Sub-Saharan Africa Transport Policy Program

RMF Report No 04/06/Kenya

Knowledge Sharing and Promotion of Appropriate Pavements and Surfacing Technologies for Low-volume Roads in Kenya, Sudan and Uganda

Workshop Report

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Nairobi, Kenya
24th February – 1st March, 2006

April 2006

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SSATP
Washington, USA

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Consultants

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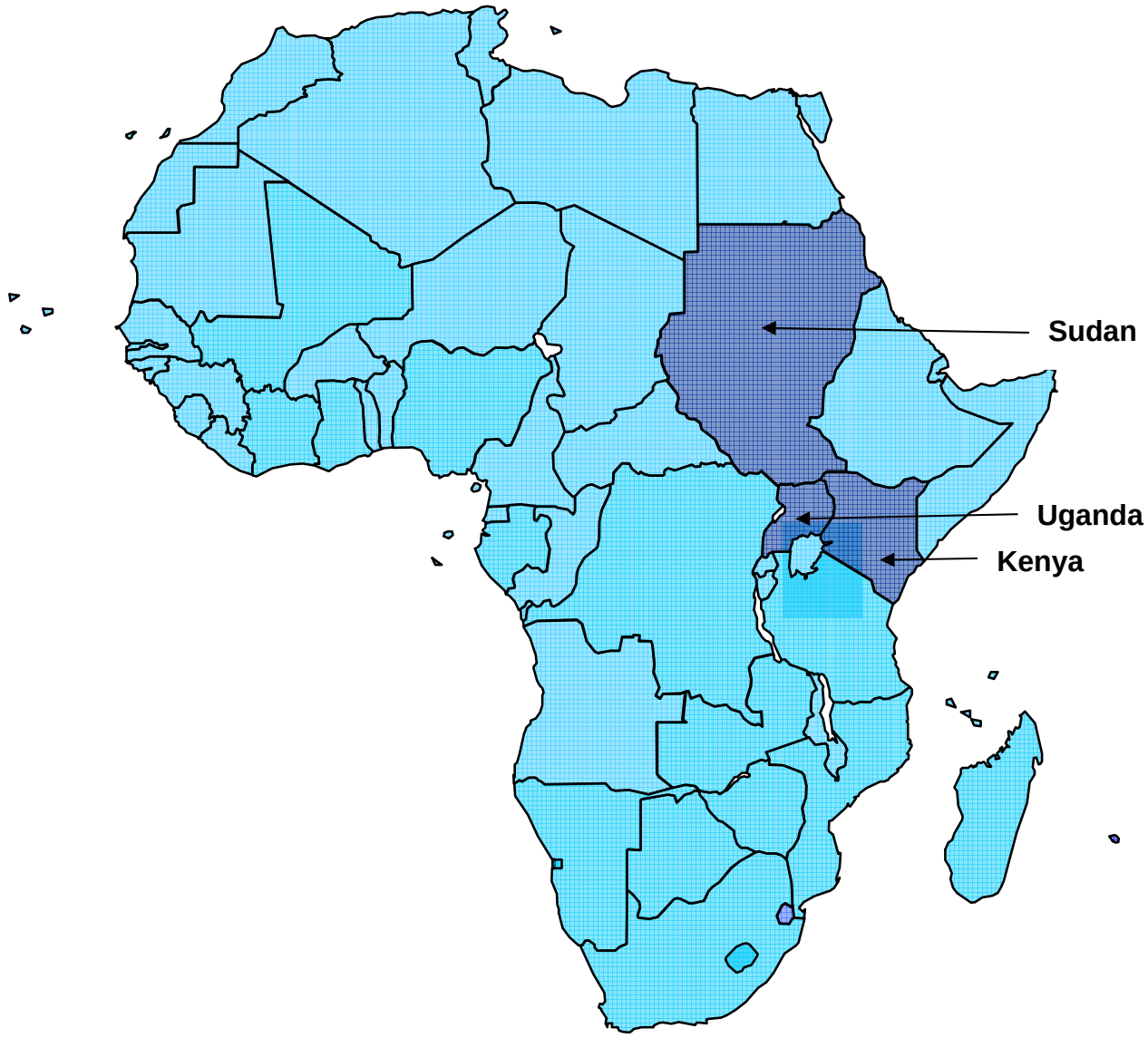
LIST OF ABBREVIATIONS

CBR	California Bearing Ratio
DBST	Double Bituminous Surface Treatment
ESA	Equivalent Standard Axles
Km	Kilometre
LTDP	Long Term Development Plan
LVSR	Low-volume Sealed Roads
MDGs	Millennium Development Goals
PI	Plasticity Index
RMF	Road Management and Financing
SADC	Southern Africa Development Community
SSA	Sub-Saharan Africa
SSATP	Sub-Saharan Transport Policy Program
TRL	Transport Research Laboratory
UK	United Kingdom
USA	United States of America
WP	Work Program

Countries Participating in the Workshop on Knowledge Sharing and Promotion of Appropriate Pavements and Surfacing Technologies for Low-volume Roads



EXECUTIVE SUMMARY

Background

1. As part of its support in the thematic area of Road Management and Financing, and on the basis of a specific recommendation arising from the last Annual meeting held in Bamako in November 2005, SSATP is promoting and disseminating aspects of the SADC Guideline on Low-volume Sealed Roads.

2. In support of the above, a workshop was held and a field visit undertaken in Kenya by a World Bank/SSATP team from 23rd February – 2nd March 2006 for participants from Kenya, Sudan and Uganda. The overall objectives of the workshop and field visit were to disseminate knowledge and promote the use of appropriate technologies in the construction of pavements and bituminous surfacings for Low-volume roads.

The Field Visit

3. A 4-day field trip was undertaken to the Turkana region (West Pokot province) in north western Kenya with the objective of exposing participants to examples of road technology involving both traditional and more innovative approaches in the use of local road construction materials as exemplified by:

(a) The Marich Pass-Lodwar-Kalakol road which is characterised by a "non-standard" pavement structure utilising naturally occurring quartzitic gravels and a low-cost, Otta seal surfacing using screened gravel from borrow pits located close to the road alignment;

(b) The Lodwar-Lokichokio road which is characterised by a "conventional" pavement structure utilising a crushed stone bases course obtained from quarrying of hard basalt rock and a double bituminous surface treatment using crushed basalt aggregate obtained from the same source.

4. The main lesson learned from the field visit is that by employing an "environmentally optimised" approach to road design, including the use of appropriate materials specifications and construction techniques, it is quite possible to provide bituminous surfaced roads cost-effectively (in life-cycle cost terms) even at relatively low levels of traffic and particularly where there is lack of "traditional" aggregates and a scarcity of water.

The Workshop

5. Following an Opening Statement by Mr. Olav Ellevset, Senior Transport Specialist, SSATP/World Bank Program. the 2-day workshop was opened by Eng. S. Gitau of the Kenya Ministry of Roads, Public Works and Housing while the Introductory Remarks were made by Dr. Daniel Wani, Undersecretary, Ministry of Works and Transport, South Sudan. The workshop was attended by a total of 26 delegates from the host country as well as from the neighbouring countries of Sudan and Uganda.

6. The workshop was designed to be interactive in order to maximise the involvement of delegates in discussing burning issues related to pavement and surfacing technologies in their respective countries.

7. The workshop program included scene-setting presentations by the SSATP/World Bank consultants and break-away working group deliberations on the presentations to discuss the challenges of implementing these new technologies. The scene-setting presentations included:

- New Approaches to Sustainable provision of Low-volume Sealed Roads
- Alternative Surfacing Technologies for Low-volume Sealed Roads
- Alternative Materials and Pavement Design Technologies for Low-volume Sealed Roads

Feedback from Workshop

8. The main issues arising from the workshop deliberations were:

(a) *Scope for introduction of new developments in road technology:*

- In general, there is much scope for application of the developments in road technology seen during the field visit and discussed during the presentations by the Consultants.

(b) *Barriers to implementing alternative technologies:*

- Lack of political support and institutionalised resistance to change.
- Lack of awareness of new developments in road technology.
- Outdated design standards and specifications.
- Reluctance of some donors to accept new technologies.

(c) *Means of overcoming barriers*

- Stronger advocacy and promotion of new developments in road technology with all stakeholders
- Agitation for a revision and updating of design standards and specifications to produce national standards for adherence by all stakeholders in the roads sector

(d) *Way forward*

- Countries to use their bi-lateral projects as a vehicle for seeking support to undertake pilot projects incorporating new developments in road technology.

Other Issues

9. Every effort should be made to undertake a life-cycle evaluation of the contrasting examples of road design exemplified by the Marich Pass-Lodwar-Kalokol road (innovative approach) and the Lodwar-Lokichokio as a basis for writing up a case history of these roads to supplement and enhance the guidance given in the SADC Guideline on Low-volume Sealed Roads.

Outcome of Workshop

The participants expressed their appreciation of the initiative taken by the SSATP/World Bank in holding the workshop. They stated that they had benefited very much from the presentations of the consultants and were of the view that the workshop had achieved its objectives.

Participants to the World Bank/SSATP Workshop on *Knowledge Sharing and Promotion of Appropriate Pavements and Surfacing Technologies for Low-volume Roads in Kenya, Sudan and Uganda:*
Nairobi, Kenya, 24th February – 1st March, 2006

1. INTRODUCTION

Background

1.1 The 2006 Work Program (WP) of the Sub-Saharan Africa Transport Policy Program (SSATP) is contained within a framework of priority thematic areas: (a) Road Management and Financing; (b) Appropriate Transport Services; and (c) Regional Integration and Transport. Overarching initiatives comprise transport strategy development based on the outcomes of ongoing poverty/transport analytical work (ensuring transport fully responsive to poverty reduction strategies) and the establishment of appropriate transport sector performance indicators linked to the Millennium Development Goals (MDGs). The work program is the second of four annual programs which will incrementally achieve the objectives of the SSATP Long Term Development Plan (LTDP) which runs to 2007.

1.2 The Road Management and Financing (RMF) Thematic area includes a number of initiatives namely: road network management (institutional and financial arrangements), road fund enhancement, road agency improvements, and capacity building and training. Many countries have embarked on reform agendas, but adherence to sound policy principles and emulation of established good practice is, in a number of cases, problematical. The SSATP is addressing demands for support in these areas in a number of ways, including the implementation of activities arising from specific recommendations made by the last SSATP Annual Meeting held in Bamako, Mali, in November 2005.

1.3 One such activity is the promotion and dissemination of the SADC Guideline on Low-volume Sealed Roads (LVSR), and support to the collection of corresponding experiences from SSA. Whilst the approach and the philosophy of the Guideline have been practiced in some countries over a number of years, the Guideline is now enabling a more comprehensive and coherent approach to be adopted in the utilization of technologies and methods that focus on the utilization of locally available materials. The major impacts of adopting such approaches include a reduction of life-cycle costs. Another important factor is a reduction in the continuous exploitation of non-renewable gravel sources, more so when "good" gravel is used in an inappropriate manner.

Objectives

1.4 The main objectives of the workshop were to disseminate knowledge and promote the use of appropriate technologies in the construction of pavements and bituminous surface treatments for Low-volume roads in SSATP partner countries, in this case, Kenya, Sudan and Uganda. The SADC Guideline on Low-volume Sealed Roads served as the guiding background document for the workshop together with supporting case study information from the Ken 042 Low-cost Pavements Project which documents the performance of Low-cost pavements constructed along the Lodwar-Kalokol road in north eastern Kenya and the Kwale-Kinango road in south eastern Kenya in 1983-85 (ref. Annex B).

Scope of Work

1.5 In order to achieve the above objectives, the following scope of work was undertaken by the SSATP/World Bank consultants, under the guidance of the RMF thematic leader.

(1) Undertaking field visits to provide participants with examples of appropriate Low-volume road technologies in terms of the use of local materials and appropriate construction methods.

(2) Undertaking an interactive workshop in Nairobi, Kenya to outline the concept and philosophy behind the SADC LVSR Guideline, including case studies, as a basis for knowledge sharing and possible application in the mentioned countries.

(3) Briefing the workshop participants on the way forward with regard to the potential for utilizing more appropriate technologies in the provision of Low-volume sealed road applications.

Terms of Reference

1.6 The Terms of Reference for the SSATP/World Bank consultants are attached as Annex A to this report.

Program

1.7 The program for fulfilling the full scope of the Terms of Reference is summarised below:

Day 1 Thursday 23 Feb.	- 16.00 hrs: Consultants arrive in Nairobi
Day 2 Friday 24 Feb.	- 08.00 -19.00: Field trip to Marich Pass-Lodwar-Lokichokio. Overnight Kitale.
Day 3 Saturday 25 Feb.	- 08.00 – 19.00 hrs: Field trip to Marich Pass-Lodwar-Lokichokio. Overnight Lokichokio.
Day 4 Sunday 26 Feb.	- 08.00 – 17.00 hrs: Return to Nairobi from field trip. Overnight Kitale.
Day 5 Monday 27 Feb.	- 08.00 – 16.00 hrs: Return to Nairobi from fieldtrip. - 16.00 – 17.30 hrs: Courtesy call on Director of Roads.
Day 6 Tuesday 28 Feb.	- 09.00 – 17.00 hrs: Day 1 of workshop
Day 7 Wednesday 29 Feb	- 09.00 – 17.00 hrs: Day 2 of workshop
Day 8 Thursday 01 Mar.	- 07.30 hrs: Consultants departure from Nairobi

2. FIELD TRIP

Background

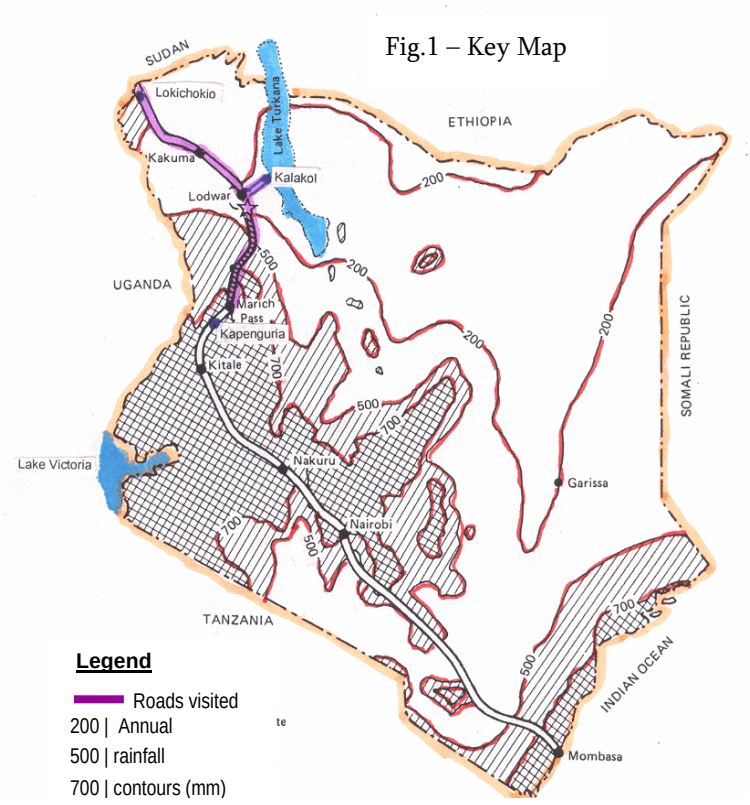
2.1 A four day field trip was undertaken to the Turkana Province in the north western area of Kenya over the period 24th – 27th February 2006. The itinerary for the trip is given in Section 1.7. In essence, the trip involved travel from Nairobi to Lokichokio, including a leg from Lodwar to Kalakol, a total travel distance both ways of approximately 2,000 km.

2.2 The main objective of the trip was to expose participants to examples of road technology involving both conventional and more innovative approaches to the use of road construction materials in the provision of Low-volume sealed roads. In this regard, the focus of attention during the field trip was on two distinctly different types of road pavements as exemplified by the following roads:

(c) Marich Pass-Lodwar-Kalakol - characterised by a "non-standard" pavement structure utilising naturally occurring quartzitic clayey gravels (PI < 20) as base course (soaked CBR > 30) obtained from borrow sources close to the alignment and a graded aggregate Otta seal using screened gravel.

(d) Lodwar-Lokichokio – characterised by a "conventional" pavement structure utilising a relatively low plasticity (PI < 6) crushed stone bases course (soaked CBR > 80%) obtained from quarrying of hard basalt rock and a double bituminous surface treatment using crushed basalt aggregate obtained from the same source.

Fig.1 – Key Map



The field trip was undertaken by participants from Kenya, North Sudan, South Sudan and Uganda as well as by the SSATP/World Bank representative and the World Bank consultants. A representative from the Ministry of Works, Kenya, accompanied the team on the leg of the trip from Kitale to Lokichokio.

Background to road sections visited

2.3 The road sections Lodwar-Kalokol and Marich Pass-Lodwar were initially constructed as gravel roads. However, these sections deteriorated rapidly in the unfavourable environment (dry climate and unsatisfactory engineering characteristics of the only available gravels) and caused serious maintenance problems. After carrying out various surfacing trials (Otta seal, sand seal and chip seals) it was decided to surface these two sections with a double Otta seal.

2.4 The following is a brief summary of the construction phases of the roads:

Phase A	Lodwar-Kalokol	Gravel road	57 km	1974-76
Phase B	Marich Pass-Lodwar	Gravel road	197 km	1975-77
Phase C	Kapenguria-Marich Pass	Bitumen road (double Chip seal	64 km	1977-84
Phase D	Lodwar-Kalokol	Bitumen road (Otta seal)	57 km	1985-86
Phase D	Marich Pass-Lodwar	Bitumen road (Otta seal)	197 km	1980-84
	Lodwar-Lokichokio	Bitumen road (double Chip seal)	213 km	1986-89

2.5 The approximate 1998 construction costs of the various sections of road were as follows:

Phase C:	5.9 mill Ksh/km
Phase D :	0.9 mill Ksh/km
Lodwar - Lockichokio	2.5 - 3.5 mill Ksh/km

Observations

Marich Pass-Lodwar

2.6 ***General:*** The road consists of a natural gravel pavement, 20 - 30 cm thick, under a double Otta seal with a 5.5 m surfaced width and 25 - 50 cm wide gravel shoulders. The road was first constructed as a gravel road between 1975-77 and later improved to a bituminous standard between 1980-84 using a double Otta Seal (no prime applied). Much of the earth works and pavement layers were constructed using “dry compaction” methods in which the materials were compacted at their in situ moisture content that varied between 0% and 2% in relation to the optimum moisture content of 6% to7%.

2.7 ***Performance:*** The bitumen surfaced road has been in service for more than 22 years with a minimum of maintenance and has carried more than double its design life of 1 million ESAs. The sections of surfacing for the last 60 km from Lodwar and from Lodwar-Kalokol are performing surprisingly well. However, the remaining part of the road has deteriorated due to lack of maintenance as a result of which full rehabilitation will be required. It is noteworthy that, apart from the surfacing, much of the pavement structure is still intact, with relatively little structural deformation of the base and subbase layers. The following photographs illustrate the current (February 2006) condition of the road.

Sections of the badly deteriorated road surfacing and shoulders (left) and other sections of the same with much of the pavement structure still being intact and the graded shoulders providing an alternative roadway (right).

Sections of the road with no maintenance (left) and with maintenance (right) illustrating the substantial benefits of carrying out simple, routine, maintenance to extend the service life of the road.

Lodwar-Kalokol

2.8 ***General:*** The 6.5 km wide surfaced road (double Otta seal – no prime) with 75 cm gravel shoulders is about 57 km in length and was constructed in 1985/86. The subbase material was obtained from the road side and was used to lift the road to an average height of about 75 cm above ground level. The base course was a naturally occurring quartzitic gravel of about 70 mm in thickness.

2.9 ***Performance:*** The road has been in service for more than 20 years with a minimum of maintenance (no resealing) and is still in generally good condition. The surfacing has remained in very good condition and there have been very few signs of distress – typically a few potholes and one major washout that have remained unattended. The traffic carried to date is much lower than on the Marich Pass - Lodwar road with an estimated ESA loading of about 0, 2 - 0, 3 million. The following photographs illustrate the current (February 2006) condition of the road.

The Lodwar-Kalokol road looking towards Kalokol and showing the excellent condition of the pavement and surfacing after more than 20 years in service with practically no maintenance.

The double Otta seal surfacing constructed from screened quartzitic gravel obtained from adjacent to the road alignment.

Lodwar-Lokichokio

2.10 ***General:*** The Lodwar-Lokichokio road was constructed between 1986-89 with a 20 cm natural gravel subbase and a 15 cm crushed stone base under a primed double bituminous surface treatment. The road is 6.0 m wide with 75 cm wide gravel shoulders – a traditional pavement structure of the time.

2.11 ***Performance - Lodwar-Loktiaung:*** This section of the road is approximately 70 km long and exhibits some surface ravelling and potholes. The pavement is generally sound although along some sections of the road there are signs of rutting in both the inner and outer wheel paths. A few areas of the pavement and surfacing have failed and, in general, the road is in need of resealing or appropriate strengthening to carry increasing levels of commercial traffic bound for Lokichokio and Southern Sudan.

2.12 ***Performance - Lokitaung – Lockichokio:*** This section of road towards Lockichokio is about 140 km long and has been resealed recently and re-marked over most of its length. The road is in good condition, although it exhibits a relatively high roughness level compared with the section from Lodwar to Lokitaung. The following photographs illustrate the current (February 2006) condition of both road sections.

The Lodwar-Lokichokio road looking towards Lokichokio and showing the generally good condition of the pavement albeit with some ravelling of the surfacing.

Drainage structures

2.13 ***General***: The roads under discussion traverse an area with numerous streams and gullies. In addition, sheet flow after intense rainfall is common along those sections of the road where the terrain is very flat. Thus, according to the design report, 182 culverts and 47 drifts were constructed along the Marich Pass-Lodwar-Kalokol road.

2.14 ***Performance:*** After more than 22 years in service, most of the drifts and culverts have performed well. However, there were a number of instances of washouts and scour on the down-stream end of drifts and at culver outlets. The photographs below illustrate the condition of these drainage structures.

Examples of well designed drifts along the Marich Pass-Lodwar road in which the bottom of the drift, forming the road surface is exactly at the level of the river bed – a requirement for good performance.

Examples of poorly designed drainage structures along the Marich Pass – Lodwar road. Insufficient depth of the downstream skirt has resulted in extensive scour of the drift (left) and a washout at a culvert outlet along the Lodwar-Kalokol road.

Lessons learned

General

2.15 There are a number of lessons to be learned from the field visit that cover a range of technical matters including road surfacings; pavement materials; compaction techniques; drift and culvert design and maintenance issues. Importantly, the road section between Marich Pass- Lodwar-Kalokol and that between Lodwar and Lockichokio provide two distinctly different types of pavements – the latter section providing a good example of a "non-standard" design in which the materials used would generally not comply with current specifications and the former section providing a good example of a more "conventional" design. These sections of road provide an excellent opportunity to undertake a life-cycle cost comparison to quantify the cost-effectiveness of the two examples of road provision adopting very different approaches to their design and construction. Nonetheless, both sections have provided similar levels of service in the same prevailing environment (traffic, climate, terrain, etc) but ***at significantly different construction and, importantly, life-cycle costs***.

Surfacings

2.16 ***Double Chip seal***: The double Chip seals used between Kapenguria - Marich Pass and Lodwar - Lockichokio have been in service for more than 20 years and, apart from a few short sections that require reconstruction, have generally performed satisfactorily. However, the entire length of road is now in need of urgent maintenance in terms of pothole patching and subsequent resealing. The section between Lokitaung and Lockichokio has already been resealed with a double chip seal.

2.17 *Otta seal:* The double Otta seal that was used for the Marich Pass-Lodwar and Lodwar-Kalakol roads has been in service for more than 20 years and has performed exceptionally well where maintenance has been carried out (e.g. the last 60 km towards Lodwar). In contrast, where no maintenance has been carried out carried out (e.g. the first 137 km from Marich Pass towards Lodwar), the surfacing has deteriorated badly although the base has generally remained in tact. Thus, it can be concluded that the double Otta seal, using relatively inexpensive, "non-standard" screened gravel, can provide a cost-effective bituminous surfacing for use in semi-arid areas such as Turkana and, when properly maintained, can provide a very long service life even for relatively high levels of traffic.

Pavement layers

2.18 The road sections between Kapenguria - Marich Pass and Lodwar - Lockichokio were both constructed with a crushed stone base over a natural gravel subbase, while the Marich Pass - Lodwar and the Lodwar - Kalakol sections were both constructed with naturally occurring quartzitic gravels in both the subbase and base layers of the pavement. In addition, in general, both layers were dry compacted. The difference in costs between these two pavement types which employ different design and construction technique is substantial – of the order of 2.5 – 3.5 times higher for the crushed stone base. As mentioned above, these road sections provide invaluable surfacing and pavement structure information that could be used to determine their life-cycle costs in similar environments as the basis for using this information to develop case histories for reference by other practitioners.

Drifts

2.19 Some 47 drifts have been constructed between Marich Pass - Lodwar - Kalokol and Lodwar-Lockichokio and, apart from a few, they have all performed satisfactorily. The underlying design and construction of the drifts that entailed placing the top of the drift at the same level as the river bed and constructing a skirt down streams to a depth of at least 1, 5 meters (see figure below) has proved to be an appropriate design which has minimised down stream erosion of the structures. Those drifts that were constructed not in level with the stream/river bed either silted up or experienced serious erosion down stream, totally exposing the skirt and, in some cases, the underside of the drift.

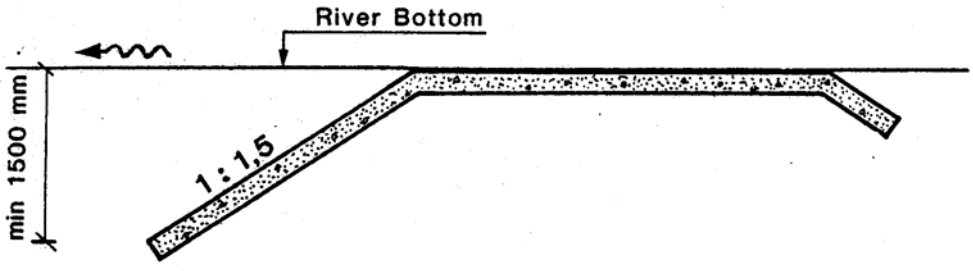


Figure 2 - Section through a typical drift on the Marich Pass – Lodwar road

Maintenance

2.20 The serious lack of any maintenance activities for the last 10-15 years (apart from the Lokitaung-Lockichokio section and partly along the Lodwar-Kalokol section) has resulted in much of the remaining sections of part of the total length of the roads falling into a very critical condition whereby, if nothing is done immediately, these sections will deteriorate very quickly and simply disappear. In fact, about 65% of the length of the Marich Pass-Lodwar road section has already deteriorated beyond repair and now requires full reconstruction. However, had timely maintenance been carried out, including resealing, the roads visited would have been in good condition and their lives would have been extended for a number of years without the need for expensive rehabilitation/strengthening works. It was interesting to observe that the pavement layers on the Marich Pass-Lodwar section were still generally intact with little or no rutting and had carried a traffic loading of more than 2 million ESAs in contrast to the design traffic loading of 1.0 million ESAs.

Conclusions

2.21 In conclusion, the field visit was obviously an eye opener for all the delegates who participated in this activity. In this regard, their exposure to the history and performance of these roads enhanced their appreciation of the fact that naturally occurring materials can be used judiciously in the provision of durable, Low-volume sealed roads. Moreover, such materials may well not comply with traditional specifications which have generally emanated from technology and research carried out in Europe and the USA over 40 years ago in very different environments. Thus, the trip may well act as catalyst for adoption of more appropriate, regional research-driven, road designs and specifications as promoted by the SADC Guideline on Low-volume Sealed Roads. The trip also highlighted the need for a more systematic write up of the road projects visited as case histories to supplement and enhance the guidance given in the SADC Guideline on Low-volume sealed roads through the provision of practical examples.

Field trip party at the equator crossing on the return trip to Nairobi

3. THE WORKSHOP

Objectives

3.1 The main objective of the workshop was to outline the concept and philosophy behind the SADC LVSR Guideline, including case studies, as a basis for knowledge sharing and promotion of appropriate technologies in the construction of pavements and bituminous surface treatments for possible application in Kenya, Sudan and Uganda.

Program

3.2 The workshop took place in the conference room of the Silver Spring hotel in Nairobi. The programme for the workshop is attached as Annex C.

Attendance

3.3 The workshop was attended by some twenty six delegates from Kenya (14 No.) South Sudan (6 No.). North Sudan (1 No.) and Uganda (2 No.). The attendance list is attached as Annex D.

Preliminaries

3.4 **Opening Statement:** The Opening Statement was made by Mr. Olav Ellevset, Senior Transport Specialist, SSATP/World Bank Program. He firstly expressed the gratitude of the SSATP Program and the World Bank to the Government of Kenya for hosting the workshop on Low-volume sealed roads in Nairobi. He also expressed his thanks to all participants to the workshop, including, those visiting from North and South Sudan and Uganda, for showing interest in the theme of the workshop.

3.5 Some of the key points made by Mr. Ellevset in his Opening Statement are as follows:

- The SSATP is a partnership of currently including 32 Sub-Saharan countries, the European Union, several bilateral , regional associations and institutions, and the World Bank for promoting sustainable transport policies that will help in reducing poverty and supporting economic growth in the members countries.
- Good roads are important for the development of any country. However, the standard and condition of the roads are not able to provide people with basic access to education, to health services, to markets for selling their produce, etc. – unfortunately a common situation in many countries.
- Delegates might have seen in their countries gravel or earth roads that have been repaired and improved with a lot of effort and money, and which have served their purpose for some time. However, too often harsh weather conditions, sometimes combined with poor materials, have made these efforts and investments last for a short period only. In these

circumstances, the investments involved in providing traditional bituminous surfacings may not be justifiable due to lack of good quality materials within reasonable haul distance and high costs in relation to the number of vehicles using the road.

- The workshop will deal with optional technologies and customized designs that are appropriate for the local climate, the materials available and the prevailing traffic volumes and loads. Typically, construction cost savings could be 10-20% compared with traditional surface treatments, and 30-50% over 20 year life-cycle cost.

- The field trip undertaken to roads in the Turkana area in north-western Kenya are of particular interest from a research point of view as they were constructed more than 20 years ago and provide valuable experience in terms of how local materials can be utilized in such environments, the impact of maintenance interventions and the pavement response to traffic loading.

- Overload control remains a serious threat to roads Kenya, Sudan and Uganda and effective control of overloading is of paramount importance in order to avoid a reduction in their design lives as well as to preserve the investments made in providing such roads.

- The workshop was meant to serve as a forum for sensitization and exchange of experiences based on practical applications in the Turkana region of north eastern Kenya.

3.6 Mr. Ellevset concluded his remarks by expressing the hope that the participants would find the outcome of the workshop interesting enough to engage in further steps for identifying the viability of customized applications within the framework of on-going and future projects in their respective countries.

3.7 **Introductory Remarks:** The Introductory Remarks were made by the Undersecretary in the Ministry of Roads and Communication in South Sudan, Dr. Daniel Wani, who thanked the organisers for affording him the opportunity to make a few introductory remarks at the start of the workshop. The remainder of his remarks may be summarised as follows:

- Southern Sudan was a very large country with a very large network of mostly gravel roads that had deteriorated badly due to lack of maintenance in the past couple decades. The country faced the challenge of how best to rehabilitate its road network and was on the look out for the most appropriate and cost-effective technology for doing so.

- Could the technological innovations being discussed at the workshop also apply to Southern Sudan? For example, Black Cotton soils posed a particular challenge, in the regions of the country north of the capital, Juba, and a solution to this problem was required.

3.8 In concluding his remarks, Dr. Wani thanked the organisers for arranging the workshop which he felt was very timely for the participating countries, particularly Sudan. He also expressed the wish that in order to take the outputs of the workshop further, consideration should be given to holding the next workshop in Juba where a larger number of Sudanese practitioners would be able to participate. Finally, he exhorted all participants to make full use of the workshop to extend their knowledge of the latest developments in road technology.

3.8 **Welcome Address**: The Welcome Address was made by Eng. Silas Gitau on behalf of the Ministry of Roads, Public Works and Housing. In his address, Eng. Gitau mentioned that Kenya had embarked on its Roads 2000 Programme which had its main focus the use of labours based methods, the use of local materials and employment creation. In his address he indicated that:

- Gravel was getting scarcer in Kenya and emphasis was now being placed on Low-cost surfacing of roads as a means of avoiding complete depletion of the remaining sources of gravel and reducing the high maintenance costs incurred on gravel roads;
- The philosophy of Low-volume sealed roads was not new to Kenya as it had been used in the Turkana region more than 20 years ago where a number of innovative techniques had been used including dry compaction techniques and graded aggregate (Otta) seals. For various reasons, these techniques are currently not being used in Kenya.
- The guidance given in the SADC Guideline on Low-volume sealed roads was particularly appropriate as funds for road construction were become increasingly scare in most countries.

3.9 Eng. Silas concluded his address by wishing the participants well in their deliberations so that the technologies being discussed and actually seen on the field trip could be more widely used in practice.

Feedback from field trip

Participants comments

3.10 The workshop commenced by providing all participants with an opportunity to highlight their observations or to make comments on what they saw or learned from their participation in the field trip. A synthesis of the participants' observations or comments is presented below:

(a) Gravel surface versus "Low-cost " seal:

- The Lodwar-Kalokol road had demonstrated conclusively that in the prevailing environment there were substantial life-cycle benefits to be derived by applying an Otta seal once in contrast to repetitive grading and regravelling over a 20 year period. Other

benefits included a reduction in the use of finite gravel resources, a reduction in institutional and plant resources, time savings and environmental benefits, especially a reduction in the dust hazard and related traffic safety problems. The actual costs and benefits should be quantified and written up as a case history.

- Very often, donor countries did not support the sealing of gravel roads at low traffic volumes as this was generally viewed as being uneconomical. It is very necessary for these donors to be willing to consider these new ideas so that recipient countries can adopt innovative road technologies in appropriate circumstances. This is one of the reasons why the technologies developed in the Turkana region are not used more widely today in Kenya.

(b) **Use of the Otta seal:**

- The Otta seal had performed at least as well as the double Chip seal at much lesser construction costs, since it allowed the use of screened gravel whilst the Chip seal required the use of crushed aggregate. This type of seal would appear to be eminently suitable for use in all countries where traditional crushed aggregate is not available or would be prohibitively costly to produce, e.g. because of long haul distances.

- The traffic carried to date on the Marich Pass-Lodwar road had demonstrated that the Otta seal was not just suitable for Low-volume roads but could also be used in relatively high traffic loading situations, at least up to 2 million ESAs. The Otta seal surfacing was just as "strong" as the double Chip seal.

- There was a very big difference in the design and construction of the Otta seal and the Chip seal. With the Otta seal, continuously graded screened aggregate of relatively low crushing strength was used in conjunction with relatively low viscosity binders (150/200 pen. grade or MC 3000) while the Chip seal required two single sizes of relatively high crushing strength aggregate with relatively high viscosity binders (e.g. 80/100 pen.grade).

(c) **Design issues:**

- The rigid application of traditional materials specifications would have precluded the use of the relatively plastic quartzitic gravels on the Marich Pass-Lodwar and Lodwar-Kalokol roads. Yet, these roads had performed exceedingly well in the prevailing traffic and climatic environment. This suggested the urgent need to review road design standards and specifications in a number of countries where such documents were outdated, often being more than 20 years old.

(d) **Construction issues**

- Dry compaction techniques offer a cost-effective means of compacting materials in arid areas where water is typically very scarce. The UK TRL trial sections located 6 km south of Lodwar had demonstrated that high densities complying with the Kenyan specifications could be achieved at low moisture contents using conventional plant and operating techniques. These sections had performed well in an arid region of Kenya over a 20 year period. However, such techniques should be used with caution in wet areas where high air voids that are associated with compaction at low moisture contents could result in significant loss of material strength were the voids to become filled with water.

(e) Maintenance issues

- The importance of timely maintenance was very clearly demonstrated on the roads visited. Although maintenance was generally not carried out in a timely fashion over most of the roads, where it had, the impact was quite significant; the surfacing had remained intact and the road was still traversable in comfort. In contrast, where no maintenance had been carried out, the surfacing had deteriorated and, in some cases, had become impassable, with traffic preferring to use the gravel shoulders, especially where they had been graded.

(f) Drainage issues

- The design of scour protection measures for both drifts and culverts is critically important in arid or semi-arid areas where high intensity rainfall can result in flash floods and sheet flow in flat areas. The designs of the drifts, particularly with regard to ensuring that the bottom of the drift, forming the road surface, is exactly at the level of the river bed, as well as the minimum vertical depth of the downstream skirt, are worthy of emulation in similar environments in other countries. As regards side drainage in flat, sandy areas, when the longitudinal drains are cut too close to the road alignment, they tend to act as a channel for sheet flow, causing under-cutting of the pavement.

(g) Summary

- The contrasting aspects of both traditional and innovative approaches to road materials utilisation, road design and construction that had been seen during the field visit, coupled with the in-depth background explanations provided by the Consultants, had provided an eye-opener for all of the delegates. In principle, many of the "non-standard" approaches could be used in appropriate circumstances in other countries. However, more in-depth training in these approaches would be required to instil the necessary confidence to adopt them in practice.

Presentations

3.11 ***Presentation No. 1*:** The first presentation was made by Mr. Mike Pinard, a SSATP/World Bank consultant, on *"Sustainable Provision of Low-volume Sealed Roads ".* Mr. Pinard's presentation, which is included as Annex E, dealt with the following main topics.

- Introduction
- Background to the SADC Guideline on Low-volume Sealed Roads
- Why Low-volume sealed roads
- New approaches and challenges

3.12 ***Presentation No. 2:*** The second presentation was made by Mr. Charles Overby, a SSATP/World Bank Consultant, on *"Bituminous Surfacings for Low-volume Sealed Roads"*. Mr. Overby's presentation, which is included in Annex E, dealt with the following main topics:

- Introduction
- Types and Performance Characteristics
- Properties and functions of surfacings
- Selection of surfacing types
- Surfacing Design and Construction
- Case Histories

3.13 ***Presentation No. 3:*** The third presentation was made by Mr. Mike Pinard on *"Materials and Pavement Design Technologies for Low-volume Sealed Roads"* Mr. Pinard's presentation, which is included as Annex E, dealt with the following main topics:

- Introduction
- Materials issues
- Pavement issues
- Other issues
- Examples

3.14 ***Presentation No. 4:*** At the request of participants, a brief presentation on the History of the Otta Seal was made by Mr. Charles Overby and dealt with the following main topics:

- Introduction
- Background
- Development
- Approach to Design and Construction

Working Group Deliberations

3.15 As a means of assessing the way forward with regard to the introduction of the alternative pavement and surfacing technologies to Kenya, Sudan and Uganda, two working groups were formed as follows:

(a) Group 1 (Kenya delegates)
(b) Group 2 (Sudan and Uganda delegates)

The two groups given the following task:

> *"Consider the scope for introducing the new developments in road technology as seen on the field trip and dealt with during the Consultants' presentations, including the constraints that may occur with regard to adopting these technologies and how they could be overcome."*

Working Group deliberations in progress: Left: Group 1 -Kenya delegates; Right Group 2 - Sudan and Uganda participants

3.16 Scope for introduction of new developments in road technology

(a) Feedback from Working Group No. 1 (Kenya):

- ***Otta seal and Sand seals***: in areas where good quality surfacing materials are very scarce such as in the drier, coastal regions of the country;
- ***dry compaction techniques:*** in the drier areas of the country where water is scarce such as in the Rift Valley;
- ***revised materials specifications:*** in areas of the country such as in the central and western regions of the country where pedegonic materials (e.g. calcrete) and laterites prevail and do not comply with traditional specifications;
- ***compaction to "refusal":*** especially with pedegonic materials and laterites in order to enhance their strength and bearing capacity;

- ***sealing of shoulders:*** especially in the wetter areas of the country such as the southern areas of the Rift Valley where some materials are moisture sensitive ;
- ***summary***: in general, there is much scope for the introduction of all the new developments in road technology derived from the experience of the design and construction of roads in the Turkana region of Kenya.

(b) Feedback from Working Group No. 2 (Sudan and Uganda):

- There are many areas in Sudan and Uganda where "standard" materials are not available or gravels are being depleted rapidly. In such situations, there is an obvious need to search for and use alternative approaches that have been proven elsewhere.
- In general, there is much scope for application of the developments in road technology seen during the field visit and discussed during the presentations by the Consultants.

3.17 **Constraints to adoption of new developments in road technology**

(a) Combined feedback from both Working Groups:

- ***Political:***

- Often lack of political will and support to adopt any developments that deviate from the traditional approaches.
- Some new developments in surfacing such as Sand or Otta seals are often viewed as inferior to 'conventional" "black top" surfaces such as asphaltic concrete.

- ***Institutional:***
  - lack of awareness of new developments in road technology and where this is not the case, an inherent resistance to change;
  - insufficient trained engineers and technicians to adopt new developments in road technology;
  - lack of proper management of existing data and scattered historical records of project experiences involving innovative technology;
  - resistance from contractors who tend to inflate their price for the new technologies because of lack of familiarity with them;
  - resistance from consultants who are often unfamiliar with the new technologies and are reluctant to "stick their necks out" and to assume what they perceive are unnecessary risks.

- ***Technical:***
  - outdated design standards and specifications which do not take account of new developments in road technology;

- a general preference by many engineers to stick to the traditional approaches by following the existing design manuals and specifications;
- traditional thinking by donors who often review country designs and insist on using existing, outdated standards and specifications particularly with regard to sealing of roads at relatively low traffic levels;
- lack of analytical models to readily quantify the benefits of new technologies;
- lack of in-country technical know-how of the new technologies;
- inevitable need to undertake pilot projects and to subsequently monitor them and produce reports which can take a long time (5–6 years) and delay the implementation of full-scale works.

- *Financial*
  - general lack of funds for engaging in development of alternative technologies through appropriate research work, training in new technologies, etc.

3.18 **Measures for overcoming constraints to adoption of new developments in road technology**

- *Political:*

- stronger advocacy and promotion of new developments in road technology;
- increased awareness of benefits of adopting new technologies.

- *Institutional:*
  - increased training and workshops for all stakeholders such as Government engineers and technicians, consultants and contractors;
  - proper electronic archiving of all research and project reports.

- *Technical:*
  - need for revision of road standards and specifications;
  - need to undertake pilot projects where warranted;
  - development of well documented and quantified case studies to convince donors to agree to adoption of new developments ;
  - need for some sharing of risks between parties to the contract when new technologies are being introduced for first time.

Way Forward

3.19 The following issues were proposed by participants as regards the way forward:

(a) A Visit Report would be prepared by participants for their parent ministries to sensitise them to the philosophy of the SADC Guideline on Low-volume Sealed Roads and to the substantial potential benefits to be derived from adopting the approaches proposed in the guideline.

(b) The Visit Report would highlight the key findings and lessons learned from the site visit and workshop as a basis for engendering a keener awareness of the new developments in Low-volume road technology a view to implementing pilot projects in their countries.

(c) Vigorous pursuit of the need to undertake urgently a revision of outdated design standards and specifications would be vigorously pursued.

(d) Mobilisation of support for holding country workshops similar to the Kenya workshop so that all stakeholders could be sensitized to the new developments in road technology as a means of facilitating their implementation where appropriate.

Workshop Closure

Summary of closing remarks by representatives from Kenya, Sudan and Uganda

3.19 The following is a summary of the closing remarks made by delegates from each of the participating countries:

- The field visit and workshop were an eye-opener for many of the delegates who had been exposed for the first time to a number of new developments in road technology that all had potential for application in their countries.

- Implementation of the new developments in road technology would be facilitated by holding country workshops to expose a wider cross-section of stakeholders to these developments.

- There was an urgent need to revise and update country design standards and specifications to accommodate the new developments in road technology.

- A change of attitude was required by donors to supporting the adoption of many new developments in road technology, including the sealing of roads at relatively low traffic levels, where life-cycle costs support this approach.

- The workshop had achieved its objective of sharing experiences with all participants on new developments in road technology including alternative pavement and surfacing technologies that are potentially applicable in Kenya, Sudan and Uganda.

Closing remarks by the SSATP/World Bank Senior Transport Specialist

3.20 On behalf of the SSATP/World Bank, Mr. Olav Ellevset firstly thanked the host country, Kenya, for kindly agreeing to hold the workshop in Nairobi. He also thanked the delegates from Kenya, Sudan and Uganda for their keen participation in the workshop. The remainder of his concluding remarks are summarized below:

3.21 In his closing remarks, Mr. Ellevset thanked highlighted some of the key issues arising from the workshop as follows:

- Gravels in many African countries are a finite resource which are being rapidly depleted. There is therefore a need to make investments in road provision more permanent by adopting low-cost surfacings where appropriate.
- Research carried out in the past 20 years in Southern Africa, including the innovative developments in road technology seen in the Turkana region of Kenya, had catalysed the re-thinking of the whole approach to the provision of Low-volume sealed roads which should be taken seriously by all African Governments.
- With the excellent presentations and very knowledgeable and interested participants from Kenya, Sudan and Uganda, the objective of the workshop, which was to share and disseminate knowledge related to appropriate technologies in the construction of pavements and bituminous surface treatments for Low-volume roads, had been achieved.

3.22 In terms of the way forward, Mr. Ellevset mentioned that this was largely in the hands of the Government in that they should use their bi-lateral projects for undertaking pilot projects and could approach the donors involved for support for doing so. In particular, he suggested that consideration should be given to updating country design standards and specifications which should then become national standards that should be adhered to by all stakeholders in the roads sector.

3.23 In concluding the workshop, Me. Ellevset again thanked all participants for their valuable contributions to the workshop deliberations and assured them that the SSATP will always be on their side in exploring new ways of providing roads in a more sustainable manner by exploiting the benefits offered by various interesting new developments in road technology.

Annexes

SUB-SAHARAN TRANSPORT POLICY PROGRAM

Short Term Consultancy Services for Facilitating Workshops on Knowledge Sharing and Promotion of Appropriate Pavements and Bituminous Surface Treatment Technologies for Low-volume Cost Seals Roads in Mali, Senegal and Burkina Faso, and Kenya, Uganda and Sudan.

Terms of Reference

Background

The 2006 Work Program (WP) of the Sub-Saharan Africa Transport Policy Program (SSATP) is contained within a framework of priority thematic areas: (a) Road Management and Financing; (b) Appropriate Transport Services; and (c) Regional Integration and Transport. Overarching initiatives comprise transport strategy development based on the outcomes of ongoing poverty/transport analytical work (ensuring transport fully responsive to poverty reduction strategies) and the establishment of appropriate transport sector performance indicators linked to the Millennium Development Goals (MDGs). The work program is the second of four annual programs which will incrementally achieve the objectives of the SSATP Long Term Development Plan (LTDP) which runs to 2007.

The Road Management and Financing (RMF) Thematic area includes a number of initiatives namely: road network management (institutional and financial arrangements), road fund enhancement, road agency improvements, and capacity building and training. Many countries have embarked on reform agendas, but adherence to sound policy principles and emulation of established good practice is, in a number of cases, problematical. The SSATP is addressing demands for support in these areas in a number of ways, including the implementation of activities arising from specific recommendations made by the last SSATP Annual Meeting held in Bamako, Mali, in November 2005.

One such activity for which the current terms of reference are written is the promotion and dissemination of the SADC Guideline on Low volume sealed roads (LVSR), and support to the collection of corresponding experiences from SSA. Whilst the approach and the philosophy of the Guideline have been practiced in some countries over a number of years, the Guideline is now enabling a more comprehensive and coherent approach to be adopted in the utilization of technologies and methods that focus on the utilization of locally available materials. The major impacts of adopting such approaches include a reduction of life-cycle costs. less consumption of scarce good construction materials. Another important factor is the a reduction in the continuous exploitation of non-renewable gravel sources, more so when "good" gravel is used in an inappropriate manner.

Objectives

The objective of the consultancy services is to disseminate knowledge and promote the use of appropriate technologies in the construction of pavements and bituminous surface treatments for low-volume roads technologies for low cost seals in SSATP partner countries, this time particularly for Mali, Senegal and Burkina Faso.

Scope of Work

Under the guidance of the RMF thematic leader, the consultants will carry out the following:

Mali:

1. To undertake field visits to assess the prevailing environment in terms of the availability of materials and road construction plant. Also, to brief the workshop participants on the way forward with regard to the potential for utilizing more appropriate technologies in the provision of low-volume sealed road applications.

2. To undertake an interactive workshop in Mali to outline the concept and philosophy behind the SADC LVSR Guideline, including case studies, as a basis for knowledge sharing and possible application in the mentioned countries.

3. To specify appropriate material testing requirements for determining the suitability of natural local materials for the construction of pavements and bituminous use as appropriate surface treatments.

Presentations and materials can be provided in English, and the SSATP will provide for English interpretation and translation of documents.

Kenya:

1. Preparation note on Kwale trials & Turkana pamphlet and provide copies to participants.

2. To participate in the field visit to Turkana and briefing participants on materials, traffic loads and the application experiences derived thereof.

3. To undertake an interactive workshop in Nairobi to outline the concept and philosophy behind the SADC LVSR Guideline, including case studies, as a basis for knowledge sharing and possible application in the mentioned countries.

4. To specify appropriate material testing requirements for determining the suitability of natural local materials for the construction of pavements and bituminous use as appropriate surface treatments.

Presentations and materials can be provided in English, and handouts are to be provided to the participants.

Resources

The consultants, Mr. Mike I. Pinard and Mr. Charles Overby, are the two of the core team of authors of the SADC Guideline for Low Volume Sealed Roads presently available. Due to the in-depth knowledge behind the Guideline, they have been selected sole source to undertake the consultancy.

Total time input for both consultants will be:

Mali:

(a) Preparation of workshop program:	0.5	days
(b) Preparation of PP presentation:	2	days
(c) Visit to Mali:	16	days
(d) Preparation of report:	2.5	days
Total:	21	days.

Kenya:

(a) Preparation of workshop program and write-ups	3	days
(b) Preparation of PP presentation:	3	days
(c) Kenya:	12	days
(d) Report writing:	3	days
(e) Travel:	4	days
Total:	25	days

Timeframe and Reporting

The Consultants will arrive in Mali on or about Sunday 15 January, and will depart on or about Saturday 21 January, 2006.

The deliverables are:
(a) Preparation of workshop program
(b) Preparation of PP Presentations for workshop
(c) Identification of typical testing programs for local materials
(d) Preparation of a report summarising the outcome of on the workshop and on the field visit

The Consultants will arrive in Kenya on or about Thursday February 23, and will depart on or about Thursday March 2, 2006.

KEN 042 LOW-COST PAVEMENTS PROJECT

Institutional Cooperation between Roads Department, MoW, Kenya and Norwegian Road Research Laboratory (NRRL)

INTRODUCTION.

The Low-cost Pavement was started 1982 with an appraisal study, which was carried out by the Norwegian Road Research Laboratory (NRRL) and Materials Branch of Ministry of Public Works. The initial contracts for the project were in 1980 between the Ministry of Works, NRRL and the Norwegian Agency for Development NORAD. (Refer to Project Report No. 4477/1).

The main objective of the Low-cost Pavement was to provide specification for construction materials to be utilized on the low volume roads in the regions without too good quality materials. It was intended that by utilizing local materials the project would achieve road pavements with both acceptable life expectancy and reasonable maintenance costs.

The construction of the trial section started in June 1983 on the arrival of the first project co-coordinator. Preliminary investigation consisted of gravel and hard stone surveys together with digging of test trenches. From August 1983 to August 1985 a total of 16 trail sections were constructed. An additional 6 sections were located adjacent to the already constructed sections.

A small change was made on the selected sections by replacing the A 23 Voi – Mwatate section by D348 Lodwar – Kalokol. The monitoring of the sections lasted from 1985 to 1989.

This informative note deals with the two projects at the Costal region, road C 105 Kwale – Kinango only.

PERFORMANCE OF ROAD TRIAL, KWALE

Key figures:

Completed:	1985		
Road width:	6.00 m +0.5 m wide gravel shoulder		
Rainfall:	Annual Mean 820 mm		
Traffic (predicted conservatively):			
AADT cum per 1995	0.865 mill.	in 2003	1.7 mill
E80's cum per 1995	0.142 mill	in 2003	0.284 mill
AADT-H per 1995	300/50	in 2003	500/100

PERFORMANCE OF BASE AND SURFACING

As per 2003 none of the sections exhibited any signs of rutting or shearing. However, both longitudinal, transverse and block cracking were evident. The block cracking was seen more predominately on the laterite section that was stabilized with coral fines. The surfacing may be described as follows:

Double Otta Seal, uncrushed laterite (both layers 5-20mm), ACV 42.

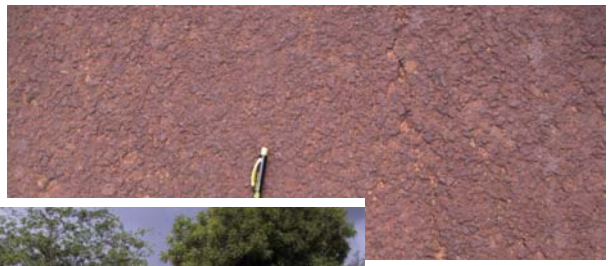
The surfacing looks good with an appearing dense smooth texture. The texture was slightly more open on the stabilized section. This may be due to a lower spray rate.

Double Otta Seal, crushed coral stone (both layers 5-14mm) ACV 32.

The sections had a dense water proof surface texture, more like an AC . The surfacing exhibited an excellent surfacing.

Double Surface Dressing (Chip seal) 10-18mm and 5-14mm, ACV 22.

The sections performed well, however, with a more open surface texture then the Otta Seal sections.



Kwale trial, "as dug" laterite as Otta Seal

Road C 106 junction A 14. Double Otta seal using crushed coral stone.

In 1985-86 the C 106 road from the Junction Turn off A14 was constructed using laterite as base course layer with a double Otta seal as the surfacing using crushed coral stone for the first 10-12 km. Immediately after construction the surfacing experienced excessive bleeding due to heavy construction traffic. This was rectified by adding coral aggregate dust over a longer period in order to absorb the excess of bitumen. In 2003 the first 5-6 km still exhibited a good performance. However, the remaining part of the road had frequent shear failures and excessive subbsase/subgrade strain.

Construction of Road trial

The road trial at Kwale is 800 m in length and was constructed during the period February to April 1985. The road trial can in general be described with the following properties:

PROPERTIES	TYPE OF SURFACING AGGREGATE		
	SOFT	MEDIUM	HARD
BITUMINOUS SURFACING	OTTA SEAL	OTTA SEAL	CHIP SEAL
Aggregate type:			
Type	Laterite (5-20 mm)	Coral stone (5-20mm)	Chippings (5- 20 mm)
ACV	42	32	22
LAA	54	38	36
< 0,425 mm	18	4	2
< 0,075 mm	10	1	0
Binder type:			
Prime	No prime	No prime	No prime
1st seal	MC 3000	MC 3000	MC 3000
Design Appl. rate	1.80	1.80	1.70
2nd seal	MC 3000	MC 3000	MC 3000
Design Appl. rate	1.90	1.80	1.30
	1% Duomine added	1% Duomine added	1% Duomine added
ROAD BASE			
Material type:	Laterite	Laterite stab. With 6 – 10 % coral fines (21,9%)	
	Km 0 - 400	km 400 - 800	
Crushed /Natr.	Natural	Natural	
PI	15	10	
PM	726	658	
< 0,425 mm	48	60	
MDD/OMC	2070/7.9	2005/8.1	
CBR at 95%	17	20	
CBR at 98%	24	31	
Thickness (mm)	116	143	
SUBGRADE			
Material type:	Silty sand/lateritic gravel		
PI	19		
<0,425	64		
MDD/OMC	1907/13.9		
CBR at 100% BS	15		
DCP CBR			
Base (0 - 150 mm)	100 - 175	31 - 165	
Subgrade (0-150 mm	68 – 170	98 - 112	
(150-300mm)	39 - 57	49 - 68	

ACTUAL HOT SPRAY RATES FOR THE KWALE - KIANGO TRIALS 1985

CHAINAGE (M)	0	200	400	600 800
SURFACING 2 SEAL				
RHS	Coral 5-14mm Binder 1,90	Laterite Binder 2,06	Mariakani 5-14mm Binder 1.14	
LHS	Chip seal 10-18mm Binder 1,00		Laterite 5-20mm Binder 1,75	Coral 5-14mm Binder 1,81
SURFACING 2 SEAL				
RHS	Coral 5-20mm Binder 1,90	Laterite 5-20mm Binder 1,86	Mariakani 5-20mm Binder 1,82	
LHS	Chip seal 16-20mm Binder 1,66		Laterite 5-20mm Binder 1,58	Coral 5-20mm Binder 1,68

Nairobi, Kenya
SSATP/World Bank Workshop

Knowledge Sharing and Promotion of Appropriate Pavements and Bituminous Surface Treatment Technologies for Low-volume Roads

Day 1-Tuesday 28th February, 2006

08.00 – 08.30	**REGISTRATION OF DELEGATES**
08.30 – 12.30	**MORNING SESSION**
08.30 – 08.40	Opening Remarks *Olav Ellevset, SSATP/World Bank*
08.40 – 08.50	Welcome Address *Eng. Silas Gitau, SSE, Min. of Roads, Public Works & Housing*
08.50 – 09.10	Introductory Remarks *Olav Ellevset, SSATP/World Bank*
09.10 – 09.40	Observations and feedback from field trip *All participants involved in field trip*
09.40 – 10.15	New Approaches to Sustainable Provision of Low-volume Sealed Roads *Mike Pinard*
10.15 – 10.45	**Coffee/Tea Break**
10.45 – 12.00	Alternative Surfacing Technologies for Low-volume Sealed Roads + Case Studies *Charles Overby*
12.00 – 12.30	Discussion *All Participants*
12.30 – 14.00	**Lunch**
14.00 – 17.00	**AFTERNOON SESSION**
14.00 – 15.15	Alternative Materials and Pavement Design Technologies for Low-volume Sealed Roads + Case Studies *Mike Pinard*
15.15 – 15.45	Discussion *All Participants*
15.45 – 16.15	**Tea/Coffee Break**
16.15 – 16.30	Instructions for Working Group Deliberations *Consultants*
16.30 – 17.00	Working Groups deliberations Theme: *Challenges of implementing new approaches*
17.00	**Closure - Day 1**

Nairobi, Kenya
SSATP/World Bank Workshop

Knowledge Sharing and Promotion of Appropriate Pavements and Bituminous Surface Treatment Technologies for Low-volume Roads

Day 2-Wednesday 1st March, 2006

08.30 – 12.30	**MORNING SESSION**
08.30 – 10.15	Working Group deliberations (Continued)
10.15 – 10.45	**Tea/Coffee Break**
10.45 – 11.15	Working Group 1 – Feedback
11.15 - 11.45	Working Group 2 – Feedback
11.45 – 12.30	Discussion *All participants*
12.30 – 14.00	**Lunch**
14.00 – 16.30	**AFTERNOON SESSION**
14.00 – 15.00	Way forward *All participants*
15.00 – 15.45	Workshop resolution
15.45 – 16.15	**Tea/Coffee Break**
16.15 – 16.40	Workshop summary *Consultants*
16.40 – 16.50	Closing remarks *Min. of Roads, Public Works & Housing*
16.50 – 17.00	Closing remarks *SSATP/World bank representative*
17.00	**Closure Day 2**

Workshop Attendance List

	COUNTRY	INSTITUTION/MINISTRY/COMPANY	FIRST NAME	LAST NAME	ADDRESS	TELEPHONE	FAX	EMAIL
1	Kenya	Ministry of Roads and Public Works	Anthony	Chiira	P. O. Box 30260 Nairobi - Kenya	254.722.852.791		achira@roadsnet.go.ke
2	Kenya	Ministry of Roads and Public Works	S. K.	Kogi	P. O. Box 30260 Nairobi - Kenya	254.20.532.732		skkogi@roadsnet.go.ke
3	Kenya	Ministry of Roads and Public Works	Joachim	Mbarua	P. O. Box 11873 00400 Nairobi - Kenya	254.20.554.8499		jmbarua@materials.roadsnet.go.ke
4	Kenya	Ministry of Roads and Public Works	Kitema	Muli	P. O. Box 30260 Nairobi - Kenya	254.20.272.3101		kmuli@roadsnet.go.ke
5	Kenya	Ministry of Roads and Public Works	Peter	Muthama	P. O. Box 30260 Nairobi - Kenya	254.272.3101		pmuthama@roadsnet.go.ke
6	Kenya	Ministry of Roads and Public Works	K.	Ndungu	P. O. Box 11873 00400 Nairobi - Kenya	254.20.554.8499		kndungu@materials.roadsnet.go.ke
7	Kenya	Ministry of Roads and Public Works	Charles	Okeyo	P. O. Box 2708 Eldoret - Kenya	254.722.849.664	254.53.206.3937	cokeyo@roadsnet.go.ke
8	North Sudan	National Highway Authority	Abubakar	Abu Elgassim	Khartoum Sudan	0912.673380	0183.235595	
9	South Sudan	Ministry of Transport and Roads	James	Alam	C/o Juba HQ South Sudan	882.164.333.4442/3		alamjj2@yahoo.co.uk
10	South Sudan	Ministry of Transport and Roads	Marko	Aleardo Paul	C/o Juba HQ South Sudan			tabanangasi@hotmail.com
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15	Uganda	Road Agency Formation Unit	Barbara	Birungi	P. O. Box 28487 Kampala	256.77.2506.686	256.41.232.807	bbirungi@rafu.or.ug
16	Uganda	Road Agency Formation Unit	David	Luyimbazi	P. O. Box 28487 Kampala	256.77.2473.661	256.41.232.807	dluyimbazi@rafu.or.uh

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Consultants' Presentations