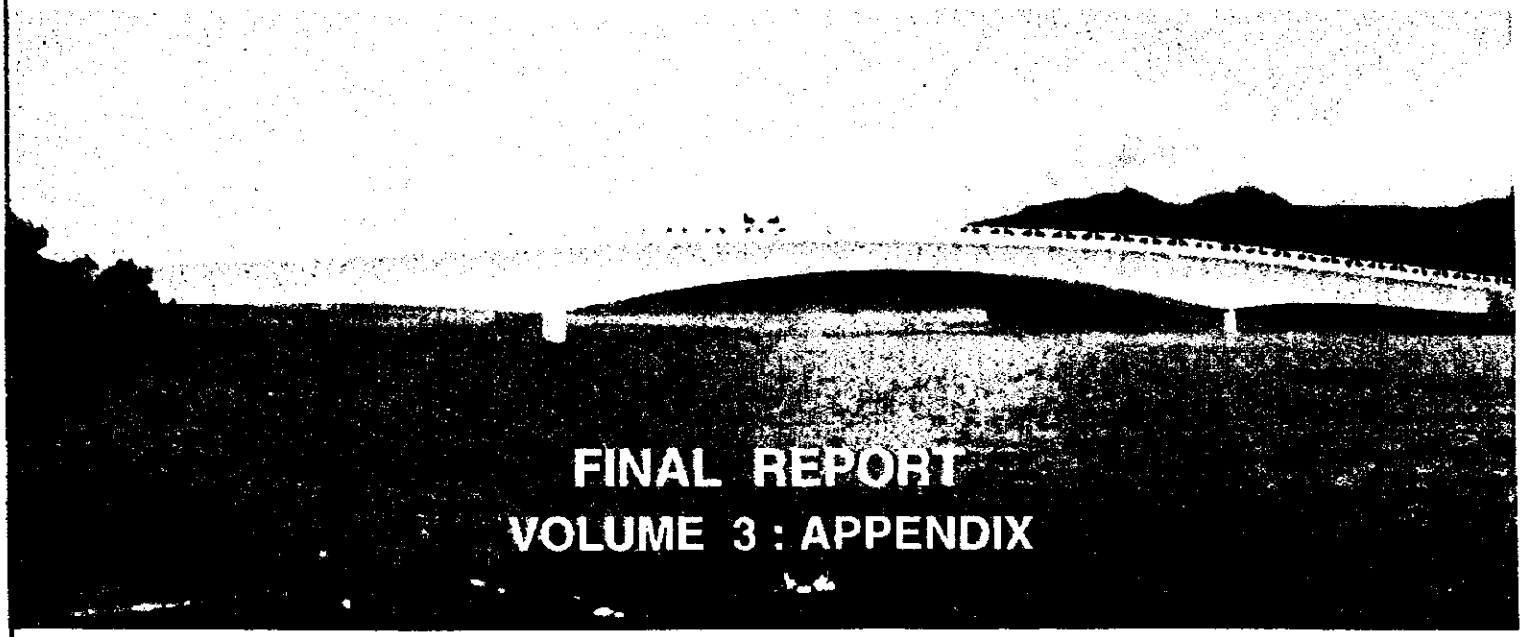
社会開発調査部報告書

No. 3

MINISTRY OF WORKS AND SUPPLIES
THE REPUBLIC OF MALAWI

THE FEASIBILITY STUDY ON THE RECONSTRUCTION OF MANGOCHI ROAD BRIDGE IN THE REPUBLIC OF MALAWI



FINAL REPORT
VOLUME 3 : APPENDIX

AUGUST 1998

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.
CHODAI CO., LTD.

MINISTRY OF WORKS AND SUPPLIES
THE REPUBLIC OF MALAWI

THE FEASIBILITY STUDY ON THE RECONSTRUCTION OF MANGOCHI ROAD BRIDGE IN THE REPUBLIC OF MALAWI

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INTRODUCTION

1.1 Scope of Work

SCOPE OF WORK

FOR

THE FEASIBILITY STUDY

ON

THE RECONSTRUCTION OF MANGOCHI ROAD BRIDGE

IN

THE REPUBLIC OF MALAWI

AGREED UPON BETWEEN

MINISTRY OF WORKS AND SUPPLIES

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Lilongwe, Dated the 7th of November 1997

Mr. M. A. Kammalere
Principal Secretary
Ministry of Works and Supplies

Mr. Kazuhiko YAMAGISHI
Team Leader
Preparatory Study Team
Japan International Cooperation Agency

Mr. J. C. T. Nthani
Deputy Secretary (Bilateral)
Ministry of Finance

A . INTRODUCTION

In response to the request of the Government of the Republic of Malawi (hereinafter refered to as "the Government of Malawi"), the Government of Japan decided to implement the Feasibility Study on the Reconstruction of Mangochi Road Bridge in the Republic of Malawi (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

Accordingly, Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, will undertake the Study, in close cooperation with the authorities concerned of the Government of Malawi. Ministry of Works and Supplies (hereinafter referred to as "MOWS") shall act as the counterpart agency to the Japanese Study Team (hereinafter referred as" the Team") and also act as the coordinating body with other relevant organizations for the smooth implementation of the Study on behalf of the Government of Malawi.

This document sets forth the Scope of Work with regard to the Study.

B. OBJECTIVES OF THE STUDY

The objective of the Study is to conduct feasibility study for the reconstruction project of Mangochi Road Bridge including its approaches for the period up to the year of 2005.

C. SCOPE OF THE STUDY

To achieve the objectives mentioned above, the Study shall cover the following items;

1. Preliminary Economic Feasibility

1.1. Socio-economic assessment

(1) Collection of socio-economic data (population, private and public investment plans, employment, land use plan and so on by national and regional level)

(2) Collection of traffic and transport data including transport system, costs, price subsidies etc.

(3) Collection of national and regional development plans

(4) Assessment of existing social-economic conditions and impacts which a new bridge construction will influence

(5) Forecast of future socio-economic framework

1.2. Traffic Analysis

(1) Traffic survey (O-D survey, axle load survey)

(2) Forecast of future traffic demand

1.3. Economic Analysis

(1) Examination of available information on vehicle operating costs, maintenance costs

(2) Preliminary estimation of economic benefits and costs derived from new bridge alternatives

(3) Cost estimate of the bridge construction and maintenance

(4) Estimation of the benefits derived from the bridge

1.4. Economic evaluation

(1) Calculation of economic internal rate of return, net present values and costs-benefits analysis

(2) Sensitivity analysis

2. Assessment of institutional capability of MOWS on road and bridge construction and maintenance

3. Preliminary Engineering

3.1. Data collection and analysis

(1) Soil and geological data

(2) Climatic and seismic data

(3) Hydrological data

(4) Topographic data

3.2. Site Survey

(1) Topographic survey

(2) Soil and geological survey

(3) Hydrological survey

(4) Land use survey

(5) Survey on materials mines for construction of road and bridge

3.3. Examination of design criteria

3.4. Comparative study of alternatives

(1) Study on the construction of new bridge and approaches (routes, location, bridge type and others)

(2) Evaluation of alternatives

3.5. Preliminary design and quantity estimate of the optimum alternative

(1) Bridge design

(2) Approach roads

(3) Quantity estimate

4. Environmental Impact

4.1. Initial environmental evaluation

4.2. Environmental impact assessment

(1) Social impacts assessment

(2) Natural environment

5. Implementation Program

5.1. Construction program

5.2. Maintenance program

6. Conclusions and Recommendations

D. STUDY SCHEDULE

The Study shall be conducted in accordance with the attached tentative schedule.

E. REPORTS

JICA shall prepare the following reports in English and submit them to the Government of Malawi;

1. Inception Report

   Twelve (12) copies

   At the commencement of the Study;

2. Interim Report

   Twelve (12) copies

   Within two and half (2.5) months after the commencement of the Study;

3. Draft Final Report

   Twelve (12) copies

   Within four (4) months after the commencement of the Study;

The written comments on the Draft Final Report from the Government of Malawi shall be delivered to JICA within one (1) month after submission of the draft final reports.

4. Final Report

   Seventeen (17) copies

   Within one (1) month after the receipt of the written comments on the Draft Final Report from the Government of Malawi

F. UNDERTAKINGS OF THE GOVERNMENT OF MALAWI

1. To facilitate the smooth conduct of the Study, the Government of Malawi shall take necessary measures;

(1) to secure the safety of the Japanese Study Team

(2) to permit the members of the Team to enter, leave and sojourn in Malawi for the duration of their assignments therein, and exempt them from foreign registration requirements and consular fees

(3) to exempt the members of the Team from taxes, duties and any other charges on equipment, machinery and other material brought into Malawi for the conduct of the Study

(4) to exempt the members of the Team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Team for their services in connection with the implementation of the Study

(5) to provide necessary facilities to the Team for the remittance as well as utilization of the funds introduced into Malawi from Japan in connection with the implementation of the Study

(6) to secure permission for the Team for entry into private properties or special areas for the conduct of the Study

(7) to secure permission for the Team to take all data and documents (including maps and photographs) related to the Study out of Malawi ; and

(8) to provide medical services as needed, while its expenses will be chargeable on members of the Team

2. The Government of Malawi shall bear claims, if any arises, against the members of the Team resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Team.

3. The counterpart agency shall, at its own expenses, provide the Team with the following in cooperation with relevant organizations;

(1) data and information related to the Study available in MOWS, including maps and photographs

(2) counterpart personnel

(3) to provide office with appropriate area and necessary equipment for the Study Team

(4) credentials or identification cards

G. UNDERTAKINGS OF JICA

For the implementation of the Study, JICA shall take the following measures:

1. to dispatch the Team to Malawi at its own expense; and

2. to pursue technology transfer to the Malawian counterpart personnel in the course of the Study.

H. OTHERS

JICA and MOWS shall consult with each other in respect of any matter that may arise from or in connection with the Study.

TENTATIVE STUDY SCHEDULE

Month	1	2	3	4	5	6
Work in Malawi						
Work in Japan						
Report Presentation	△ IC/R		△ IT/R	△ DF/R		△ F/R

IC/R: Inception Report

IT/R: Interim Report

DF/R: Draft Final Report

F/R : Final Report

1.2 Minutes of Meeting (Dated 7th Nov., 1997)

MINUTES OF MEETING

ON

THE SCOPE OF WORK

FOR

THE FEASIBILITY STUDY

ON

THE RECONSTRUCTION OF MANGOCHI ROAD BRIDGE

IN

THE REPUBLIC OF MALAWI

AGREED UPON BETWEEN

MINISTRY OF WORKS AND SUPPLIES

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Lilongwe, Dated the 7th of November 1997

Mr. M. A. Kammalere
Principal Secretary
Ministry of Works and Supplies

Mr. Kazuhiko YAMAGISHI
Team Leader
Preparatory Study Team
Japan International Cooperation Agency

Mr. J. C. T. Nthani
Deputy Secretary (Bilateral)
Ministry of Finance

The preparatory study team for the Feasibility Study on the Reconstruction of Mangochi Road Bridge in the Republic of Malawi (hereinafter referred to as "the Study") organized by the Japan International Cooperation Agency (hereinafter referred to as "JICA") headed by Mr. Kazuhiko YAMAGISHI visited the Republic of Malawi from 1st November to 8th November, 1997, and had a series of discussions with the government of Malawi, represented by Ministry of Works and Supplies (hereinafter referred to as "MOWS"). List of participants is shown in Attachment 1.

As a result of the said discussions, both sides reviewed and came to an agreement on the Scope of Work (hereinafter referred to as "S/W") of the Study, and signed it on 7th November, 1997.

This document summarizes major items discussed between both sides and is meant to supplement the S/W for the smooth conduct of the Study.

1. Reconfirmation of the project justification

MOWS reaffirmed the study team that this project is still high on Government's priority. MOWS informed the study team that the design of the road from Mangochi through Chiponde, Ntaja, Naminga to Liwonde has been completed and the tendering process started in October, 1997 with a prequalification exercise. Completed Tender Documents and a Feasibility Study Report were submitted to the study team for inspection. As a result of the upgrading of this road, the only bottleneck will be the Mangochi Bridge.

MOWS informed the team that plans are underway for the European Union (EU) to fund the rehabilitation of the M10 road from Mua to Monkey Bay to a Class 1 bitumen road.

MOWS also informed the team that the Development Bank of Southern Africa (DBSA) have expressed interest to fund the improvement of the Mangochi to Makanjila road along the eastern shore of Lake Malawi. Completion of the construction of this road will attract tourism and agricultural development.

2. Title of the Study

Both sides agreed to use "The Feasibility Study on the Reconstruction of Mangochi Road Bridge in the Republic of Malawi" as the title of the Study.

3. Study Area

Both sides agreed that the Study should cover the existing Mangochi Road Bridge, approaches, and environs.

4. Target year

Both sides agreed that the target year of the Study shall be 2005.

Desirable schedule of this project may be as follows;

Phase I	Feasibility Study	1998. 2. - 1998. 8.
II	Detailed Design	1999 - 2000
III	Construction	2000 - 2002

5. Economic evaluation

MOWS requested that the full scale study team should use the HDM-III for economic analysis and evaluation. The Japanese side agreed.

6. Environmental survey

Both sides agreed that the full scale study team and MOWS would cooperate to carry out environmental survey.

7. Steering Committee

Both sides agreed that the Government of Malawi would establish a Steering Committee consisting of Sections of MOWS (Planning, Bridges, Highways, Construction, Planning & Evaluation), Ministry of National Heritage, Ministry of Forestry, Fisheries and Environmental Affairs, Ministry of Finance, National Economic Council co-opted as required.

8. Undertaking of the Government of Malawi

(1) The Japanese side requested MOWS to provide the office space for the full-scale study team. MOWS agreed.

(2) The Government of Malawi shall provide the full-scale study team with copies of all available data , reports and any information considered relevant for the execution of the Study.

9. Undertaking of JICA

(1) The Malawian side requested that the Malawian counterpart personnel take advantage of training in Japan related to the Study to promote effective technology transfer. The Japanese side promised to convey this request to the JICA Headquarters in Tokyo.

(2) The Japanese side agreed that JICA would bear the costs to collect new data and information if required in the course of the Study.

(3) The Malawian side requested that JICA will bear the following costs:

(a) fee of necessary equipment (electricity, telephone, fax machine, furniture)

(b) appropriate numbers of vehicles to be used while the full scale study team is in Malawi

The Japanese side promised to convey these requests to JICA headquarters.

Attachment 1

PARTICIPANTS LIST

THE MALAWIAN SIDE

1. Mr. M. A. Kammalere	Secretary, Ministry of Works and Supplies (MOWS)
2. Mr. J. A. Makunje	Acting Director of Roads, MOWS
3. Mr. E. L. K. Mwakhwawa	Deputy Director of Roads, MOWS
4. Mr. B. Kapoteza	Chief Civil Engineer, MOWS
5. Mr. B. Nayeja	Civil Engineer, MOWS
6. Mr. L.S. Siwande	Chief Planning & Evaluation Officer, MOWS

THE JAPANESE SIDE

1. Mr. Kazuhiko YAMAGISHI	Team Leader, Preparatory Study Team
2. Mr. Koichi KITO	Study Planning, Preparatory Study Team
3. Mr. Masahiro ISHIDA	Bridge Maintenance Planning, Preparatory Study Team
4. Mr. Keiichi SAKAEBARA	Natural Conditions/Environment, Preparatory Study Team
5. Mr. Tetsuo SEKI	Assistant Resident Representative, JICA Malawi Office

1.3 Minutes of Meeting (Dated 20th Feb., 1998)

MINUTES OF MEETING
FOR
INCEPTION REPORT
OF
THE FEASIBILITY STUDY
ON
THE RECONSTRUCTION OF MANGOCHI ROAD BRIDGE
IN
THE REPUBLIC OF MALAWI
AGREED UPON BETWEEN
MINISTRY OF WORKS AND SUPPLIES
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

LILONGWE, MALAWI
FEBRUARY 20TH 1998

Mr.E.L.K.Mwakhwawa
Director of Roads
Ministry of Works and Supplies

多田一正
Mr. Kazumasa Tada
Team Leader
JICA Study Team

Minutes of Meeting

In response to the request of the Ministry of Works and Supplies (MOWS) of the Republic of Malawi, the Japan International Cooperation Agency (JICA) despatched a JICA Study Team to Malawi on February 16, 1998 to initiate "The Feasibility Study on the Reconstruction of Mangochi Road Bridge in the Republic of Malawi" (hereinafter referred to as the "Study").

(1) The JICA Study Team first made a courtesy call at 10:00 a.m. February 19 to Minister of Works and Supplies in his office.

(2) The meeting was called to order at 9:00 a.m. February 20, 1998 in the Conference room of the MOWS Headquarters in Lilongwe.

(3) The leader of the Study Team, Mr. K. Tada submitted to the Director of Roads of the MOWS 12 copies of the Inception Report of the Study. The Team Leader went ahead to explain the purposes, contents, work flow and methodology of the Study.

The Director of Roads accepted the Inception Report.

(4) The Director of Roads proposed it was not appropriate to apply the HDM-III model developed by the World Bank to the socio-economic evaluation of this Study as the Study is a bridge project not a road project.

The Study Team agreed with his proposal. Instead of applying the full HDM-III model, the Study Team suggested another economic evaluation method in accordance with standard international practice.

The MOWS expressed their approval to the suggestion by the Study Team.

(5) Based on their experience with concrete and steel bridges, the MOWS strongly expressed their preference for a concrete bridge.

The MOWS also stated their preference to the Study Team for a new bridge alignment in close proximity to the existing bridge alignment to minimize resettlement problems.

The Study Team will take into consideration MOWS' proposals and the Team will recommend the best type of bridge and new bridge alignment as a result of the studies in Malawi.

ANNEX

THE FEASIBILITY STUDY ON THE RECONSTRUCITON OF
MANGOCHI ROAD BRIDGE MEETING – 20TH FEBRUARY, 1998

List of Attendance

THE MALAWI SIDE

Mr.E.L.K. Mwakhwawa	Director of Roads, MOWS : The Chairman of the Steering Committee
Mr. B. Kapoteza	Chief Civil Engineer, MOWS
Mr. B. Nayeja	Civil Engineer, MOWS
Mr. L.S. Siwande	Chief Planning & Evaluation Officer, MOWS
Mr. G.J. Chunda	Deputy Chief Civil Engineer (Materials),MOWS
Mr. S.T. Banda	Civil Engineer (Bridge)
Mr. B.K. Chongwe	Dipromate Survey Technician

THE JAPANESE SIDE

Mr. Tetsuo SEKI	Assistant Residence Representative, JICA
Mr. Kazumasa TADA	Team Leader/Transport Planning/Bridge Planning
Mr. Junji YASUI	Bridge Design/Maintenance Planning
Mr. Derek BELL	Traffic Survey/Traffic Demand Forecast/Economic Analysis
Mr. Takanori HAYASHIDA	Environmental Analysis/Evaluation of Social Impact
Mr. Koichiro SEKI	Natural Condition Survey (Geotechnical Investigation)

(6) The Study Team and MOWS agreed that the navigational clearance of the new bridge should be approximately the same as that of the existing bridge.

(7) The Team Leader requested that during the Study the Study Team should be given full cooperation by the Malawian side, especially in executing field surveys and collecting relevant data for the Study. As for the traffic survey, the Study Team emphasized necessity of the police officers at the survey points.

MOWS assured the Team that every assistance they would require would be given to them in line with minutes of meeting of the Scope of Work signed the 7 th of November 1997.

(8) For the the smooth implementation of the Study, a Steering Committee will be in force under the chairmanship of the MOWS and will consist of following members :

Mr.E.L.K. Mwakhwawa	Director of Roads, MOWS : The Chairman of the Steering Committee
Mr. B. Kapoteza	Chief Civil Engineer, MOWS
Mr. B. Nayeja	Civil Engineer, MOWS
Mr. L.S. Siwande	Chief Planning & Evaluation Officer, MOWS
Mr. G.J. Chunda	Deputy Chief Civil Engineer (Materials), MOWS
Mr. S.T. Banda	Civil Engineer (Bridge)
Mr. B.K.Chongwe	Diplomate Survey Technician
Mr. Nirenda	Deputy Director, Planning and Design, MOWS

Members from other relevant organisations will be co-opted into meeting as and when required.

(9) Counterpart Personnel

The Study Team and MOWS also agreed the specific counterpart personnel.

Bridge Engineer	Mr. S.T. Banda
Highway Engineer	Mr. B. Nayeja
Transport and Environment	Mr. B. Kapoteza
Economist	Mr. L.S. Siwande
Geotechnical Engineer	Mr. G.J. Chunda
Surveyor	Mr. B.K.Chongwe

1.4 Minutes of Meeting (Dated 2nd Apr., 1998)

MINUTES OF MEETING
FOR
INTERIM REPORT
OF
THE FEASIBILITY STUDY
ON
THE RECONSTRUCTION OF MANGOCHI ROAD BRIDGE
IN
THE REPUBLIC OF MALAWI
AGREED UPON BETWEEN
MINISTRY OF WORKS AND SUPPLIES
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

LILONGWE, MALAWI
2 APRIL 1998

Mr. E.L.K. Mwakhwawa
Director of Roads
Ministry of Works and Supplies

多田一正

Mr. Kazumasa Tada
Team Leader
JICA Study Team

山岸一秀

Mr. Kazuhiko Yamagishi
Leader
Advisory Committee

Minutes of Meeting

In response to the request of the Ministry of Works and Supplies (MOWS) of the Republic of Malawi, the Japan International Cooperation Agency (JICA) dispatched a JICA Study Team to Malawi on 16 February 1998 to initiate "The Feasibility Study on the Reconstruction of Mangochi Road Bridge in the Republic of Malawi" (hereinafter referred to as the "Study"). JICA also dispatched JICA Advisory Committee members to Malawi on 30 March 1998 to join the meeting concerning submission of the Interim Report of this Study.

(1) The JICA Advisory Committee made a courtesy call at 9:00 a.m. on 1 April 1998 to the Principal Secretary of the Ministry Works and Supplies in his office.

(2) The Steering Committee, chaired by the Director of Roads, was called to order at 9:00 a.m. on 2 April 1998 in the conference room of the MOWS Headquarters in Lilongwe.

(3) The leader of the Study Team, Mr. K. Tada submitted to the Director of Roads 12 copies of the Interim Report of the Study. The Team Leader went ahead to explain the results of the Study conducted during the study team's stay in Malawi.

The Director of Roads accepted the Interim Report.

(4) During a discussion on the Interim Report, the following items were confirmed by the Malawian and Japanese sides:

1) Both sides agreed that the selected route will be planned downstream of the nearby existing bridge.

2) The exact location of the centerline and the bridge length will be finally determined after further study in Japan in due consideration of topographic survey results and hydrological study conducted in Malawi.

3) The Project Steering Committee indicated that according to Roads Department design standards, the minimum number of lanes on a primary road such as this one (i.e., Mangochi Bridge) is two lanes. This is a national planning policy. The Study Team will discuss these issues with JICA headquarters officials.

4) The bridge type will be finalized after futher consideration in Japan, reflecting data collected in Malawi such as material cost and maintenance cost.

5) The Malawian side assured that they would be responsible for undertaking the following items: land acquisition, relocation of residents, historical monument, water intake facility and power line, dismantling of the existing bridge, and attachment of utilities to the new bridge.

ANNEX

THE FEASIBILITY STUDY ON THE RECONSTRUCTION OF MANGOCHI ROAD BRIDGE MEETING – 2 APRIL 1998

List of Attendance

THE MALAWIAN SIDE

Mr. E.L.K. Mwakhwawa	Director of Roads, MOWS : The Chairman of the Steering Committee
Mr. B. Nayeja	Civil Engineer, MOWS
Mr. L.S.C. Siwande	Chief Economist, MOWS
Mr. G.J. Chunda	Deputy Chief Civil Engineer (Materials), MOWS
Mr. S.T. Banda	Civil Engineer (Bridge), MOWS
Mr. W.M. Michala	Director of Antiquities, Ministry of National Heritage
Mr. S.A. Mapila	Fisheries Department, Lilongwe
Mr. D.M. Chirwa	Municipal Engineer, Ministry of Local Government and Sports
Mr. O.H.M. Gondwe	Survey Superintendent
Mr. P.W. Somers	Department of Environmental Affairs

THE JAPANESE SIDE

Mr. Kazuhiko Yamagishi	Leader, Advisory Committee
Mr. Masahiro Ishida	Advisory Committee
Ms. Chisato Tanaka	Coodinator, JICA
Mr. Yusuke Kitamura	Resident Representative, JICA Malawi Office
Mr. Tetsuo Seki	Assistant Residence Representative, JICA Malawi Office
Mr. Kazumasa Tada	Team Leader/Transport Planning/Bridge Planning
Mr. Junji Yasui	Bridge Design/Maintenance Planning

Mr. Derek Bell	Traffic Survey/Traffic Demand Forecast/Economic Analysis
Mr. Isamu Suzuki	Construction Plan/Cost Estimate
Dr. Takanori Hayashida	Environmental Analysis/Evaluation of Social Impact
Mr. Yasushi Higa	Natural Condition Survey (Hydrological and Hydraulic Invesigation/Topographic Survey)
Mr. Koichiro Seki	Natural Condition Survey (Geotechnical Investigation)

1.5 Minutes of Meeting (Dated 30th Apr., 1998)

MINUTES OF MEETING
FOR
THE FEASIBILITY STUDY
ON
THE RECONSTRUCTION OF MANGOCHI ROAD BRIDGE
IN
THE REPUBLIC OF MALAWI
AGREED UPON BETWEEN
MINISTRY OF WORKS AND SUPPLIES
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

LILONGWE, MALAWI
30 APRIL 1998

Mr. E.L.K. Mwakhwawa
Director of Roads
Ministry of Works and Supplies

多田一正

Mr. Kazumasa Tada
Team Leader
JICA Study Team

Minutes of Meeting

The leader of the Study Team,Mr. Kazumasa Tada,visited the Director of Roads of the Ministry of Works and Supplies (MOWS) of the Republic of the Malawi ,Mr. E.L.K. Mwakhwawa, on 30 th April, 1998 in order to convey and explain following results finally determined in the course of the study in Japan :

1) Bridge length is 220m long.
2) A caisson type foundation is recommendable to the substructures of this Study.
3) A three span continuous prestressed concrete bridge with box girder and two lanes should be applied to superstructure.
4) After due considerations in Japan obtained from data regarding earthquick records in Malawi, maximum seismic coefficient for horizontal component is adequate to be applied as 0.10 instead of 0.15 although final check has been investigated in Japan.

The Director of Roads of MOWS agreed with the above mentioned explanations by the Team Leader of the Study.
General drawing and location of the center line of this bridge with approach roads are attached to ANNEX.

ANNEX

THE FEASIBILITY STUDY ON THE RECONSTRUCTION OF MANGOCHI ROAD BRIDGE MEETING – 30 APRIL 1998

List of Attendance

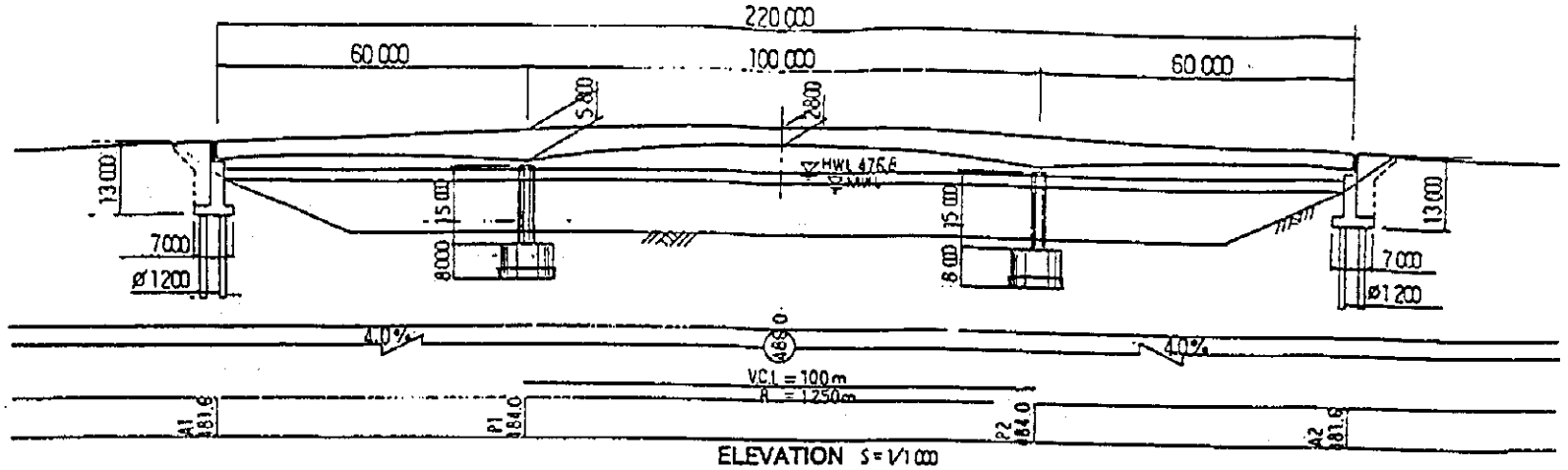
THE MALAWIAN SIDE

Mr. E.L.K. Mwakhwawa	Director of Roads, MOWS : The Chairman of the Steering Committee

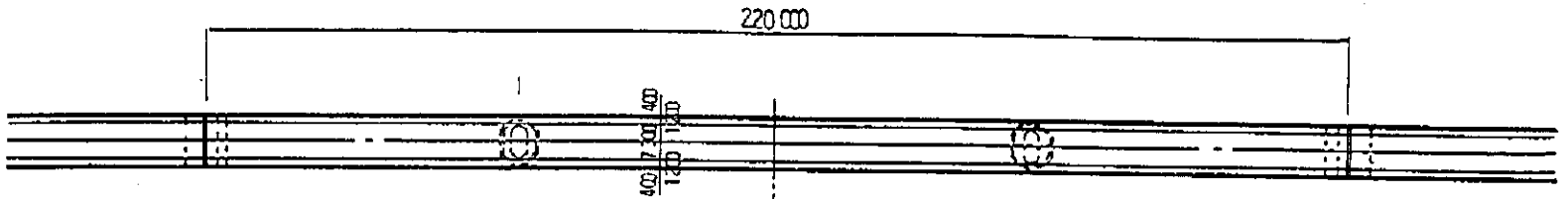
The Japanese Side

Mr. Tetsuo Seki	Assistant Residen Representative, JICA Malawi Office
Mr. Kazumasa Tada	Team Leader/Transport Planning/Bridge Planning

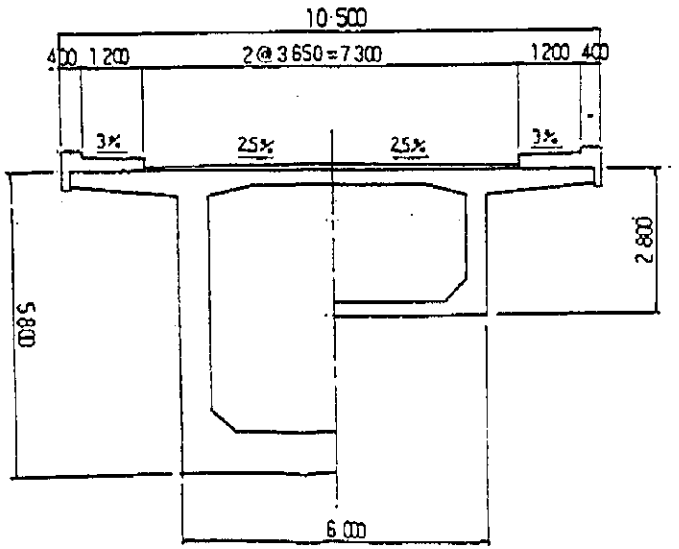
MANGOCHI BRIDGE (PC BOX GIRDER)



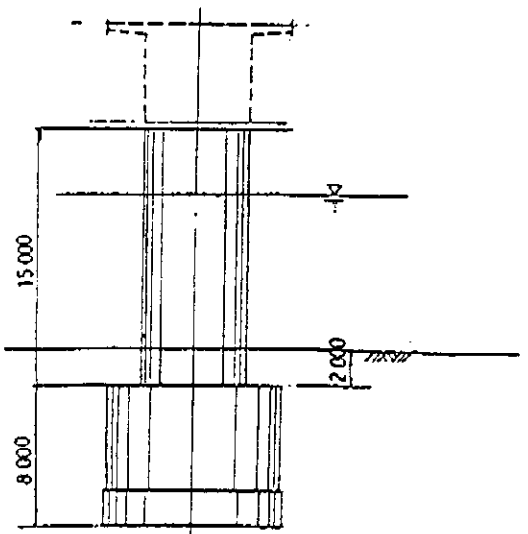
ELEVATION S=1/1 000



PLAN S=1/1 000



TYPICAL CROSS SECTION S=1/100



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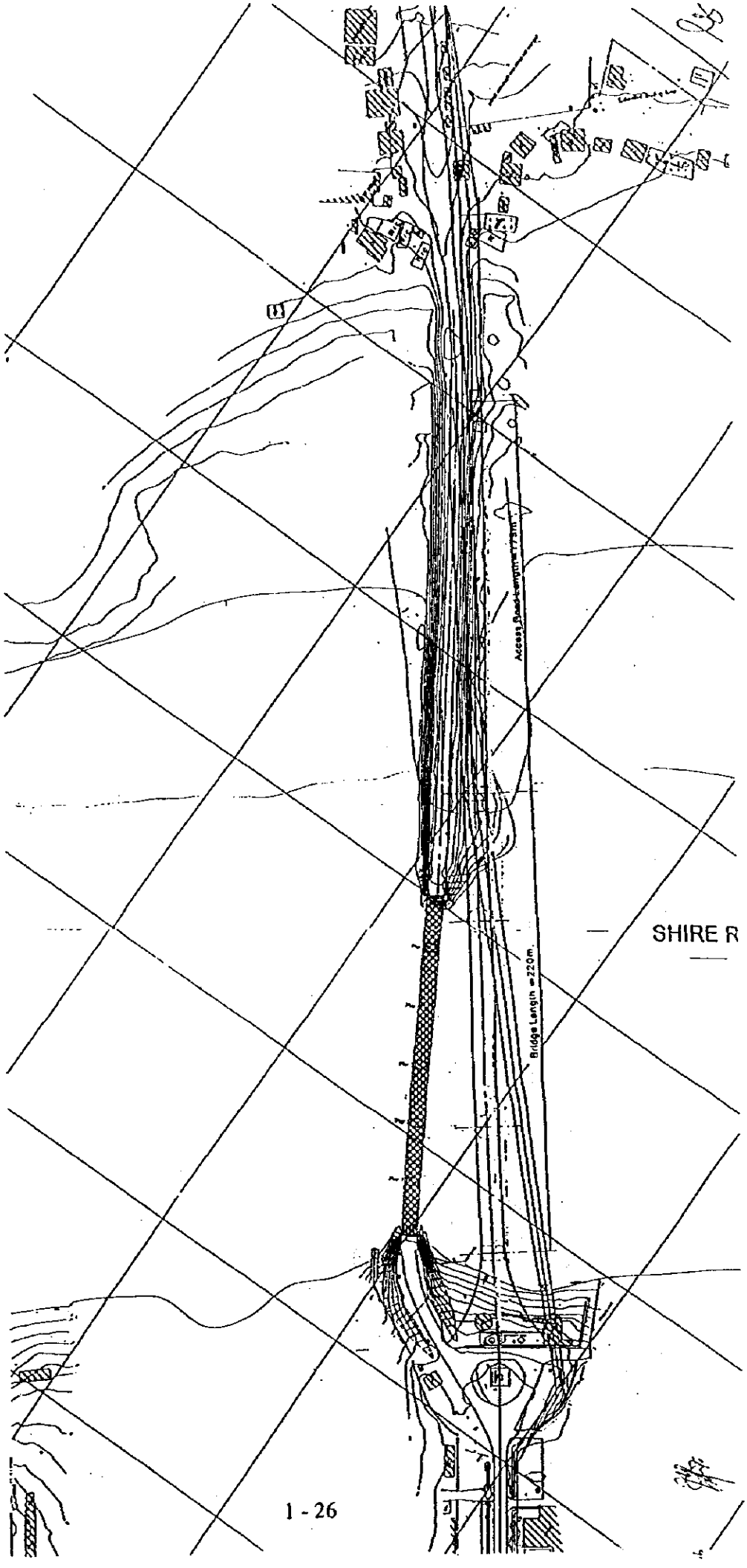

Access Road Length = 1.2km
Bridge Length = 220m
SHIRE R

1.6 Minutes of Meeting (Dated 2nd July, 1998)

MINUTES OF MEETING
FOR
DRAFT FINAL REPORT
OF
THE FEASIBILITY STUDY
ON
THE RECONSTRUCTION OF MANGOCHI ROAD BRIDGE
IN
THE REPUBLIC OF MALAWI
AGREED UPON BETWEEN
MINISTRY OF WORKS AND SUPPLIES
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

LILONGWE, MALAWI
2 JULY 1998

Mr. E.L.K. Mwakhwawa
Director of Roads
Ministry of Works and Supplies

Mr. Kazumasa Tada
Team Leader
JICA Study Team

Witnessed by

Mr. Kazuhiko Yamagishi
Leader
Advisory Committee

Minutes of Meeting

In response to the request of the Ministry of Works and Supplies (MOWS) of the Republic of Malawi, the Japan International Cooperation Agency (JICA) dispatched a JICA Study Team to Malawi on 27 June 1998 to submit the Draft Final Report on the "The Feasibility Study on the Reconstruction of Mangochi Road Bridge in the Republic of Malawi". JICA also dispatched JICA Advisory Committee members to Malawi on the same day to join the meeting concerning submission of the Draft Final Report of this Study.

After a series of discussions between the Study Team and the members of Steering Committee concerned with the projects for the Feasibility Study on the Reconstruction of Mangochi Road Bridge in the Republic of Malawi, the following subjects were confirmed and agreed upon by both sides.

1. Submission of the Draft Final Report and Explanation

(1) The leader of the Study Team, Mr. K. Tada, submitted to the Director of Roads 12 copies of the Draft Final Report of the Study. The Director acknowledged receipt of the report.

(2) The Director of Roads expressed his appreciation to the Advisory Committee and the Study Team for the efforts that they made in all stages of the study.

(3) The Team Leader went ahead to explain the results of the Study conducted in Japan at the Steering Committee meeting, chaired by the Director of Roads, called to order on 1 July 1998 in the conference room of the MOWS Headquarters in Lilongwe.

(4) The Malawian side is to adjust the vertical and horizontal alignment of the road of the Naminga-Mangochi project, based on the results of this bridge project.

2. The Final Report

(1) The Final Report is scheduled to be submitted by August 1998 to MOWS after finalization of the report taking into consideration comments that might be raised by the Steering Committee. The comments, if any, shall be forwarded to the JICA Malawi office by 10 July 1998.

(2) Both sides agreed that the Final Report shall be kept confidential for three years.

3. Other

The Malawian side strongly requested the Japanese side to implement this Project under the Japanese grant aid program. The Japanese side promised to convey the request to the Government of Japan.

ANNEX

THE FEASIBILITY STUDY ON THE RECONSTRUCTION OF MANGOCHI ROAD BRIDGE MEETING – 1 JULY 1998

List of Attendance

THE MALAWIAN SIDE

Mr. E.L.K. Mwakhwawa	Ministry of Works and Supplies, Director of Roads and Chairman of the Steering Committee
Mr. T. Nyirenda	Ministry of Works and Supplies, Deputy Director of Roads
Mr. B. Nayeja	Ministry of Works and Supplies
Mr. G.J. Chunda	Ministry of Works and Supplies
Mr. S. Mapila	Ministry of Forestry, Fisheries, and Environmental Affairs, Department of Fisheries
Mr. G.S.Z. Jere	Ministry of Finance
Mr. M.D.A. Mulebe	Ministry of Transport
Mr. W. Michala	Department of Antiquities
Mr. D.M. Chirwa	Department of Local Government
Mr. B.C. Kapoteza	Ministry of Works and Supplies

THE JAPANESE SIDE

Mr. Kazuhiko Yamagishi	Leader, Advisory Committee
Mr. Masahiro Ishida	Advisory Committee
Mr. Tetsuo Seki	Assistant Resident Representative, JICA Malawi Office
Mr. Kazumasa Tada	Team Leader/Transport Planning/Bridge Planning
Mr. Junji Yasui	Bridge Design/Maintenance Planning
Mr. Derek Bell	Traffic Survey/Traffic Demand Forecast/ Economic Analysis

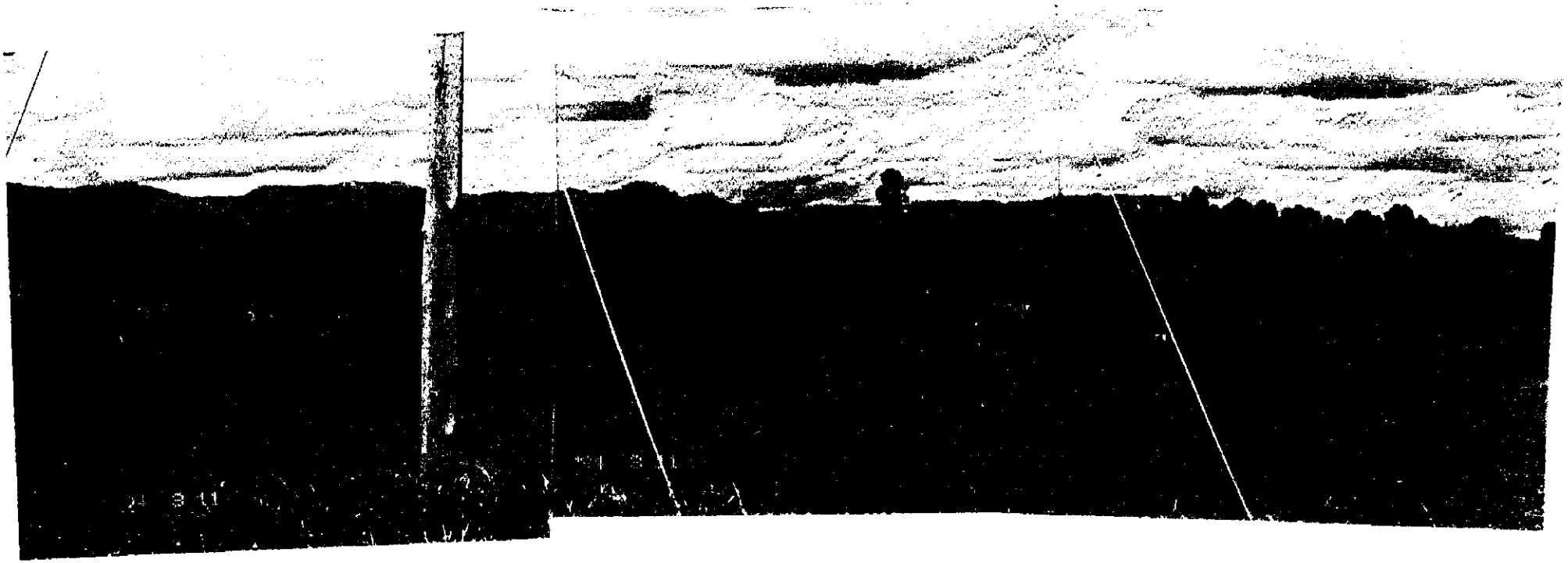
APPENDIX 2

PHOTOGRAPHIC RECORDS

1. Overview of the existing Mangochi Road Bridge (taken from west bank, fishery department house).

2. West bank of the Shire River: downstream side (taken from the bridge).

3. West bank of the Shire River: upstream side (taken from the east bank).



4. East bank of the Shire River: downstream side (taken from the bridge).

5. East bank of the Shire River: upstream side (taken from the bridge site).

6. Queen Victoria Monument

7. Gun from HMS Guendolin and kiosk (illegal squatter)

APPENDIX 3

GEOGRAPHIC SURVEY

3.1 Boring Log BH1

MATERIALS LABORATORY-JATULA PARTNERS CONSULTING ENGINEERS

DRILLING HOLE LOG
LOG OF TEST BORE/PIT/AUGER HOLE

PROJECT: Mangochi Bridge Site			
LOCATION: Mangochi Bridge Site		COORDINATES:	AREA
EXCUSSION METHOD: Percussion		DIM: 150mm	GWL: 474.360m
GROUND ELEVATION: 475.070m		DATE:20/03/98	RECORDED : MACHILA/BANDA
BORE HOLE: 3		CHAINAGE(km)	LOGGED BY: G.J.CHUNDA

DEPTH (m)	GRAPHIC	SAMPLE TYPE & DEPTH(m)	No. OF BLOWS IN 150mm	No. OF BLOWS IN 300mm	S.P.T. N-VALUE	DESCRIPTION	REMARKS
475.070	::::::::::					Soft darkish grey silty	Percussive
473.070	::::::::::	473.070	1	2	2		
	--*-*-*					soft sand	
471.070	*-*-*-*-*	471.070	1	2	2		
	::::::::::					soft sandy	
469.070	::::::::::	469.070	3	9	9	clay	
	::::::::::						
467.070	::::::::::	467.070	6	25	25		
	--*-*-*	466.070	4	31	31	Medium dense	
465.070	*-*-*-*-*					sand	
	--*-*-*						
463.070	*-*-*-*-*	463.070	13	41	41		
	::::::::::	462.070	8	34	34	sandy clay	
461.070	*-*-*-*-*		13	33	33	Medium dense	
	--*-*-*	460.070	14	32	32	sand	
459.070	::::::::::		11	39	39		
	::::::::::	458.070	11	30	30		
457.070	::::::::::	457.070	8	40	40		
	::::::::::	456.070	13	41	41		
453.070	::::::::::	453.070	15	92	92	Very dense	
	::::::::::					to extremely	
451.070	::::::::::	451.070	25	55++	55++	dense sandy	
	::::::::::	450.070	52	55++	55++	clay	
449.070	::::::::::	449.070	49	55++	55++		
	::::::::::						
447.070	::::::::::	447.070	23	71	71		
	::::::::::						
445.070	::::::::::		38	110	110		
	--*-*-*		43	94	94	Very dense	
443.070	*-*-*-*-*		20	89	89	sand	End of BH
441.070							
439.070							
437.070							
435.070							
433.070							

UD = Undisturbed Sample
N = S.P.T. N-Vlue
D = disturbed sample
*0*0*0* = gravel
-*--0-*-= weathered rock with pebbles

--*-* = Silty clayey sand
::::::: = Sandy silty clay
-*0*0*- = Sand with pebbles
::0::0:: = clay with pebbles
--*--*- = Weatherd rock

3.2 Boring Log BH2

MATERIALS LABORATORY-JATULA PARTNERS CONSULTING ENGINEERS

DRILLING HOLE LOG
LOG OF TEST BORE/PIT/AUGER HOLE

PROJECT: Mangochi Bridge Site		
LOCATION: Mangochi Bridge Site	COORDINATES:	AREA
EXCUSSION METHOD: Percussion	DIM: 150mm	GWL: 474.450m
GROUND ELEVATION: 474.630m	DATE:07/03/98	RECORDED : MACHILA/BANDA
BORE HOLE: 2	CHAINAGE(km)	LOGGED BY: G.J.CHUNDA

DEPTH (m)	GRAPHIC	SAMPLE TYPE & DEPTH(m)	No. OF BLOWS IN 150mm	No. OF BLOWS IN 300mm	S.P.T. N-VALUE	DESCRIPTION	REMARKS
474.630	::::::::					Soft darkish grey silty clay	Percussive Drilling
472.630	::::::::	472.630	0	0	0		
	::::::::	471.630	0	0	0		
470.630	*-*-*-*-*						
	--*-*-*	469.630	1	7	7		
468.630	*-*-*-*-*					Very dense grey coarse sand	
	--*-*-*	467.630	5	70	70		
466.630	*-*-*-*-*						
	--*-*-*	465.630	5	19	19		
464.630	::::::::	464.630	14	46	46	Dense grey silt	
	::::::::						
462.630	::::::::						
	::::::::						
460.630	::::::::	460.630	13	33	33	Medium dense grey sandy silt	
	::::::::	459.630	10	39	39		
458.630	::::::::	458.630	15	46	46		
	::::::::	UD457.63					
456.630	::::::::	456.630	17	48	48		
	::::::::	455.630	9	37	37		
454.630	::::::::	454.630	9	60	60	Very dense to extremely dense sandy clay	
	::::::::						
452.630	::::::::	452.630	29	107	107		
	::::::::	451.630	39	108	108		
450.630	::::::::						
	::::::::	449.760	16	93	93		
448.630	::::::::	448.630	26	108	108		
	::::::::						
446.630	::::::::	446.630	20	108	108		
	::0::0:::	445.630	43	94	94	Very dense mudstone	End of BH
444.630	::0::0:::	444.630	20	89	89		
440.630							
438.630							
436.630							
434.630							
432.630							

UD = Undisturbed Sample
N = S.P.T. N-Vlue
D = disturbed sample
*0*0*0* = gravel
-*--0-*- = weathered rock with pebbles

--*-* = Silty clayey sand
::::::: = Sandy silty clay
-*0*0*- = Sand with pebbles
::0::0:: = clay with pebbles
--*--*- = Weatherd rock

3.3 Boring Log BH3

MATERIALS LABORATORY-JATULA PARTNERS CONSULTING ENGINEERS

DRILLING HOLE LOG
LOG OF TEST BORE/PIT/AUGER HOLE

PROJECT: Mangochi Bridge Site		
LOCATION: Mangochi Bridge Site	COORDINATES:	AREA
EXCUSSION METHOD: Percussion	DIM: 150mm	GWL: 474.340m
GROUND ELEVATION: 474.920m	DATE:28/02/98	RECORDED : MACHILA/BANDA
BORE HOLE: 1	CHAINAGE(km)	LOGGED BY: G.J.CHUNDA

DEPTH (m)	GRAPHIC	SAMPLE TYPE & DEPTH(m)	No. OF BLOWS IN 150mm	No. OF BLOWS IN 300mm	S.P.T. N-VALUE	DESCRIPTION	REMARKS
474.920	*-*-*-*-*					Loose dark brown sand	Percussive Drilling
	--*-*-*	473.920	3	7	7		
472.920	*-*-*-*-*	472.920	7	14	14		
	--*-*-*	471.920	2	8	8		
470.920	*-*-*-*-*	470.920	3	18	18		
	--*-*-*	469.920	3	17	17		
468.920	*-*-*-*-*	468.920	3	16	16		
	--*-*-*	467.920	8	53	53		
466.920	::::::::::	466.920	14	66	66	Dense bluish grey sandy clay	
	::::::::::						
464.920	::::::::::	464.920	9	39	39		
	::::::::::	463.920	3	29	29	Banded bluish grey sandy clayey silt	
462.920	::::::::::						
	::::::::::						
460.920	::::::::::						
	::::::::::	459.920	13	44	44	Stiff dark grey sandy silty clay	
458.920	::::::::::	458.920	15	56	56		
	::::::::::	457.920	14	40	40		
456.920	::::::::::	UD456.920	10	34	34		
	::::::::::	455.920	10	39	39		
454.920	::::::::::	454.920	12	43	43		
	::::::::::	UD453.920					
452.920	::::::::::	452.920	3	37	37		
	::::::::::	451.920	35	75	75	Very dense sandy clay	
450.920	::::::::::						
	::::::::::						
448.920	::::::::::	448.920	21	98	98		106mm Penetration
	::0::0:::						
446.920	::0::0:::	446.920	10	45	45	Dense mudstone	
	::0::0:::	445.920	9	44	44		
444.920	::0::0:::	444.920	18	87	87		
	::0::0:::						
440.920	::0::0:::	440.920	11	42	42		
	::0::0:::	439.920	17	37	37		
438.920	::0::0:::						
	::0::0:::	437.920	10	51	51	Very dense limestone	
436.920	::0::0:::	436.920	16	55++	55++		
	::0::0:::	435.920	22	66	66		
434.920	::0::0:::	434.920	24	78	78		
432.920							

UD = Undisturbed Sample
N = S.P.T. N-Vlue
D = disturbed sample
*0*0*0* = gravel
-*--0-*- = weathered rock with pebbles

--*-* = Silty clayey sand
:::::::: = Sandy silty clay
-*0*0*- = Sand with pebbles
::0::0:: = clay with pebbles
--*--*- = Weatherd rock

LABORATORY TEST RESULTS

PROJECT:- MANGOCHI BRIDGE SITE

LOCATION:- WEST BANK (BH1)

BH PIT	SAMP No.	DEPTH (metres)	PARTICLE..SIZE DISTRIBUTION PERCENTAGE PASSING BS SIEVE SIZE MILLIMETRES					MICRONS					ATTERBERG LIMITS		CLASSIFICATION	TRIAXIAL/BOX SHEAR			
			19.0	13.2	9.5	4.75	2.36	.600	.425	.300	.150	.075	L.L. %	P.I. %		BULK DENS. kg/m^3	M/C %	SHEARING RESISTANCE kN/m^2	ANGLE Degrees
BH1	1	0.00-1.45				100	98	55	36	19	9	3	N	P	A-1-b(0)				
	2	1.45-4.80				100	98	43	23	13	3	0	N	P	A-1-b(0)				
	3	4.80-6.50				100	92	28	21	14	5	2	N	P	A-1-b(0)				
	4	6.50-7.00			100	99	92	55	46	40	33	27	54	33	A-2-7(3)				
	5	7.00-11.35				100	96	45	32	22	10	6	N	P	A-1-b(0)				
	6	11.35-16.20				100	99	89	85	82	76	55	35	15	A-7-5(6)				
	7	16.20-2135				100	99	82	74	66	57	49	47	26	A-7-6(9)				
	8	21.35-28.30			100	99	95	55	45	34	27	18	28	12	A-2-6(0)				
	9	28.30-30.00	98	97	95	93	91	85	83	82	80	69	50	24	A-7-6(15)				
	1	15.65-16.10					100	85	77	70	59	45	47	24	A-7-6(6)	2058	15.4	15.5	12
	2	17.85-18.30				100	99	83	75	69	61	51	52	28	A-7-6(11)	2088	17.2	100	22
	3	20.90-21.35				100	99	83	74	66	47	28	39	21	A-2-6(2)	2118	18.1	9	28

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Site Operator

Location BH1 Date 12/03/98

Sample No. 1 Depth 0.00 – 1.45m Description

Sieving

Total Weight of dry Sample: 1850 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max* Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm						2500
19.0 mm						2000
13.2 mm						1500
9.5 mm						1000
6.7 mm						750
4.75 mm	10.1	10.1	0.5	99.5	100	500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm						300
No. 7 (2.36 mm)	34.1	44.2	2.4	97.6	98	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	794.5	838.7	45.3	54.7	55	75
No. 36 (.425 mm)	344.2	1182.9	63.9	36.1	36	75
No. 52 (.300 mm)	316.8	1499.7	81.1	18.9	19	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	190.2	1689.9	91.3	8.7	9	40
No. 200 (.075 mm)	96.5	1786.4	96.6	3.4	3	25
Passing No. 200 (.075 mm)	63.6	3.4				
Total	1850					

W. & A.

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Site Operator

Location BH 1 Date 13/08/98

Sample No. 2 Depth 1.45 – 4.80m Description

Sieving

Total Weight of dry Sample: 905 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max* Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm						2500
19.0 mm						2000
13.2 mm						1500
9.5 mm						1000
6.7 mm						750
4.75 mm	0·3	0·3	0·0	99·96	100	500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm						300
No. 7 (2.36 mm)	17·9	18·2	2·0	98·0	98	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	498·1	576·3	57·0	43·0	43	75
No. 36 (.425 mm)	182·0	698·3	77·2	22·8	23	75
No. 52 (.300 mm)	89·4	787·7	87·0	13·0	13	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	88·0	875·7	96·8	3·2	3	40
No. 200 (.075 mm)	29·1	904.8	99·9	0·0	0	25
Passing No. 200 (.075 mm)	0·2	0·0				
Total	905	100				

W. & A.

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Operator

Location BH1 Date 12/8/98

Sample No. 8 Depth 4.80–6.50 Description

Sieving

Total Weight of dry Sample: 3000 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max* Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm						2500
19.0 mm						2000
13.2 mm						1500
9.5 mm						1000
6.7 mm				100		750
4.75 mm	0.5	0.5	0.02	99.9	100	500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm						300
No. 7 (2.36 mm)	269.3	262.8	8.76	91.2	92	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	1910.2	2173.0	72.43	27.6	28	75
No. 36 (.425 mm)	196.8	2369.8	79.00	21.0	21	75
No. 52 (.300 mm)	209.3	2579.1	86.00	14.0	14	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	266.2	284.53	94.84	5.2	5	40
No. 200 (.075 mm)	91.0	2936.3	97.9	2.1	2	25
Passing No. 200 (.075 mm)	63.7	2.1				
Total	3000					

W. & A.

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Site Operator _____

Location BH1 Date 13/03/98

Sample No. 4 Depth 6.50 - 7.00m Description _____

Sieving _____

Total Weight of dry Sample: 1725 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max* Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm						2500
19.0 mm						2000
13.2 mm						1500
9.5 mm	1.9	1.9	0.1	99.9	100	1000
6.7 mm						750
4.75 mm	11.2	13.1	0.8	99.2	99	500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm						300
No. 7 (2.36 mm)	122.7	135.8	7.9	92.1	92	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	640.0	775.8	45.0	55.0	55	75
No. 36 (.425 mm)	149.4	925.2	53.6	46.4	46	75
No. 52 (.300 mm)	112.4	1037.6	60.2	40.0	40	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	116.7	1154.3	66.9	33.1	33	40
No. 200 (.075 mm)	97.7	1252.0	72.6	27.4	27	25
Passing No. 200 (.075 mm)	473.0	27.4				
Total	1725					

W. & A.

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Site Operator

Location BH1 Date 12/03/98

Sample No. 5 Depth 7.00 – 11.35 Description

Sieving

Total Weight of dry Sample: 1830 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max* Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm						2500
19.0 mm						2000
13.2 mm						1500
9.5 mm						1000
6.7 mm						750
4.75 mm	0.8	0.8	0.04	99.96	100	500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm						300
No. 7 (2.36 mm)	67.2	68.0	3.7	96.3	96	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	931.7	999.7	54.6	45.4	4.5	75
No. 36 (.425 mm)	352.2	1351.9	68.4	31.6	32	75
No. 52 (.300 mm)	181.1	1433.0	78.3	21.7	22	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	210.9	1643.9	89.8	10.2	10	40
No. 200 (.075 mm)	79.9	1723.8	94.2	5.8	6	25
Passing No. 200 (.075 mm)	106.2	5.8				
Total	1830					

W. & A.

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Site Operator

Location BH1 Date 13/03/98

Sample No. 6 Depth 11.35–16.20 m. Description

Sieving

Total Weight of dry Sample: 670 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max* Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm						2500
19.0 mm						2000
13.2 mm						1500
9.5 mm						1000
6.7 mm						750
4.75 mm						500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm				100		300
No. 7 (2.36 mm)	5.1	5.1	0.8	99.2	99	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	71.6	76.7	11.4	88.6	89	75
No. 36 (.425 mm)	21.4	98.1	14.6	85.4	85	75
No. 52 (.300 mm)	22.1	120.2	17.9	82.1	82	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	39.9	160.1	23.9	76.1	76	40
No. 200 (.075 mm)	140.0	300.1	44.8	55.2	55	25
Passing No. 200 (.075 mm)	369.9	55.2				
Total	670					

W. & A.

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Site, Operator

Location BH1 Date 13/03/98

Sample No. 7 Depth 16.20-21.35M Description

Sieving

Total Weight of dry Sample: 1600 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max* Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm						2500
19.0 mm						2000
13.2 mm						1500
9.5 mm						1000
6.7 mm						750
4.75 mm	0.5	0.5	0.03	99.9	100	500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm						300
No. 7 (2.36 mm)	11.6	12.1	0.8	99.2	99	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	280.0	292.1	18.3	81.7	82	75
No. 36 (.425 mm)	131.4	423.5	26.5	73.5	74	75
No. 52 (.300 mm)	115.3	538.8	33.7	66.3	66	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	143.8	682.6	42.7	57.3	57	40
No. 200 (.075 mm)	135.9	818.5	51.2	48.8	49	25
Passing No. 200 (.075 mm)	781.5	48.8				
Total	1600					

W. & S.

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Site Operator

Location BH1 Date 12/03/98

Sample No. 8 Depth 21.35 - 28.30 Description

Sieving

Total Weight of dry Sample: 1485 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max° Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm						2500
19.0 mm						2000
13.2 mm						1500
9.5 mm						1000
6.7 mm						750
4.75 mm	13.8	13.8	0.9	99.1	99	500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm						300
No. 7 (2.36 mm)	59.0	72.8	4.9	95.1	95	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	592.4	665.2	44.8	55.2	55	75
No. 36 (.425 mm)	156.8	822.0	55.4	44.6	45	75
No. 52 (.300 mm)	154.3	976.3	65.7	34.3	34	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	115.9	1092.2	73.5	26.5	27	40
No. 200 (.075 mm)	122.0	1214.2	81.8	18.2	18	25
Passing No. 200 (.075 mm)	270.8	18.2				
Total	1485					

W. & S.

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Site Operator

Location BH 1 Date 12/08/98

Sample No. 9 Depth 28.30 - 37.95m Description

Sieving

Total Weight of dry Sample: 1820 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max* Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm				100		2500
19.0 mm	30.4	30.4	1.7	98.3	98	2000
13.2 mm	24.4	54.8	3.0	97.0	97	1500
9.5 mm	29.0	83.8	4.6	95.4	95	1000
6.7 mm						750
4.75 mm	41.8	125.6	6.9	93.1	93	500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm						300
No. 7 (2.36 mm)	33.9	159.5	8.8	91.2	91	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	118.2	277.7	15.3	84.7	85	75
No. 36 (.425 mm)	31.0	308.7	17.0	83.0	83	75
No. 52 (.300 mm)	22.2	330.9	18.2	81.8	82	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	36.4	367.3	20.2	79.8	80	40
No. 200 (.075 mm)	193.2	560.5	30.8	69.2	69	25
Passing No. 200 (.075 mm)	1259.5	69.2				
Total	1820					

W. & A.

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Site Operator

Location BH 1 Date 14/03/98

Sample No. U/100 Depth 15.65 - 16.10 m Description

Sieving

Total Weight of dry Sample: 379.2 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max* Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm						2500
19.0 mm						2000
13.2 mm						1500
9.5 mm						1000
6.7 mm						750
4.75 mm						500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm						300
No. 7 (2.36 mm)	1.6	1.6	0.43	99.6	100	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	55.7	57.3	15.4	84.6	85	75
No. 36 (.425 mm)	27.9	85.2	22.9	77.1	77	75
No. 52 (.300 mm)	24.9	110.1	29.6	70.4	70	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	41.2	151.3	40.7	59.3	59	40
No. 200 (.075 mm)	54.8	206.1	55.4	44.6	45	25
Passing No. 200 (.075 mm)	166.1	44.6				
Total						

W. & A.

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Site Operator

Location BH1 Date

Sample No. U100 Depth 17.85–18.30m Description

Sieving

Total Weight of dry Sample: 420.4 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max* Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm						2500
19.0 mm						2000
13.2 mm						1500
9.5 mm						1000
6.7 mm						750
4.75 mm						500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm						300
No. 7 (2.36 mm)	3.8	3.8	0.9	99.1	99	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	66.0	69.8	83.4	83.4	83	75
No. 36 (.425 mm)	34.8	104.6	24.9	75.1	75	75
No. 52 (.300 mm)	27.3	131.9	31.4	68.6	69	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	33.5	165.4	39.3	60.7	61	40
No. 200 (.075 mm)	41.6	207.0	49.2	50.8	51	25
Passing No. 200 (.075 mm)	213.4	50.8				
Total	420.4					

W. & S.

MATERIALS LABORATORY

SIEVE ANALYSIS OF SOIL

Site Mangochi Bridge Site Operator

Location BH1 Date 15/03/98

Sample No. 3 (U/100) Depth 20·9 - 21·35M Description

Sieving

Total Weight of dry Sample: 547·0 g Dry.

B.S. Sieve Size	Weight Retained g	Weight Retained g	Per cent Retained	Total Passing %	Remarks	Max° Sieve Load g
75.50 mm						
63.0 mm						
53.0 mm						4500
37.5 mm						3500
26.5mm						2500
19.0 mm						2000
13.2 mm						1500
9.5 mm						1000
6.7 mm				100		750
4.75 mm	0·5	0·5	0·1	99·9	100	500
Passing 4.75 mm						
Riffled Sample 4.75 mm Passing						
3.35 mm						300
No. 7 (2.36 mm)	5·8	6·3	1·2	98·8	99	200
No. 14 (1.18 mm)						100
No. 25 (.600 mm)	89·1	95·4	17·4	82·6	83	75
No. 36 (.425 mm)	49·7	145·1	26·5	73·5	74	75
No. 52 (.300 mm)	43·5	188·6	34·5	65·5	66	50
No. 72 (.212 mm)						50
No. 100 (.150 mm)	104·2	292·8	53·5	46·5	47	40
No. 200 (.075 mm)	103·4	396·2	72·4	27·6	28	25
Passing No. 200 (.075 mm)	150·8	27·6				
Total	547·0					

W. & A.

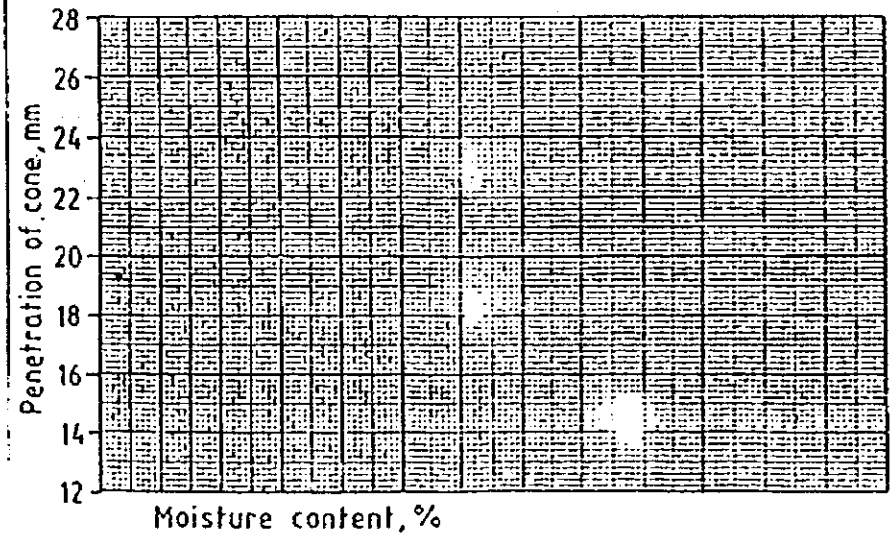
BS 1377 : Part 2 : 1990

Liquid limit (cone penetrometer) and plastic limit **Form 2.C**

Location	Mangotsfield Bridge	Job ref.	
		Borehole/ Pit no.	BH 1
Soil description	Dark brown medium Sand	Sample no.	B 1
		Depth	0.00 m/ 1.45
Test method	BS 1377 : Part 2 : 1990 : 4.3/4.4*	Date	

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.						
Mass of wet soil + container	g					
Mass of dry soil + container	g					
Mass of container	g					
Mass of moisture	g					
Mass of dry soil	g					
Moisture content	%					

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm				
Final dial gauge reading	mm				
Average penetration	mm				
Container no.					
Mass of wet soil + container	g				
Mass of dry soil + container	g				
Mass of container	g				
Mass of moisture	g				
Mass of dry soil	g				
Moisture content	%				



Sample preparation *

as received

washed on 425 µm sieve

air dried at ..... °C

oven dried at ..... °C

not known

Proportion retained on 425 µm sieve ..... %

Liquid limit	%
Plastic limit	%
Plasticity Index	

* : delete as appropriate

Operator	Checked	Approved

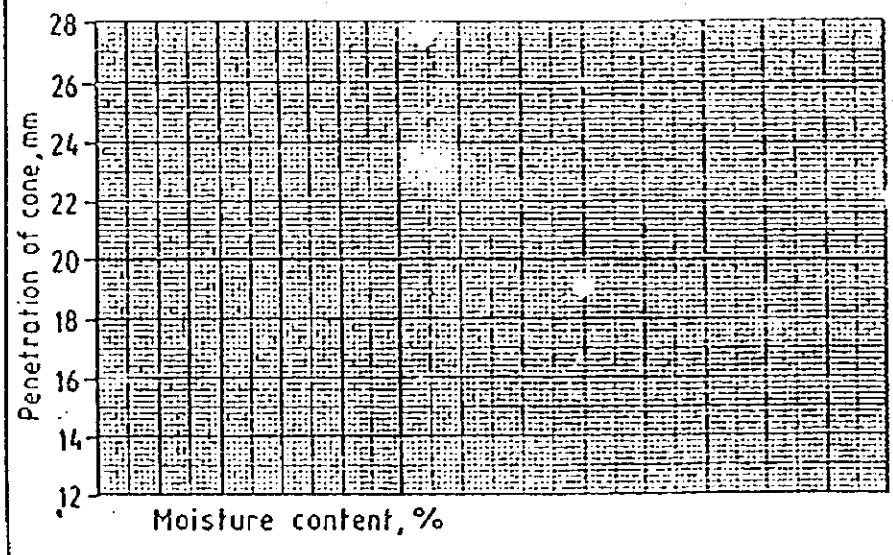
BS 1377 : Part 2 : 1990

Liquid limit (cone penetrometer) and plastic limit — Form 2.C

Location	Mangochi Bridge	Job ref.	
		Borehole/ Pit no.	BH1
Soil description	Whitish Brown Medium to Coa Sand.	Sample no.	2
		Depth	1.45-1.80
Test method	BS 1377 : Part 2 : 1990 : 4.3/4.4*	Date	11-3-98

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.						
Mass of wet soil + container	g					
Mass of dry soil + container	g					
Mass of container	g					
Mass of moisture	g					
Mass of dry soil	g					
Moisture content	%					

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm				
Final dial gauge reading	mm				
Average penetration	mm				
Container no.					
Mass of wet soil + container	g				
Mass of dry soil + container	g				
Mass of container	g				
Mass of moisture	g				
Mass of dry soil	g				
Moisture content	%				



Sample preparation *

as received

washed on 425 µm sieve

air dried at ..... °C

oven dried at ..... °C

not known

Proportion retained on 425 µm sieve ..... %

Liquid limit %

Plastic limit %

Plasticity index

* Delete as appropriate

Operator	Checked	Approved

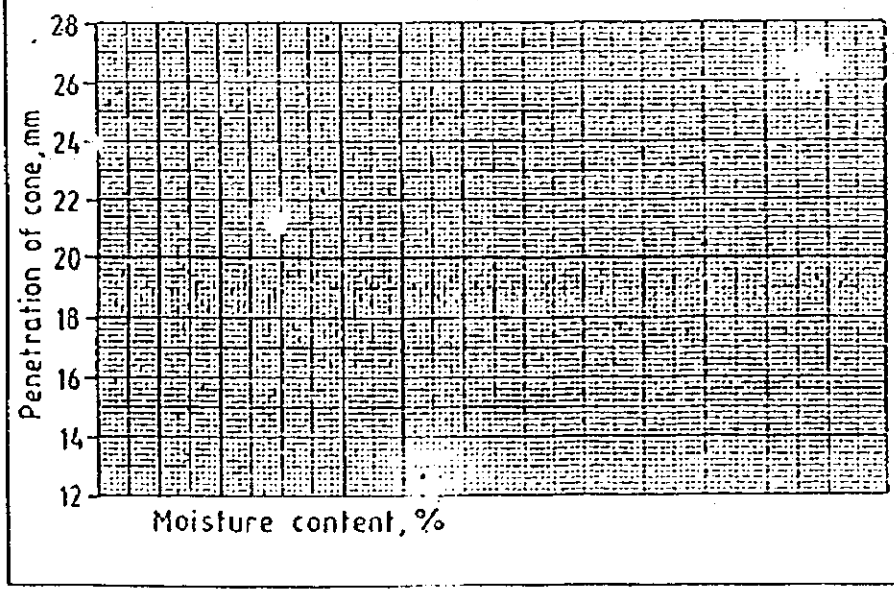
BS 1377 : Part 2 : 1990

Liquid limit (cone penetrometer) and plastic limit | Form 2.C

Location	Margaret Bridge.	Job ref.	
		Borehole/ Pit no.	BH1
Soil description	Whitish grey to coarse sand.	Sample no.	3
		Depth	480-600
Test method	BS 1377 : Part 2 : 1990 : 4.3/4.4*	Date	21-3-98

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.						
Mass of wet soil + container	g					
Mass of dry soil + container	g					
Mass of container	g					
Mass of moisture	g					
Mass of dry soil	g					
Moisture content	%					

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm				
Final dial gauge reading	mm				
Average penetration	mm				
Container no.					
Mass of wet soil + container	g				
Mass of dry soil + container	g				
Mass of container	g				
Mass of moisture	g				
Mass of dry soil	g				
Moisture content	%				



Sample preparation *

as received

washed on 425 µm sieve

air dried at ..... °C

oven dried at ..... °C

* Known

Proportion retained on 425 µm sieve ..... %

Liquid limit	%
Plastic limit	%
Plasticity Index	

* Delete as appropriate

Operator	Checked	Approved

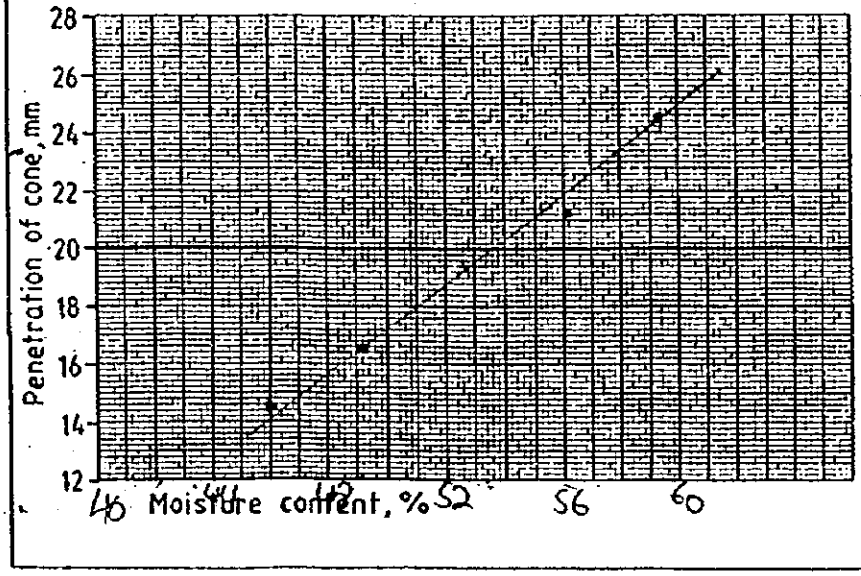
BS 1377 : Part 2 : 1990

Liquid limit (cone penetrometer) and plastic limit Form 2.C

Location Mengochi Bridge		Job ref.	
		Borehole/ Pit no.	BH1
Soil description Blueish grey Sandy clay		Sample no.	A
		Depth	6.50 m 750
Test method	BS 1377 : Part 2 : 1990 : 4.3/4.4*	Date	11-3-98

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.		13		118		
Mass of wet soil + container	g	11.16		11.98		
Mass of dry soil + container	g	10.18		10.86		
Mass of container	g	5.62		5.64		
Mass of moisture	g	0.98		1.12		
Mass of dry soil	g	4.76		5.42		
Moisture content	%	20.6		19.1		20.6

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm	0	0	0	0
Final dial gauge reading	mm	14.5	16.5	21.3	24.5
Average penetration	mm				
Container no.		DC2	M	A1	LK
Mass of wet soil + container	g	24.20	27.30	17.92	30.18
Mass of dry soil + container	g	17.84	19.60	12.56	21.46
Mass of container	g	4.00	3.94	3.84	6.28
Mass of moisture	g	6.36	7.7	5.36	8.72
Mass of dry soil	g	13.84	15.66	9.02	14.68
Moisture content	%	46.0	49.2	56.1	59.4



Sample preparation *

as received

washed on 425 µm sieve

air dried at ..... °C

oven dried at ..... °C

not known

Proportion retained on 425 µm sieve ..... %

Liquid limit	53.6	% 54
Plastic limit	20.6	%
Plasticity Index	33.0	33

* Delete as appropriate

Operator	Checked	Approved

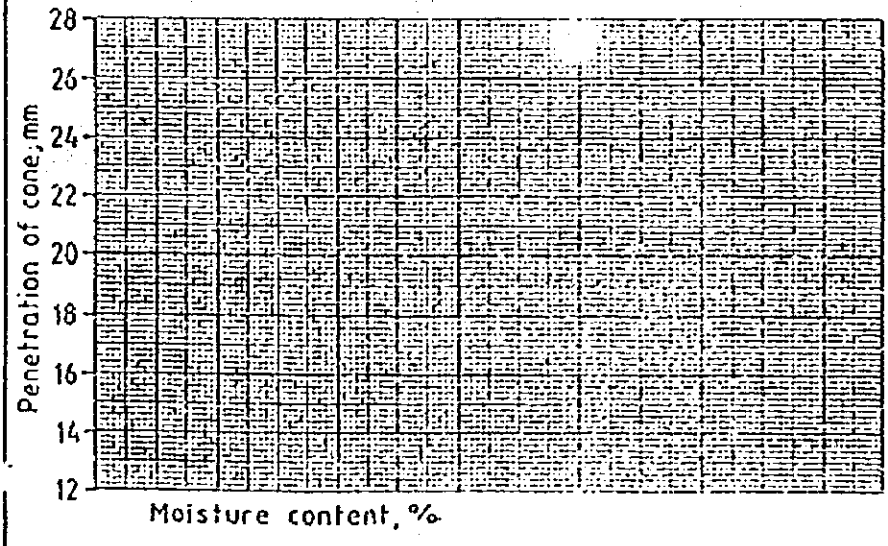
BS 1377 : Part 2 : 1990

Liquid limit (cone penstrometer) and plastic limit Form 2.C

Location	Mongodhi Bridge.	Job ref.	
		Borehole/ Pit no.	BH1
Soil description	Bonded bluish grey medium Sand.	Sample no.	S
		Depth	2.00 = 11.35 m
Test method	BS 1377 : Part 2 : 1990 : 4.3/4.4*	Date	11-3-99

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.						
Mass of wet soil + container	g					
Mass of dry soil + container	g					
Mass of container	g					
Mass of moisture	g					
Mass of dry soil	g					
Moisture content	%					

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm				
Final dial gauge reading	mm				
Average penetration	mm				
Container no.					
Mass of wet soil + container	g				
Mass of dry soil + container	g				
Mass of container	g				
Mass of moisture	g				
Mass of dry soil	g				
Moisture content	%				



Sample preparation *

as received

washed on 425 μm sieve

air dried at ..... °C

oven dried at ..... °C

not known

Proportion retained on 425 μm sieve ..... %

Liquid limit %

Plastic limit %

Plasticity Index

* Delete as appropriate

Operator	Checked	Approved

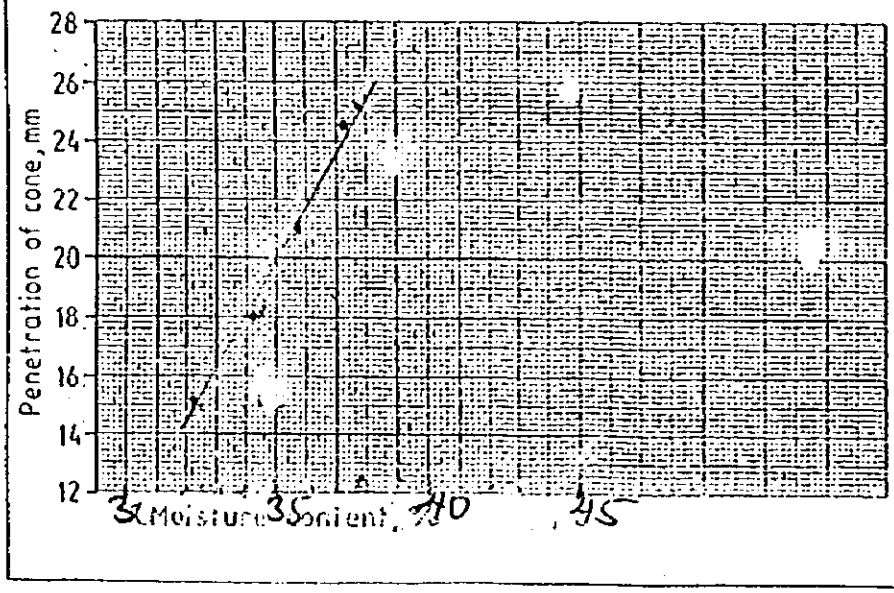
BS 1377 : Part 2 : 1990

Liquid limit (cone penetrometer) and plastic limit | Form 2.C

Location Mangoch Bridge Bonded yellowish grey sandy clay silt.	Job ref.	
	Borehole/ Pit no.	BH1
Soil description	Sample no.	6
	Depth	11.35-16.20
Test method BS 1377 : Part 2 : 1990 : 4.3/4.4	Date	11-3-98

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.		81		12x		
Mass of wet soil + container	g	11.48		12.52		
Mass of dry soil + container	g	10.66		11.50		
Mass of container	g	6.60		6.48		
Mass of moisture	g	0.82		1.02		
Mass of dry soil	g	4.06		5.02		
Moisture content	%	20.2		20.3		20.3

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm	0	0	0	0
Final dial gauge reading	mm	15.2	18.6	21.0	24.6
Average penetration	mm				
Container no.		73	A B	118	45
Mass of wet soil + container	g	28.42	33.18	32.84	27.86
Mass of dry soil + container	g	22.82	26.06	25.62	21.36
Mass of container	g	5.44	5.22	5.62	3.92
Mass of moisture	g	5.6	7.12	7.22	6.5
Mass of dry soil	g	17.38	20.84	20.2	17.44
Moisture content	%	32.2	34.2	35.7	37.3



Sample preparation *

as received

washed on 425 µm sieve

air dried at ..... °C

oven dried at ..... °C

not known

Proportion retained on 425 µm sieve ..... %

Liquid limit	35.1 %	35
Plastic limit	20.3 %	
Plasticity index	14.8	15

* Delete as appropriate

Operator	Checked	Approved

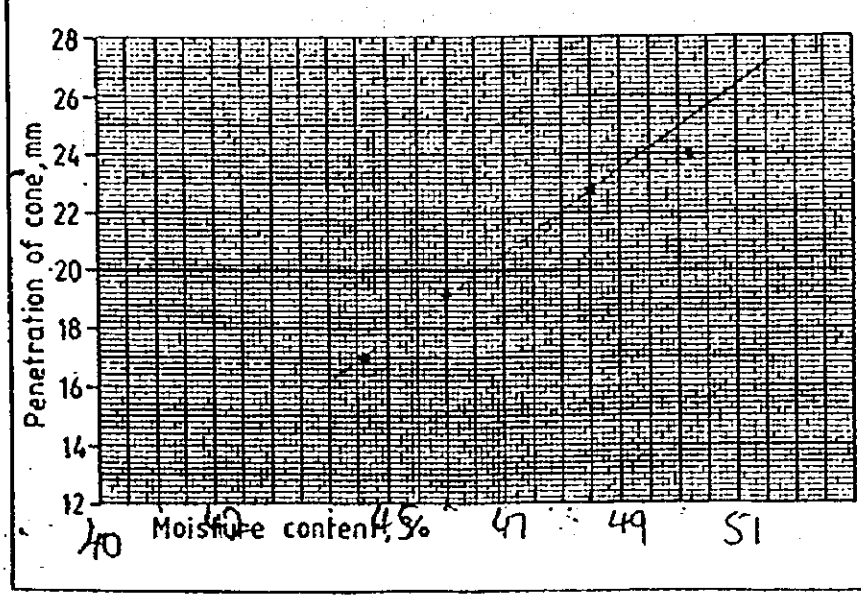
BS 1377 : Part 2 : 1990

Liquid limit (cone penetrometer) and plastic limit **Form 8.0**

Location Mangaoi Bridge	Job ref.	---
	Borehole/ Pit no.	BH1
Soil description Stiff bluish grey silty sandy clay.	Sample no.	7
	Depth	16.28 - 21.35
Test method BS 1377 : Part 2 : 1990 : 4.3/4.4*	Date	11-3-92

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.		G9K		M11		
Mass of wet soil + container	g	3.86		3.82		
Mass of dry soil + container	g	3.78		3.74		
Mass of container	g	5.54		5.46		
Mass of moisture	g	0.58		058		
Mass of dry soil	g	2.74		2.78		
Moisture content	%	20.3		20.9		21.1

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm	0	0	0	0
Final dial gauge reading	mm	no	19.2	22.8	24.0
Average penetration	mm				
Container no.		B	C3	G91	10 10
Mass of wet soil + container	g	23.30	22.14	25.40	22.80
Mass of dry soil + container	g	17.90	16.84	18.86	16.98
Mass of container	g	5.46	5.32	5.46	5.40
Mass of moisture	g	5.5	5.3	6.5	5.82
Mass of dry soil	g	12.34	11.52	13.4	11.6
Moisture content	%	44.6	46.0	48.5	50.2



Sample preparation *

as received

washed on 425 µm sieve

air dried at ..... °C

oven dried at ..... °C

not known

Proportion retained on 425 µm sieve ..... %

Liquid limit	46.6	%
Plastic limit	21.1	%
Plasticity index	25.5	

* Delete as appropriate

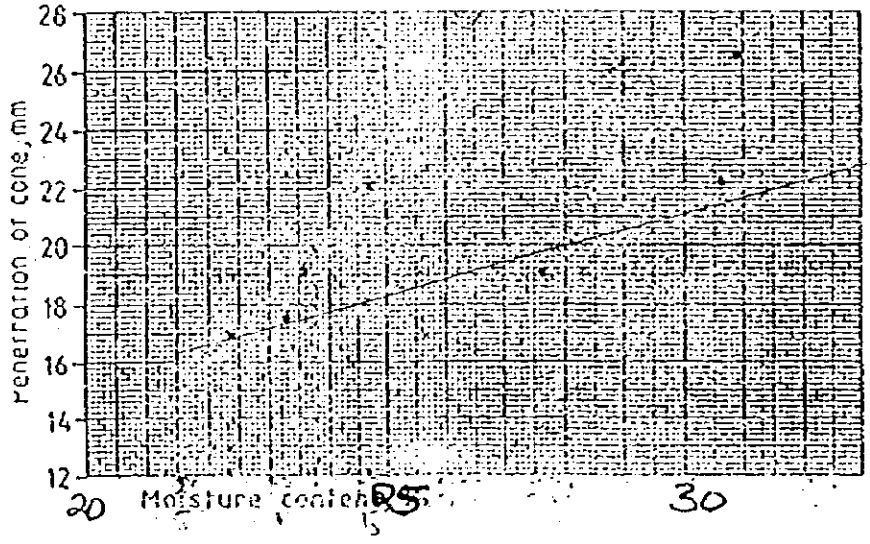
Operator	Checked	Approved

'quid limit (cone penetrometer) and plastic limit — Form 2.C

Location	Mangodu Bridge	Job ref.	
		Borehole/ Pit no.	BH1
Soil description	Whitish grey slightly clayey Sand, silty medium to coarse	Sample no.	8
		Depth	21.35 to 28.30
Test method	BS 1377 : Part 2 : 1990 : 4.3/4.4	Date	11.3.98

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.		25-2		69		
Mass of wet soil + container	g	10.82		11.20		
Mass of dry soil + container	g	10.24		10.58		
Mass of container	g	6.58		6.68		
Mass of moisture	g	0.58		0.62		
Mass of dry soil	g	3.66		3.9		
Moisture content	%	15.8		15.9		15.9

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm	0	0	0	0
Final dial gauge reading	mm	17.5	19.1	22.2	26.5
Average penetration	mm				
Container no.		Gxx	G3	16	W H4
Mass of wet soil + container	g	26.64	22.34	24.00	32.90
Mass of dry soil + container	g	22.72	18.70	19.66	26.44
Mass of container	g	5.88	5.52	5.48	5.46
Mass of moisture	g	3.92	3.64	4.34	6.46
Mass of dry soil	g	16.84	13.18	14.18	20.98
Moisture content	%	23.3	27.6	30.6	30.8



Sample preparation *

as received
washed on 425 µm sieve
air dried at ..... °C
oven dried at ..... °C
not known
Proportion retained on 425 µm sieve ..... %

Liquid limit	28.2 %	28
Plastic limit	15.9 %	
Plasticity index	12.3	12

* Delete as appropriate

Operator	Checked	Approved

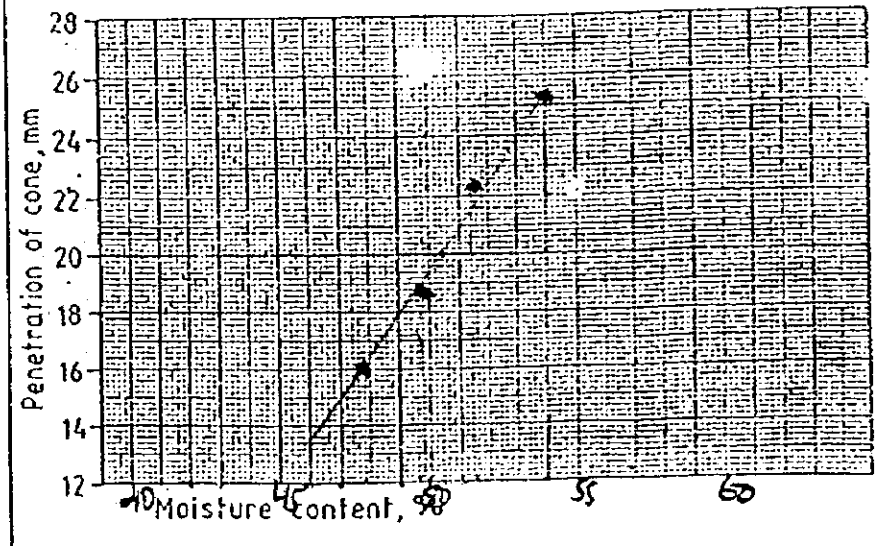
BS 1377 : Part 2 : 1990

Liquid limit (cone penetrometer) and plastic limit — Form 2.C

Location	Mungoon Bridge site	Job ref.	
		Borehole/ Pit no.	BH 1
Soil description	yellowish brown mottled clayey silty with chalk lime or pebbles 10 parts.	Sample no.	9
		Depth	28.30 - 30.00
Test method	BS 1377 : Part 2 : 1990 : 4.3/4.4*	Date	11-3-98

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.		GB		227		
Mass of wet soil + container	g	10.16		9.58		
Mass of dry soil + container	g	9.44		8.96		
Mass of container	g	6.74		6.56		
Mass of moisture	g	0.72		0.62		
Mass of dry soil	g	2.7		2.4		
Moisture content	%	26.7		25.8		26.3

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm	0	0	0	0
Final dial gauge reading	mm	16.0	8.3	23.1	25.1
Average penetration	mm				
Container no.		130	X	544	S
Mass of wet soil + container	g	22.36	32.72	29.04	37.88
Mass of dry soil + container	g	16.66	23.46	21.04	26.48
Mass of container	g	4.74	4.84	5.42	5.36
Mass of moisture	g	5.7	9.26	8.0	11.4
Mass of dry soil	g	11.92	18.62	15.62	21.12
Moisture content	%	47.8	49.7	51.2	54.0



Sample preparation *

as received

washed on 425 µm sieve

air dried at ..... °C

oven dried at ..... °C

not known

Proportion retained on 425 µm sieve ..... %

Liquid limit	50.2	%
Plastic limit	26.3	%
Plasticity Index	23.9	

* Delete as appropriate

Operator	Checked	Approved

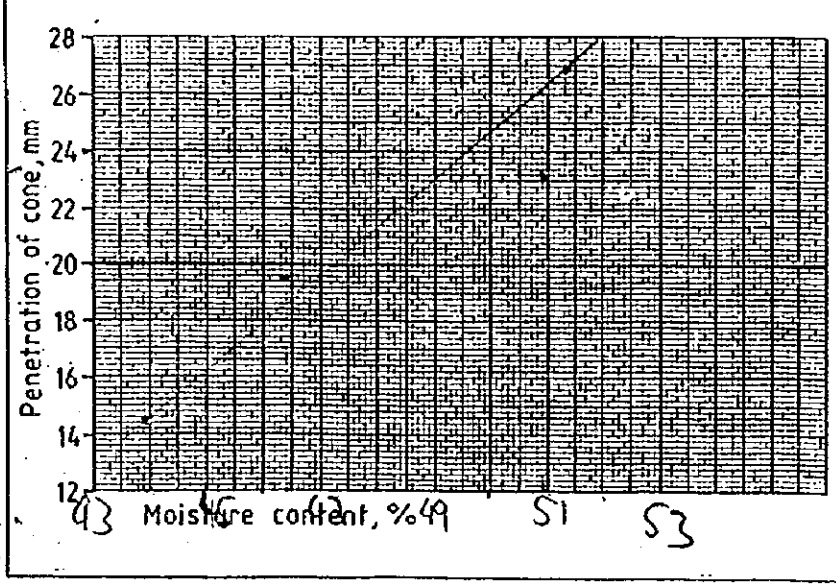
BS 1377 : Part 2 : 1990

Liquid limit (cone penetrometer) and plastic limit — Form 2.C

Location Morgan Bridge Site	Job ref.	
	Borehole/ Pit no.	BH 1
Soil description Stiff yellowish grey silty sandy clay.	Sample no.	U 1100
	Depth	15.65m - 16.10
Test method BS 1377 : Part 2 : 1990 : 4.3/4.4[4]	Date	14-03-97

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.		G9		C		
Mass of wet soil + container	g	14.30		14.60		
Mass of dry soil + container	g	12.64		12.88		
Mass of container	g	5.46		5.46		
Mass of moisture	g	1.66		1.72		
Mass of dry soil	g	7.18		7.42		
Moisture content	%	23.1		23.2		23.2

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm	0	0	0	0
Final dial gauge reading	mm	MS	MS	23.2	26.9
Average penetration	mm				
Container no.		WH4	118	13	G9K
Mass of wet soil + container	g	24.94	22.04	26.96	27.10
Mass of dry soil + container	g	19.00	16.78	19.20	20.16
Mass of container	g	5.46	5.44	5.42	5.46
Mass of moisture	g	5.94	5.26	7.76	7.54
Mass of dry soil	g	13.54	11.34	14.28	14.7
Moisture content	%	43.9	46.4	54.8	51.3



Sample preparation *

as received

washed on 425 µm sieve

air dried at ..... °C

oven dried at ..... °C

not known

Proportion retained on 425 µm sieve ..... %

Liquid limit	47.4	%
Plastic limit	23.2	%
Plasticity index	24.3	

* Delete as appropriate

Operator	Checked	Approved

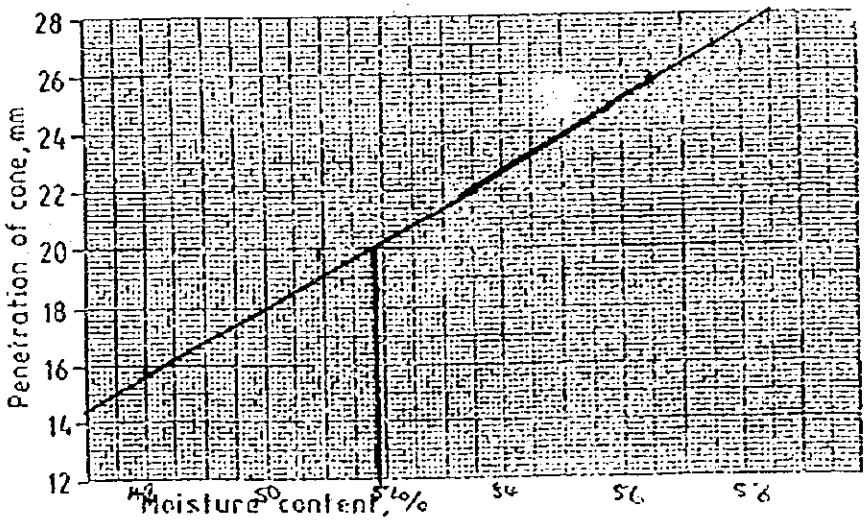
S 1377 : Part 2 : 1990

'quid limit (cone penetrometer) and plastic limit | Form 2.C

Location	Mangochi Bridge Site	Job ref.	
		Borehole/ Pit no.	BH
Soil description	Stiff Grey Silty Sandy Clay	Sample no.	U/100
		Depth	17.25 m 17.30
Test method	BS 1377 : Part 2 : 1990 : 4.3/4.4*	Date	14-3-91

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.		10,10		H2		
Mass of wet soil + container	g	10.84		11.07		
Mass of dry soil + container	g	10.00		10.18		
Mass of container	g	6.52		6.38		
Mass of moisture	g	0.84		0.9		
Mass of dry soil	g	3.48		3.8		
Moisture content	%	24.1		23.6		23.9

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm	0	0	0	0
Final dial gauge reading	mm	15.4	19.2	22.0	25.2
Average penetration	mm				
Container no.		10	C3	X	130
Mass of wet soil + container	g	24.02	11.32	25.04	22.58
Mass of dry soil + container	g	17.98	9.30	13.00	16.20
Mass of container	g	5.40	5.32	4.84	4.90
Mass of moisture	g	6.04	2.02	7.04	6.38
Mass of dry soil	g	12.58	3.98	13.16	11.3
Moisture content	%	48.0	50.8	53.5	56.5



Sample preparation *

- as received
- washed on 425 µm sieve
- dried at ..... °C
- oven dried at ..... °C
- not known

Proportion retained on 425 µm sieve ..... %

Liquid limit	51.8	% 52
Plastic limit	23.9	%
Plasticity Index	27.9	28

* Delete as appropriate

Operator	Checked	Approved

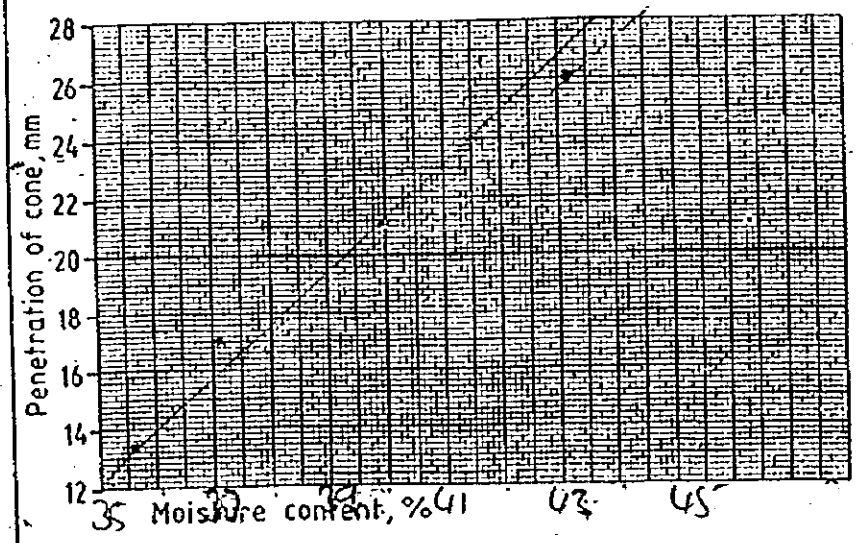
BS 1377 : Part 2 : 1990

Liquid limit (cone penetrometer) and plastic limit — Form 2.C

Location: Nangochi Bridge	Job ref.	
	Borehole/ Pit no.	BH1
Soil description: Blueish grey silty clayey sand.	Sample no.	U100
	Depth	20.9 m 21.35 m
Test method: BS 1377 : Part 2 : 1990 : 4.3/4.4*	Date	15-3-98

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Container no.		84		99		
Mass of wet soil + container	g	14.38		14.14		
Mass of dry soil + container	g	13.24		12.96		
Mass of container	g	6.64		6.42		
Mass of moisture	g	1.14		1.18		
Mass of dry soil	g	6.6		6.54		
Moisture content	%	17.3		18.0		17.7

LIQUID LIMIT	Test no.	1	2	3	4
Initial dial gauge reading	mm	0	0	0	0
Final dial gauge reading	mm	134	170	211	260
Average penetration	mm				
Container no.		544	1	C4	S
Mass of wet soil + container	g	26.42	26.08	30.64	18.30
Mass of dry soil + container	g	20.92	20.42	23.44	14.40
Mass of container	g	5.46	5.40	5.46	5.38
Mass of moisture	g	5.5	5.6	7.2	3.9
Mass of dry soil	g	15.46	15.08	17.98	9.02
Moisture content	%	35.6	37.1	40.0	43.2



Sample preparation *
- as received
- washed on 425 µm sieve
- air dried at ..... °C
- oven dried at ..... °C
- not known

Proportion retained on 425 µm sieve ..... %

Liquid limit 39.0 % 39

Plastic limit 17.7 %

Plasticity index 21.3 21

* Delete as appropriate

Operator	Checked	Approved

Triaxial Test
Mohr Circles

D 19

Form K18M

MANGOCHI BRIDGE SITE

sample no.	
Location no. BH 1	
date: 14-03-98	

Bulk density = 2058 Kg/M³

C = 155 KN/M²

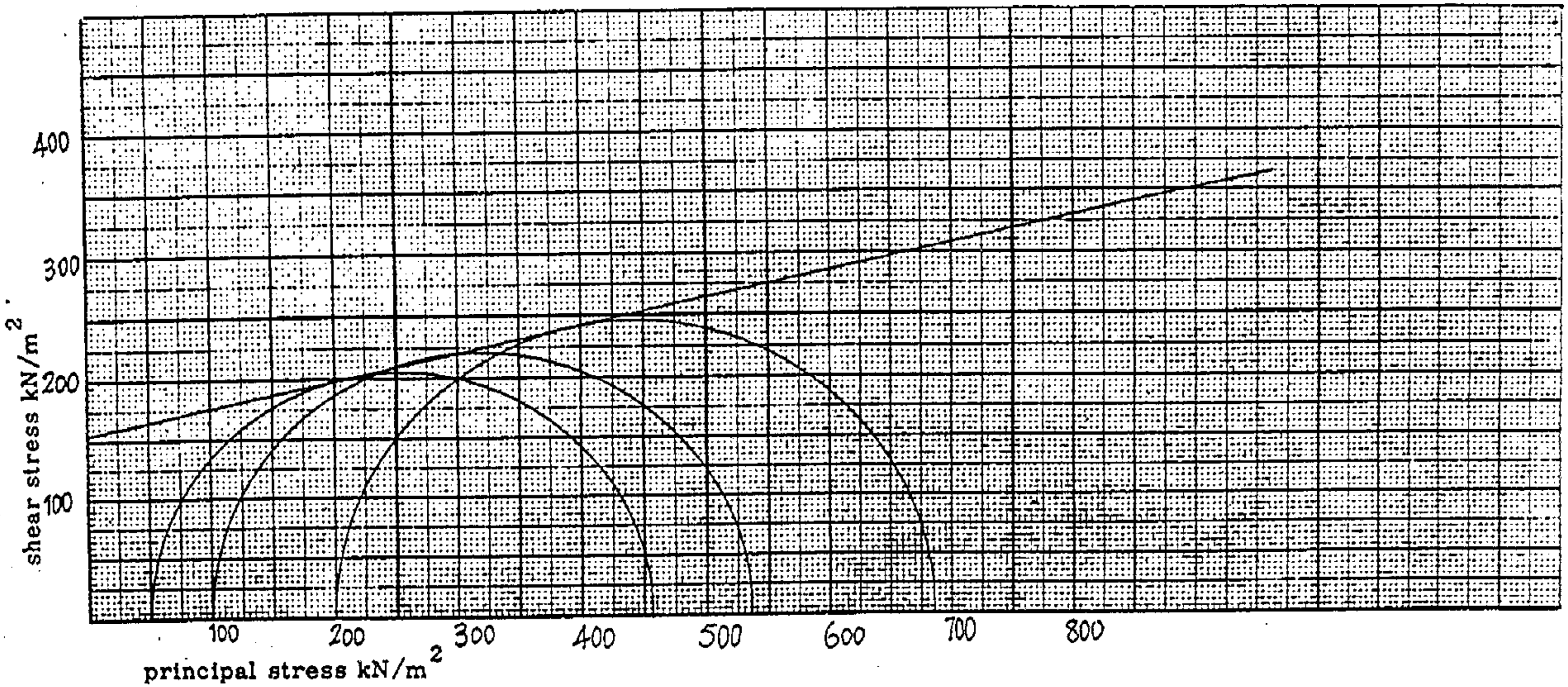
ϕ = 12°

M/c = 15.4 %

15.65 —— 16.10 M

Stiff whitish grey silty sandy clay

spec ident.	cell/p kN/m^2	stress kN/m^2	$\sigma_1 - \sigma_3$ kN/m^2	σ_3 kN/m^2	σ_1 kN/m^2
1	404.2				454.2
2	433.1				533.1
3	483.3				683.3



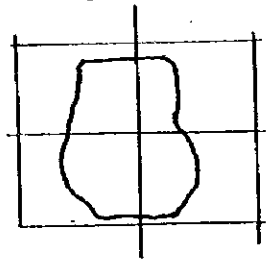
MATERIALS LABORATORY
TRIAXIAL COMPRESSION TEST
ON SAMPLE 762mmLONG AND 381mm DIA.

Loc. No. BH 1 Name MANGOCHI BRIDGE SITE Date 14-3-98
Sample No. ____ Tube No. ____ Length ____ Dia. ____
Wet Weight 1774 gm. Bulk Density ____ kg/m³ ____
Moisture Content ____ %
Proving Ring No. ____ Proving Ring Constant 0.32 LB/DIV at Failure
Cell Pressure 200 KN/ m² Rate of Strain ____ per cent per min

Strain Dial	Stress Dial	Load kg	Area cm²	Compressive Stress	Strain %
0	0		11·40		0.0
5	60		11·419		0.167
10	90		11·439		0.333
15	110		11·458		0.500
20	128		11·477		0.667
25	146		11·497		0.833
30	158		11.516		1.0
45	192		11.574		1.5
60	217		11.639		2.0
75	238		11.697		2.5
80	245		11.761		3.0
105	269		11.819		3.5
120	284		11·884		4.0
135	294		11·948		4.5
150	305		12·013		5.0
165	315		12·077		5.5
180	327		12·142		6.0
210	346		12·271		7.0
240	365		12·400		8.0
270	387		12·529		9.0
300	398		12·658		10.0
330	410		12·787		11.0
360	425		12·961		12.0
390	436		13·110		13.0
420	446		13·277	478.382	14.0
450	455		13·419	482.810	15.0
480	461		13·581	483.342	16.0
510	465		13·742	481.829	17.0
540	467		13·923	477.605	18.0
570	468		14·097	472.720	19.0
600	469		14·258	468.381	20.0
630	468		14·445	461.332	21.0
660			14·632		22.0
690			14·819		23.0
720			15·019		24.0
750			15·219		25.0

15.65 – 16.10 M

Laboratory Assistant's Description of Sample



Sketch of Sample after failure

*Conditions at failure

1. Plastic Bulging ✓
2. Shear Plane (Angle)
3. Vertical Cracks ____

Compressive Strength ____ kg
____ kg
Failure Strain ____ %
*Indicate type of failure.

483.342

(1) 404.192 KN/M²
(2) 433.123 KN/M²
(3) 483.342 KN/M²

MATERIALS LABORATORY
TRIAXIAL COMPRESSION TEST
ON SAMPLE 76·2mmLONG AND 38·1mm DIA.

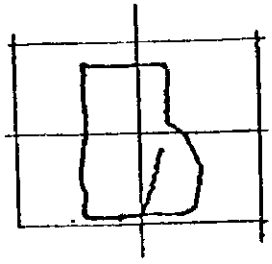
Loc. No. BH 1 Name MANGOCHI BRIDGE Date 14-3-96
Sample No. Tube No. Length Dia.
Wet Weight 177.2 gm. Bulk Density kg/m³
Moisture Content %
Proving Ring No. Proving Ring Constant at Failure
Cell Pressure 100 KN/ m² Rate of Strain per cent per min

15·65 — 16.10M

Strain Dial	Stress Dial	Load kg	Area cm²	Compressive Stress	Strain %
0	0		11·40		0.0
5	30		11·419		0.167
10	51		11·439		0.333
15	65		11·458		0.500
20	77		11·477		0.667
25	87		11·497		0.833
30	98		11.516		1.0
45	126		11.574		1.5
60	150		11.639		2.0
75	171		11.697		2.5
80	179		11.761		3.0
105	204		11.819		3.5
120	219		11·884		4.0
135	234		11·948		4.5
150	248		12·013		5.0
165	262		12·077		5.5
180	276		12·142		6.0
210	300		12·271		7.0
240	325		12·400		8.0
270	344		12·529		9.0
300	360		12·658		10.0
330	376		12·787		11.0
360	387		12·961		12.0
390	393		13·110		13.0
420	401		13·277		14.0
450	408		13·419	432.938	15.0
480	413		13·581	433.016	16.0
510	418		13·742	433.123	17.0
540	422		13·923	431.584	18.0
570	426		14·097	430.296	19.0
600	428		14·258	427.435	20.0
630	430		14·445	423.873	21.0
660	432		14·632	420.403	22.0
690	432		14·819	415.097	23.0
720			15·019		24.0
750			15·219		25.0

433.123

Laboratory Assistant's Description of Sample



Sketch of Sample after failure

*Conditions at failure

1. Plastic Bulging
2. Shear Plane (Angle)
3. Vertical Cracks

Compressive Strength kg
kg
Failure Strain %
*Indicate type of failure.

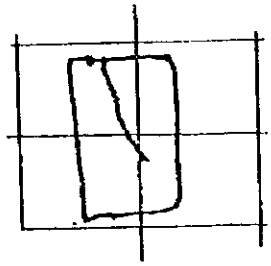
MATERIALS LABORATORY
TRIAXIAL COMPRESSION TEST
ON SAMPLE 76·2mmLONG AND 38·1mm DIA.

Loc. No. B11 1 Name MANGOCHI BRIDGE Date 14-3-98
Sample No. ____ Tube No. ____ Length ____ Dia. ____
Wet Weight 177.7 gm. Bulk Density ____ kg/m³ ____
Moisture Content ____ %
Proving Ring No. ____ Proving Ring Constant ____ at Failur
Cell Pressure 50 KN/ m² Rate of Strain ____ per cent per mi

Strain Dial	Stress Dial	Load kg	Area cm²	Compressive Stress	Strain %
0	0		11·40		0.0
5	45		11·419		0.167
10	62		11·439		0.333
15	78		11·458		0.500
20	94		11·477		0.667
25	110		11·497		0.833
30	128		11.516		1.0
45	172		11.574		1.5
60	210		11.639		2.0
75	239		11.697		2.5
80	750		11.761		3.0
105	293		11.819		3.5
120	316		11·884		4.0
135	332		11·948	395.665	4.5
150	341		12·013	404.192	5.0
165	338		12·077	398.513	5.5
180			12·142		6.0
210			12·271		7.0
240			12·400		8.0
270			12·529		9.0
300			12·658		10.0
330			12·787		11.0
360			12·961		12.0
390			13·110		13.0
420			13·277		14.0
450			13·419		15.0
480			13·581		16.0
5 0			13·742		17.0
540			13·923		18.0
570			14·097		19.0
600			14·258		20.0
630			14·445		21.0
660			14·632		22.0
690			14·819		23.0
720			15·019		24.0
750			15·219		25.0

15.65—16.10M

Laboratory Assistant's Description of Sample



Sketch of Sample after failure

*Conditions at failure

1. Plastic Bulging
2. Shear Plane (Angle) 404.192
3. Vertical Cracks ____

Compressive Strength ____ kg
____ kg
Failure Strain ____ %
*Indicate type of failure.

Triaxial Test
Mohr Circles

Form K18M

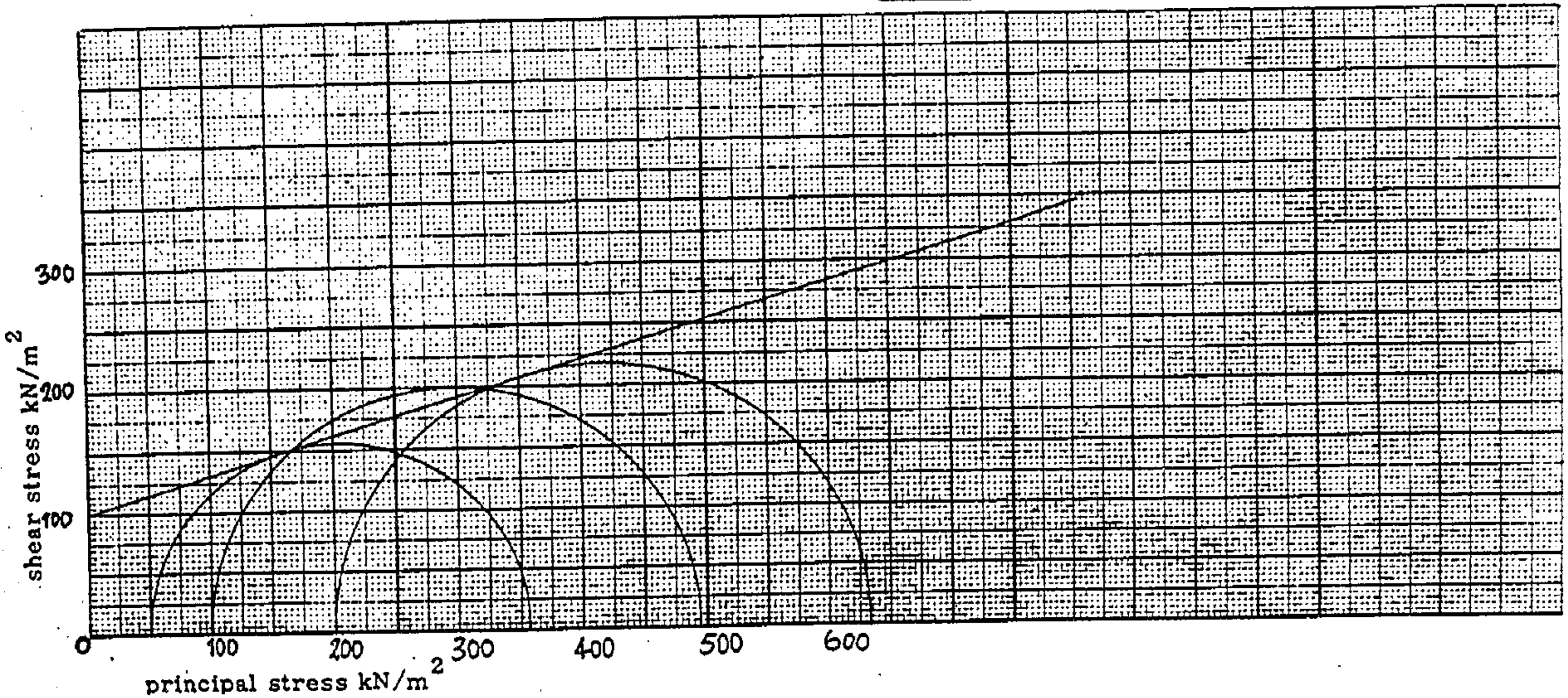
MANGOCHI BRIDGE SITE

sample no. 3	
Location no. BH-1	
date: 14-03-98	

17.85 — 18.30M

Bulk density = 2088 Kg/M³
c = 100 KN/M²
ϕ = 22°
M/C = 17.2 %

spec ident.	cell/p kN/m²	stress kN/m²	$\sigma_1 - \sigma_3$ kN/m²	σ_3 kN/m²	σ_1 kN/m²
1	50	304.6			354.6
2	100	394.5			494.5
3	200	431.4			631.4



MATERIALS LABORATORY

TRIAXIAL COMPRESSION TEST

ON SAMPLE 76·2mm LONG AND 38·1mm DIA.

Loc. No. BH 1 17·85–18·30M Name MANOCHI BRIDGE Date 14-03-78

Sample No. 3 Tube No. 1 Length ____ Dia. ____

Wet Weight 174 gm. Bulk Density ____ kg/m³ ____

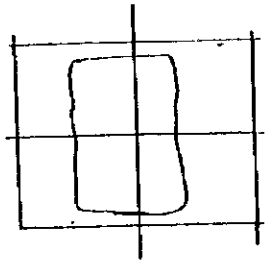
Moisture Content ____ % Proving Ring Constant ____ at Failure

Proving Ring No. ____ Rate of Strain ____ per cent per min

Cell Pressure 50 KN/ m²

Strain Dial	Stress Dial	Load kg	Area cm²	Compressive Stress	Strain %
0	0		11·40		0.0
5	40		11·419		0.167
10	55		11·439		0.333
15	66		11·458		0.500
20	76		11·477		0.667
25	85		11·497		0.833
30	93		11.516		1.0
45	116		11.574		1.5
60	139		11.639		2.0
75	162		11.697		2.5
80	186		11.761		3.0
105	209		11.819		3.5
120	231		11·884		4.0
135	249	296.769	11·948		4.5
150	257	304.626	12·013	309.626	5.0
165	257	303.012	12·077		5.5
180	240	281.453	12·142		6.0
210			12·271		7.0
240			12·400		8.0
270			12·529		9.0
300			12·658		10.0
330			12·787		11.0
360			12·961		12.0
390			13·110		13.0
420			13·277		14.0
450			13·419		15.0
480			13·581		16.0
5 0			13·742		17.0
540			13·923		18.0
570			14·097		19.0
600			14·258		20.0
630			14·445		21.0
660			14·632		22.0
690			14·819		23.0
720			15·019		24.0
750			15·219		25.0

Laboratory Assistant's Description of Sample



Sketch of Sample after failure

*Conditions at failure

1. Plastic Bulging
2. Shear Plane (Angle)
3. Vertical Cracks ____

Compressive Strength ____ kg

____ kg

Failure Strain ____ %

*Indicate type of failure.

50 KN = 304.626 KN/M²

100 KN = 394.479 KN/M²

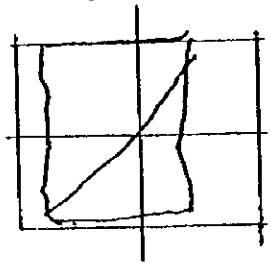
200 KN = 431.418 KN/M²

MATERIALS LABORATORY
TRIAXIAL COMPRESSION TEST
ON SAMPLE 76·2mm LONG AND 38·1mm DIA.

Loc. No. BH1 17.85–18.30M Name MANGOCHI BRIDGE Date 14-03-89
Sample No. 3 Tube No. Length Dia.
Wet Weight 182 gm. Bulk Density kg/m³
Moisture Content %
Proving Ring No. Proving Ring Constant at Failu
Cell Pressure 100 KN/ m² Rate of Strain per cent per mi

Strain Dial	Stress Dial	Load kg	Area cm²	Compressive Stress	Strain %
0	0		11·40		0.0
5	47		11·419		0.167
10	67		11·439		0.333
15	83		11·458		0.500
20	98		11·477		0.667
25	112		11·497		0.833
30	125		11.516		1.0
45	163		11.574		1.5
60	200		11.639		2.0
75	233		11.697		2.5
80	265		11.761		3.0
105	293		11.819		3.5
120	317		11·884		4.0
135			11·948		4.5
150			12·013		5.0
165			12·077		5.5
180			12·142		6.0
210	317		12·271		7.0
240	327		12·400		8.0
270	335		12·529		9.0
300	342		12·658		10.0
330	347		12·787		11.0
360	353		12·961		12.0
390	358		13·110		13.0
420	364		13·277		14.0
450	369		13·419		15.0
480	373		13·581		16.0
510	379		13·742		17.0
540	384		13·923		18.0
570	390		14·097	393.934	19.0
600	395		14·258	394.479	20.0
630	400		14·445	394.301	21.0
660	405		14·632	394.127	22.0
690	410		14·819	393.958	23.0
720	415		15·019	393.455	24.0
750			15·219		25.0

Laboratory Assistant's Description of Sample



Sketch of Sample after failure

*Conditions at failure

1. Plastic Bulging
2. Shear Plane (Angle)
3. Vertical Cracks

Compressive Strength kg
kg
Failure Strain %
*Indicate type of failure.

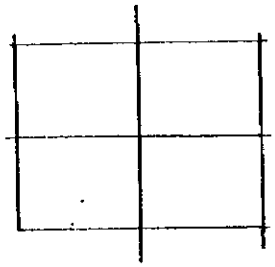
394.479 KN/M

MATERIALS LABORATORY
TRIAXIAL COMPRESSION TEST
ON SAMPLE 762mmLONG AND 38·1mm DIA.

Loc. No. BH 1 12·85–18·30m Name MANGOCHI BRIDGE Date 14–03–90
Sample No. 3 Tube No. Length Dia.
Wet Weight 183·2 gm. Bulk Density kg/m³
Moisture Content %.
Proving Ring No. Proving Ring Constant at Failure
Cell Pressure 200 KN/m² Rate of Strain per cent per min

Strain Dial	Stress Dial	Load kg	Area cm²	Compressive Stress	Strain %
0	0		11·40		0.0
5	50		11·419		0.167
10	80		11·439		0.333
15	105		11·458		0.500
20	130		11·477		0.667
25	150		11·497		0.833
30	172		11.516		1.0
45	221		11.574		1.5
60	265		11.639		2.0
75	302		11.697		2.5
80	329		11.761		3.0
105	347		11.819		3.5
120	356		11·884	426.553	4.0
135	362		11·948	431.418	4.5
150	362		12·013	↑	5.0
165	~~362~~		12·077	429.084	5.5
180	358		12·142	419.834	6.0
210	347		12·271	402.697	7.0
240			12·400		8.0
270			12·529		9.0
300			12·658		10.0
330			12·787		11.0
360			12·961		12.0
390			13·110		13.0
420			13·277		14.0
450			13·419		15.0
480			13·581		16.0
5 0			13·742		17.0
540			13·923		18.0
570			14·097		19.0
600			14·258		20.0
630			14·445		21.0
660			14·632		22.0
690			14·819		23.0
720			15·019		24.0
750			15·219		25.0

Laboratory Assistant's Description of Sample



Sketch of Sample after failure

*Conditions at failure

1. Plastic Bulging
2. Shear Plane (Angle) A31.418 KN/M²
3. Vertical Cracks

Compressive Strength kg
kg
Failure Strain %
*Indicate type of failure.

Triaxial Test Mohr Circles

Mangochi Bridge

Depths 20.9 — 21.35 m

Bulk Density = 2118 kg/m³

Mc = 18.1%

c = 9.0 kN/m²

φ = 28.0°

sample no.	3
Location no.	BH1
date:	13 — 3 — 1998

spec ident.	cell/p kN/m²	stress kN/m²	$\sigma_1 - \sigma_3$ kN/m²	σ_3 kN/m²	σ_1 kN/m²
1	50	87.0			
2	100	170.8			
3	200	344.2