Blantyre City Assembly
Ministry of Local Government and Rural Development
The Republic of Malawi

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR IMPROVEMENT OF
BLANTYRE CITY ROADS
IN
THE REPUBLIC OF MALAWI

March 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

KATAHIRA & ENGINEERS INTERNATIONAL

PREFACE

Japan International Cooperation Agency (JICA) conducted the preparatory survey on the Project for the Improvement of Blantyre City Roads in the Republic of Malawi.

JICA sent to Malawi a survey team from October 27 to November 17, 2009.

The team held discussions with the officials concerned of the Government of Malawi, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Malawi from February 16 to 24, 2010, in order to discuss a draft outline design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Malawi for their close cooperation extended to the teams.

March, 2010

Kiyofumi Konishi
Director General,
Economic Infrastructure Department
Japan International Cooperation Agency

March, 2010

Letter of Transmittal

We are pleased to submit to you the preparatory survey report on the Project for the Improvement of Blantyre City Roads in the Republic of Malawi.

This survey was conducted by Katahira & Engineers International, under a contract to JICA, during the period from October 2009 to March 2010. In conducting the survey, we have examined the feasibility and rationale of the project with due consideration to the present situation of Malawi and formulated the most appropriate outline design for the project under Japan's Grant Aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Tsuyoshi Yamajuku
Project Manager,
Preparatory Survey Team on the Project
for the Improvement of Blantyre City
Roads in the Republic of Malawi

Katahira & Engineers International

Summary

1. Outline of the Country

The Republic of Malawi (hereinafter referred to as "Malawi") is located in the eastern Africa and the southern hemisphere, which is a landlocked country surrounded by Tanzania, Zambia and Mozambique.

The population is 14.28 million in 2008, GNI is 4.27 billion dollars and GNI per capita is 290 dollars, Economic growth rate is 9.7%, Consumer prices rate is 8.9%. The major industry is agriculture representing by main products, 80% of labor works agriculture relation. The shares of GDP are 34% of primary industry, 21% of secondary industry and 45% of tertiary industry. The major export agricultural production is sugar, tea and cigarette.

2. Background of the Project

Malawi is a landlocked country surrounded by three other nations whose road system plays a leading role in commodity and passenger transportation, international logistics, and is an important source of economic growth. There are a total 16,500kms of roads in Malawi, 6,500kms of which are either part of a road network, are major trunk road or other economical transportation routes. Of these, 43% are paved. However, budget constraint has led to deterioration and damage of road surface in many existing roads. Consequently, road infrastructure development is considered a high propriety in the country's national development plan. In response, the "Road Sector Investment Program (2003-2012), ROADSIP" was formulated in 2002 and transport corridors to neighboring South African nations and domestic trunk roads have mainly been developed.

The project site, "Blantyre Administrative District", is located approximately 300kms south of Lilongwe, the capital of Malawi and the most industrially advanced. Most of the roads in the city have been constructed in the beginning of the 1950s. The present traffic volume becomes much larger than designed volume not only due to corrosiveness of deterioration of road surface, but also population concentration and industrialization. Consequently, the chronic traffic congestion and traffic accidents stemming from current large traffic volume have led to serious damage to daily life and business activity.

Although repairing works for road has been carried out by the Government of Malawi's own budget, all routes to be repaired have not been covered due to budget

constraint. In this context, the Government of Malawi requested 42 roads for improvement to the Government of Japan for Grant Aid. In response to the request, a preliminary study on the project was carried out by JICA Study Team so as to clarify the contents of request and project area, and prioritize the target routes. It was consequently confirmed that the proposed project, which consists of Chipembere Highway and Livingstone Avenue of 7.47 km in total, is valid for implementation in grant aid scheme.

Based on the above survey results, the Government of Japan determined to implement the basic design study on "The Project for the Improvement of Blantyre City Roads" during the period of November 2006 to June 2007. The Exchange of Note concerning the Grant Aid project on Chipembere Highway Phase-1 was agreed on July 2007. After the implementation of detailed design and tendering, construction began on March 2008.

For the phase-2, the exchange of note was agreed in July 2008. Nevertheless, since the Consultant which was in charge of the Phase-1 refused detailed design and construction supervision, implementation of the project was suspended. The Government of Japan determined to call off the implementation of the Phase-2. Instead, Government of Japan determined to conclude the new Exchange of Note.

3. Outline design of the study and contents of the project

JICA dispatched the preparatory study team to Malawi between 27 October 2009 and 17 November 2009 for the execution of outline design study for Chipembere Highway and Livingstone Avenue, about 4.36 km in total length, and the team conducted the discussions with concerned Malawian officials and investigations of the project site.

After coming back Japan, the team carried out outline design for the appropriate contents of the Project based on the result of the field survey and prepared the draft report of the study for the result of outline design.

JICA dispatched the team to Malawi between 16 February 2010 and 24 February 2010 for the explanation of draft report and the team made discussions, confirmation and agreement regarding the contents of the draft report.

The contents of the Project finally agreed are shown below.

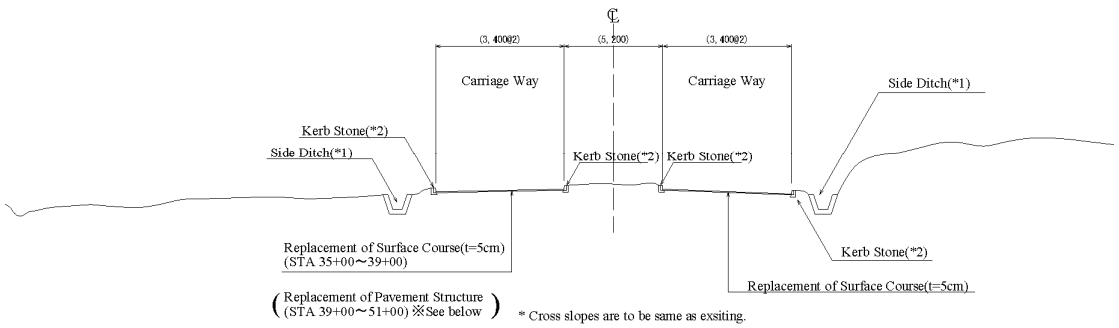
1) Section-3 Chipembere Highway : Chichiri RA ~ Yianakis RA, 2.75 km
2) Section-4 Chipembere Highway : Yianakis RA ~ Standard Bank IC, 0.72 km
3) Section-5 Livingstone Avenue : Standard Bank IC ~ Illovo RA, 0.89 km

Road design requirements are as follows.

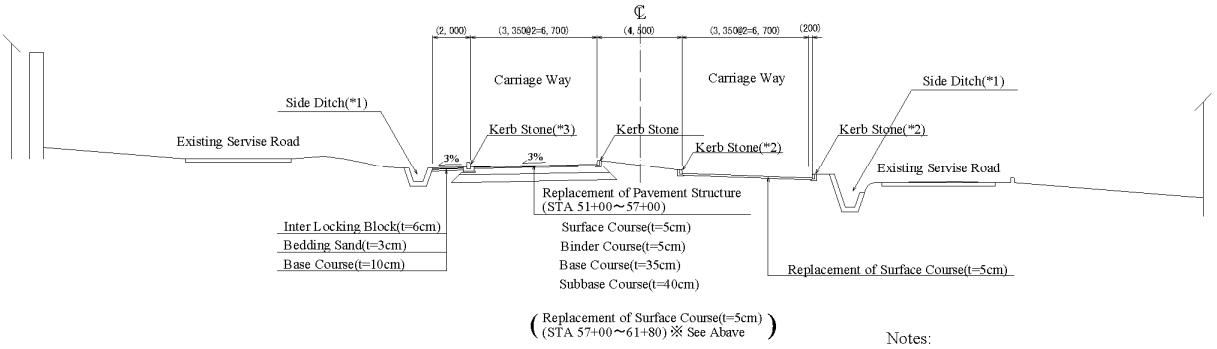
Table-1: Overview of Facilities (Repaired Components)

Section		Repaired Components	Repaired Item
Chipembere Highway 3.47km	Section-3 2.75km	Pavement Replacement	Replacement 5cm surface at good condition of sub-base course. Replacement from sub-base at bad condition of sub-base course.
		Bus Lay Byes	4 locations in total, Installation of street lights.
		Drainage Facilities	Repairing of existing drainage facilities. Security of drainage routes until flow end.
		Kerb Stones	Repairing of existing kerb stones, Installation of kerb stones at new section.
		Side walk Pavement	Repairing of existing side walk. Interlocking Block surface.
	Section-4 0.72km	Extending of existing road.	Extending road width 4-lane from 2-lane. Replacement of pavement from sub-base course.
		Bus Lay Byes	1 location in total, Installation of street lights.
		Drainage Facilities	Installation new U-shape drain with cover. Security of drainage routes until flow end.
		Structure	2 locations in total, Installation of pipe culvert(ϕ 1500).
		Kerb Stones	Installation of kerb stones on both side.
		Side walk Pavement	Construct of side walk. Interlocking Block surface.
Livingstone Avenue Section-5 0.89km		Pavement Replacement	Replacement of pavement from sub-base course.
		Drainage Facilities	Installation new U-shape drain with cover. Security of drainage routes until flow end.
		Kerb Stones	Installation of kerb stones on both side.
		Side walk Pavement	Repairing of existing side walk. Interlocking Block surface.

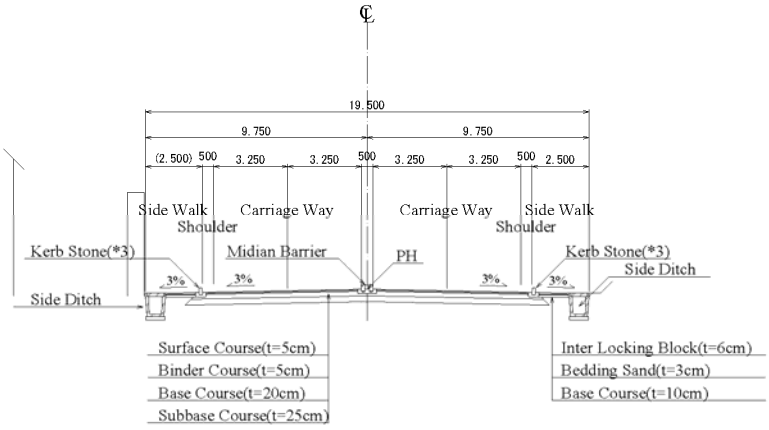
Typical cross sections of subject road are as below.



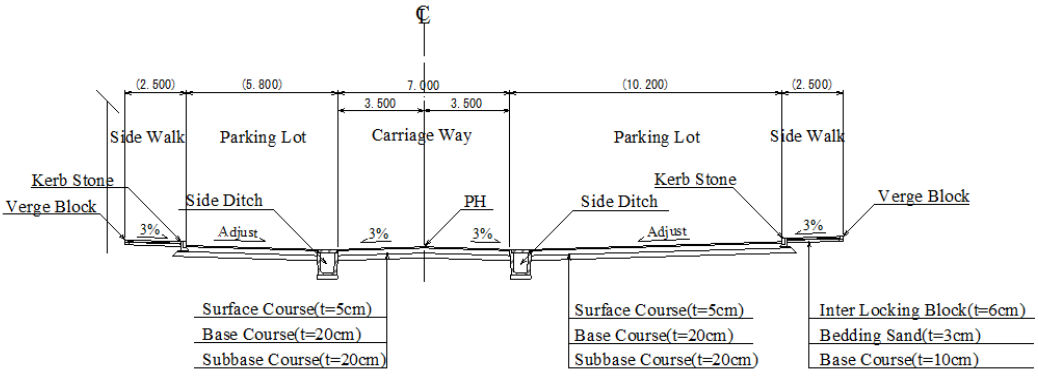
Section-3 (Chichiri RA to Maselema RA) Typical Cross Section



Section-3 (Maselema RA to Yianakis RA) Typical Cross Section



Section-4 (Yianakis RA to Standard Bank IC) Typical Cross Section



Section-5 (Standard Bank IC to Illovo RA) Typical Cross Section

Contents of the facilities under outline design scheme are as below.

Table-2 Contents of the Facilities under Outline Design Scheme

Facilities	Specifications	Unit
Road Length	Chipembere Highway: Section-3 (2.75km), Section-4 (0.72km) Livingstone Avenue: Section-5 (0.89km)	km
Carriageway Pavement	Surface Course (Hot Asphalt Concrete) (t=50mm)	sq.m
	Base Course (Hot Asphalt Concrete) (t=50mm)	sq.m
	Upper Sub-base Course (Mechanical Stabilized Aggregate) (t=200mm～350mm)	sq.m
	Lower Sub-base Course (Crusher Run) (t=200mm～400mm)	sq.m
Sidewalk Pavement	Interlocking Block (t=60mm)	sq.m
	Sub-base Course (Mechanical Stabilized Aggregate) (t=100mm)	sq.m
Approach Road Pavement	Surface Course (Hot Asphalt Concrete) (t=30mm)	sq.m
	Sub-base Course (Mechanical Stabilized Aggregate) (t=100mm)	sq.m
Drainage	U-Shape Concrete Drain (Bottom Width = 535mm)	l.m
	V-Shape Concrete Drain (Bottom Width = 600mm)	l.m
	V-Shape Concrete Drain (Bottom Width = 300mm)	l.m
	Catch Pit	set
	RC pipe Culvert (Pre-cast, Inner Diameter = 600mm)	l.m
	RC Pipe Culvert (Cast-in-place, Inner Diameter = 600mm)	l.m
	RC Pipe Culvert (Pre-cast, Inner Diameter = 1,500mm)	l.m
Kerb Stone	Kerb Stone	l.m
	Verge Block	l.m
Traffic Sign	Warning & Regulatory Signs	set
Road Marking	Center Line (w=150mm), Shoulder Line (w=150mm), Pedestrian Crossing (w=450mm), Stop Line (w=450mm), etc.	l.m

4. Implementation Schedule and Project Cost

In case the Project is implemented by Japan's Grant Aid, the period for the detailed design is 5.0 months and the implementation period is 17.5 months in total.
The cost borne by Malawian side to implement the Project is estimated at 5.1 million Malawian Kwacha.

5. Verification of appropriateness of the Project

It is expected the following effects by implementing the Project.

(1) Direct Effect

- Travel time at off peak hour will be shorten from present level of 7 minutes to 5 minutes on 4.36 km of Section-3 to 5 and at peak hour will be shorten from present level of 17 minutes to 12 minutes.
- Average moving speed will be improved from present speed of 36 km/hour to 55 km/hour.
- Maintenance cost of road rehabilitation will be reduced from present cost of 14.00 million MK / year to 6.63 million MK / year.
- Since sidewalk will be constructed, traffic for pedestrian and bicycle will be more safe and comfortable.

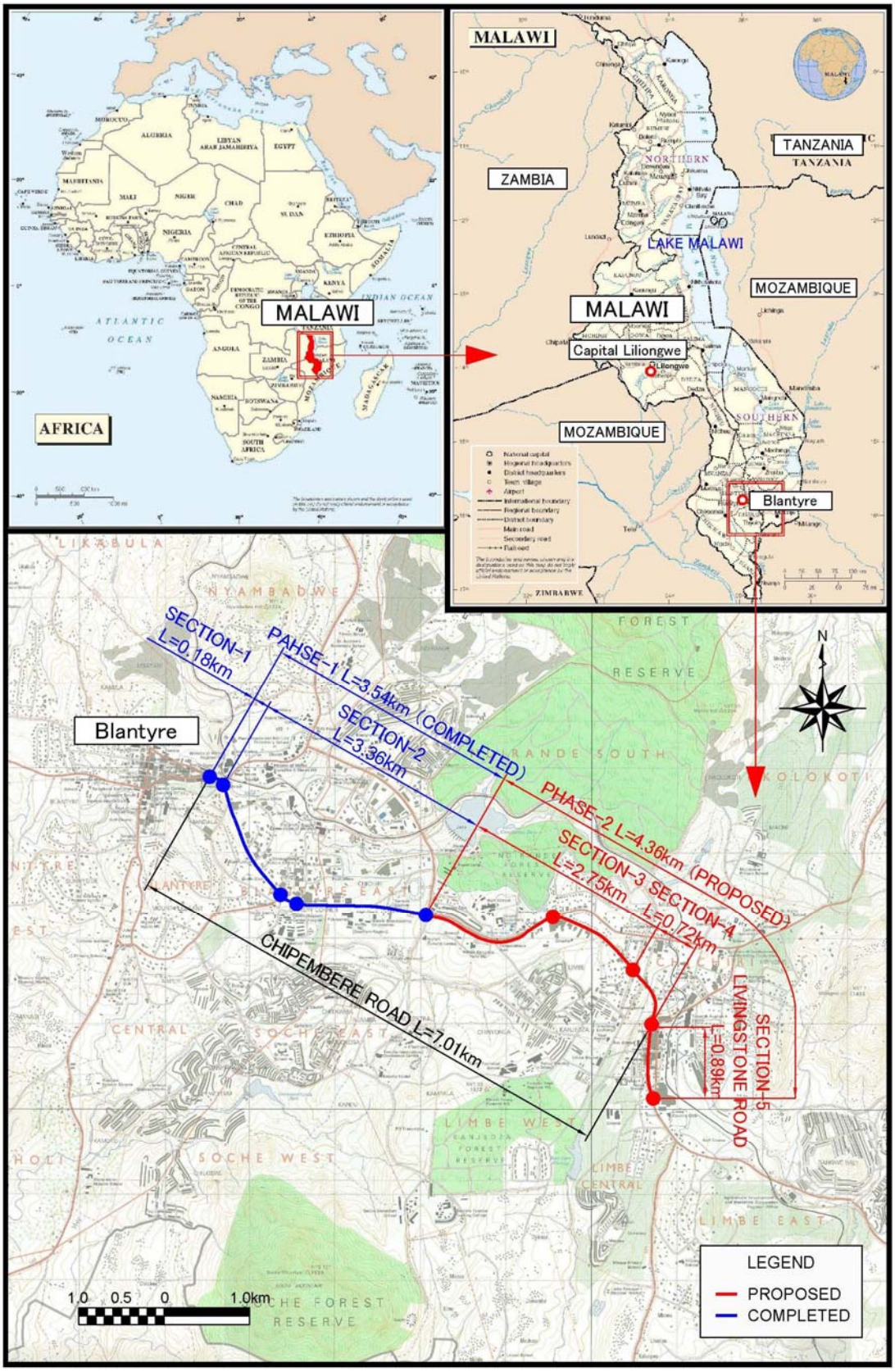
(2) Indirect Effect

- The measure of effective traffic and physical distribution will be offered, access of infrastructure for inhabitance life will be improved, so the activation of social and economic action will be contributed.
- The number of maintenance route for public bus and mini-bus will be increased, so the comfortable way will be improved and the frequency of service will be increased, therefore the mobility of inhabitant will be improved.
- The drainage facilities will be maintained, so the rainwater will be drained quickly on the road, and the time of pavement damage will be restrained.
- The reaction time of emergency traffic will be shorted for improvement of subject routes, and the security of region will be contributed for improvement of street lights.
- The numbers of traffic lane should be increased from 2 to 4-lane at section-4, and the turning left will be prohibited for improvement of center separator, so the number of traffic accident in crossing will be contributed.

The Project is expected above effects and it will secure the smooth and safety urban transport, revitalize regional social and economical activities and contribute the improvement of living environment for the residents generally. Therefore it is confirmed the appropriateness of the implementation of the Project by Japan's Grant Aid. It guesses that the effects of this project will be lager if the road network of Blantyre city is farther developed and the maintenance is executed certainly.

Contents

［Appendices］



Location Map

Perspective (Chipembere Highway Section-4 / Widening to 4-lane)

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ABBREVIATIONS

AASHTO	: American Association of State Highway and Transportation Officials
AC	: Asphalt Concrete
BCA	: Blantyre City Assembly
CBR	: California Bearing Ratio
DBST	: Double Bituminous Surface Treatment
DCPT	: Dynamic Cone Penetration Test
EIA	: Environmental Impact Assessment
ESAL	: Equivalent Single Axe Load
EU	: European Union
GDP	: Gross Domestic Product
GOJ	: Government of Japan
GOM	: Government of Malawi
IC	: Interchange
IEE	: Initial Environmental Examination
IRI	: International Roughness Index
JICA	: Japan International Cooperation Agency
M/D	: Minutes of Discussion
MK	: Malawian Kwacha
MLGRD	: Ministry of Local Government and Rural Development
RA	: Roundabout
RAP	: Resettlement Action Plan
ROW	: Right of Way
SATTC	: Southern African Transport and Communications Commission
TOR	: Terms of Reference
USD	: United States Dollar
WB	: World Bank

CHAPTER 1 BACKGROUND OF THE PROJECT

1.1 BACKGROUND OF THE PROJECT

The Republic of Malawi is a landlocked country sharing international borders with Tanzania in the north, Mozambique in the south, and Zambia in the west. Road transport sector playing key role of physical and passenger transportation including cross border physical distribution is principal infrastructure for the Malawi's economic growth. The total length of road network in the whole nation is estimated at 16,500 km including 6,500 km of major trunk roads and other roads for economic/transport-purpose. The total length of paved road accounts for 43% of those of economic/transport-purpose roads. However, budget constraint has led to deterioration and damage on road surface in many existing road. Thus, development of road infrastructure is one of the most important challenges of National Development Policy. On this account, the Government of Malawi has been making effort to develop the transport corridor to neighboring countries in southern Africa and domestic trunk road, in line with "Investment Program in Road Sector (2003-2012), ROADSIP".

The project area, "Blantyre City Assembly" (hereinafter referred to as BCA), which consists of Blantyre city and neighboring city namely Limbe is located about 300 km south of Lilongwe, capital of the nation. In addition, Blantyre is the largest and most advanced industrialized city of the nation. Most of the roads in the city were constructed in the beginning of the 1950's. The present traffic volume becomes much larger than designed volume due not only to corrosiveness of deterioration of road surface, but also population concentration and industrialization. Consequently, the chronic traffic congestion and traffic accidents stemming from current large traffic volume have led to serious damage in daily civil life.

Although repairing works for road has been carried out by the Malawi Government's own budget, all routes to be repaired have not been covered due to budget constraint. In this context, the Government of Malawi requested the Government of Japan to improve 42-section under Grant Aid.

In response to the request, a preliminary study on the project was carried out by JICA study team so as to clarify the contents of request and project area, and prioritize the target routes. It was consequently confirmed that the proposed project, which consists of Chipembere Highway and Livingstone Avenue of 7.47 km in total, is valid for implementation in grant aid scheme.

Based on the above survey results, the Government of Japan determined to implement the

basic design study on “Development Project on Road Network in Blantyre City” during the period of November 2006 to June 2007. The Exchange of Note (hereinafter referred to as E/N) concerning the Grant Aid project on Chipembere Highway phase-1 was agreed on July 2007. After the implementation of detailed design and tendering, construction began on March 2008.

For the phase-2, the E/N was agreed in July 2008. Nevertheless, since the Consultant which was in charge of the phase-1 refused to conduct detailed design and construction supervision, implementation of the project was suspended. The Government of Japan determined to call off the implementation of the phase-2. Instead, GOJ determined to conclude the new E/N.

1.2 NATURAL CONDITIONS

Malawi is located at east coast of Africa and the southern hemisphere, which is a landlocked country surrounded by Tanzania, Zambia and Mozambique. Regarding topography, most of territory is located on tableland, 20% area of territory of Lake Malawi is located at west riverbank.

The Project area is the city of Blantyre and located at hilly land on the south of Shire valley. The altitude is 600 m to 1700 m. Average rainfall is about 1,200 mm in a year, the heavy rain season comes from December to March and the dry season comes from April to November and the temperature is moved so much through a year with 10℃ to 30℃.

1.3 ENVIRONMENTAL AMD SOCIAL CONSIDERATION

The survey team confirmed that “Project Component” is same as the basic design at the Minutes of Discussion (MD) meeting. The Environmental Impact Assessment (EIA) at the basic design has been worked out in the condition of widening to 4-lane, therefore the EIA is still effective for this stage. This was confirmed with Blantyre City Assembly (BCA).

BCA is implementing Relocation Plan based on original road design plan. There are seven objects (six fences and gates and one residence with store) in the ROW area. BCA has held stakeholder meeting so as to reach a consensus for relocation among landlords. And BCA has already paid compensation for relocation to six landlords until August 2008 except the residence.

BCA requested the survey team to change the survey component on widening Chipembere highway from 2-lane to 4-lane but not 3-lane.
Regarding the residence in ROW area, relocation is not necessary in case of 3-lane widening, but the residence occupy the ROW. Implementation schedule proposed by the survey team is

unable to follow due to time constraint of the relocation. BCA inquired the survey team the possibility of widening without relocation of the residence by adjusting sidewalk width partially. In response to this inquiry, the survey team roughly assessed the alternatives. As the result of assessment, it was clarified that widening was able to be conducted without relocation if the sidewalk width is not 2.5m but 1.0m with approximately 15m length. BCA eventually requested the survey team to implement widening of 4-lane with 1.0m sidewalk width for the securement of the implementation schedule.
The survey team discussed with JICA to propose the widening of 4-lane without relocation. After the meeting, the survey team verified an appropriateness of widening of 4-lane, and the outline design was finally carried out in this condition. And it was confirmed that BCA will not relocate this residence and will not pay the compensation fee.

Cutting of the roadside trees was refrained as much as possible. Nevertheless, existing three peaces of roadside trees could not be avoided cutting because those trees existed in the widening area at section-4. Re-planting will be conducted in accordance with the EIA report after cutting.

CHAPTER2 CONTENTS OF THE PROJECT

2.1 BASIC CONSEPT OF THE PROJECT

2.1.1 OVER GOAL AND PROJECT PURPOSE

Since most of the roads in Blantyre were constructed in the 1950s, the growth of traffic volume, due to increasing levels in population concentration, further industry development and pavement damage from severe use throughout the years, has resulted in daily traffic congestion and a higher number of accidents. From this situation, different obstacles can be noticed in relation to citizens' ordinary life and economic activity in general. Therefore, it is expected that, by strengthening road conveyance capacity levels through the improvement of Blantyre city roads, the social economy of Blantyre, and that of Malawi for that matter, shall be activated.

Overall Goal: Malawian economy will grow vigorously.

Project Objective: Capacity of transport in Blantyre City will be encouraged.

2.1.2 BASIC CONCEPT OF THE PROJECT

The project will involve the improvement of Japanese Grant Aid Scheme in order to accomplish the above overall goal including construction to improve roads in Blantyre City. Through this, improvement of road network in Blantyre, mitigation of traffic congestion, and safe traffic are expected. The requested Japanese assistance will include the improvement of major trunk roads, Chipembere Highway (3.47km) and Livingstone Avenue (0.89km), in order to ensure safe and smooth traffic flow in Blantyre City.

1) Section-3: Chipembere Highway (Chichiri RA – Yianakis RA: 2.75 km);

2) Section-4: Chipembere Highway (Yianakis RA – Standard Bank IC: 0.72 km)

3) Section-5: Livingstone Avenue (Standard Bank IC – Illovo RA: 0.89 km)

2.2 OUTLINE DESIGN OF THE JAPANESE ASSISTANCE

2.2.1 DESIGN POLICY

(1) Basic Policy

1) Survey result of traffic volume

It is compared survey result of traffic volume when basic design and outline design.

Table 2.2-1 Survey result of traffic volume

Traffic Volume Survery (2006)

	Sedan / Wagon	Articulated Truck (Semi&Full Trailer)	Motorcycle/ Bike Trailer	TOTAL
Section-3				
PCU	1.00	6.00	0.50	
Survey Data	7,695	572	197	
2-lane	7,695	572	197	
1day conversion	7,695	572	197	
Conversion number	7,695	3,432	99	11,226
Traffic volume for 1-lane (number/day)				5,613
Section-4				
PCU	1.00	6.00	0.50	
Survey Data	7,023	427	158	
1-lane	7,023	427	158	
1day conversion	7,023	427	158	
Conversion number	7,023	2,562	79	9,664
Traffic volume for 1-lane (number/day)				9,664
Section-5				
PCU	1.00	6.00	0.50	
Survey Data	3,595	131	174	
1-lane	3,595	131	174	
1day conversion	3,595	131	174	
Conversion number	3,595	786	87	4,468
Traffic volume for 1-lane (number/day)				4,468

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Traffic Volume Survery (2009)

	Sedan / Wagon	Articulated Truck (Semi&Full Trailer)	Motorcycle/ Bike Trailer	TOTAL
Section-3				
PCU	1.00	6.00	0.50	
Survey Data	21,759	1,983	524	
4-lane	21,759	1,983	524	
1day conversion	21,759	1,983	524	
Conversion number	21,759	11,898	262	33,919
Traffic volume for 1-lane (number/day)				8,480
Section-4				
PCU	1.00	6.00	0.50	
Survey Data	13,409	499	231	
2-lane	13,409	499	231	
1day conversion	16,761	624	289	
Conversion number	16,761	3,744	145	20,650
Traffic volume for 1-lane (number/day)				10,325
Section-5				
PCU	1.00	6.00	0.50	
Survey Data	8,695	538	151	
2-lane	8,695	538	151	
1day conversion	8,695	538	151	
Conversion number	8,695	3,228	76	11,999
Traffic volume for 1-lane (number/day)				6,000

The summary of above table is as next page.

Table 2.2-2 Comparing traffic volume

Traffic volume for 1-lane (number/ day)	Basic design (2006)	Outline design (2009)	Increase rate
Section-3	5,613	8,480	1.510
Section-4	9,664	10,325	1.068
Section-5	4,468	6,000	1.343

Every section were increased. Particularly, increase rate of section-3 and 4 were remarkable. It is limited capacity of traffic volume at section-4 by present 2-lanes. It is impossible to correspondence more traffic volume by 2-lanes.

① Section-3

The number of traffic volume per one day for 1-lane was 8,500 at present, the number of future traffic volume per one day for 1-lane will be 14,100 – 17,800 at 15 years later. That's future traffic volume will be corresponded 4-lanes by Japanese Road Association (JRA) design standard, the present lane is proper.

The damage of road pavement is seen to advance after 2 years of basic design survey on pavement condition.

② Section-4

The number of traffic volume per one day for 1-lane was 10,300 at present, the number of future traffic volume per one day for 1-lane will be 17,100 – 18,400 at 15 years later. That's future traffic volume will be corresponded 4-lanes by JRA design standard, we consider that the request from Malawi is proper to widen 4-lanes at setuion-4.

The damage of subbase course is seen to advance by survey result of Crack investigation on this survey.

③ Section-5

The number of traffic volume per one day for 1-lane was 6,000 at present, the number of future traffic volume per one day for 1-lane will be 10,000 – 10,500 at 15 years later. That's future traffic volume will be corresponded 2-lanes by JRA design standard, the present lane is proper.

The damage of subbase course is seen to advance by survey result of crack investigation on this survey.

2) Widening to 4-lane

The survey team discussed with the Government of Malawi to confirm the project area as described in page 1-2. Although widening of the Section-4 was initially determined as 2-lane to 3-lane in the basic design (additional 1-lane for right-turn), widening was finally decided to 4-lane due to the following reasons;

① Securement of Traffic Capacity

Based on the traffic volume survey, additional lane is required for the estimated future traffic volume. There are six objects like fences and gates in ROW area which are easy to relocate, and BCA is relocating now. Also there is a residence with store here, but it is not necessary to relocate by adjusting sidewalk width after widening to 4-lane.

② Relocation for widening to 4-lane

There are six objects like fences and gates in ROW area which are easy to relocate, and BCA is relocating now. Also there is a residence with store here, but it is not necessary to relocate by adjusting sidewalk width after widening to 4-lane.

③ Traffic safety

For right turn, 4-lane road by using roundabouts is safer than 3-lane by using center lane (See Figure2.2-1).

④ Traffic Bottle Neck

Traffic flow has been changed by improving Section-1&2, Chipembere Highway from 2-lane to 4-lane. Therefore it became difficult to secure traffic capacity.

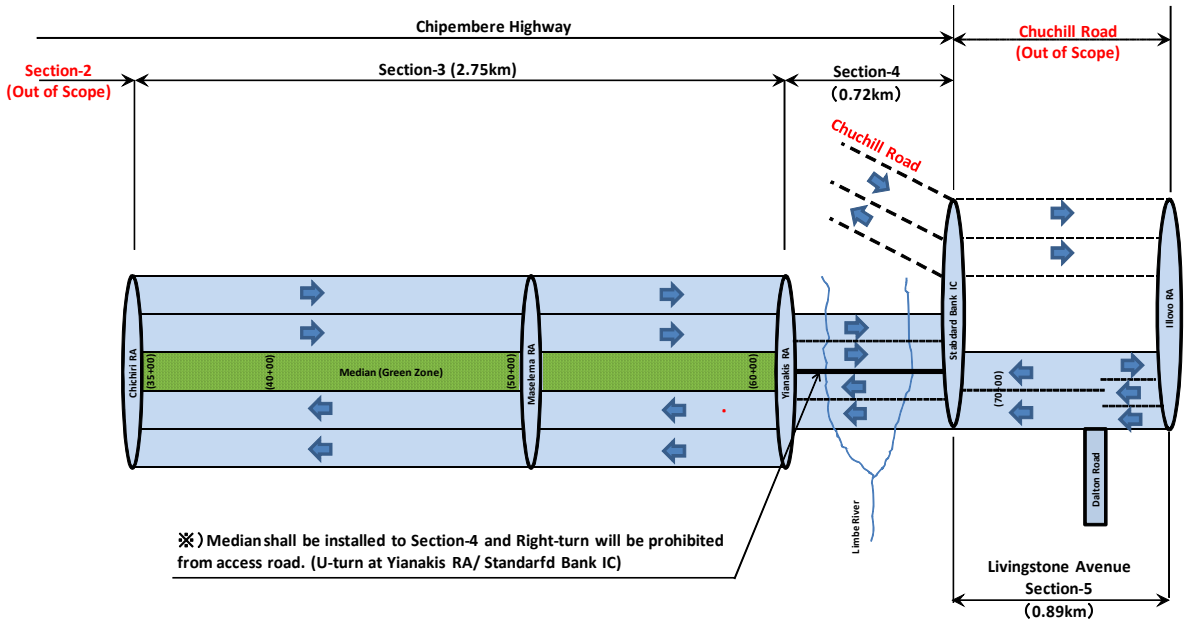


Figure 2.2-1 Lane number at section-4

3) Pavement

The following investigation/test were carried out through the site investigation to technically assess the road condition, and choose appropriate repairing method for pavement taking into consideration present circumstances.

- ✓ Crack investigation
- ✓ Benkelman Beam Testing
- ✓ Dynamic Cone Penetration

(2) Natural Environmental Conditions Policy

The features of natural environment in the project area are that lots of offices and buildings exist along the route, and there is little flat area from the geographical view point. The improvement of slope should be taken in longitudinal and cross section, taking into account the entrance/exit of offices and buildings. In addition, construction plan taking into consideration economical design, negative impact for inhabitant stemming from noise and tremble, and securing the existing traffic system, should be considered.

(3) Socio-Economic Conditions Policy

As stated in (1) Basic Policy, widening from 2-lane to 4-lane should be applied to Section-4 taking into consideration social/economic condition. And considering there are many commuters by walking in Blantyre, the following should be carried out;

- ✓ Construction of sidewalk in all sections
- ✓ Improvement of five (5) bus lay byes

(4) Construction & Procurement Conditions Policy

Construction material should be chosen taking into consideration quality, cost, and reliability of procurement. In addition, efficient construction plan should be made taking into consideration procurement condition on material, machinery, and labor management.

(5) Practical Use Policy for Local Contractor

The local contractor including construction material and machinery are available in the project area. Because the construction in the project section is, however, technically difficult as stated in (2) Natural Environmental Conditions Policy, technical guidance by the Japanese Engineer is quite necessary.
The construction method, which is applicable and manageable by the local government, should be adopted.

(6) Operation and Maintenance Conditions Policy

Open channel type is basically applied to the drainage facility along the road for easy operation and maintenance. In addition, the pavement, which is manageable by the local contractor, should be adopted. Since the operation and maintenance is not so difficult for the local government, asphalt concrete pavement is generally adopted.

(7) Grade Setting Policy for Facilities

The number of lanes was determined based on the number of lanes of the existing road Sections-3 and 5. The number of lanes for Section-4 was determined as mentioned in (1). The numbers of lanes are as follows;

- ✓ 4-lanes in Section-3
- ✓ 2-lanes (One way) in Section-5
- ✓ 4- lanes in Section-4

The design velocity in Section-3 was determined as 60 km/h. The design velocity in Sections-4 and 5 was, however, determined as 50 km/h due to geometrical constraint in the project area.

Since the survey team confirmed that existing arch culverts are still functioning, arch culvert under existing road should be kept and the additional pipe culvert should be connected under the widening area.

(8) Construction Method Policy

Procedure and standard of material test and final inspection to be required for quality assurance should be explicitly mentioned in the design report and specification. Quality assurance should be carried out in accordance with design report and specification. Construction plan was made based on the following considerations;

- ✓ Safety and environment for inhabitant and the persons related to construction work
- ✓ Minimizing the impact on the existing traffic within the proposed construction period

(9) Social Consideration Policy

The following points should be considered at the time of the planning, designing, and construction to minimize potential influences to environment and society;

- ✓ The road alignment should be layout within ROW to minimize land acquisitions.
- ✓ Removal of trees and objects should be minimized
- ✓ Waste arisen from construction works should be minimized and should be properly treated
- ✓ To minimize congestion during construction, number of lanes of existing road should be maintained
- ✓ Countermeasure against noise, vibration, and dust pollution should be considered
- ✓ The conditions indicated in the EIA license should be fully complied

(10) Environmental Consideration Policy

① Environmental Impact Assessment (EIA)

The survey team confirmed that "Project Component" is same as the basic design at the Minutes of Discussion (MD) meeting. The Environmental Impact Assessment (EIA) at the basic design has been worked out in the condition of widening to 4-lane, therefore the EIA is still effective for this stage. This was confirmed with Blantyre City Assembly (BCA).

② Relocation for widening

BCA is implementing Relocation Plan based on original road design plan. There are seven objects (six fences and gates and one residence with store) in the ROW area. It was judged that these compensation costs (land cost and relocation cost) are reasonable because they are more expensive than market price in Blantyre city (3,000,000 MKW/ha). BCA has held stakeholder meeting so as to reach a consensus for relocation among landlords. And BCA has already paid compensation for relocation to six landlords until August 2008 except the residence.

③ Widening to 4-lane

BCA requested the survey team to change the survey component on widening Chipembere highway from 2-lane to 4-lane but not 3-lane.

Regarding the residence in ROW area, relocation is not necessary in case of 3-lane widening, but the residence occupy the ROW. Implementation schedule proposed by the survey team is unable to follow due to time constraint of the relocation. BCA inquired the survey team the possibility of widening without relocation of the residence by adjusting sidewalk width partially. In response to this inquiry, the survey team roughly assessed the alternatives. As the result of assessment, it was clarified that widening was able to be conducted without relocation if the sidewalk width is not 2.5m but 1.0m with approximately 15m length. BCA eventually requested the survey team to implement widening of 4-lane with 1.0m sidewalk width for the securement of the implementation schedule.

The survey team discussed with JICA to propose the widening of 4-lane without relocation. After the meeting, the survey team verified an appropriateness of widening of 4-lane, and the outline design was finally carried out in this condition. And it was confirmed that BCA will not relocate this residence and will not pay the compensation fee.

④ Street Planting

Cutting of the roadside trees was refrained as much as possible. Nevertheless, existing three peaces of roadside trees could not be avoided cutting because those trees existed in the widening area at section-4. Re-planting will be conducted in accordance with the EIA report after cutting.

⑤ Underground Utilities

It is required to relocate underground utilities such as electric lines, water pipes for widening to 4-lane. According to BCA, Relocation of utilities will be finished until May 2010, before construction stage.

2.2.2 BASIC PLAN (CONSTRUCTION PLAN)

2.2.2.1 ROAD DESIGN

The road design is carried out based on the policy of the basic design in principle. But the following are modified design policy from the basic design as indicated in Appendix-2, Technical Note.

(1) Modified points from basic design

After discussion with BCA, the following are modified from basic design:

- ✓ Pavement Structure (Cemented (sub)base to Granular (sub)base)
- ✓ Widening in Section-4 is not to 3-lane but 4-lane.
- ✓ Pavement method of sidewalk is changed form tile type to interlocking type.

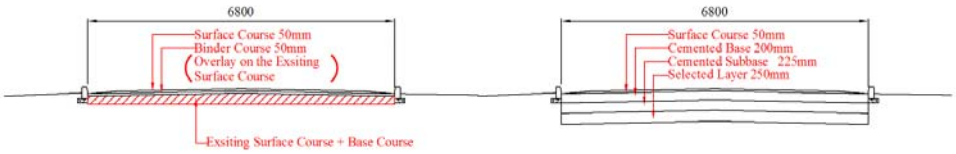
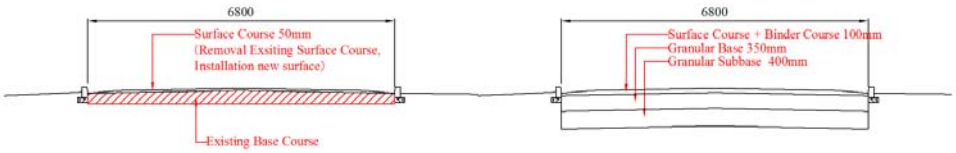
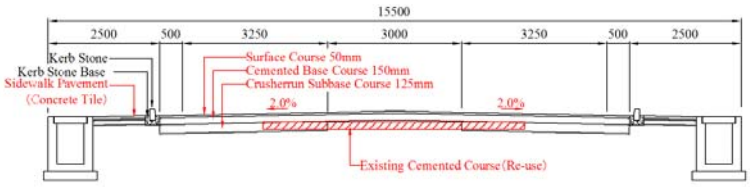
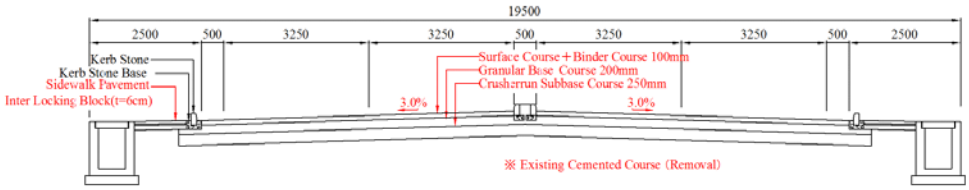
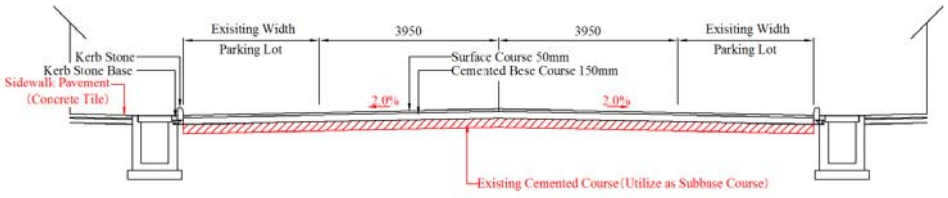
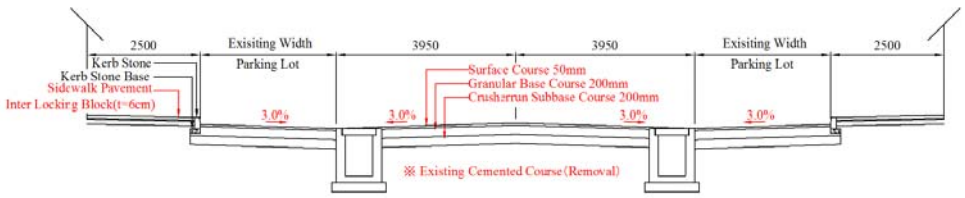
Photo 2.2-1 Concrete tile type

Photo 2.2-2 Interlocking block type

- ✓ Cross-sectional slope of Sections-4 and 5 is changed from 2% to 3%.
- ✓ Hump is not set into the whole section.
- ✓ No traffic signal is newly constructed (Existing traffic signals should be utilized).
- ✓ Existing drainage facility should be used as possible at Section-3.
- ✓ Width of bus stop is modified from 3.0 m to 4.0 m in accordance with Malawian new standard. (However if land space is limited, width of bus lay bye can be reduced with 1.0 m width sidewalk).
- ✓ Construction area and curve radius of access road is determined in accordance with standard drawing. In case that there are structures on the project road area, curve radius should be determined without relocation.
- ✓ For river crossing facility, new pipe culvert (Ø=1,500 mm) should be connected to the existing arch culvert instead of 1.5m x 1.5m box-culvert, because the existing culverts have no functional problem based on the field survey.

Modified design policy is tabulated in Table 2.2-3.

Table 2.2-3 Modified points from Basic Design

Drawing
General Section (Overlay/Replacement of Surface)　　Special Section (Replacement from sub-grade)    
・Repairment method at General Section: Overlay (New Surface on the existing surface)⇒Replacement of Surface (Removal & Replace surface) ・Pavement Structure at Special Section : Asphalt + Cemented (sub)base⇒ Ashpalt + Granular (Sub)base ・Pavement Type of Sidewalk: Concrete Tyle ⇒ Interlocking Block Type ・The width of bus Lay Bye; 3m⇒4m
   
・Number of Lanes: 3-lane (total Width 15.5m)⇒ 4-lane (Total Width 19.5m) ・Utilizing Existing Cemented (sub)base⇒ Removal & Replace from subbase by Granular material ・Cross-section Slope : 2%⇒3% ・Pavement Type of Sidewalk: Concrete Tyle ⇒ Interlocking Block Type ・The width of bus Lay Bye; 3m⇒4m
   
・Utilizing Existing Cemented (sub)base⇒ Removal & Replace from subbase by Granular material ・Cross-section Slope : 2%⇒3% ・Pavement Type of Sidewalk: Concrete Tyle ⇒ Interlocking Block Type ・Location of Drainage : In Sidewalk⇒In Shoulder

(2) Design Standard

- ✓ Design Standard of Malawi
- ✓ Design Standard of Southern Africa Transport and Communications Commission (SATCC)
- ✓ Design Standard of American Association of State Highway and Transportation Officials (AASHTO)
- ✓ Japanese Road Association (JRA) etc.

(3) Typical Cross Section of Road

After discussion with BCA, the following Typical Cross Sections for each section were confirmed.

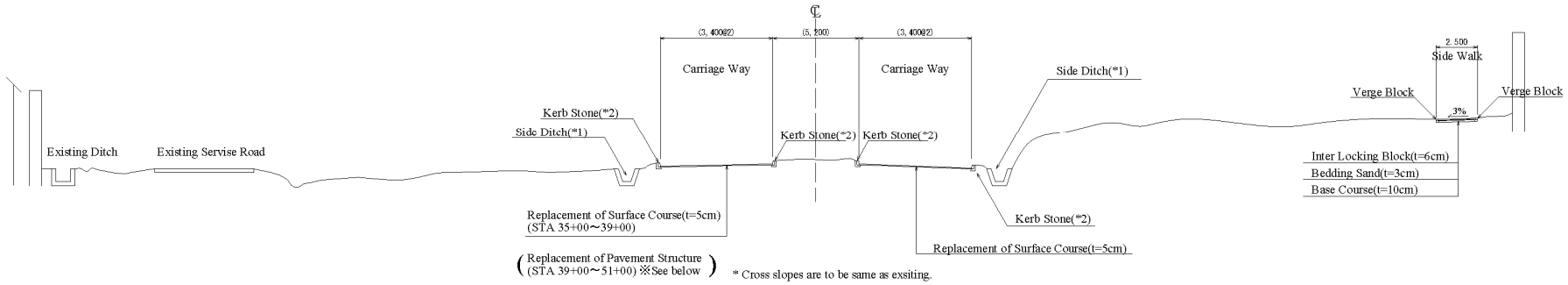
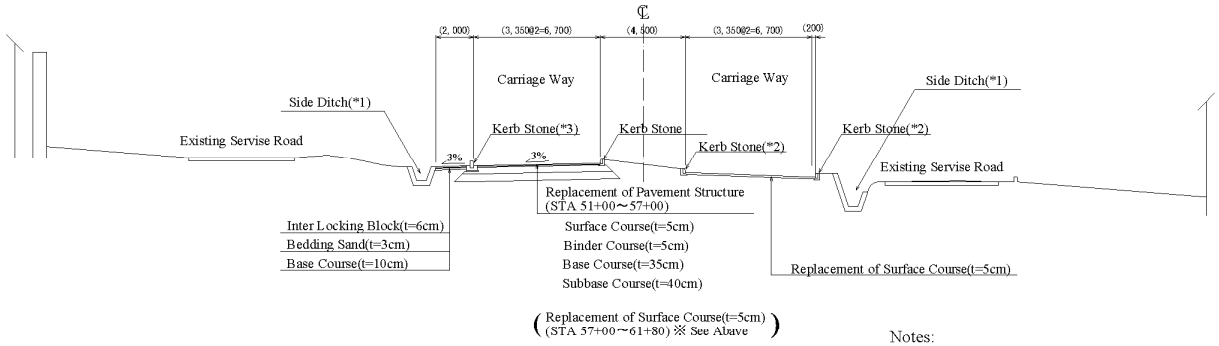


Figure 2.2-2 Section-3 (Chichiri RA to Maselema RA) Typical Cross Section



Notes:
1. Figure in ( ) shows a dimendion of the exisiting road.
2. Existing side ditches are to be utilized for those shown with *1 by cleaning or repairing if existing side ditches are damaged.
3. Existing kerb stones are to be utilized for those shown with *2 by painting. Where existing kerb stones are damaged or missing, new kerb stone are to be installed.
4. Flat type kerb stones are to be installed for those shown with *3.
5. The section from 34+35 to 35+00 is not included in the Project.

Figure 2.2-3 Section-3 (Maselema RA to Yianakis RA) Typical Cross Section

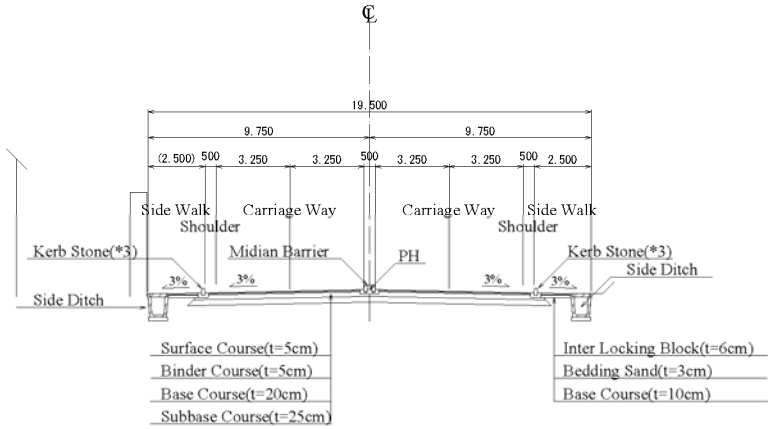
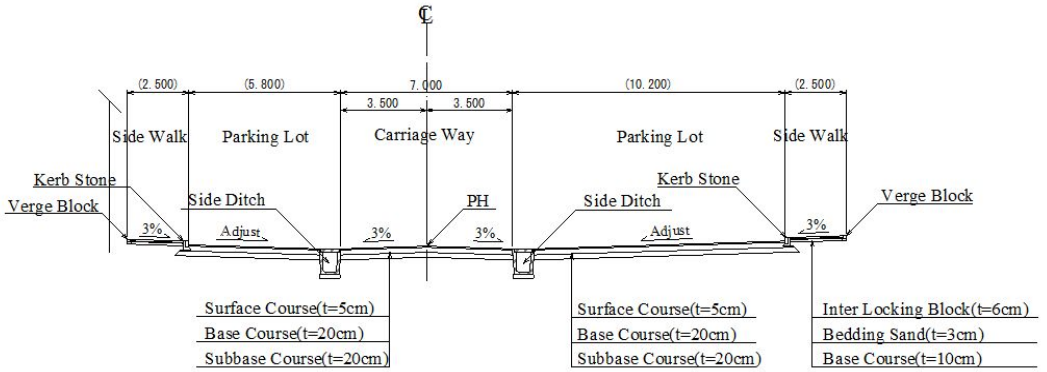


Figure 2.2-4 Section-4 (Yianakis RA to Standard Bank IC) Typical Cross Section



Notes:
1. Figure in ( ) shows a dimension of existing road.
2. Flat type kerb stones are to be installed for those shown with *3.

Figure 2.2-5 Section-5 (Standard Bank IC to Illovo RA) Typical Cross Section

(4) Horizontal/Vertical Alignment

Improvement of alignment has constraint because the project road is located in urban district and there are lots of buildings along the road and there are many utility poles and manholes that exist in the sidewalk. Therefore, existing alignment is adopted to proposed road design as a rule except the following improvements:

- ✓ Improvement of horizontal alignment based on the widening of Section-4
- ✓ Adjustment of vertical alignment in line with improvement of cross sectional slope of 3% in Sections 4 and 5
- ✓ Improvement of vertical alignment of two (2) river crossing points in Section-4

2.2.2.2 PAVEMENT DESIGN

(1) Design Policy

The following are modified design policy in this stage:

- ✓ Granular material is used for base course material instead of cemented material
- ✓ Replacement of surface layer should be adopted instead of overlay method

[The problems of cemented material]

- ✓ According to SATCC, utilizing cemented material should be adopted only if crushed stone material is not available locally. It is confirmed that crushed stone is available in Blantyre City.
- ✓ Reflection crack arising in cemented material can penetrate surface of asphalt concrete cement.
- ✓ Difficulty of construction in rainy season.

[The problems of overlay method]

- ✓ In case the condition of existing surface is not good, the crack can easily reach up to the surface.
- ✓ Overlay method needs good condition not only of surface, but also base/sub-base course. It is obvious that base/sub-base course will have some problems in the section where flatness cannot be maintained. Therefore, overlay method is not suitable for these sections.
- ✓ Overlay method which makes the elevation higher will be inappropriate in Sections-4 and 5 because there are a lot of existing buildings and offices.

Accordingly, design should be carried out in the light of availability in asphalt concrete surface and crushed stone sub-base course.

Design Policy on Section-3

[Previous policies on basic design]

1) Overlay method (existing asphalt surface covered by new asphalt)

2) Replacement method (replacement surface by asphalt, base course and sub-base course by cemented materials)

*) Applying area using the two above methods were determined by PSI value (5: Extremely good, 4: Good, 3: Normal, 2: Poor, 1: Extremely poor) which was evaluated by four members of the Study Team. 1) Overlay method was adopted to more than PSI=2 average, and 2) Replacement method was adopted to less than PSI=2 average.

[Modified Design Policies]

1) Replacement of surface layer (replacement of surface after removal of existing surface)

2) Replacement method (replacement of asphalt concrete surface, crushed stone of base course, and crushed stone of sub-base course by granular materials)

3) Applying area using the two above methods are determined based on the results of Benkelman Beam Testing (See Appendix A7-7);

- ✓ From 34+35 to 35+00 (in & out bound): No improvement of pavement. (because already improved in Phase 1)
- ✓ From 35+00 to 39+00, and 57+00 to 61+80 (outbound), From 35+00 to 61+80 (inbound): Replacement of surface layer.
- ✓ From 39+00 to 57+00 (outbound): Replacement method.

Design Policy on Sections-4 and 5

[Previous policies on basic design]

1) To utilize existing sub-base (to replace surface asphalt and base course by cemented material)

2) To construct new pavement structure at widening portion in Section-4 (surface by asphalt, base course and sub-base course by cemented materials)

[Modified Design Policies]

1) Replacement method (replacement of asphalt concrete surface, crushed stone of base course, and crushed stone of sub-base course by new materials)

2) To construct new pavement structure at widening portion in Section-4 (surface by asphalt, base course and sub-base course by granular materials)

*) It was judged that the replacement method should be adopted for all sections in Sections 4 and 5 based on Crack Investigation Result. (See Appendix A7-5)

(2) Pavement Design

Design Standard

Pavement structure was designed based on Japanese Road Association (JRA) standard (TA method) (See appendix A7-11).

Design Period

15 years (2012 to 2026) as initial service period

Design Traffic Volume

Based on the result of Traffic Survey (See appendix A7-1)

Design load

Traffic Volume of Heavy vehicles (per 1 direction, per 1 day) is quoted for JRA.

Design CBR

Same CBR values as the basic design were quoted based on Dynamic Cone Penetration Testing Result for confirmation of Appropriateness of previous CBR values (See Appendix A7-10).

1) Section-3: CBR = 4

2) Section-4, 5: CBR = 12

Materials for Pavement

Pavement design was calculated using the following materials based on the reason mentioned in (1), Design Policy:

1) Surface course: Hot Asphalt Mixtures

2) Base course: Mechanical Stabilized gravel (CBR>80)

3) Sub-base course: Crusher Run (CBR>30)

*) Interlocking block (t=6cm) pavement is used for sidewalk pavement.

2.2.2.3 INTERSECTION DESIGN

The following 3 intersections for improvement are included in this project:

1) Maselema Roundabout

2) Yianakis Roundabout

3) Illovo Roundabout

Based on the basic design policy, widening of the intersections should not be included in this phase. Only improvement of existing structures should be done. In addition, asphalt mixture using the same material as the general road should be used for intersection pavement because of the following reasons:

- ✓ Semi-flexible pavement proposed in the basic design has no achievement in Malawi, and it is difficult for BCA to maintain.
- ✓ Wheel rut could not be observed at any intersections in the field survey.
- ✓ BCA's maintenance level is high for asphalt pavement. Repairing for pothole with flatness can be observed in many places. Meanwhile, BCA cannot repair for special pavement like a concrete pavement.
- ✓ Asphalt pavement is more economical than semi-flexible pavement.

2.2.2.4 STRUCTURAL DESIGN

Photo 2.2-3 Existing arch culvert

There are 2 crossing structures along Section-4 at the tributary of Limbe River. Existing structures are arch type and made by brick. They are old structures constructed in 1950s, but have no functional problem (Passing water area, Damage level etc). A 1.5m X 1.5m box-culvert was proposed in the basic design stage. However, a ϕ 1,500 mm Pile culvert should be proposed to connect to the existing structure in this outline design.

2.2.2.5 DRAINAGE DESIGN

(1) Design Policy

Existing drainage structure should be utilized as much as possible at Section-3 based on the field survey result. But the size should be studied by the newest rainfall data. Regarding drainage at Sections-4 and -5, all drainage structures should be replaced with new structure because of big damage.

Considering easy maintenance, open drainage (for enough space) or U-shape with simple cover (for narrow space) should be proposed. Pipes should be placed only to cross-drainage and under entrance because of difficulty of maintenance. Minimum size of pipe should be ϕ 600 mm for easy maintenance.

(2) Drainage Design

*) See appendix A7-13 for the detail of calculation of drainage

Dimension Plan for Drainage Structures

Dimensions of side-ditch and cross-drainage pipes were determined based on the following drainage calculations.

Design Rainfall Volume

The rainfall data at Chichiri observation point for the past 10 years which is near to the beginning point of the project road was taken.

This data was adopted for the drainage design. The design rainfall volume was calculated by Normal Probability Distribution Method.

- ✓ Side-ditch ; 107.4mm/h (3-year probability)
- ✓ Cross-drainage ; 120.8mm/h (5-year probability)
- ✓ River Crossing ; 136.4mm/h (10-year probability)

Calculation of Discharge

Discharge was calculated by Rational Formula as following;

$Q = 1/3.6 \times A \times C \times I$

Where, Q: Discharge (m^3/sec)
A: Catchment Area (ha)
C: Coefficient of Discharge (=0.8 for Road surface)
I: Intensity of Rainfall (mm/hr)

Calculation of Drainage Structures' Sizes

Sizes of drainage structures were determined based on the Manning's Formula for velocity of flow with about 20% extra room above the calculated depth of water (cross section area of flow) as following;

V = 1/n x R^(2/3) x I^(1/2)

Where, V: Velocity of Flow (m/sec)
n: Coefficient of Roughness (Concrete pipe= 0.013, and Concrete Ditch= 0.015)
R: Hydraulic Mean Depth (Cross Section Area of Flow/ Wetted Perimeter)
I: Gradient of Flow Surface

2.2.2.6 DESIGN OF SAFETY FACILITIES

(1) Signals, Humps

As mentioned in 2.2.1., there are no signals along this project road. Existing signals (2 signals) should be utilized. And there are no humps in this project area.

(2) Traffic Signs

The following traffic signs are placed at necessary points:

- ✓ Stop Sign
- ✓ Speed Limit
- ✓ Give Way
- ✓ Roundabout
- ✓ Bus Lay Bye
- ✓ Pedestrian Crossing
- ✓ Traffic Signals
- ✓ No Entry
- ✓ One-way Road
- ✓ Direction to be Followed

(3) Road Markings

The following road marking signs are placed:

- ✓ Center Line
- ✓ Shoulder Line
- ✓ Allow of Direction
- ✓ Stop Line
- ✓ Pedestrian Crossing

Photo 2.2-4 Ordinary Pedestrian Crossing
Width is only 2m, therefore difficult to see from driver seat

Photo 2.2-5 New type pedestrian Crossing
This type has been adopted in Phase I with 3m width, therefore easy to see from driver seat