African Community Access Programme

Project AFCAP/KEN/089

Research Project for Low Volume Sealed Roads in Kenya (Kiambu, Central Region)

Final Report

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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 maximize 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 organizations across Africa.

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PROJECT BACKGROUND

A significant portfolio of research activities has now been established in the AFCAP participating countries. AFCAP provides technical assistance for these activities and promotes the uptake of the research findings through revised, country specific design standards and specifications.

AFCAP has been asked by the Kenya Government to support a process of developing new design standards for low volume sealed roads. As part of this process it is intended to construct research and demonstration sections on roads in the Central Province using low volume sealed road design standards.

In consultation with Kenya Rural Roads Authority, KeRRA and the Materials Testing and Research Department in the Ministry of Roads, 5 sites were selected for design using a simplified method for design of LVSRs based on Dynamic Cone Penetrometer (DCP) tests with a DCP Design Catalogue developed by Council for Scientific and Industrial Research (CSIR), South Africa. The method obviates the need for extensive laboratory sub-grade testing at the design stage, yet provides reliable results. Designs based on this catalogue can give substantial cost savings for upgrading of rural gravel and earth roads to LVSR standard.

Region	Road	Length	Remarks
Murang'a	E 511	900 m	Sep/Oct 12
Kiambu	**D 379**	**400 m**	**Completed**
Nyandarua	D 382	600 m	Sep/Oct 12
Nyeri	D 435	600 m	Jan/Feb 13
Laikipia	D 462	700 m	Cancelled

The Laikipia section has since been rehabilitated through another project and was hence cancelled from the research project.

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LIST OF ABBREVIATIONS

ACV	:	Aggregate Crushing Value
ADT	:	Average Daily Traffic
ADDT	:	Average Annual Daily Traffic
AASHTO	:	American Association of State Highway and Transportation Officials
AFCAP	:	African Community Access Programme
CBR	:	California Bearing Ratio
CESA	:	Cumulative Equivalent Standard Axles
CL	:	Center line
CRC	:	Constituency Roads Committee
CSIR	:	Council for Science and Industrial Research
DCP	:	Dynamic cone Penetrometer
DN	:	The average penetration rate in mm/blow of the DCP in a pavement layer
DN_{150}	:	Number of blows to penetrate to 150 mm
DSN_{800}	:	The total number of blows to penetrate to 800 mm depth
ESA	:	Equivalent Standard Axle
FACT	:	Fines Aggregate Crushing Value
FI	:	Flakiness Index
Hrs.	:	Hours
ILO	:	International Labour Organization
IRI	:	International Roughness Index
KeRRA	:	Kenya Rural Roads Authority
Km	:	Kilometer
KN	:	Kilo newton
Kshs	:	Kenya shillings
LAA	:	Los Angeles Abrasion Value
Ltd	:	Limited
LHS	:	Left hand side
Ltrs	:	Litres
LV	:	Low Volume
LVSRs	:	Low Volume Sealed Roads
N	:	Newton

m	:	Metres
mm	:	Millimetres
m^2	:	Square Metre
m^3	:	Cubic Metre
MESA	:	Million Equivalent Standard Axles
MC	:	Medium Curing Bitumen
Md	:	Man-day
MDD	:	Maximum dry density
Mins.	:	Minutes
OMC	:	Optimum moisture content
OPC	:	Ordinary Portland cement
PI	:	Plasticity Index
POL	:	Petrol, Oil and Lubricant
PPC	:	Pozzolanic Portland cement
RHS	:	Right hand side
T	:	Tonnes
ToR	:	Terms of Reference
US$	:	United States dollar
UCS	:	Unconfined Compression Strength
UK	:	United Kingdom
VEF	:	Vehicle Equivalent Factor
Vpd	:	Vehicles per day

Person day Amount of work done by one per day (8 working hours) or a given task work for the day. This applies to Man-day.

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Executive Summary

The research section on D 379 in Kiambu was designed using the DCP Design Method based on the Malawi DCP Design Catalogue. The method aims to simplify design of Low Volume Sealed Roads utilizing as far as possible in situ materials and the inherent strength of these materials at in-service moisture content that is normally below Optimum Moisture Content.

The road had been re-gravelled in 2010/11 and had a laterite gravel wearing course of 120-150 mm on top of mainly in situ highly plastic red coffee soil.

Typical characteristics of the laterite gravel and red coffee soil are shown in table 1 below.

Table 1: Typical characteristics of in situ subgrade and laterite gravel wearing course before construction

			ATTERBERG LIMITS					Comp. T180								
			LL	PL	PI	LS	PM	MDD	OMC	Moisture condition	CBR at various compaction levels				Increase from 93% to 98%
	Layer	Ref.	(%)	(%)	(%)	(%)		(Kg/m^3)	(%)		93%	95%	98%	100%	
D379 Kiambu	Subgrade	0+000	50	28	22	11	1650	1658	14.4	4-Dsoak	3	4	5	6	
										OMC	Test not done				
										.75 OMC	Test not done				
	Gravel	0+000	44	22	22	11	726	1910	14.0	4-Dsoak	20	30	40	42	100%
										OMC	125	145	165	195	32%
										.75 OMC	185	194	197	217	6%
	Subgrade	0+200	45	20	25	12	1950	1700	18.6	4-Dsoak	10	12	15	16	
										OMC	Test not done				
										.75 OMC	Test not done				
	Gravel	0+200	40	22	18	9	612	1910	14.0	4-Dsoak	22	27	34	35	55%
										OMC	47	56	69	78	47%
										.75 OMC	132	144	150	155	14%
	Subgrade	0+350	46	21	25	12	1575	1700	18.6	4-Dsoak	9	12	15	17	67%
										OMC	62	64	68	70	10%
										.75 OMC	128	135	146	150	14%
	Gravel	0+350	42	23	19	9	855	1865	13.2	4-Dsoak	5	7	11	12	120%
										OMC	92	102	120	132	30%
										.75 OMC	154	160	167	170	8%

The road was in a good motorable condition with slight rutting in the wheel paths and had a reasonable drainage system. The effective width of the carriageway was only about 4m - 4.5m forcing motorist to drive on the shoulders or in the side slope with the outer wheels when they meet traffic from opposite direction.

Widening would therefore be required, but the narrow road reserve (typical for Kiambu Region) would limit the total width that could be achieved without acquiring adjacent properties.

Traffic counts were carried out in January 2012. ADT was estimated at 1021 distributed as follows:

Table 2: ADT for D379 Kiambu

Region: Kiambu Direction: Combined both directions	Adjusted ADT (+30%)	% of ADT
Bicycles	72	7%
Others (NMT)	0	Not counted
Motor Bikes	258	25%
Cars	302	30%
Vans/Matatus	366	36%
Small trucks	3	0.3%
Buses	3	0.3%
Medium trucks - 2 axles	14	1.4%
Heavy trucks - 3 axles	2	0.2%
Articulated trucks - 4 or more axles	0	0%
Total	1021	100%

Based on axle load surveys on comparable roads in the project area reduced Vehicle Equivalent Factors were used to estimate the Design Traffic Loading:

Table 3: Reduced VEFs for estimation of Design Traffic Loading

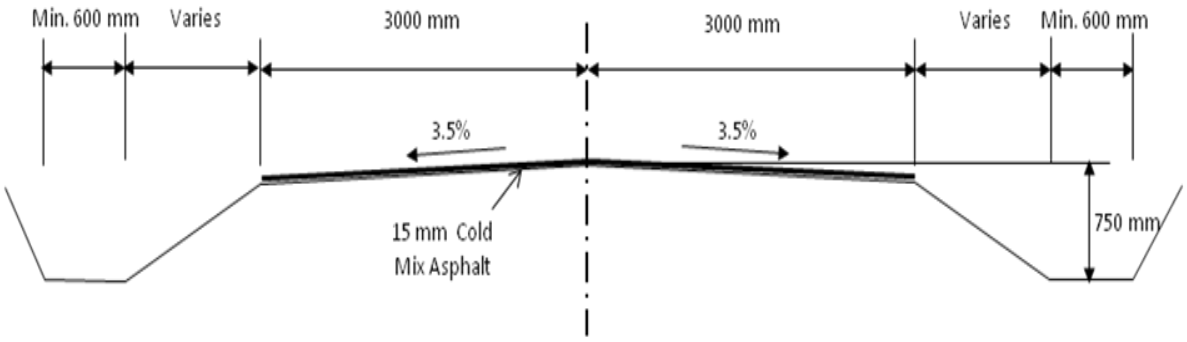
Vehicle class	VEF (reduced)
Buses	0.08
Medium trucks – 2 axles	0.6
Heavy trucks – 3 axles	1.69
Articulated trucks – 4+ axles	2.76

Table 4: Design Traffic Loading CESA for D 379 Kiambu

D379 Kiambu	Combined both directions		
Design period (years)	5	10	15
CESA (standard VEF, Kenya RDM)	43245	97494	165585
CESA (reduced VEF)	22429	50584	85943

A Design Traffic Loading of 85,943 CESA for a 15 year design period was used for the pavement design using the WinDCP software to analyse the DCP data.

Figure 1: Cross section for D 379 Kiambu



Standard Cross Section

The analysis of the DCP data showed that no additional pavement layer was required for the estimated 15 year design traffic loading.

The road was widened by benching in layer using the in situ subgrade up to subgrade formation level. An imported laterite 150 mm base layer was placed on the benches to tie in with the existing pavement. The exisiting pavement was then scarified to a depth of about 75 mm to retain as much as possible of the consolidated strength of the pavement, topped up as necessary to compensate for rutting, then the whole base layer was compacted to refusal using a 10 tonnes vibrating roller. Control tests shows that minimum density requirements on both the benches (100% T 99) and base (98% T 180) were generally achieved.

The base was primed with MC 30 before sealing with 20 mm Cold Mix Asphalt, later rolled and compacted to 15 mm thickness.

The total cost of construction amounts to Ksh 5.2 million or US$ 62,000 for the 400 m section which equates to Ksh 13 million/km or US$ 155,000/km. With economies of full scale construction for the entire road link under similar conditions, this cost is expected to come down significantly.

Analysis of the “as built” DCP data shows that the end result is a well balanced pavement capable of carrying the 15 year design traffic loading. The DCP analysis also suggest that the Power Exponent of 4.5 normally used in Kenya for calculating the Vehicle Equivalent Factors, can be reduced to 3.0. This will have a profound effect on the estimation of the actual design traffic loading based on the axle load survey that is to be carried out as part of the monitoring programme. It therefore can be concluded that use of the reduced VEFs in the design is justified.

1 INTRODUCTION

1.1 Objectives

The overall objective of the project is to support rural development through improved and sustainable rural transport. To this end, the project will:

- Research on the use of the DCP Design Method for application of appropriate LVSR designs which aims to reduce initial Investment and Life Cycle Costs for LVSRs compared to current design standards;
- Research on appropriate bituminous sealing options for LVSRs; and
- Demonstrate the application of different construction methods, including labour based methods, for the provision LVSRs.

The main focus of the project is on appropriate, cost effective pavement design for LVSRs using the DCP design method. However, appropriate geometric standards with regard to current and future traffic as well as traffic safety issues are also being considered.

Cost effective pavement design and appropriate geometric standards will enable Kenya to upgrade a larger portion of the rural road network than current standards allow for. Many benefits will thus potentially accrue from the research including:-

- Cheaper, reliable and sustainable all weather transport in larger parts of the rural areas
- Reduced extraction of dwindling gravel resources and environmental degradation
- Less exposure of the rural population and road users to dust from earth and gravel roads

1.2 Project location

The test section comprising the first 400 m of D 379 as it branches off from the tarmacked road C 64 at Wamwangi, is located in Gatundu South in Kiambu Region . This location is indicacted on the map below as pointed out by the red arrow.

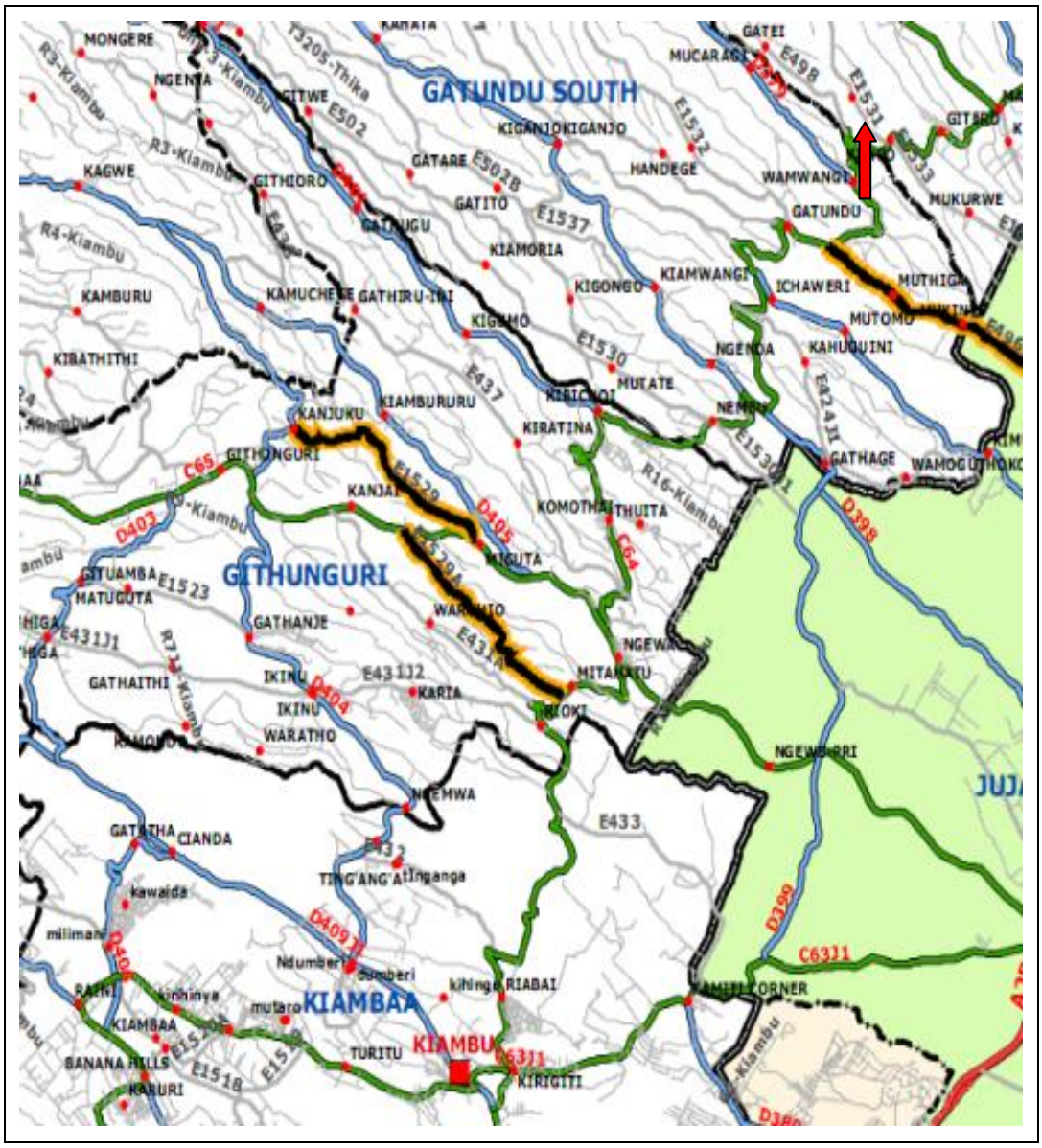
1.3 Pre-construction condition

This section of Road D 379 – Kiambu was improved in 2010/11 by the Regional Manager using the labour based techniques and was in good motorable condition by the time it was selected for the study with a laterite gravel wearing course of 120-150 mm thickness.

The drainage system was in fair condition with two cross culverts at each end of the section.

ROAD MAP NETWORK OF GATUNDU SOUTH-KIAMBU REGION, CENTRAL KENYA

Road research section in Wamwangi – Gatundu South, Central Kenya



1.4 Project design

The project design is covered in the Design Report, dated 5th July 2012.

Below is given the key elements of the pavement design parameters.

1.4.1 Traffic analysis

The ADT and Design Traffic Loading were estimated based on traffic counts in mid-January, 2012.

Table 5: Summary of the traffic count at the Wamwangi - Gatundu junction

Region: Kiambu	Road: D 379		Location: At Wamwangi, junction C 64				Time: 6 AM to 6 PM			Adjusted
Direction: Combined both directions	1/14/2012	1/15/2012	1/16/2012	1/17/2012	1/18/2012	1/19/2012	1/20/2012	Total	ADT	ADT (+30%)
Bicycles	8	61	121	70	91	33	1	385	55	72
Others (NMT)	0	0	0	0	0	0	0	0	0	0
Motor Bikes	78	138	198	269	311	311	85	1390	199	258
Cars	84	152	172	293	341	327	259	1628	233	302
Vans/Matatus	79	278	353	364	292	323	281	1970	281	366
Small trucks	4	0	3	2	4	2	1	16	2	3
Buses	0	11	2	2	1	0	2	18	3	3
Medium trucks - 2 axles	12	37	12	4	2	4	6	77	11	14
Heavy trucks - 3 axles	0	7	3	2	0	0	0	12	2	2
Articulated trucks - 4 or more axles	0	1	0	0	0	1	0	2	0	0
Total	265	685	864	1006	1042	1001	635	5498	785	1021

The Design Traffic Loading was computed using both the Vehicle Equivalent Factors from the part III of the Roads Design Manual and reduced VEFs based on axle load surveys in the project area.

Table 6: Vehicle Equivalent Factors used for analysis

Vehicle class	VEF (Kenya)	VEF (reduced)
Buses	1	0.08
Medium trucks – 2 axles	1	0.6
Heavy trucks – 3 axles	4	1.69
Articulated trucks – 4+ axles	4	2.76

Table 7: DESA 2012 for D 379 Kiambu

	Combined both directions			Combined both directions		
Vehicle class	ADT (2012)	VEF[2]	DESA	ADT (2012)	VEF[1]	DESA
Buses	3	0.08	0	3	1	3
Medium trucks - 2 axles	14	0.6	9	14	1	14
Heavy trucks - 3 axles	2	1.69	4	2	4	9
Articulated trucks - 4 or more axles	0	2.76	1	0	4	1
Total DESA 2012			14			27

The traffic loading of 85,943 CESA for a 15 year design period using the reduced VEF and 80% of the combined traffic on both directions, was subsequently used for the pavement design.

Table 8: Design Traffic Loading for D 379

D 379 Kiambu	Combined both directions		
Design period (years)	5	10	15
CESA (standard VEF)	43245	97494	165585
CESA (reduced VEF)	22429	50584	85943

1.4.2 Cross-section.

The Standard Cross Section chosen for the Kiambu test section is as shown in the previous executive summary Figure 1. The cross section profile adopted borrowed heavily on the R 2000 profile standards with the following modification:

- Carriageway width of 6.0m to include a shoulder which is not catered for in normal profile
- The in slope was varied and the construction adopted 1.5m instead of the normal 1.2m
- The grades in this design is 1 in 29 (3.5 %) instead of the normal 8-10% in the R 2000 cross section

The existing carriageway effective width varied from 4.0 to 5.0 m (as shown in figure 1 - the proposed cross section, in the executive summary). Widening by benching in layers and constructing relatively steep side slopes was done to fit the proposed cross section within the width of the reserve.

1.4.3 DCP Design

DCP measurements taken in November 2011 and January 2012 were analysed based on the DCP design curve for the appropriate traffic class in the DCP Design Catalogue:

Pavement design catalogue for different LVR categories

Pavement Class E80 x 10^6	LV 0.01 0.003 – 0.010	LV 0.03 0.010 – 0.030	LV 0.1 0.030 – 0.100	LV 0.3 0.100 – 0.300	LV 1.0 0.300 – 1.000
150mm Base ≥ 98% BSH	DN ≤ 8	DN ≤ 5	DN ≤ 4	DN ≤ 3.2	DN ≤ 2.5
150mm Subbase ≥ 95% BSH	DN ≤ 19	DN ≤ 14	DN ≤ 9	DN ≤ 6	DN ≤ 3.5
150mm subgrade 93% BSH	DN ≤ 33	DN ≤ 25	DN ≤ 19	DN ≤ 12	DN ≤ 6

DN = DCP penetration rate in mm/blow

Figure 2: Low Volume Road DCP Design Catalogue

DCP penetration rates down to a depth of 800 mm were analysed using the WinDCP Software using the following extended design curve:

User defined DCP Design Curve based on LV 0.1 above

- 0-150 mm DN≤4
- 151-300 mm DN≤9
- 301-450 mm DN≤19
- 451-800 mm DN≤50

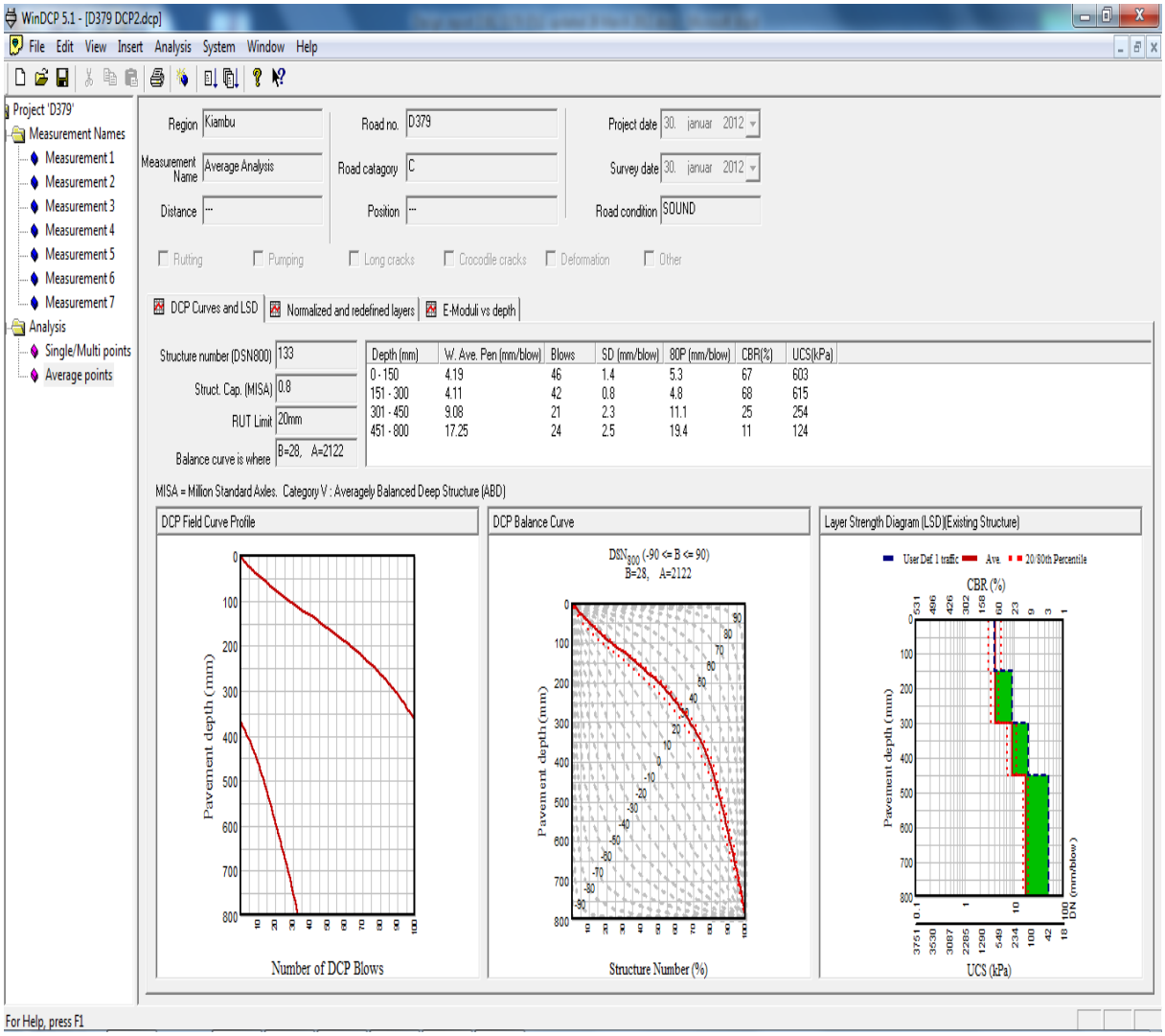


Figure 3: WinDCP results analysis for the D 379 pavement

The analysis showed that no additional pavement layer was required.

The pavement was widened by benching in layers using in situ subgrade material up to subgrade formation level and 150 mm laterite base course material placed on top to tie in with exisiting gravel wearing course . The existing wearing course was topped up as necessary and reshaped and finally compacted to refusal with heavy compaction equipment, 10 Tonnes bomag vibrating roller(to a minimum of 98% Mod AASHTO) before priming and sealing with Cold Mix Asphalt.

1.5 INVENTORY, FIELD SURVEY and ALIGNMENT DATA

Prior to construction of the research road section, a field survey was conducted to compile a complete inventory of existing structures and collect alignment data. The Inventory and Alignment Data are detailed as shown in **ANNEX A**.

The construction followed the existing horizontal and vertical alignment. The vertical alignment rises gently from km 0+000 to km 0+220 at a grade starting at approximately 1% rising to 2%, then descends to km 0+400 at grades starting at approximately 3% reducing to 2% at the cross culvert thus allowing adequate provision for the road drainage.

The horizontal alignment consists of two straights connected by a gentle left curve with a radius of 450 m from Chainage 0+220 to 0+300.

2 DESIGN SPECIFICATIONS/DRAWINGS

Drawings and design specification for both the pavement and drainage structures adopted for the Kiambu D 379 road research together with a brief description of the construction methods followed are given in details as shown in **Annex B.**

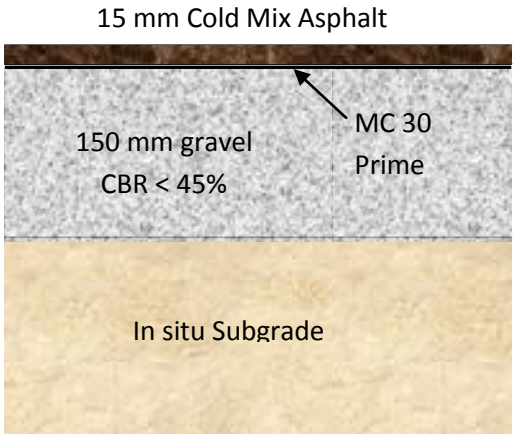
2.1 CONSTRUCTION METHOD

1. Grub vegetation in side drains and on the road side to required width.
2. Widen the formation by benching in layers.
3. Import additional laterite gravel for the widened shoulders.
4. Scarify the top 75 mm of the existing wearing course, top up with additional gravel as needed, reshape and compact to refusal to form a uniform 150 mm thick layer.
5. Cut new side drains with invert 750 mm below finished road crown, slope and back slope (by labour).

NB: - Although from the Kiambu road research experience we didn't achieve the 750 mm height (h) throughout the drain as shown in details of the as built cross section data in **ANNEX A,** corrections can be done where room for such allowance can be achieved.

6. Lay a 15 mm Cold Mix Asphalt wearing course (by labour).

Figure 5: Pavement structure on D 379 Kiambu



3 CONSTRUCTION AND SUPERVISION

3.1 WORK PROGRAMME AND RESOURCES

The following resources were used for the construction:

Table 9 : Resources used for the construction of D 379

RESOURCES	CATEGORY
1) PLANT AND MACHINERY	a)Water Bowser
	b)Tippers
	c)Motor Grader
	d)Double Steel 3T Bomag roller
	e)10 T vibrating Bomag roller
2) MATERIALS	a)Gravel
	b)Aggregates (0/6 & 6/10)
	c)Aggregate 14/20 - Culverts
	d)Culvert Blocks
	e)Bags of cement
	f)Sand
	g)MC 30 - Bitumen
3) TOOLS AND EQUIPEMENTS	a)Fabricated gauge boxes
	b)Square nosed spades
	c)Mixing trays
	d)Squeegees
	e)Camber board
	f)Hand Lance Sprayer
4) CASUAL LABOURERS	a)Men
	b)Women
	c)Youth

The weekly site activities and the monthly progress reports are shown in details in **ANNEX C.**

3.2 CONSTRUCTION METHODOLOGY

The research aims at determining to what extent one can use the existing pavement structure to successfully construct LVSRs. The construction therefore attempts to minimize disturbance of the existing road structure so that advantage is taken of the consolidation of the materials that has taken place under traffic.

The construction method adopted was a combination of both Equipment and Labour based method. This was programmed to take 8 weeks comprising 6 working days. The 0.4 km section was constructed sequentially as follows;

3.2.1 Trees and Stumps Removal

Trees and Stumps within the construction width were removed by labour. Stumps removal involved excavation to a depth more than 750mm and then cutting. The cut materials were then collected and disposed of away from the road reserve. Some were cut into pegs used during the setting out of various parts of the work. This activity is shown in below:

Photo 3-1: Stump removal during site clearing

3.2.2 Stripping and Grubbing

The activity was done through a combination of labour and equipment. The equipment used was a motorized grader. Labour was only engaged on sections where the grader maneuverability was hampered due to lack of turning space. The grubbing was done over a width of 12 m. Top soil including grass and other unsuitable materials were deposited outside the cleared or working area as per the design profile. The following photos show the activity in progress and when completed.

Photo 3-2: Top soil removal during stripping

Photo 3-3: Section showing the process of stripping complete

3.2.3 Road widening (Benching)

Benching was done with heavy construction plant. The benches were 2 m wide either side of the existing pavement. They were back filled using in situ side borrow materials. This was processed into a homogeneous mix watered then shaped to level achieving thicknesses ranging between 180-250 mm before compacting using 10 T Bomag Roller. The benches were then tested for relative density both by sand replacement method and DCP. See materials Testing Results for the benches in details as shown in **ANNEX C** of this report.

Table 10 below shows a summary of the bench layer results. We can be concluded that the test for the sub base passed since the indication of the relative compaction (AASHTO T 99)

ranges between 102 % - 109 %, way above the average expected threshold of 100 % relative compaction for benches.

Table 10: Summary of compaction test results for bench layers

LHS		RHS	
CHAINAGE	RELATIVE COMPACTION (AASHTO T 99)	CHAINAGE	RELATIVE COMPACTION (AASHTO T 99)
0+070	105%	0+280	103%
0+100	104%	0+310	103%
0+130	102%	0+340	107%
0+160	109%	0+370	102%
0+190	106%	0+400	102%
0+220	103%		

laboratory compaction tests results:

MDD	1538 kg/m^3
OMC (LHS)	25.8 %
OMC (RHS)	25.5 %

The following set of photos best illustrates the aspects for road widening;

Photo 3-4: benching using a motor grader

Photo 3-5: watering the bench during processing

Photo 3-6: size of the 1st layer bench, 0+200LHS after compaction (approximately 120 mm)

Photo 3-7: compaction on 1st layer RHS and processing on the LHS

Photo 3-8: field sand displacement on the 1st layer bench

Photo 3-9: DCP test on the 1st layer bench

3.2.4 Base formation

A grader was used to scarify the top 75 mm of the existing road gravel wearing course. This was followed by topping up with additional gravel as required, reshaping and compacting to refusal to form a uniform 150 mm thick layer over 7.0 m width pavement. The material was sourced at the same quarry as the insitu scarified gravel on the road.

Laboratory tests on both insitu and quarry gravel were taken to ascertain materials consistency in quality. Scarification was limited to 75mm to ensure that the initial conditions of the road pavement were not interfered with.

The layer was then processed to form a homogeneous mix, watered, shaped and compacted. Field density tests and DCP were then done. A grade as per the design profile was checked using camber board before confirmation was made using surveying level.

The surface was then protected from normal traffic until the compaction results were out. This was followed by an application of MC 30. For details, see materials test results for the base In **ANNEX C**.

Table 11: Summary of compaction test results for base

CHAINAGE	RELATIVE COMPACTION % (at OMC 14.0 %, MDD 1865 kg/m^3)	CHAINAGE	RELATIVE COMPACTION % (at OMC 13.6 %, MDD 1890 kg/m^3)
0+030 (CL)	98 %	0+210 (CL)	100 %
0+060 (LHS)	95 %	0+240 (LHS)	97 %
0+090 (RHS)	97 %	0+270 (RHS)	100 %
0+120 (CL)	102 %	0+300 (CL)	102 %
0+150 (LHS)	100 %	0+330 (LHS)	99 %
0+180 (RHS)	98 %	0+360 (RHS)	100 %

Compaction to refusal with a 10 tonnes vibrating roller was expected to give relative compaction of at least 98%. This was generally achieved as shown above apart from three results at 95 % & 97 % relative compaction respectively.

The next set of photos illustrates the activities described above during the road base formation for the Kiambu research section:

Photo 3-10: dumping gravel material for bench

Photo 3-11: processing and grading of road base

Photo 3-12: compacting the road base to refusal

Photo 3-13: checking levels of the base

3.2.5 Ditching and Excavation for structures

The activity of cutting side drains including in-slope, back slope and ditch was primarily done by labour. In-slopes measuring 1.5m were cut on the compacted benches to achieve a stable slope. A ditch measuring 0.6m wide was cut 0.58 m deep. The back slope was cut 0.5m inside.

NB: - The theoretical ditch camber template was supposed to be 0.64 m deep so that we could achieve the 750 mm drains depth, but since the as built Kiambu road cross section drains average at 600 to 700 mm, we can conclude the drains were cut 0.58 m deep.

Quality was regulated using a ditch and slope template prefabricated to achieve the design profiles. The grades were maintained using boning rods and line and level.

The task rates used were;

- Ditching 3-4m^3/md
- Sloping 3.5-4.6m^3/md
- Back sloping 3.5-4.6m^3/md

The task rates used were obtained from the Ministry of Public Works - Minor Roads Programme Technical Manual Volume 1.

Photo 3-14: ditch formation in progress

Photo 3-15: inner slope formation

Photo 3-16: back slope formation and lining

3.2.6 Application of MC 30

The cutback bitumen was applied using labour. The equipment used was a locally modified hand sprayer. Before the application the surface was prepared by sweeping all loose remnants of soil/gravel or other foreign materials. The centre line was re-established for setting out road width for priming.

Photo 3-17: Brooming the compacted base surface

(NB; it's done from center towards the edge)

Photo 3-18: an improvised hand lance sprayer

The objectives of priming the base are as outlined below:

- Help maintain adhesion between the road base and the bituminous surfacing and further to seal surface pores in the road base.
- If the surfacing construction is delayed, it provides the road base with a temporary protection against rainfall and light traffic until the surfacing can be laid.

3.2.6.1 Description of the treatment;

The surface was sprayed with water to suppress the dust and allow the primer to spread more easily over the surface and to penetrate the road base.

The depth of penetration of the prime achieved was between 3-6 mm. The prime spray rate/coverage achieved over selected sections of the road is tabulated as below:

Table 12 : MC 30 application rate for D 379-Kiambu Research Section

DATE 2012	TIME	Period Minutes	CHAINAGE	LENGTH (L)	MC 30 QUANTITY	AREA (6.2m×L)	SPRAY RATE
6th JULY	11:00 - 11:33 a.m.	33	Km 0+080 to 0+110	30 m	200 Ltrs.	186 m^2	**1.08 Ltrs/m^2** **5.64 m^2/min.**
	1:00 - 1:28 p.m.	28	Km 0+110 to 0+140	30 m	200 Ltrs.	186 m^2	**1.08 Ltrs/m^2** **6.6 m^2/min.**
7th JULY	10:30 - 11:25 a.m.	55	Km 0+140 to 0+200	60 m	400 Ltrs.	372 m^2	**1.075 Ltrs/m^2** **6.76 m^2/min.**
9th JULY	11:30 - 12:00 p.m.	30	Km 0+250 to 0+280	30 m	200 Ltrs.	186 m^2	**1.08 Ltrs/m^2** **6.2 m^2/min.**
	12:20 - 12:45 p.m.	25	Km 0+280 to 0+307	30 m	200 Ltrs.	167.4 m^2	**1.19 Ltrs/m^2** **6.7 m^2/min.**
	3:00 - 3:34 p.m.	34	Km 0+310 to 0+340	30 m	200 Ltrs.	186 m^2	**1.08 Ltrs/m^2** **5.5 m^2/min.**
	3:50 - 4:20 p.m.	30	Km 0+340 to 0+372	32 m	200 Ltrs.	198.4 m^2	**1.01 Ltrs/m^2** **6.6 m^2/min.**
14th JULY	11:00 - 11:25 a.m.	25	Bell mouth		160 Ltrs.	150 m^2	**1.07 Ltrs/m^2** **6.0 m^2/min.**

To ensure that an even coverage within each section to be primed was achieved, three people were used to operate the hand lance sprayer every time. A section of 30 to 40 m stretch of the road was marked out and a drum of 200 litres of MC 30 was emptied into the heating chamber. After heating the primer to required temperature, the hand lance sprayer was positioned at the centre of the road section to be primed, and then one person held the sprayer handle in position, while another pushed the pump handle. The third person ensured that after the primer was pumped, he pulled the mechanism slowly away from primed sections. Since the pipe handle was long and had enough pressure to spray, the person spraying only moved to the road edges from the center. They also repeated sections that were partially covered by the primer when sprayed during the process of pulling the mechanism.

The surface was left to dry and penetrate for at least 72hrs and over before application of surface treatment depending on the prevailing weather condition.

3.2.6.1.1 Equipment and tools

- Measuring tape of minimum 10m long
- Ball of string
- Brooms
- Hand lance sprayer
- Thermometer

3.2.6.1.2 Materials

- Water
- MC 30

The hand sprayer was fitted with a thermometer to monitor the temperature of the bituminous binder and ensure the application temperature was maintained at 60°C through controlled heating .The sprayed surface was then allowed to absorb the MC 30 before cold asphalt surfacing could be applied.

3.2.6.1.3 Construction Notes

1. Priming was carried out and the surface left to dry and allow enough time for the MC 30 to penetrate. This was achieved for 72hrs and over before laying of other bituminous surface treatments
2. Sweeping of the road was done from the center of the road to the edges to remove loose materials
3. The area to be primed was then delineated into sections and marked out with a string.
4. Water was then lightly sprayed on the road surface using water cans that deliver a free spray
5. The hand lance sprayer was checked if it is working correctly and this was done on waste ground

Photo 3-19: watering the broomed surface lightly using a free flow can

Photo 3-20: a thermometer fitted in the modified hand lance sprayer ensures the primer is applied at controlled temperature

Photo 3-21; priming process in action

Photo 3-22: a section after 24hrs of priming. It was left further to dry for another 48hrs or more before surfacing for the MC 30 to penetrate fully

3.2.7 Cold mix asphalt Surfacing

Construction of the Cold Mix Asphalt surfacing was done in accordance with the guidelines and specifications shown in **ANNEX B**. This was done mainly by labour and the only equipment used was the 3 tonne sit-on double drum Bomag roller and locally fabricated hand tools.

3.2.7.1 Equipment and tools

- Measuring tape
- String
- Shovel
- Rakes
- Brooms
- Watering cans
- Buckets
- Sit-on 3 tonne double steel Bomag Roller
- Guide rails
- Mixing trays

3.2.7.2 Materials

- Aggregates 6/10 mm and 0/6mm
- K365 cationic Emulsion
- Water
- A4 anionic Stable grade emulsion

The preferable aggregate grading table and upper and lower limits are shown in **ANNEX B**

The actual grading achieved is shown below:

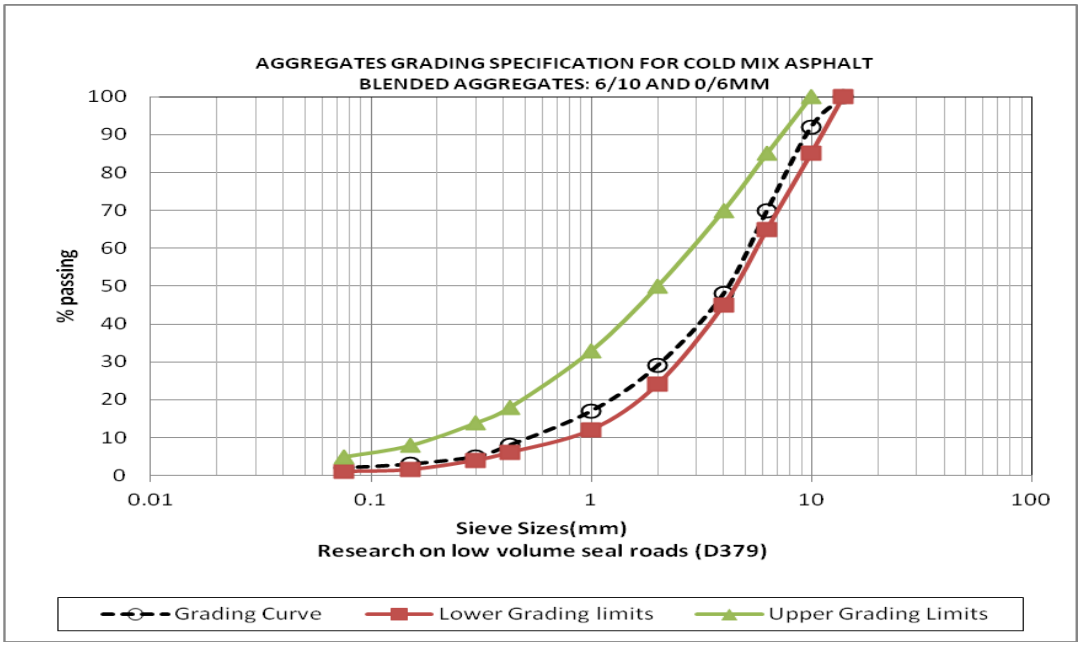


Figure 4: Graph illustrating the grading envelope and achieved grading for the cold mix aggregates

The grading is within the required envelope, but it would be prefered to be closer to the upper limit. This resulted in a fairly open surface texture lacking in fines.

3.2.7.3 Aggregate properties

The aggregates were imported from Tebere Quarry. Aggregate physical properties were as shown below:

Table 13: properties of the cold mix aggregate

Parameter	Results	Specifications	Remarks
ACV (%)	13.6	Max 30	O.K
LAA (%)	19.1	Max 40	O.K
SSS	2.8	Max 12	O.K
FI for [6/10 mm aggregates]	37.5	Max 30	**Not O.K**
PI on material passing	Non Plastic	Non Plastic	O.K

The slightly high Flakiness Index for the 6/10mm fraction is not regarded as having any serious detrimental effect on the performance of the surfacing.

3.2.7.4 Work Method

The mixing and laying of the Cold Mix Asphalt surfacing was done by labour using only hand tools and purpose made equipment. Compaction was done by a 3T double drum steel roller type.

3.2.7.5 Preparing the area to be sealed

Before the sealing operation starts, the base was cleaned of all deleterious material, dust, animal droppings etc.

20x20mm guide rails were then fixed to the base in a suitably wide strip. In the Kiambu research section, we adopted a strip width of 1.55 m to accommodate the 3.1 m lane of carriage width either side.

NB; The reason as to why guide rail strips was 3.1m instead of the 3.0m was that during rolling and compaction of the cold mix asphalt layer, the guiderails prevented the roller from compacting the edges completely, and after the guide rails were removed after rolling, part of the edge (which was a weak point) peeled off further during compacting with the roller vibrating and when exposed to traffic, hence the addition of 0.1 m either side catered for the roller on its vibrating mode avoid pushing the rail out of line.

A thin tack coat of 1:6 diluted A4 Anionic Stable Grade emulsion was then spread on the area between the guide rails using watering can and soft brooms and allowed to set and dry before the mixing and placing of the asphalt commenced.

Photo 3-23: primed section ready for sealing

Photo 3-24: application of a dilute tack coat A-4

3.2.7.6 Mixing

The mixing was done in purpose made mixing trays. The photo for the mixing trays and the dimensions are provided in **ANNEX B**

The mixing was done;

- Thoroughly to ensure that all aggregates were coated with emulsion, and;
- Progressively until the mix had the consistency of a thick soup.

The mixing is best done with square nosed spades (**See ANNEX B,** for the photo) to ensure that material in the corners of the tray are properly mixed with the rest. The photo below shows the aspects of this activity.

Photo 3-25: mixing of the cold mix asphalt using square nosed spades

3.2.7.7 Placing and leveling

When the mixing was completed, the mix was quickly placed on the road in between the guide rails and leveled to the top of the guide rails before the onset of the breaking of the emulsion (turn from brown to black), after which point the mix gets sticky and difficult to spread.

Photo 3-26: placing cold mix between guide rails

Photo 3-27: spreading and leveling the cold mix

3.2.7.8 Compaction

Rolling commenced once the guide rails had been removed and the initial breaking of the asphalt had commenced for the full depth of the layer. This is show in the following photo:

Photo 3-28: initial rolling of the cold mix asphalt layer with the roller in static mode

3.2.7.9 Construction of the adjacent strip

In placing the asphalt on the adjacent section of the road allowance was made for the thickness of 14mm of the compacted asphalt already placed on the first section of the road.

This was achieved by placing 6 mm mild steel flat bar (**SEE ANNEX B** for the specification) on top of the compacted asphalt and 20mm guide rails on the other edge of the strip as illustrated below;

Photo 3-29: allowance for the construction of the adjacent strip by placing 6mm flat bar on top of the compacted asphalt (NB; use of plastic cover to protect damaging the fresh layer surface)

3.2.7.10 Construction Joints

Longitudinal and transverse joint are potential weak spots in the asphalt surfacing. Extra care was therefore taken to ensure tight joints and good bonding between the old and new asphalt.

Photo 3-30: illustration of trimmed joints of a new layer adjacent to an old layer

All joints were neatly trimmed and any foreign matter (mud, dust, animal droppings etc.) removed before the new asphalt was laid against the joint.

On joints against asphalt that has been constructed a day or earlier, emulsion was applied on the joint surface with a soft brush.

After construction all joints were inspected, and where there was a slight "gap" in the joint, a small amount of emulsion was applied in the gap and crusher dust spread on top to properly seal the joint.

Photo 3-31: spreading of fresh cold mix to correct openings

Photo 3-32: crusher dust used to seal joints

Table 14: cold mix spread rate for selected sections of the D 379 Kiambu road research

DATE 2012	CHAINAGE	AREA (L×W)	No. of BATCHES	COLD MIX SPREAD RATE
13th JULY	Km 0+150 to 0+160	10m×3.1m = 31 m^2	14	**18.06 Ltrs/ m^2**
	Km 0+230 to 0+305	75m×1.55m = 116.3 m^2	62	**21.34 Ltrs/ m^2**
	Km 0+236 to 0+240	4m×3.1m = 12.4 m^2	7	**22.6 Ltrs/ m^2**
16th JULY	Km 0+213 to 0+303	90m×1.55m = 140 m^2	56	**16.3 Ltrs/ m^2**
	Km 0+317 to 0+400	83m×3.1m = 257.3 m^2	118	**18.5 Ltrs/ m^2**
17th JULY	Km 0+305 to 0+400	95m×3.1m = 294.5 m^2	140	**19.2 Ltrs/ m^2**
18th JULY	Bell mouth	42m×5.7m = 240 m^2	115	**19.16 Ltrs/ m^2**

NB; the volume of a batch is 40 litres (0.04 m^3), these comprises of 0/6 aggregate 28 litres and 6/10 12 litres. See **ANNEX B** for the mix proportion details

The spread rates achieved above differ in various sections since it depended on the regulation requirement.

Task rate of laying the asphalt was 15 person days for 240 $m^{2.}$

Table 15: A-4 application rate for selected sections

DATE 2012	A - 4 QUANTITY	AREA	APPLICATION RATE
12th JULY	14 Ltrs.	22m×1.55m = 34.1 m^2	**0.41 Ltrs/m^2**
16th JULY	42 Ltrs.	52m×1.55m = 80.6 m^2	**0.52 Ltrs/m^2**
18th JULY	33 Ltrs.	56m×3.1m = 173.6 m^2	**0.44 Ltrs/m^2**

3.2.8 Drainage structures

The activity was done by labour. The structures were mainly access culverts and access drifts. These were constructed to allow the locals access to their properties.

The table below shows the details of the structures provided;

Table 16: a list of drainage structures provided on Kiambu D 379

CHAINAGE FOR LHS	CHAINAGE FOR RHS
0+020 – CROSS CULVERT (Existing)	0+020 – CROSS CULVERT (6.8 m long-600mm diameter)
0+038 – **4.0m** ACCESS DRIFT	
0+073 – **4.0m** ACCESS DRIFT	
	0 + 132 – **5m** ACCESS CULVERT
0+154 – **4.0m** ACCESS DRIFT	
	0 + 195 – **8m** ACCESS CULVERT
0+196 – **2m** ACCESS CULVERT	
0+240 – **6m** ACCESS CULVERT	
	0 + 252 – **6m** ACCESS CULVERT
	0 + 322 – **2m** ACCESS CULVERT
0+343– **2m** ACCESS CULVERT	
	0 + 370 – **4m** ACCESS CULVERT
	0 + 380 – **3.4m** ACCESS DRIFT
0+390 – **2m** ACCESS CULVERT	
	0 + 390 – MITRE DRAIN

A total of **37 m** length culverts were installed (**12m** on the LHS, **25 m** on the RHS). Each of the culverts installed was of standard dimensions of **600mm** in diameter and approximately **1m** in length.

4 number Drifts were also installed as indicated in the table above.

The following production rates were generated during the execution of the works:

- Excavation of Drift Foundations and transportation of building blocks, 8 person days
- Packing of building blocks for the access drift, 6 Person days.
- Filling the gaps in between the blocks in the access drift with mortar, 2 person days
- Amount of cement used during the construction of the access drift, 9 bags.
- No. of building blocks used during construction access drift, 350 building blocks per each access drift (size 200mmx200mmx350mm).
- Excavation for trenches for access culvert installation 8m length, 4 person days
- Preparation and laying of the bed for access culverts using concrete class 20/25 8m in length, 5 person days.
- Volume of concrete used for the bed during access culverts installation was 1.1m^3 using 10 bags of cement.
- Installation of culvert rings, formwork preparation and haunching took 10 person days, a total volume of 1.4 m^3 concrete class 20/25 and 14 bags of cement.

3.2.9 Concrete Mix;

Because the locally available cement was PPC (not OPC), the bed and apron was batched using ratio of 1:2:4 as the strength of cement was 32.5N (not 42.5N).

- Access culverts were constructed using culvert ring 600mm diameter, 1.0 m long capable of interlocking.
- The excavation length varied as shown in the above table but was complete for bed and footed aprons. (see attached drawings in **ANNEX B** for culvert foundations)
- The beds were then laid by using class 20/25 mix concrete and the apron using the same mix
- The rings were then positioned by interlocking and sealing any space in between using cement sand mortar of mix ratio 1:3.
- False work using properly joined timber were then constructed taking into consideration the thickness of surround &wing walls/headwalls
- Surround and head/wing walls were then placed using class 20/25 concrete vibrated and steel finished.
- Curing was to commence immediately for seven days but the false works were removed after 12 hours.

The following set of photos show the activities that were carried out during the construction of the access culverts.

Photo 3-33: trench excavation for culvert bed

Photo 3-34: laying class 20/25 concrete mix on bed

Photo 3-35: interlocking the culvert rings

Photo 3-36: joining timber to form the false works

Photo 3-37: haunching of surround, head/wing walls

Photo 3-38: completed culvert-curing continues

3.2.10 Access drifts;

Excavation was done as per respective attached drawing (see **ANNEX B**). Building blocks were then arranged (mostly interlocking) to achieve the drains grade.

Mortar, of mix ratio 1:3 was then used to fill in gaps arising thereof after interlocking and close up fills beneath with gravel or back fill soil. For a standard size access drift construction, 350 No. block size 350mm x200mm x 200mm

Photo 3-39: excavation of the drift level

Photo 3-40: packing and interlocking the blocks

Photo 3-41: mortaring the drift

Photo 3-42: completed access drift

3.3 CONSTRUCTION OBSERVATION

1. **Side drainage –** Side drainage is one of the most important factors affecting pavement performance. Such drainage may be quantified in terms of a "drainage factor" which is the product of the height of the crown of the road above the bottom of the ditch (h) and the horizontal distance, d, from the centerline of the road to the bottom of the ditch , **figure 5** (TRL, 2002). The minimum desirable value of h is 0.75m (derived from performance-related surveys – TRL 1996), whilst the horizontal distance d is related to the width of the paved carriageway plus shoulder (d3), the horizontal component of the side slope (d2) (side slope typically 1:3) and the half width of the trapezoidal drain (d) (see Figure 5 below).

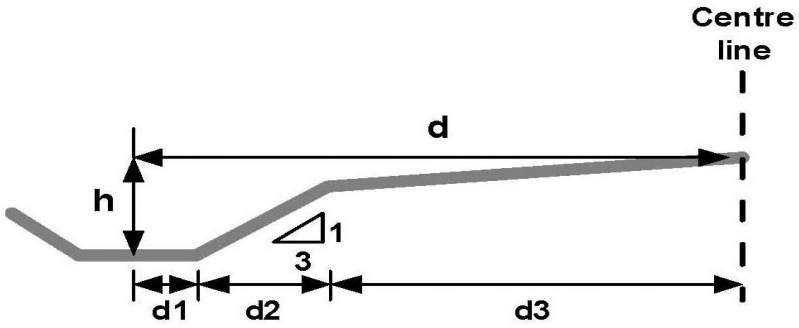


Figure 5: Drainage parameters for the side drain

NB; the drains were not lined in this research section but they were cut in a compacted bench and base.

Based on a range of values of d and a minimum value of h of 0.75m, the classification of road drainage for LVSRs in terms of their drainage factor is shown below.

Table 17: classification of road drainage

Drainage Factor DF=d x h	Classification
<2.5	Very Poor
2.5-5.0	Poor
5.1-7.5	Moderate
>7.5 or free draining	Good

For the research section, the approximate DF will be:

DF = 5.3 x 0.75 = 4.0

According to the table above, the drainage is classified as "poor". However, since the whole sections are at 1% grade or more, the classification can be moved up one class to "Moderate".

Lining of the drains would move the drainage up one further class to "good" and should be considered to minimize the influence of moisture in the outer part of the pavement.

2. **Base layer** – A 7.0m wide base layer was provided. However, the bituminous surfacing was laid on 6.2 m wide carriage way. The un-surfaced area approximately 0.5 m rounding off of the shoulders is therefore stable and will allow lateral drainage of the water to be collected at the drainage channel and support to the edge of the surfacing to prevent edge breaks. The cross fall of the base was constructed and kept at 1 in 29 (3.5%) and the same grade would be used in bituminous surfacing. This was checked using a fabricated camber board.

3. **Dynamic Cone Penetration Measurements** – The DCP instrument was used to measure the penetration per blow into the improved widening and base layer of the pavement. This gave an indication of the insitu shear strength of the material. The profile depth achieved gave an indication of the insitu properties of the materials in the entire pavement layer down to the depth of penetration, 800 mm.

   The research section gave a correlation between DCP measurements and the laboratory CBR as 0.40 (see attached laboratory results in the **ANNEX C**).

   DCP measurements were undertaken at 30m intervals in both the outer and inner wheel paths.

   For the analysis of the "as built" DCP tests compared to the DCP design, see 3.4.1.2 below.

3.4 TESTING AND ANALYSIS OF RESULTS

3.4.1 Field Density Tests

The field density tests were carried out during the construction to confirm the achieved compaction. This was part of the quality control procedure for the research section. The research design specified compaction to refusal. These tests were done using laboratory facilities of the Ministry of Roads, Material Department. The tests carried out were mainly Sand Replacement and Dynamic Cone Penetrometer tests (DCP).

3.4.1.1 Sand Replacement

The sand replacement (sand cone method) was used to determine the density of compacted bench and base. A sample was removed by hand excavating a hole in the soil. The insitu volume of the sample is determined by measuring the volume of dry, free flow sand necessary to fill the hole. A special cone is used to pour the sand into the hole. The dry weight of the sample is then determined in the laboratory.

The various results are attached in **ANNEX C.**

3.4.1.2 As built DCP analysis

DCP tests to the full depth of 800 mm were carried out on 5th July 2012, approximately one week after the final compaction of the base.

9 points within the test section were tested:

Table 18: List of points for as built DCP test within the D 379 Kiambu road section

Chainage	Centre line	Out wheel path LHS	Outer wheel path RHS
0+020	Point 1		
0+070		Point 2	
0+120			Point 3
0+170	Point 4		
0+220		Point 5	
0+270			Point 6
0+320	Point 7		
0+370		Point 8	
0+420			Point 9

The full screen shots of the analysis of the DCP tests are shown in **ANNEX C.**

The following shows the layer strength diagrams and output tables of weighted average penetration, 80-percentile, DCP CBR and UCS compared to the DCP analysis used for the design.

From **figure 6** below, it can be seen that an overall strengthening of the pavement has been achieved, mostly for the upper 150mm base layer, compared to the Design DCP analysis by reworking the top of the layer and re-compacting, as recommended.

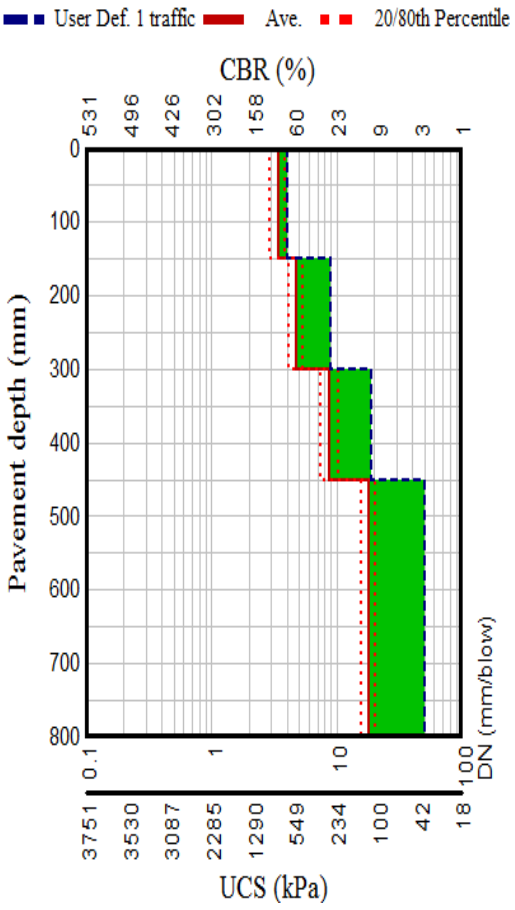
The Structural Capacity has increased from 0.8 MESA (Million Equivalent Standard Axles) to 1.0 MESA.

From **table 19** below, The 80-percentile (confidence level meaning that maximum 20% of values for the layer strength measured anywhere within the section may be weaker than the shown values, which is deemed to be reasonable level of safety for this class of road) is within the Design Curve specifications as shown below:

Table 19: DCP Design curve and 80-percentile DN value

Layer	Design Curve (DCP penetration)	80-percentile
0 -150 mm	4 mm	3.9 mm
151- 300 mm	9 mm	5.4 mm
301 – 450 mm	19 mm	10.3 mm
451 – 800 mm	50 mm	20.4 mm

The apparent reduced strength of the layer from 151- 300 mm, DCP CBR 57% reduced from 68%, is ascribed to the fact that the Design DCP tests were taken on the consolidated pavement whereas the As built DCP tests include points on the widened pavement constructed from bottom up with in situ subgrade material. The underlying layers from 301 mm depth down to 800 mm show no significant change.

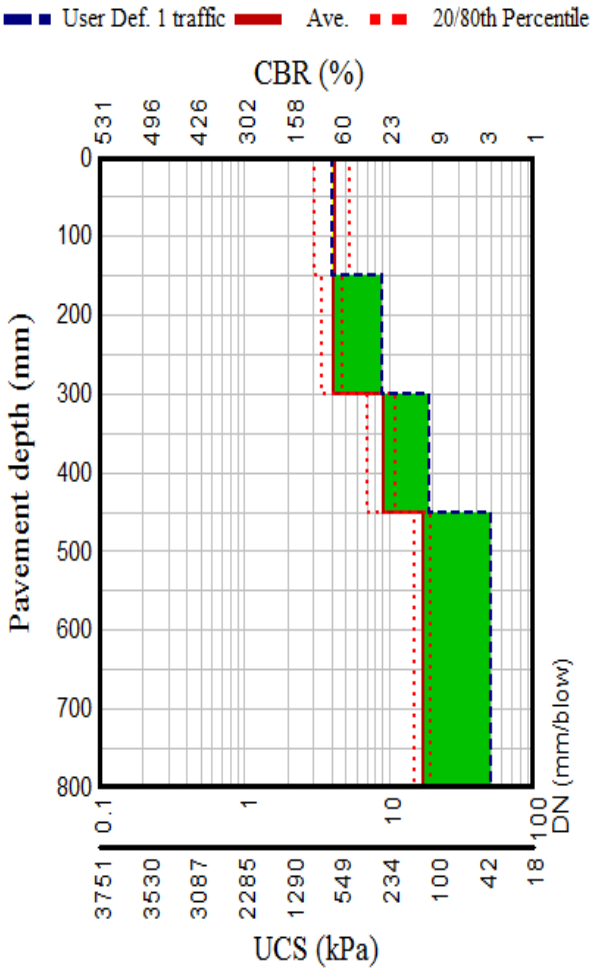


Structure number (DSN800)	141
Struct. Cap. (MISA)	1.0
RUT Limit	20mm
Balance curve is where	B=30, A=1054

Depth (mm)	W. Ave. Pen (mm/blow)	Blows	SD (mm/blow)	80P (mm/blow)	CBR(%)	UCS(kPa)
0 - 150	3.40	57	0.6	3.9	87	761
151 - 300	4.75	38	0.7	5.4	57	524
301 - 450	8.84	22	1.7	10.3	26	262
451 - 800	18.14	24	2.7	20.4	10	117

MISA = Million Standard Axles. Category IV : Well-Balanced Deep Structure (WBD)

Figure 6: as built DCP analysis - Average all points 5th July 2012



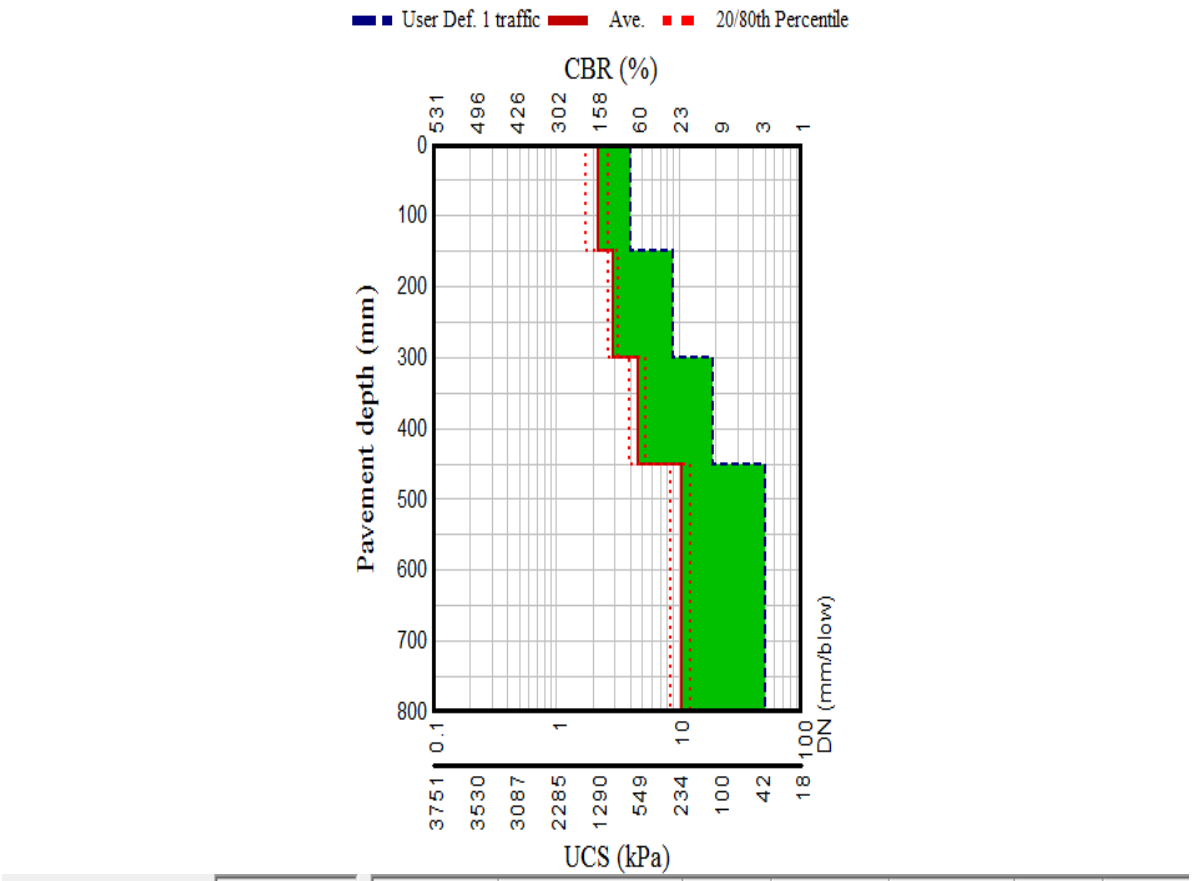
m

Structure number (DSN800)	133
Struct. Cap. (MISA)	0.8
RUT Limit	20mm
Balance curve is where	B=28, A=2122

Depth (mm)	W. Ave. Pen (mm/blow)	Blows	SD (mm/blow)	80P (mm/blow)	CBR(%)	UCS(kPa)
0 - 150	4.19	46	1.4	5.3	67	603
151 - 300	4.11	42	0.8	4.8	68	615
301 - 450	9.08	21	2.3	11.1	25	254
451 - 800	17.25	24	2.5	19.4	11	124

MISA = Million Standard Axles. Category V : Averagely Balanced Deep Structure (ABD)

Figure 7: Design DCP analysis - Average all points 30th January 2012



Structure number (DSN800)	204
Struct. Cap. (MISA)	3.7
RUT Limit	20mm
Balance curve is where	B=28, A=1239

Depth (mm)	W. Ave. Pen (mm/blow)	Blows	SD (mm/blow)	80P (mm/blow)	CBR(%)	UCS(kPa)
0 - 150	2.19	80	0.5	2.6	152	1245
151 - 300	2.91	54	0.3	3.2	106	907
301 - 450	4.65	35	0.9	5.4	58	536
451 - 800	10.46	36	2.3	12.4	21	217

MISA = Million Standard Axles. Category V : Averagely Balanced Deep Structure (ABD)

Figure 8: as built DCP analysis - Average points 1, 4 & 7 at CL

Figure 8 above shows the strength of the pavement measured at 3 points on the Centre Line. This illustrates the importance of maintaining as much as possible the strength of the existing pavement that has been consolidated under years of trafficking.

Figure 9 below shows the strength of the pavement in the outer wheel paths (LHS and RHS combined), which fall in the widened sections of the pavement. The 80-percentile for the upper layer 0 -150 mm is marginally outside the Design Curve specification (4.6 mm penetration vs. 4.0 mm as specified). This is probably caused by a combination of factors:

- The field densities achieved is marginally below the minimum requirement of 98% Mod AASHTO on some points, i.e. compaction to refusal was not done or the moisture content was too high at the time of compaction.
- The imported lateritic gravel is weaker than specified (32% at 98% compaction vs. the specified 45% soaked CBR)

Despite this, the structural capacity in the outer wheel paths is 0.4 MESA, which is still well above the 15 year design traffic load for this road. The road is also expected to consolidate further when exposed to traffic.

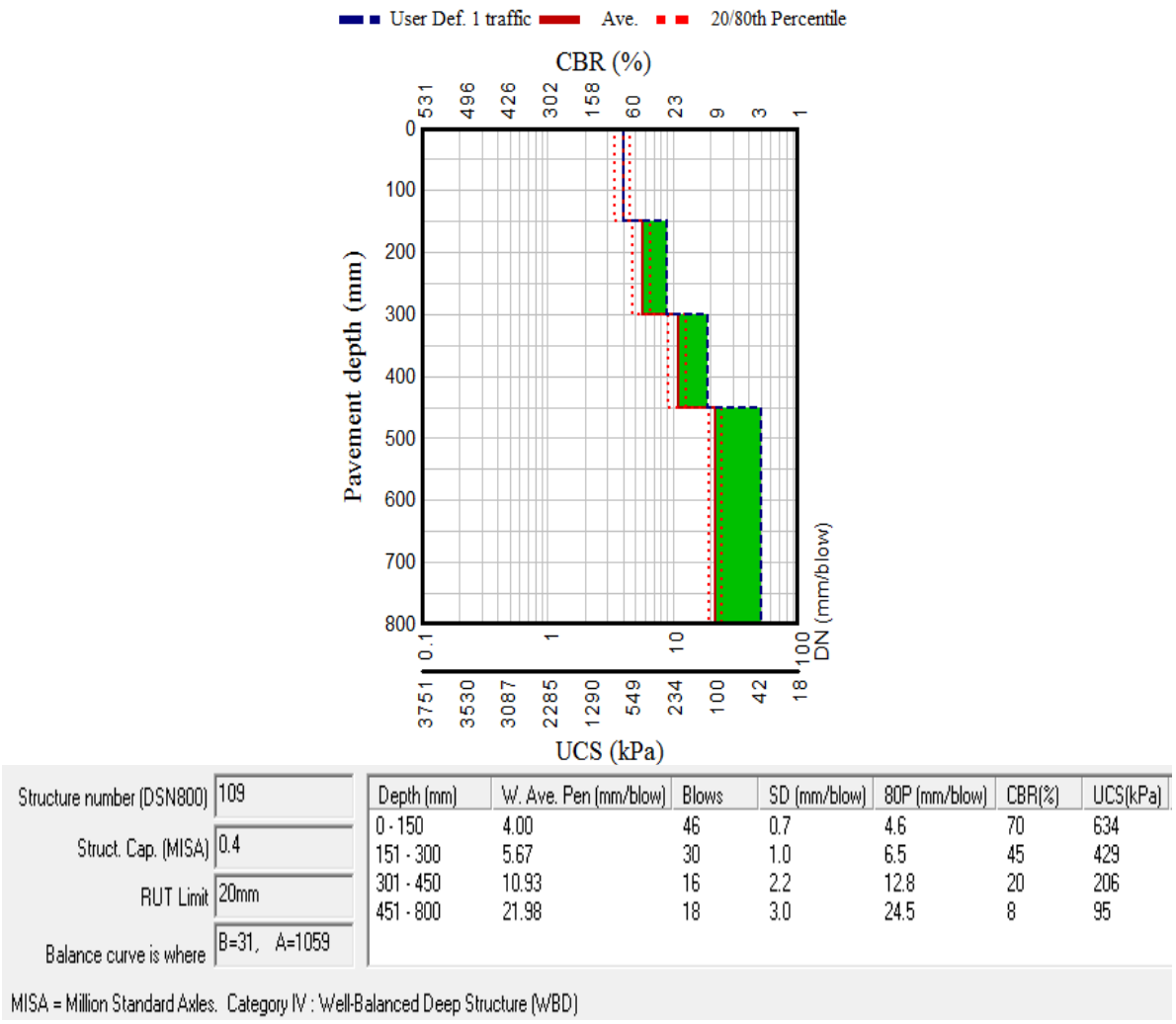


Figure 9: as built analysis - average points 2, 3, 5, 6, 8 and 9 at outer wheel path (LHS AND RHS)

3.4.1.3 Vehicle Equivalent Factors

Reduced VEFs based on Axle Load Survey on D 398 Ruiro –Monduro were used for estimation of the design traffic load:

Vehicle class	VEF
Buses	0.08
Medium trucks - 2 axles	0.6
Heavy trucks - 3 axles	1.69
Articulated trucks - 4 or more axles	2.76

Table 20: Reduced VEFs used for calculation of the design traffic load

The As built DCP data gives the following parameters for the pavement:

	2	3
23	***Results***	
24	Design Structure Number in blows (DSN800)	141
25	BN100 of data	21.7
26	BN100 of SPBC	34.0
27	Rut Limit	20mm
28	Structural capacity (Million Standard Axles, 80 kN)	1.0
29	SPBC (Standard Pavement balance curve)	A=1054, B=30

Table 21: WinDCP data for the As Built DCP measurements

The Balance Number (BN) represents the percentage of the DCP strength of the pavement to a certain depth. Pavements with a high BN100 (approaching a BN of 80) are considered to be shallow whilst those with low BN values are considered to be deep. A relationship between the BN100 value and the "n" exponent used to calculate the load equivalency factor has also been found with shallower pavements being more susceptible to high loads (i.e., a higher n exponent) than deep pavements.

The damaging effect of a particular load on the pavement structure relative to a standard load is usually expressed by the "equivalency factor" F:

$$F = \left(\frac{P}{80}\right)^n$$

where P = Applied load
80 = Standard 80 kN axle load
n = An exponent (usually 4.2) that describes the sensitivity of the pavement to loads that are larger or less than 80 kN

Figure 10 below shows the relationship between the pavement balance number (BN) and the "n" exponent more likely to be related to that pavement structure.

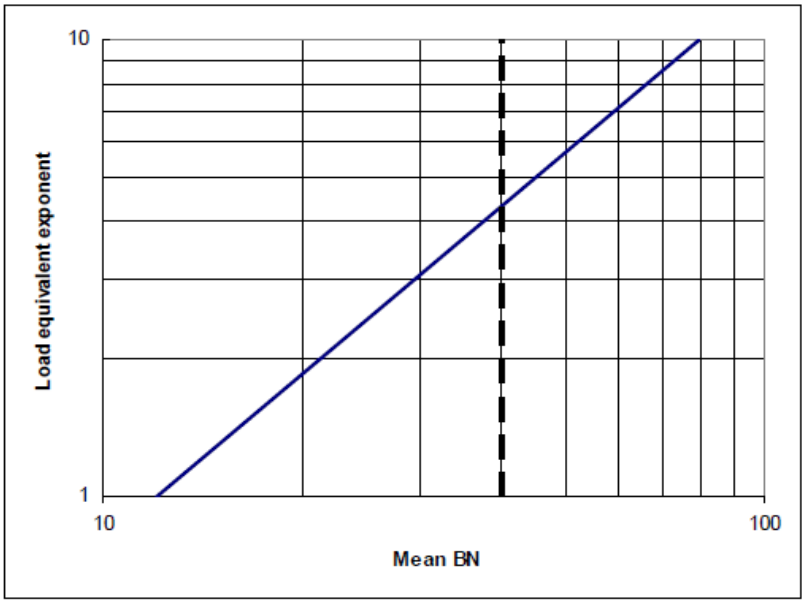


Figure 10: Relationship between pavement balance number and Power Exponent "n"

According to the above the new pavement is a well-balanced deep structure. From the BN100 value of 21.7 in table 17 and the relationship between BN100 and "n" in figure 11, a more realistic value for "n" would be as low as 2.0. However, it is not recommended to use "n" values lower than 3.

In Kenya "n" value of 4.5 is used. Reducing this to 3.0 would have a profound effect on the calculation of the VEFs for this road. It therefore seems that using the reduced VEFs in table 16 is justified. The actual VEFs to be used for re-estimating the Design Traffic Load for this road using the n value of 3.0 will be determined based on the axle load survey to be conducted as part of the monitoring programme.

3.5 MEETINGS AND VISITS

3.5.1 Meetings

3.5.1.1 Pre-commencement meeting

The meeting was held at the KeRRA regional offices in Kiambu on 21st May, 2012. It was attended by all the concerned parties to the Research project including:

1. KeRRA Headquarters
2. KeRRA Kiambu Region
3. ILO country Representative
4. Materials Department
5. Norken (I) Ltd

The roles and responsibilities of all the parties were clarified in accordance to the ToR. From this meeting, it was decided that, preparatory works and mobilization were to begin immediately as the main works commenced on 28th May, 2012.The major works did not start until 4th June, 2012 due to some delays in mobilization.

A steering committee was then formed and tasked with the responsibility of reporting and monitoring on the progress of the project. See **ANNEX E** for the minutes thereof.

3.5.1.2 Steering Committee meetings

The steering committee has held a total of four meetings to:

- Review the program of works
- Review budget
- Plan and make critical decisions arising from the implementation of work ranging on quality, method of work, quantities achieved and general procurement of works.
- Minutes of Progress site meetings are in **ANNEX E.**

3.5.2 Visits

Several visits by interested persons have been received on site. Such visitors included:

3.5.2.1 Jon Hongve on 29th May, 2012.

He was accompanied by Esther and Tom from the Materials Department. His comments;

- Arrange to sample aggregates, the materials supplied to be used in the cold mix (A 4, MC 30 & K365)
- The tests of the above materials to include Gradation, ACV, SSS, FI. Esther and Tom (from materials department) also delivered the DCP kit to site

3.5.2.2 Nkululeko Leta of AFCAP visited on 13th June, 2012

His comments:

- Need to come up with a comprehensive construction report.
- Note any modification to the design during construction
- Need to come up with lessons learnt during the construction.

3.5.2.3 Roads 2000 Central Province Phase 2 Delegations

The delegation led by the Regional Manager visited research section on 19th July 2012. The purpose was to inspect the progress of works. The project was of their interest as they are launching LVSRs in their programme. The teams also stressed on the need to keep proper records of both the design and construction of the Research section as the works they intend to start will possibly borrow a lot from the envisaged findings.

3.5.2.4 Roads 2000 Programme Coast Province, KILIFI COUNTY Constituency Roads Committee – 25th July 2012

The RM from Kilifi Region was leading a delegation of the CRC officials in visiting roads projects in Murang'a and Kiambu Regions. This was to familiarize themselves and compare the working techniques being used to construct and maintain roads in the two regions including the Roads 2000 technique of LVSRs. The team was taken through the construction methodology and a field demonstration was set up for them of the actual construction of Cold Asphalt surfacing. After they learned about the expected cost per kilometer, they undertook to start a trial road in their region.

3.6 CONSTRUCTION COSTS

The initial Engineers Estimate of the cost of the Works was Kshs. 5.2 MILLION (US$ 61,900 at exchange rate of 84 Kshs/US$). After the execution of the works, the expenditure incurred for the whole project was as indicated in tables below.

The cost per kilometre is below Kshs.13 MILLION (US$ 154,750). This cost is low when compared with the cost of conventional designs. It should be borne in mind that the research section is only 400 m long. With economies of full scale construction of an entire road using the same design and construction method, the costs will come down further.

The tabulated information shown is a breakdown of the procurement of the key resources for the construction of the Kiambu Research Section.

Table 22: a summary of all the resources and costing for the D 379 road research project

RESOURCE	COST(Kshs.)	COST(US$)	PERCENTAGE COST
MATERIALS	3,508,060	41,763	67.40%
MACHINERY	1,343,045	15,990	25.80%
CASUAL LABOUR	354,050	4,215	6.80%
TOTAL RESOURCES	**5,205,155**	**61,968**	**100%**

Table 23 : a list of cost of major activities as a % to total activities cost

MAJOR ACTIVITIES	COST(Kshs.)	COST(US$)	PERCENTAGE COST
1). STRIPPING AND GRUBBING	**52,100**	**620**	**1.01%**
2). PAVEMENT CONSTRUCTIONS	**2,370,000**	**28,214**	**46.13%**
a). Widening	1,058,500	12,601	
b). Laterite - Base	901,000	10,726	
c). Rip, shape & compact	410,500	4,887	
3). PRIME & SEAL	**2,059,000**	**24,512**	**40.07%**
a). MC 30	288,000	3,429	
b). Cold mix asphalt-bitumen	1,196,000	14,238	
c). Cold mix-Aggregates	575,000	6,845	
4). DRAINAGE WORKS	**657,000**	**7,821**	**12.79%**
a). Side drains excavation	50,000	595	
b). Culverts installation	607,000	7,226	
TOTAL	**5,138,100**	**61,168**	**100.00%**

The above table showing the major activities excludes the expenses of staff allowances incurred by the consulting firm Norken (I) LTD – Kenya, but does include the casual labour expenses for the named activities.

NB; the rate of exchange of the US$ to Kenyan Shilling during the months of June – August was on average 84 Kshs. to 1 US$.

3.6.1 PROCUREMENT OF RESOURCES

3.6.1.1 Materials

The procurement of materials required during the construction was done prior to the construction. This included purchasing and fabrication of hand tools & quality control tools, supply of gravel, aggregates for cold asphalt and culverts, bituminous surfacing (K365, A-4 & MC 30).

The breakdown of the above materials cost is as tabulated below;

Table 24: a list of the materials costs used during construction

ITEM	ACTUAL COST (Kshs.)	ACTUAL COST (US$)
Colas EA(bitumen)	1,425,060	16,965
Gravel	901,000	10,834
Aggregates (0/6 and 6/10)	575,000	6,845
Aggregates, Culvert Rings, Blocks	607,000	7,226
TOTAL MATERIAL COST	**3,508,060**	**41,763**

NB; the rate of exchange of the US$ to Kenyan Shilling during the months of June – August was an average 1 US$ = Kshs. 84.

3.6.1.2 Machinery

The main machinery used during the construction of the Kiambu Research Section was a motor grader, Bomag steel rollers and water bowser. All these were procured from the Chief Mechanical and Transport Engineer, through Mechanical Transfer Fund (MTF).

Table 25: a list of the machinery cost incurred during road construction

ITEM	Actual Cost (Kshs)	Actual Cost (US$)
Plant operator Allowance	215,515	2,567
Hire of Grader	500,320	5,956
Hire of Roller	280,320	3,337
Hire water Bowser	140,000	1,667
POL – Fuel	206,890	2,463
TOTAL EQUIPMENT COST	**1,343,045**	**15,990**

NB; the rate of exchange of the US$ to Kenyan Shilling during the months of June – August was an average 1 US$ = Kshs. 84.

3.6.1.3 Labour

Labour requirements for the Kiambu Research Section included semi-skilled & un-skilled labour, all of which were sourced locally. The semi-skilled were given some on-site training to enable them successfully handle the construction processes. They were four numbers and had qualification of ordinary diploma in civil engineering and training on R 2000 labour based Road Construction and over 3 years in practice.

The unskilled labour was sourced locally and included men and women. The recruitment of the same was done with the assistance of the Local Area Chief –through a public baraza. On the same, their

wage rate was mentioned and agreed upon as they were based on the government labour wages rate. They were to be paid bi-weekly, through a well-documented master roll register.

The total cost of casual wages for the construction of the research section is a tabulated below;

Table 26: a tabulation of the list of the labour expenses

ITEM	Actual Cost (Kshs)	Actual Cost (US$)
Casual Wages	275,840	3,284
Miscellaneous expenses	18,210	217
Staff allowance&mobilzation	60,000	715
TOTAL LABOUR EXPENSES	**354,050**	**4,215**

NB; the rate of exchange of the US$ to Kenyan Shilling during the months of June – August was an average of 1 US$ = Kshs. 84.

3.7 POST CONSTRUCTION

The following set of photos shows the D 379-Kiambu Road research section when it was completed and opened to traffic as to date **Photo 3-43: Chainage km 0+280 to 0+400**

Photo 3-44: a view showing the finished road from Chainage 0+020 to 0+260 near the church junction

Photo 3-45: a view showing adjacent culverts with the finished road surface and the bell mouth

The vertical alignment showing road profile of the completed road section levels as they were taken with various drainage structure positions and the horizontal cross sections at various intervals of the as built D 379 Kiambu section are show in details in **ANNEX A**

4 OBSERVATIONS AND RECOMMENDATIONS

4.1 Materials

The DCP Design Method is a new concept aiming to make best use of locally available and in situ materials for construction of Low Volume Sealed Roads.

Laboratory tests of the in situ subgrade were carried out from samples taken during the DCP testing. The results are shown in table 27 below:

Table 27: Laboratory tests of subgrade and gravel prior to construction

				ATTERBERG LIMITS					Comp. T180				CBR at various compaction levels			
	Sample No	Layer	Ref.	LL (%)	PL (%)	PI (%)	LS (%)	PM	MDD (Kg/m^3)	OMC (%)	FMC	Moisture condition	93%	95%	98%	100%
D379 Kiambu	554/S/2011	Subgrade	0+000	50	28	22	11	1650	1658	14.4	22	4-Dsoak	3	4	5	6
												OMC				
												.75 OMC				
	555/S/2011	Gravel	0+000	44	22	22	11	726	1910	14.0	16	4-Dsoak	20	30	40	42
												OMC	125	145	165	195
												.75 OMC	185	194	197	217
	556/S/2011	Subgrade	0+200	45	20	25	12	1950	1700	18.6	23	4-Dsoak	10	12	15	16
												OMC				
												.75 OMC				
	557/S/2011	Gravel	0+200	40	22	18	9	612	1910	14.0	11	4-Dsoak	22	27	34	35
												OMC	47	56	69	78
												.75 OMC	132	144	150	155
	558/S/2011	Subgrade	0+350	46	21	25	12	1575	1700	18.6	16	4-Dsoak	9	12	15	17
												OMC	62	64	68	70
												.75 OMC	128	135	146	150
	559/S/201	Gravel	0+350	42	23	19	9	855	1865	13.2	15	4-Dsoak	5	7	11	12
												OMC	92	102	120	132
												.75 OMC	154	160	167	170

Knowledge of the inter relationship between the moisture, density and strength of the material used in the construction of LVSRs provides critical insight into how to use such materials to ensure good performance in the prevailing road environment. Laboratory investigation of this relationship is of paramount importance in deciding how best to use these materials in the construction of LVSRs.

4.2 Material inventory

Experience with different materials, particularly the in situ subgrades, from the research sections and subsequent performance monitoring should be compiled into a national materials inventory database. Such inventories, if kept, could be used as follows:

- Keep records centrally and readily available as reference for future development
- Reducing costs, especially of consultancies
- Enable rapid material location and identification, simplify design
- Develop pavement performance relationship for input into pavement management systems
- Develop local material performance correlations for possible specifications and research

4.3 Construction

Standard quality control tests were carried out in order to verify compliance with specifications. However, extensive control testing is often a bottleneck during the construction and it has been shown that excellent results can be achieved with proper design, supervision and control of the construction process. The following aspects are critical:

Drainage: To ensure correct invert levels in the side drains (and hence a desired Drainage Factor) and proper grades in the drains.

Compaction at or near to OMC: The mixing of water in the layer works must be done throughout the whole layer, not just watering from the top, before compaction. The water bowser must be in good working order and directed during the watering process to ensure that no section is receiving excess water. Frequently when the water bowser starts, stops and turns, lack of co-ordination between the driver and the assistant on the spray bar and/or leakage from the spray bar causes sections to receive excess water resulting in sponging.

Compaction to refusal: Compaction should be done (at or near OMC) until the material visibly no longer moves under the drum or the drum no longer leaves a mark on the surface of the layer. Compaction to refusal has then been achieved and it serves no purpose to specify additional passes.

The project has shown that relative densities in excess of 100% can be achieved and this should always be the goal in particular for high PI or moisture sensitive materials like the ones used for the project.

The research section has confirmed that compaction with heavy equipment (10 tonnes Vibrating Bomag Roller), with the material being at its or near optimum moisture content and evenly spread, and having all the qualities specified in the design specifications, not only maximize the strength potential of the respective layer, but also reduces their moisture susceptibility and so can contribute to improved pavement performance giving it longer life.

5 LESSONS LEARNT

5.1.1 Dissemination of project objectives

It is important that all parties are fully aware of the project objectives, the design approach and specific construction requirements to ensure that all factors are taken into consideration in the planning and execution of other projects.

5.1.2 Supervision

Tight supervision and control of the construction process is required to achieve the best possible result. Specific attention must be paid to the watering and compaction of the layer works and that design profiles are as per design particularly drain invert levels and grades to ensure a functional drainage system and prevent moisture ingress into the pavement.

5.1.3 Quality Control

- Workable arrangements for timely quality control during the construction must be put in place well before the construction starts.
- Tests on the materials should be conducted before use to ensure their compliance with specifications. When locally available materials are used, i.e. side borrow for benching, their properties in situ and after processing and compaction are established noting improvements in their otherwise inferior properties before any improvement (treatment) is done.
- Quality control tools need to be prearranged and availed before construction works begin. The research section borrows heavily from the Roads 2000 technique hence locally prefabricated quality control tools including ditch, slope and camber templates were used.
- The DCP should be calibrated for the materials to be used to facilitate quick testing of field densities.

5.1.4 Design profile

The slope should be as long as possible within the existing road reserve to get the drain as far from the pavement as possible thereby maximizing the Drainage Factor and to achieve a slope preferable not steeper than 1:3. For the project 1.5 m in slope was adopted.

5.1.5 Bituminous surfacing

The Cold Asphalt should not be laid if rain is expected during or soon after construction since the emulsion will be washed out before it has set and the asphalt has been compacted.

The grading of the aggregates should be checked before construction to ensure that it is close to the upper limit of the grading envelope. It was noted that with the actual grading used, the surface texture immediately after compaction was fairly open and lacking in fines, however, the asphalt is expected to bed down and the surface texture to improve quite rapidly under trafficking.

5.1.6 Construction Time

Good co-ordination is required to keep construction time at an acceptable level and possibly reduce it. With the experience gained from this section, it is expected that the other test sections can be constructed at a relatively higher pace. Important factor to reduce the construction time would be:

- The laboratory testing must be efficient and timely giving results to enable construction to progress on test areas.
- The procurement of equipment, tools and materials must be done timely.
- Decision making must be enhanced.

5.1.7 Community participation

The local community participated willingly and with great enthusiasm in the project.

Many people have gained experience with the construction methods, particularly construction of the Cold Mix Asphalt which was entirely labour based.

The community at large is satisfied with the project and hope for the continuation of the project with upgrading of the entire road link.

5.1.8 Depth of the side drains

If the depth from the proposed road crown to the invert of the proposed side ditch is specified as 0.75 m, the following factors may affect the attainment of these depth in some road section:-

- If existing cross culverts inlet and outlet inverts levels do not allow for the specified depth and it is decided to retain the culverts
- Where accessibility to adjoining compounds is to be provided in form of a drift, the resulting drain is not easily accessed by small vehicles
- Where mitre drains are to be provided, their lengths should not extend to beyond 5 meters as their maintenance would prove to be fairly difficult

It may therefore be necessary to reconsider the issue of the specification for the side drains in light to the above mentioned factors.

ANNEX A

Inventory of culverts and drifts

There is one existing 600mm Φ cross culvert 7.2m long at Chainage 0+020 that is in good condition but only needs improvement at the outlet approach. There is also one existing access culvert at Wambugu Catholic Church at Chainage 0+254 that needs replacement. See Table below;

Table 28: a list of the inventory of the existing structures

Chainage	Description	Remarks
0+020	600mm Φ Cross culvert, 7.2m long.	Existing intact head/ wing walls. Headwall type 2
0+040	600mm Φ Access culvert 6.3m long	Proposed LHS, to be replaced. Headwall type 4

Additional Culverts & drifts

Both the access culverts and drifts are proposed as indicated below;

Table 29: list of the proposed culverts and drifts

Chainage	Description	Remarks
0+040	600mm Φ Access culvert, 6.3m long	Proposed RHS, headwall type 4
0+070	Access drift	Proposed LHS
0+130	Access drift	Proposed RHS
0+190	Access drift	Proposed RHS
0+195	Access drift	Proposed LHS
0+240	Access drift	Proposed LHS
0+250	600mm Φ Access culvert, 6.3m long	Proposed RHS, headwall type 4
0+370	Access drift	Proposed RHS

FIELD SURVEY AND ALIGNMENT DATA

Pre – Construction Vertical alignment road profile and horizontal cross sections

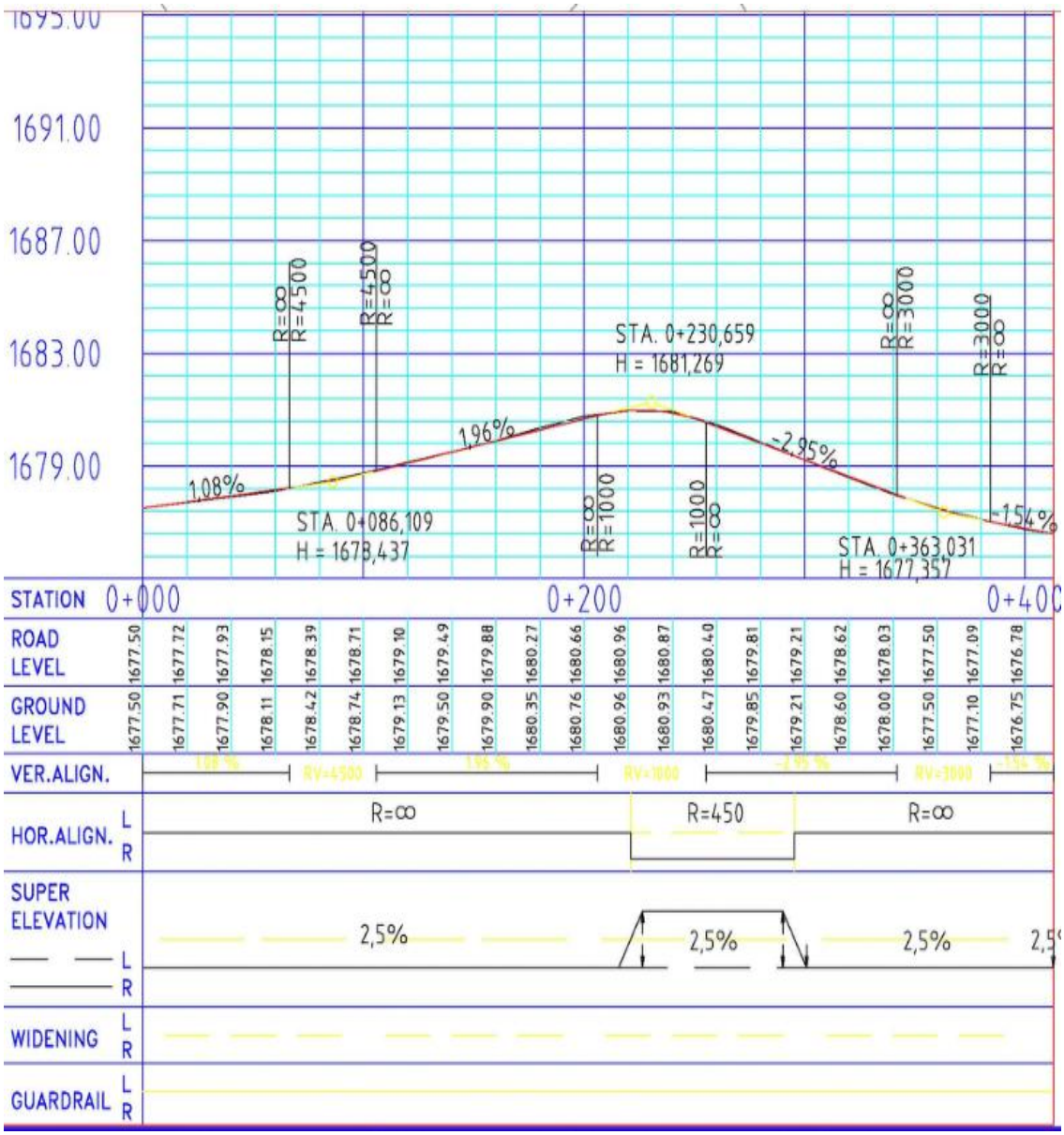
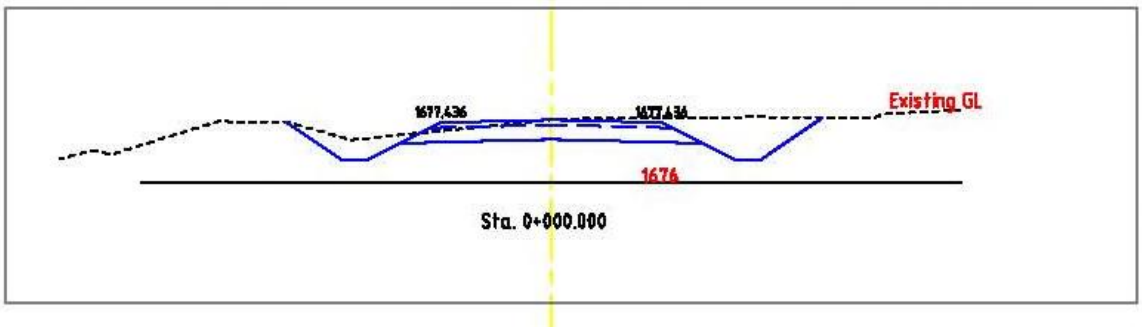
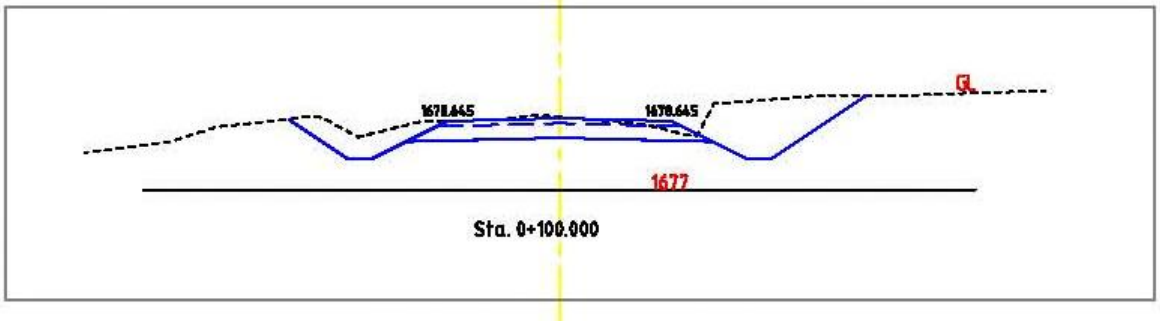
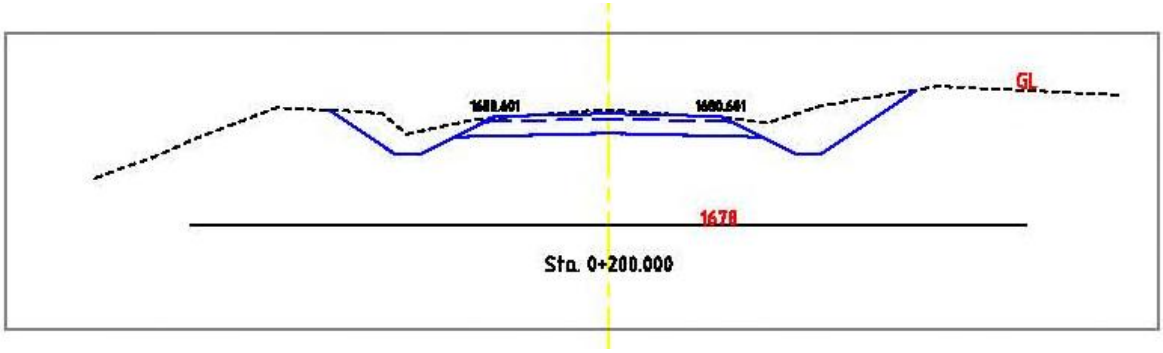


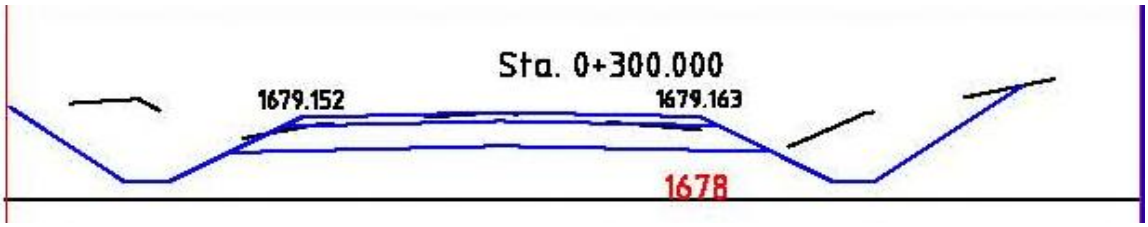
Figure 11: vertical alignment data for D 379 from km 0+000 to 0+400

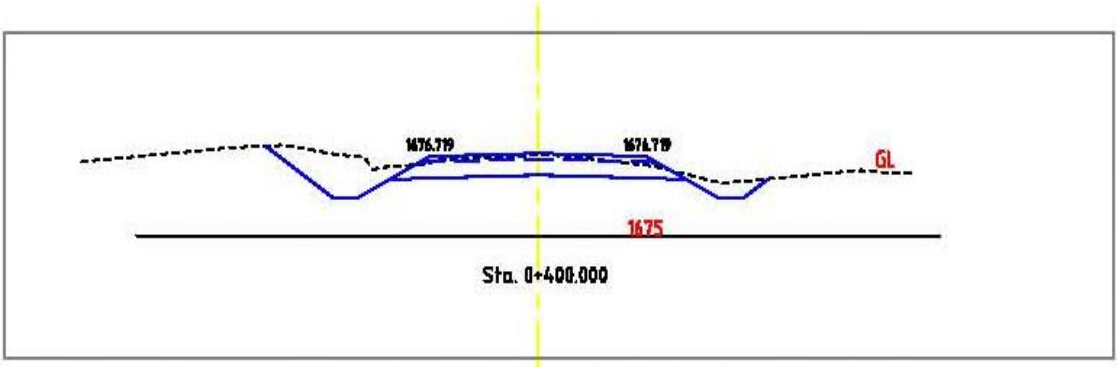
The following series of figures shows the alignment data of the existing ground level and the proposed cross section of the road at various Chainage.


1677.636
1677.636
Existing GL
1676
Sta. 0+000.000


1678.645
1678.645
GL
1677
Sta. 0+100.000


1680.601
1680.601
GL
1678
Sta. 0+200.000


Sta. 0+300.000
1679.152
1679.163
1678


1676.719
1676.719
GL
1675
Sta. 0+400.000

As Built field survey levels of the finished road surface and drainage structures

The figure below shows the invert levels of the inlet and outlet of the existing cross culvert as well as the drop inlet. This shows a vertical height of 710 mm from the bottom of the ditch to the crown of the finished road.

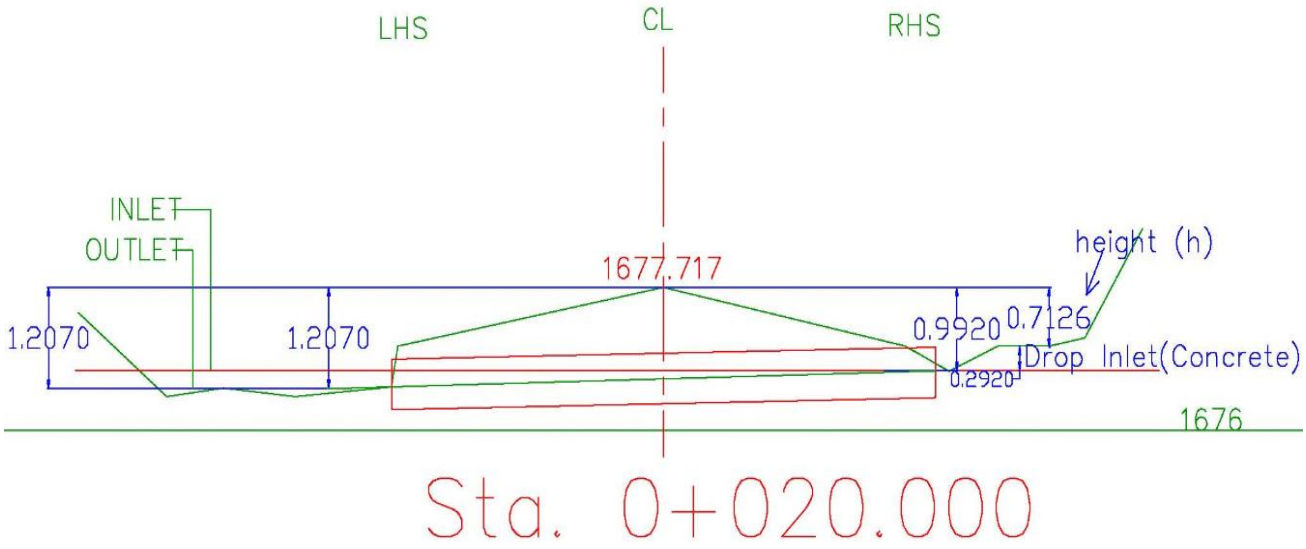
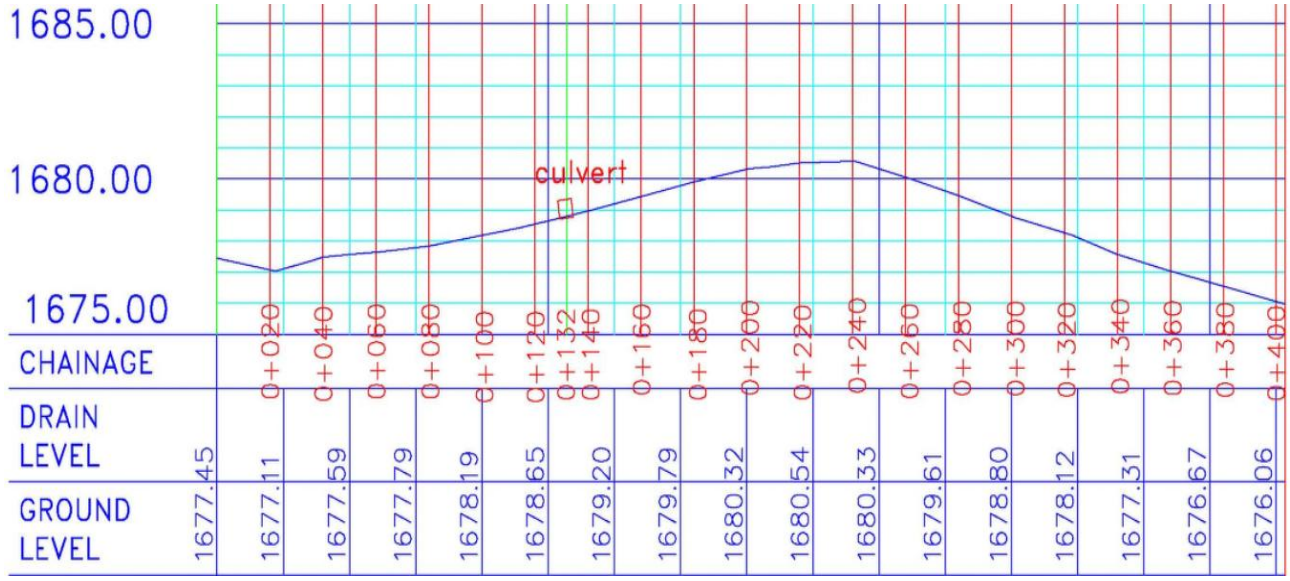
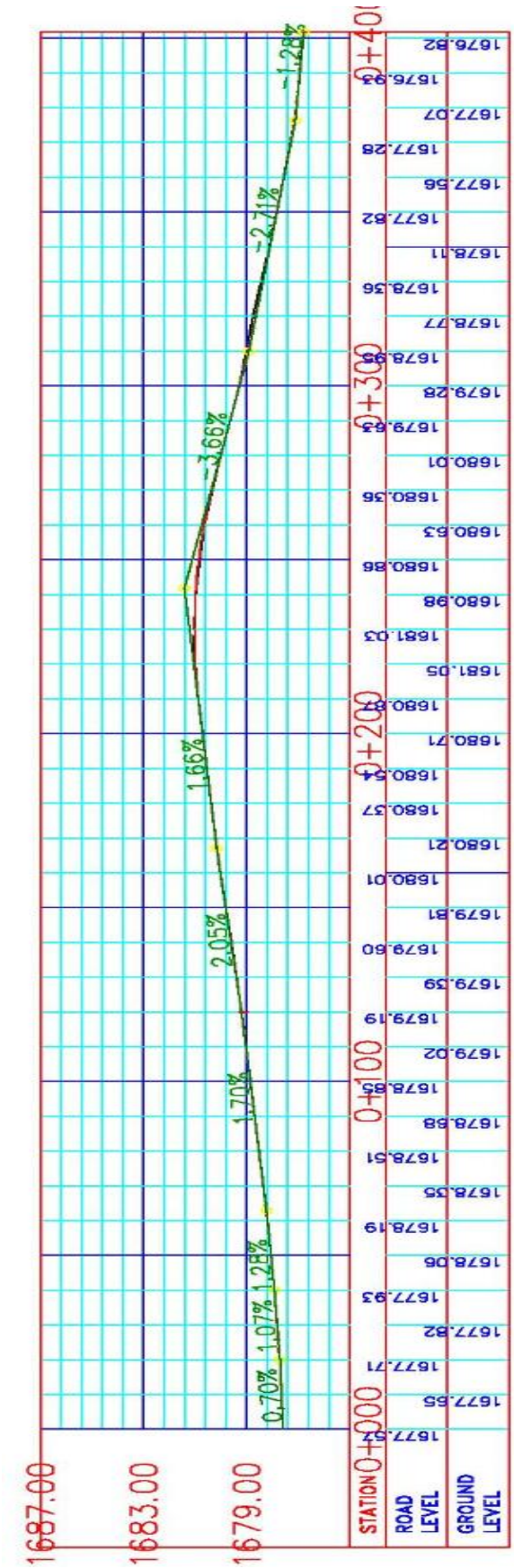


Figure 12: cross culvert at Chainage 0+020

Figure 13: a vertical profile of the drain ditch levels for D 379



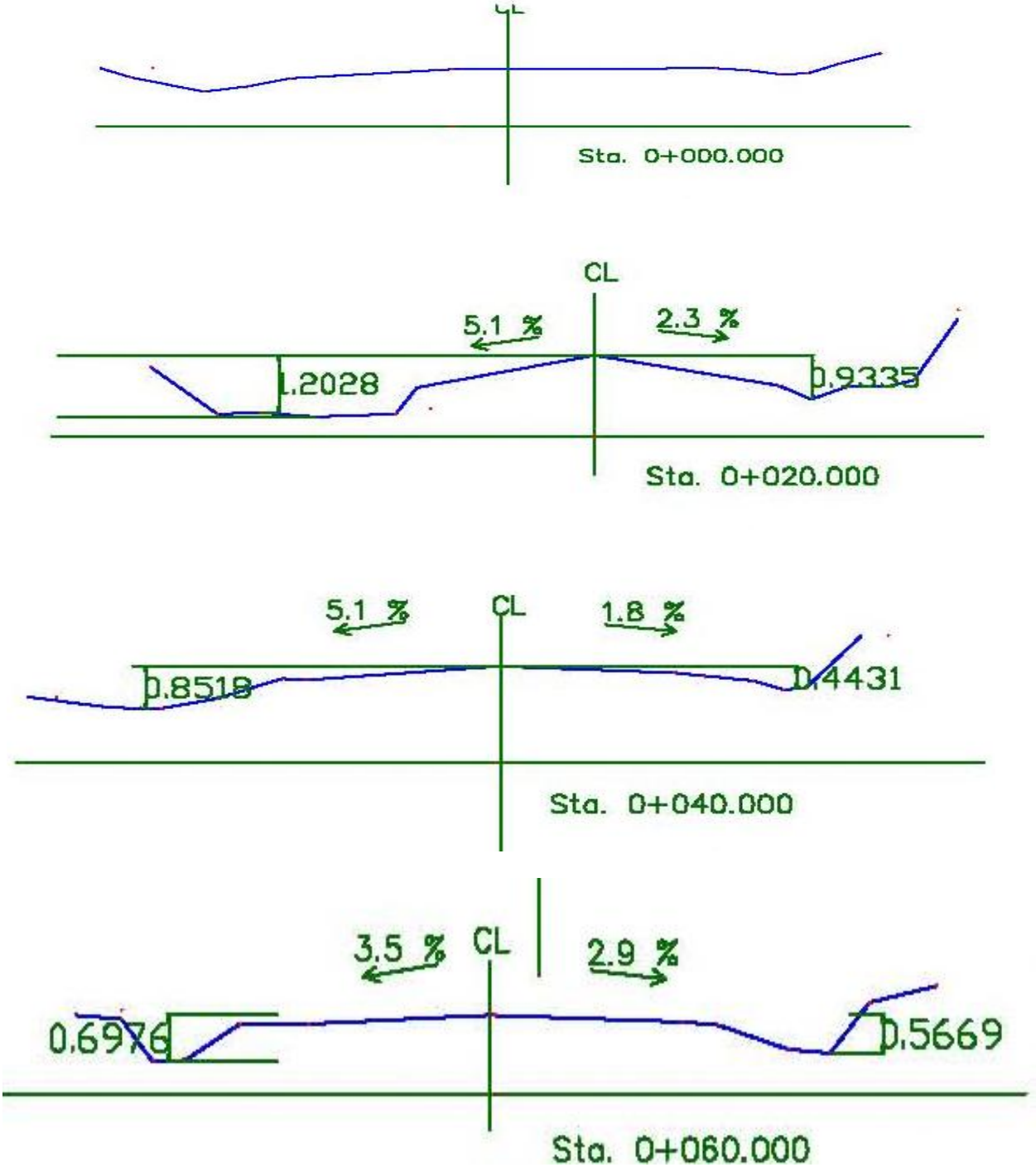


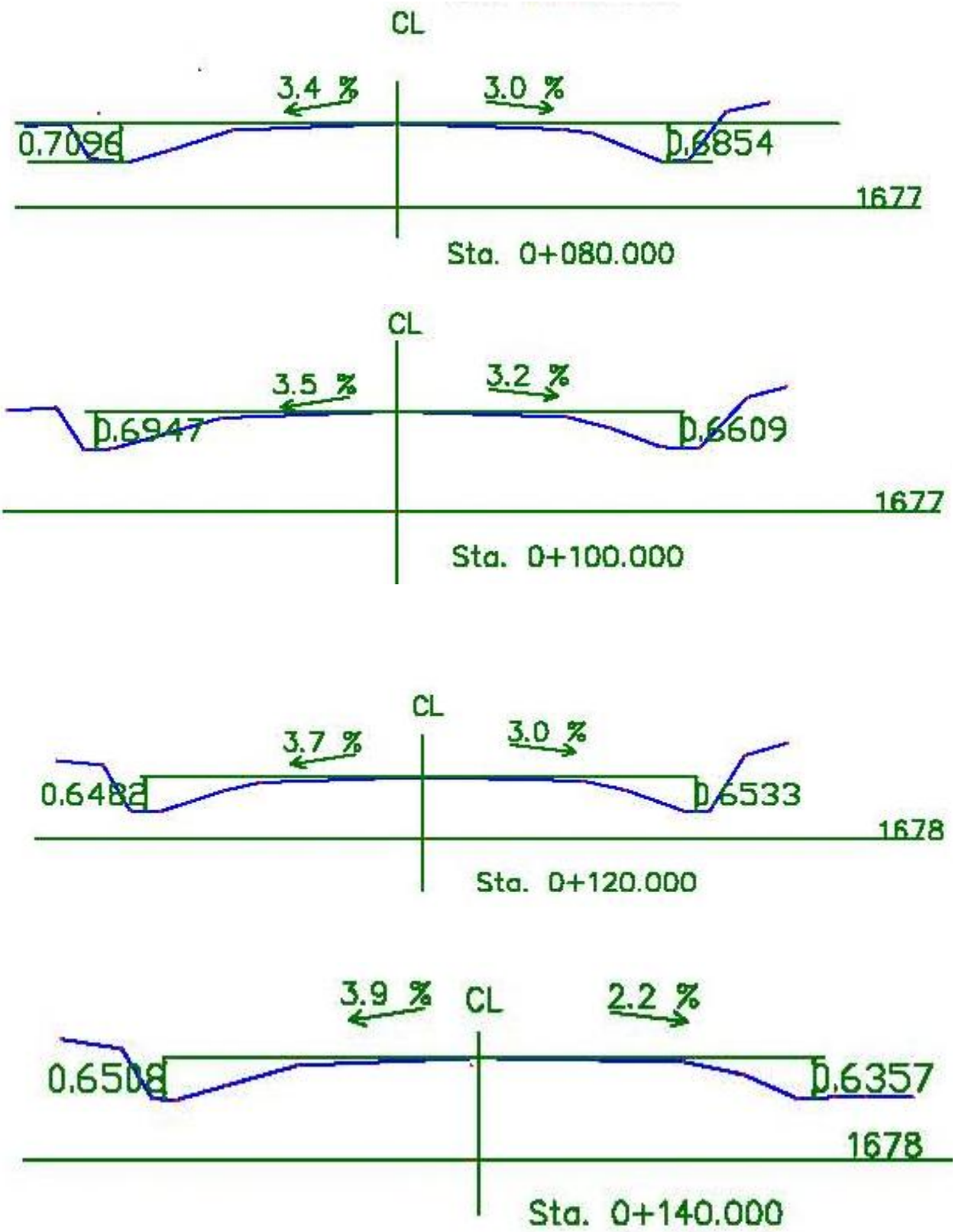
THE PROFILE OF THE AS BUILT ROAD SURFACE CENTRE LINE

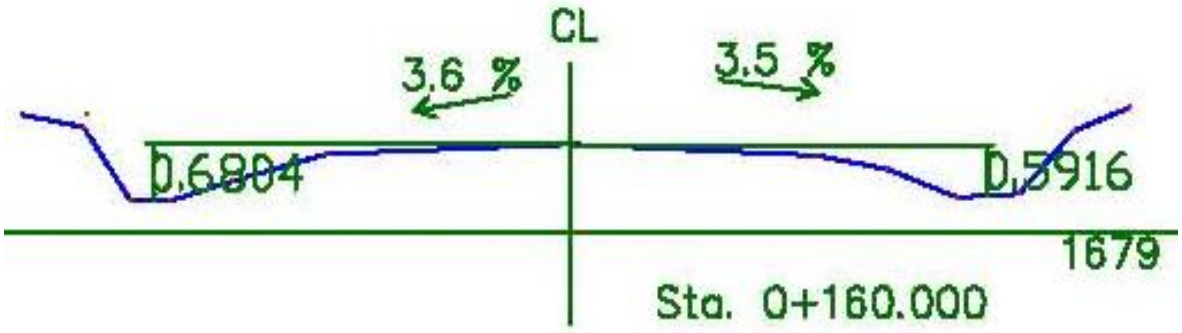
The green line shows the longitudinal profile of the proposed road center line while the red line against it shows the as built crown level of

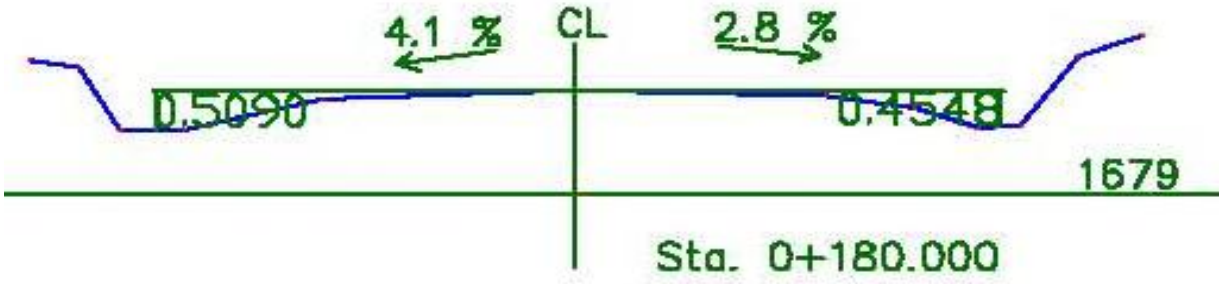
the road surface. It can be seen that they match apart from the change of the slope at the peak where there is a deviation.

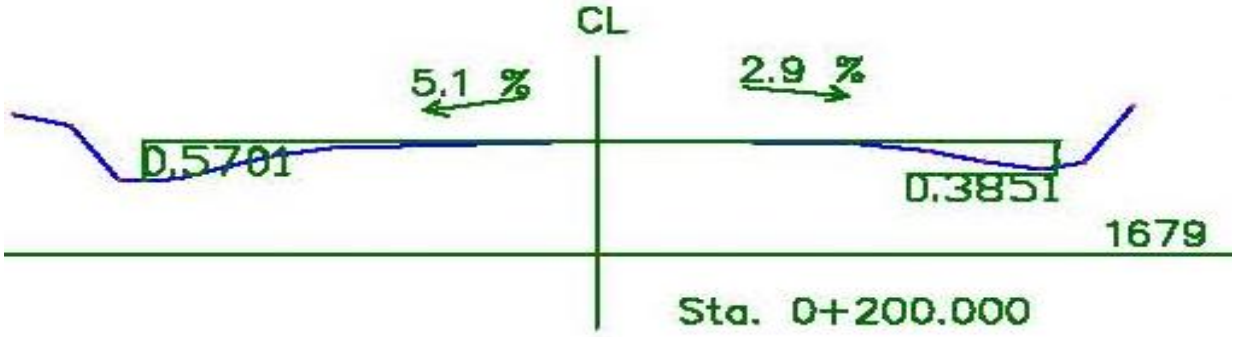
The following figures show the cross sections at various Chainage intervals of 20 m for the whole road research D 379 section of the as built road surface. Detailed are the outlined road surface camber, and the vertical height from the bottom of the ditch to the crown of the finished road surface.

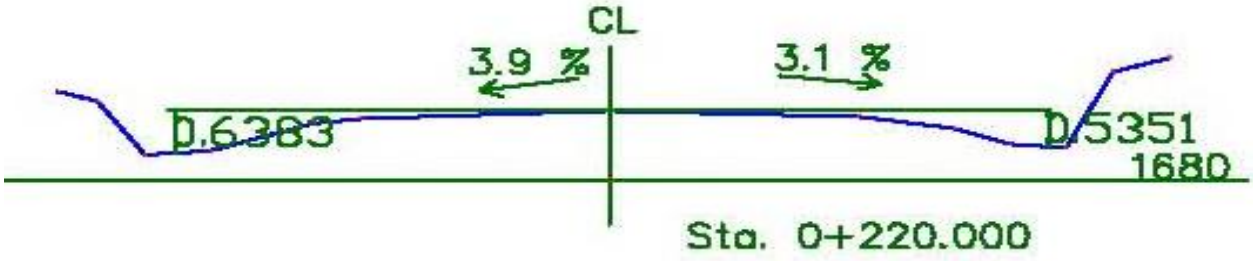


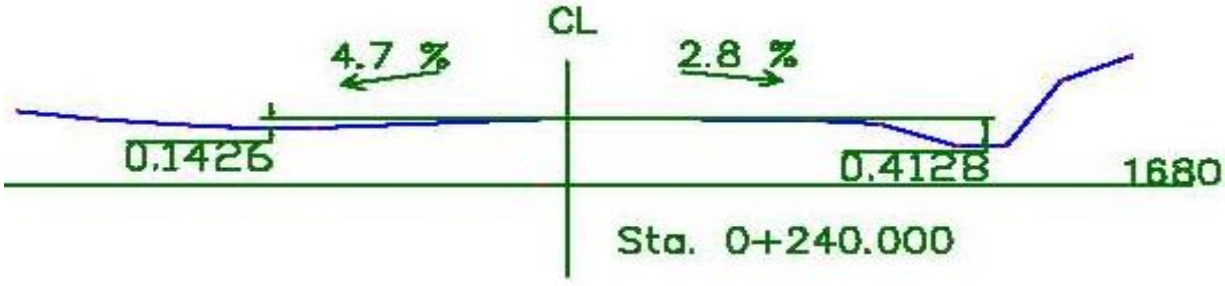

CL
3.4 %
3.0 %
0.7096
0.6854
1677
Sta. 0+080.000
CL
3.5 %
3.2 %
0.6947
0.6609
1677
Sta. 0+100.000
CL
3.7 %
3.0 %
0.6482
0.6533
1678
Sta. 0+120.000
3.9 %
CL
2.2 %
0.6508
0.6357
1678
Sta. 0+140.000

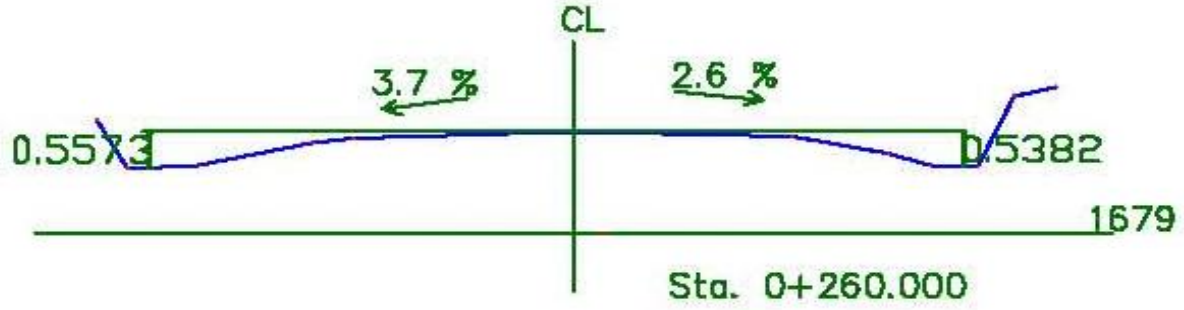

CL
3.6 %
3.5 %
0.6804
0.5916
1679
Sta. 0+160.000

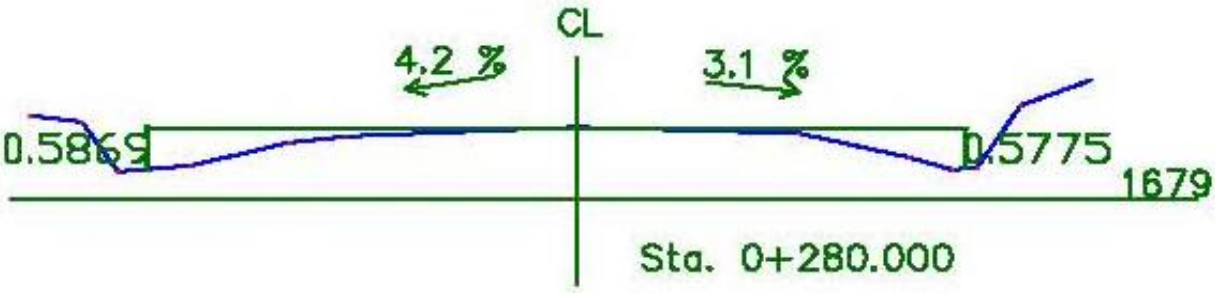

4.1 %
CL
2.8 %
0.5090
0.4548
1679
Sta. 0+180.000

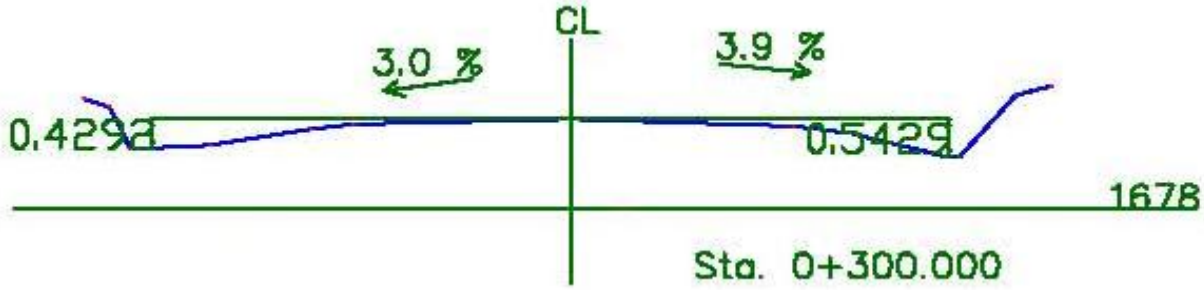

CL
5.1 %
2.9 %
0.5701
0.3851
1679
Sta. 0+200.000

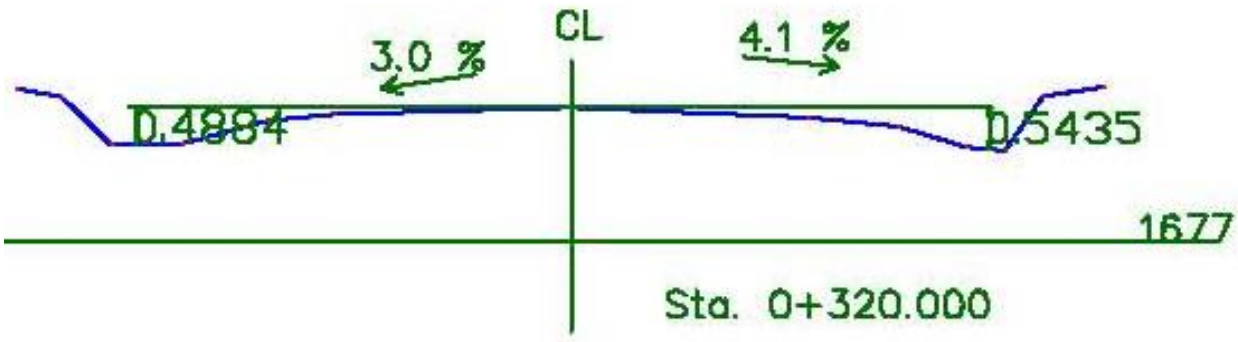

CL
3.9 %
3.1 %
0.6383
0.5351
1680
Sta. 0+220.000

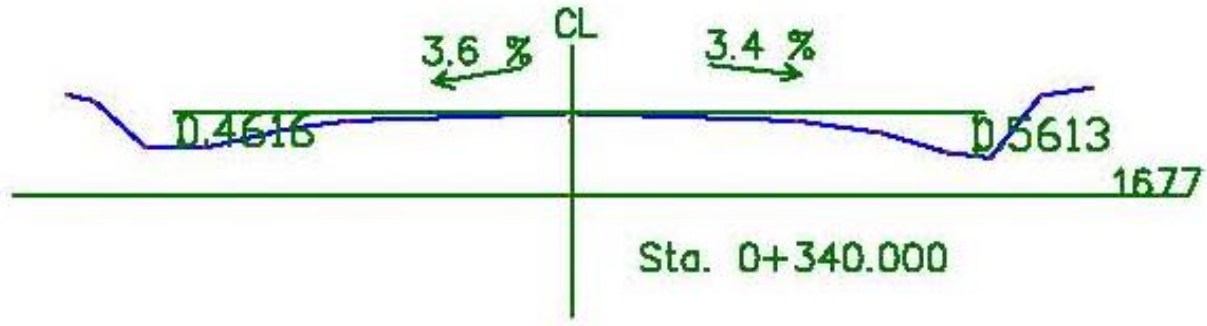

CL
4.7 %
2.8 %
0.1426
0.4128
1680
Sta. 0+240.000

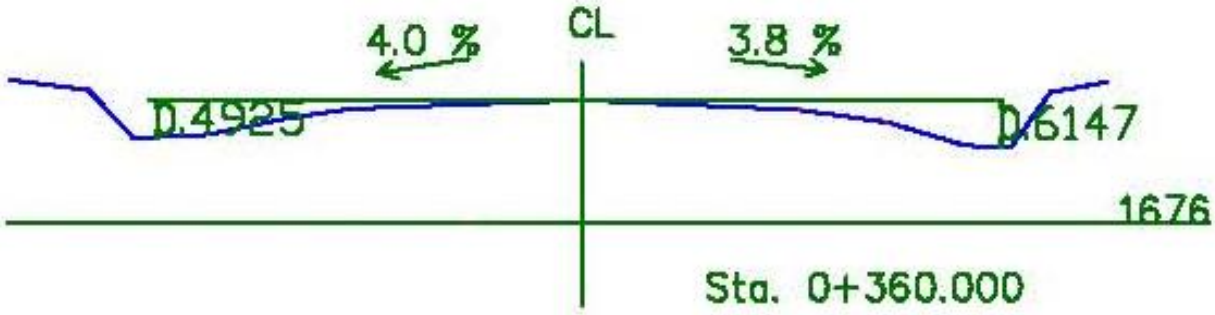

CL
3.7 %
2.6 %
0.5573
0.5382
1679
Sta. 0+260.000

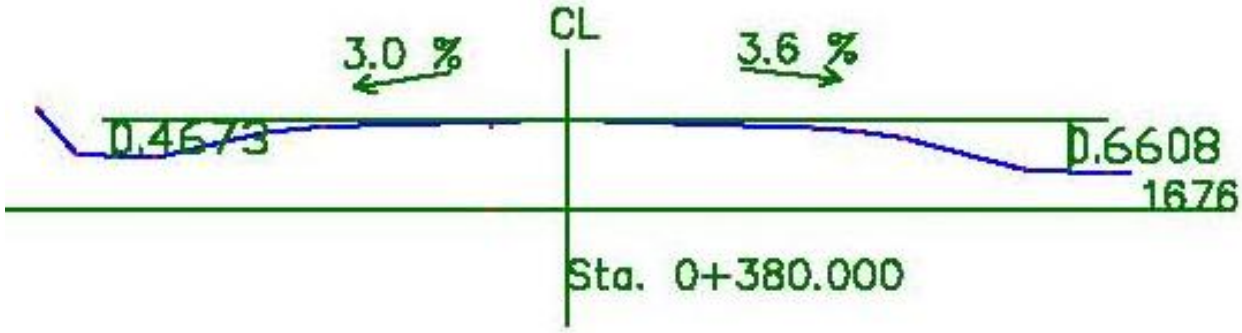

CL
4.2 %
3.1 %
0.5869
0.5775
1679
Sta. 0+280.000

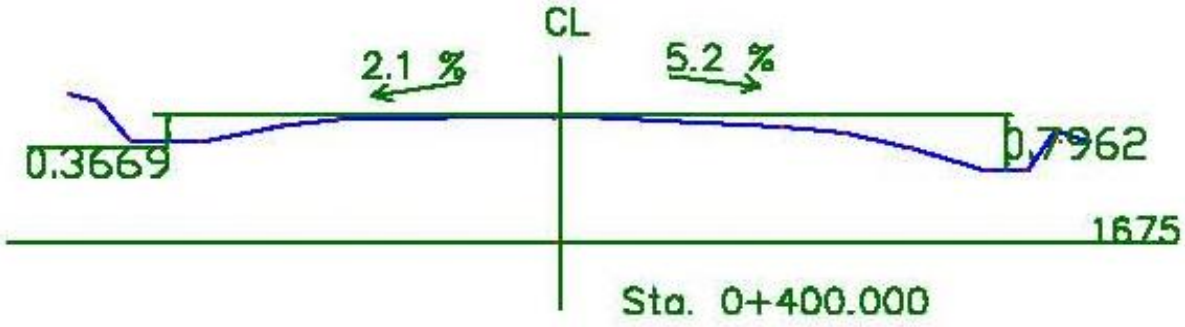

CL
3.0 %
3.9 %
0.4293
0.5429
1678
Sta. 0+300.000


CL
3.0 %
4.1 %
0.4884
0.5435
1677
Sta. 0+320.000


CL
3.6 %
3.4 %
0.4616
0.5613
1677
Sta. 0+340.000


CL
4.0 %
3.8 %
0.4925
0.6147
1676
Sta. 0+360.000

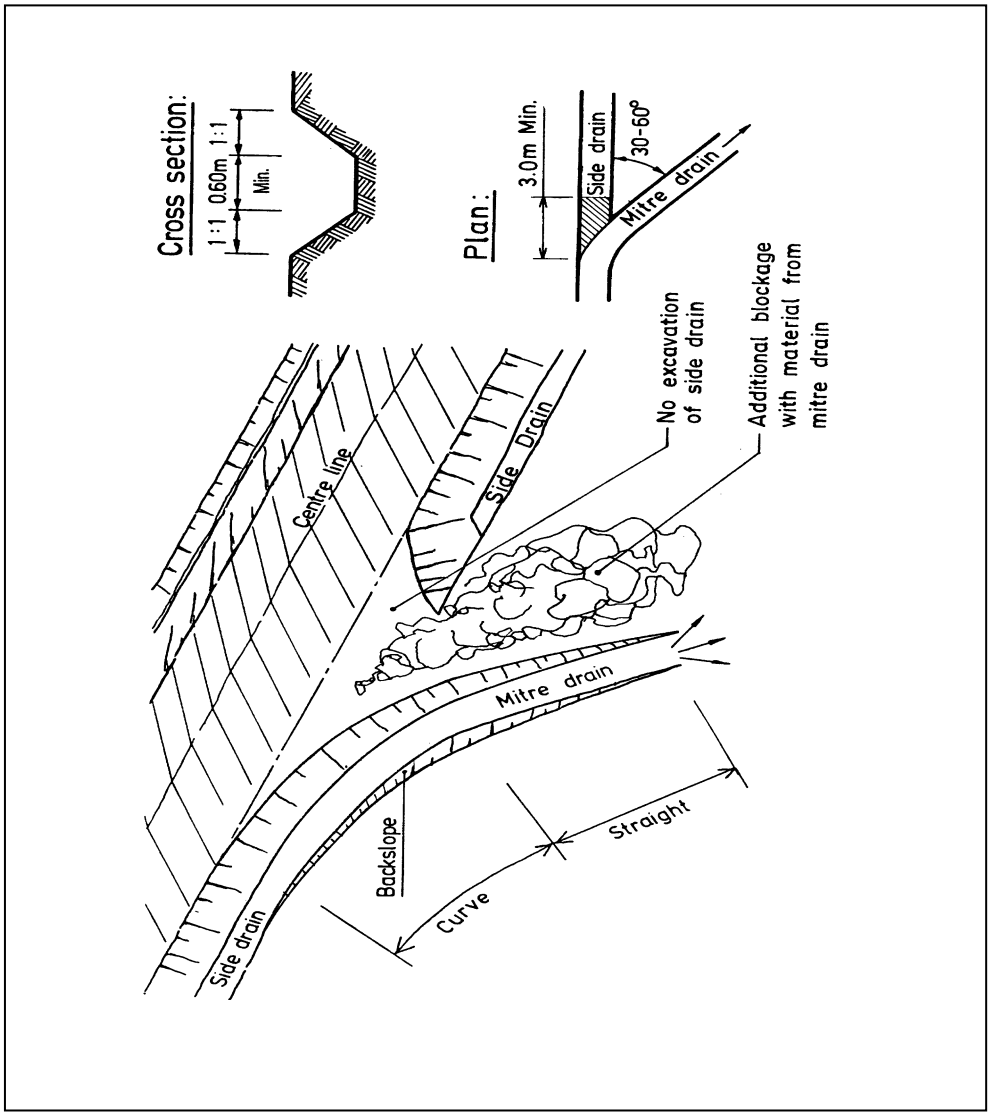

CL
3.0 %
3.6 %
0.4673
0.6608
1676
Sta. 0+380.000


CL
2.1 %
5.2 %
0.3669
0.7962
1675
Sta. 0+400.000

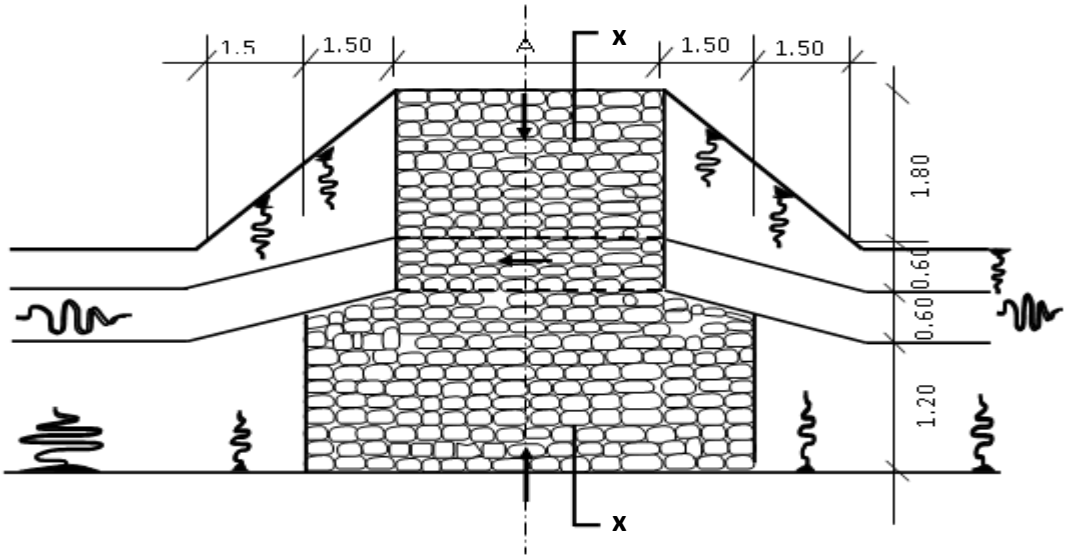
ANNEX B

DESIGN DRAWINGS AND SPECIFICATIONS

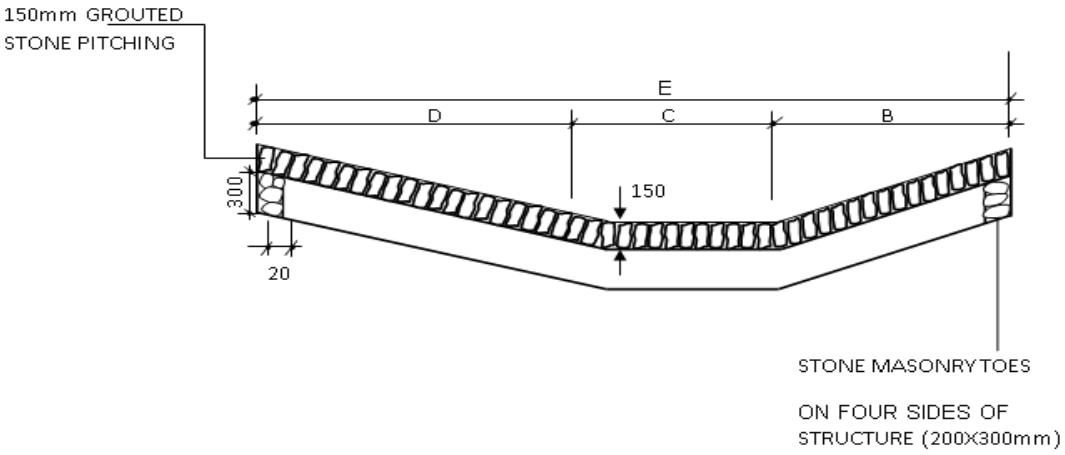
Mitre Drain



Access Drift



Constructions dimensions illustrating the **plan** of an access drift



Section X – X of the access drift

Table 30: dimensions and quantities of excavation of access drift

QUANTITIES TABLE								
Cross section	DIMENSIONS					Excavation (m3)	Stone masonry (m^3)	150mm Grouted stone pitching (m3)
	A	B	C	D	E			
A	4000	1800	600	1800	4200	7.50	1.30	21.75
	6000	1800	600	1800	4200	10.00	1.60	30.15
B	4000	1400	400	1800	3600	7.00	1.20	18.30
	6000	1400	400	1800	3600	9.00	1.50	25.50

Access Culverts

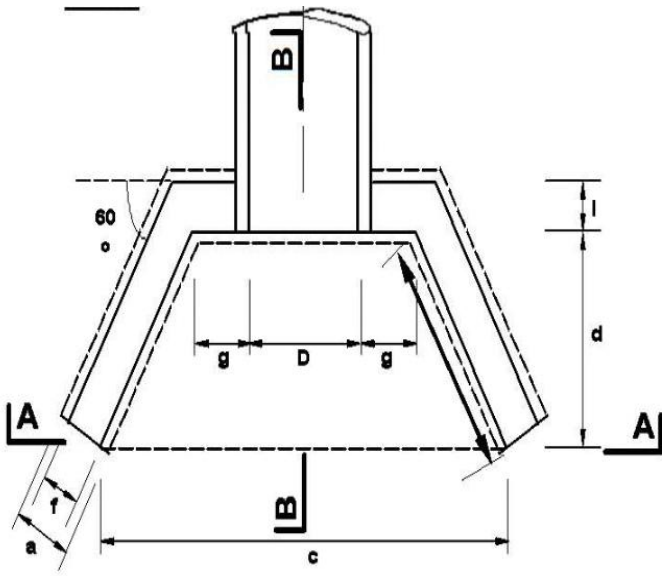


Figure 14: plan for the head and wing wall

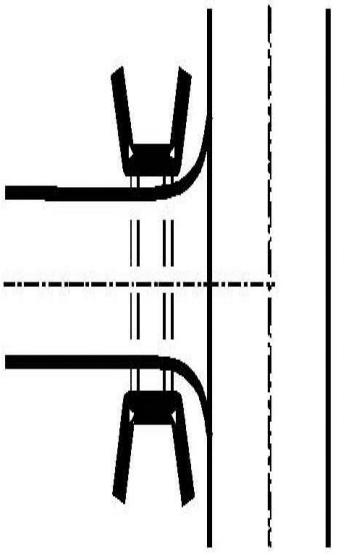


Figure 15: entry and exit structure type

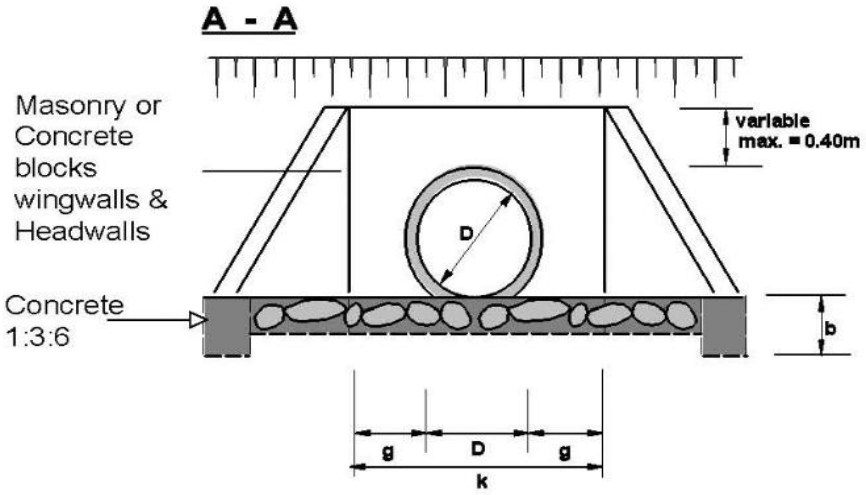


Figure 16: cross section A-A showing the apron, head and wing walls

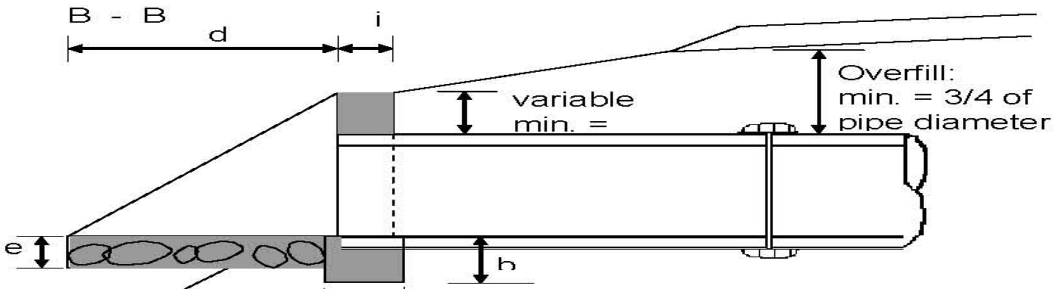


Figure 17: cross section B-B of the plan

Table 31: dimensions and materials requirements for access culvert structures

PIPE DIAMETER IN (M)			TYPE A (CONCRETE BLOCKS			TYPE B (STONE MASONRY)		
			450	600	900	450	600	900
	DIMENSION	UNIT						
a	FOUNDATION	m	0.30	0.30	0.30	0.40	0.40	0.60
b	FOUNDATION	m	0.30	0.30	0.40	0.30	0.30	0.40
c	FOUNDATION		2.20	2.35	2.89	2.20	2.35	2.89
d	APRON	m	1.00	1.00	1.20	1.00	1.00	1.20
e	APRON	m	0.20	0.20	0.20	0.20	0.20	0.20
f	WALL	m	0.20	0.20	0.20	0.40	0.40	0.40
g	WALL	m	0.30	0.30	0.30	0.30	0.30	0.30
h	WALL	m	1.15	1.15	1.39	1.15	1.15	1.39
l	WALL	m	0.20	0.20	0.20	0.40	0.40	0.40
k	APRON	m	1.05	1.20	1.50	1.05	1.20	1.50
	MATERIAL REQUIREMENT							
	FOUNDATION							
	(Concrete)	m^3	0.3	0.32	0.51	0.4	0.42	1.03
	HEAD/WINGWALLS							
	(Concrete/Masonry)	m^3	0.4	0.47	0.67	0.8	0.93	1.35
	APRON							
	(Concrete)	m^3	0.33	0.36	0.53	0.33	0.36	0.53

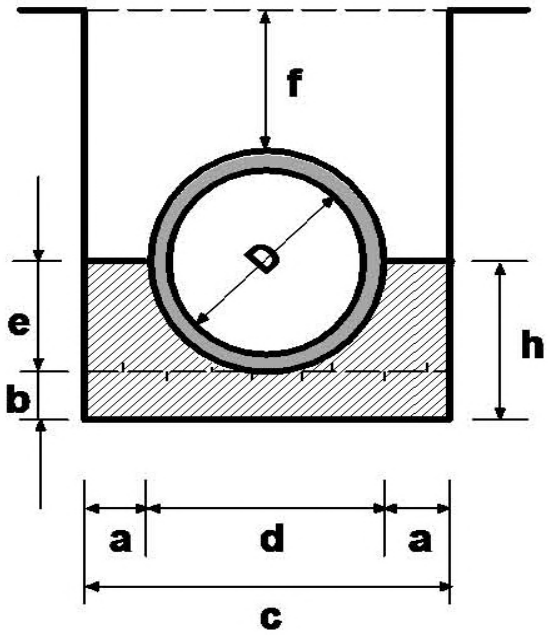


Figure 18: a bedding and haunch concrete profile of the access culvert

Table 32: dimensions of concrete culverts and material requirements for filling

Diameter (D)	450 (mm)	600 (mm)	900 (mm)
	Dimensions in (m)		
a	0.15	0.2	0.2
b	0.1	0.15	0.15
c	0.86	1.12	1.48
d	0.56	0.72	1.08
e	0.14	0.18	0.27
f (min.)	0.34	0.45	0.68
g	-	-	-
h	0.24	0.33	0.42
i	-	-	-
Concrete	Volume in (m3/m)		
	0.16	0.3	0.48
Application	- Fair subgrade condition; - Overfill > ¾ Diameter; - Seasonal waterflow only.		
Remarks	- Use gravel material for back/ overfill.		

450 (mm)	600 (mm)	900 (mm)
Dimensions in (m)		
0.15	0.2	0.2
0.1	0.15	0.15
0.86	1.12	1.48
0.56	0.72	1.08
0.28	0.36	0.54
0.34	0.45	0.68
-	-	-
0.38	0.51	0.69
-	-	-
Volume in (m3/m)		
0.2	0.37	0.56
- Fair to poor subgrade Condition; - Overfill > ¾ Diameter; - Seasonal waterflow only.		
- Use gravel material for back/ overfill.		

Cold mix asphalt specification

Mix Proportions

The following mix proportions were used for the cold asphalt mix;

1. Maximum batch volume **40 litres**
2. Aggregates;
   - i. 6/10 stone **12 litres**
   - ii. 0/6 crusher dust **28 litres**
   - iii. 0/2 fine sand **3 litres** (as directed by Engineer, if required to obtain the required grading)
3. K3 65% -Cationic Emulsion **6 litres**
4. Water **1 litre** (when aggregates are dry)

Aggregate Grading

The aggregates shall be continuously graded and within the specified grading envelope shown below. It is preferable to achieve a grading as close to the upper limit as possible.

Table 33: the percentage limits for the aggregate grading

Sieve aperture	Percentage passing%	
	Upper limit	Lower limit
14	100	100
10	100	85
6.3	85	65
4	70	45
2	50	24
1	33	12
0.425	18	6
0.3	14	4
0.15	8	1.5
0.075	5	1

Cold mix tools

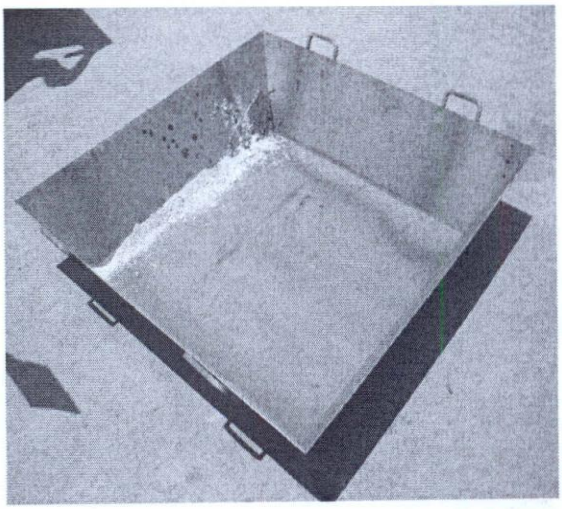


Photo 0-1: purpose made mixing trays

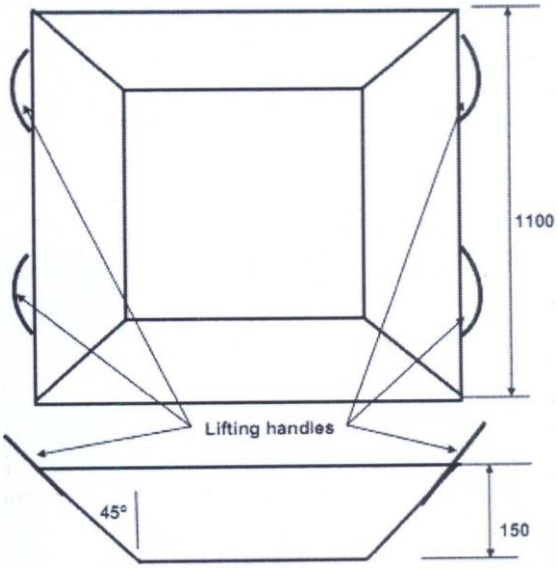


Figure 19: mixing tray dimensions

Photo 0-2: square nosed mixing spades

ANNEX C

MATERIAL TESTING RESULTS

Benches results

GATUNDU RESEARCH PROJECT.

WA-MWANGI ROAD D379

Materials Testing

KM 0+070 - 0+240 BENCHES. LHS SUMMARY FOR FIELD RELATIVE COMPACTION

Layer tested SUBGRADE Specification Compaction ..... Moisture Content .....

DATED TESTED	CHAINAGE OR TEST NO	POSITION FROM CL METRES	DEPTH OF HOLE (MM)	FIELD WET DENSITY Kg/m3	FIELD DRY DENSITY Kg/M3	FIELD MOISTURE CONTENT %	MAXIMUM DRY DENSITY Kg/m3 (MDD)	OPTIMUM MOISTURE CONTENT % (OMC)	RELATIVE COMPACTION %	RELATIVE MOISTURE CONTENT %	REMARKS
31.05.2012	0+070 LHS	3.5	150	1956	1619	20.8	1538	25.8	105	81	
31.05.2012	0+100 LHS	3.2	150	1927	1598	20.6	1538	25.8	104	80	
31.05.2012	0+130 LHS	3.4	150	1995	1576	20.3	1538	25.8	102	79	
31.05.2012	0+160 LHS	3.3	150	2003	1687	18.7	1538	25.8	109	72	
31.05.2012	0+190 LHS	3.2	150	1997	1635	22.1	1538	25.8	106	86	
31.05.2012	0+220 LHS	3.4	150	1917	1589	20.6	1538	25.8	103	80	

SOURCE OF MATERIAL... IMPROVED RED SOIL ON BENCHES.

TECHNICIAN..... RESIDENT ENGINEER ..... OK Approved

5/6/12

GATUNDU RESEARCH PROJECT.

WA-MWANGI ROAD D379

Materials Testing

KM 0+280 - 0+400 BENCHES. RHS SUMMARY FOR FIELD RELATIVE COMPACTION

Layer tested SUBGRADE Specification Compaction ..... Moisture Content .....

DATED TESTED	CHAINAGE OR TEST NO	POSITION FROM CL METRES	DEPTH OF HOLE (MM)	FIELD WET DENSITY Kg/m3	FIELD DRY DENSITY Kg/M3	FIELD MOISTURE CONTENT %	MAXIMUM DRY DENSITY Kg/m3 (MOD)	OPTIMUM MOISTURE CONTENT % (OMC)	RELATIVE COMPACTION %	RELATIVE MOISTURE CONTENT %	REMARKS
31.05.2012	0+280 RHS	3.5	150	1899	1550	22.5	1510	25.5	103	88	
31.05.2012	0+310 RHS	3.4	150	1883	1548	21.7	1510	25.5	103	85	
31.05.2012	0+340 RHS	3.3	150	1872	1531	22.3	1510	25.5	101	87	
31.05.2012	0+370 RHS	3.5	150	1937	1546	25.3	1510	25.5	102	99	
31.05.2012	0+400 RHS	3.4	150	1914	1543	24.0	1510	25.5	102	94	

SOURCE OF MATERIAL... IMPROVED RED SOIL ON BENCHES.

TECHNICIAN.....

RESIDENT ENGINEER ..... OK - Approved. 5/6/12

Base results

GATUNDU RESEARCH PROJECT.

WA-MWANGI ROAD D379

Materials Testing

KM 0+000 - 0+200 (CARRIAGE WAY) SUMMARY FOR FIELD RELATIVE COMPACTION

Layer tested BASE. Specification Compaction ..... Moisture Content .....

DATED TESTED	CHAINAGE OR TEST NO	POSITION OF TEST	DEPTH OF HOLE (MM)	FIELD WET DENSITY Kg/m3	FIELD DRY DENSITY Kg/M3	FIELD MOISTURE CONTENT %	MAXIMUM DRY DENSITY Kg/m3 (MDD)	OPTIMUM MOISTURE CONTENT % (OMC)	RELATIVE COMPACTION %	RELATIVE MOISTURE CONTENT %	REMARKS
21.06.2012	0+030	CL	150	2033	1825	11.4	1865	14.0	**98**	81	
21.06.2012	0+060	LHS	150	2060	1779	15.8	1865	14.0	**95**	113	
21.06.2012	0+090	RHS	150	2091	1817	15.1	1865	14.0	**97**	107	
21.06.2012	0+120	CL	150	2144	1906	12.5	1865	14.0	**102**	89	
21.06.2012	0+150	LHS	130	2134	1872	14.0	1865	14.0	**100**	100	
21.06.2012	0+180	RHS	150	2078	1823	14.0	1865	14.0	**98**	100	

SOURCE OF MATERIAL... LATERITIC GRAVEL FROM KIMUNYU QUARRY

TECHNICIAN.....

RESIDENT ENGINEER .....

Results ok 9/7/12

GATUNDU RESEARCH PROJECT.

WA-MWANGI ROAD D379

Materials Testing

KM 0+200 - 0+400 (CARRIAGE WAY) SUMMARY FOR FIELD RELATIVE COMPACTION

Layer tested BASE Specification Compaction ..... Moisture Content .....

DATED TESTED	CHAINAGE OR TEST NO	POSITION OF TEST	DEPTH OF HOLE (MM)	FIELD WET DENSITY Kg/m3	FIELD DRY DENSITY Kg/M3	FIELD MOISTURE CONTENT %	MAXIMUM DRY DENSITY Kg/m3 (MDD)	OPTIMUM MOISTURE CONTENT % (OMC)	RELATIVE COMPACTION %	RELATIVE MOISTURE CONTENT %	REMARKS
21.06.2012	0+210	CL	140	2131	1899	12.2	1890	13.6	**100**	90	
21.06.2012	0+240	LHS	150	2083	1826	14.1	1890	13.6	**97**	104	
21.06.2012	0+270	RHS	150	2153	1897	13.5	1890	13.6	**100**	99	
21.06.2012	0+300	CL	130	2193	1930	13.6	1890	13.6	**102**	100	
21.06.2012	0+330	LHS	150	2146	1873	14.6	1890	13.6	**99**	107	
21.06.2012	0+360	RHS	120	2158	1898	13.7	1890	13.6	**100**	101	
21.06.2012	0+390	CL	125	2083	1856	12.5	1890	13.6	**98**	92	

SOURCE OF MATERIAL... LATERITIC GRAVEL FROM KIMUNYU QUARRY

TECHNICIAN.....

RESIDENT ENGINEER .....

Results ok 9/7/12

DCP results

UK DCP V3.1Title Tests Summary Report for subgrade

Project Name: Research on Low volume Sealed Roads using DCP design Method D379

Road Name: D379 Lab CBR (soaked) = 8%

Test No.	Test Date	Chainage (	Location	Offset (m)	DN (mm/blow)	Subgrade CBR	SNP	DCP correlation
1	7/6/2012	0.01	LHS	3.3	7.6	27	1.86	0.30
2	7/6/2012	0.01	RHS	3.2	4.2	50	2.08	0.16
3	5/6/2012	0.03	RHS	3.1	12.3	16	1.57	0.50
4	7/6/2012	0.04	LHS	3.1	8.7	27	1.85	0.30
5	5/6/2012	0.06	RHS	3.3	7.9	28	1.86	0.29
6	31/5/2012	0.07	LHS	3.5	7.5	34	1.96	0.24
7	5/6/2012	0.09	RHS	3.2	9.2	22	1.76	0.36
8	31/5/2012	0.1	LHS	3.2	10.5	23	1.78	0.35
9	5/6/2012	0.12	RHS	3.2	12.6	17	1.6	0.47
10	31/5/2012	0.13	LHS	3.4	1.5	23	1.78	0.35
11	5/6/2012	0.15	RHS	3.2	9.1	24	1.79	0.33
12	31/5/2012	0.16	LHS	3.2	8.2	29	1.89	0.28
13	5/6/2012	0.18	RHS	3.1	14	15	1.53	0.53
14	31/5/2012	0.19	LHS	3.2	8.5	30	1.89	0.27
15	5/6/2012	0.21	RHS	3.2	5	48	2.07	0.17
16	31/5/2012	0.22	LHS	3.4	7.8	33	1.94	0.24
17	5/6/2012	0.24	RHS	3.3	6.5	38	1.99	0.21
18	5/6/2012	0.25	LHS	3.2	10.9	22	1.76	0.36
19	5/6/2012	0.28	LHS	3.3	11.1	22	1.75	0.36
20	31/5/2012	0.28	RHS	3.5	10.1	26	1.84	0.31
21	5/6/2012	0.31	LHS	3.2	8.2	28	1.88	0.29
22	31/5/2012	0.31	RHS	3.4	10.5	24	1.79	0.33
23	5/6/2012	0.34	LHS	3.1	8.4	27	1.85	0.30
24	31/5/2012	0.34	RHS	3.3	9.7	27	1.86	0.30
25	5/6/2012	0.37	LHS	3.3	8.5	27	1.86	0.30
26	31/5/2012	0.37	RHS	3.5	8.5	30	1.89	0.27
27	5/6/2012	0.4	LHS	3.2	10.7	23	1.77	0.35
28	31/5/2012	0.4	RHS	3.4	10	24	1.8	0.33
				Average	9	27.3	1.83	0.32

UK DCP V3.1Title Tests Summary Report for Base Layer

Project Name: Research on Low volume Sealed Roads using DCP design Method D379

Road Name: D379 Lab CBR Soaked = 26%

Test No.	Chainage (km)	Location	Base DN (mm/blow)	Base in-situ CBR%	Base Thickness (mm)	Pavement Strength, SN	DCP correlation
1	0.03	CL	4.3	68	141	0.82	0.38
2	0.06	LHS	4.6	61	158	0.87	0.42
3	0.09	RHS	5.6	49	145	0.73	0.53
4	0.12	CL	3.6	81	152	0.92	0.32
5	0.15	LHS	5.4	52	153	0.78	0.50
6	0.18	RHS	3.8	75	163	0.97	0.35
7	0.21	CL	4.0	71	150	0.88	0.36
10	0.3	CL	3.4	88	145	0.9	0.30
11	0.33	LHS	4.9	61	165	0.88	0.43
12	0.36	RHS	5.3	52	140	0.73	0.50
13	0.39	CL	3.2	88	160	1	0.29
Average			4	68	152	0.86	0.40

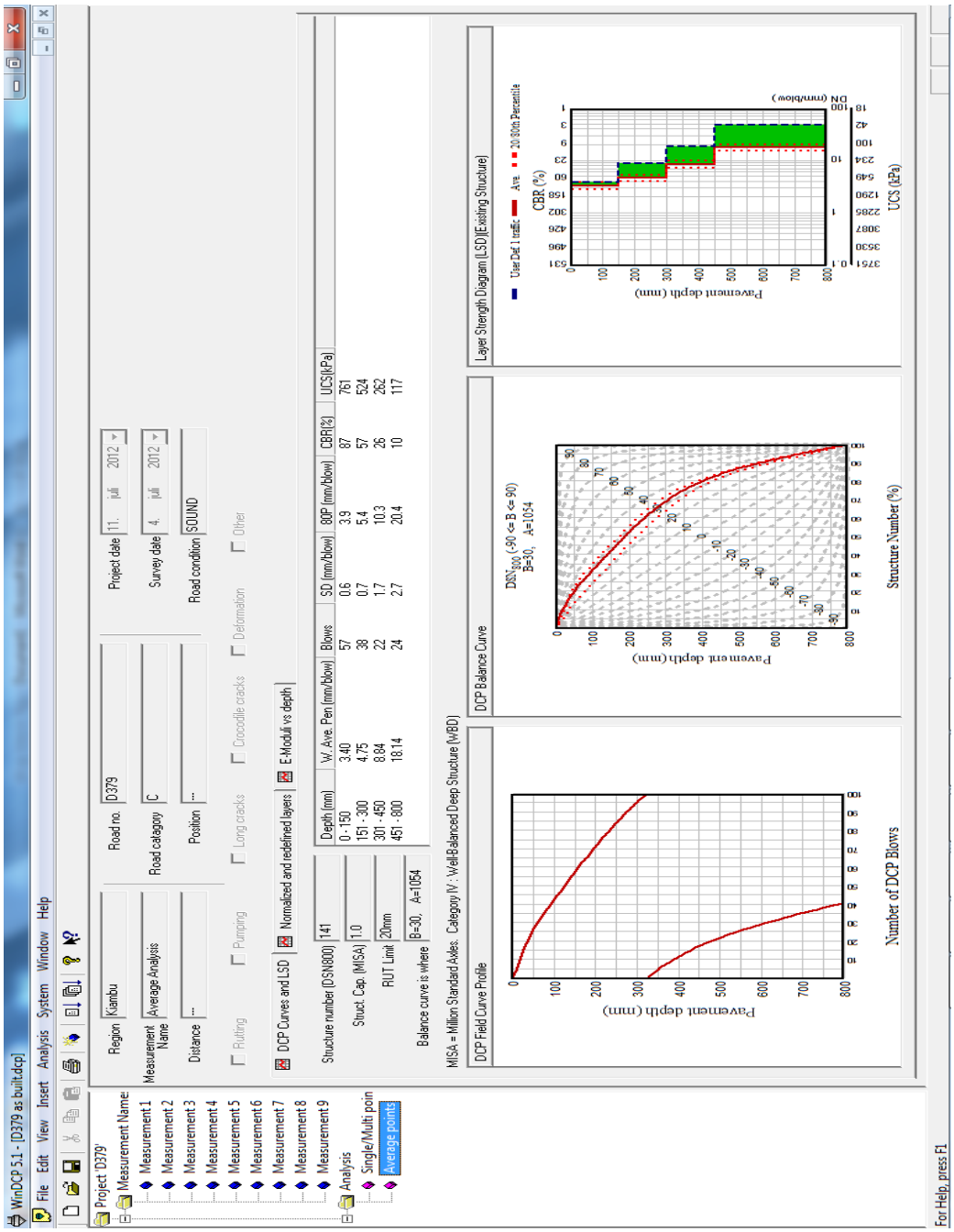


Figure 20: as built DCP - average all points

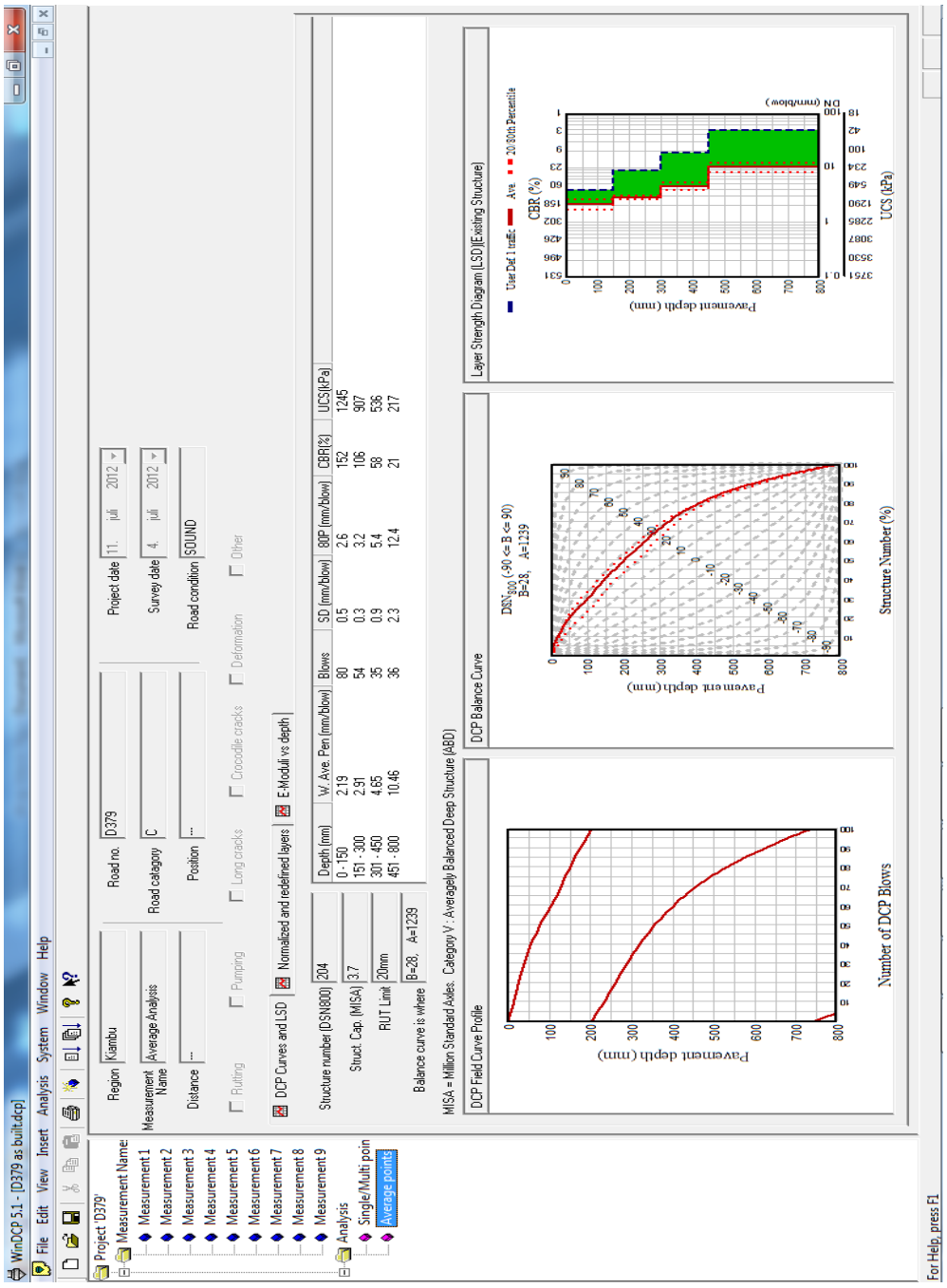


Figure 21: as built DCP-average points 1, 4 and 7 at CL

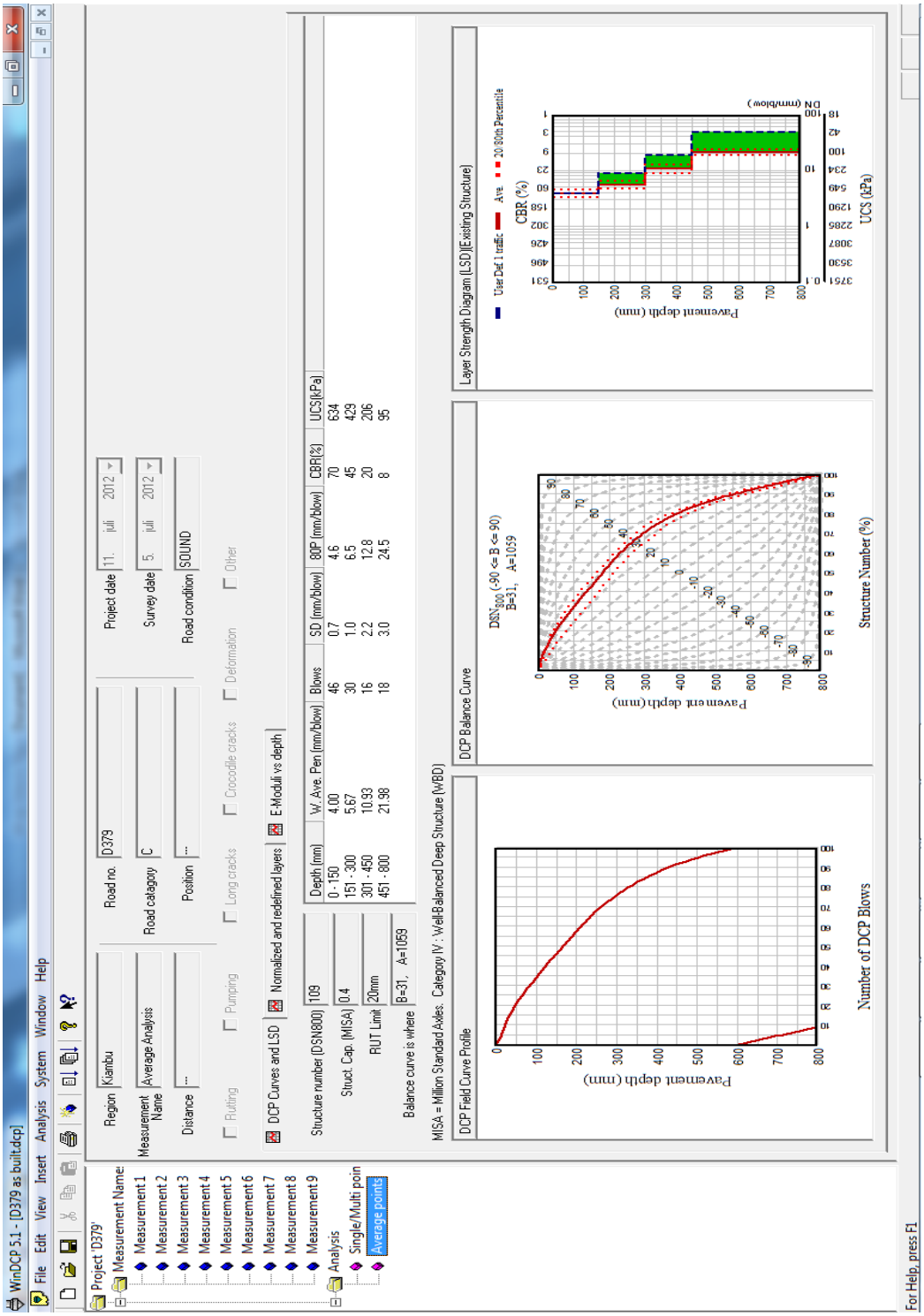


Figure 22: as built DCP - average points 2, 3, 5, 6 8 and 9 at the outer wheel path (LHS and RHS)

ANNEX D

Daily and Monthly Site Activities Reports

Construction of Research Section in Kiambu – Central Province Kenya								D379 Kiambu Region	
Whole Months Site Activity Report: A:- SITE CLEARING								Months of MAY,JUNE&JULY - 2012	
#	Activity	Chainage From	Chainage To	Unit	Quantity	Task Rate	WD	Materials	Unit	Quantity
A.1	Setting out - Horizontal Alignment									
A.2	Bush/Grass Clearing									
A.3	Stripping and Grubbing									
A.4	Trees / Stumps Removal									
A.5	Boulder Removal									
A.6	Spreading of the top soil	0+040	0+450	m^2			26			
A.7	Support Staff						5			
A.8	Culvert Opening	0+000	0+020	No.	1		5			
A.9	Mitre Drain Opening	0+000	0+020	No.	2		1	Equipment	Unit	Quantity
								Grader	Hrs.	3.5
								Roller	Hrs.	4.0
						Total WD	37		Total HRS	7.5

Construction of Research Section in Kiambu – Central Province Kenya										D379 Kiambu Region
Whole Months Site Activity Report: B:- ROAD FORMATION										Months of MAY,JUNE&JULY - 2012
#	Activity	Chainage		Unit	Quantity	Task Rate	WD		Materials	Unit	Quantity
		From	To								
B1	Setting out – Vertical Alignment	0+000	0+220	m	220		2				
a	Excavation to level Slots	0+000	0+450	m	450		4				
b	Reshaping Slots										
B.2	Excavation to level & spreading	0+040	0+180	m^3	25.2	1.8	14				
B.3	**1st Compaction (road bed)**										
B.4	Mitre drains /										
B.5	Catch water drains										
B.6	Side borrow / Embankments										
B.7	Ditching and spreading	0+020	0+320	m^3	118.5	9.6	47				
B.8	**2nd Compaction**										
B.9	Back slopes & spreading	0+040	0+400	m^3	140.5	4	45		**Equipment**	**Unit**	**Quantity**
B.10	Side slopes & spreading	0+020	0+304	m^3	88.4	3	23				
B.11	Ditch Clearing	0+000	0+020	m	20	20	1				
B.12	Ditch Excavation	0+320	0+400	m^3	7.2	3.6	26				
B.13	Support staff						20				
						Total WD	**158**			**Total HRS**	

Construction of Research Section in Kiambu – Central Province Kenya **D379 Kiambu Region**

Whole Months Site Activity Report: C:- CULVERTS AND STRUCTURE WORKS

Months of MAY,JUNE&JULY - 2012

#	Activity	Chainage From	Chainage To	Unit	Quantity	Task Rate	WD
C.1	Site Clearance						20
C.2	Removal of existing structure	0+280	0+400	m^3	9.0	3	3
C.3	Excavation of Trench / Foundation	0+000	0+390	m^3	24.24	4	17.3
C.4	Laying of Hardcore and Compaction	0+340	0+390	m^3	5.23		20
C.5	Erecting Formwork	0+135	0+380	m^3	2.13		30
C.6	Placing of BRC Mesh / Re-bars	0+130	0+390	m^3	11.15		46
C.7	Batching, Mixing, Placing, Compacting	0+195	0+280	m^3	21		22
a	Mortar (1:3)						
b	Concrete Class 15 (1:3:6)						26
c	Concrete Class 20 (1:2:4)						1
C.8	Curing of Concrete (Concrete Surround)	0+000	0+280				5
C.9	Installation of pipe culverts , 600mm	0+135	0+280	No.	8		
C.10	Mitre Drain	0+400	0+450				5
C.11	Construction of Head and Wing walls	0+020	0+400				39
C.12	Selected backfill to structure	0+000	0+400				26
C.13	Stone Parking – Side Drift	0+080	0+380				
C.14	Support Staff						40
C.15	Access Drift & Mortaring	0+000	0+380	m^3	22.3	3	26

Materials	Unit	Quantity
Cement, Ballast & Sand	Bags	81.5
Equipment	**Unit**	**Quantity**

Construction of Research Section in Kiambu – Central Province Kenya **D379 Kiambu Region**

Whole Months Site Activity Report: D:- IMPROVED SUB GRADE LAYER WORKS (GRAVELLING) **Months of MAY,JUNE&JULY - 2012**

#	Activity	Chainage From	Chainage To	Unit	Quantity	Task Rate	WD
D. 1	Setting Out Dumping Distances	0+000	0+450				9
D. 2	Haulage of approved gravel Material	0+000	0+450	m^3	250		
D. 3	Repair and Compaction of sub grade	0+000	0+450	m	450		
D. 4	Fixing of Shutters						
D. 5	Batching of Sub Base Materials						
D. 6	Loading hauling Mixing, watering and Spreading						
D. 7	Compaction of improved Sub grade Layer	0+000	0+450	m^3	3150		
D. 8	Support Staff						3
						Total WD	12

Materials	Unit	Quantity
Gravel	m^3	250
Aggregates - 0/6	m^3	10
Aggregates - 6/10	m^3	10
Equipment	**Unit**	**Quantity**
Roller 3T	Hrs.	12
Grader	Hrs.	5.3
Trucks	No.	3
	Total	

Construction of Research Section in Kiambu – Central Province Kenya D379 Kiambu Reg

Whole Months Site Activity Report: D:- IMPROVED SUB GRADE LAYER WORKS (REPAIR)

Months of MAY,JUNE&JULY - 2012

#	Activity	Chainage From	Chainage To	Unit	Quantity	Task Rate	WD
D.1	Setting Out of horizontal alignment	0+000	0+450	m	1730		39
D.2	Setting Out of vertical alignment						
D.3	Setting Out of slots for side drains						
D.4	Sub-base ripping and shaping	0+000	0+450	m^2	6247	machine	
D.5	Spreading & mixing of stabilizer						
D.6	Compaction of sub-base	0+000	0+450	m^2	11802		4
D.7	Support Staff						12
D.8	Opening of culverts inlet	0+000	0+020				4
						Total WD	59

Materials	Unit	Quantity
Gravel	m^3	250
Aggregates - 0/6	m^3	10
Aggregates - 6/10	m^3	10

Equipment	Unit	Quantity
Roller 3T	Hrs.	48.0
Grader	Hrs.	78.3
Water Bowser	Hrs.	8
	Total Hrs.	134.3

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Whole Months Site Activity Report: E:- BASE LAYER WORKS Months of MAY,JUNE&JULY - 2012

#	Activity	Chainage From	Chainage To	Unit	Quantity	Task Rate	WD
E.1	Setting Out Dumping Distances	0+080	0+260	m	180		3
E.2	Haulage of base Material	0+080	0+260	m^3	120		
E.3	Repair and Compaction of sub grade						
E.4	Fixing of Shutters						
E.5	Batching of Base Materials						
E.6	Mixing, Dumping and Spreading						
E.7	Compaction of Sub Base Layer	0+220	0+450	m^2	1610		
E.8	Curing of Sub Base Layer						
E.9	Support staff						
						Total WD	3

Materials	Unit	Quantity
Gravel	m^3	120

Equipment	Units	Quantity
Roller 3T	Hrs.	4
Grader	Hrs.	7.5
Trucks	No.	2
Water Bowser	Hrs.	3
Total HRS		

Construction of Research section in Kiambu - Central Provision Kenya										D379 Kia
Whole Months Site Activity Report: F:- COLD MIX ASPHALT LAYER WORKS										Months of MAY,JUNE&JULY - 2012
#	Activity	Chainage		Unit	Quantity	Task Rate	WD		Materials	Unit	Quantity
		From	To								
F.1	Setting Out Dumping Distances								K-3 65%	Ltrs.	9703
F.2	Brooming Sub base layer	0+020	0+415	m^2	4009		35		A-4	Ltrs.	132
F.3	Priming of Sub base layer	0+020	0+410	m^2	3859		27		Aggregates - 0/6	m^3	47.82
F.4	Correcting irregularities of Sub base layer	0+400	0+410	m^2	400		4		Aggregates - 6/10	m^3	24.99
F.5	Fixing of Steel Shutters	0+000	0+235	m	670		58		Kerosene	Ltrs.	60
F.6	Haulage of Aggregate	0+000	0+020	m^2	345		4		MC 30	Ltrs.	2160
F.7	Batching of Asphalt Materials	0+000	0+020	m^2	1292.1		9		Diesel	Ltrs.	17
F.8	Mixing, Dumping and Spreading	0+000	0+410	m^2	2410.57		158		Cement, Sand & Ballast	Bags	10
F.9	Compaction of Asphalt Layer	0+000	0+410	m^2	2176.97		1		Equipment	Unit	Quantity
F.10	Curing of Asphalt Layer								One (3Tonnes Roller)	Hrs.	12
F.11	Support staff						45		One D/Cabin Pickup	Hrs.	24
F.12	Culverts, cement & sand off-loading						7		One Hand Sprayer	Hrs.	6
						Total WD	348		Total HRS		

DAY	ACTIVITY(S)	RESOURCES ALLOCATION				REMARKS
		RESOURCES	UNIT	PLAN	ACHIEVED	
1 (24th-May Thursday)	**Site Clearing** Tress/Stump removal	Support Staff Casual Labour	WD WD	2 10	2 10	Main activity was removal of tree/ stumps to clear way for the widening path of the road**{From Chainage 0+000 to 0+130}**
2 (25th-May Friday)	**Site Clearing** Tress/Stump removal	Support Staff Casual Labour	WD WD	2 11	2 12	Removal of tree/ stumps continued on day 2 further ahead of the road section**{From Chainage 0+130 to 0+200}**
3 (26th-May Saturday)	**Site Clearing** Bush/Grass clearing	Support Staff Casual Labour	WD WD	2 11	2 12	The whole road section was cleared of bush/grass**{From Chainage 0+000 to 0+450}**. The task rate was 1 Person clears 150 SM, a gang of 12 people were used to clear a quantity of 1800 SM
4 (28th-May Monday)	**Site Clearing** Stripping & Grubbing	Grader (GK A742 Support Staff Casual Labour	Hrs WD WD	8 4	5 2 3	The grader only achieved 5Hrs Instead of the 8Hrs planned. This was due to delay in mobilising the grader to the site. Work started at 12.05pm, main activity was stripping&grubbing**{From Chainage 0+000 to 0+220}**including spoiling away from the working area approximately 13 M. Further spoiling is to be done by labour due to lack of space for the grader to turn freely.
5 (29th-May Tuesday)	**Site Clearing** Setting out - Benches Stripping & Grubbing	Grader (GK A742 Casual Labour Water Bowser(KA Support Staff	Hrs WD Hrs WD	8 4	7 15 0.5 2	Setting out of benches was carried out**{From Chainage 0+000 to 0+200}**.Processing of 1st layer benches continued, more watering required before compaction. Water bowser broke down. Stripping & Grubbing was done**{From Chainage 0+200 to 0+450}**There was a **site visit** by Jon & Esther-Materials Dept.,brought DCP equipment to site.
6 (30th-May Wednesday)	**Site Clearing** Stripping & Grubbing Compaction of Benches	Casual Labour Grader (GK A742 Water Bowser(KA Support Staff Bomag Roller(GK	WD Hrs Hrs WD Hrs	 8 8	18 4.5 2 2 3	Stripping & Grubbing was done**{From chainage 0+260 to 0+450},** a quantity of 2300 SM**.**A request was made for test for section **0+000 to 0+200 LHS & 0+240 to 0+440 RHS**. Compaction of Benches was done**{From chainage 0+000 to 0+200, then 0+240 to 0+440}.**

7 (31st-May Thursday)	**Site Clearing** Stripping & Grubbing Compaction of Benches	Casual Labour Grader (GK A742 M) Water Bowser(KAX 800M Bomag Roller(GK A093 R) Support Staff	WD Hrs Hrs Hrs WD	19 10 2 6 2	Stripping & Grubbing was done**{From chainage 0+000 to 0+240}**. Compaction of benches was done**{From chainage 0+000 to 0+220, then 0+240 to 0+440}**. Processing of the 1st layer benches continued on section **0+000 to 0+240 RHS & 0+240 to 0+440 LHS,** finally these sections are sealed to await further processing. Tests taken as requested for.
8 (4th-June Monday)	**Site Clearing** Stripping & Grubbing Compaction of Benches	Casual Labour Grader (GK A742 M) Water Bowser(KAX 800M Bomag Roller(GK A093 R) Support Staff	WD Hrs Hrs Hrs WD	19 5 2 6 2	Stripping & Grubbing was done**{From chainage 0+220 to 0+450}**. Compaction of benches was done**{From chainage 0+000 to 0+220, then 0+240 to 0+440}**. Test results for 1st layer benches at **0+080 to 0+220 LHS & 0+240 to 0+440 RHS** are released and are ok.
9 (5th-June Tuesday)	**Improved Sub Grade Layer Works (Gravelling)** Setting out - Benches Stripping & Grubbing Compaction of Benches	Casual Labour Grader (GK A742 M) Water Bowser(KAX 800M Bomag Roller(GK A093 R) Support Staff	WD Hrs Hrs Hrs WD	3 4 2 3 1	Stripping & Grubbing was done**{From chainage 0+025 to 0+060}**. Compaction of benches was done**{From chainage 0+000 to 0+220, then 0+240 to 0+440}**. Benching of the bellmouth & the reprocessing of bench at **0+000 to 0+060 LHS** continues. The section is watered and to be compacted the next day. Tests done for benches at **0+000 to 0+240RHS & 0+220 to 0+440LHS**
10 (6th-June Wednesda	**Improved Sub Grade Layer Works (Gravelling)** Stripping & Grubbing Stripping & Grubbing	Tipper (KBQ 689S) Tipper(KBH 541S) Support Staff	Trips Trips WD	6 6 2	**120 cubic metres** of gravel materials was delivered to site. The tippers were each of capacity 10 cubic metres & spaced at 7 metres interval. They made a total of **12 trips**
	Stripping & Grubbing Stripping & Grubbing Compaction of Benches	Casual Labour Grader (GK A742 M) Water Bowser(KAA 348D) Bomag Roller(GK A093 R) Support Staff	WD Hrs Hrs Hrs WD	20 5 2 3 1	Stripping & Grubbing was done{**From chainage 0+025 to 0+060**}. Compaction of benches was done{**From chainage 0+000 to 0+220, then 0+240 to 0+440**}. Requested for tests for the bellmouth section.

11 (7th-June Thursday)	**Improved Sub Grade Layer Works (Gravelling)** Haulage of approved gravel Material	Tipper (KBQ 689S) Tipper(KBH 541S) Tipper(KBN 169X) Support Staff	Trips Trips Trips WD		6 6 1 2	**130 cubic metres** of gravel materials was delivered to site. The tippers were each of capacity 10 cubic metres & spaced at 7 metres interval. They made a total of **13 trips**
	Site Clearing Stripping & Grubbing Compaction of Benches	Casual Labour Grader (GK A742 M) Water Bowser(KAA 348D) Bomag Roller(GK A093 R) Support Staff	WD Hrs Hrs Hrs WD	 8 8 	18 4.5 2 3 1	Stripping & Grubbing was done**{From chainage 0+080 to 0+240}**. Compaction of benches was done**{From chainage 0+025 to 0+060}**. Bellmouth section was tested. Processing of 2nd layer bench at **0+080 to 0+240 RHS**
12 (8th-June Friday)	**Improved Sub Grade Layer Works (Gravelling)** Setting Out Dumping Distance Haulage of approved gravel Material	Casual Labour Tipper (KBQ 689S) Tipper(KBH 541S) Tipper(KBN 169X) Support Staff	WD Trips Trips Trips WD		3 6 5 5 2	**160 cubic metres** of gravel materials was delivered to site. The tippers were each of capacity 10 cubic metres & spaced at 7 metres interval. They made a total of **16 trips**. A Steering committee meeting was held on site. No other activity was carried out due to bad weather-mostly rainy and the road section was wet. Both Setting out dumping distances & haulaged of gravel material was done **{From chainage 0+284 to 0+385}**
13 (9th-June Saturday)	**Improved Sub Grade Layer Works (Gravelling)** Haulage of approved gravel Material	Tipper (KBQ 689S) Tipper(KBH 541S) Support Staff	Trips Trips WD		5 4 3	**90 cubic metres** of gravel materials was delivered to site. The tippers were each of capacity 10 cubic metres & spaced at 7 metres interval. They made a total of **9 trips.** Haulage of gravel material was carried out**{From Chainage 0+000 to 0+070}**.
14 (11th-June Monday)	**Improved Sub Grade Layer Works (Gravelling)** Repair & Compaction of sub g	Casual Labour Water Bowser Bomag Roller Grader (GK A742 M) Support Staff	WD Hrs Hrs Hrs WD	 8 	3 1 4 3.9 3	Repair & compaction of sub grade was carried out**{From 0+000 to 0+450}**. Sample ballast was delivered to site. i.e. One lorry has **0-6" aggregate**, while other **6-10" aggregate**. On this, a complete aggregate test is to be done before more can be approved for supply to site. Check hardness, soundness, shape, and cleanliness. LAA, ACV, SSS, FI. Angularity and grading

15 (12th-June Tuesday)	**Improved Sub Grade Layer Works (Gravelling)** Processing of base	Casual Labour Bomag Roller Grader (GK A742 Support Staff	WD Hrs Hrs WD	3 4 6.6 1	Processing of base on the improved sub grade layer was carried out**{From chainage 0+070 to 0+220}**. Ripping of the top 75mm existing gravel layer & stock piling wth the hauled gravel to be processed to a homogeneous mix before shaping & compacting to refusal.
16 (13th-June Wednesday)	**Improved Sub Grade Layer Works (Gravelling)** Setting Out Dumping Distance Processing of base	Casual Labour Casual Labour Bomag Roller Grader (GK A742 Water Bowser Support Staff	WD WD Hrs Hrs Hrs WD	3 11 5 8.6 2 1	Processing of base on the improved sub grade layer was carried out**{From chainage 0+000 to 0+220}**. Request for a surveyor to give levels on which to place layer and reposition the beacons. Processing of base layer**{From Chainage 0+000 to 0+220},** watering and continuously turning the soil to obtain a uniform mix. **AFCAP Engineer - Letta -visited the site.**
17 (14th-June Thursday)	**Base Layer Works** Mixing, Dumping and Spreadir	Casual Labour Water Bowser Bomag Roller Grader (GK A742 Support Staff	WD Hrs Hrs Hrs WD	5 4 4 5 4	The process of mixing, dumping and spreading was carried out**{From chainage 0+000 to 0+400}**. The ripping was to be precisely **75mm** and no compaction on the surface thereof as the research section is to borrow as much as possible on the original strength and properties of the road constructed based on R 2000 principles.
18 (15th-June Friday)	**Base Layer Works** Mixing, Dumping & Spreading Compaction of base layer	Casual Labour Water Bowser Bomag Roller Grader (GK A742 Support Staff	WD Hrs Hrs Hrs WD	6 2.9 4 9 4	The process of mixing, dumping and spreading was carried out**{From chainage 0+220 to 0+450}**. The compaction of the base layer was done**{From Chainage 0+000 to 0+220}**. The processing for the base layer{**From chainages 0+220 to 0+450**}was done

19 (16th-Jun Saturday)	**Base Layer Works** Mixing, Dumping & Spreading Compaction of base layer	Casual Labour Water Bowser Bomag Roller Grader (GK A742 Support Staff	WD Hrs Hrs Hrs WD	6 4 4 9 4	The process of mixing, dumping and spreading was carried out**{From chainage 0+000 to 0+200}**. The compaction of the base layer was done**{From Chainage 0+000 to 0+200}.** Watering needed before further vibtrated compaction. Shaping to be regulated using camber board locally fabricated to allow for a grade of 3.5%. This will later be confirmed using a level.
20 (18th-Jun Monday)	**Base Layer Works** Mixing, Dumping & Spreading Compaction of base layer	Casual Labour Bomag Roller Grader (GK A742 Support Staff	WD Hrs Hrs WD	6 4 7.5 4	The process of mixing, dumping and spreading was carried out**{From chainage 0+200 to 0+450}**. The compaction of the base layer was done**{From Chainage 0+000 to 0+200}.** Work delays due to lack of water. Grades confrimed for the first 200m using a level & the use of camber board is fairly adequate. Cleaning of the culvert at **chainage 0+020** begins & the material thereof carefully damped to latter used in regulation of the surface before application of MC30
21 (19th-Jun Tuesday)	**Base Layer Works** Compaction of base layer	Bomag Roller Grader (GK A742 Water Bowser	Hrs Hrs Hrs	4 7.5 2	The compaction of the base layer was done{**From Chainage 0+220 to 0+450**}. Need to fabricate the slope ditch template. Ditching starts.
	Road Formation Setting out-Vertical alignment Ditching and Spreading	Casual Labour Casual Labour	WD WD	2 3	Setting out of vertical alignment was carried out{**From chainage 0+000 to 0+220**}. For the 1st compaction for the road bed, ditching and spreading was done{**From chainage 0+020 to 0+040**}
22 (20th-June Wednesda	**Base Layer Works** Batching of base materials Compaction of Base Layer	Water Bowser Bomag Roller Grader (GK A742 Support Staff	Hrs Hrs Hrs WD	2 4 5.2 4	During the activity for the base layer works, both of the base materials followed by compaction of the base layer was done{**From chainage 0+220 to 0+450**}
	Road Formation-1st Compactio Ditching & Spreading	Casual Labour	WD	14	During the 1st Compaction of the road bed formation, ditching and spreading was done{**From chainage 0+040 to 0+180**}

23	**Base Layer Works**				The compaction of the base layer was done{**From Chainage 0+000**
(21st-June	Compaction Base Layer	Bomag Roller	Hrs	4	**to 0+450**}
Thursday)	**Road Formation**	Casual Labour	WD	4	Excavation of the level slots was done{**From chainage 0+000 to**
	Excavation of level slots for				**0+450**}. A total no. of 22 slots were done. Ditching and spreading for
	verticle alignment	Casual Labour	WD	11	the 1st compaction was carried out{**From chainage 0+040 to**
	Ditching & Spreading	Support Staff	WD	4	**0+180**}. Base layer tested both for sand replacement and DCP{**From**
					chainage 0+000 to 0+450}
24	**Road Formation-1st Compaction**	Casual Labour	WD	20	During the 1st Compaction of the road bed formation, ditching and
(22nd-June	Ditching & Spreading	Support Staff	WD	3	spreading was done{**From chainage 0+020 to 0+240**}. Cutting of
Friday)					drains begins. The slope ditch template is used and the material
					thereof spread out away from the road. The grade of the ditch is
					checked using boning road to ensure proper drainage.
25	**Road Formation-1st Compaction**	Casual Labour	WD	12	During the 1st Compaction of the road bed formation, ditching and
(25th-June	Ditching & Spreading	Support Staff	WD	3	spreading was done{**From chainage 0+240 to 0+320, then From**
Monday)					**0+260 to 0+400**}
26	**Road Formation-2nd Compaction**				During the 2st Compaction of the Road formation, back slopes and
(26th-June	Back slopes & Spreading	Casual Labour	WD	9	spreading was done{**From chainage 0+020 to 0+304**}. The activity of
Tuesday)	Side slopes & Spreading	Casual Labour	WD	9	side slopes & spreading was done{**From 0+025 to 0+285**}
		Support Staff	WD	4	

27 (27th-June Wednesday)	**Road Formation-1st Compaction** Ditching & Spreading	Casual Labour	WD	2	During the 1st Compaction of the road bed formation, ditching and spreading was done{**From chainage 0+320 to 0+400**}
	Road Formation-2nd Compaction				During the 2st Compaction of the Road formation, back slopes and spreading was done{**From chainage 0+040 to 0+130**}. The activity of side slopes & spreading was done{**From 0+025 to 0+100**}. Base later tested both for sand replacement & DCP{**From chainage 0+000 to 0+450**}
	Back slopes & Spreading	Casual Labour	WD	9	
	Side slopes & Spreading	Casual Labour	WD	5	
		Support Staff	WD	3	
28 (28th-June Thursday)	**Road Formation-2nd Compaction**				During the 2st Compaction of the Road formation, back slopes and spreading was done{**From chainage 0+100 to 0+240**}. The activity of side slopes & spreading was done{**From 0+135 to 0+220**}
	Back slopes & Spreading	Casual Labour	WD	9	
	Side slopes & Spreading	Casual Labour	WD	7	
		Support Staff	WD	3	
29 (29th-June Friday)	**Road Formation-2nd Compaction**				During the 2st Compaction of the Road formation, back slopes and spreading was done{**From chainage 0+240 to 0+450,LHS**}. The activity of side slopes & spreading was done{**From 0+220 to 0+430,RHS**}
	Back slopes & Spreading	Casual Labour	WD	12	
	Side slopes & Spreading	Support Staff	WD	4	
	Correcting irregularities of Sub base layer	Casual Labour	WD	21	
30 (2nd-July Monday)	**Cold Mix Asphalt Layer Works**	Support Staff	WD	5	Watering & brooming the base layer was done{**From chainaige 0+020 to 0+200**}. This was followed by priming of the base layer{**From 0+020 to 0+085**}. The MC 30 supplied is to be tested to confirm the properties including Kinematic viscosity. Sections **0+020 to 0+050** & **0+050 to 0+085** were taken as trials section with 4ltrs. & no kerosene added respectively. It was observed that the penetrability of both controls were fairly good. However, samples were taken to the lab for confirmation of the properties before adopting a consistent mix for further application.
	Watering & Brooming base layer	Casual Labour	WD	15	
	Priming of the base layer	Casual Labour	WD	8	
		Hand Sprayer			
		MC 30	Ltrs.	400	
		KEROSENE	Ltrs.	10	

31 (3rd-July Tuesday)					There were no works going on site since they were waiting for the results on MC 30 previously applied to conclude if to further the works ahead wth a neat coat or a diluted one. Planned for culvert installations to begin and the test on aggregate quality was requested.
32 (5th-July Thursday)	**Cold Mix Asphalt Layer Works**	Support Staff	WD	4	During the Cold mix asphalt layer works, all the activities carried out on this date-5th-July, were done{From chainages 0+020 to 0+050}
	Brooming Sub base layer	Casual Labour	WD	2	
	Fixing of Steel Shutters	Casual Labour	WD	3	
	Batching of Asphalt Materials	Casual Labour	WD	3	
	Mixing, Dumping and Spreading	Casual Labour	WD	9	
	Compaction of Asphalt Layer	Aggregate - 0/6	CM	1.1	
		Aggregate - 6/10	CM	0.5	
		A - 4	Ltrs.	6	
		K 3 65%	Ltrs.	234	
		KEROSENE	Ltrs.	7	
		DIESEL-BOMAG D/ROLLER			

33 (6th-July Friday)	**Cold Mix Asphalt Layer Works**	Support Staff	WD	4	Brooming the sub base layer in preparation for the Cold Mix AC application was done{**From Chainage 0+080 to 0+260**}followed by priming using the hand sprayer{**From Chainage 0+080 to 0+170**}. Steel shutters were fixed{**From Chainage 0+020 to 0+050**}. The activity of haulage of aggregate was carried out**{From 0+050 to 0+070**}. The AC layer was finally compacted{**From chainage 0+020 to 0+050,then 0+050 to 0+070**}
	Brooming Sub base layer	Casual Labour	WD	5	
	Priming of Sub base layer	Casual Labour	WD	3	
	Fixing of Steel Shutters	Casual Labour	WD	3	
	Haulage of Aggregate	Casual Labour	WD	4	
	Batching of Asphalt Materials	Casual Labour	WD	3	
	Mixing, Dumping and Spreading	Casual Labour	WD	10	
	Compaction of Asphalt Layer	Aggregate - 0/6	CM	3.3	
		Aggregate - 6/10	CM	1.7	
		A - 4	Ltrs.	16	
		K 3 65%	Ltrs.	714	
		MC 30	Ltrs.		
		Hand Sprayer	Hrs	3	
		DIESEL-BOMAG D/R	Ltrs.	10	
34 (7th-July Saturday)	**Cold Mix Asphalt Layer Works**	Support Staff	WD	2	Brooming the sub base layer in preparation for the Cold Mix AC application was done{**From Chainage 0+170 to 0+300**}followed by priming using the hand sprayer{**From Chainage 0+170 to 0+230**}. A gang of 7 people were used to off load the culverts, sand & cement. a total of 38 Culverts were delivered to the site. 1 piece was supposed to be replaced due to breakage.
	Brooming Sub base layer	Casual Labour	WD	5	
	Priming of Sub base layer	Casual Labour	WD	3	
		Hand Sprayer	Hrs.	3	

35	**Cold Mix Asphalt Layer Works**	Support Staff	WD	6	Brooming the sub base layer in preparation for the Cold Mix AC application was done{**From Chainage 0+230 to 0+410**}followed by priming using the hand sprayer{**From Chainage 0+230 to 0+400**}. Steel shutters were fixed{**From Chainage 0+070 to 0+150**}. The activity of batching of AC materials was carried out**{From 0+070 to 0+150**}&mixing ,dumping and spreading was done{From Chainage 0+070 to 0+150}.The AC layer was finally compacted{**From chainage 0+070 to 0+150**}
(9th-July	Brooming Sub base layer	Casual Labour	WD	6	
Monday)	Priming of Sub base layer	Casual Labour	WD	4	
	Batching of Asphalt Materials	Casual Labour	WD	4	
	Haulage of Aggregate	Casual Labour	WD	4	
	Mixing, Dumping and Spreading	Casual Labour	WD	6	
	Compaction of Asphalt Layer	Casual Labour	WD	1	
		Aggregate - 0/6	CM	7.2	
		Aggregate-6/10(KBN 541S)	CM	3.6	
		A - 4	Ltrs.	33	
		K 3 65%	Ltrs.	762	
		Hand Sprayer	Hrs	6	
		DIESEL-BOMAG D/ROLLER	Hrs	4	
		KEROSENE	Ltrs.	15	
		MC 30	Ltrs.	1200	
		D/CABIN PICK-UP	Hrs	8	
36	**Cold Mix Asphalt Layer Works**	Support Staff	WD	6	Steel shutters were fixed{**From Chainage 0+160 to 0+235**}. The activity of batching of AC materials was carried out**{From 0+160 to 0+235**}&mixing ,dumping and spreading was done{From Chainage 0+160 to 0+235}.The AC layer was finally compacted{**From chainage 0+160 to 0+235**}
(10th-July	Fixing of Steel Shutters	Casual Labour	WD	4	
Tuesday)	Batching of Asphalt Materials	Casual Labour	WD	3	
	Mixing, Dumping and Spreading	Casual Labour	WD	15	
	Cement, ballast & sand	Casual Labour	WD	5	
	Haulage of Aggregate	Casual Labour	WD	4	
	Compaction of Asphalt Layer	Casual Labour	WD	1	
		Aggregate - 0/6	CM	6.5	
		Aggregate-6/10(KBN 541S)	CM	3.3	
		A - 4	Ltrs.	14	
		K 3 65%	Ltrs.	660	
		DIESEL-BOMAG D/ROLLER	Hrs	4	
		KEROSENE	Ltrs.	15	
		D/CABIN PICK-UP	Hrs	8	

37	**Cold Mix Asphalt Layer Works**	Support Staff	WD	6	The Steel shutters were fixed{From Chainage 0+070 to 0+150}.This covered an area of 248 SM.The other activities of batching of AC materials&mixing ,dumping and spreading and final compaction of the AC layer were done{{From Chainage 0+070 to 0+150}and covered same area. The Side access drift was done{From Chainage 0+000 to 0+115}. The total quantity was 6.3 CM.
(11th-July	Fixing of Steel Shutters	Casual Labour	WD	4	
Wednesday)	Haulage of Aggregate	Casual Labour	WD	4	
	Mixing, Dumping and Spreading	Casual Labour	WD	15	
	Compaction of Asphalt Layer	Casual Labour	WD		
	Access Drifts works	Casual Labour	WD	3	
		Aggregate - 0/6	CM	5.9	
		Aggregate-6/10	CM	3.5	
		A - 4	Ltrs.	13	
		K 3 65%	Ltrs.	696	
		DIESEL-BOMAG D/R	Hrs	4	
		D/CABIN PICK-UP	Hrs	8	
38	**Cold Mix Asphalt Layer Works**	Support Staff	WD	5	The activity of batching of AC materials was carried out{From 0+150 to 0+228},this covered a surface area of 218.6SM&mixing ,dumping and spreading was done{From Chainage 0+239 to 0+315}.The AC layer was finally compacted{From chainage 0+239 to 0+315}, on an area 235.6SM. The excavated material for the culverts foundation was 4.5CM in total quantity
(12th-July	Batching of Asphalt Materials	Casual Labour	WD	35	
Thursday)	Haulage of Aggregate	Casual Labour	WD	4	
	Compaction of Asphalt Layer	Casual Labour	WD	1	
	Excavation of Trench/foundation	Casual Labour	WD	3	
		Aggregate - 0/6	CM	3.4	
	Fixing of Steel shutters	Casual Labour	WD	4	
		Aggregate - 6/10	CM	1.5	
		A - 4	Ltrs.	14	
		K 3 65%	Ltrs.	372	
	Excavation of Trench(culvert)	Casual Labour	WD	2	

39 (13th-July Friday)	**Cold Mix Asphalt Layer Works**	Support Staff	WD	5	The activity of batching of AC materials was carried out{From 0+150 to 0+240},this covered a surface area of 160SM&mixing ,dumping and spreading was done{From Chainage 0+150 to 0+240}.The AC layer was finally compacted on the same.The excavated material for the culverts foundation was 6.7CM in total quantity at chainage 0+240
	Fixing of Steel shutters	Casual Labour	WD	4	
	Batching of Asphalt Materials	Casual Labour	WD	30	
	Compaction of Asphalt Layer	Casual Labour	WD	1	
	Excavation of Trench/foundation	Casual Labour	WD	3	
		Aggregate - 0/6	CM	2.1	
		Aggregate - 6/10	CM	1.1	
		A - 4	Ltrs.	8	
		K 3 65%	Ltrs.	456	
		DIESEL-BOMAG D/R	Hrs		
40 (14th-July Saturday)	**Cold Mix Asphalt Layer Works**	Support Staff	WD	4	Brooming and the priming of the sections was done{From chainage 0+000 to 0+020}
	Brooming of sub base layer	Casual Labour	WD	6	
	Priming of the sub base layer	Casual Labour	WD	11	
		MC 30	Ltrs.	160	
		KEROSENE	Ltrs.	10	
		Hand Sprayer	Hrs		
41 (16th-July Monday)	**Cold Mix Asphalt Layer Works**	Support Staff	WD	5	The activity of batching of AC materials was carried out{From 0+213 to 0+400},this covered a surface area of 400SM. Same applies to the activities of mixing, dumping and spreading followed by the final compaction of the A/C layer. Removal of existing structures on Chainages 0+280 to 0+400 quantified to 9.0 CM.
	Fixing of Steel Shutters	Casual Labour	WD	4	
	Mixing, Dumping and Spreading	Casual Labour	WD	32	
	Haulage of Aggregate	Casual Labour	WD	3	
	Removal of existing structure	Casual Labour	WD	3	
		Aggregate - 0/6	CM	4.9	
		Aggregate - 6/10	CM	2.5	
		A - 4	Ltrs.	28	
		K 3 65%	Ltrs.	1144	
		DIESEL-BOMAG D/R	Hrs		

42 (17th-July Tuesday)	**Cold Mix Asphalt Layer Works** Batching of Asphalt Materials Mixing, Dumping and Spreading Fixing of Steel shutters	Support Staff Casual Labour Casual Labour Casual Labour Aggregate - 0/6 Aggregate - 6/10 A - 4 K 3 65% Cement, Ballast & sa DIESEL-BOMAG D/RO	WD WD WD WD CM CM Ltrs. Ltrs. Bags Hrs	5 3 34 4 3.9 1.7 16 840 10	The activity of batching of AC materials was carried out{From 0+305 to 0+400},this covered a surface area of 295SM. Same applies to the activities of mixing, dumping and spreading followed by the final compaction of the A/C layer. The Concrete Mixer and the poker used for the culverts was accounted for in the miscellous budget. 500 pieces of stones were delivered to the site
43 (18th-July Wednesday)	**Cold Mix Asphalt Layer Works** Priming of the sub base layer Correcting irregulaties of sub-base Fixing of Steel shutters Batching of Asphalt Materials Mixing, Dumping and Spreading Compaction of Asphalt Layer Access side drift Erection of formwork for culverts	Support Staff }Casual Labour Casual Labour Casual Labour Casual Labour Aggregate - 0/6 Aggregate - 6/10 K 3 65% Cement, Ballast & sa A-4	WD }WD WD WD WD CM CM Ltrs. Bags Ltrs.	5 }45 5 6 2.4 2 1436 11.5 11	The priming of the sub base layer&correction of the irregularities of the sub base layer was done From chainage 0+000 to 0+020. Same applied to the activities of fixing the steel shutters,haulage of aggregate & batching of the A/C materials. The surface area covered was 345SM. Mixing, dumping & spreading was done{From chainage 0+000 to 0+020}, an area of 173.9 SM was covered. The access drift for the culverts was done from chainage 0+000 to 0+220, the quantified material was 16CM. The formworks were erected on chainages 0+135 to 0+340

44	**Cold Mix Asphalt Layer Works**	Support Staff	WD	5	The activity of batching of AC materials was carried out{From 0+000 to 0+020},this covered a surface area of 170.9SM. Same applies to the activities of mixing, dumping and spreading followed by the final compaction of the A/C layer. The erection of culverts for the culverts was carried out from chainage 0+135 to 0+280, same was done to the curing of concrete works&installation of pipe culverts
(19th-July	Batching of Asphalt Materials	Casual Labour	WD		
Thursday)	Mixing, Dumping and Spreading	Casual Labour	WD	45	
	Compaction of Asphalt Layer	Casual Labour	WD		
	Erection of formwork for culverts	Casual Labour	WD	3	
	Curing of the culverts works	Casual Labour	WD		
	Insatallation of 600mm Culvert pipes	Pipes	No.	8	
		Aggregate - 0/6	CM	3.6	
		Aggregate - 6/10	CM	1.5	
		K 3 65%	Ltrs.	762	
		DIESEL-BOMAG	Hrs		
45	**Culverts and Structure works**	Support Staff	WD	5	
(20th-July	Excavation of foundations	Casual Labour	WD	4	
Friday)	Erection of formwork for culverts	Casual Labour	WD	6	The excavation of the trench/foundation was done from chainage 0+343 to 0+390. Formwork for the culvert works was done on chainage 0+280. The process of batching, mixing,pacing&compaction on the culverts was carried out From chainage 0+220 to 0+280, concrete class 20 was used. The side access drift was done at chainage 0+070
	Batching,mixing,placing&compacting	Casual Labour	WD	8	
	Access side drift	Casual Labour	WD	4	
	Concrete class 20	Casual Labour	WD	1	
	Insatallation of 600mm Culvert pipes	Pipes	No.	12	
46	**Cold Mix Asphalt Layer Works**	Support Staff	WD	5	The activities of brooming,priming&correction of irregularities of the sub base layer was carried out on chainage 0+400 to 0+410. The Formwork for the culvert works was done on chainage 0+115 & 0+240. The process of batching mixing,pacing&compaction on the culverts was carried out From chainage 0+195 to 0+240. The motor filling on the access drift was done on chainage 0+070
(21st-July	Brooming of sub base layer	Casual Labour	WD	2	
Saturday)	Priming of the sub base layer	Casual Labour	WD	11	
	Correcting irregulaties of sub-base	Casual Labour	WD	11	
	Erection of formwork for culverts	Casual Labour	WD	6	
	Batching,mixing,placing&compacting	Casual Labour	WD	}26	
	Aggregate - 0/6	CM		3.6	
	Aggregate - 6/10	CM		1.5	
	K 3 65%	Ltrs.		762	
	Concrete class 15	Casual Labour	WD		
	Access drift&motor filling	Casual Labour	WD		
	Parking stones for access drift	Casual Labour	WD		

47	**Culverts and Structure works**	Support Staff	WD	5	
(23rd-July	Casting concrete bed	Casual Labour	WD	20	The concrete bed was cast a total quantity of 0.83 CM, on chainage
Monday)	concrete surround	Casual Labour	WD	1	0+390 to 0+343. The concrete surround was on chainage 0+130 &
	Selected backfill to structure	Casual Labour	WD	6	selected backfill to the culvert structure was on chainage 0+345.
	Access side drift	Casual Labour	WD	5	The access drift was on chainage 0+380
48	**Culverts and Structure works**	Support Staff	WD	5	The Formwork for the culvert works was erected from chainage
(24th-July	Erection of formwork for culverts	Casual Labour	WD	6	0+220 to 0+280. The process of batching
Tuesday)	Batching,mixing,placing&compacting	Casual Labour	WD	14	mixing,pacing&compaction on the culverts was carried out on
	Selected backfill to structure	Casual Labour	WD	4	chainage 0+195. The access side drift done was at chainage 0+380.
	Access side drift	Casual Labour	WD	4	The selected backfill to structure was on chainage 0+135
	Curing of the culverts works	Casual Labour	WD	1	
		Cement, Ballast & sa	Bags	20	
49	**Cold Mix Asphalt Layer Works**	Support Staff	WD	5	For the cold mix asphalt layer works, mixing, dumping and
(25th-July	Batching of Asphalt Materials	Casual Labour	WD	}32	spreading were done from chainage 0+400 to 0+410. This covered
Wednesday	Mixing, Dumping and Spreading	Casual Labour	WD		an area of 62 SM. The erection of the formwork on the LHS was
	Compaction of Asphalt Layer	Casual Labour	WD		done on chainage 0+240, while the selected backfill for the
		Aggregate - 0/6	CM	1.12	structure was on RHS at chainage 0+195. Stones were parked on
		Aggregate - 6/10	CM	0.48	the access side drift at chainage 0+380
		K 3 65%	Ltrs.	240	
		DIESEL-BOMAG D/RC	Hrs		
	Culverts and Structure works	Support Staff	WD	5	
	Erection of formwork for culverts	Casual Labour	WD	6	
	concrete surround	Casual Labour	WD	13	
		Cement, Ballast & sa	Bags	23	

50	**Culverts and Structure works**	Support Staff	WD	5	The erection of the formwork was done from chainage 0+195 to 0+345m, the concrete surround was done at the same chainage. The total quantity used was 2.15 CM. The access side drift worked on was at chiange 0+380
(26th-July	Erection of formwork for culverts	Casual Labour	WD	6	
Thursday)	Concrete surround	Casual Labour	WD	23	
	Access side drift	Casual Labour	WD		
		Cement, Ballast & sand	Bags	23	
51	**Culverts and Structure works**	Support Staff	WD	5	The erection of the formwork was done from chainage 0+370 to 0+390m, the concrete surround was done at the same chainage. The total quantity used was 9.0 CM. The access side drift worked on was at chiange 0+380
(27th-July	Erection of formwork for culverts	Casual Labour	WD	6	
Friday)	Concrete surround	Casual Labour	WD	23	
	Access side drift	Casual Labour	WD	2	
	Curing of the culverts works	Casual Labour	WD	1	
	Selected backfill to structure	Casual Labour	WD	2	
		Cement, Ballast & sand	Bags	17	
52	**Culverts and Structure works**	Support Staff	WD	5	The construction of the head, wing walls and aprons for the culvert works was done from chainage 0+020 to 0+390
(28th-July	Curing of the culverts works	Casual Labour	WD	2	
Saturday)	Construction of Head&wing walls	Casual Labour	WD	16	
	Access side drift	Casual Labour	WD	4	
		Cement, Ballast & sand	Bags	10	
53	**Culverts and Structure works**	Support Staff	WD	5	
(30th-July	Curing of the culverts works	Casual Labour	WD	1	The curing of the concrete works was done from chainage 0+000 to 0+280. The activities of construction of the head&wing walls, selected back fill to the structure & the works on the side access drift was done from chainage 0+280 to 0+400. The mitre drain from chainage 0+400 to 0+450 was also cleared of loss materials
Monday)	Construction of Head&wing walls	Casual Labour	WD	28	
	Access side drift	Casual Labour	WD	4	
	Mitre drain	Casual Labour	WD	5	
	Selected backfill to structure	Casual Labour	WD	2	
54	**Culverts and Structure works**	Support Staff	WD	5	The trench at the chainage 0+000 was excavated and cleared of looose materials. The whole road section structures from chainage 0+000 to 0+400 were backfilled
(31st-July	Excavation of trench	Casual Labour	WD	5	
Tuesday)	Site Clearance	Casual Labour	WD	20	
	Selected backfill to structure	Casual Labour	WD	6	

ANNEX E

Minutes of progress meetings

Minutes of Pre-commencement Committee Meeting held at the Regional Manager's Office at Kiambu on 21st May 2012

Attendance

Name	Designation	Organization	Email Address	Mobile No.
Eng. J. K. Murage	Regional Manager	KeRRA Kiambu	muragejk@yahoo.com	0722801088
Asfaw Kidanu		ILO/KeRRA	kidanu@ilo.org	0717354065
Hillary O. Akwiri	Engineer	KeRRA Planning & R2000	hillary.akwiri@yahoo.com	
Charles K. Muema	Engineer	Norken (I) Ltd	muema_charles@yahoo.com	0722759299
Peter Otieno Odero	Engineer	Norken (I) Ltd	epeter18order@yahoo.com	
Tom Odhiambo		MoR Materials Dept.	tomrae61@yahoo.com	0722314893
Esther Amimo	Engineer	MoR Materials Dept.	emmyamimo@gmail.com	0720360624
Kiboi Kirugah	District Mech. Off.	MTF Kiambu	kkirugah@yahoo.com	0722788601
Etale Tunya	Roads Engineer	DSC-Max & Partners	rtunya@yahoo.com	0722884820
Chomba A.K. Gateri	Training Technician	MSC R2000 Phase 2	chombagateri@ymail.com	0722833173
Joseph Rugenyi	CRO Gatundu South	KeRRA Kiambu	jrungeny@gmail.com	0715528110
Isaac Ngure	Regional Accountant	KeRRA Kiambu	isaac.ngure7@gmail.com	0723559969
Catherine Kangangi	Procurement Officer	KeRRA Kiambu	waithirakate@yahoo.com	0725736971

No	Item	Action
1	**Introduction and Apologies** The meeting started under the chairmanship of the Regional Manager. Catherine Kangangi offered opening prayers. The chairman requested self-introduction.	

2 **2.1**	**Opening Remarks by Regional Manager** The RM informed that attendees that the purpose of the meeting is to start up the African Community Access Program (AFCAP) project that is a trial road works project to be located on D379 road in Gatundu South. He explained that AFCAP is funded by the British government through the Department for International Development (DFID). He said that the purpose of the trial is to come up with the design standards and specifications for the Low Volume Seal Roads in Kenya. He hoped with the success of this project, more donors will come forward and fund more rural road projects.	
2.2	**Remarks from KeRRA HQs** Mr. Asfaw Kidanu said that there is a need for all the parties involved that is, KeRRA, Norken (I) Ltd and AFCAP to clarify their roles to avoid conflicts during implementation. He also inquired if the RM has sufficient technical personnel to manage the project	
2.3	**Remarks from Norken (I) Ltd** Mr. Charles Muema clarified that their role will be that of supervision of the works with assistance from RM staff. They will produce the program of the works and give a list of the tools and equipment required. Mr. Peter Odero added that they will be filling all the reporting forms and give a final report at the end of the project	
2.4	**Remarks from Materials Department** Ms. Esther Amimo want it clarified if the test road will use the existing road surface as the subgrade. She also inquired if the gravel source is near the trial road site. She said that they have a set of DCP equipment, but a second one will be required when all the trial roads are rolled out.	
2.5	**Remarks from Mechanical Transport Fund (MTF)** Mr. Kiboi confirmed that the following equipment are available: motor grader, steel roller, pedestrian roller and hand sprayer. He was to confirm the availability of the water bowser. He said all these equipment are available for hire at a minimum rate of 4hrs after which the hire rate is calculated hourly. These are dry rates and the hirer is supposed to pay for fuel, operators and other incidental consumables.	
2.6	**Remarks from DSC** Tunya said that the DSC is ready to support the RM in the supervision of the project. He sought clarification if only the DCP equipment will be used for compaction tests. He requested for the availing of the reporting forms and supervision structure before the start of the project.	
3	**Publicity of the Project** Members agreed that publicity of the project through a board and a public baraza was important.	Steering Committee
4	**Steering Committee** The RM appointed a Steering Committee that will be tasked with reporting and monitoring on the progress of the project. The members of the committee will be:	

	i. Etale Tunya-Chairman ii. Joseph Rungenyi iii. Hillary Akwiri iv. Charles Mwema v. Peter Odero vi. Tom Odhiambo vii. Esther Amimo viii. Chomba Gateri The first task of the committee was to: 1. Review the program of works; 2. Review the budgets from RM and Norken with a view of harmonising them; 3. Set the tentative date of starting the project including all the initial requirements.	
5	**AOB** The RM reiterated the importance of ensuring that this project succeeds as it will help spur more donor funds into financing of our rural road network. He appealed to the steering committee to sit immediately so as to jump start the project without further delay. There being no further business, the meeting was closed with a word of prayer at 12 mid-day.	

Minutes of 1st Steering Committee Meeting held at the Regional Manager's Office at Kiambu on 21st May 2012

Attendance

Name	Designation	Organization	Email Address	Mobile No.
Etale Tunya	Roads Engineer	DSC-Max & Partners	rtunya@yahoo.com	0722884820
Hillary O. Akwiri	Engineer	KeRRA Planning & R2000	hillary.akwiri@yahoo.com	
Charles K. Muema	Engineer	Norken (I) Ltd	muema_charles@yahoo.com	0722759299
Peter Otieno Odero	Engineer	Norken (I) Ltd	epeter18order@yahoo.com	
Tom Odhiambo		MoR Materials Dept.	tomrae61@yahoo.com	0722314893
Esther Amimo	Engineer	MoR Materials Dept.	emmyamimo@gmail.com	0720360624
Chomba A.K. Gateri	Training Technician	MSC R2000 Phase 2	chombagateri@ymail.com	0722833173
Joseph Rugenyi	CRO Gatundu South	KeRRA Kiambu	jrungeny@gmail.com	0715528110

No	Item	Action
1	**Agenda** The meeting started at 12.15 pm under the chairmanship of the Etale Tunya. He read out the agenda of the meeting as: i. Review of the program for the works; ii. Harmonisation and review of the budget; iii. Set a date for the start of the works; iv. Other pertinent actions to aid the execution of the works; v. AOB; vi. Date for next Steering Committee Meeting.	All
2 **2.1**	**Program for the works** Mr. Peter Odero took the members through the program as initially planned as follows: i. Activity 1: Erection of beacons had already been done; ii. Activity 2: Setting out had already been done but to be re-checked; iii. Activity 3: Stripping & grubbing which was to take 5 days to be shortened to 2 days since equipment will be used. However, stump removal activity which had been left out will be incorporated here, and since it will take 4 days, the 5 days initially planned for Activity 3 will remain the same; iv. Activity 4:To widen the road by 2m, benching will be done in layers with the 1st layer of 150mm compacted using burrow material from the side drains and the 2nd layer of 150mm compacted using imported lateritic gravel. The time period of 10 days for this activity remains the same; v. Activity 6: Rip, shape and compaction of whole carriageway- Additional lateritic gravel will be imported to achieve a 150mm compacted base. The time period of 7 days for this activity remains the same; vi. Activity 7: Material Testing will be continuous with three anticipated levels- at the subgrade, 1st fill and 2nd fill. Both the DCP and sand replacement methods will be used for compaction tests. vii. Activity 8: Priming-Material Department to be involved in the purchase of MC-30 to ensure that a minimum viscosity of 30 is achieved. The time period of 7 days will remain the same. viii. Activity 9: Access culvert installation time period of 7 days will remain the same. ix. Activity 10: Reinstatement of side drains/outlets/mitre drains: The time period of 11 days will remain the same. This will be done by labour method. x. Activity 11: Installation of scour checks will be substituted with Access Drifts as they are not required. The time period of 7 days will remain the same. xi. Activity 12: Mix and place Cold Mix Asphalt. The time period of 12 days to remain the same.	
2.2	The members concurred that the program will remain 8 weeks but through joint efforts by all, this period could be shortened to 6 weeks. Mr. Charles Muema said that the challenge to this will be the timely supply of material by the RM's Office.	All
3	**Harmonisation and Review of the Budget**	

3.1	Mr. Hillary Akwiri presented budget estimates from the RM Kiambu which had been approved by KeRRA Headquarters. The total budget amount was Kshs.5,216,060.	
3.2	Mr. Peter Odero presented budget estimates by Norken (I) Ltd that amounted to Kshs. 3,145,000.	
3.3	After deliberations by members, it was agreed that the budget from the RM of Kshs. 5,216,060 be adopted as it was more representative and captured all the items required in the project.	All
4	**<u>Setting the date of start for the works</u>**	
4.1	Members were in agreement that the works start immediately on Wednesday 23rd with the following preliminary activities:	Rugenyi
4.2	Sensitization baraza and recruitment of labour-this was to be arranged in consultation with the local administration for Wednesday 23rd May.	Rugenyi/ Muema/
4.3	Stump removal to be done on Thursday 24th May. Hand tools to be arranged with the RM's Office.	Odero/ Rugenyi
4.4	Grubbing and stripping to start on Monday 28th May. The grader to be availed at Gatundu on Sunday 27th May.	Rugenyi
	Roller and water bowser to be availed on site on Monday 28th May.	
5	**<u>Other pertinent Activities</u>**	
5.1	Tools and Equipment: Members agreed that purchase and fabrication of tools & equipment to start immediately to avoid delays when the works start.	Rugenyi/ Gateri
5.2	Hand sprayer: this substituted the distributor on recommendation of Mr. Chomba Gateri. Mr. Tom Odhiambo inquired if the hand sprayer had a temperature regulator given that large quantities of kerosene will be used. Gateri was to check this. Members agreed if temperature regulation will offer challenges then we shall revert back to the distributor.	Gateri/ Odhiambo Tunya/
5.3	Quality testing: The materials department suggested the recruitment of a laboratory technologist for a period of 2 months to carry out the field tests. He/she will be paid from the allowances set aside for Quality Control. This was not conclusive and the members agreed that a final decision be arrived at after consulting the RM.	Odhiambo/ Esther
6	**<u>AOB</u>**	
6.1	Norken were to avail the reporting forms to members before the start of the project. These were to be emailed to all.	Odero
6.2	Tunya requested Norken the availing of the design report. Odero averred that KeRRA HQs had the final design and should distribute it to all.	Akwiri
6.3	The quantities of K-365 emulsion were found to be understated in the budget. Mr. Gateri informed members that from experience at the LVSR D415 Mackenzie-Muruka in Muranga, 6 litres of emulsion covered 2 sq.m of pavement surface. And since in this case we had 2400 sq. m (400m x 6m) of pavement surface, it follows that we shall require 7,200 litres (6/2 x 2400) of K-365 emulsion and not the 2,200 litres stated.	All
6.4	It was generally agreed that the actual quantities of K-365 emulsion will be realized during the actual works and since the budget had adequate provisions, the matter was	Esther

	rested at this point. Esther informed members that she will email the specifications for the cold mix asphalt before purchases are done.	
7	**Date for the next Steering Committee Meeting** The members agreed on Monday 4th June 2012 as the date for the next meeting There being no further business, the meeting was closed at 3.30pm.	All

Minutes of 2nd Steering Committee Meeting held at the Site on D379 Road in Kiambu on 8th June 2012

Attendance

Name	Designation	Organization	Email Address	Mobile No.
Eng. J.K. Murage	Regional Manager	KeRRA Kiambu	muragejk@yahoo.com	0722801088
Etale Tunya	Roads Engineer	DSC-Max & Partners	rtunya@yahoo.com	0722884820
Hillary O. Akwiri	Engineer	KeRRA HQ Planning & R2000	hillary.akwiri@yahoo.com	0721880336
Benjamin M. Maara	Engineer	KeRRA HQ Planning & R2000	maarason2000@yahoo.com	0722975272
Charles K. Muema	Engineer	Norken (I) Ltd	muema_charles@yahoo.com	0722759299
Peter Otieno Odero	Engineer	Norken (I) Ltd	epeter78order@yahoo.com	0722310778
Esther Amimo	Engineer	MoR Materials Dept.	emmyamimo@gmail.com	0720360624
Chomba A.K. Gateri	Training Technician	MSC R2000 Phase 2	chombagateri@ymail.com	0722833173
Joseph Rugenyi	CRO Gatundu South	KeRRA Kiambu	jrugeny@gmail.com	0715528110

No	Item	Action
1	**Introduction and Agenda** The meeting started at 9.00am under the chairmanship of the Regional Manager. He said the agenda of the meeting was: i. Introduction; ii. Opening Remarks; iii. Last Meeting Minutes; • Confirmation • Matters arising iv. Progress Report from Norken	All

	v. Reaction from Members vi. AOB He requested for self-introduction for those present.	
2	**<u>Opening Remarks</u>** The RM thanked members for attending the meeting. He was happy with the progress achieved so far but expressed his apprehension on the cost overruns by equipment. He said the equipment should be used efficiently to manage the costs.	
3 **3.1** **3.2**	**<u>Last Meeting Minutes</u>** **Confirmation:** i. On item 3.1 Mr. Charles Muema requested that the amount Kshs. 3,145,000 be substituted by Kshs. 4,997,050 as this was Norken's correct estimate for the project. ii. The members confirmed as true the rest of the minutes. **Matters Arising:** i. On item 2.2, on the issue of supply of materials the RM reported that this should not be a problem since the money for the project has already been released by KeRRA HQs and materials will be supplied on time; ii. On item 4: Setting the dated of the start of the works. All set dates were achieved as planned; iii. On item 5.2: Hand Sprayer. It was agreed that improvising/adjusting the hand sprayer provided by the MTF to start immediately. Mr. Owra of Norken through Mr Muema, was to provide guidance on the type of thermometer to be purchased for temperature regulation; iv. On Item 5.3: Quality Testing. The RM confirmed to have attached one of his staff to the project who will carry out all material tests in conjunction with the Materials Department.	Rugenyi/ Gateri
4	**<u>Progress achieved</u>** Mr. Peter Odero took the members through the progress achieved so far and what was expected after this: i. He said the activities were well beyond schedule with stripping and grubbing completed and benching of the first layer complete and compaction tests done. Imported gravel has already been dumped for use in activity no. 6 below. ii. Activity no. 6 will involve scarifying the top 100mm of the existing wearing coarse, mixing with imported gravel and spreading over the whole carriageway and then compacting to form a uniform layer of 150mm and a slope of 3.5%; iii. After (ii) above the other activities will follow as scheduled earlier i.e material testing, priming, access culvert installation, reinstatement of side drains/outlets/mitre drains, access drifts and mixing & placing cold mix asphalt	
5	**<u>Reaction from Members</u>**	

5.1	**Material Supply:** i. Imported lateritic gravel had already been supplied and only a few more trucks may be required; ii. The RM had already ordered for 8000 litres of K3-65, 3000 litres of MC-30 and 400 litres of A4-60 which will be delivered from Tuesday, 12th June; iii. Material supplier to supply 0/6 and 6/10 chippings immediately	RM/ Rugenyi RM/ Rugenyi Rugenyi Esther
5.2	**Material Testing:** i. Materials dept reported that they have results for in-situ CBR from the DCP data and were waiting results for CBR at 4-Dsoak and CBR at OMC so that they can calibrate the DCP equipment; ii. Materials Dept. are to perform aggregate grading and quality tests on chippings 0/6, 6/10 and also 10/14 & 14/20. Samples to be availed to them; iii. It was requested that Materials Dept to give tests results for CBR at 0.75OMC in addition to 4-Dsoak and OMC; **iv.** It was also requested that material results should include explanations and comments.	Rugenyi/ Gateri Esther Esther Rugenyi
5.3	**Traffic Control:** It was agreed that the road be closed before priming to avoid interference from traffic. The local DC and OCS are to be informed and appropriate traffic control signs fabricated.	
6	**<u>AOB</u>**	
6.1	Mr. Akwiri informed the meeting that he was leaving the project and introduced Mr. Benjamin Maina Maara who will replace him;	
6.2	Mr. Odera said that progress is good, equipment and fuel have been availed on time and emphasized the need to do material tests and include explanation & comments;	
6.3	Mr. Gateri observed that the grader was missing the back rippers and it will present a problem during scarifying the existing wearing course. The RM indicated that a combination of the middle rippers and the blade will suffice.	
6.4	Mr. Maara observed that an exposed excavation where headwalls were demolished posed a danger to motorists and a barrier should be erected.	
6.5	Mr. Mwema emphasized the need for proper documentation of expenses as the final costs will be required. He said a surveyor was required to establish the final pavement levels.	Rugenyi
6.7	The RM enquired if there was a file for daily reporting. Mr. Odero replied in the affirmative. The RM was impressed by the seriousness of all the members in executing the works. He said the success of the project will be important and help in developing unit cost for LVSRs.	
7	**<u>Date for the next Steering Committee Meeting</u>** The members agreed on Monday 18th June 2012 as the date for the next meeting There being no further business, the meeting was closed at 9.50am.	All

Minutes of 3rd Steering Committee Meeting held at the Site on D379 Road in Kiambu on 26th June 2012

Research Project for Establishment of Appropriate Design Standards for Low Volume Seal Roads in Kenya-AFCAP/KEN/89
Minutes of 3rd Steering Committee Meeting held at the Site on D379 Road in Kiambu on 26th June 2012

Attendance

Name	Designation	Organization	Email Address	Mobile No.
Eng. J.K. Murage	Regional Manager	KeRRA Kiambu	muragejk@yahoo.com	0722801088
Etale Tunya	Roads Engineer	DSC-Max & Partners	rtunya@yahoo.com	0722884820
Hillary O. Akwiri	Engineer	KeRRA HQ Planning & R2000	hillary.akwiri@yahoo.com	0721880336
Charles K. Muema	Engineer	Norken (I) Ltd	muema_charles@yahoo.com	0722759299
Peter Otieno Odero	Engineer	Norken (I) Ltd	epeter78order@yahoo.com	0722310778
Chomba A.K. Gateri	Training Technician	MSC R2000 Phase 2	chombagateri@ymail.com	0722833173
Joseph Rugenyi	CRO Gatundu South	KeRRA Kiambu	jrugeny@gmail.com	0715528110

Absent with Apologies

Esther Amimo	Engineer	MoR Materials Dept.	emmyamimo@gmail.com	0720360624

No	Item	Action
1	**Agenda** The meeting started at 9.15am under the chairmanship of the Regional Manager. He said the agenda of the meeting was: i. Opening Remarks; ii. Last Meeting Minutes; • Confirmation • Matters arising iii. Progress Report from Norken iv. Reaction from Members v. AOB	All
2	**Opening Remarks** The RM thanked members for attending the meeting. He was impressed with the commitment and team work that all members had displayed so far.	
3 3.1	**Last Meeting Minutes** **Confirmation:** i. The members confirmed as true the minutes for the 2nd Steering Committee Meeting held on 8th June 2012.	

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3.2	**Matters Arising:** i. On item 3.2 (iii) the thermometer had already being purchased. The hand sprayer was ready except lack of a nozzle, repair of wheels and purchase of 2 other solid wheels. Members agreed that the nozzle can be borrowed from the Miruka project in Muranga and the wheels to be repaired and purchased immediately. Testing was to proceed the following day. ii. On Item 5.2: Material Testing. The whole item was still outstanding. The Material Department to give an update in the next meeting. iii. Item 5.3 Traffic Control: Rugenyi reported that locals had no problem with the closure of the road; iv. On item 6.5 on documentation, the RM informed members that the KeRRA Kiambu Accounts Department, Procurement Department and the Gatundu CROs Office will give a full account of the materials used and money spent.	Rugenyi/ Gateri Materials Department
4	**Progress achieved** Mr. Peter Odero took the members through the progress achieved so far as follows: i. Activity no. 6 i.e. rip, shape & compact completed and the base formed. Compaction tests done; ii. Activity no. 8 i.e. Priming will start after one week to allow for natural drying. Regulation and brooming to be done on 27th and 28th June (i.e. Thursday and Friday); iii. Activity no. 12 i.e. Mix and Place Cold Mix Asphalt to proceed immediately after Priming; iv. Activity no. 9 (reinstate side drains, outlets and mitre drains) and activity no. 10 (access culverts installation) to proceed simultaneously with activity no. 8 and 12 above. He said the works are on schedule.	
5	**Reaction from Members**	
5.1	**Material Supply:** i. A list of material for Culvert Installation, Drifts and AC was tabled by Mr. Rugenyi; ii. The RM asked that all requisitions for materials to be presented to Mr. Rugenyi by close of business on that day, 26th June so that procurement can be done by Friday as he will be out of the country from 1st July;	RM/ Rugenyi RM/ Rugenyi
5.2	**Material Testing:** The RM enquired about the calibration of the DCP. Mr. Tunya asked to follow up with the Materials Department;	Esther
5.3	**Mix Design:** Mr. Gateri requested that the Materials Department to provide the mix design for MC-30 before priming commences.	Esther

2

5.4	**Interim Report:** Mr. Muema informed members that AFCAP had requested an interim report up to and including 22nd June 2012. It was agreed that members will provide Mr. Odero with information including the design, minutes, test results and costs to enable him compile this report.	All
6	AOB	
6.1	Mr. Mwema reiterated the need for the Materials Department to provide the test results for the aggregates early before the works advanced.	Materials Department
6.2	Mr. Odero emphasized the need for Materials Department to give complete materials reports for all the tests done.	Materials Department
6.3	Mr. Gateri enquired if the payments for the casual labourers will be on time. The RM reassured him on this.	
6.4	Mr. Rugenyi reminded members that a courtesy call to the District Commissioner was still outstanding and should be honoured before completion of the project.	
7	**Date for the next Steering Committee Meeting** The members agreed on Thursday, July 12 2012 as the date for the next meeting There being no further business, the meeting was closed at 9.45am.	All

Chairman: Eng. J.K. Murage

Signature:..... 12th July 2012

Proposed: CHOMBA GATERI

Signature:.....

Seconded: PETER D. ODERO

Signature:.....

3

ANNEX F

Terms of Reference

Design

The pavement design is carried out by the AFCAP Consultant in conjunction with the Materials Testing and Research Department.

DCP tests have been carried out on all sections and samples taken of the alignment soils to determine the properties of the subgrade and existing gravel wearing course under various compaction efforts and moisture contents.

Design specifications are given in the attached Design Report.

The design aims to make optimal use of the strength of the consolidated pavement and sub grade under the existing carriageway. As a general rule therefore, the existing pavement should be disturbed as little as possible during construction. The upper existing pavement layer shall only be reshaped to achieve correct camber and compacted to refusal using a heavy vibrating roller.

The same procedure shall be followed in case a new pavement layer is to be placed on top of the old gravel wearing course.

Alignment and Cross section

The sections shall be constructed on the existing alignment. No alterations of either horizontal or vertical alignment are foreseen.

Cross Sections are given in the Design Report. The side slopes will vary according to the available width of the road reserve, but should preferably not be steeper than 1:2.

Drainage

For a low cost design, it is imperative that the drainage system be functional to keep the pavement and subgrade as dry as possible throughout the year.

All the research sections have a functional drainage system and in general only minor works are needed to clean and restore the drains and existing culverts to their original state. Where the roads are widened, one or both side drains may have to be moved away from the Centre line by excavating into the back slope. On steeper sections one or both side drains may have to be lined. Some access culverts may also have to be installed.

Details of the drainage works are given in the Design Report.

Scope of Services

The Consultant shall carry out the following services for the Research Sections in Nyandarua (D382), Murang'a (E511) and Kiambu (D379):

Set out the works

Supervise the construction of the research sections in collaboration with the respective Regional Managers, the Materials Testing & Research Laboratory and the AFCAP Consultant.

Install concrete beacons at suitable intervals for future performance monitoring of the research sections.

At the beginning of this assignment, and in coordination with the KeRRA Regional Managers, the consultant must prepare a Works Programme for each site and submit it to the AFCAP Consultant for verification and approval. Estimated maximum duration of construction of each section is six weeks. Where feasible, implementation of the projects will be planned to run concurrently.

Consultant's staff

For the services outlined above the consultant shall post experienced Supervisor(s) on each site for the duration of the construction period. In addition, the Supervisor(s) shall be supported by a Senior Engineer from time to time to ensure that the works are carried out in accordance with the specifications.

Control Testing

It is envisaged that all control testing will be carried out by the Materials Testing and Research Department. The Consultant may however be requested to carry out Field Density Testing. The consultant shall therefore specify the cost of density testing at each work site.

Construction method

The works will be carried out using force account units under the direction of the respective Regional Managers.

The reshaping of the existing pavement will be done by motor grader and heavy compaction equipment.

Any additional pavement layers will be constructed by labour based methods similar to the methods used on the Demonstration Road D415 in Murang'a Region. Likewise all drainage works shall be done by labour.

The bituminous seal will be Cold Mix Asphalt constructed by labour.