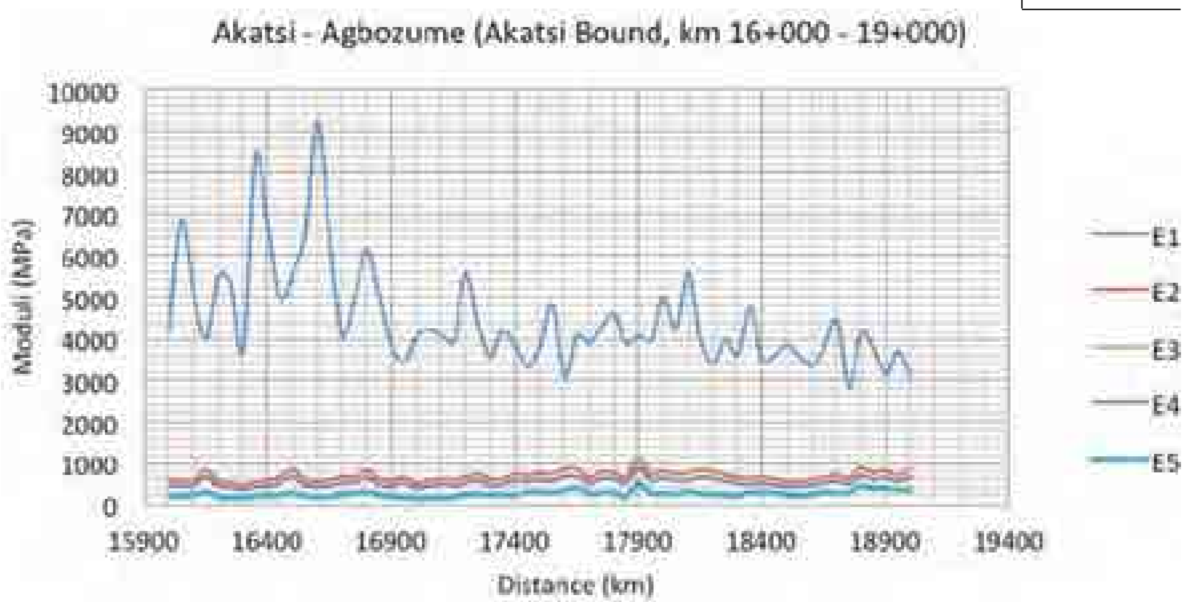


Figure A2.2.4-10: Falling Weight Deflection Test Results for Akatsi - Agbozume (Akatsi Bound, km 16+000 - 19+000)

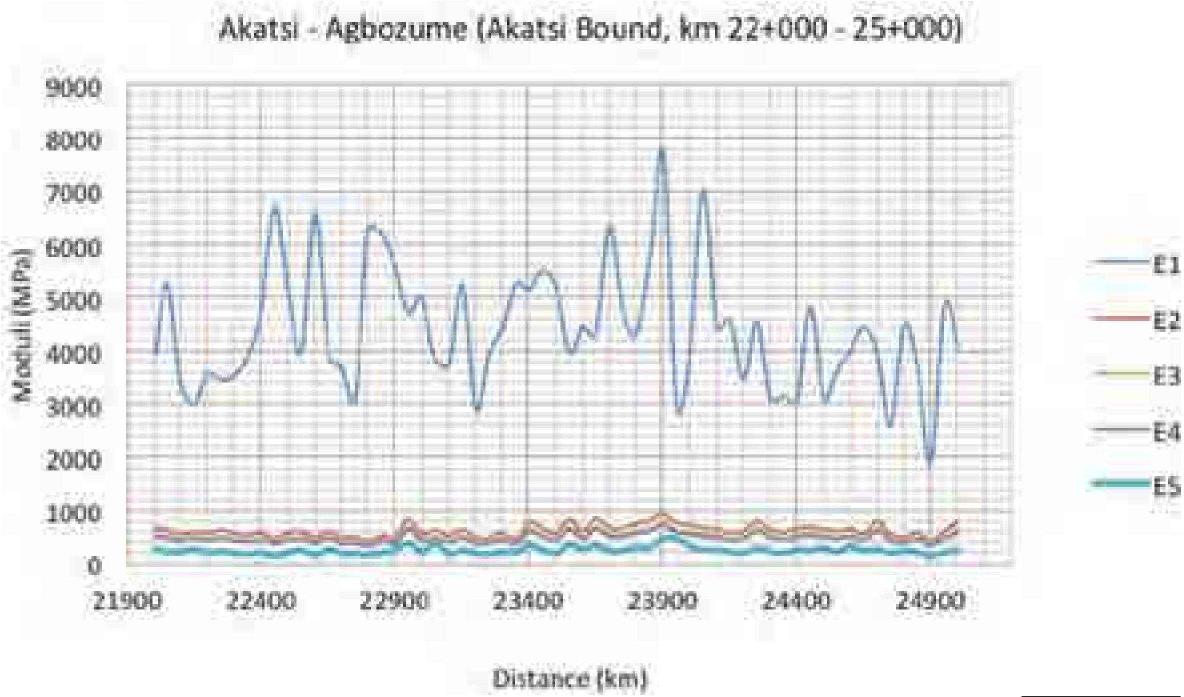


Figure A2.2.4-11: Falling Weight Deflection Test Results for Akatsi - Agbozume (Akatsi Bound, km 16+000 - 19+000)

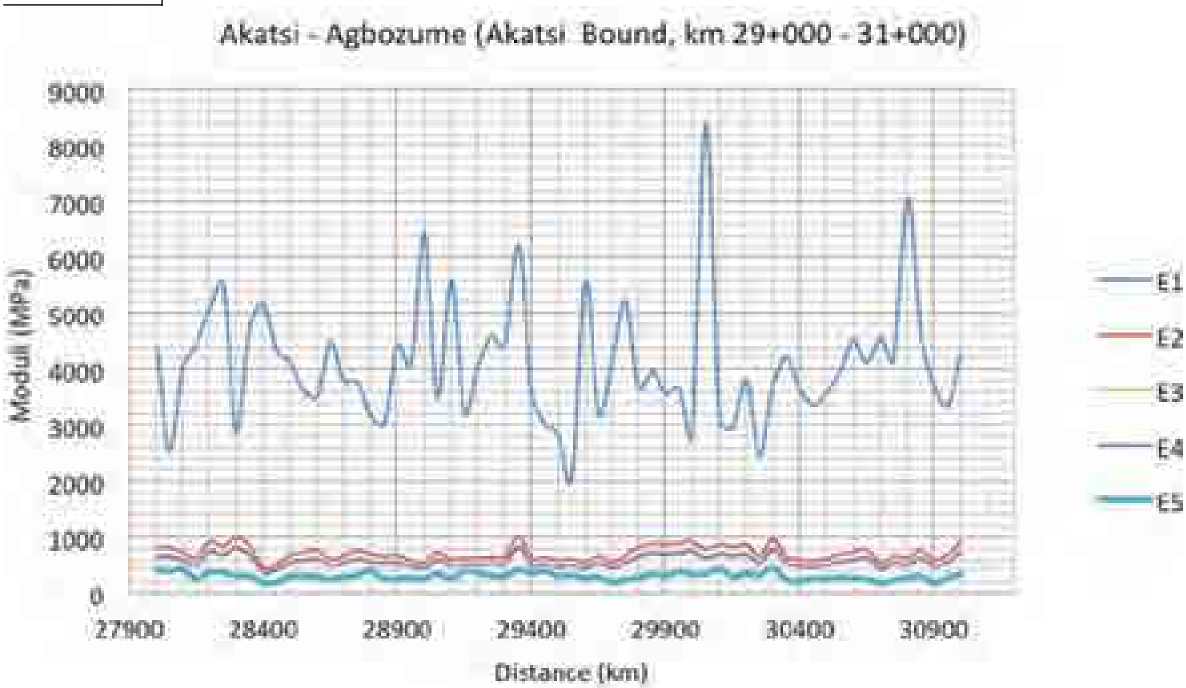


Figure A2.2.4-12: Falling Weight Deflection Test Results for Akatsi - Agbozume (Akatsi Bound, km 16+000 - 19+000)

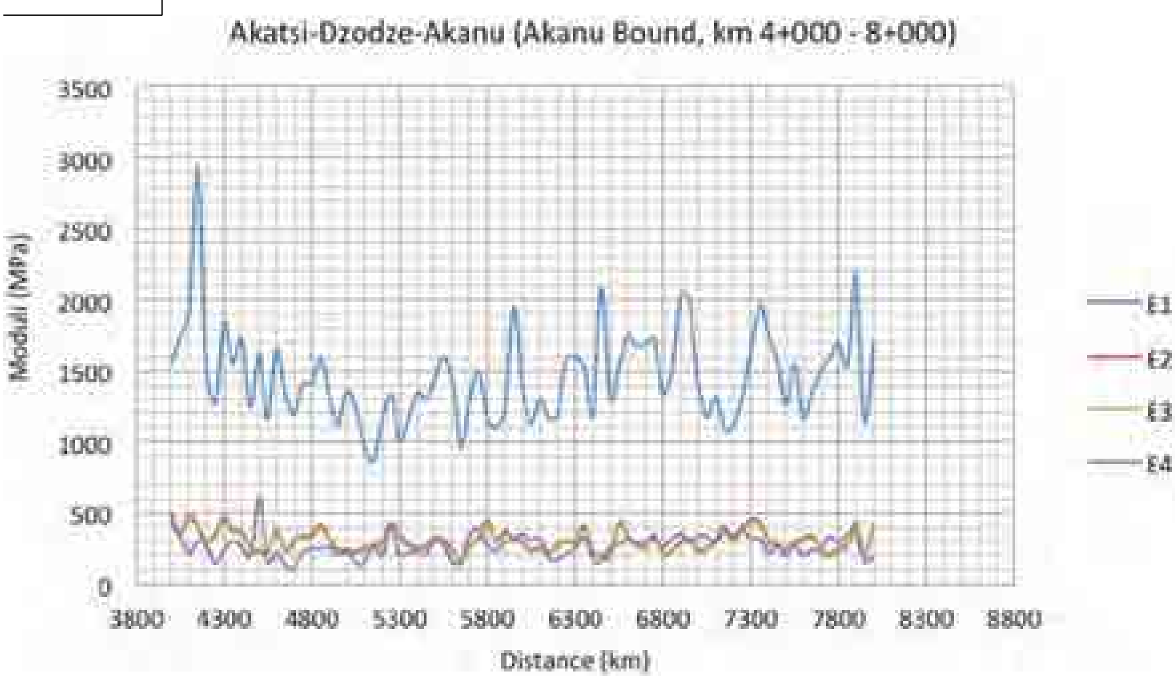


Figure A2.2.4-13: Falling Weight Deflection Test Results for Akatsi – Dzodze - Akanu (Akanu Bound, km 4+000 - 8+000)

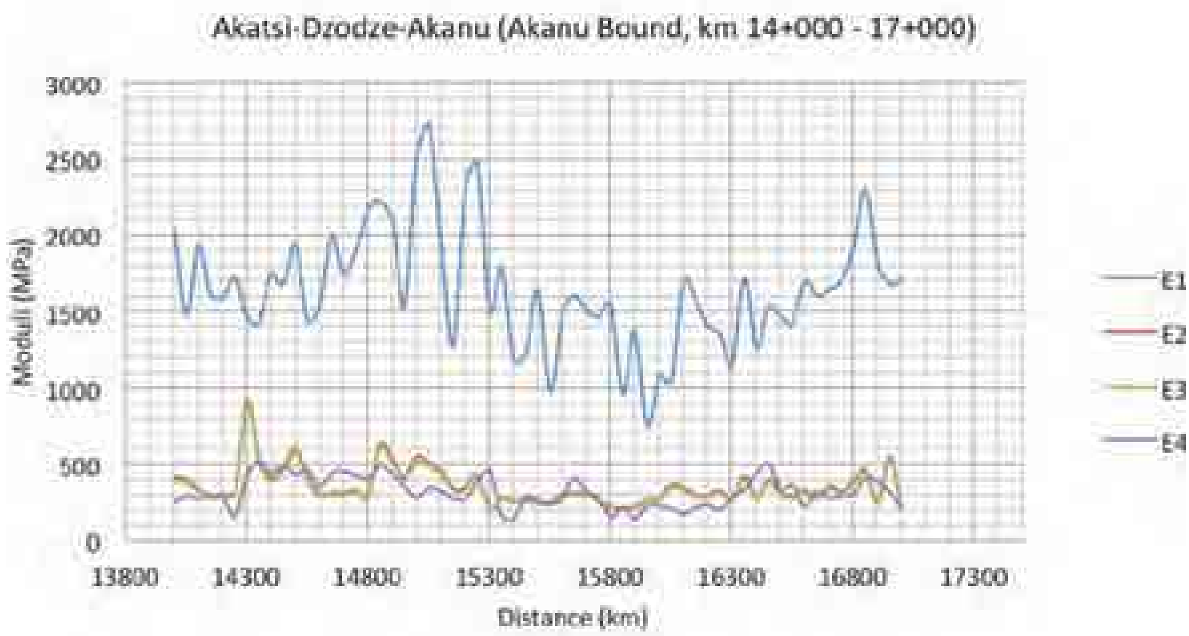


Figure A2.2.4-14: Falling Weight Deflection Test Results for Akatsi - Dzodze - Akanu (Akanu Bound, km 14+000 - 17+000)

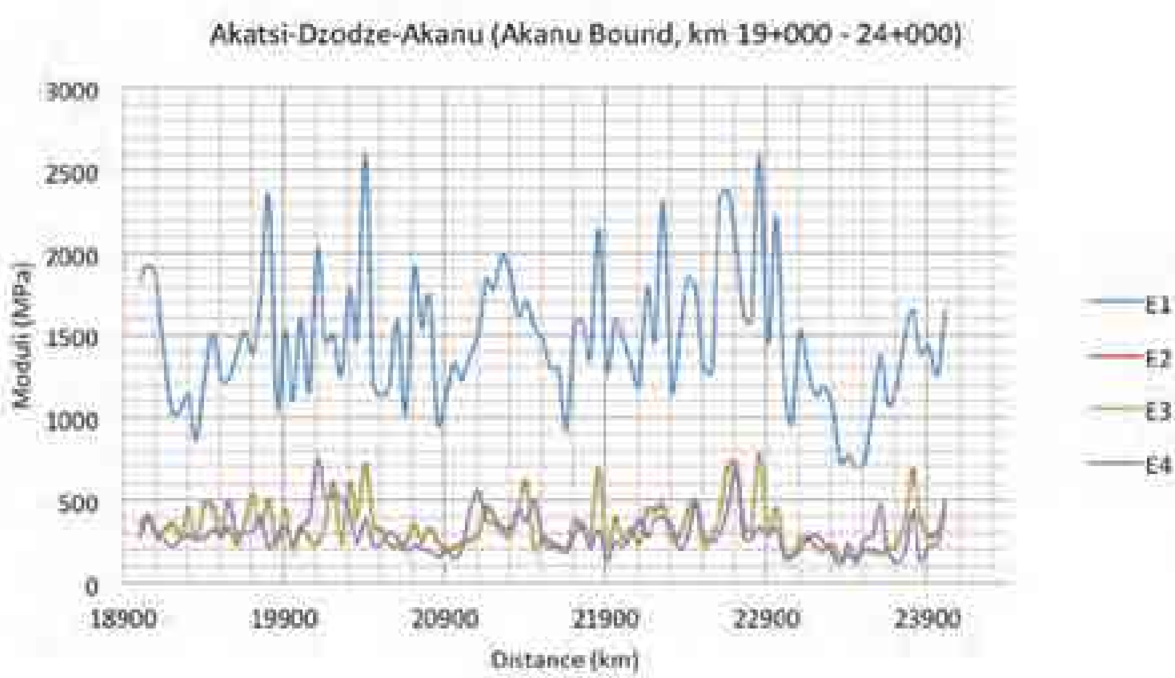


Figure A2.2.4-15: Falling Weight Deflection Test Results for Akatsi - Dzodze - Akanu (Akanu Bound, km 19+000 24+000)

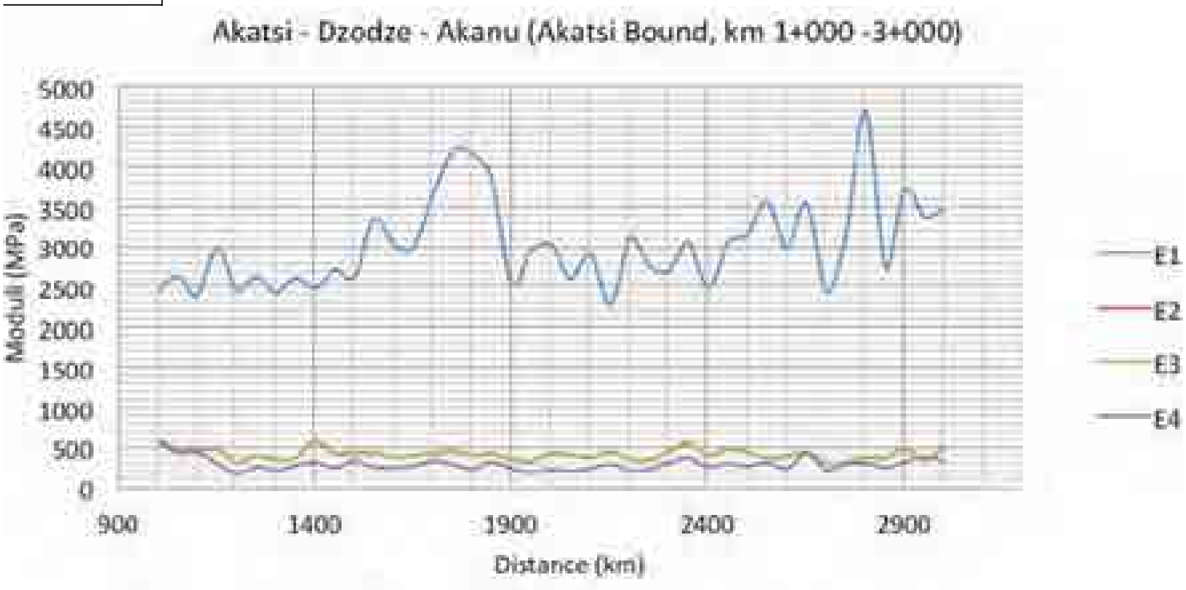


Figure A2.2.4-16: Falling Weight Deflection Test Results for Akatsi - Dzodze - Akanu (Akatsi Bound, km 1+000 - 3+000)

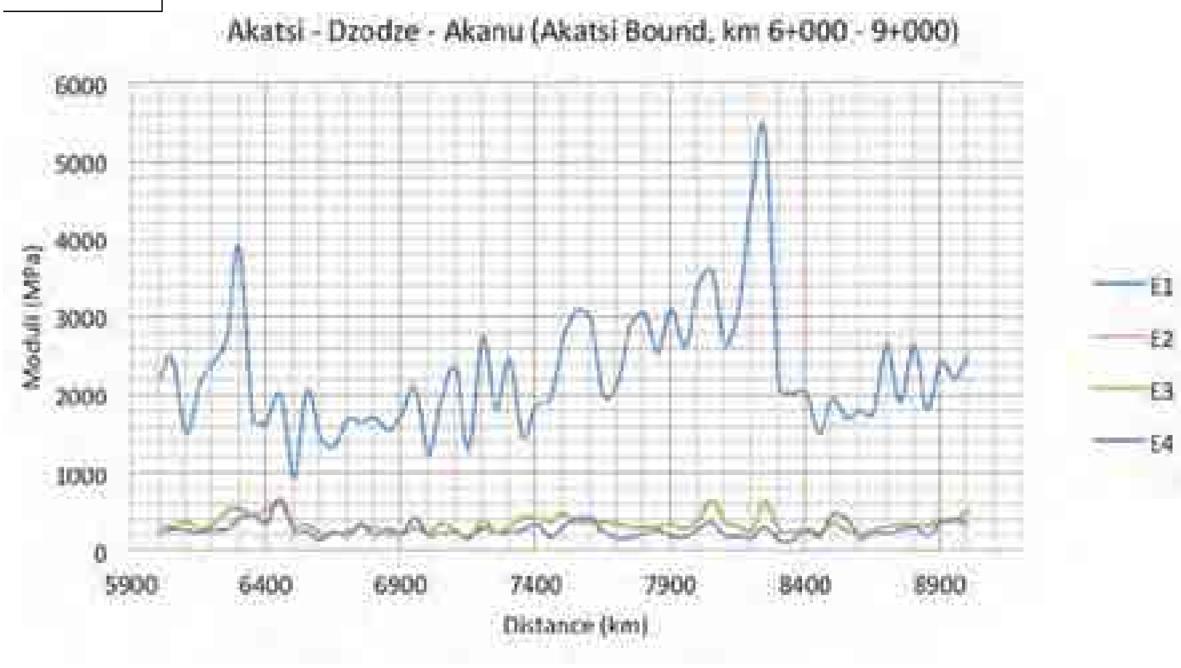


Figure A2.2.4-17: Falling Weight Deflection Test Results for Akatsi - Dzodze - Akanu (Akatsi Bound, km 6+000 - 9+000)

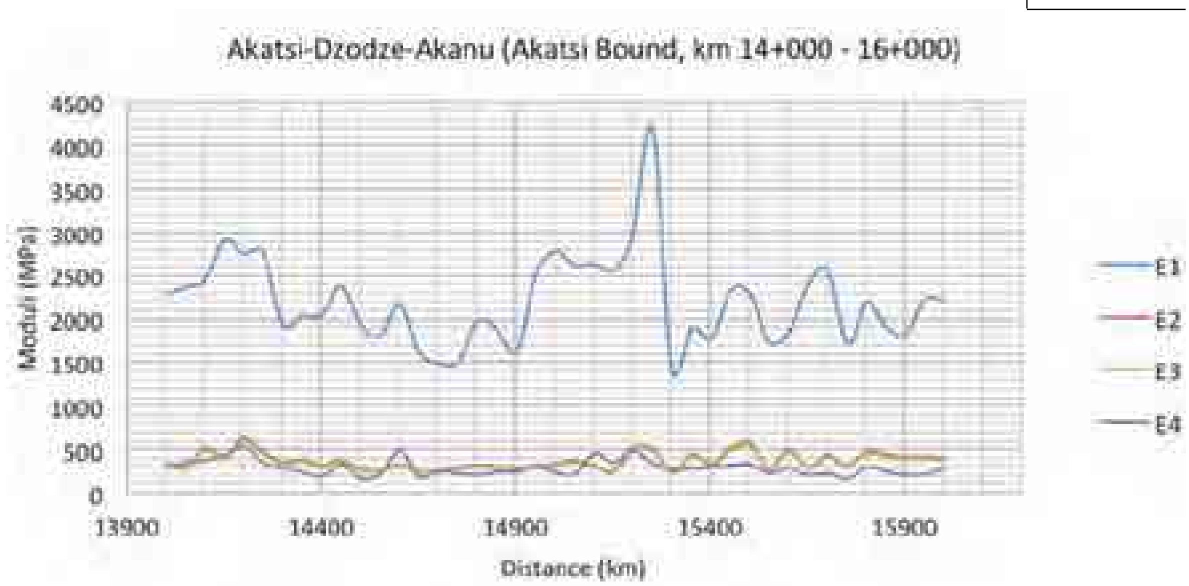


Figure A2.2.4-18: Falling Weight Deflection Test Results for Akatsi - Dzodze - Akanu (Akatsi Bound, km 14+000 - 16+000)

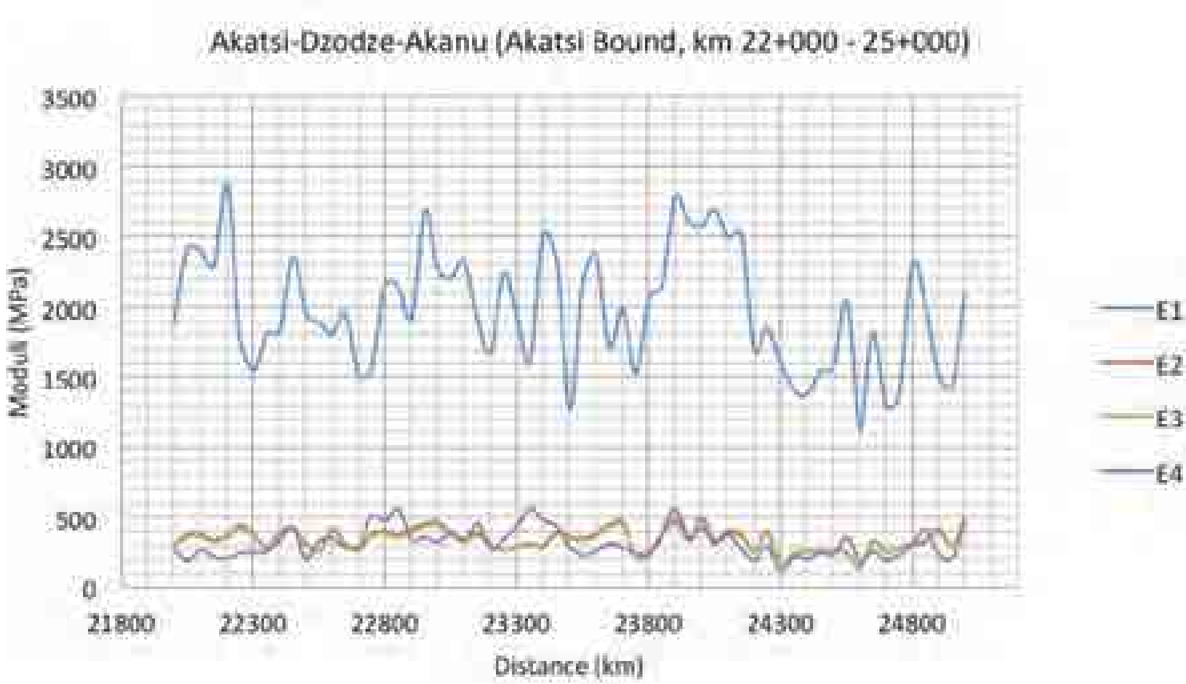


Figure A2.2.4-19: Falling Weight Deflection Test Results for Akatsi - Dzodze - Akanu (Akatsi Bound, km 22+000 - 25+000)

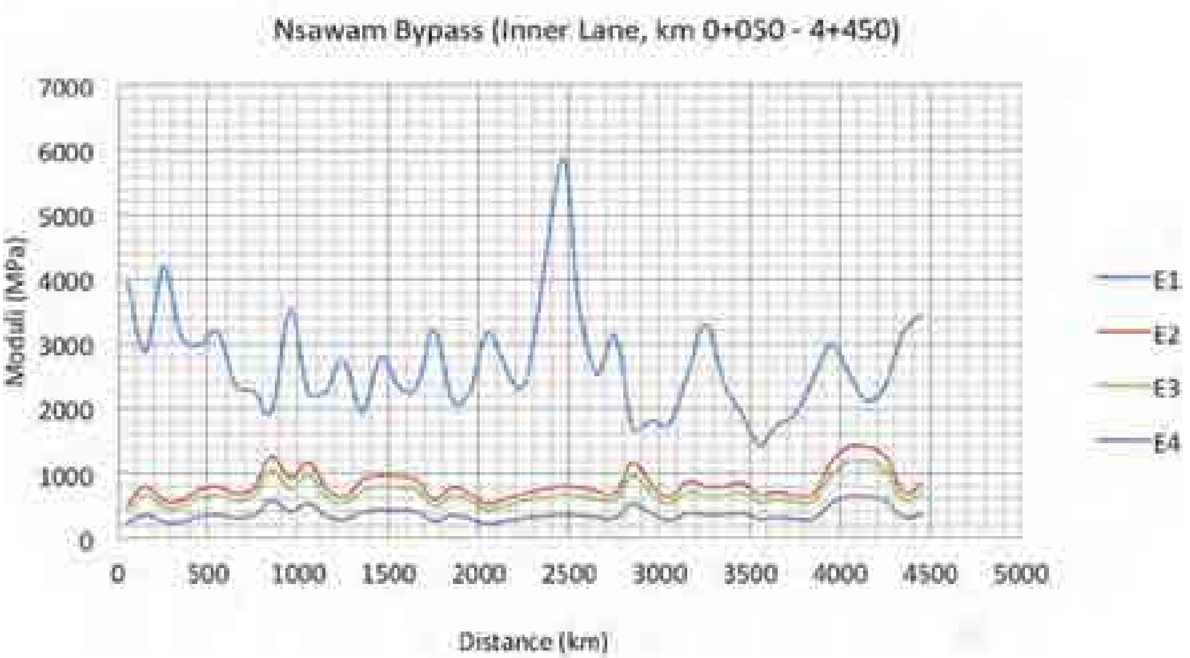


Figure A2.2.4-20: Falling Weight Deflection Test Result for Nsawam Bypass (Inner Lane, km 0+050 - 4+450)

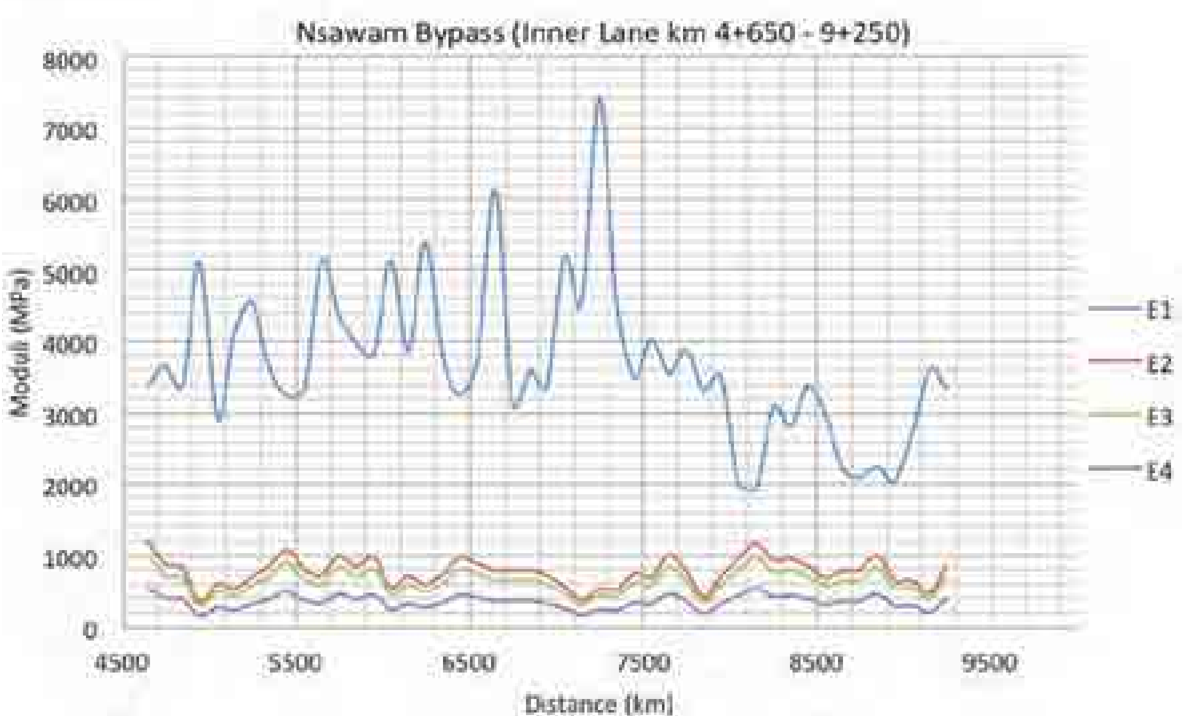


Figure A2.2.4-21: Falling Weight Deflection Test Result for Nsawam Bypass Bypass (Inner Lane, km 4+650 - 9+250)

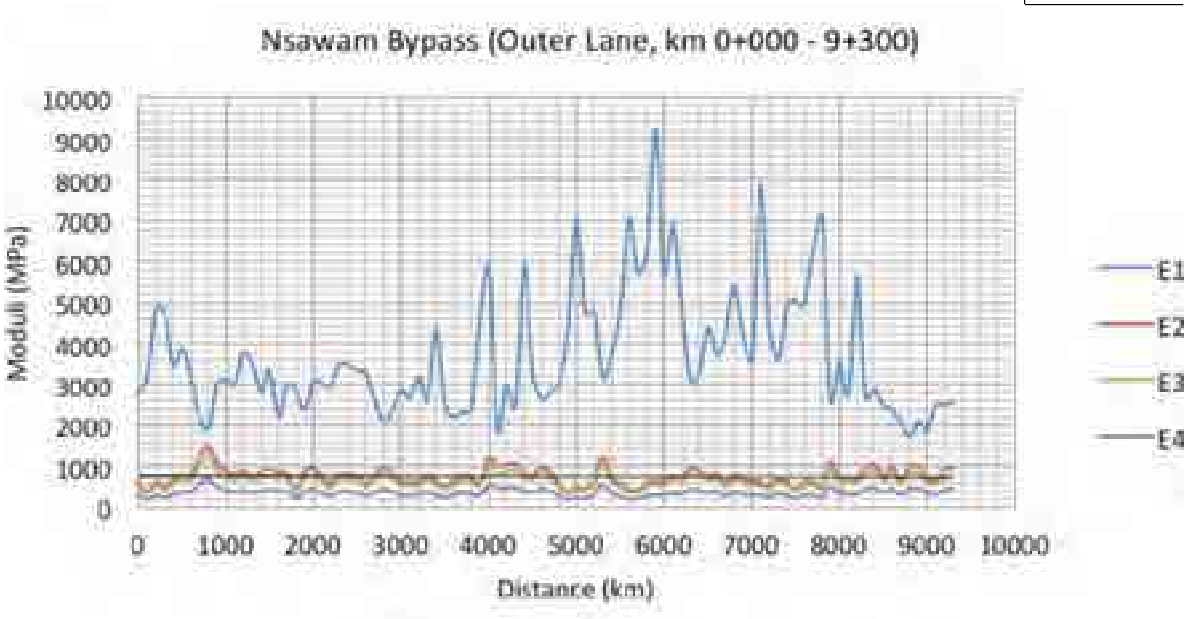


Figure A2.2.4-22: Falling Weight Deflection Test Result for Nsawam Bypass (Outer Lane, km 0+000 - 9+300)

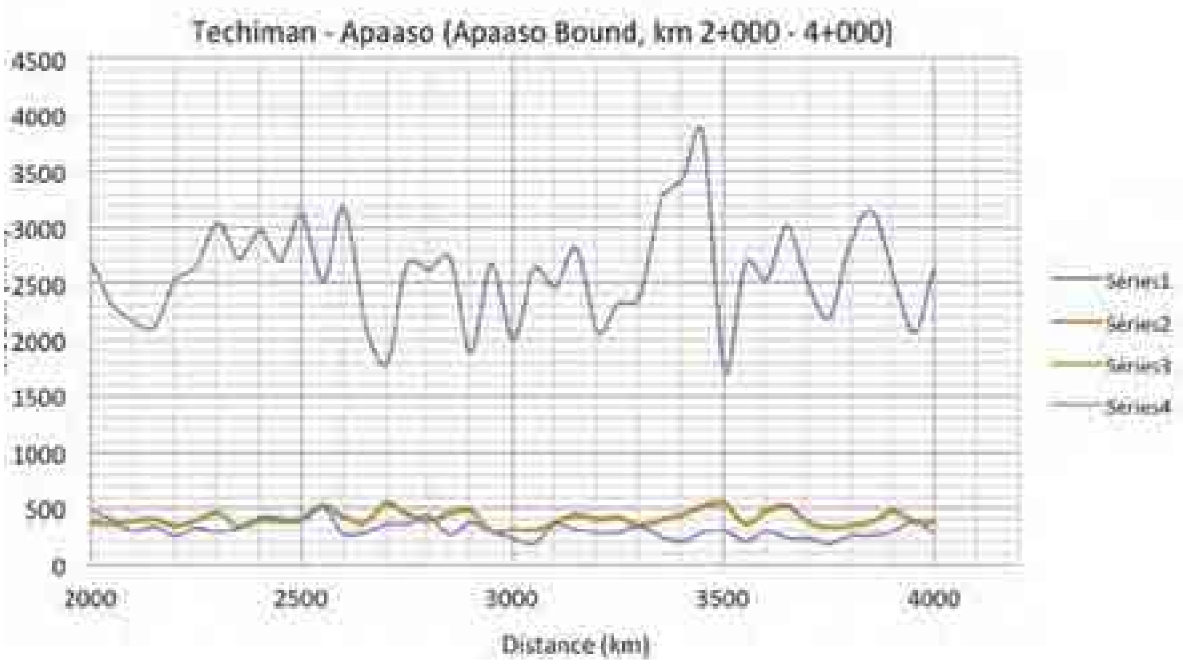


Figure A2.2.4-23: Falling Weight Deflection Test Result for Techiman – Apaaso (Apaaso Bound, km 2+000 - 4+000)

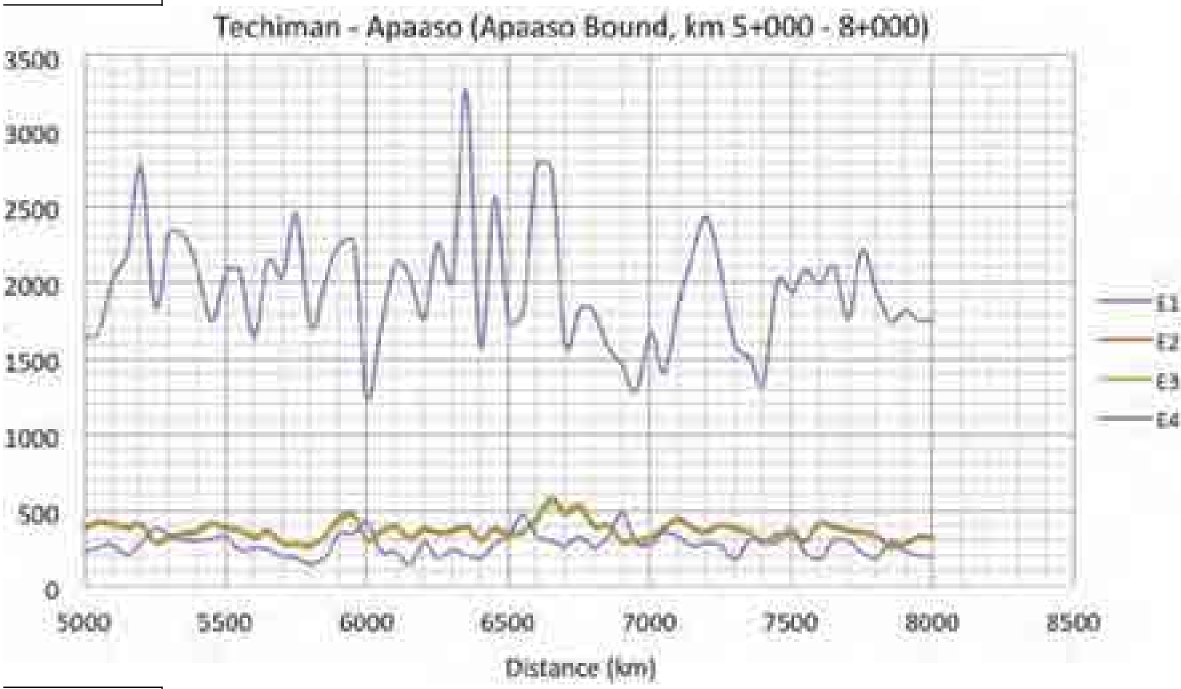


Figure A2.2.4-24: Falling Weight Deflection Test Result for Techiman - Apaaso (Apaaso Bound, km 5+000 - 8+000)

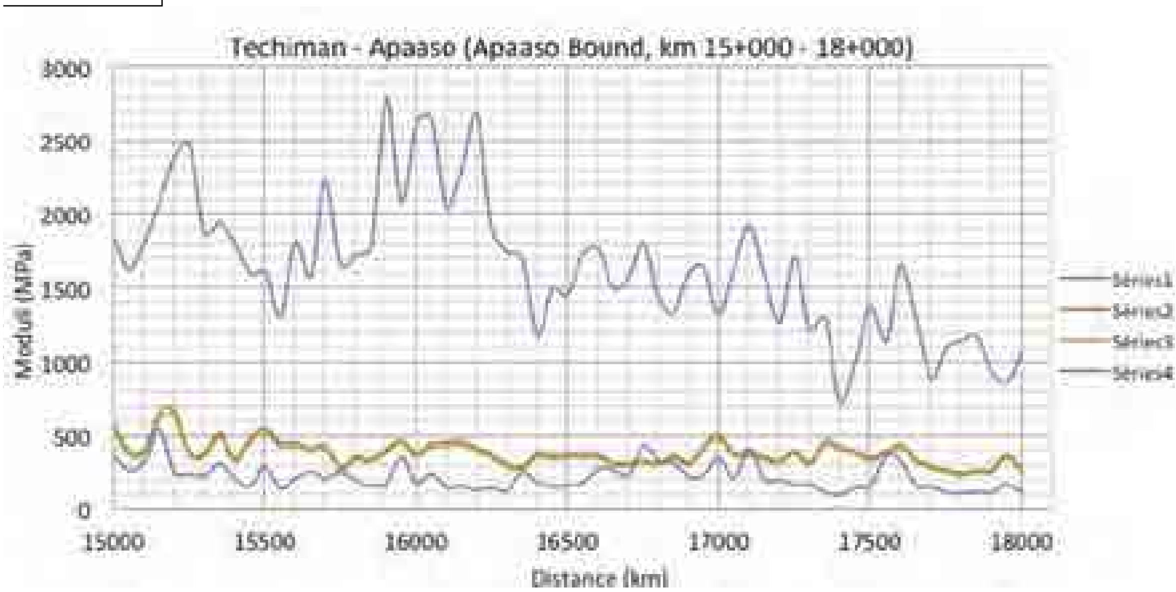


Figure A2.2.4-25: Falling Weight Deflection Test Result for Techiman - Apaaso (Apaaso Bound, km 15+000 - 18+000)

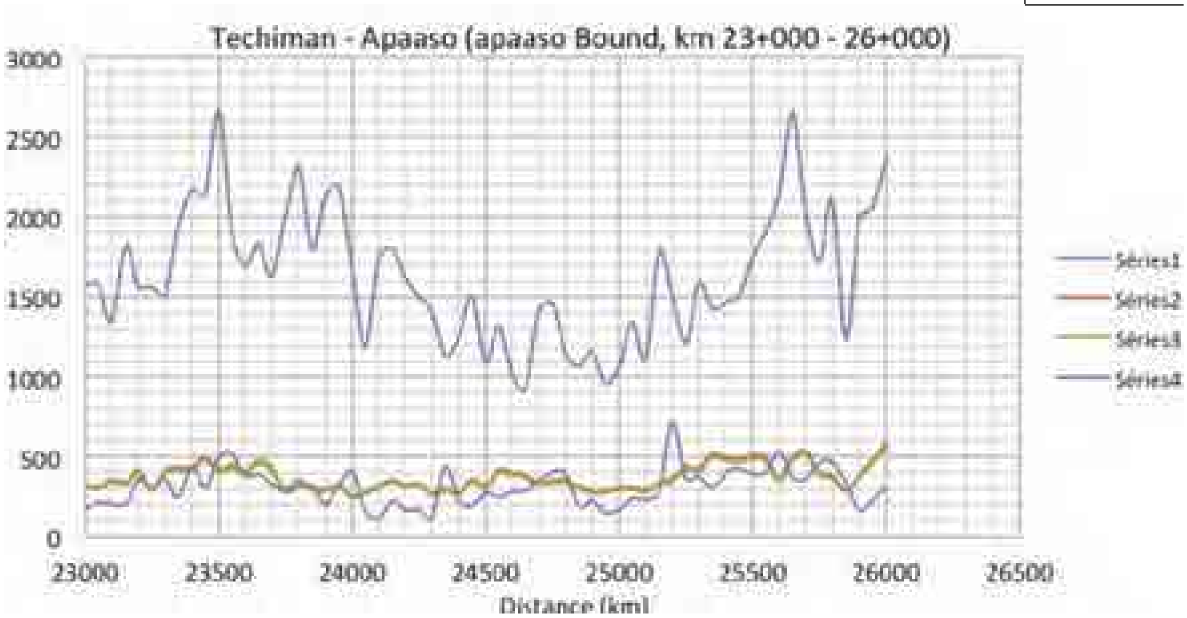


Figure A2.2.4-26: Falling Weight Deflection Test Result for Techiman - Apaaso (Apaaso Bound, km 23+000 - 26+000)

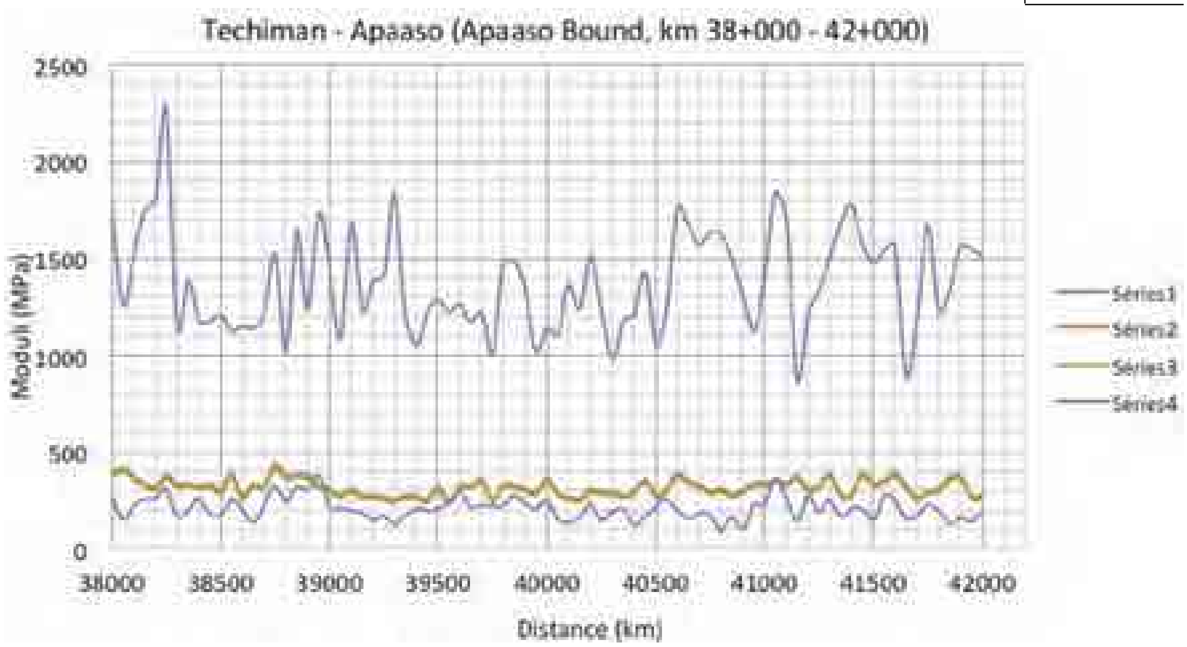


Figure A2.2.4-27: Falling Weight Deflection Test Result for Techiman - Apaaso (Apaaso Bound, km 38+000 - 42+000)

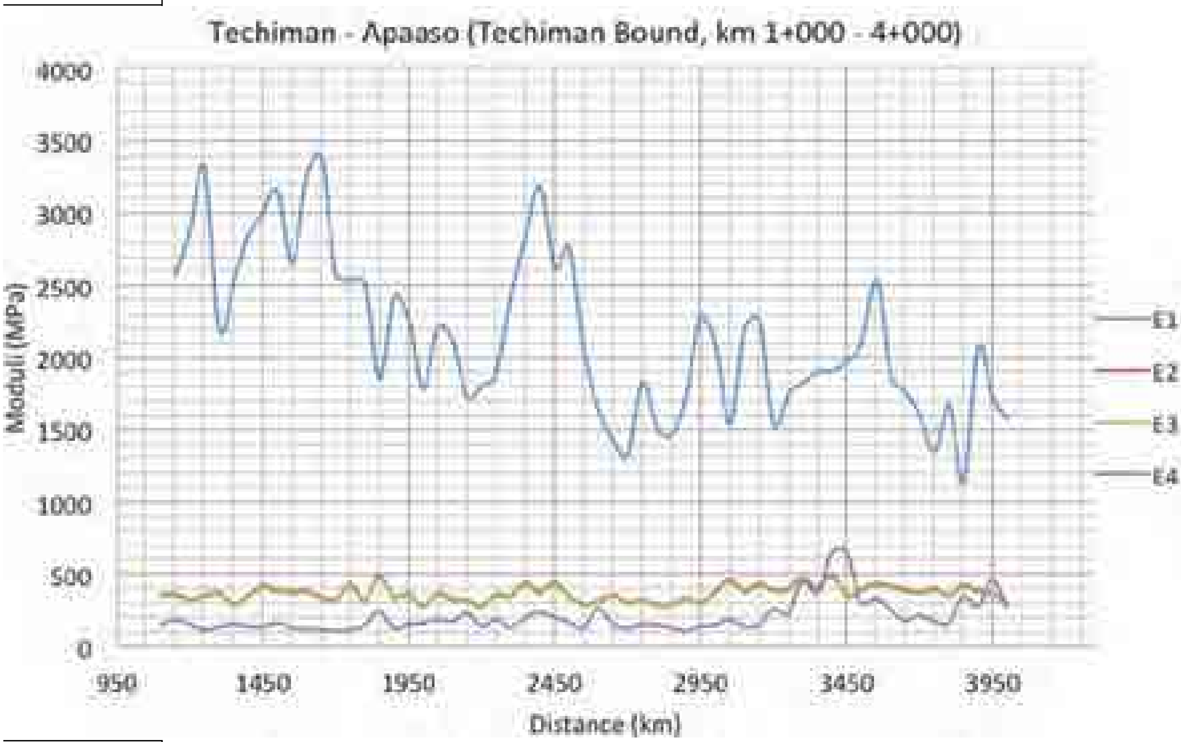


Figure A2.2.4-28: Falling Weight Deflection Test Result for Techiman - Apaaso (Techiman Bound, km 1+000 - 4+000)

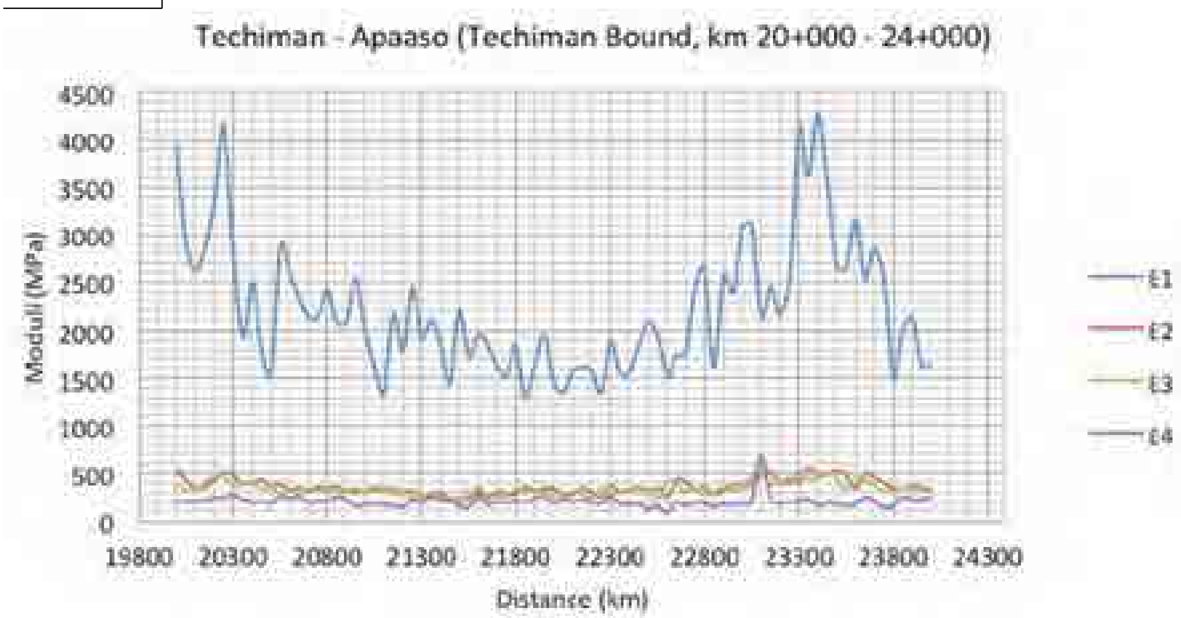


Figure A2.2.4-29: Falling Weight Deflection Test Result for Techiman - Apaaso (Techiman Bound, km 20+000 - 24+000)

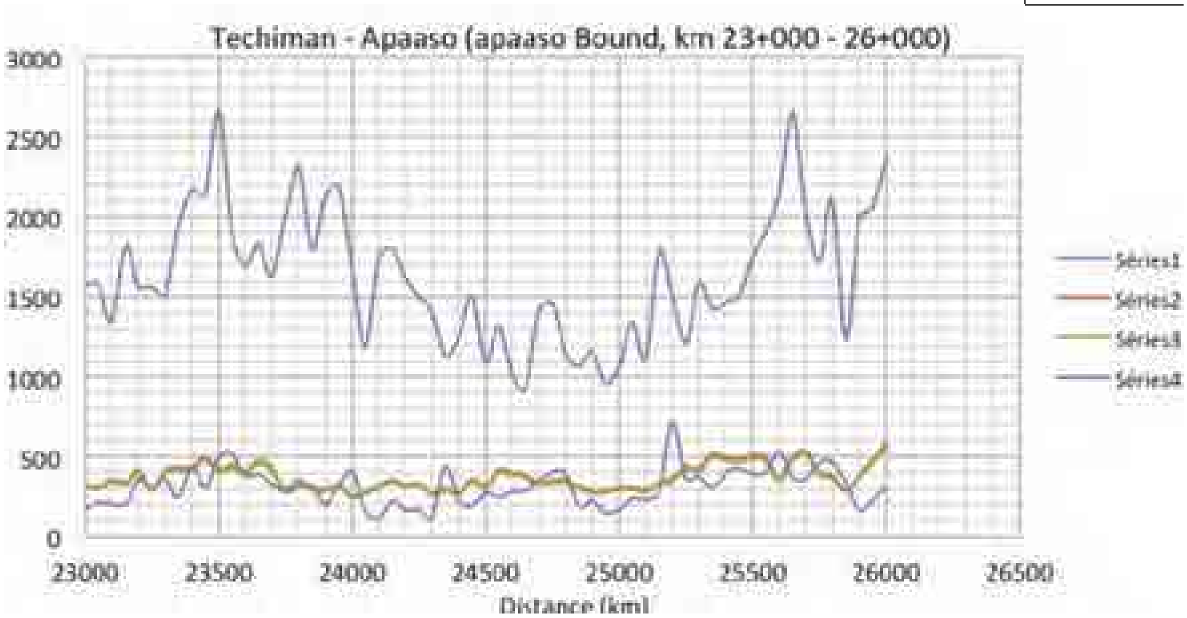


Figure A2.2.4-30: Falling Weight Deflection Test Result for Techiman - Apaaso (Techiman Bound, km 26+050 - 30+000)

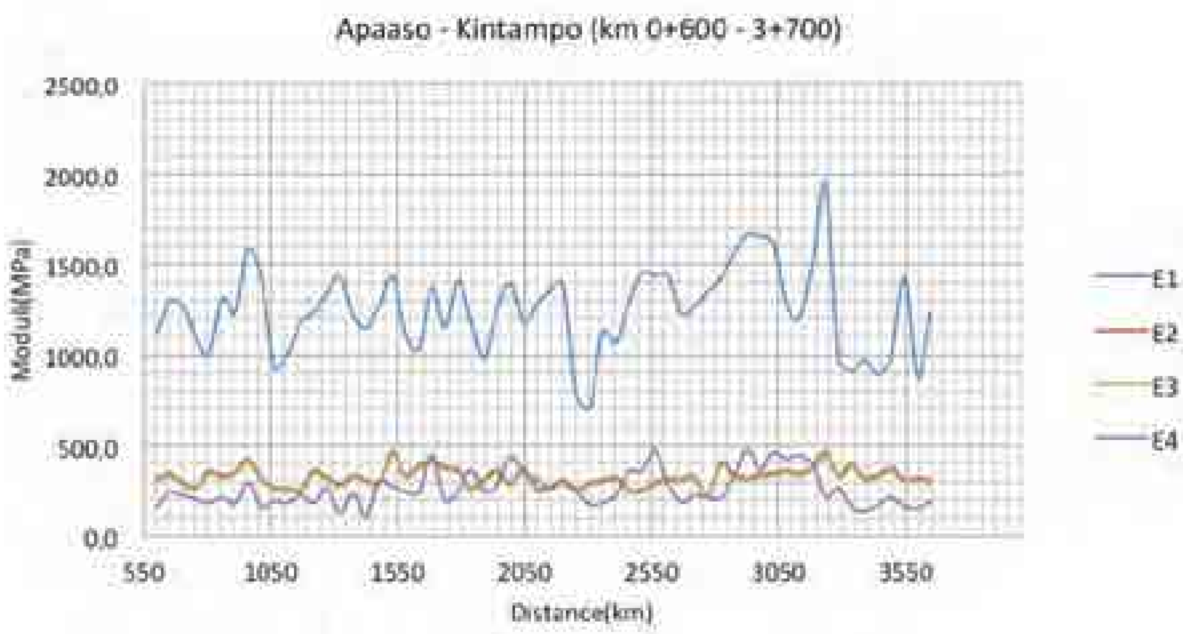


Figure A2.2.4-31: Deflection Test Result for Apaaso - Kintampo (Kintampo Bound, km 0+600 - 3+700)

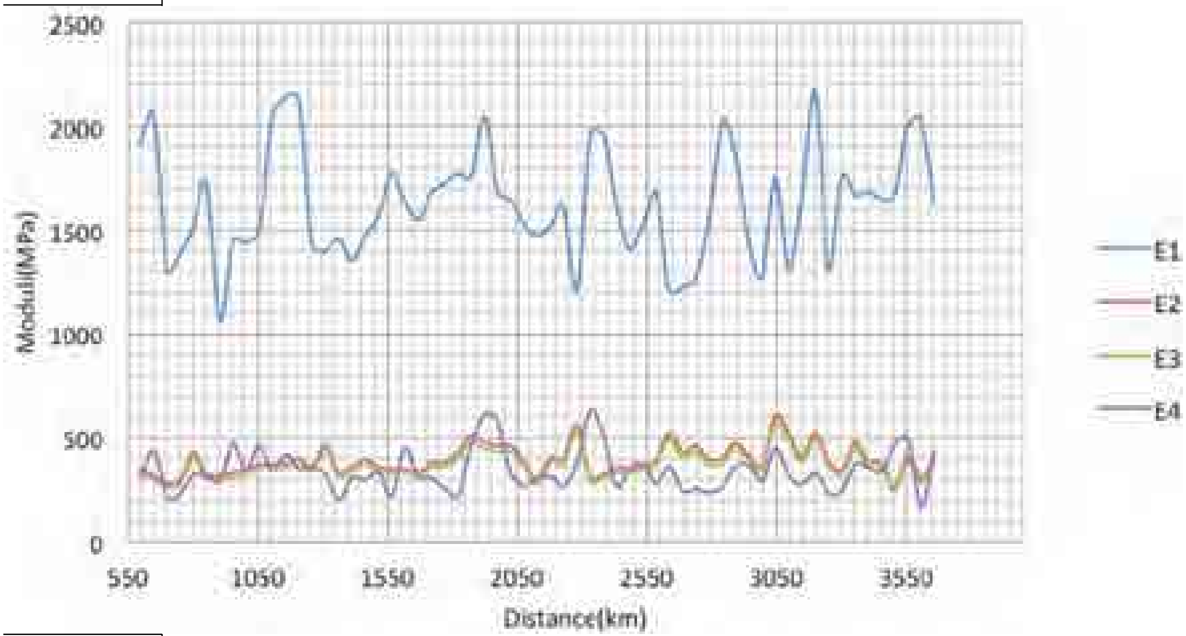


Figure A2.2.4-32: Deflection Test Result for Apaaso - Kintampo (Apaaso bound, km 0+600 - 3+700)

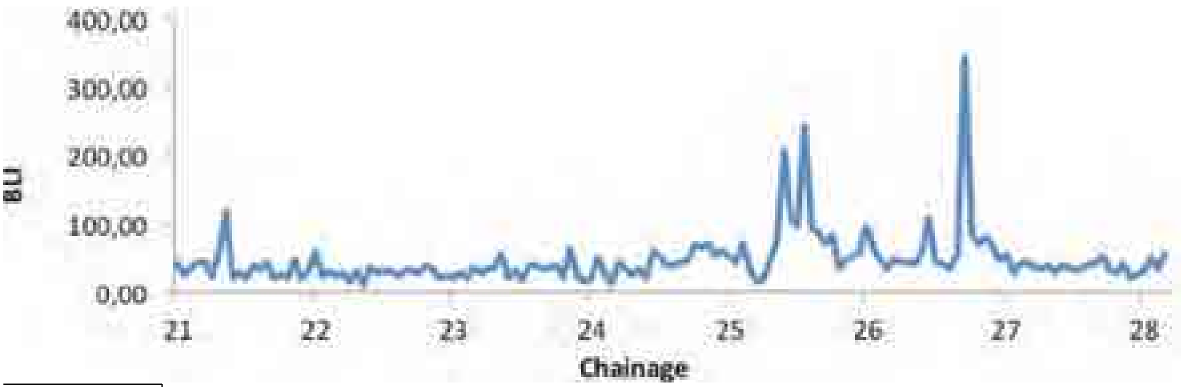


Figure A2.2.5-1: Base Layer Index (BLI) Values for Athi River - Namanga Road Section

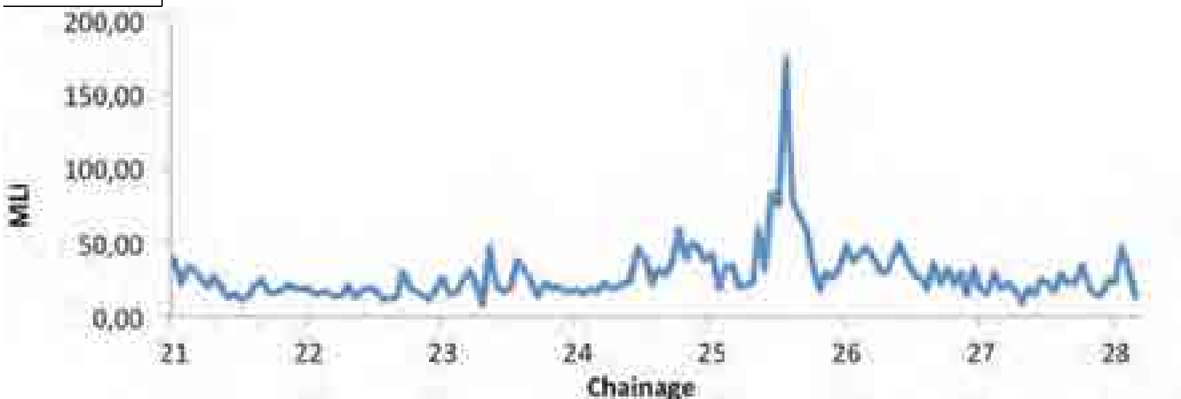


Figure A2.2.5-2: Middle Layer Index (MLI) Values for Athi River - Namanga Road Section

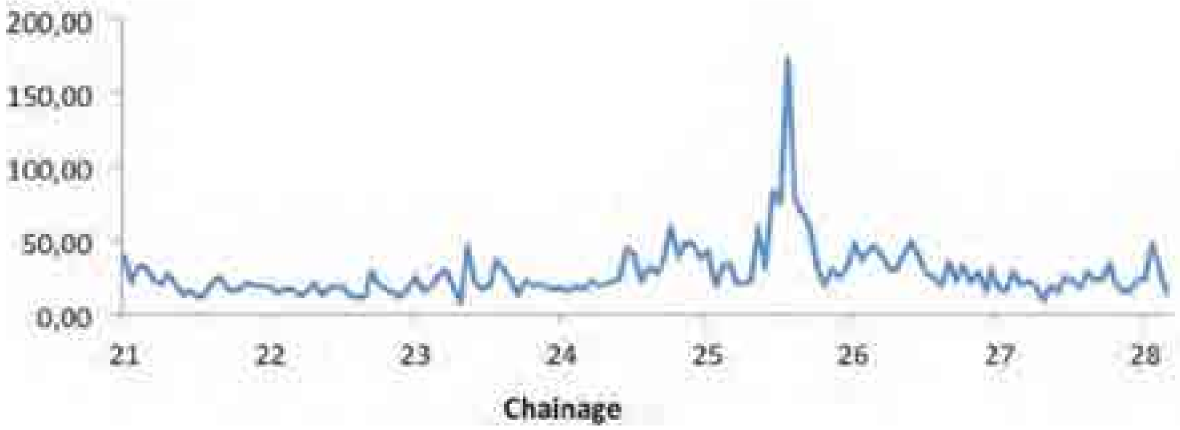


Figure A2.2.5-3: Lower Layer Index (LLI) Values for Athi River - Namanga Road Section

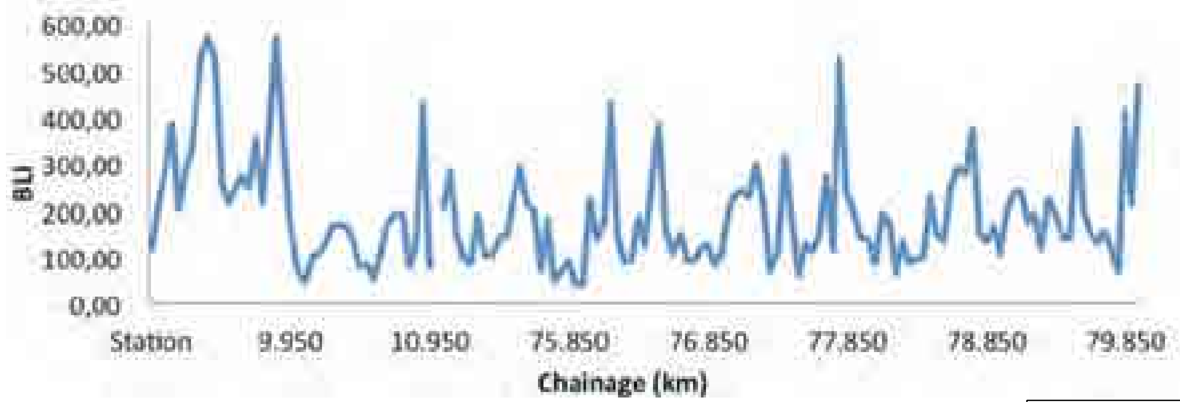


Figure A2.2.5-4: Base Layer Index (BLI) Values for Isiolo - Merillie Road Section

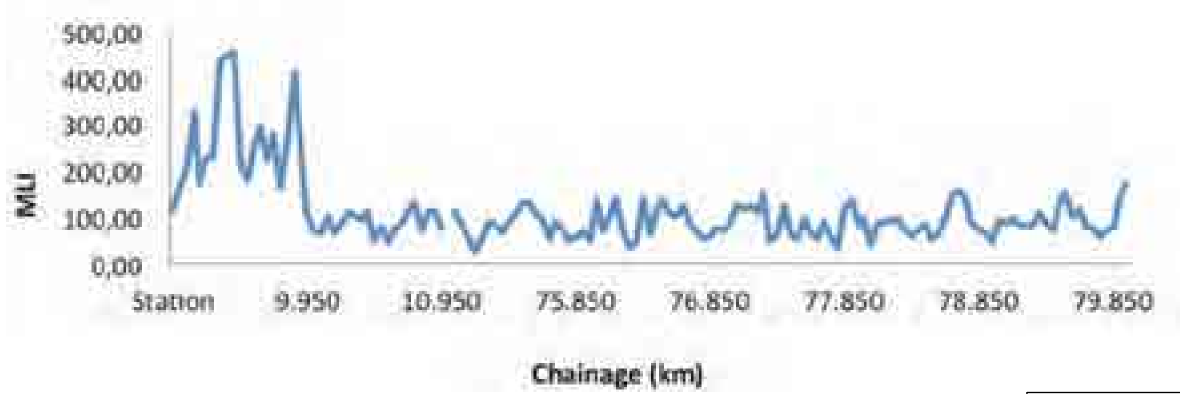


Figure A2.2.5-5: Middle Layer Index (MLI) Values for Isiolo - Merillie Road Section

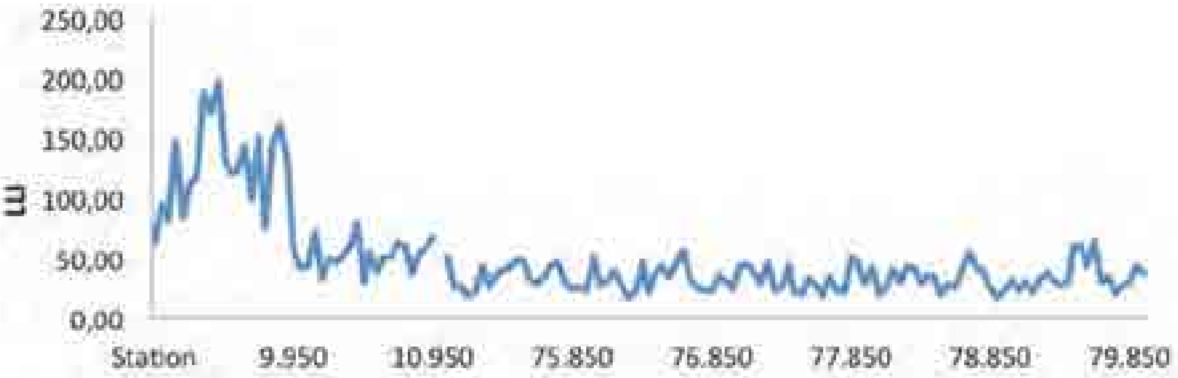


Figure A2.2.5-6: Lower Layer Index (LLI) Values for Isiolo - Merille Road Section

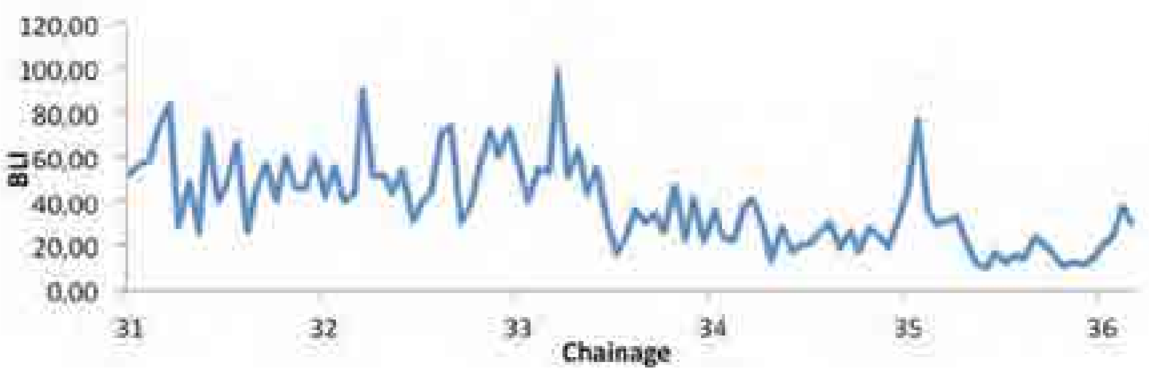


Figure A2.2.5-7: Base Layer Index (BLI) Values for Nairobi - Thika Road Section

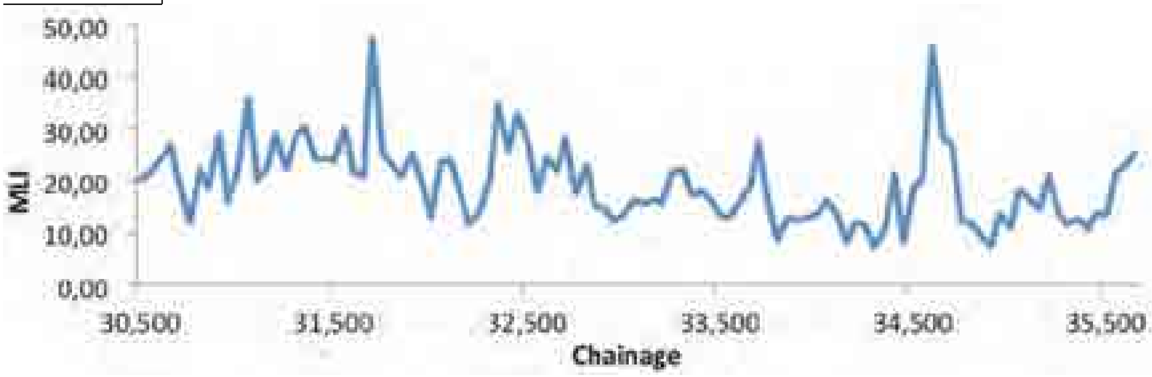


Figure A2.2.5-8: Middle Layer Index (MLI) Values for Nairobi - Thika Road Section

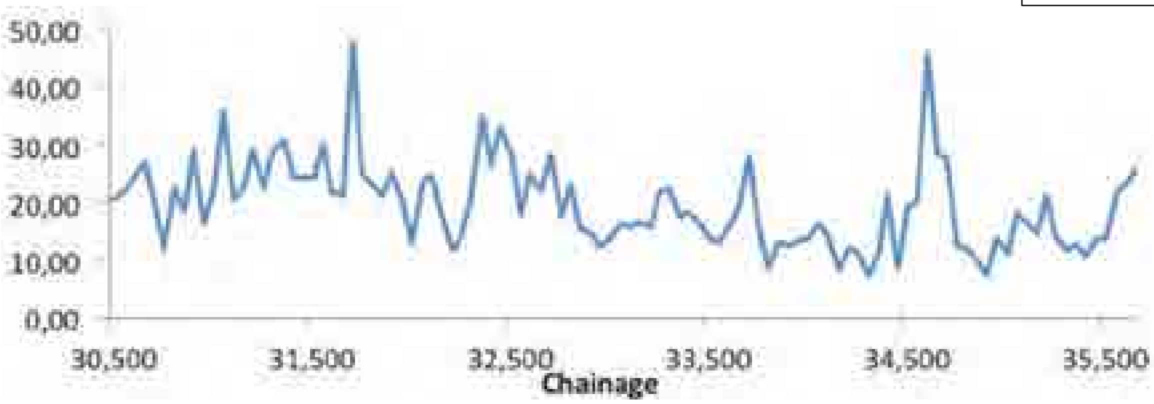


Figure A2.2.5-9: Lower Layer Index (LLI) Values for Nairobi - Thika RoadSection.

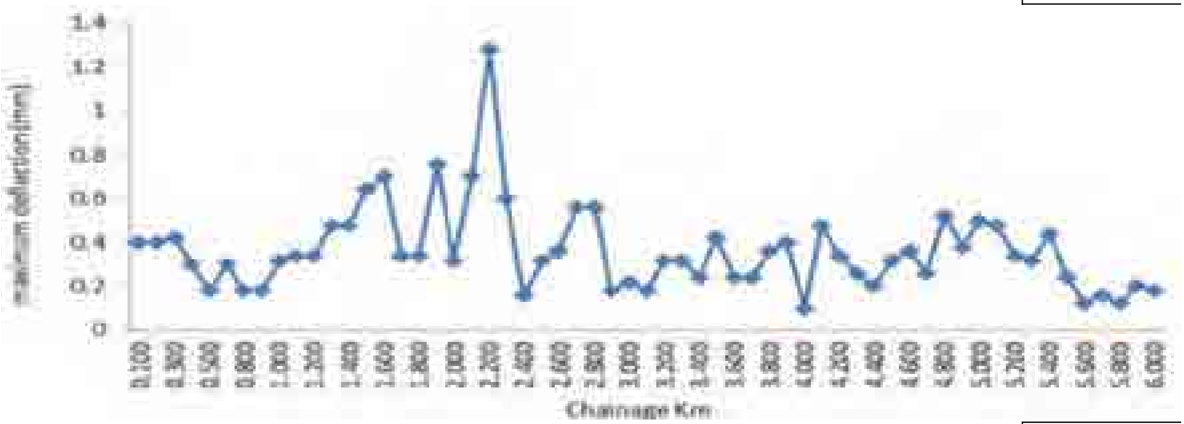


Figure A2.2.6a-1: Maximum Deflections for Amani - Dunga Road Section (Dunga Bound, km 0 - 6)

Figure A2.2.6a-2: Figure A2.2.6a-2: Maximum Deflections for Amani - Dunga Road Section (Amani Bound, km 0 - 6)

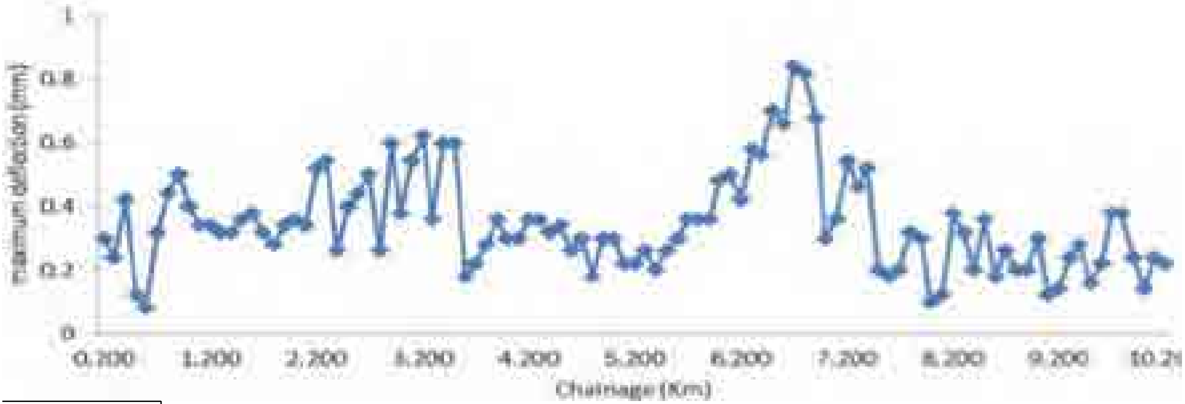


Figure A2.2.6a-3: Maximum Deflections for Manzizini - Fumba Road Section (Fumba Bound, km0 + 100 - 10 + 100)

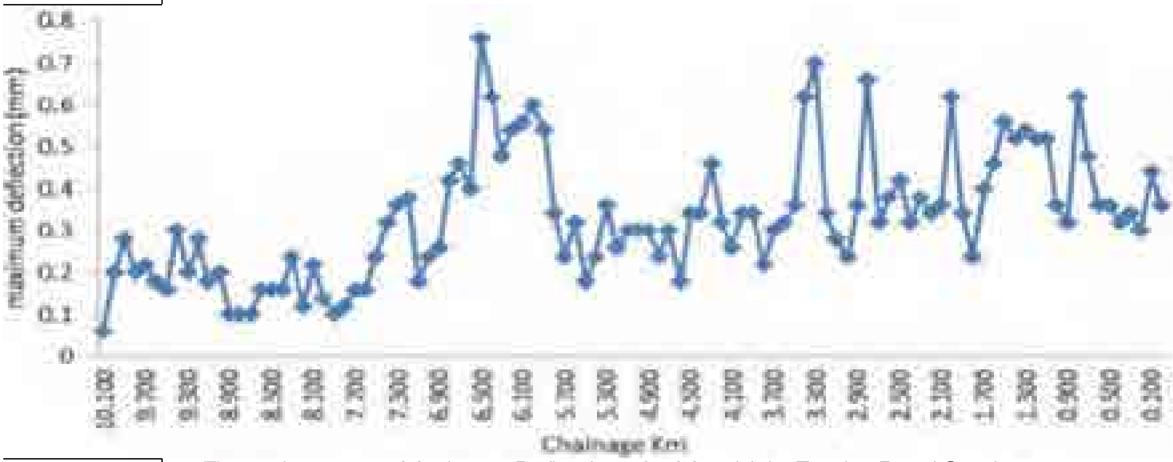


Figure A2.2.6a-4: Maximum Deflections for Manzizini - Fumba Road Section (Manzizini Bound, km 0 + 100 - 10 + 100)

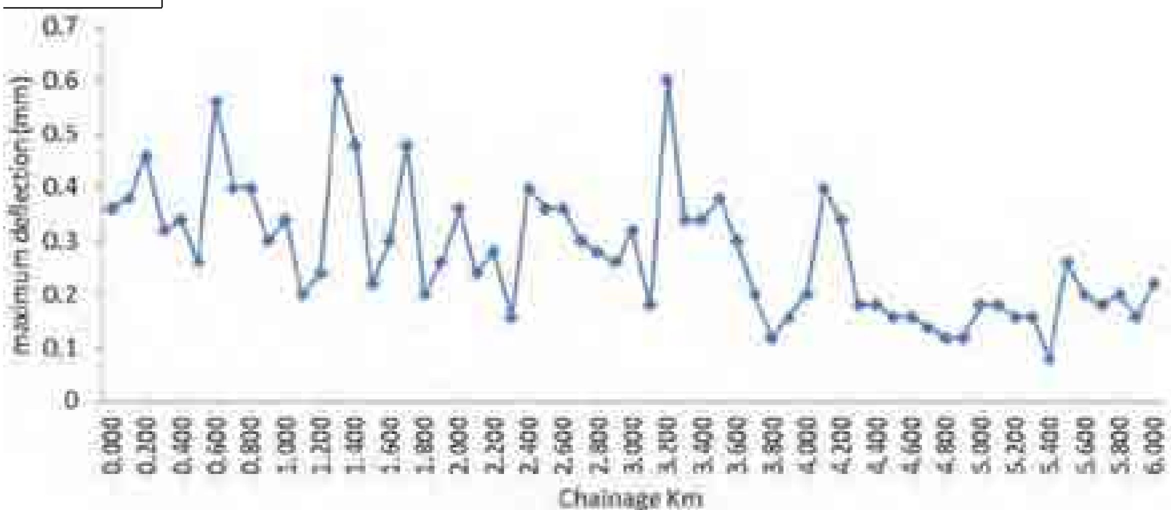


Figure A2.2.6a-5: Maximum Deflection for Mfenesini - Bumbwini Road Section (Bumbwini Bound, km 0 - 6)

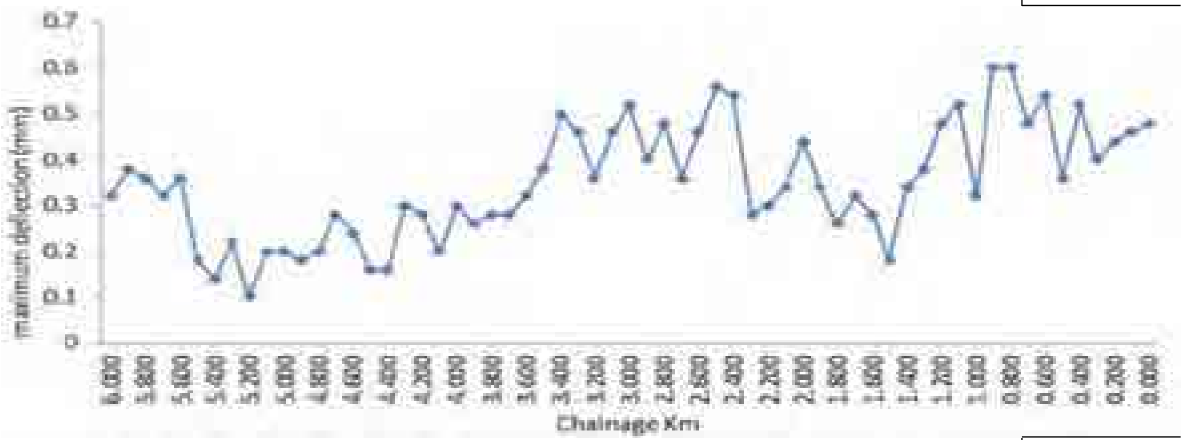


Figure A2.2.6a-6: Maximum Deflections for Bumbwini - Mfenesini Road Section (Mfenesini Bound, km 0 - 6)

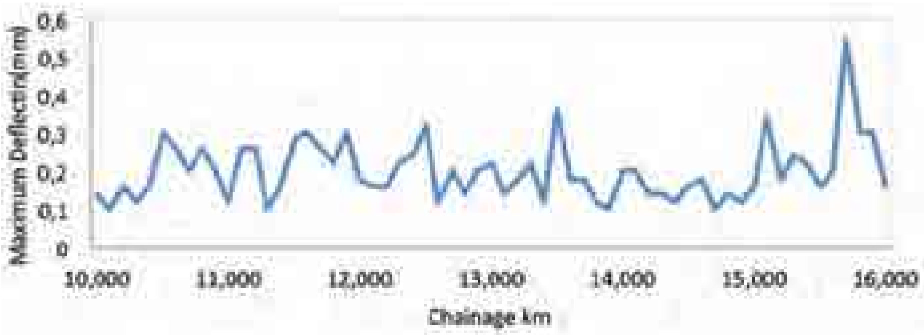


Figure A2.2.6b-1: Maximum Deflections for Singida - Katesh Road Section (Katesh Bound, km 10 - 16)

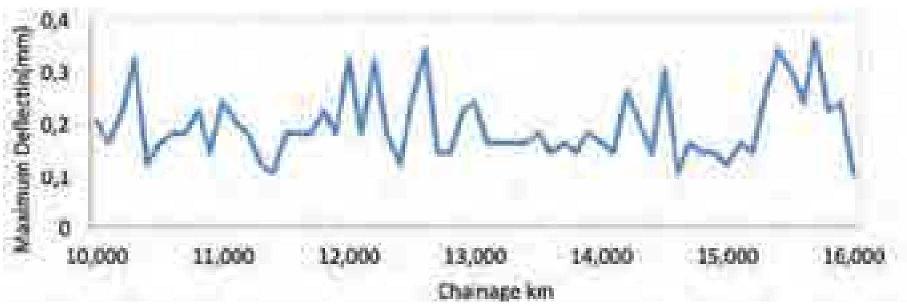


Figure A2.2.6b-2: Maximum Deflections for Singida - Katesh Road Section (Singida Bound, km 10 - 16)

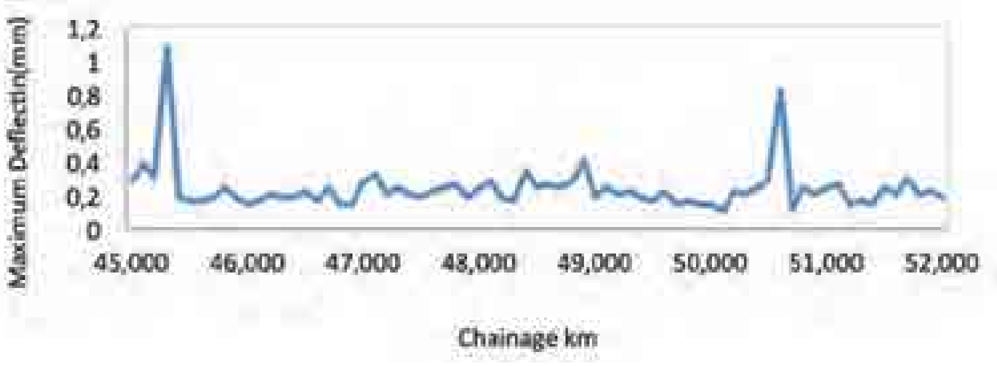


Figure A2.2.6b-3: Maximum Deflections for Singida - Katesh Road Section (Katesh Bound km 45 - 52)

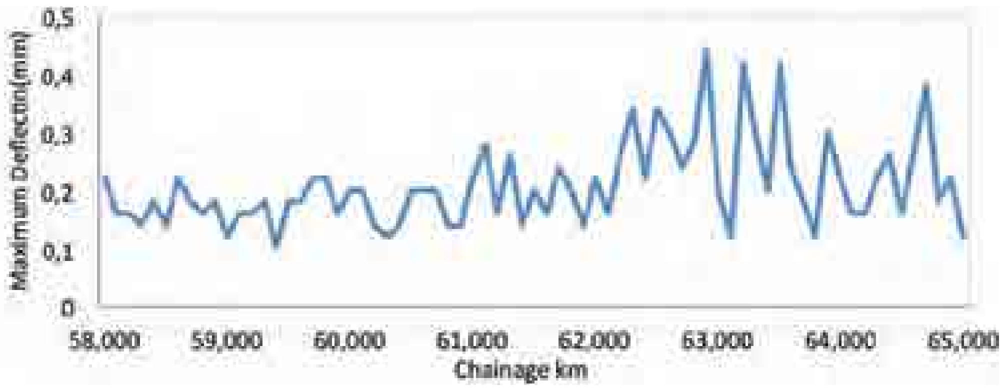


Figure A2.2.6b-4: Maximum Deflections for Singida - Katesh Road Section (Singida Bound, km 45 - 52)

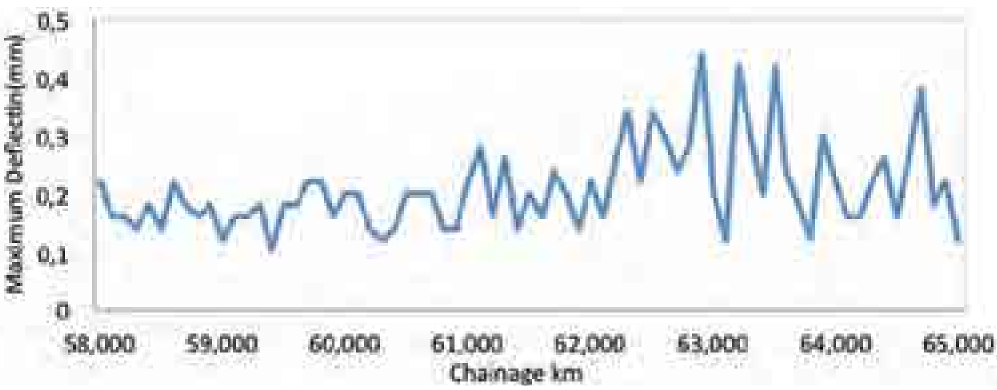


Figure A2.2.6b-5: Maximum Deflections for Singida - Katesh Road Section (Katesh bound km 58 - 65)

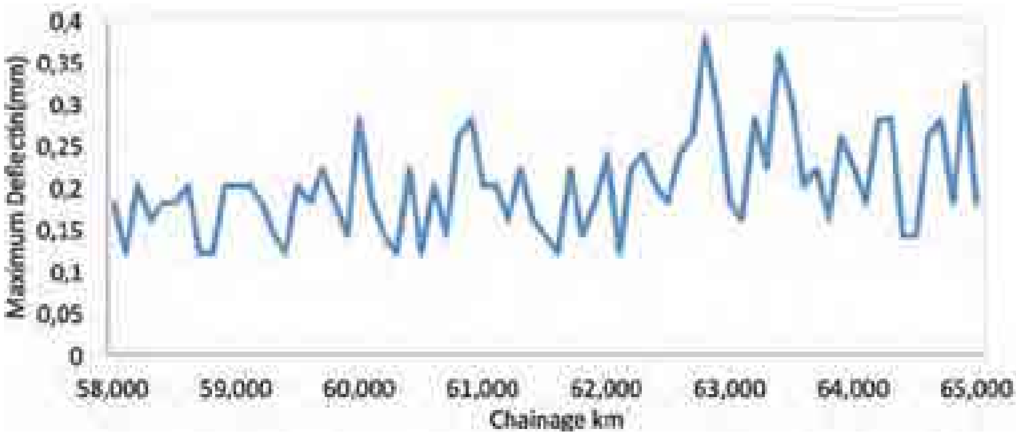


Figure A2.2.6b-6: Maximum Deflections for Singida - Katesh Road Section (Singida Bound, km 58 - 65)

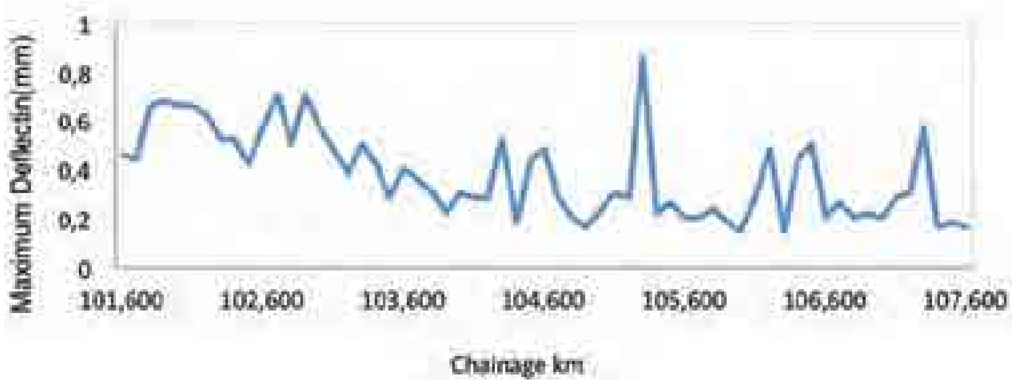


Figure A2.2.6b-7: Maximum Deflections for Katesh - Dareda Road Section (Dareda Bound, km 101.6 - 107.6)

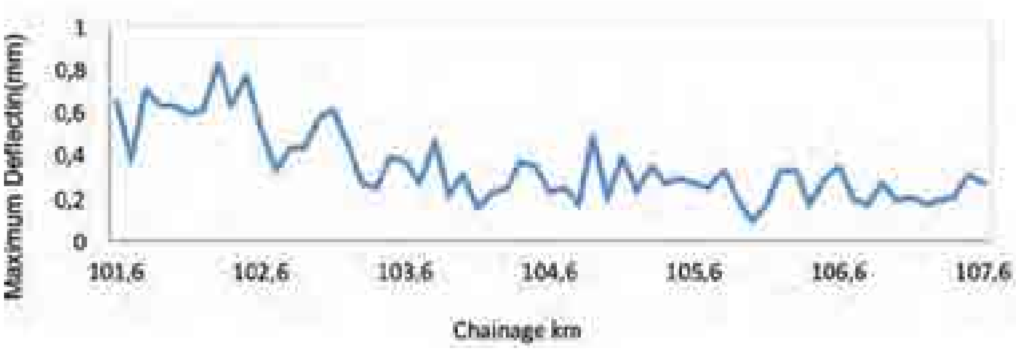


Figure A2.2.6b-8: Maximum Deflections for Katesh - Dareda Road Section (Katesh Bound, km 101.6 - 107.6)

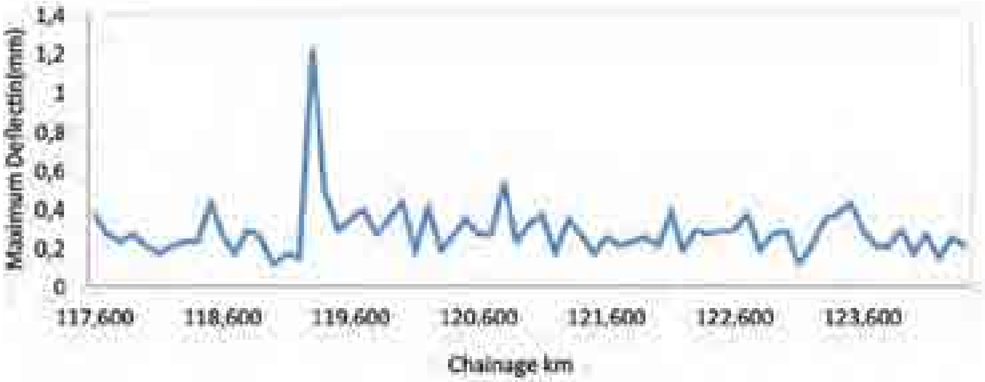


Figure A2.2.6b-9: Maximum Deflections for Katesh - Dareda Road Section (Dareda Bound, km 117.6 - 124.6)

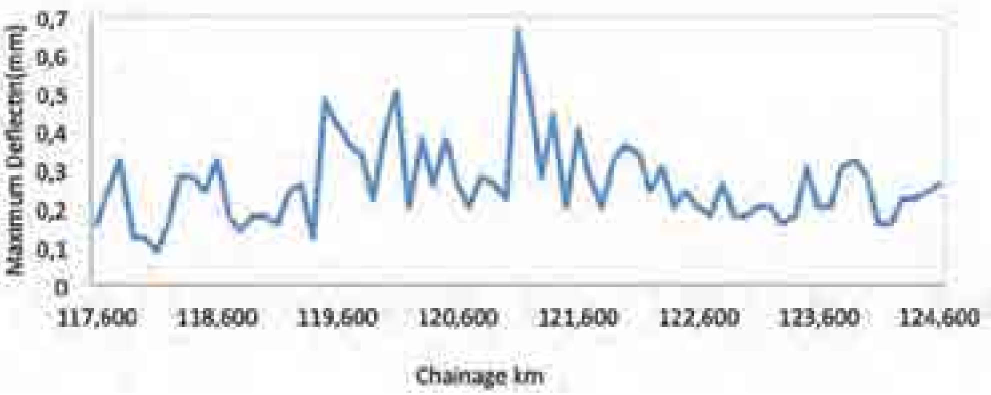


Figure A2.2.6b-10: Maximum Deflections for Katesh - Dareda Road Section (Dareda Bound, km 117.6 - 124.6)

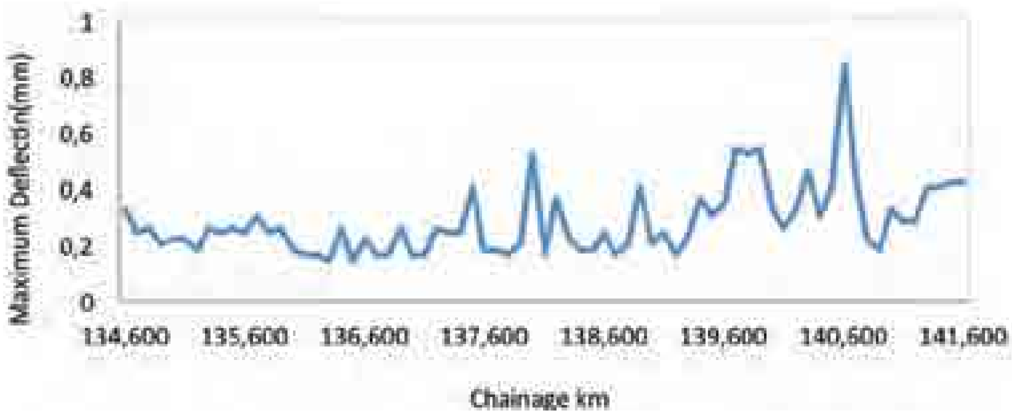


Figure A2.2.6b-11: Maximum Deflections for Kateh - Dareda Road Section (Dareda Bound, km 134.6 - 141.6)

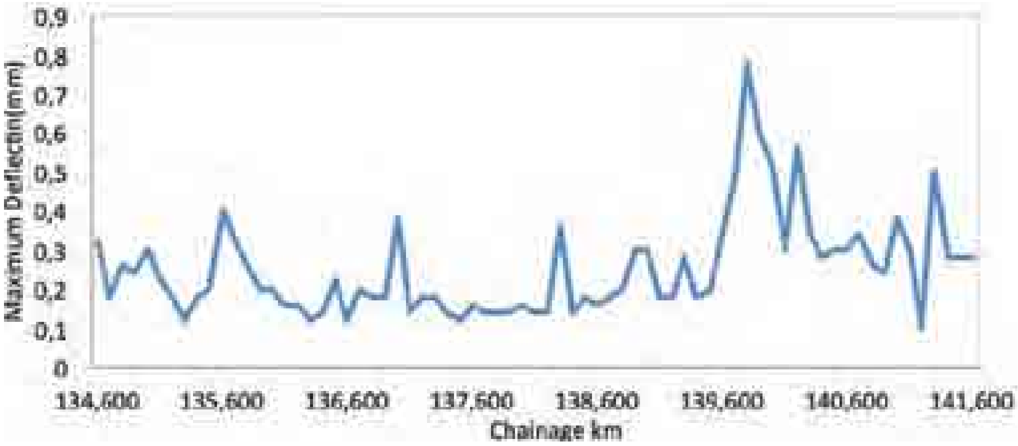


Figure A2.2.6b-12: *Maximum Deflections for Katesh - Babati - Minjingu Road Section (Katesh Bound km 134.6 - 141)*

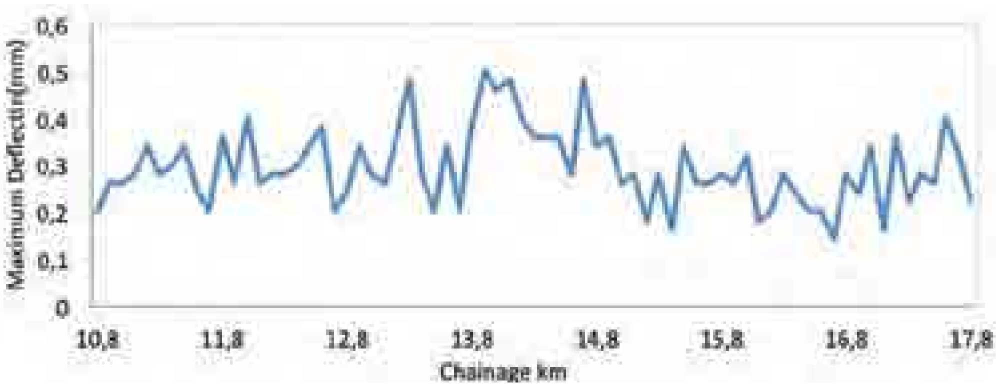


Figure A2.2.6b-13: *Maximum Deflections for Dareda - Babati - Minjingu Road Section (Minjigu Bound, km 10.8 - 17.8)*

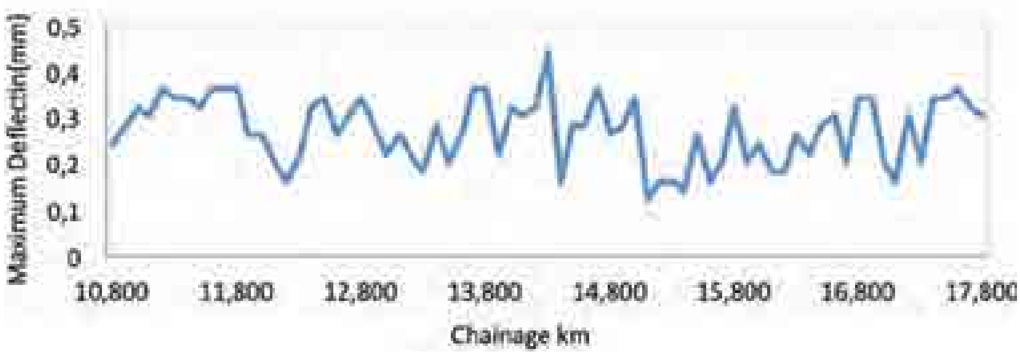


Figure A2.2.6b-14: *Maximum Deflections for Dareda - Babati - Minjingu - Road Section (Dareda Bound, km 10.8-17.8)*

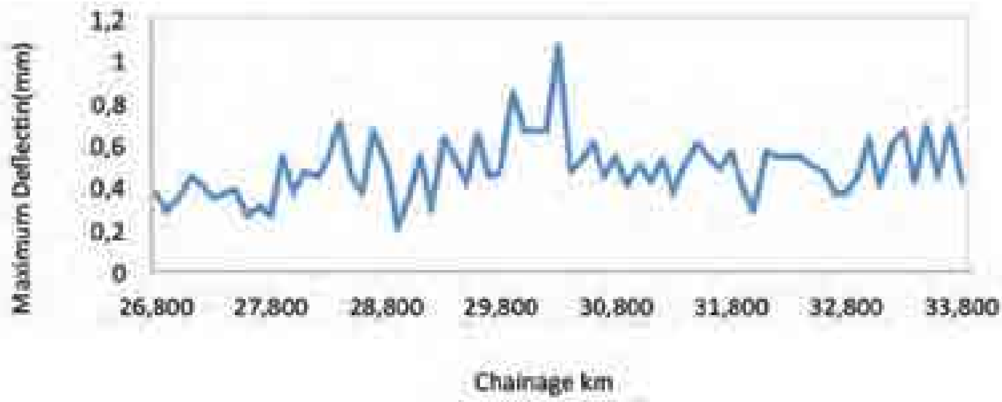


Figure A2.2.6b-15: Maximum Deflections for Dareda - Babati - Minjingu Road Section (Minjingu Bound, km 26.8 - 33.8)

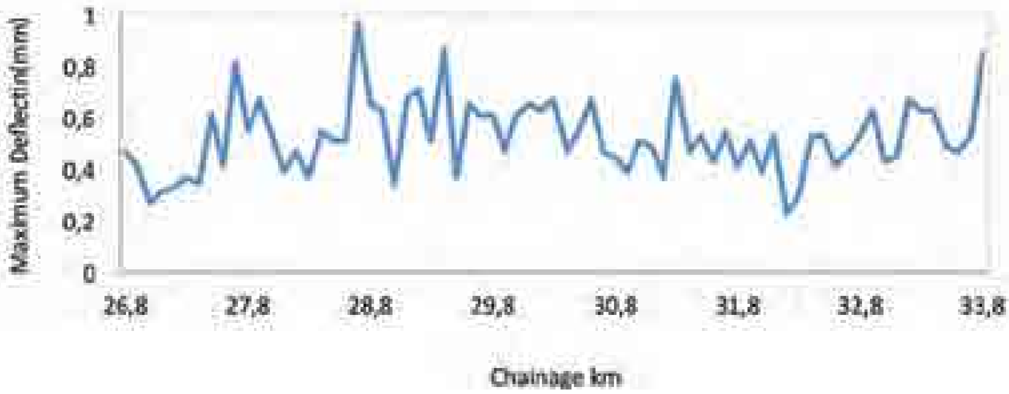


Figure A2.2.6b-16: Maximum Deflections for Dareda - Babati - Minjingu Road Section (Dareda Bound, km 26.8 - 33.8)

Figure A2.2.6b-17: Maximum Deflections for Dareda - Babati - Minjingu Road Section (Minjingu Bound, km 45.0 - 51.0)

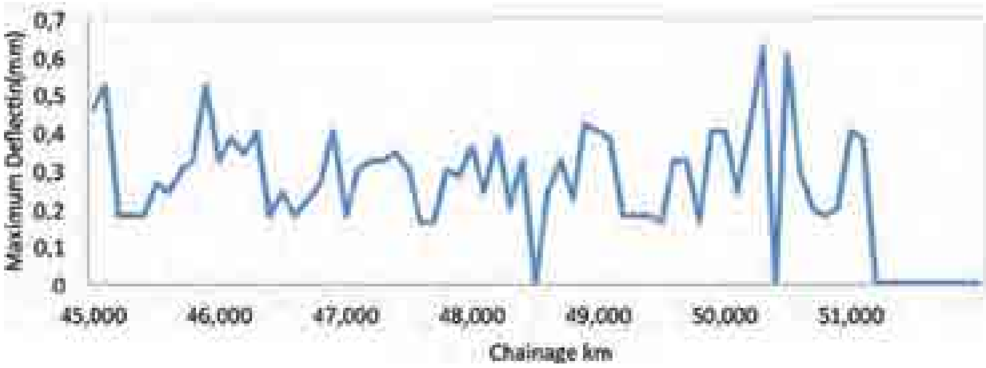


Figure A2.2.6b-18: Maximum Deflections for Dareda - Babati - Minjingu Road Section (Dareda Bound, km 45.0 - 51.0)

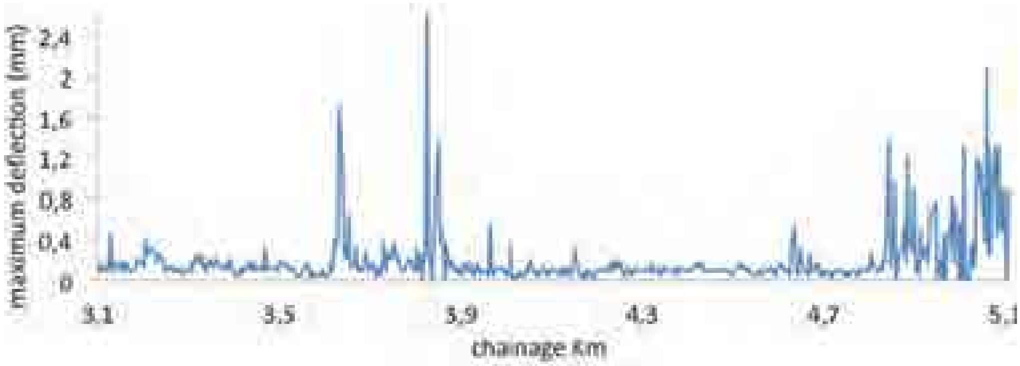


Figure A2.2.7-1: Maximum Deflections for Bab El Khadra - Station Metro Road Section

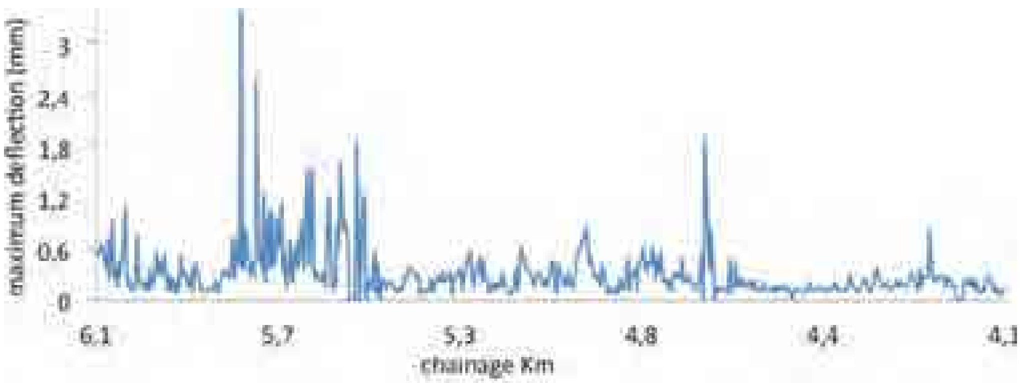


Figure A2.2.7-2: Maximum Deflections for Stade Rades - Ben Arous Road Section

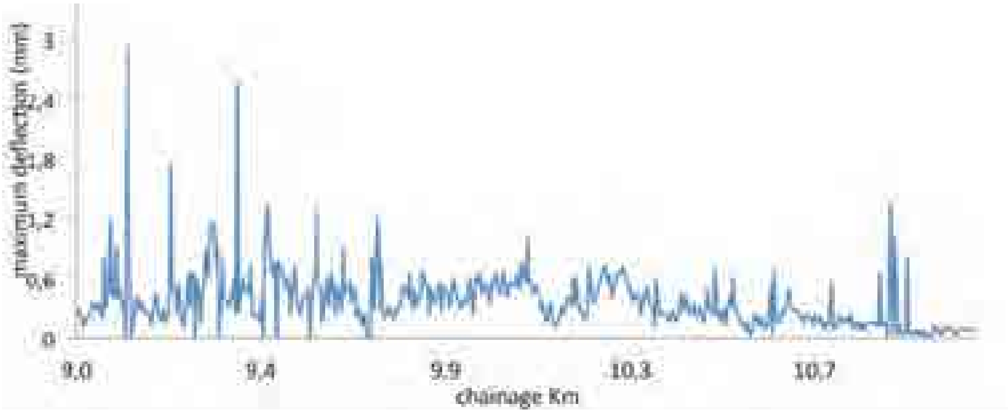


Figure A2.2.7-3: Maximum Deflections for Ben Arous - Mornag Road Section

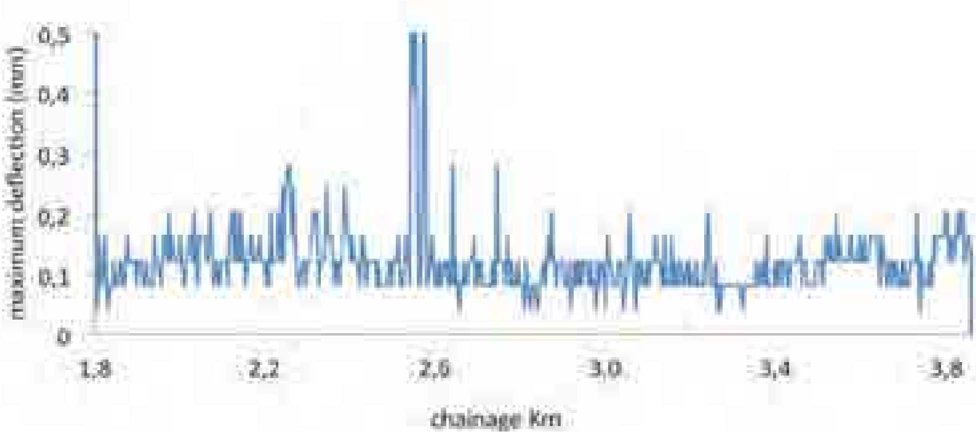


Figure A2.2.7-4: Maximum Deflections for Carrefour Hopital Ariana - RR 31 Road Section

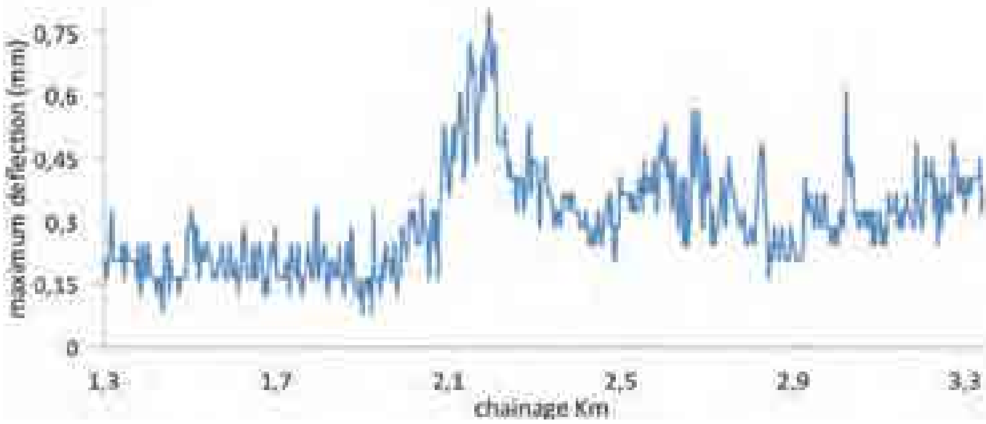


Figure A2.2.7-5: Maximum Deflections for Jdaida - Tebourba Road Section

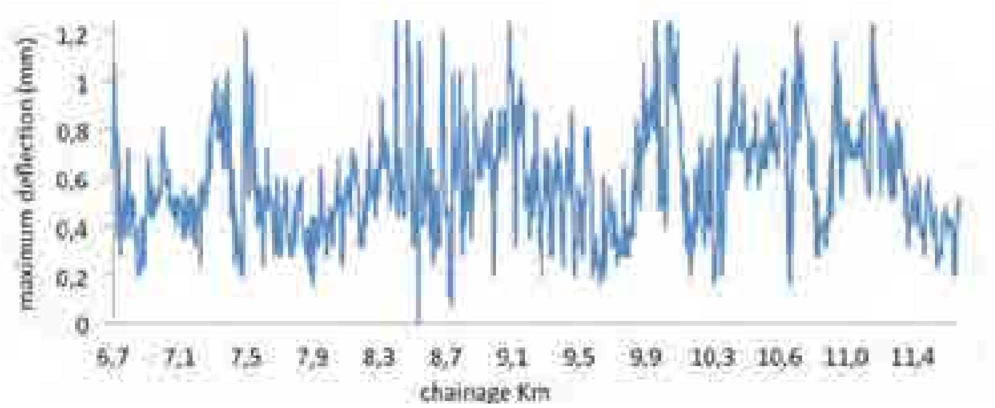


Figure A2.2.7-6: Maximum Deflections for Limite Gouvernorat de Ben Arous - Grombalia Road Section

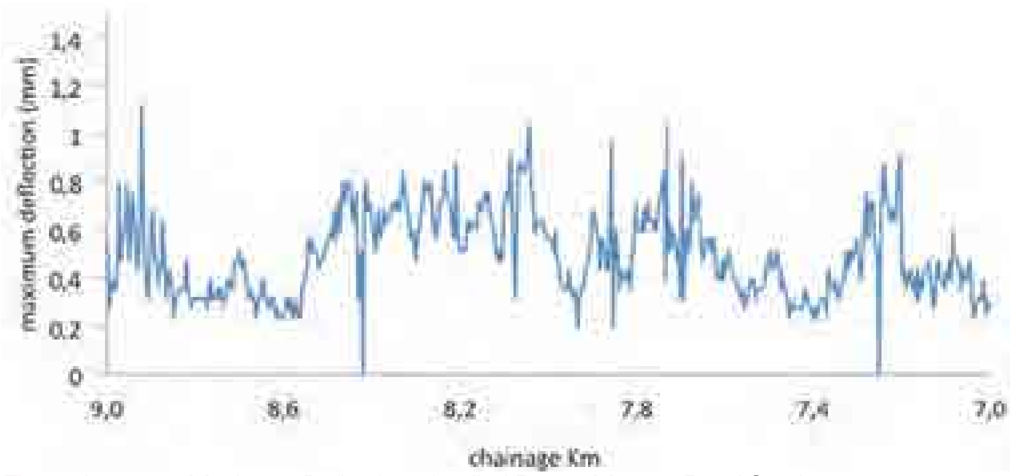


Figure A2.2.7-7: Maximum Deflections for Jbel Rsas - Mornag Road Section

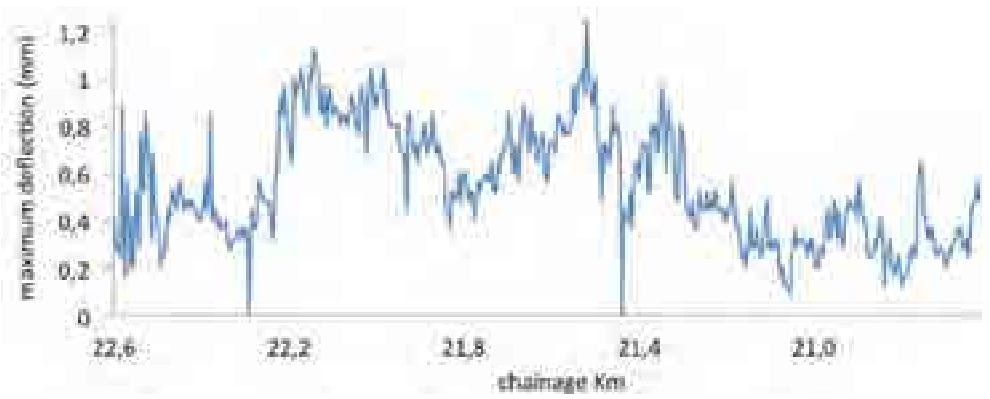


Figure A2.2.7-8: Maximum Deflections for Khlidia - Jbel Rsas Road Section

Figure A2.2.8-1: Maximum Deflections for Kabale - Kisoro - Bunagana Road Section (Kisoro Bound, km 5+000 - km 10+000)

Figure A2.2.8-2: Maximum Deflections for Kabale - Kisoro - Bunagana Road Section (Kabale Bound, km 10+000 - km 15+000)

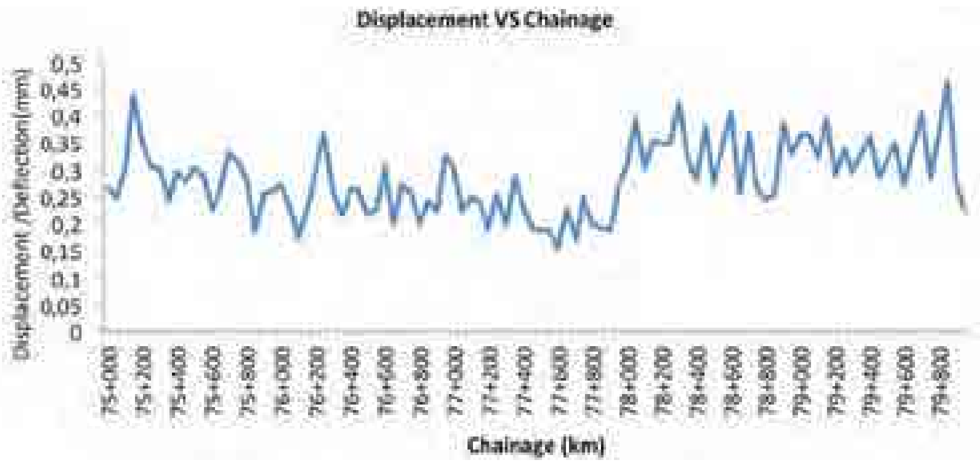


Figure A2.2.8-3: Maximum Deflections for Kabale - Kisoro - Bunagana Road Section (Kisoro Bound, km 75+000 - km 79+800)

Figure A2.2.8-4: Maximum Deflections for Kabale - Kisoro - Bunagana Road Section (Kabale Bound, km 80+000 - km 85+000)

Appendix 2.3: Laboratory test results

Table A2.3.1-1: Results of Gradation Test for Bituminous Concrete Samples for Bamenda - Batibo - Numba Road Section

Chainage (km)	Sieve size (mm)							
	10	6.3	4	2	1	0.315	0.160	0.08
12+061 (LHS)	99.1	70.6	56.2	36.1	25.6	15.9	12.1	8.7
30+040 (LHS)	98.2	69.3	55.1	35.8	25.5	14.8	11.5	7.7
4+330 (RHS)	99.2	71.4	56.5	37.1	26.1	14.5	10.8	8.1
17+030 (RHS)	98.5	68.5	55.4	36.5	26.2	14.8	11.3	8.5
Specification Limits (%)	90-100	65-75	50-60	30-45	20-32	10-18	8-14	7-9

Table A2.3.1-2: Marshal Stability, Relative Compaction and Bitumen Content Results for Bituminous Concrete Samples for Bamenda - Batibo - Numba Road Section

Chainage	Thickness (mm)	Bitumen Content (%)	Marshall Stability (N)	Relative Compaction (%)
12+061 (LHS)	71	5.61	2480	99.2
30+040 (LHS)	60	5.64	2490	99.2
4+330 (RHS)	55	5.70	2480	98.8
17+030 (RHS)	52	5.62	2470	98.4

Table A2.3.1-3: Test Results on Base, Sub-base and Subgrade Course Samples

Chainage	Pavement Layer	Optimum Moisture Content (%)	Maximum Dry Density (kg/m3)	Liquid Limit	Plastic Limit	CBR at 95% MDD
17+030	Base	5.5	2.41	-	-	92.5
Specified Limits	-	*> 2.0*	-	-	*> 80*	
17+030	Sub-base	15.5	1.88	56.3	37.4	43.0
Specified Limits	-	*1.8 – 2.2*	-	-	*> 30*	
17+030	Subgrade	16.3	1.87	57.4	38.2	42.5
Specified Limits	-	*> 1.7*	-	-	*>15*	

Table A2.3.1-4: Gradation Test Results for Bituminous Concrete Sample for Nandeke - Mbere Road Section

Chainage (km)	Percent Passing - SIEVE SIZE (mm)									
	14	12.5	10	6.3	4	2	1	0.315	0.160	0.08
88+675	99	91.8	83.6	69.5	62.7	40.1	28.8	16.8	11.7	8
102+225	98.8	93.7	83.6	71.6	61.5	38.4	26.6	16	11.1	7.4
119+425	98.3	92.1	85	68.2	63.6	43.2	31.4	18.3	12.9	8.7
Specified Limits (%)	90-100	90-100	90-100	65-75	50-60	30-45	20-32	10-18	8-14	7-9

In all the three cases, while fraction passing 10mm size is less, the fraction passing 4 mm size is more than the specified limits.

Table A2.3.1-5: Results of Tests on Bituminous Concrete Samples for Nandeke - Mbere Road Section

Chainage	Thickness (mm)	Bitumen Content (%)	Marshall Stability (%)	Relative Compaction (%)
88+675	50	5.9	1531	96.4
102+225	50	6.0	1388	96.6
119+425	50	6.2	1312	96.8

Table A2.3.2-1: Particle Size Distribution for Asphalt Concrete Sample on N'sele - Lufimi Road Section

Sieve Size (Mm)		16.5	10	5	4	2	1	0.315	0.2	0.08
Passing (%)		100	98	65	53	38	30	20	13	2
Specificied Limit	Min (%)	100	95	51	44	30	23	14	10	7
	Max (%)	100	100	65	59	45	33	21	16	10

Table A2.3.2-2: Particle Size Distribution Test Results for Bitumen Injected Base Sample on N'sele - Lufimi Road Section

Sieve Size (Mm)		25	20	10	4	2	1	0.315	0.2	0.08
Passing (%)		100	86	68	38	30	24	18	11	3
Specificied Limit	Min (%)	100	85	52	32	25	20	12	9	2
	Max (%)	100	90	75	52	40	33	23	19	10

Table A2.3.2-3: Gradation Test Results for Bituminous Concrete Samples for Kwango - Kenge Road Section

Sieve Size (Mm)		17	10	5	4	2	1	0.315	0.2	0.08
Passing (%)		100	86	60	52	36	29	23	16	2
Specificied Limit	Min (%)	100	95	51	44	30	23	14	10	7
	Max (%)	100	100	65	59	45	33	21	16	10

Table A2.3.3-1: Test on Bitumen Layers for Road Sections in Ghana

Section	Specimen type	Bulk Volume	Bulk specific gravity	Lab.Max. specific gravity	Air voids (%)
Nsawan bypass	WC	323.20	2.316	2.579	10.18
Nsawan bypass	BC	650.30	2.398	2.549	5.91
Nsawan bypass	DBM	306.40	2.261	2.529	10.59
Akatsi - Dzodze	WC	578.30	2.421	2.564	5.57
Dzodze - Akanu	WC	292.80	2.383	2.508	4.98
Agbozume –Aflao	WC	219.80	2.442	2.534	3.63
Agbozume –Aflao	BC	831.80	2.463	2.542	3.09
Akatsi - Agbozume	WC	269.7	2.345	2.555	8.23
Akatsi - Agbozume	BC	753.10	2.402	2.582	6.97
Akatsi bypass	WC	227.6	2.436	2.541	4.15
Akatsi bypass	BC	881.50	2.490	2.552	2.43
Techiman - Apaaso	BC	422.6	2.226	2.471	9.92
Apaaso -Kintampo	BC	459.20	2.278	2.473	7.88

Table A2.3.3-2: Bitumen Content and Gradation of Bituminous Layer of Road Sections in Ghana

Road name	Layer Type	Bitumen content (%)	28 mm	20 mm	14 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	425 µ	300 µ	150 µ	75 µ
Nsawam bypass	WC	6.4	99.73	99.73	99.73	83.01	66.09	54.04	43.14	33.02	21.91	16.77	9.41	4.85
Nsawam bypass	BC	4.3	99.45	90.4	82.88	66.86	50.86	42.65	33.4	25.67	17.98	14.35	8.90	5.23
Akatsi - Dodze	WC	5.1	99.63	99.63	97.32	85.27	65.24	50.96	38.72	29.77	21.82	17.95	12.44	4.88
Dodze - Akanu	WC	5.0	99.58	99.58	99.58	90.77	63.58	45.34	34.97	28.27	21.88	18.21	11.40	5.83
Dodze - Akanu	BC	4.9	99.78	97.88	87.94	75.96	57.96	44.09	36.06	30.56	24.15	20.20	11.81	5.43
Agbozume-Aflao	WC	7.7	99.3	99.3	90.48	82.87	56.34	39.86	30.59	24.36	19.38	15.04	8.58	4.4
Agbozume-Aflao	BC	4.9	99.01	97.35	87.59	79.24	59.09	43.41	34.00	27.62	21.66	17.73	11.05	6.23
Akatsi -Agbozume	WC	4.3	98.86	94.19	85.57	75.88	59.20	45.52	35.78	28.86	22.44	18.80	12.20	6.08
Akatsi -Agbozume	BC	6.3	98.83	87.68	79.47	65.85	40.62	27.12	20.59	16.84	14.13	12.40	8.50	4.30
Akatsi bypass	WC	4.6	99.05	98.36	91.43	82.91	58.51	39.49	30.54	25.16	19.90	17.13	11.70	6.63
Akatsi bypass	BC	4.6	98.38	96.96	91.11	80.76	56.68	40.64	31.99	26.26	20.6	17.33	11.19	5.66
Techiman - Apaaso	WC	4.9	97.59	97.59	96.78	86.02	66.05	45.90	34.20	25.92	18.75	15.22	8.55	4.53
Techiman - Apaaso	BC	4.7	99.48	93.16	81.63	70.69	52.42	39.35	30.23	23.28	1.03	13.7	8.63	4.99
Apaaso -Kintampo	WC	4.6	99.5	99.5	92.54	79.95	54.92	43.81	33.86	25.98	18.84	15.34	9.06	4.85
Apaaso -Kintampo	BC	4.8	98.88	95.31	75.16	67.67	51.36	34.66	26.81	21.32	16.55	13.65	8.85	5.25

Table A2.3.3-3: Test Results on Crushed Rock Base for Road Sections in Ghana

Road Name	Gradation Test									LAA	Absorption (%)	Atterberg Test			Compaction Test		Relative Compaction (%)
	Percentage By weight passing																
	75 mm	53 mm	37.5 mm	20. mm	10.0 mm	5.0 mm	2 mm	0.425 mm	0.075 mm	(%)		LL %	PL %	PI %	MDD Kg/m3	OMC %	
Nsawam Bypass	100	100	100	71	44	36	29	17	5	24.2	1.213	Non Plastic			-	-	-
Akatsi - Dzodze	100	100	100	64	43	34	27	22	10	18.5	1.071	Non Plastic			2390	5	94
Dzodze - Akanu	100	100	100	73	49	39	30	24	11	21.3	1.602	Non Plastic			2420	5	96
Agbozume - Aflao	100	100	84	75	59	52	38	24	10	20.3	1.992	Non Plastic			2469	4	91
Akatsi - Agbozume	100	100	100	82	67	48	32	21	10	22.9	1.216	Non Plastic			2465	4.6	89
Akatsi Bypass	100	100	84	72	53	44	31	19	9	19.7	1.623	Non Plastic			2330	4.6	93
Techiman - Apaso	100	100	100	69	48	38	26	15	6	19	0.945	Non Plastic			2440	5.7	89
Apaaso - Kintampo	100	100	100	75	59	46	33	19	7	20.4	0.895	Non Plastic			2426	5.1	92

Table A2.3.3-4: Test Results on Sub-base for Road Sections in Ghana

Road Name	Gradation Test													Atterberg Test			Compaction Test		Relative Compaction (%)
	Percentage By weight passing																		
	75 mm	53 mm	37.5 mm	26.5 mm	19.0 mm	9.5 mm	4.75 mm	2 mm	1 mm	0.425 mm	0.3 mm	0.15 mm	0.075 mm	LL %	PL %	PI %	MDD Kg/m3	OMC %	
Akatsi - Dzodze	100	100	100	100	100	79	61	49	43	36	32	24	18	31.6	12.7	18.9	2380	5.2	95
Dzodze - Akanu	100	100	100	100	90	89	70	58	52	47	46	42	36	32	21	11	2212	7.3	96
Agbozume - Aflao	100	100	100	100	100	75	61	48	43	40	38	35	31	35.9	21.1	14.8	2230	10.2	94
Akatsi - Agbozume	100	100	100	100	100	84	60	42	34	30	29	26	23	36	21	15	2300	7.2	95
Akatsi Bypass	100	100	100	100	100	85	58	41	36	33	31	28	24	36.8	21.1	15.7	2191	8.3	93
Nsawam Bypass*	100	100	100	100	100	88	69	45	31	21	17	12	8	-	-	-	-	-	-
Techiman - Apaso	100	100	100	100	96	87	72	62	59	55	48	33	27	30	22	9	-	-	-
Apaaso - Kintampo	100	100	100	100	98	91	78	65	60	54	46	29	23	28	19	9	-	-	-

*Core was fractured

Athi River - Namanga

Table A2.3.4-1: Test Results for Base and Sub-base Course Samples

Chainage	Pavement Layer	Moisture Content (%)	Optimum Moisture Content (%)	MC / OMC	Dry Density (kg/m³)	Maximum Dry Density (kg/m³)	% MDD
26+250	Base	5.9	11.7	0.5	1715	1752	98
26+250	Sub-base	9.4	12.8	0.7	1692	1742	97
85+500	Base	10.4	12.1	0.9	1715	1764	97
85+500	Sub-base	10.7	12.0	0.9	1684	1734	97

Table A2.3.4-2: Gradation Test Results for Bituminous Samples Samples

Chainage	28 mm	20 mm	14 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	425 µ	300 µ	150 µ	75 µ	Particle Shape
26+250	100	100	85.6	76.7	65.9	60.3	34.3	22.6	14.5	12.2	8.9	3.5	Cubical
83+500	100	100	96.0	85.2	73.2	67.2	40.1	26.6	18.2	15.8	12.2	6.2	Cubical

Table A2.3.4-3: Test Results for Asphalt Concrete Samples

Chainage	Stability (N)	Bitumen Content (%)	Core Density (Kg/m³)	Marshall Density (Kg/m³)	Relative	Thickness (mm)	Air Voids (%)	Flow (mm)	Specific gravity of Mix (g/m³)	Water absorption (%)	L.A.A
26+250	9400	6.3	2153	2285	94.2	60	3.9	3.1	2375	0.5	24
83+500	9500	6.3	2134	2288	93.3	55	4.0	2.8	2383	0.4	23
Specified Limits	9000	4.5	-	-	95	-	3-6	2-4	-	Max. 2	Max. 30

All the specified requirements have been met.

Isiolo - Merille Road

Table A2.3.4-4: Test Results for Base and Sub-base Course Samples

Chainage	Pavement Layer	Moisture Content (%)	Optimum Moisture Content (%)	MC / OMC	Dry Density (kg/m³)	Maximum Dry Density (kg/m³)	% MDD
98+000	Base	13.4	12.6	1.06	1695	1712	99
78+000	Sub-base	17.8	18.0	0.99	1596	1604	99.5

Table A2.3.4-5: Gradation Test Results for Samples of Asphalt Concrete

Chainage	28 mm	20 mm	14 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	425 µ	300 µ	150 µ	75 µ	Particle Shape
98+000	100	100	95.2	74.4	55.9	48	29.7	19.8	12.5	10.5	7.8	4.1	Cubical
78+000	100	100	94.4	78.1	59.6	49.8	34.1	24.3	16.3	14.0	11.1	7.3	Cubical

Table A2.3.4-6: Test Results for Samples of Asphalt Concrete

Chainage	Stability (N)	Bitumen Content (%)	Core Density (Kg/m³)	Marshall Density (Kg/m³)	Relative	Thickness (mm)	Air Voids (%)	Flow (mm)	Specific gravity of Mix (g/m³)	Water absorption (%)	L.A.A
98+000	9300	7.1	2428	2503	97.0	50	4.2	3.2	2613	0.3	25
78+000	9400	7.0	2494	2480	100.6	45	4.0	3.5	2584	0.4	25
Specified Limits	9000	4.5	-	-	95	-	3-6	2-4	-	Max. 2	Max. 30

All the specified requirements have been met.

Table A2.3.4-7: Test Results for Base and Sub-base Course Samples

Chainage	Pavement Layer	Moisture Content (%)	Optimum Moisture Content (%)	MC / OMC	Dry Density (kg/m³)	Maximum Dry Density (kg/m³)	% MDD
33+000	Base	8.8	5.6	1.57	1871	1896	99
33+000	Sub-base	17.8	20.4	0.87	1654	1688	98
35+250	Base	9.1	4.4	2.06	2009	1998	101
35+250	Sub-base	18.4	19.4	0.94	1709	1709	100

Table A2.3.4-8: Gradation Test Results for Bituminous Samples

Chainage	28 mm	20 mm	14 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	425 µ	300 µ	150 µ	75 µ	Particle Shape
33+000	100	80.6	67.8	-	38.5	-	24.4	21.2	-	13.8	-	7.5	Cubical
35+250	100	81.6	66.5	-	36.0	-	18.2	13.2	-	7.6	-	2.6	Cubical

Table A2.3.4-9: Test Results for Bituminous Concrete Samples

Chainage	Stability (N)	Bitumen Content (%)	Core Density (Kg/m³)	Marshall Density (Kg/m³)	Relative	Thickness (mm)	Air Voids (%)	Flow (mm)	Specific gravity of Mix (g/m³)	Water absorption (%)	L.A.A
33+000	9500	6.0	2279	2263	100.7	70	4.0	3.5	2358	0.4	24
35+250	9600	5.8	2224	2274	97.8	71	4.1	3.7	2370	0.4	23
Specified Limits	9000	4.5	-	-	95	-	3-6	2-4	-	Max. 2	Max. 30

All the specified thickness requirements have been met.

Amani - Dunga

Table A2.3.5a-1: Pavement Composition Details Obtained from Test Pit Observation

Chainage	Pavement Composition (mm)		
	Asphalt	Base Course	Sub base
Km 1+500	72	195	200

All the specified thickness requirements have been met.

Table A2.3.5a-2: Laboratory Test Results on Base Course Material

Test Pit Location/ Chainage		Type of Test									
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear shrinkage (%)	Grading Modulus	TFV (Dry) (kn)	TFV (wet) (kn)	MDD (kg/m³)	OMC (%)	Field Moisture (%)
1+500 (LHS)	Value Obtained	26	18	8	5	2.26	105	85	2238	9.0	1.2
	Specified Limits*	Max. 30	-	Max. 8	Max. 4	Min. 2.0	Min. 80kn	Min. 60% dry TFV	-	-	-

All the specified requirements, except that of Linear Shrinkage have been met.

Table A2.3.5a-3: Results of CBR Test on Base Course Material

Three point CBR value	DD (kg/m3)	CBR (%)	MDD (%)	Swell (%)
(2.5 kg) 3 layers/62 blows	1983	50	89	-
(4.5 kg) 5 layers/30 blows	2012	51	90	-
(4.5 kg) 5 layers/62 blows	2053	57	92	0.02
Specified Limit*	-	xxMin. 80	-	Max. 0.5

* Specified limits as per Table 7.2 of Tanzania Pavement and Material Design Manual

** Not meeting the specified requirement

Table A2.3.5a-4: Laboratory Test Results on Sub-base Course Material

Test Pit 1 Location/ Chainage		Type of Test									
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear shrinkage (%)	Grading Modulus	TFV (Dry) (kn)	TFV (wet) (kn)	MDD (kg/m³)	OMC (%)	Field Moisture (%)
1+500 (LHS)	Test Value Obtained	24	18	6	4	2.26	-	-	2241	10.3	1.4
	Specified Limits**	Max. 40	-	Max. 14	Max. 7	Min. 1.5	-	-	-	-	-

All specified requirements have been met.

Table A2.3.5a-5: Results of CBR Test on Sub-base Course Material

Three point CBR value	DD (kg/m3)	CBR (%)	MDD (%)	Swell (%)
(2.5 kg) 3 layers/62 blows	1884	26	84	-
(4.5 kg) 5 layers/30 blows	1892	50	84	-
(4.5 kg) 5 layers/62 blows	1923	79	86	0.02
Specified Limit*	-	xxMin. 45	-	Max. 0.5

* Specified limits as per Table 7.3 of Tanzania Pavement and Material Design Manual

** Meets specified requirement at 86% MDD.

Mfenesini to Bumbwini Road

Table A2.3.5a-6: Pavement Composition Obtained from Test Pit

Chainage	Pavement Composition (mm)		
	Asphalt	Base Course	Sub base
Km 1+300	50	190	200

All the specified thickness requirements have been met

Table A2.3.5a-7: Laboratory Test Results on Base Course Material

Test Pit Location/ Chainage		Type of Test									
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear shrinkage (%)	Grading Modulus	TFV (Dry) (kn)	TFV (wet) (kn)	MDD (kg/m³)	OMC (%)	Field Moisture (%)
1+300 (LHS)	Test Value Obtained	28	19	9	5	2.42	78	63	2291	9.4	0.8
	Specified Limits**	Max. 30	-	Max. 8	Max. 4	Min. 2.0	Min. 80kn	Min. 60% dry TFV	-	-	-

All the specified requirements, except that of Linear Shrinkage have been met.

Table A2.3.5a-8: Results of CBR Test on Base Course Material

Three Point CBR Value	DD (kg/m3)	CBR (%)	MDD (%)	Swell (%)
(2.5 kg) 3 layers/62 blows	1931	23	84	-
(4.5 kg) 5 layers/30 blows	1961	35	86	-
(4.5 kg) 5 layers/62 blows	1991	49	87	0.01
Specified Limit*	-	**Min. 80	-	Max. 0.5

* Specified limits as per Table 7.2 of Tanzania Pavement & Material Design Manual

** Not meeting the specified requirement

Table A2.3.5a-9: Laboratory Test Results on Sub-base Material

Test Pit Location/ Chainage		Type of Test									
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear shrinkage (%)	Grading Modulus	TFV (Dry) (kn)	TFV (wet) (kn)	MDD (kg/m^3)	OMC (%)	Field Moisture (%)
1+500 (LHS)	Value Obtained	31	16	15	9	2.32	-	-	2395	8.0	3.6
	Specified Limits**	Max. 40	-	Max. 14	Max. 7	Min. 1.5	-	-	-	-	-

All the specified requirements, except that of Linear Shrinkage, have been met.

Table A2.3.5a-10: Results of CBR Test on Sub-base Course Material

Three point CBR value	DD (kg/m3)	CBR (%)	MDD (%)	Swell (%)
(2.5 kg) 3 layers/62 blows	1856	10	77	-
(4.5 kg) 5 layers/30 blows	1907	13	80	-
(4.5 kg) 5 layers/62 blows	1946	15	81	0.02
Specified Limit *	-	** Min. 25	-	Max. 0.5

*Specified limits as per Table 7.3 of Tanzania Pavement & Material Design Manual

** Not meeting the specified requirement

Manzizini to Fumba Road

Table A2.3.5a-11: Laboratory Test Results on Base Material

Test Pit Location/ Chainage		Type of Test									
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear shrinkage (%)	Grading Modulus	TFV (Dry) (kn)	TFV (wet) (kn)	MDD (kg/m^3)	OMC (%)	Field Moisture (%)
1+900 (LHS)	Test Value Obtained	22	16	6	4	2.58	108	95	2426	7.3	0.7
	Specified Limits**	Max. 30	-	Max. 8	Max. 4	Min. 2.0	Min. 80kn	Min. 60% dry TFV	-	-	-

All the specified requirements have been met.

Table A2.3.5a-12: Results of CBR Test on Base Course Material

Three point CBR value	DD (kg/m3)	CBR (%)	MDD (%)	Swell (%)
(2.5 kg) 3 layers/62 blows	2107	81	87	-
(4.5 kg) 5 layers/30 blows	2118	99	87	-
(4.5 kg) 5 layers/62 blows	2130	122	88	0.02
Specified Limit*	-	**Min. 80	-	Max. 0.5

* Specified limits as per Table 7.2 of Tanzania Pavement & Material Design Manual

** Meeting the specified requirement

Table A2.3.5a-13: Laboratory Test Results of Sub-base Course Material

Test Pit Location/ Chainage		Type of Test									
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear shrinkage (%)	Grading Modulus	TFV (Dry) (kn)	TFV (wet) (kn)	MDD (kg/m³)	OMC (%)	Field Moisture (%)
1+500 (LHS)	Value Obtained	30	19	11	7	2.17	-	-	2238	10.3	2.1
	Specified Limits**	Max. 40	-	Max. 14	Max. 7	Min. 1.5	-	-	-	-	-

Table A2.3.5a-14: Results of CBR Test on Sub-base Course Material

Three point CBR value	DD (kg/m3)	CBR (%)	MDD (%)	Swell (%)
(2.5 kg) 3 layers/62 blows	2015	8	90	-
(4.5 kg) 5 layers/30 blows	2061	25	92	-
(4.5 kg) 5 layers/62 blows	2083	46	93	0.34
Specified Limit**	-	**Min. 25	-	Max. 0.5

** Specified limits as per Table 7.3 of Tanzania Pavement and Material Design Manual

** Meeting the specified requirement at 92% and 93% MDD.

Singida - Katesh Road

Table A2.3.5b-1: UCS Test Results for Base and Sub-base Course Samples

Chainage	Pavement Layer	Height (cm)	Diameter (cm)	Weight (gm)	Density (kg/m³)	Corrected Height (cm)	Load (KN)	Corrected Load(KN)	Area (cm²)	Strength (Kpa)
10+745	Base	14.7	14.5	5179	2135	14.7	32.51	32.3	165.05	1955
10+745	Sub-base	16	14.4	5045	1937	16	20.27	20.1	162.78	1236

Table A2.3.5a-13: Laboratory Test Results of Sub-base Course Material

Test Pit Location/ Chainage		Type of Test									
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear shrinkage (%)	Grading Modulus	TFV (Dry) (kn)	TFV (wet) (kn)	MDD (kg/m³)	OMC (%)	Field Moisture (%)
1+500 (LHS)	Test Value Obtained	24	18	6	4	2.26	-	-	2241	10.3	1.4
	Specified Limits**	Max. 40	-	Max. 14	Max. 7	Min. 1.5	-	-	-	-	-

All specified requirements have been met

Table A2.3.5b-3: Results of CBR Test on Sub-base Course Material

Three point CBR value	DD (kg/m3)	CBR (%)	MDD (%)	Swell (%)
(2.5 kg) 3 layers/62 blows	1884	26	84	-
(4.5 kg) 5 layers/30 blows	1892	50	84	-
(4.5 kg) 5 layers/62 blows	1923	79	86	0.02
Specified Limit*	-	xxMin. 45	-	Max. 0.5

* Specified limits as per Table 7.3 of Tanzania Pavement and Material Design Manual

** Meets specified requirement at 86% MDD.

Katesh to Babati Road

Table A2.3.5b-4: UCS Test Results for Base and Sub-base Course Samples

Chainage	Pavement Layer	Height (cm)	Diameter (cm)	Weight (gm)	Density (kg/m³)	Corrected Height (cm)	Load (KN)	Corrected Load(KN)	Area (cm²)	Strength (Kpa)
135+200	Base	14.5	14.5	4902.5	2049	14.5	33.48	33.2	165.05	1955
135+200	Base	15.3	14.3	5167.5	2104	15.3	32.51	32.3	160.52	1236
135+200	Sub-base	13.0	14.6	4354.5	2002	13.0	13.40	13.3	165.05	1236

Babati to Minjingu Road

Table A2.3.5b-5: UCS Test Results on Sub-base Course Samples

Chainage	Pavement Layer	Height (cm)	Diameter (cm)	Weight (gm)	Density (kg/m³)	Corrected Height (cm)	Load (KN)	Corrected Load(KN)	Area (cm²)	Strength (Kpa)
11+625	Sub-base	12.5	14.2	4019	2031	12.5	15.1	15.0	158.29	947
11+625	Sub-base	12.7	14.1	4119.5	2078	12.7	14.92	14.8	156.07	949

Table A2.3.6-1: Results of Tests on the Bituminous Wearing Course for Bab El Khadra - Station Metro Road Section (MC 135)

Layer Type	Location	Bitumen content (%)	Stability (N)	Flow (mm)	20 mm	16 mm	12.5 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	400 µ	200 µ	80 µ
Wearing Course	Ch. 5+600	4.8	2126	2.6	100	92.6	85.9	79.1	68.4	63.5	45.3	28.9	18.0	13.2	9.4
Specification Limits for WC	-	5.0	≥9000	2-4	100	100	90-100	75-85	54-66	40-55	28-40	20-32	12-20	10-16	7-9

Meets Specifications Except for Grading which Lies outside the Specified Envelope for a Few Sizes

Table A2.3.6-2: Results of Tests on the Bituminous Wearing Course for Ben Arous - Stade Rades Road Section (GP 1)

Layer Type	Location	Bitumen content (%)	Stability (N)	Flow (mm)	20 mm	16 mm	12.5 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	400 µ	200 µ	80 µ
Wearing Course	Ch. 8+965	5.1	1577	3.8	100	97.4	87.6	77.1	54.7	44.8	30.2	21.2	14.5	11.3	8.6
Specification Limits for WC		5.0	≥9000	2-4	100	100	90-100	75-85	54-66	40-55	28-40	20-32	12-20	10-16	7-9

Meets Specifications Except for Grading which Lies outside the Specified Envelope for a Few Sizes

Table A2.3.6-3: Results of Tests on the Bituminous Wearing Course for Ben Arous - Mornag Road Section (MC 34)

Layer Type	Location	Bitumen content (%)	Stability (N)	Flow (mm)	20 mm	16 mm	12.5 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	400 µ	200 µ	80 µ
Wearing Course	Ch. 9+950	5.0	1549	3.3	100	92.6	79.3	68.7	58.2	50.8	35.0	24.3	15.8	11.6	8.1
Specification Limits for WC		5.0 ±0.3	≥9000	2-4	100	100	90-100	75-85	54-66	40-55	28-40	20-32	12-20	10-16	7-9

Meets Specifications Except for Grading which Lies outside the Specified Envelope for a Few Sizes

Table A2.3.6-4: Results of Tests on the Bituminous Wearing Course for Carrefour Hopital Ariana - RR31 Road Section (X 20)

Layer Type	Location	Bitumen content (%)	Stability (N)	Flow (mm)	20 mm	16 mm	12.5 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	400 µ	200 µ	80 µ
Wearing Course	Ch. 3+000	5.0	2742	2.3	100	100	97.6	84.6	63.0	44.0	29.0	18.0	13.0	9.0	7.0
Specification Limits for WC		5.4 ±0.3	≥9000	2-4	100	100	86-100	72-85	53-68	41-55	29-40	20-30	14-20	9-16	7-10

Meets Specifications Except for Grading which Lies outside the Specified Envelope for a Few Sizes

Table A2.3.6-5: Results of Tests on the Bituminous Wearing Course for Jdaida - Tebourba Road Section (RVE 511)

Layer Type	Location	Bitumen content (%)	Stability (N)	Flow (mm)	20 mm	16 mm	12.5 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	400 µ	200 µ	80 µ
Wearing Course	Ch. 3+000	5.3	2182	2.6	100	100	93.7	84.7	63.0	44.2	28.5	18	13.5	10.0	7.0
Specification Limits for WC		5.0 ±0.3	≥9000	2-4	100	100	86-100	72-85	53-68	41-55	29-40	20-30	14-20	9-16	7-10

Meets Specifications Except for Grading which Lies outside the Specified Envelope for a Few Sizes

Table A2.3.6-6: Results of Tests on the Bituminous Wearing Course for Grombalia - Limite Gouvernorat de Ben Arous Road Section (RVE 573)

Layer Type	Location	Bitumen content (%)	Stability (N)	Flow (mm)	20 mm	16 mm	12.5 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	400 µ	200 µ	80 µ
Wearing Course	Ch. 9+000	5.5	1462	3.6	100	100	100	88.6	69.2	43.3	27.5	20.1	14.2	11.3	8.8
Specification Limits for WC		5.4 ±0.3	≥9000	2-4	100	100	86-100	72-85	53-68	41-55	29-40	20-30	14-20	9-16	7-10

Meets Specifications Except for Grading which Lies outside the Specified Envelope for a Few Sizes

Table A2.3.6-7: Results of Tests on the Bituminous Wearing Course for Khlidia - Jbel Rsas Road Section (RVE 565)

Layer Type	Location	Bitumen content (%)	Stability (N)	Flow (mm)	20 mm	16 mm	12.5 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	400 μ	200 μ	80 μ
Wearing Course	Ch. 21+000	4.1	1462	3.8	100	84.2	70.3	62.6	51.6	45.4	30.8	21.4	13.9	10.3	7.8
Specification Limits for WC		*	≥9000	2-4	100	100	86-100	72-85	53-68	41-55	29-40	20-30	14-20	9-16	7-10

Meets Specifications Except for Grading which Lies outside the Specified Envelope for a Few Sizes; * Not Available

Table A2.3.6-8: Results of Tests on the Bituminous Wearing Course for Khlidia - Jbel Rsas Road Section (MC 35)

Layer Type	Location	Bitumen content (%)	Stability (N)	Flow (mm)	20 mm	16 mm	12.5 mm	10 mm	6.3 mm	4 mm	2 mm	1 mm	400 μ	200 μ	80 μ
Wearing Course	Ch. 8+015	4.1	1462	4.1	100	92.2	79.0	68.0	57.0	49.1	33.3	22.9	15.2	11.5	8.5
Specification Limits for WC		*	≥9000	2-4	100	100	86-100	72-85	53-68	41-55	29-40	20-30	14-20	9-16	7-10

Meets Specifications Except for Grading which Lies outside the Specified Envelope for a Few Sizes; * Not Available

Table A2.3.7-1: Results of Tests on the Bituminous Wearing Course at km 10 + 100 for Kabale - Kisoro Road Section

Layer Type	Thickness	Bitumen content (%)	Stability (N)	Air Voids (%)	Flow (mm)	28 mm	20 mm	10 mm	6.3 mm	5 mm	2 mm	1.18 mm	600 μ	425 μ	300 μ	150 μ	75 μ	Relative compaction (%)
Wearing Course	57	7.7	1480	4.73	2.65	100	97.0	56.7	40.7	35.5	23.2	18.2	13.0	10.4	8.1	5.1	3.4	98.3
Specification Limits for WC	≥50	4.6±0.3	≥8000	3-5	2-4	-	-	-	-	-	-	-	-	-	-	-	-	96

Specifications Met, Except for a Higher Bitumen Content which Could be Accounted for by Layer of Surface Dressing Laid Prior to Construction of Wearing Course (Road Shows no Bleeding).

Table A2.3.7-2: Results of Tests on Crushed Rock Base for Kabale - Kisoro Road Section

Test Results and Specification Limits	Chainage	Thickness (mm)	Ten Percent Fines Value		Atterberg Test			Relative Compaction
			Dry (kN)	Soaked/Dry (%)	LL	PL	PI	
Test Results	10 +100	156	190	90		Non Plastic		100.2
Specification Limits	-	150	≥110	≥75		Non Plastic		100

Material and Relative Compaction Meet Specified Requirements

APPENDIX 3 : COMPLIANCE MATRIX

Project Information

ROAD SECTION Pobe - Ketou		REPUBLIC OF BENIN
Length (Km)		42.80
Geo-metry	Carriage Way Width (m)	7
	Shoulder Width (m)	1.5m
Pavement Structure	Surfacing	60mm overlay/60mm of wearing
	Base	250mm cement stabilized with Geo-grid
	Sub base	200mm Natural Gravel
Construction Information	Commencement Date	2006
	Original Completion Date	2009
	Actual Completion Date	2009 (No time overrun)
	% Contract Period Overrun	0
	Contract Sum	17,444,000,000 F CFA
	Final Cost	18,040,185,000 F CFA
	% Cost Overrun	3.4
	Contractor	Sogea-Satom (France)
	Supervisor	Cowi A/S, Denmark
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	93
	Present Serviceability Index (PSI)	4.77
	Pavement Condition Rating	Very Good
	Average Roughness (IRI)	1.28
	Riding Condition Rating	Good
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Very Good
	Overall Quality Rating	Very Good

Project Information

ROAD SECTION Ketou - Illara		REPUBLIC OF BENIN
Length (Km)		16.50
Geo-metry	Carriage Way Width (m)	7
	Shoulder Width (m)	1.5
Pavement	Surfacing	Double Surface Dressing
	Base	200mm Cement Stabilized Gravel
	Sub base	150mm Natural Gravel
Construction	Commencement Date	2006
	Original Completion Date	2007
	Actual Completion Date	2007
	% Contract Period Overrun	0
	Contract Sum	3,346,818,769 F CFA
	Final Cost	3,346,818,769 FCFA
	% Cost Overrun	0
	Contractor	Colas (France)
	Supervisor	Scet Tunisie (Tunisia)
	Construction Contract Rating	Satisfactory
Quality	Pavement Condition Score	88
	Present Serviceability Index (PSI)	4.60
	Pavement Condition Rating	Very Good
	Average Roughness (IRI)	1.27
	Riding Condition Rating	Good
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Very Good
	Overall Quality Rating	Very Good

Project Information

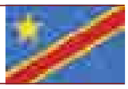
ROAD SECTION Bamenda - Batibo - Numba		CAMEROON
Length (Km)		43.24+20
Geo-metry	Carriage Way Width (m)	7
	Shoulder Width (m)	1 / 1.5
Pavement	Surfacing	70 mm overlay / 50mm wearing course
	Base	200 Crushed Rock Base
	Sub base	250mm Natural Gravel (Batibo-Numba)
Construction Information	Commencement Date	February, 2010
	Original Completion Date	February, 2013
	Actual Completion Date	June, 2014
	% Contract Period Overrun	47 %
	Contract Sum	28,276,438,939 F CFA
	Final Cost	31,645,291,141 F CFA
	% Cost Overrun	12 %
	Contractor	China Communication Construction Company (China)
	Supervisor	SNC-Lavalin International Inc. (Canada)
	Construction Contract Rating	Moderately Satisfactory
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	92 / 90
	Present Serviceability Index (PSI)	473 / 4.66
	Pavement Condition Rating	Very Good
	Average Roughness (IRI)	1.66 / 1.50
	Riding Condition Rating	Fair
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Very Good
	Overall Quality Rating	Good

Project Information

ROAD SECTION Nandeke - Mbere		CAMEROON
Length (Km)		97.10 (72.8 + 14.3)
Geo-metry	Carriage Way Width (m)	7
	Shoulder Width (m)	1.5/1
Pavement	Surfacing	50 mm Asphalt Concrete / Multiple Surface Dressing
	Base	200 mm Crushed Rock
	Sub base	300 mm Natural Gravel
Construction Information	Commencement Date	June, 2009
	Original Completion Date	June, 2011
	Actual Completion Date	December, 2013
	% Contract Period Overrun	75 %
	Contract Sum	32,402,734,517 FCFA
	Final Cost	39,650,358,169 F CFA
	% Cost Overrun	22 %
	Contractor	DTP Terrassement of the Bouygues Group (France)
	Supervisor	Studi International (Tunisia)
	Construction Contract Rating	Unsatisfactory
Quality Evaluation	Pavement Condition Score	60
	Present Serviceability Index (PSI)	2.83
	Pavement Condition Rating	Fair
	Average Roughness (IRI)	1.26
	Riding Condition Rating	Good
	Structural Capacity Rating	Good
	Pavement Layer Rating	Very Good
	Overall Quality Rating	Good

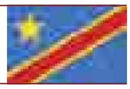
Project Information

ROAD SECTION Nsele - Lufimi		DEMOCRATIC REPUBLIC OF CONGO
Length (km)		93.58
Geo-metry	Carriage Way Width (m)	7
	Shoulder Width (m)	1
Pavement Structure	Surfacing	40mm Asphalt Concrete
	Base	120mm Bitumen Injected Sand
	Sub base with selected Natural Gravel	250mm Recycled Pavement
Construction Information	Commencement Date	December, 2008
	Original Completion Date	December, 2010
	Actual Completion Date	December, 2010
	% Contract Period Overrun	0
	Contract Sum	US$ 41,738 Million
	Final Cost	US$ 41,738 Million
	% Cost Overrun	0
	Contractor	Sinohydro (China)
	Supervisor	Studi International (Tunisia)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	83
	Present Serviceability Index (PSI)	4.36
	Pavement Condition Rating	Very Good
	Average Roughness (IRI)	-
	Riding Condition Rating	Good
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Very Good
	Overall Quality Rating	Very Good



Project Information

ROAD SECTION Kwango - Kenge		DEMOCRATIC REPUBLIC OF CONGO
Length (km)		70.3
Geo-metry	Carriage Way Width (m)	7
	Shoulder Width (m)	1
Pavement Structure	Surfacing	50mm Asphalt Concrete
	Base	150mm Cement Stabilized Gravel
	Sub base	150mm Cement Stabilized Gravel
Construction Information	Commencement Date	December, 2008
	Original Completion Date	December , 2010
	Actual Completion Date	January, 2011
	% Contract Period Overrun	4.16 %
	Contract Sum	US$ 52,824 Million
	Final Cost	US$ 52,824 Million
	% Cost Overrun	0
	Contractor	Sinohydro (China)
	Supervisor	AIC Progetti (Italy)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	60
	Present Serviceability Index (PSI)	2.83
	Pavement Condition Rating	Fair
	Average Roughness (IRI)	-
	Riding Condition Rating	Fair
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Very Good
	Overall Quality Rating	Good



Project Information

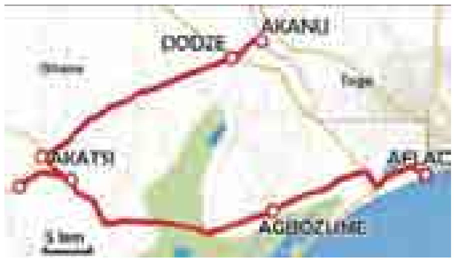
ROAD SECTION Agbozume - Aflao / Akatsi Bypass		GHANA
Length (km)		27.10
Geometry	Carriage Way Width (m)	7.3
	Shoulder Width (m)	2.5
Pavement	Surfacing	165mm Asphalt Concrete
	Base	200mm Crushed Rock
	Sub base	200mm Natural Gravel
Construction Information	Commencement Date	1st January, 2009
	Original Completion Date	15th January, 2011
	Actual Completion Date	1st August, 2014
	% Contract Period Overrun	83 %
	Contract Sum	GH¢ 38,597,148.16
	Final Cost	GH¢ 50,658,851.60
	% Cost Overrun	31 %
	Contractor	China Geo-Engineering Cooperation (China)
	Supervisor	Conterra Ltd. (Ghana)
Quality Evaluation	Construction Contract Rating	Unsatisfactory
	Pavement Condition Score	87
	Present Serviceability Index (PSI)	4.66
	Pavement Condition Rating	Very Good
	Average Roughness (IRI)	1.91
	Riding Condition Rating	Fair
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good

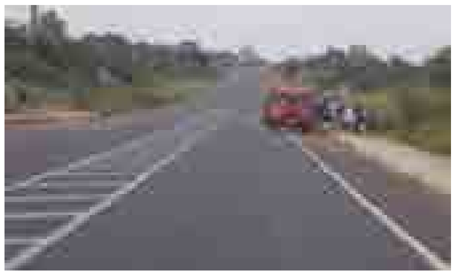
Project Information

ROAD SECTION Akatsi - Agbozume		GHANA
Length (km)		31.60
Geometry	Carriage Way Width (m)	7.3
	Shoulder Width (m)	2.5
Pavement Structure	Surfacing	165mm Asphalt Concrete
	Base	200mm Crushed Rock
	Sub base	200mm Natural Gravel
Construction Information	Commencement Date	15th January, 2009
	Original Completion Date	15th January, 2011
	Actual Completion Date	15th October, 2011
	% Contract Period Overrun	38 %
	Contract Sum	GH¢ 38,852,495.10
	Final Cost	GH¢ 42,421,876.22
	% Cost Overrun	9 %
	Contractor	China Geo-Engineering Corporation (China)
	Supervisor	Conterra Ltd (Ghana)
	Construction Contract Rating	Moderately Satisfactory
Quality Evaluation	Pavement Condition Score	87
	Present Serviceability Index (PSI)	4.56
	Pavement Condition Rating	Very Good
	Average Roughness (IRI)	1.89
	Riding Condition Rating	Fair
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good

Project Information

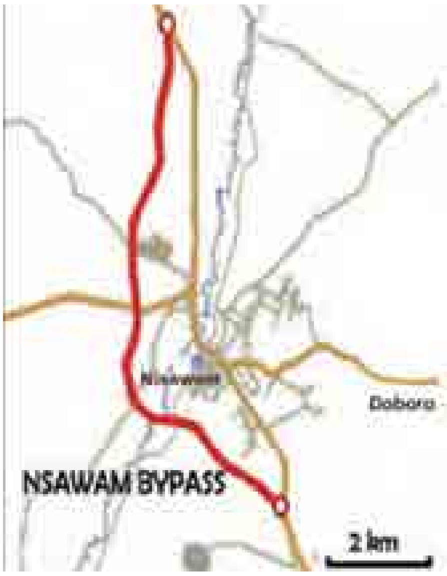
ROAD SECTION Akatsi - Dzodze - Akanu		**GHANA**
Length (km)		30.00
Geometry	Carriage Way Width (m)	7.3
	Shoulder Width (m)	2.5
Pavement Structure	Surfacing	100mm Asphalt Concrete (50mm WC + 50mm BC)
	Base	200mm Crushed Rock
	Sub base	300mm Natural Gravel
Construction Information	Commencement Date	1st June, 2009
	Original Completion Date	30th November,2011
	Actual Completion Date	29th February, 2012
	% Contract Period Overrun	18 %
	Contract Sum	GH¢ 28,364,144.72
	Final Cost	GH¢ 27,699,259.51
	% Cost Overrun	-2 %
	Contractor	China Jiangxi Corporation (China)
	Supervisor	Twum Boafo and Partners (Ghana)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	82
	Present Serviceability Index (PSI)	4.3
	Pavement Condition Rating	Good
	Average Roughness (IRI)	1.73
	Riding Condition Rating	Fair
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good

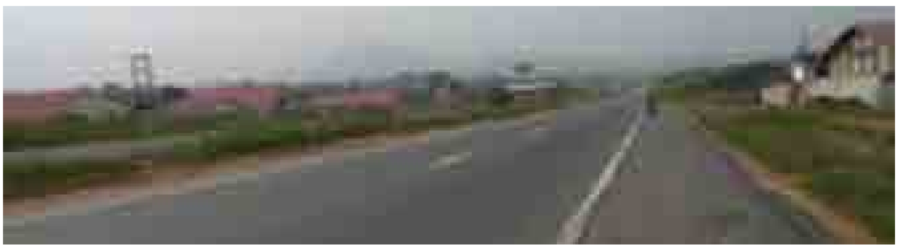




Project Information

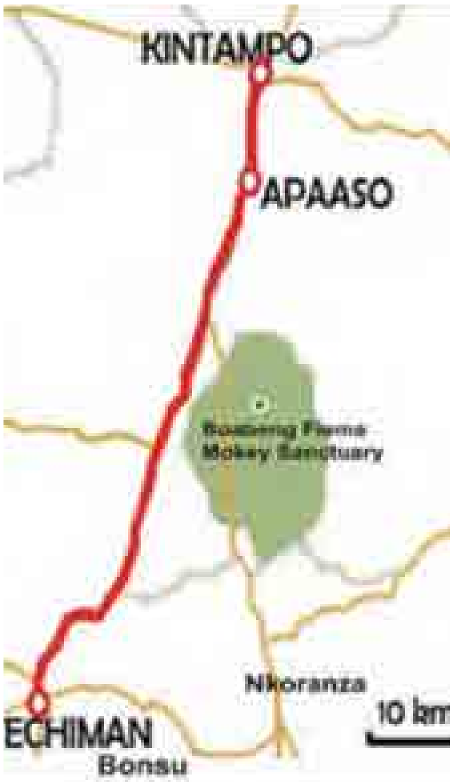
ROAD SECTION Nsawam Bypass		GHANA
Length (km)		9.30
Geometry	Carriage Way Width (m)	7.3
	Shoulder Width (m)	2.5 (Outer) /1.5(Inner)
Pavement Structure	Surfacing	180 mm A/C (40mm Wearing Course + 60 mm Binder Course + 80 mm Dense Bitumen Macadam
	Base	200mm Crushed Rock Base
	Sub base	200mm Cement Stabilized Gravel
Construction Information	Commencement Date	17th June, 2008
	Original Completion Date	16th June, 2010
	Actual Completion Date	31st September, 2012
	% Contract Period Overrun	85 %
	Contract Sum	GH¢ 28,197,485.34
	Final Cost	GH¢ 33,731,038.02
	% Cost Overrun	19 %
	Contractor	China Railway Wuju Cooperation (China)
	Supervisor	Comptran Engineering and Planning Associates (Ghana)
	Construction Contract Rating	Unsatisfactory
Quality Evaluation	Pavement Condition Score	93
	Present Serviceability Index (PSI)	4.77
	Pavement Condition Rating	Very Good
	Average Roughness (IRI)	1.43
	Riding Condition Rating	Good
	Structural Capacity Rating	Good
	Pavement Layer Rating	Very Good
	Overall Quality Rating	Very Good





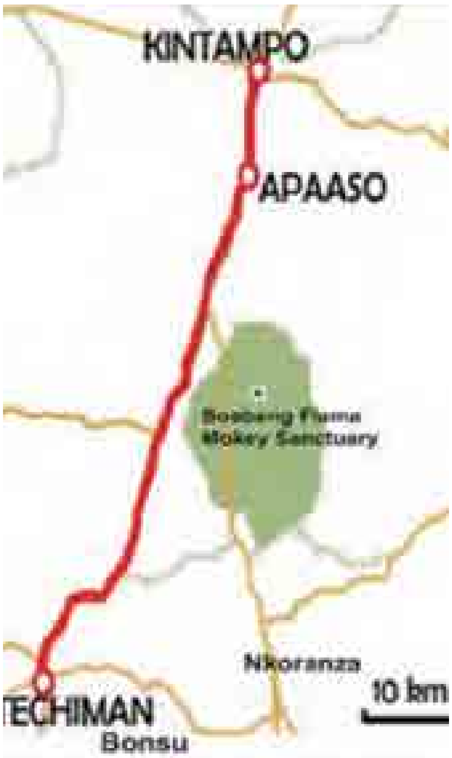
Project Information

ROAD SECTION Techiman - Apaaso		GHANA
Length (km)		53.70
Geometry	Carriage Way Width (m)	7.3
	Shoulder Width (m)	2.5
Pavement Structure	Surfacing	40mm mm Asphalt Concrete Wearing Course + 60mm Binder Course
	Base	200mm Crushed Rock
	Sub base	200mm Natural Gravel
Construction Information	Commencement Date	1st June, 2008
	Original Completion Date	1st March, 2011
	Actual Completion Date	30th June, 2012
	% Contract Period Overrun	52 %
	Contract Sum	GH¢ 36,058,579.20
	Final Cost	GH¢ 54,658,060.00
	% Cost Overrun	51.6 %
	Contractor	Shinsung Engineering and Construction Company Ltd (China)
	Supervisor	Conterra Ltd (Ghana)
	Construction Contract Rating	Unsatisfactory
Quality Evaluation	Pavement Condition Survey	80
	Present Serviceability Index (PSI)	4.16
	Pavement Condition Rating	Good
	Average Roughness (IRI)	1.53
	Riding Condition Rating	Fair
	Structural Capacity Rating	Mediocre
	Pavement Layer Rating	Fair
	Overall Quality Rating	Fair



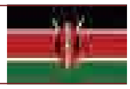
Project Information

ROAD SECTION		GHANA
Apaaso-Kintampo		
Length (km)		6.30
Geometry	Carriage Way Width (m)	7.3
	Shoulder Width (m)	2.5
Pavement Structure	Surfacing	40mm mm Asphalt Concrete Wearing Course + 60mm Binder Course
	Base	200mm Crushed Rock
	Sub base	200mm Natural Gravel
Construction Information	Commencement Date	16th October, 2010
	Original Completion Date	16th July, 2011
	Actual Completion Date	16th July, 2011
	% Contract Period Overrun	0
	Contract Sum	GH¢ 7,533,588.77
	Final Cost	GH¢ 17,486,030.63
	% Cost Overrun	132.1 %
	Contractor	Shinsung Engineering and Construction Company Ltd (China)
	Supervisor	Conterra Ltd (Ghana)
	Construction Contract Rating	Unsatisfactory
Quality Evaluation	Pavement Condition Score	80
	Present Serviceability Index (PSI)	4.16
	Pavement Condition Rating	Good
	Average Roughness (IRI)	1.53
	Riding Condition Rating	Fair
	Structural Capacity Rating	Mediocre
	Pavement Layer Rating	Fair
	Overall Quality Rating	Fair



Project Information

ROAD SECTION Athi River - Namanga		KENYA
Length (km)		136.00
Geometry	Carriage Way Width (m)	7
	Shoulder Width (m)	2
Pavement Structure	Surfacing	50mm Asphalt Concrete
	Base	150mm Dense Bituminous Macadam
	Sub base	200mm Cement Stabilized Gravel
Construction Information	Commencement Date	November, 2007
	Original Completion Date	May, 2010
	Actual Completion Date	27th February, 2012
	% Contract Period Overrun	35 %
	Contract Sum	Ksh 6,208,705,229. 80
	Final Cost	-
	% Cost Overrun	-
	Contractor	China National Engineering Cooperation (China)
	Supervisor	Gibb East Africa (Kenya)
	Construction Contract Rating	Moderately Satisfactory
Quality Evaluation	Pavement Condition Score	84
	Present Serviceability Index (PSI)	4.42
	Pavement Condition Rating	Good
	Average Roughness (IRI)	2.05
	Riding Condition Rating	Fair
	Structural Capacity Rating	Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good



Project Information

ROAD SECTION Isiolo - Merille		KENYA
Length (km)		136.00
Geometry	Carriage Way Width (m)	7
	Shoulder Width (m)	2
Pavement Structure	Surfacing	50mm Asphalt Concrete
	Base	200mm Cement Stabilized Gravel
	Sub base	200mm Natural Gravel
Construction Information	Commencement Date	November, 2007
	Original Completion Date	May, 2010
	Actual Completion Date	10th September, 2010
	% Contract Period Overrun	13.33 %
	Contract Sum	Ksh 4,875,409,271.00
	Final Cost	Ksh 4,875,409,271.00
	% Cost Overrun	0
	Contractor	China Wu Yi Co Ltd of Fuzhou City (China)
	Supervisor	Gibb East Africa (Kenya)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	82
	Present Serviceability Index (PSI)	4.3
	Pavement Condition Rating	Good
	Average Roughness (IRI)	1.6
	Riding Condition Rating	Fair
	Structural Capacity Rating	Mediocre
	Pavement Layer Rating	Good
	Overall Quality Rating	Fair

Project Information

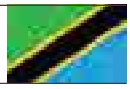
ROAD SECTION Nairobi-Thika		KENYA
Length (km)		45.00
Geometry	Carriage Way Width (m)	11 - 14
	Shoulder Width (m)	No Shoulders but Service Roads of varying width, Walkways& Bicycle lanes.
Pavement Structure	Surfacing	40mm/50mm Asphalt
		Concrete 120-170mm Dense Bituminous Macadam
	Base	250mm Improved Crushed Roads
	Sub base	200 - 250mm Natural Gravel
Construction Information	Commencement Date	January 2009
	Original Completion Date	27th July, 2011
	Actual Completion Date	11th October 2012
	% Contract Period Overrun	28.3 % 36.67 % -3 %
	Contract Sum	Lot -1 - 8,030,386,596.64 Lot - 2 - 8,690,568,489.73 Lot - 3 - 9,441,732,008.00
	Final Cost	Lot -1 - 9,230,902,053.63 *Lot - 2 Lot - 3 - 9,988,166,743.00
	% Cost Overrun	14.95 % 14.35 % 5.79 %
	Contractor	China Wu Yi Co Ltd of Fuzhou City, Sinohydro Corp, Shengli Engineering Const. Group Co. Ltd (China)
	Supervisor	CES Pvt Ltd (India)
	Construction Contract Rating	Moderately Satisfactory
Quality Evaluation	Pavement Condition Score	93
	Present Serviceability Index (PSI)	4.77
	Pavement Condition Rating	Very Good
	Average Roughness (IRI)	1.5
	Riding Condition Rating	Fair
	Structural Capacity Rating	Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good

*Lot - 2 Not provided by Road Administration

Project Information

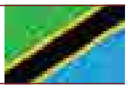
ROAD SECTION Amani - Dunga		TANZANIA
Length (km)		12.75
Geometry	Carriage Way Width (m)	6
	Shoulder Width (m)	1 - 1.5
Pavement Structure	Surfacing	40mm Asphalt Concrete
	Base	125mm Crushed Rock
	Sub base	125 - 200mm Natural Gravel
Construction Information	Commencement Date	1st October, 2009
	Original Completion Date	31st December, 2010
	Actual Completion Date	30th June, 2012
	% Contract Period Overrun	87.3 %
	Contract Sum	*19,990,680,530 TSHs
	Final Cost	*20,779,291,097 TSHs
	% Cost Overrun	3.9 %
	Contractor	M/S Mwanainchi Engineering & Contracting Company Ltd (MECCO) (Tanzania)
	Supervisor	Black & Veatch (South Africa)
	Construction Contract Rating	Unsatisfactory
Quality Evaluation	Pavement Condition Score	95
	Present Serviceability Index (PSI)	4.83
	Pavement Condition Rating	Very Good
	Average Roughness (IRI)	1.45
	Riding Condition Rating	Good
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Very Good

*Total for Amani - Dunga & Mfenisini - Bumbwini Road Sections



Project Information

ROAD SECTION Manzizini - Fumba		TANZANIA
Length (km)		17.81
Geometry	Carriage Way Width (m)	6
	Shoulder Width (m)	1 - 1.5
Pavement Structure	Surfacing	40mm Asphalt Concrete
	Base	125mm Crushed Rock
	Sub base	125 - 200mm Natural Gravel
Construction Information	Commencement Date	2006 (Terminated and Re-awarded)
	Original Completion Date	2007
	Actual Completion Date	4th November, 2009
	% Contract Period Overrun	100 %
	Contract Sum	4,821,293,060 TSHs
	Final Cost	*
	% Cost Overrun	-
	Contractor	M/S Mwanainchi Engineering & Contracting Company Ltd (MECCO) (Tanzania)
	Supervisor	Black & Veatch (South Africa)
	Construction Contract Rating	Unsatisfactory
Quality Evaluation	Pavement Condition Score	92
	Present Serviceability Index (PSI)	4.73
	Pavement Condition Rating	Very Good
	Average Roughness (IRI)	1.27
	Riding Condition Rating	Good
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Very Good

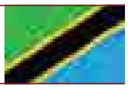


*Final Cost not provided by Road Administration

Project Information

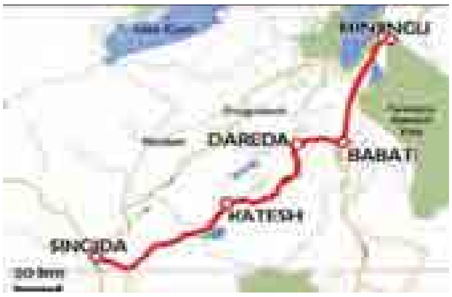
ROAD SECTION Mfensini - Bumbwini		**TANZANIA**
Length (km)		13.10
Geometry	Carriage Way Width (m)	6
	Shoulder Width (m)	1 - 1.5
Pavement Structure	Surfacing	40mm Asphalt Concrete
	Base	125mm Crushed Rock
	Sub base	125 - 200mm Natural Gravel
Construction Information	Commencement Date	1st October, 2009
	Original Completion Date	31st December, 2010
	Actual Completion Date	30th June, 2012
	% Contract Period Overrun	87.33
	Contract Sum	*19,990,680,530 TSHs
	Final Cost	*20,779,291,097 TSHs
	% Cost Overrun	3.9
	Contractor	M/S Mwanainchi Engineering & Contracting Company LTD (MECCO) (Tanzania)
	Supervisor	Black & Veatch (South Africa)
	Construction Contract Rating	Poor
Quality Evaluation	Pavement Condition Score	95
	Present Serviceability Index (PSI)	4.83
	Pavement Condition Rating	Very Good
	Average Roughness (IRI)	1.31
	Riding Condition Rating	Good
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Very Good

*For Both Amani - Dunga and Mfenisini - Bumbwini Road Sections.



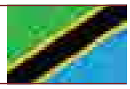
Project Information

ROAD SECTION Singda - Katesh		TANZANIA
Length (km)		65.10
Geometry	Carriage Way Width (m)	6.5
	Shoulder Width (m)	1.5
Pavement Structure	Surfacing	Double Surface Dressing
	Base	150mm Cement Stabilized Gravel
	Sub base	250mm Cement Improved Gravel
Construction Information	Commencement Date	11th March, 2009
	Original Completion Date	10th September, 2011
	Actual Completion Date	31st July, 2012
	% Contract Period Overrun	13.33 %
	Contract Sum	Tsh 51,626,214,569.00
	Final Cost	Tsh 51,626,214,569.00
	% Cost Overrun	0
	Contractor	Sinohydro (China)
	Supervisor	Africon (now Aurecon) (South Africa)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	67
	Present Serviceability Index (PSI)	3.30
	Pavement Condition Rating	Fair
	Average Roughness (IRI)	1.68
	Riding Condition Rating	Fair
	Structural Capacity Rating	Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good

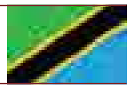


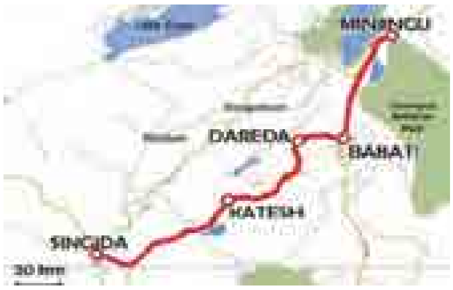
Project Information

ROAD SECTION Katesh - Dareda		TANZANIA
Length (km)		73.80
Geometry	Carriage Way Width (m)	6.5
	Shoulder Width (m)	1.5
Pavement Structure	Surfacing	Double Surfacing Dressing
	Base	150mm Cement Stabilized Gravel
	Sub base	250mm Cement Improved Gravel
Construction Information	Commencement Date	11th March, 2009
	Original Completion Date	10th September, 2012
	Actual Completion Date	January, 2012
	% Contract Period Overrun	26.67 %
	Contract Sum	Tsh 64,145,236,879.00
	Final Cost	Tsh 66,023,554,890.00
	% Cost Overrun	2.9 %
	Contractor	Sinohydro Corporation (China)
	Supervisor	COWI A/S, (Denmark)
	Construction Contract Rating	Moderately Satisfactory
Quality Evaluation	Pavement Condition Score	69
	Present Serviceability Index (PSI)	3.43
	Pavement Condition Rating	Fair
	Average Roughness (IRI)	3.8
	Riding Condition Rating	Mediocre
	Structural Capacity Rating	Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Fair



Project Information

ROAD SECTION Dareda - Minjingu		TANZANIA 
Length (km)		84.60
Geometry	Carriage Way Width (m)	6.5
	Shoulder Width (m)	1.5 - 2
Pavement Structure	Surfacing	50mm Asphalt Concrete
	Base	150mm Crushed Rock
	Sub base	300mm Cement Stabilized Gravel
Construction Information	Commencement Date	11th March, 2009
	Original Completion Date	10th March, 2012
	Actual Completion Date	1st August, 2012
	% Contract Period Overrun	15.83 %
	Contract Sum	Tsh 84,919,693,728.00
	Final Cost	Tsh 84,878,733,020.95
	% Cost Overrun	-0.5 %
	Contractor	China Henan International Cooperation Group Ltd (China)
	Supervisor	Crown-TECH Consult Ltd, (Tanzania)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	69
	Present Serviceability Index (PSI)	3.43
	Pavement Condition Rating	Fair
	Average Roughness (IRI)	1.7
	Riding Condition Rating	Fair
	Structural Capacity Rating	Mediocre
	Pavement Layer Rating	Good
	Overall Quality Rating	Fair



Project Information

ROAD SECTION Bab el Khadra - Station Metro (MC 135)		**TUNISIA**
Length (km)		7.00
Geometry	Carriage Way Width (m)	2 x 10.5
	Shoulder Width (m)	2.5
Pavement Structure	Surfacing	80mm Asphalt Concrete
	Base	250/300mm Bituminous Gravel/ Crushed Gravel/Humidified Reconstituted Crushed Gravel
	Sub base	Existing Pavement
Construction Information	Commencement Date	1st July, 2010
	Original Completion Date	31st January, 2011
	Actual Completion Date	26th February, 2011
	% Contract Period Overrun	0
	Contract Sum	*8,382,190,000 Dinars
	Final Cost	*8,336,671,863 Dinars
	% Cost Overrun	-0.5 %
	Contractor	Enterprise K. Kobbi (Tunisia)
	Supervisor	Road Administration (Tunisia)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	58
	Present Serviceability Index (PSI)	2.7
	Pavement Condition Rating	Fair
	Average Roughness (IRI)	3.22
	Riding Condition Rating	Mediocre
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good

*Total for MC 135, GP 1 and MC 34

Project Information

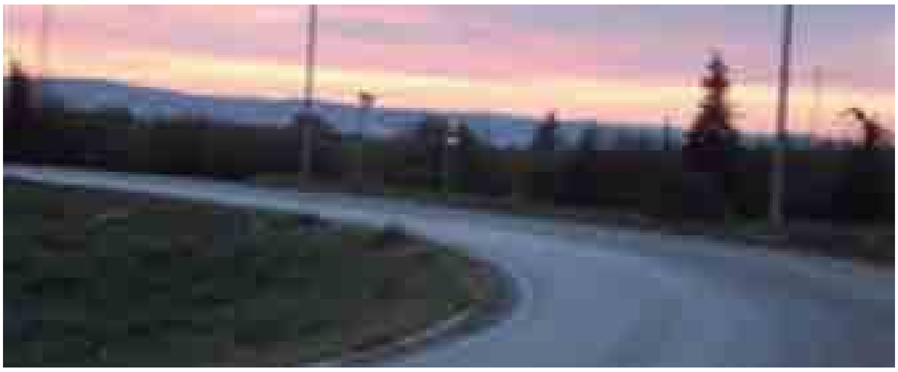
ROAD SECTION		TUNISIA
Ben Arous - Stade Rades (GP 1)		
Length (km)		6.50
Geometry	Carriage Way Width (m)	13 - 15
	Shoulder Width (m)	2.5
Pavement Structure	Surfacing	80mm Asphalt Concrete
	Base	250/300mm Bituminous Gravel /Crushed Gravel/Humidified Reconstituted Crushed Gravel
	Sub base	Existing Pavement
Construction Information	Commencement Date	1st July, 2010
	Original Completion Date	31st January, 2011
	Actual Completion Date	26th February, 2012
	% Contract Period Overrun	0
	Contract Sum	*8,382,190,000 Dinars
	Final Cost	*8,336,671,863 Dinars
	% Cost Overrun	-0.5 %
	Contractor	Enterprise K. Kobbi (Tunisia)
	Supervisor	Road Administration (Tunisia)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	68
	Present Serviceability Index (PSI)	3.36
	Pavement Condition Rating	Fair
	Average Roughness (IRI)	2.99
	Riding Condition Rating	Mediocre
	Structural Capacity Rating	*
	Pavement Layer Rating	Good
	Overall Quality Rating	Fair

*Total for MC 135, GP 1 and MC 34

Project Information

ROAD SECTION Ben Arous - Mornag (MC 34)		TUNISIA
Length (km)		4.40
Geometry	Carriage Way Width (m)	7.6
	Shoulder Width (m)	Right shoulder 2m Left Shoulder 1.5m
Pavement Structure	Surfacing	80 mm Asphalt Concrete
	Base	250/300 mm Bituminous Gravel/Crushed Gravel/HRCG
	Sub base	Existing Pavement
Construction	Commencement Date	1st July, 2010
	Original Completion Date	31st January, 2011
	Actual Completion Date	26th February, 2011
	% Contract Period Overrun	0
	Contract Sum	*8,382,190,000 Dinars
	Final Cost	*8,336,671,863 Dinars
	% Cost Overrun	-0.5 %
	Contractor	Enterprise K. Kobbi (Tunisia)
	Supervisor	Road Administration (Tunisia)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	84
	Present Serviceability Index (PSI)	4.42
	Pavement Condition Rating	Good
	Average Roughness (IRI)	2.31
	Riding Condition Rating	Fair
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good

*Total for MC 135, GP 1 and MC 34



Project Information

ROAD SECTION		TUNISIA
Carrefour Hopital Ariana - RR 31 (X 20)		
Length (km)		8.30
Geometry	Carriage Way Width(m)	7.6 x 2
	Shoulder Width (m)	1.5m
Pavement Structure	Surfacing	80mm Asphalt Concrete
	Base	250/300mm Bituminous Gravel/ Crushed Gravel/HRCG
	Sub base	Existing Pavement
Construction Information	Commencement Date	11th July, 2011
	Original Completion Date	10th December,2011
	Actual Completion Date	8th January, 2012
	% Contract Period Overrun	10 %
	Contract Sum	*3,935,679,000 Dinars
	Final Cost	*3,626,011,161 Dinars
	% Cost Overrun	-7.9 %
	Contractor	Enterprise ETEP (Tunisia)
	Supervisor	Road Administration (Tunisia)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	84
	Present Serviceability Index (PSI)	4.42
	Pavement Condition Rating	Good
	Average Roughness (IRI)	2.25
	Riding Condition Rating	Fair
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good

*Total for X 20 and RVE 511

Project Information

ROAD SECTION Jdaida - Tebourba (RVE 511)		**TUNISIA**
Length (km)		8.80
Geometry	Carriage Way Width(m)	7.6
	Shoulder Width (m)	2
Pavement Structure	Surfacing	80mm Asphalt Concrete
	Base	250/300mm Bituminous Gravel/Crushed Gravel/HRCG
	Sub base	Existing Pavement
Construction Information	Commencement Date	11th July, 2011
	Original Completion Date	10th December, 2011
	Actual Completion Date	8th January, 2012
	% Contract Period Overrun	10 %
	Contract Sum	*3,935,679,000 Dinars
	Final Cost	*3,626,011,161 Dinars
	% Cost Overrun	-7.9 %
	Contractor	Enterprise ETEP (Tunisia)
	Supervisor	Road Administration (Tunisia)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	83
	Present Serviceability Index (PSI)	4.36
	Pavement Condition Rating	Good
	Average Roughness (IRI)	2.17
	Riding Condition Rating	Fair
	Structural Capacity Rating	Very Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good

*Total for RVE 511and X 20

Project Information

ROAD SECTION		TUNISIA
Grombalia - Limite Gouvernorat de Ben Arous (RVE 573)		
Length (km)		19.00
Geometry	Carriage Way Width(m)	7.6
	Shoulder Width (m)	1.5
Pavement Structure	Surfacing	80mm Asphalt Concrete
	Base	250/300mm Bituminous Gravel/Crushed Gravel/HRCG
	Sub base	Existing Pavement
Construction Information	Commencement Date	4th January, 2011
	Original Completion Date	3rd July, 2012
	Actual Completion Date	12th April, 2012
	% Contract Period Overrun	-2.77 %
	Contract Sum	7,803,005,000 Dinars
	Final Cost	8,765,296,213 Dinars
	% Cost Overrun	12.3 %
	Contractor	Enterprise K. Kobbi (Tunisia)
	Supervisor	Road Administration (Tunisia)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	70
	Present Serviceability Index (PSI)	3.50
	Pavement Condition Rating	Good
	Average Roughness (IRI)	2.39
	Riding Condition Rating	Fair
	Structural Capacity Rating	Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good

Project Information

ROAD SECTION Mornag - Jbel Rsas (MC 35)		TUNISIA
Length (km)		10.20
Geometry	Carriage Way Width(m)	7.6
	Shoulder Width (m)	1.5
Pavement Structure	Surfacing	80mm Asphalt Concrete
	Base	250/300mm Bituminous Gravel /Crushed Gravel/HRCG
	Sub base	Existing Pavement
Construction Information	Commencement Date	6th July, 2010
	Original Completion Date	5th March, 2011
	Actual Completion Date	15th July, 2012
	% Contract Period Overrun	22.5 %
	Contract Sum	*12,296,700,000 Dinars
	Final Cost	*13,343,200,488 Dinars
	% Cost Overrun	8.5 %
	Contractor	Enterprise K. Kobbi (Tunisia)
	Supervisor	Road Administration (Tunisia)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	76
	Present Serviceability Index (PSI)	3.90
	Pavement Condition Rating	Good
	Average Roughness (IRI)	2.50
	Riding Condition Rating	Fair
	Structural Capacity Rating	Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Good

*Total for MC 35 and RVE 565

Project Information

ROAD SECTION Khlidia - Jbel (RVE 565)		TUNISIA
Length (km)		11.00
Geometry	Carriage Way Width (m)	7.6
	Shoulder Width (m)	1.5
Pavement Structure	Surfacing	80mm Asphalt Concrete
	Base	250/300mm Bituminous Gravel/Crushed Gravel/HRCG
	Sub base	Existing Pavement
Construction Information	Commencement Date	6th July 2010
	Original Completion Date	5th March, 2012
	Actual Completion Date	15th July, 2012
	% Contract Period Overrun	22.5 %
	Contract Sum	*12,296,700,000 Dinars
	Final Cost	*13,343,200,488 Dinars
	% Cost Overrun	8.5 %
	Contractor	Enterprise K. Kobbi (Tunisia)
	Supervisor	Road Administration (Tunisia)
	Construction Contract Rating	Satisfactory
Quality Evaluation	Pavement Condition Score	70
	Present Serviceability Index (PSI)	3.50
	Pavement Condition Rating	Fair
	Average Roughness (IRI)	2.8
	Riding Condition Rating	Fair
	Structural Capacity Rating	Fair
	Pavement Layer Rating	Fair
	Overall Quality Rating	Fair

* Total for MC 35 and RVE 565

Project Information

ROAD SECTION Kabale - Kisoro - Bunagana /Kyanika		UGANDA
Length (km)		100.14
Geometry	Carriage Way Width (m)	6
	Shoulder Width (m)	1.5/1
Pavement	Surfacing	50mmA/C / Surface Dressing 50mmA/C
Structure	Base	125mm Crushed Rock
	Sub base	275mm Crushed Rock
	Sub base	Existing Pavement
Construction Information	Commencement Date	22nd March, 2007
	Original Completion Date	21st March, 2010
	Actual Completion Date	21st Sept, 2012
	% Contract Period Overrun	84 %
	Contract Sum	Ush 147,067,121,956
	Final Cost	Ush 195,445,535,968
	% Cost Overrun	33 %
	Contractor	SBI International Holdings (Switzerland)
	Supervisor	Mott Macdonald, (UK)
	Construction Contract Rating	Unsatisfactory
Quality Evaluation	Pavement Condition Score	68
	Present Serviceability Index (PSI)	3.63
	Pavement Condition Rating	3.23/3.07
	Average Roughness (IRI)	Fair
	Riding Condition Rating	Mediocre
	Structural Capacity Rating	Good
	Pavement Layer Rating	Good
	Overall Quality Rating	Fair

APPENDIX 4 : ACTIONS TO BE TAKEN BY ROAD ADMINISTRATIONS TO IMPROVE THE PERFORMANCE OF PROJECT CONTRACTS

Most projects that do not perform as expected suffer from a number of issues. The issues include a poorly defined scope usually as a result of non-involvement of key stakeholders; unrealistic estimates for project execution; and inadequate tracking of project progress due to executive detachment.

A number of steps can be taken to improve the project management process to assist RAs in improving the performance of their contracts for road projects. These may include the following:

1. Review the Draft Final Report for the Detailed Design for the project, either in-house if there is adequate capacity or by a third party if not, paying particular attention to traffic projections, pavement design, safety and bill of quantities.
2. Carry out public consultations with key stakeholders to manage expectations and seek suggestions for possible improvements.
3. Finalize the Detailed Design Report with realistic estimates for cost and project execution period.
4. Once project commences, set a time table for meetings between RA Executives with project supervisor to discuss project progress – both financial and physical; and challenges needed to be overcome. This should be apart from the routine monthly meetings.
5. Set up a computer based project control system to alert RA as soon as quantities for individual line items are exceeded and to provide the projected project cost in real time to enable RAs quickly alert financiers and other key stakeholders with the underlying reasons for any possible cost and time overrun.
6. RAs should develop manuals for Contract Management which would guide the supervisor and RA staff on the procedures to be followed from contract signing to project completion. The manuals will clearly set out the contents of the monthly and quarterly reports, when ad-hoc reports are required and the type of information required in the ad-hoc reports. It will also indicate actions to be taken in response to unusual events to minimize the risk of financial claims and time extensions.

APPENDIX 5 : ROAD SECTOR MANAGEMENT, FUNDING ARRANGEMENT AND SUSTAINABILITY RISK

Country Road Management, Maintenance Funding Arrangement and Sustainability Risk

REPUBLIC OF BENIN

No.	ROAD SUB SECTOR INFORMATION		
1	Network Statistics	a. Total Length of Network (km)	15,500
		b. Classified Network (km)	8,300
		c. Paved Network (km)	2,100
		d. Paved Network as % of Classified Network	25.3
		e. Current Network in Good or Fair Condition (%)	66
2	Road Management	a. Road Agency	No
		b. Department in Ministry	Yes
3	Source of Maintenance Funding	a. Road Fund	Yes
		b. Government Budget	No
		c. Road Fund through Government Budget	No
		d. % of Maintenance Needs Covered	50%
4	Maintenance Planning	a. Is there a Maintenance Management System in place?	No
5	Protection of Road Infrastructure	a. Is there an Axle Load Control System?	No
		b. Effectiveness Rating	N/A
6	Capacity of Implementing Agencies	a. Capacity Rating	Low
7	Local Contracting Capacity	a. Capacity Rating	Low
		Overall risk to sustainability	**High**

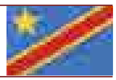
Country Road Management, Maintenance Funding Arrangement and Sustainability Risk

REPUBLIC OF CAMEROON

No.	ROAD SUB SECTOR INFORMATION		
1	Network Statistics	a. Total Length of Network (km)	50,500
		b. Classified Network (km)	28,857
		c. Paved Network (km)	5,250
		d. Paved Network as % of Classified Network	18.19
		e. Current Network in Good or Fair Condition (%)	58
2	Road Management	a. Road Agency	No
		b. Department in Ministry	Yes
3	Source of Maintenance Funding	a. Road Fund	No
		b. Government Budget	No
		c. Road Fund through Government Budget	Yes
		d. % of Maintenance Needs Covered	50%
4	Maintenance Planning	a. Is there a Maintenance Management System in place?	No
5	Protection of Road Infrastructure	a. Is there an Axle Load Control System?	Yes
		b. Effectiveness Rating	Moderate
6	Capacity of Implementing Agencies	a. Capacity Rating	Moderate
7	Local Contracting Capacity	a. Capacity Rating	Low
		Overall risk to sustainability	**High**

Country Road Management, Maintenance Funding Arrangement and Sustainability Risk

DEMOCRATIC REPUBLIC OF CONGO



No.	ROAD SUB SECTOR INFORMATION		
1	Network Statistics	a. Total Length of Network (km)	171,250
		b. Classified Network (km)	42,250
		c. Paved Network (km)	2,250
		d. Paved Network as % of Classified Network	5.33
		e. Current Network in Good or Fair Condition (%)	44
2	Road Management	a. Road Agency	No
		b. Department in Ministry	Yes
3	Source of Maintenance Funding	a. Road Fund	Yes
		b. Government Budget	No
		c. Road Fund through Government Budget	No
		d. % of Maintenance Needs Covered	50%
4	Maintenance Planning	a. Is there a Maintenance Management System in place?	No
5	Protection of Road Infrastructure	a. Is there an Axle Load Control System?	No
		b. Effectiveness Rating	N/A
6	Capacity of Implementing Agencies	a. Capacity Rating	Moderate
7	Local Contracting Capacity	a. Capacity Rating	Low
		Overall risk to sustainability	**High**

N/A - Not Applicable

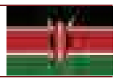
Country Road Management, Maintenance Funding Arrangement and Sustainability Risk

REPUBLIC OF GHANA

No.	ROAD SUB SECTOR INFORMATION			
1	Network Statistics	a.	Total Length of Network (km)	109,515
		b.	Classified Network (km)	67,450
		c.	Paved Network (km)	12,442
		d.	Paved Network as % of Classified Network	18.45
		e.	Current Network in Good or Fair Condition (%)	69
2	Road Management	a.	Road Agency	Yes
		b.	Department in Ministry	No
3	Source of Maintenance Funding	a.	Road Fund	Yes
		b.	Government Budget	No
		c.	Road Fund through Government Budget	No
		d.	% of Maintenance Needs Covered	70%
4	Maintenance Planning	a.	Is there a Maintenance Management System in place?	Yes
5	Protection of Road Infrastructure	a.	Is there an Axle Load Control System?	Yes
		b.	Effectiveness Rating	Moderate
6	Capacity of Implementing Agencies	a.	Capacity Rating	Moderate
7	Local Contracting Capacity	a.	Capacity Rating	Moderate
	Overall risk to sustainability			**Moderate**

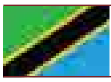
Country Road Management, Maintenance Funding Arrangement and Sustainability Risk

REPUBLIC OF KENYA



No.	ROAD SUB SECTOR INFORMATION		
1	Network Statistics	a. Total Length of Network (km)	160,886
		b. Classified Network (km)	63,575
		c. Paved Network (km)	9,273
		d. Paved Network as % of Classified Network	14.59
		e. Current Network in Good or Fair Condition (%)	70
2	Road Management	a. Road Agency	Yes
		b. Department in Ministry	No
3	Source of Maintenance Funding	a. Road Fund	Yes
		b. Government Budget	No
		c. Road Fund through Government Budget	No
		d. % of Maintenance Needs Covered	70%
4	Maintenance Planning	a. Is there a Maintenance Management System in place?	No
5	Protection of Road Infrastructure	a. Is there an Axle Load Control System?	Yes
		b. Effectiveness Rating	Moderate
6	Capacity of Implementing Agencies	a. Capacity Rating	Moderate
7	Local Contracting Capacity	a. Capacity Rating	Moderate
	Overall risk to sustainability		**Moderate**

Country Road Management, Maintenance Funding Arrangement and Sustainability Risk



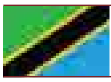
REPUBLIC OF TANZANIA

No.	ROAD SUB SECTOR INFORMATION			
1	Network Statistics	a.	Total Length of Network (km)	90,807
		b.	Classified Network (km)	86,472
		c.	Paved Network (km)	6,578
		d.	Paved Network as % of Classified Network	7.61
		e.	Current Network in Good or Fair Condition (%)	63
2	Road Management	a.	Road Agency	Yes
		b.	Department in Ministry	No
3	Source of Maintenance Funding	a.	Road Fund	Yes
		b.	Government Budget	No
		c.	Road Fund through Government Budget	No
		d.	% of Maintenance Needs Covered	70%
4	Maintenance Planning	a.	Is there a Maintenance Management System in place?	Yes
5	Protection of Road Infrastructure	a.	Is there an Axle Load Control System?	Yes
		b.	Effectiveness Rating	High
6	Capacity of Implementing Agencies	a.	Capacity Rating	Moderate
7	Local Contracting Capacity	a.	Capacity Rating	Moderate
	Overall risk to sustainability			**Low**

Country Road Management, Maintenance Funding Arrangement and Sustainability Risk

	REPUBLIC OF TUNISIA		
No.	**ROAD SUB SECTOR INFORMATION**		
1	Network Statistics	a. Total Length of Network (km)	19,418
		b. Classified Network (km)	19,418
		c. Paved Network (km)	14,757
		d. Paved Network as % of Classified Network	76.00
		e. Current Network in Good or Fair Condition (%)	71.5
2	Road Management	a. Road Agency	No
		b. Department in Ministry	Yes
3	Source of Maintenance Funding	a. Road Fund	No
		b. Government Budget	Yes
		c. Road Fund through Government Budget	No
		d. % of Maintenance Needs Covered	70%
4	Maintenance Planning	a. Is there a Maintenance Management System in place?	No
5	Protection of Road Infrastructure	a. Is there an Axle Load Control System?	No
		b. Effectiveness Rating	N/A
6	Capacity of Implementing Agencies	a. Capacity Rating	Moderate
7	Local Contracting Capacity	a. Capacity Rating	High
		Overall risk to sustainability	**Moderate**

Country Road Management, Maintenance Funding Arrangement and Sustainability Risk



REPUBLIC OF UGANDA

No.	ROAD SUB SECTOR INFORMATION		
1	Network Statistics	a. Total Length of Network (km)	70,746
		b. Classified Network (km)	35,800
		c. Paved Network (km)	8,360
		d. Paved Network as % of Classified Network	23.35
		e. Current Network in Good or Fair Condition (%)	50
2	Road Management	a. Road Agency	Yes
		b. Department in Ministry	No
3	Source of Maintenance Funding	a. Road Fund	No
		b. Government Budget	No
		c. Road Fund through Government Budget	Yes
		d. % of Maintenance Needs Covered	40%
4	Maintenance Planning	a. Is there a Maintenance Management System in place?	No
5	Protection of Road Infrastructure	a. Is there an Axle Load Control System?	Yes
		b. Effectiveness Rating	Moderate
6	Capacity of Implementing Agencies	a. Capacity Rating	Moderate
7	Local Contracting Capacity	a. Capacity Rating	Moderate
		Overall risk to sustainability	**Moderate**

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