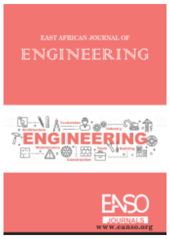

East African Journal of Engineering
eaje.eanso.org
Volume 6, Issue 1, 2023
Print ISSN: 2707-5389 | Online ISSN: 2707-5397
Title DOI: https://doi.org/10.37284/2707-5397

EANSO
EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Surface Condition Survey of The Thika-Magumu Road Pavement

Robert Yvonne [1], Dr. Simpson Nyambane Osano, PhD[1] & Prof. Sixtus Kinyua Mwea, PhD[1]*

[1] University of Nairobi, P. O. Box 30197-00200 Nairobi, Kenya.
* Author for Correspondence https://orcid.org/0000-0001-6366-2544; Email: yvonnerobert@students.uonbi.ac.ke

Article DOI: https://doi.org/10.37284/eaje.6.1.1101

Publication Date:

22 February 2023

Keywords:

Pavement Defects, Visual Inspection, Surface Regularity Tests, PSR (Present Serviceability Rating), Traffic Analysis, FWD (Falling Weight Deflectometer), Pavement Distress and Road Maintenance

ABSTRACT

In developing countries, large sums of money are spent annually to enhance and maintain road networks as allocated by road authorities. The need of road users in most countries all over the world is to have safe, economic, and smooth roads despite pressure on road authorities to further reduce expenditure. Money allocation for road infrastructure is among the many priorities competing for government funds, thus causing the pressure. The objective of this thesis was to evaluate the performance of the Thika-Magumu road, identify the defects on the pavement, and finally find the best remedy for the defects established. This was done by visual inspection, in which the road was inspected and photographs taken. Surface regularity tests were carried out to determine the extent of ruts on the road. Roughness measurement was carried out to determine the roughness of the road, PSR to verify the rating of the road, the deflection of the road was measured using the FWD and traffic analysis was done to determine the axle loading on the Thika-Magumu road and the effect on the pavement. There were different types of pavement distress that enhanced the cost of maintenance of this road, such as a pothole and a crack. The usefulness of the research findings was that it gave a guide on the process to prolong the life span of the pavement hence reducing the need to replace the pavement and also the finding were used to assist the government and road authorities in budgeting for road maintenance.

APA CITATION

Yvonne, R., Osano, S. N., & Mwea, S. K. (2023). Surface Condition Survey of The Thika-Magumu Road Pavement *East African Journal of Engineering*, *6*(1), 36-47. https://doi.org/10.37284/eaje.6.1.1101

CHICAGO CITATION

Yvonne, Robert, Simpson Nyambane Osano and Sixtus Kinyua Mwea. 2023. "Surface Condition Survey of The Thika-Magumu Road Pavement". *East African Journal of Engineering* 6 (1), 36-47. https://doi.org/10.37284/eaje.6.1.1101.

HARVARD CITATION

Yvonne, R., Osano, S. N., & Mwea, S. K. (2023) "Surface Condition Survey of The Thika-Magumu Road Pavement", *East African Journal of Engineering*, 6(1), pp. 36-47. doi: 10.37284/eaje.6.1.1101.

Article DOI: https://doi.org/10.37284/eaje.6.1.1101

IEEE CITATION

R., Yvonne., S. N., Osano., & S. K., Mwea, "Surface Condition Survey of The Thika-Magumu Road Pavement" *EAJE*, vol. 6, no. 1, pp. 36-47, Feb. 2023.

MLA CITATION

Yvonne, Robert, Simpson Nyambane Osano & Sixtus Kinyua Mwea. "Surface Condition Survey of The Thika-Magumu Road Pavement." *East African Journal of Engineering*, Vol. 6, no. 1, Feb. 2023, pp. 36-47, doi:10.37284/eaje.6.1.1101.

INTRODUCTION

The project is located in Kiambu and Nyandarua Counties. The project starts from Magumu, takes an easterly direction and terminates at Thika (A2 junction). The total length of the road is approximately 67.654 kilometres.

The existing road alignment is poorly drained and exhibits serious pavement failures that will be discussed here. Until now it has served as a key link between Naivasha and Thika towns. The topography for the road is mostly hilly terrain with the exception of a short stretch of about 3km at the start (Magumu) which is generally flat and from km 59 to Km 67 the terrain is rolling to flat. The climate of the area is such that there exist two long rain seasons falling between March–May and October - December. The rest of the year has occasional light rains**.** The average annual rainfall received within the project area is 1,200 mm yearly with the wettest months being April and December.

Pavement failure is a common occurrence in roads that is attributed to various reasons; this could be due to exhaustion of the pavement life or poor workmanship during implementation causing the defects to be seen before the end of design life. The defects on the road include and are not limited to rutting, alligator cracks, longitudinal cracks, and potholes. These defects could be corrected in various manners. The design criteria are of great importance in the mix, whether it is a cold mix or a hot mix (McAsphalt Industries Limited, 1983). For the bituminous mixes, both the aggregates and the binder played a critical part in the design mix so as to ensure that the approved mix stayed workable and cohesive depending on the surrounding factors such as climate.

Carrying out an evaluation of the pavement competence and settling on the maintenance or rehabilitation measures is of importance in the road sector. The kilometres of roads that fail before the completion of the design period have been alarming in the recent past. These failures are attributed to poor designs or constructions which lead to defects such as pothole patching and rutting cracks among others; hence the road cannot achieve its design period. With the development and improvement of technology, modern methods of testing pavement strength have come up to ensure during construction all pavement layers achieve the required standards so as to avoid untimely and unnecessary road defects.

In order to choose the technique to use in pavement rehabilitation, there is a need for traffic studies, surface condition surveys and pavement structural condition surveys. In every financial year, a percentage of the national budget is allocated to the State Department of Infrastructure in Kenya. As per the treasury proposal, this is used to cater for road developments, railways, and any other kind of development. The Treasury also noted that 2.5% of the infrastructure budget allocation is used for the rehabilitation of roads. In this study, the evaluation of the pavement was done to ascertain the performance of the road and offer the possible solution to the defects, which in return provided a longer life span of the pavement. The findings from the analysis were also documented to assist in future referencing of the same road and would be used as a case study for other roads. Identification of the primary causes of pavement failures enabled us to get solutions for these defects. This formed the basis of this paper.

Article DOI: https://doi.org/10.37284/eaje.6.1.1101

MATERIALS AND METHOD

The Thika Magumu road after a life span of five years since it was rehabilitated, exhibited varied pavement failures/distress at different sections as detailed in the visual condition survey section of this paper. In the visual road survey, several steps and procedures were carried out to come up with the final pavement evaluation report. The methodology included the following:

Visual condition survey entailed taking into account the current state of the road as viewed. The Hawkeye-2000 Pavement Surface Profiler (PSP), which was used in this survey, is an automatic equipment that can perform Roughness and Rutting measurements using the Laser Profiler Beam (LPB) and Pavement Surface Distress Logging using Pavement Logging Video Cameras (PLVC). (ASTM D4694 - 09., 1996) Collection of the road surface condition and distress data was done using pavement and centre cameras and complemented with a windscreen survey. Identification, measurement of intensity and determination of the severity of surface distress was done in accordance with (Kenya Road Design Manual Part III , 1987), (IV, 1988) and the (ASTM E1082 - 90, 2012)

Roughness measurement was also carried out to measure the smoothness of the road. The standard way of measuring the roughness of a road is by conducting the International Roughness Index (IRI). This method was established by the World Bank in the 1980s. (ASTM D4695 - 03, 2008) It measures the roughness in meters per kilometre m/km. This is derived from the suspension motion on the vehicle divided by the kilometres that the vehicle has travelled.

Determination of the Pavement Condition Index (PCI) was also carried out to determine the rating of the pavement and the extent of damage to the surface. PCI is a calculated numerical value from surface distress for a particular pavement section and it indicates the surface condition of the pavement in a range from 0 (Failed) to 100 (Good). It is determined based on the type and level of distress observed. (ASTM D6433-07, 2015) was used to determine the PCI values of the pavement.

Traffic Survey Analysis was done to help in the back analysis of deflection data for the structural evaluation of the pavement. Classified traffic counts and axle load surveys were carried out from 23rd to 30th June 2022 and from 21st to 24th July 2022, respectively. The classified traffic counts were conducted to determine the nature of traffic on the road in terms of volumes and traffic composition, while an axle load survey of commercial vehicles was conducted to determine vehicle equivalence factors for the derivation of design traffic loading.

A structural Condition Survey was carried out to determine the residual strength of the existing and hence the overlay requirement for the pavement and establish the most viable maintenance intervention measures. The tasks under structural evaluation included: Coring, Trenching, Logging, Material Sampling and Testing, and, Deflection measurement and analysis.

A falling Weight Deflectometer (FWD) was used to identify defects in different pavements, such as urban roads, airports, and railway tracks. The machine was enclosed inside a trailer and for ease of mobility, it was connected to another car to make it mobile. Deflection measurements were conducted from 9th to 15th June 2022 with FWD equipment that meets the requirement of ASTM D4694 - 09 (1996) and ASTM D4695 - 03 (2008). The deflection measurements were conducted on both lanes at intervals of approximately 100 m on the Outer Wheel Path (OWP) at an offset of about 0.7 m from the edge of the carriageway. At each drop point, raw deflection (rd) readings were taken for the fourteen (14) consecutive geophone points of 0, 20, 30, 45, 60, 75, 90, 105, 120, 135, 150, 165, 180, and 200 cm. Back calculation to establish pavement and subgrade layers moduli and, thereby, the condition

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of pavement and subgrade material was conducted using Rosy design software.

RESULTS AND ANALYSIS

Visual Condition Survey

The observations made during the detailed surface condition surveys through the Hawkeye-2000 Pavement Surface Profiler and windscreen survey were harmonized and summarized into uniform sections as indicated in *Table 1* below:

Table 1: Surface Condition Survey Observations

Chainage (Km)	Section Length (Km)	Surface Condition Description	Remark/Probable Intervention
5+000 – 5+500	0.5	Alligator cracks Edge failure Native black cotton subgrade Poor drainage	Reconstruction section
5+500 – 5+700	0.2	Alligator cracks & Joint failure Black cotton native subgrade	Reconstruction section
5+700 –	0.1	No visible surface defects	Shoulders to be improved and section overlaid.
5+800 – 5+950	0.15	Isolated potholes and alligator Cracks Worn out shoulder	Section for spot, drainage and shoulder improvement.
5+950 – 6+020	0.7	Pavement deformation, Poor/no drainage	Reconstruction section

Roughness Measurement

The roughness data was processed using Hawkeye-2000 processing software with roughness in terms of IRI in m/Km. The ARRB Group Rating scale was used to rate the roughness data and measured the average IRI for each delineated homogeneous section as presented in *Table 2*.

Table 2: Average IRI for Homogeneous Sections

Road Name	HS	Points	Min IRI Lane, m/Km	Average IRI Lane, m/Km	Max IRI Lane, m/Km
Magumu - Thika LHS	Km 0 - 5.2	50	2.3	5.0	14.7
	Km 5.2 - 7.0	16	1.7	2.1	4.6
	Km 7.0 - 9.1	18	2.0	4.9	12.2
	Km 9.1 - 19.8	103	1.5	3.8	11.5
	Overall Mean	187	1.9	4	10.8
Magumu - Thika RHS	Km 0 - 5.2	48	1.9	4.5	14.4
	Km 5.2 - 7.0	14	2.1	2.9	4.9
	Km 7.0 - 9.1	21	1.8	4.4	12.7
	Overall Mean	83	1.9	3.9	10.7
Mean (both lanes)		135	1.9	4.0	10.8

From the roughness measurements, it can be noted that the average International Roughness Index (IRI) for the entire road is 4.0 m/km rated as **Good** with values ranging from 1.9 m/km to 10.8 m/Km**.**

Article DOI: https://doi.org/10.37284/eaje.6.1.1101

Pavement Condition Index

The summary of PCI values and ratings for the road sections are presented in *Table 3* below;

Table 3: PCI Values & rating for Homogeneous Sections

Road Section	HS	Points	Min of PCI	Average of PCI	Max of PCI
Magumu - Thika LHS	Km 0 - 5.2	50	31	51	69
	Km 5.2 - 7.0	16	51	66	80
	Km 7.0 - 9.1	18	34	53	74
	Km 9.1 - 19.8	103	35	56	83
	Overall Mean	187	38	57	77
Magumu - Thika RHS	Km 0 - 5.2	48	31	50	75
	Km 5.2 - 7.0	14	50	64	73
	Km 7.0 - 9.1	21	33	54	78
	Km 9.1 - 19.8	102	35	55	77
	Overall Mean	186	38	57	77
Mean (both lanes)		187	38	57	77

From the PCI Values, it can be noted that the average PCI Value is 57, rated as **Fair** with values ranging from 38 (rated as **Very Poor**) to 77 (rated as **satisfactory).**

Surface Regularity Results

The measured average rut depth in mm for each homogeneous section of the road is summarized in *Table 4*.

Table 4: Average Rut depths for Homogeneous Sections

Road Name	HS	Points	Min Rut (mm)	Average Rut (mm)	Max Rut (mm)
Magumu - Thika LHS	Km 0 - 5.2	50	0.6	4	10.3
	Km 5.2 - 7.0	16	0.4	1.4	2.3
	Km 7.0 - 9.1	18	0.8	2.8	9.7
	Km 9.1 - 19.8	103	0.4	3.2	13.6
	Overall Mean	187	0.6	2.9	9.0
Magumu - Thika RHS	Km 0 - 5.2	48	0.8	3.7	10.9
	Km 5.2 - 7.0	14	0.6	1.6	3.1
	Km 7.0 - 9.1	21	0.6	2.7	9.9
	Overall Mean	83	0.7	2.7	8.0
Mean (both lanes)		135	0.7	2.8	8.5

From the Rut depth measurements, it is noted that the average Rut depth for the entire road is 2.8 mm, rated as being of **No Rutting** with values ranging from 0.7 mm to 8.5 mm**.**

Article DOI: https://doi.org/10.37284/eaje.6.1.1101

Traffic Analysis

Average Daily Traffic (ADT)

The average daily count based on the vehicle volumes was computed by getting the weighted average for all the days in the week. The summaries of the average daily traffic (ADT) flows that were determined during the recording period and the actual daily-recorded traffic flows are presented below.

Table 5: Average Daily Traffic on Magumu - Thika (B20/D1315) Road

Station	Motor Cycles	Cars	Van/Matatu	Pick-up	Bus	MGV	HGV 1	HGV2
Kirasha	2162	1352	718	229	2	456	127	6
Kamwangi	1608	1872	1034	683	16	820	187	84
Ngoingwa	875	3298	1803	473	10	528	119	72
Total	4645	6523	3555	1385	28	1804	433	161
% Composition	25.1%	35.2%	19.2%	7.5%	0.2%	9.7%	2.3%	0.9%

MGV -Medium Goods Vehicles
HGV- Heavy Goods Vehicles*

The ADT was used to determine whether the road had the capacity to carry the prevailing and projected traffic volumes and also for projections of the traffic loading. The following is noted on the traffic regime on the road.

Traffic Loading Projection in Design Periods

The design daily equivalent standard axles were converted to cumulative ESA using the formula below:

$$Cumulative\ ESA = 365\ x\ T_2\ x\ \frac{((1+r)^n -)}{r} \quad [1]$$

Where: CESA – Cumulative Equivalent of Standard Axles, T2 – Daily number of standard axles for the base year, r – Annual traffic growth rate in percent & n – Design period in years.

A sensitivity analysis was done so as to assess traffic variation at growth rates ranging from 4.0% to 6.0% with a mean of 5.0% with the Daily ESA of the road sections. The cumulative equivalent standard axles from the analysis are presented in *Table 6*.

Table 6: Cumulative ESA on the road based on various growth rates (millions)

Station	Design Period	Annual Traffic Growth Rate		
		4.0%	**5.0%**	**6.0%**
Kirasha	15	8.60	9.27	10.00
	20	12.79	14.20	15.80
Kamwangi	15	20.27	21.85	23.57
	20	30.15	33.48	37.24
Ngoingwa	15	14.38	15.50	16.72
	20	21.39	23.75	26.42

Article DOI: https://doi.org/10.37284/eaje.6.1.1101

The forecasted traffic loading is as follows:

- Station 1 (Kirasha): Design traffic class T3 for 15-year and T2 for 20-year design periods, based on a 5.0% annual traffic growth rate;
- Station 2 (Kamwangi): Design Traffic class T2 for a 15-year and T1 for a 20-year design period, based on 5.0% annual traffic growth; and,
- Station 3 (Ngoingwa): Design Traffic class T2 for 15 and 20-year design periods, based on 5.0% annual traffic growth
- Traffic projection at Station 2 (Kamwangi) was adopted for analysis of the pavement for uniformity.

Structural Condition Survey Analysis

The thickness and description of each layer was entered in a standard logging sheet as summarized in *Table 7*.

The pavement layer materials sampled were subjected to laboratory testing and analysis. Reinstatement of pavement on the trial pit excavation areas was done after sampling.

Table 7: Summary of Pavement and Subgrade Logging

Logging Points	Surfacing Material and Thickness, mm	Base Material Thickness, mm	Sub base Material Thickness, mm	Top 300 mm Subgrade Material
KM 0+100 LHS	40 mm AC	200 mm GCS	130 mm Gravel	Brownish Gravel
Km 5+000 RHS	40 mm AC	120 mm GCS	100 mm Gravel	Reddish Gravel
Km 10+030 LHS	30 mm AC	130 mm GCS	100 mm Gravel	Reddish Gravel
Km 14+800 RHS	40 mm AC	120 mm GCS	80 mm Gravel	Reddish Gravel
Km 20+430 LHS	50 mm AC	120 mm GCS	100 mm Gravel	Reddish Gravel

AC- Asphalt Concrete
GCS- Graded Crushed Stone

Subgrade and Pavement Materials Testing

Pavement materials were sampled from the trench pits and subjected to laboratory testing. From the subgrade and native soils test results, the following is deduced:

- Native subgrade material has a CBR range of between 2-30% and a PI range of between 17-30%;
- Improved Subgrade material on sections has a CBR range of between 2-30% and a PI range of between 17-30%;
- 91% of the subgrade and native soils have a CBR of less than 10% between Km 0 – Km 25.4;
- Plasticity index values range from 16-30%;
- MDD values range between 1085 – 1835 Kg/m^3;
- All MDD values between Km 0 – Km 25.4 are below 1400 Kg/m^3 with values ranging between 1085 – 1280 Kg/m^3; and,
- Relative moisture content values range between 79.4 – 111.0%, while Relative compaction values range between 85.6 – 106.5%.

From the subbase material test results, the following is deduced:

- The CBR values range between 23 – 40%;
- Plasticity index values range for Natural Gravel Subbase range between 8 – 19%;

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- MDD values for Natural Gravel Base range between 1400 – 1920 Kg/m^3; and,
- Relative moisture content values range between 80.3 – 111.4%, while Relative compaction values range between 85.7 – 105.9%.

From the base material test results in *Table 3*, the following is deduced:

- The CBR values for the CIG base range between 35 – 45%;
- Plasticity index values for GCS base range between 5 – 8% indicating contamination;
- Plasticity index values range for CIG base range between 14 – 18%, which did not comply with the requirements;
- MDD values for GCS base range between 1850 – 1960 Kg/m^3;
- MDD values for CIG base range between 1650 – 1890 Kg/m^3; and,
- Relative moisture content values range between 81.2 – 109.2%, while Relative compaction values range between 81.8 – 102.5%.

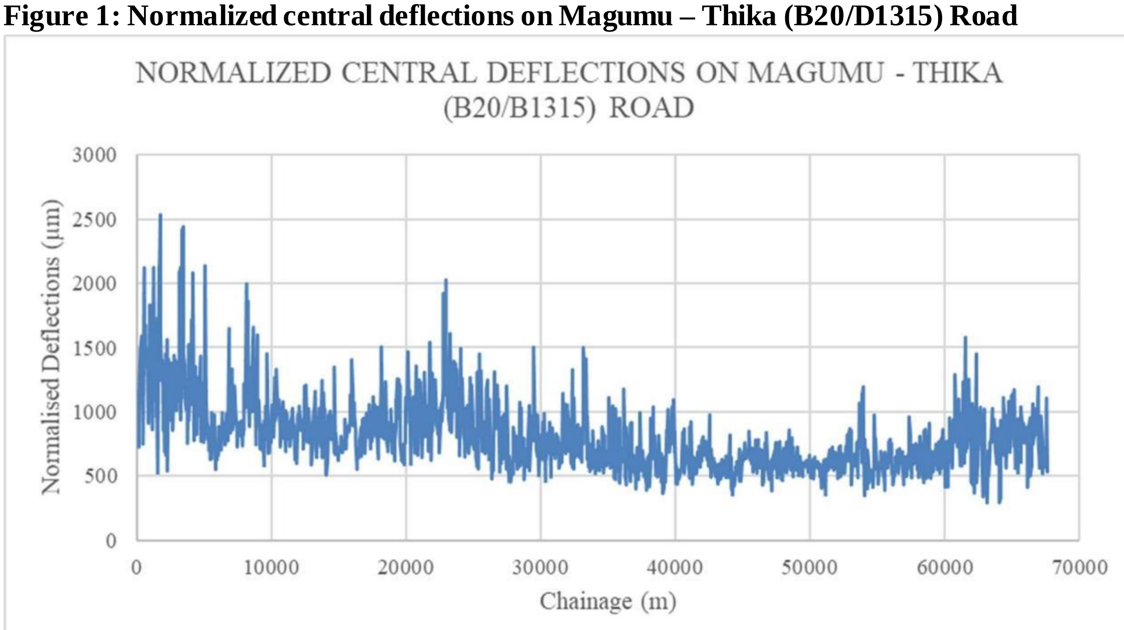
The following were noted from the AC test results:

- Binder content**:** Out of 25 cores, five cores (20%) were found to have binder content beyond the permissive range from the design binder content of 5.5+ - 0.3%.
- 13 out of 25 cores have VIM values greater than 8%, above the specifications for AC type II wearing course indicating a water ingress susceptible pavement.

Falling Weight Deflectometer Results and Analysis

The target load during testing was 50 KN, which resulted in standard pressure of 707 KPa. In the field, attempts were made to test at this pressure as much as possible. Due to the gradient and nature of the road surface, the resultant pressure was in most cases, slightly lower or above this pressure. To standardize, the FWD deflection data were normalized. The normalized deflections were plotted against chainage, as shown in *Figure 1*.

Figure 1: Normalized central deflections on Magumu – Thika (B20/D1315) Road



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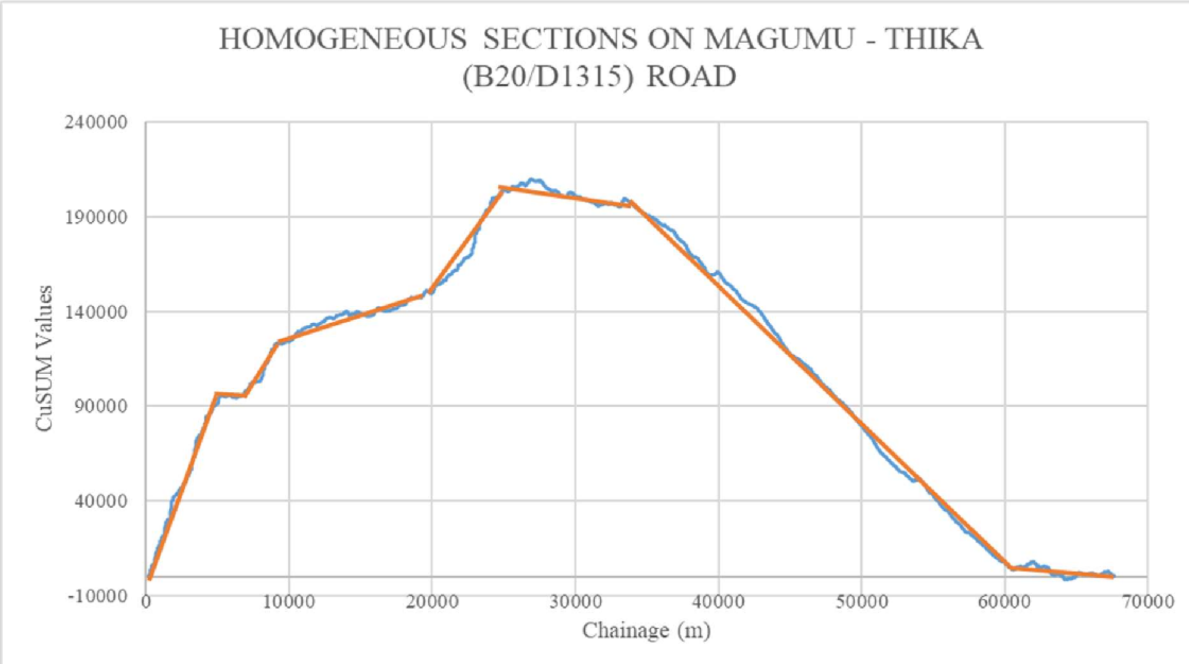
Further, the normalized central deflections were used to establish homogeneous sections using the Cumulative Sum of Difference from the Mean (CuSUM) method of the central deflections. The CuSUM values are presented in the graph in *Figure 2*.

Figure 2: Graphs of Homogeneous Sections on Magumu – Thika (B20/D1315) Road



Back Calculation and Overlay Design

Back-Calculation for Pavement and Subgrade Moduli

The deflection data was analyzed using RoSy Design Software. The necessary input parameters and the criteria for analysis of the outputs are as follows.

The following design parameters were considered during data input for RoSy Design analysis:

- Existing road Lane width of 3.5m with a carriageway width of 7.0m;
- Pavement Design Temperature of 250C;
- Existing pavement as established from logging;
- Fatigue laws as presented in RDM Part 3;
- Rehabilitation design period of 15 years with a 20-year sensitivity analysis; and,
- Daily ESA of 1770 was established from the traffic survey.

The pavement analysis was carried out under conditions in RDM parts III and V and therefore compared to elastic moduli in section 8.2.3 of Road Design Manual Part III for Material and Pavement Design for New Roads as follows:

- Asphalt concrete type I - 4000 MPa;
- Graded crushed stone of base quality - 400 MPa;
- Cement improved material of base quality - 1000 MPa;
- Cement improved gravel of subbase quality - 300 MPa;
- Natural Gravel Subbase - 200 MPa. and,
- Subgrade Strength - 90 MPa

Article DOI: https://doi.org/10.37284/eaje.6.1.1101

Additionally, the pavement was checked for residual life and hence strength, critical layer and overlay requirements for each homogenous section as the basis for rehabilitation/strengthening intervention recommendation. The Pavement Layers Moduli (PLM) per Homogeneous Sections (HS) are summarized in *Table 8*.

Table 8: Average Pavement Layers Moduli on Homogeneous Sections

Road Name	Homogeneous section	Mean Moduli, MPa				Critical Layer
		Surfacing	Base	Subbase	Subgrade	
Magumu - Thika (B20/D1315) Road	Km 0 - 5.2	1874	264	724	61	Base
	Km 5.2 - 7.0	1662	345	642	88	Base
	Km 7.0 - 9.1	1233	255	699	76	Base
	Km 9.1 - 19.8	1848	378	621	84	Subbase
	Km 19.8 - 25.2	1432	360	911	64	Subbase
	Km 25.2 - 34.0	1607	445	675	100	Subbase
	Km 34.0 - 61.2	4041	406	755	146	Base
	Km 61.2 - 67.7	5710	242	1269	103	Base
	Overall Mean	3025	369	780	109	

The following was noted from the tabulated pavement moduli

- Only the homogenous sections on km 34.0 – 67.7 had mean moduli values above 4000 MPa for AC Type I. The rest of the sections had mean moduli values below 4000 MPa and hence structurally deficient;
- GCS base: All except homogeneous sections between Km 25.2 – 45 have moduli values below 400 MPa for base quality GCS;
- CIG base: All the homogenous sections have moduli values below 1000 MPa CIG base;
- Subbase: All the homogeneous sections have moduli values above 300 MPa for cement/lime-treated gravel subbase provided in RDM III (1987).
- The RDM part III (1987) notes that underlying foundational layers should have a strength of not less than 10% of the subsequent layers. This requirement is not met for the pavement on the sections between Km 0 – 5.2, Km 19.8 – 25.2 and Km 61.2 -67.7. All the other sections have subbase strength greater than ten (10) times the subgrade strength.
- The critical layer on the homogenous sections is either base or subbase indicating that the failures and/or the failures observed on the sections are resulting from the deficiency in either of the two layers.

Overlay Requirements

The strengthening thicknesses for the homogeneous sections for selected design periods are presented in *Table 9*.

Article DOI: https://doi.org/10.37284/eaje.6.1.1101

Table 9: Required Mean Overlay Design (mm) and Residual life on Homogeneous Sections

Road Name	Homogeneous section	Reinforcement, mm	
		15 -YR	20-YR
Magumu - Thika (B20/D1315) Road	Km 0 - 5.2	225	250
	Km 5.2 - 7.0	185	205
	Km 7.0 - 9.1	205	230
	Km 9.1 - 19.8	190	210
	Km 19.8 - 25.2	200	225
	Km 25.2 - 34.0	170	190
	Km 34.0 - 61.2	175	195
	Km 61.2 - 67.7	210	230
	Overall Mean	185	205

Note; For Thicknesses ≥ 60 mm, the overlay material is DBM and for thicknesses less than 60 mm, the Overlay is Asphalt Concrete. This is because DBM has coarse aggregates of a bigger size than AC; this makes it stable at a thickness of greater than 60 mm as compared to AC which has a smaller aggregate size.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Traffic Surveys and Analysis: Design Traffic class T2 of 21.85 million equivalent standard axles for a 15-year design period, based on 5.0% annual traffic growth, was adopted due to the anticipated traffic as discussed in the traffic analysis above.

Surface Condition Survey: Main defects observed are alligator and longitudinal cracking, deformation, and potholes**.** The road had a mean IRI value of 3.6 m/Km which indicates a **Fair** riding quality, rut depths ranging from 0.1 mm rated as **No Rutting** to 17.9 mm rated as **Medium severity** and mean PCI of 61 rated as **Fair** in a range of 0 **(Failed)** to 100 **(Good).**

Structural Condition Survey

a) Pavement Materials Test Results:

- **Surfacing:** The AC surfacing did not meet the binder content, voids in mix and elastic modulus requirements provided in Road Design Manual III, 1987. The surfacing is deteriorated on most sections of the road.

- **Base:** The GCS and CIG base did not meet the elastic modulus requirements of 400 MPa and 1000 MPa, respectively, provided in RDM III, 1987. The remoulded CIG base CBR values indicated compliance with requirements for materials for improvement for base construction. The GCS was also contaminated with plastic materials and the suitability for re-use can only be assessed on the criteria for gravel.

- **Subbase:** The remoulded average subbase gravel CBR values indicated suitability for re-use. The mean modulus for the subbase met the requirements of 200 MPa provided in RDM III, 1987, and,

- **Subgrade:** The low subgrade CBR values indicated the presence of poor subgrade materials susceptible to moisture variations. In most sections however, and as indicated by the elastic modulus, the subgrade materials are of S4 quality. This implies that there was a need to improve the material for better stability or use borrowed material of higher quality.

Article DOI: https://doi.org/10.37284/eaje.6.1.1101

b) **Deflection Measurements:** The high deflections recorded for most sections of the road indicate that the pavement has low bearing capacity.

- ***Pavement analysis and Rehabilitation Design*:** The road is structurally deficient and requires an average overlay of 185 mm DBM for a 15-year design period based on Road Design Manual Part III.

From surface and structural condition surveys, the road was deficient for the projected Traffic Class T2. The appropriate intervention under the prevailing road condition was the reconstruction of the entire road to Standard Pavement Structure Type 12 for traffic class T2 and subgrade class S5 as follows:

- Surfacing: 50 mm AC Type I (0/20);
- Base: 125 mm DBM (0/30) in two layers;
- Subbase: 125 mm base quality GCS (0/30) Class A; and,
- Subgrade: S5 subgrade.

Considering the cost and current scope of work, the sectional interventions below were recommended. Further, it is expected that a 50 mm AC overlay will be laid on the entire road within seven years in order for the road to carry the projected traffic for 15 years.

i. Km 0+000- Km 5+000

a) Carry out benching and widening as necessary;

b) Reconstruct the pavement as follows:

- The existing pavement should be scarified, topped up with a material of minimum CBR of 14%, where necessary to form 300 mm subgrade;
- Construct 150 mm CIG60 sub base to carriageway & shoulders;
- Construct 200 mm 2% cement treated GCS base class A to carriageway & shoulders;
- Construct 50 mm AC type I (0/20) to carriageway; and,
- Apply a single seal surface dressing of 10/14 mm chippings on the carriageway and a double seal of 14/20 and 6/10 mm chippings to the shoulders.

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