Crown Agents

AFCAP

UKaid
from the British people

Targeted Interventions for Low Volume Roads in Mozambique

AFCAP/MOZ/001/C

Quarterly Progress Report No.7

By Kenneth Mukura

October 2012

TRL

This project was funded by the Africa Community Access Programme (AFCAP) which promotes safe and sustainable access to markets, healthcare, education, employment and social and political networks for rural communities in Africa.

Launched in June 2008 and managed by Crown Agents, the five year-long, UK government (DFID) funded project, supports research and knowledge sharing between participating countries to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources.

The programme is currently active in Ethiopia, Kenya, Ghana, Malawi, Mozambique, Tanzania, Zambia, South Africa, Democratic Republic of Congo and South Sudan and is developing relationships with a number of other countries and regional organisations across Africa.

This material has been funded by UKaid from the Department for International Development, however the views expressed do not necessarily reflect the department's or the managing agent's official policies.

For further information visit https://www.afcap.org

Preface

This quarterly report provides details of the work carried out by TRL on Mozambique AFCAP/RRIP Phase 2 for the past 3 months from August 2012. This project has been ongoing for over 2 years and a lot of work has been accomplished. The report provides an insight into the activities carried out during this reporting period, the achievements and challenges that have been faced and the plans for the next reporting period.

Table of Contents

1 Introduction

The AFCAP/RRIP Phase 2 project has resulted in great successes being achieved at each demonstration site.

1. The development of new and appropriate specifications for Otta seals for low volume roads which are now being adopted on several projects in Mozambique.
2. The training of contractors and consultants on the application of innovative designs and construction methods. For example, the use of a blend of fine coastal sands and clay (matope) has been report by ANE as a viable and cost effective solution which is now proven through the relevant projects:
    a. Marracuene Macaneta Project leading to the resort area of Macaneta. All weather passability has been achieved through the use of very poor locally available materials and the perennial passability problems of loose sand in the dry season and boggy sections of black cotton clays in the wet season have been resolved at low cost.
    b. The Maragra Machubo Road which had similar problems with Marracuene Macaneta Road was constructed using a blend of sand and clay (Matope) and ANE has reported good performance of the blended materials.
3. The research component which was TRL's main objective on the project has also gone well and a lot of trial sections have been built and performance monitoring is in progress. Early indications of performance are positive.

This report is mainly focused on Beira Savane Project which has experienced some problems:

1. There has been poor performance by the contractor, TCO. Despite the concerted effort by the project team to encourage the contractor to work and complete the project, it is now apparent that the contractor has failed.
2. The project was previously designed on the basis of very low and light traffic mainly destined for the beach resort of Savane. However, the scenario has since changed and traffic has increased beyond the levels considered appropriate for low volume roads. This was caused by the discovery of a borrow pit for sand for land fill in Beira City.
3. The change of designs made necessary by the changes in traffic.

This meant that both the design and the contract needed to be reviewed and a way forward mapped out in order to move towards the finality of this project. This report covers the work that has been accomplished to this effect during this reporting period.

The report also covers the monitoring activities in brief. The details of the monitoring activities and interim data analysis is covered in detail in a separate report.

2 Progress for the reporting period

TRL carried out several tasks during this reporting period ending October 2012.

2.1 Beira Savane Project

The Beira Savane Project has stalled for a very long time owing to the failure by the contractor to deliver the job and also the need to accommodate the sudden increase in traffic that was not anticipated at the initial design stage.

1. At the initial design stage the traffic volume was approximately 50 vehicles per day and the largest vehicle was the bakery truck which used to deliver bread to a settlement 25km from Beira City. The bulk of the traffic comprised of 4x4 pickup trucks belonging to tourists travelling to and from the Savane Beach Resort. This was typical of a low volume road where there was very little chance of any rapid increase in traffic. In terms of the traffic engineering calculations almost 90% of the vehicles would have had very little or no effect on the pavement.
2. The discovery of a borrow pit of sand for landfill lead to the influx of very heavy tipper trucks, approximately 180 per day but it was not just the number of vehicles but the overloading on the road pavement. Consequently, pavement fatigue resulted from repeated loading and damage caused by the individual wheel load on the pavement.
3. The design standards were based on the low traffic volumes and as such the types of surfacings were chosen on that basis. The influx of heavy tipper trucks rendered the capacity of the road inadequate and inevitably the sections that were completed deteriorated rapidly. It was evident that most of the failures were superficial i.e. in the surfacing. Some sections which had emulsion treated base (ETB) did not deteriorate to the same extent. The ETB was thus tested to the extreme limits as it was subjected to heavy traffic and weather elements for long periods of time without surfacing cover and showed unexpectedly high resilience. This became a very important research finding.
4. There were two options available to the project team and the Road Administration, ANE
    a. To put in place regulation that prohibits trucks weighing in excess of 5 tonnes access to this road. This was unpopular because this would hamper the rapid development of Beira City. It is important to note that Beira City is being built on a fill because most areas flood during the rainy season. Such a move would be economically and politically unsustainable.
    b. To enhance the designs in order to accommodate the tipper trucks hauling sand. This was the most viable option though it would incur extra cost to the project.
5. Meetings were held involving the project team and ANE and the following decisions were made.
    a. There was a need to redesign the pavement in order to enhance the strength of the base and surfacing, in particular to be able to carry the heavy traffic. The surfacing in the previous design was mostly sand seal on ETB using local sand. The new design would include:
        i. Cold mix at the junction with N6
        ii. Penetration Macadam using aggregate from Chiluvo. Two layers involving 20-40mm size aggregate for the first layer and 5-13mm for the second layer
        iii. Double surface dressing for the bulk of the trial section

b. To avoid too much damage, ANE decided to place a limit of 7 tonnes as a temporary measure before the construction of the section is completed which is now in force.
c. It was important to sort out contractual issues related to the procurement of works because it was evident that the contractor had failed. It was recommended that the contract be rescinded unless the contractor showed commitment to complete the works in the shortest possible time that would be allowed by the client. To date no such commitment has materialized and the contract is being terminated. The procurement of works through a different contractor should commence soon.
d. TRL was requested to produce new designs commensurate with the prevailing scenario related to the influx of heavy tipper trucks.

6. TRL has prepared designs to enhance the base and surfacing in order to accommodate the heavy tipper trucks. The detailed BoQs are given in the Appendix. This has been one of the main tasks accomplished by TRL during this reporting period.

2.2 Guideline on Specifications and Work Norms for LVRs

This reporting period saw the drafting of the Guideline on Specifications and Work Norms for Low Volume Roads which is an updated version of the Guideline drafted during Phase 1 of the Mozambique AFCAP Project. The Guideline covers pertinent areas of road provision and maintenance including:

1. Planning
2. Road evaluation
3. Drainage design
4. Geometric design
5. Pavement design and work norms
6. Surfacing design and work norms
7. Road maintenance

This document provides a full package of concise specifications and procedures for practitioners to be able to carry out low volume road design. The document also provides a step-by-step approach which helps to simplify the technical aspects and procedures for the practitioners.

2.3 Monitoring surveys

TRL also carried out the monitoring surveys which are aimed at quantifying the performance parameters for the purpose of evaluating the variations in performance of the various trial sections which should culminate in the development of appropriate specifications for low volume roads. The data that has been collected shall be made available in a separate Monitoring Report.

Pending a contract extension with Crown Agents, the monitoring surveys shall continue until February 2013 and thereafter the data shall be aggregated and analysed in order to develop recommendations for modification of specifications for low volume roads.

2.4 Other Projects

This section covers projects that were designed by TRL under AFCAP funding. Supervision of construction is being carried out under a direct contract with ANE sponsored by SIDA. The projects involve innovative designs which allow the use of weak locally available sand and sandy clay materials for roadbases.

2.4.1 Cumbana-Chacane Project

This project is being carried out in Inhambane Province. The project involves a number of useful trials including:

1. Use of armouring technology for weak and fine non-plastic sands found abundantly in Inhambane Province. Armouring involves the use of a layer of aggregate over a weak pavement layer. On this project locally available calcrete aggregate was used for the armouring. The aggregate (20-50mm size) was applied in the upper 50mm of the sand base and technically it performs two vital functions
    a. It enhances the overall strength of the sand base
    b. Prevents failure of the surfacing through creation of an amalgamated surfacing which infers that the base and surfacing (sand seal) become one thus eliminating the common failure of the surfacing due to loosening of the interface between the surfacing and the sand base.
2. Use of penetration macadam surfacing over sand bases which is likely to be a viable alternative to cement stabilisation in the design of low volume sealed roads. In this case locally available natural calcrete aggregate will be used for the construction of the penetration macadam.

The project is 90% complete.

1. 4km of subbase of red sand has been complete
2. 4km of armoured sand road base has also been completed
3. 4km of surfacing has been applied but a double seal is required. To date only a single seal has been applied.
4. The sand base which will be sealed with penetration macadam has been prepared.
5. Priming and the construction of penetration macadam surfacing is still outstanding. The contractor is yet to procure the prime (MC30) and emulsion (SS60) for the surfacing.

The works have been carried out properly but progress has been very slow. See photos in Appendix.

2.4.2 Chinhacanine Nalazi Project

This project is being carried out in Gaza Province. The designs for the drainage were carried by the provincial consultant, Cotop and the construction was carried out ahead of TRL contract for the supervision of Phase 3 of the Rural Road Investment Programme (RRIP).

TRL designe the embankments, pavement and the surfacing. The embankment (1.7m high) was constructed using sandy clay soil found locally. A blend of the sandy clay and locally available river sand was used for the construction of the base layer. However, the strength was inadequate and a layer of aggregate was applied on top of the blended base to enhance the overall strength of the base and also prevent base/surfacing interface failure which is common on surfacing that is placed on plastic bases.

A lot of progress had been achieved

1. The construction of the embankment was completed by August 2011
2. The armoured and blended road base was completed by September 2011
3. Preparation for surfacing had been carried out with the supply of materials at 50%. The bulk of the surfacing aggregate had been supplied but there was no bitumen on the market until May 2012 so surfacing could not be carried out.
4. The contractor also needed to correct some of the armouring which had not been carried out properly.

Unfortunately, a tropical storm hit the areas in January and damaged the site including other roads in the coastal areas to the tune of USD 17 milllion.

The drainage was inadequate and some of the drainage structures were washed away including some parts of the embankment which were overtopped.

TRL has since assisted with preparation of designs with enhanced drainage discharge capacity and this included the design of a causeway also referred to as a vented drift or ford. This structure allows for overtopping during flooding also taking advantage of the flood routing effect. The designs have since been given to ANE and the new provincial consultant. Additional funding has been requested for the repairs of the flood damage and additional drainage structures.

3 Plans for the next reporting period

The next reporting period shall involve a few activities.

1. Finalizing the Guideline should there be comments from the AFCAP Technical Management Team.
2. Three dissemination workshops for the Guideline as shall be advised by ANE. These will be carried out in the Northern, Central and Southern Regions of Mozambique.
3. Should the procurement of works be concluded quickly supervision of construction works may be carried out on Beira Savane Road during the next reporting period.
4. It is planned that the next and final monitoring surveys will commence during the next reporting period i.e. in January 2013.

It is anticipated that the workshops that have been planned will help in the implementation of the specifications and work norms that have been developed through this project.

4 Issues

There are a few contractual issues that should be highlighted in this quarterly report.

1. A letter requesting an extension of time was submitted to AFCAP for consideration including justification. Though there has been an agreement in principle a formal agreement is yet to be received.
2. TRL is prepared to contribute to the works on Beira Savane Project but the actual inputs will depend on how quickly ANE can put in place a replacement contractor to carry out the construction works.

5 Appendix

News BoQs

Cross-sectional and pavement design: Revised to accommodation heavy tipper trucks

Beira - Savane Road

Works	QTY	Rate	Amount
Section 1: 0+000 to 0+100 (100m): 100mm ETB with 6% emulsion content + cold mix (necessary for turning effect at the junction) Scarify 100mm, level, water, mix and compact to 95% of MDD Mod AASHTO minimum. Cross-fall 3%.			
Place 300mm sand subbase, water mix and compact to 95% MDD Mod AASHTO minimum, in 150mm layers. Cross-fall 3%			
Place mountable kerbing on either side (230m total length)			
Place 100mm Emulsion Treated Base (ETB) at 6% emulsion content, compacted to 95% MDD Mod AASHTO minimum, cross fall 3%, 7m width			
Apply prime at 0.6L/m2 MC30 on 7m width.			
Cold mix asphalt 7m wide, 15mm thick (6m carriageway and 0.5m shoulders), crossfall 3%			
First 50m, cladd side slopes with cement bricks made on site or fired clay bricks whichever is cheaper. Side slope incline 1 in 4.			
First 50m LHS, shallow concrete lined V-drain, 1 in 3 slopes either side.			
Section 2: 8+400 to 8+700 (300m): Neat sand base + penetration macadam surfacing			
Scrap off sand seal surfacing.			
Scarify existing sand base to a depth of 100mm, mix, water and recompact to minimum 95% mdd Mod. AASHTO, 6m width			
Prime sand base at 1.0L/m2 with MC30 or 50:50 diluted SS60 emulsion, 6m width			
Apply first layer of penetration macadam; 20mm-40mm size aggregate laid by machine and/or labour, roll to settle the aggregate and spray 2.0L/m2 MC3000 or 80/100 pen bitumen, 6m width.			
Apply second layer of penetration macadam; 5mm-13mm size aggregate laid by machine and/or labour, roll to settle the aggregate and pray 1.4L/m2 MC3000. It may be necessary to apply a thin layer of local sand in order to be able to open to traffic within 3 days of application to prevent pick up of surfacing, 6m width			

Section 3: 8+700 to 9+200 (500m): 100mm ETB (6% emulsion content) + penetration macadam surfacing.			
Scarify existing sand subbase to a depth of 100mm, mix, water and recompact to minimum 95% mdd Mod. AASHTO, 6m width			
Construct 100mm Emulsion Treated Base at 6% SS60 emulsion content and compact to 95% MDD Mod AASHTO, 6m width			
Apply prime at 0.6L/m2 MC30 or 0.8L/m2 of SS60 diluted with water 50:50 proportions. 6m width			
Apply first layer of penetration macadam; 20mm-40mm size aggregate laid by machine and/or labour, roll to settle the aggregate and pray 2.0L/m2 MC3000 or 80/100 pen bitumen. 6m wdth.			
Apply second layer of penetration macadam; 5mm-13mm size aggregate laid by machine and/or labour, roll to settle the aggregate and pray 1.4L/m2 MC3000. It may be necessary to apply a thin layer of local sand in order to be able to open to traffic within 3 days of application to prevent pick up of surfacing. 6m width			
Section 4: 9+200 to 9+950: 100mm ETB with 6% SS60 emulsion stabilisation + cape seal surfacing			
Scarify existing sand subbase to a depth of 100mm, mix, water and recompact to minimum 95% mdd Mod. AASHTO, 6m width			
Construct 100mm Emulsion Treated Base at 6% SS60 emulsion content and compact to 95% MDD Mod AASHTO			
Apply prime at 0.6L/m2 MC30 or 0.8L/m2 of SS60 diluted with water 50:50 proportions. 6m width.			
Apply single surface dressing: Apply 1.5L binder MC3000 or 80/100 (preferred) followed by 13mm size aggregate chipping. 6m width.			
Apply slurry seal, 10mm thick. 6m width.			
Section 5: 9+950 to 10+700: 100mm ETB + Double surface dressing			
Scarify existing ETB to a depth of 100mm, mix, water and recompact to minimum 95% mdd Mod. AASHTO, 6m width			
Construct 100mm Emulsion Treated Base at 6% SS60 emulsion content and compact to 95% MDD Mod AASHTO. 6m width.			
Apply prime at 0.6L/m2 MC30 or 0.8L/m2 of SS60 diluted with water 50:50 proportions.			

Apply double surface dressing: Apply MC3000 followed by 19mm size aggregate chipping, roll for 3 days applying 8 passes per day, open to traffic at 40km/h maximum for 2 weeks. Clean surface and apply the seal coat; spray MC3000 and apply 13mm aggregate and roll for 3 days applying 8 passes each day. Open to traffic and limit speed at 40km/h maximum for 2 weeks before allowing normal operating speed. 6m width.			
Section 6: 10+700 to 11+350 Correct irregularities on existing cement stabilised base + Double surface dressing			
Correct any irregularities on the existing cement stabilised base with cold mix. 6m width.			
Apply prime at 0.6L/m2 MC30 or 0.8L/m2 of SS60 diluted with water 50:50 proportions. 6m width.			
Apply double surface dressing; Apply MC3000 followed by 19mm size aggregate chipping, roll for 3 days applying 8 passes per day, open to traffic for 2 weeks at 40km/h maximum. Clean surface and apply the seal coat: spray MC3000 and apply 13mm aggregate and roll for 3 days applying 8 passes each day. Open to traffic and limit speed at 40km/h maximum for 2 weeks before allowing normal operating speed. 6m width.			
Final clearing Sections 2 to 6: Place and roll organic soil on un sealed shoulders to the level of surfacing for vegetative growth and prevention of edge break.			

Beira Savane Road

The tipper trucks plying Beira Savane Road

Damage on Beira Savane Road caused by heavy tipper trucks

Cumbana Chacane Project

Armoured sand base

Sand seal on armoured sand base

Amalgamated surfacing (sand seal)

Chinhacanine Nalazi Project

Armoured and blended sand/clay base

Flood damage