社会開発調査部報告書

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS REPUBLIC OF THE PHILIPPINES

DETAILED ENGINEERING DESIGN STUDY

> ON

PAN-PHILIPPINE HIGHWAY IMPROVEMENT PROJECT (MINDANAO SECTION)

> FINAL REPORT MAIN TEXT

> > MARCH 1997

KATAHIRA & ENGINEERS INTERNATIONAL NIPPON ENGINEERING CONSULTANTS CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a detailed engineering design study on Pan-Philippine Highway Improvement Project (Mindanao Section) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Mr. Kunihiko Sawano of Katahira & Engineers International, and composed of members from Katahira & Engineers International and Nippon Engineering Consultants Co., Ltd., twice between September 1995 to January 1997.

The team held discussions with the officials concerned of the Government of the Philippines, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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 the Philippines for their close cooperation extended to the team.

March 1997

Kimio Fujita President Japan International Cooperation Agency

March 1997

Mr. Kimio Fujita President Japan International Cooperation Agency Tokyo, Japan

Dear Mr. Fujita,

Letter of Transmittal

We are pleased to submit to you the Final Report of the Detailed Engineering Design Study on Pan-Philippine Highway Improvement Project (Mindanao Section) in the Republic of the Philippines. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and your Agency as well as the Department of Public Works and Highways and other authorities concerned of the Government of the Philippines.

This report presents the results of the detailed engineering design including the preparation of construction plan and tender documents, cost estimate and environmental impact assessment. The project aims to cope with the various problems that the road presently suffers from, and to make the road solid, reliable and comfortable.

In view of the urgency of improving the project road which is the only axis in the east Mindanao, and of the need for socio-economic development in Mindanao Island as a whole, we recommend that the Government of the Philippines implement this project as a top priority.

We wish to take this opportunity to express our sincere gratitude to your Agency and the Ministry of Foreign Affairs. We also wish to express our deep gratitude to the Department of Public Works and Highways and other authorities concerned of the Government of the Philippines for the close cooperation and assistance extended to us during our investigations and study.

Very truly yours,

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Kunihiko Sawano Team Leader, Detailed Engineering Design Study on Pan-Philippine Highway Improvement Project (Mindanao Section)

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الم المحمل المحمد المتعادية المحملين أوالي المحمل المحملية والمحملية والمحمد المحمد المحمد المحمد المحمد المحم المحمل المحمد المحمد

المحكمة وتحقيق من المحكمة المح المحكمة المحكمة وتحقيق من المحكمة المحك المحكمة المحكمة

TABLE OF CONTENTS

<u>PAGE</u>

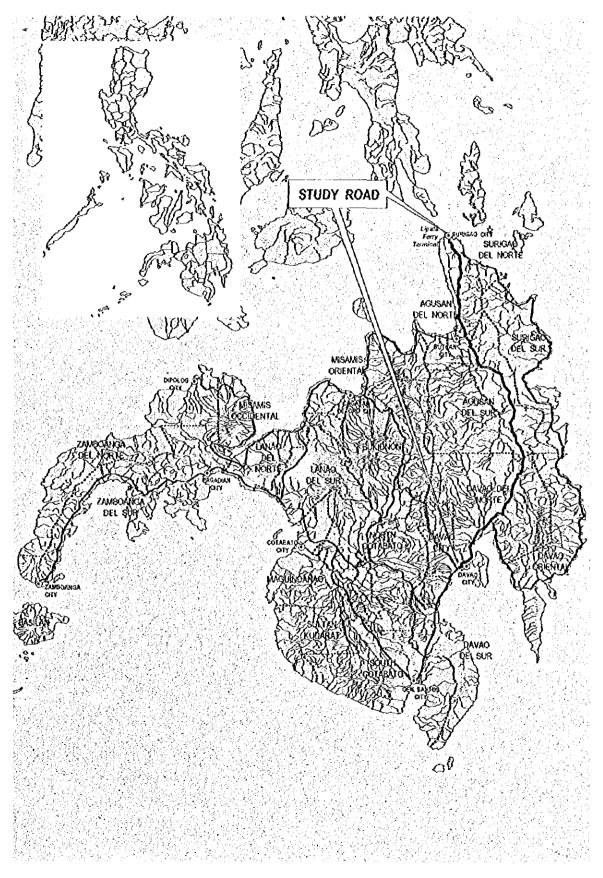
PART I	INTRODUCTION	
CHAPTER I	INTRODUCTION	
1.1	Background of the Study	1-1
1.2	Objective of the Study	1-2
1.3	Study Road	1-2
1.4	Scope of the Study	1-2
1.5	Study Flow	1-2
1.6	Study Flow Organization of the Study	1-4
1.7	Reports	1-5
PART II	ENGINEERING SURVEY	
CHAPTER 2	EXISTING ROAD CONDITION SURVEY	$f_{1} \rightarrow 0$
2.1	Roadway and Drainage Survey	2-1
2.2	Slope Survey	2-10
2.3	Bridge Survey	2-11
· 2		
CHAPTER 3	TRAFFIC SURVEY	
3.1	Traffic Survey	3-1
3.2	Estimated Future Traffic	
CHAPTER 4	TOPOGRAPHIC SURVEY	
4.1	Route Survey	4-1
4.2	Topographic Survey at Bridge Sites, Slopes	
	and Flood-prone Areas	4-3
4.3	River Profile and Cross-section Survey	4-3
4.4	Aerial Photographic Survey and Mapping	
CHAPTER 5	SOILS/MATERIAL AND GEOTECHNICAL	
	INVESTIGATION	
5.1		
	Pavement Rehabilitation Design	5-1
5.2	Geotechnical Investigation for Stope Protection Design	
5.3	Geotechnical Investigation for Bridge Foundation Design	5-2
5.4	Soils Investigation for Soft Ground Sections	5-3
5.5	Soils Investigation for Sianib Section	5-3
5.6	Soils Investigation for Liboganon River Bank Design	5-4
5.7	Material Sources Investigation	5-4
		•

CHAPTER 6 HYDROLOGICAL INVESTIGATION AND ANALYSIS 6.1 6.2 6.3 6.4 6.5 6.6 6.7 6.8 Scouring Around Pier 6-25

6.9Summary of the Result of Analysis6-316.10Recommendation6-38

PART III DETAILED DESIGN

1	CONTRACT PACKAGING	
7.1	Contract Packaging	7-1
7.2		
8	ROADWAY REHABILITATION/IMPROVEMENT	
8.1	Design Policies	8-1
8.2	Geometric Design Standards	8-1
8.3	Pavement Design	8-2
8.4	Shoulder Design	8-35
8.5	Typical Roadway Cross-section	8-36
8.6		
8.7	Embankment Slope Stability and Consolidation Settlement	
	at Soft Ground Areas	8-49
9	ROADWAY DRAINAGE IMPROVEMENT	
9.1	Design of Culverts (RCPC/RCBC)	9-1
9.2	Side Ditches/Under Drain	9-8
10	BRIDGE REHABILITATION/IMPROVEMENT	
10.1	Present Condition of Bridges	10-1
10.2	Rehabilitation Criteria and Rehabilitation Method	10-7
10.4	Scope of Works for Bridges	10-22
11	SLOPE PROTECTION	·
11.1	Design Criteria	11-1
11.2	Scope of Works for Slopes	11-6
12	COUNTERMEASURES AGAINST FLOOD	
12.1	Design Criteria	12-1
12.2		
	7.1 7.2 8 8.1 8.2 8.3 8.4 8.5 8.6 8.7 9 9.1 9.2 10 10.1 10.2 10.3 10.4 11 11.1 11.2 12.1	7.1 Contract Packaging 7.2 Naming of Contract Packages 8 ROADWAY REHABILITATION/IMPROVEMENT 8.1 Design Policies 8.2 Geometric Design Standards 8.3 Pavement Design 8.4 Shoulder Design 8.5 Typical Roadway Cross-section 8.6 Monkayo Bypass Alignment Study 8.7 Embankment Slope Stability and Consolidation Settlement at Soft Ground Areas 9 ROADWAY DRAINAGE IMPROVEMENT 9.1 Design of Culverts (RCPC/RCBC) 9.2 Side Ditches/Under Drain 10 BRIDGE REHABILITATION/IMPROVEMENT 10.1 Present Condition of Bridges 10.2 Rehabilitation Criteria and Rehabilitation Method 10.3 Structural Design Criteria 10.4 Scope of Works for Bridges 11.1 Design Criteria 11.2 Scope of Works for Slopes 112 COUNTERMEASURES AGAINST FLOOD

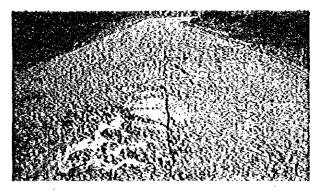


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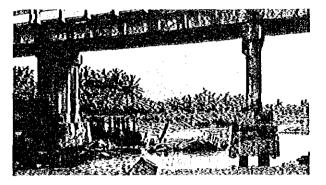
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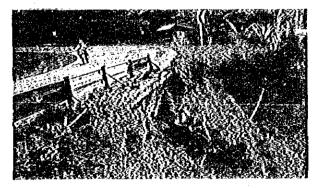
TYPICAL SITE CONDITION AND IMPROVEMENT WORKS



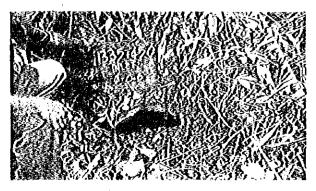
CONCRETE PAVEMENT IN VERY BAD CONDITION. TOTAL RECONSTRUCTION WITH CONCRETE PAVEMENT.



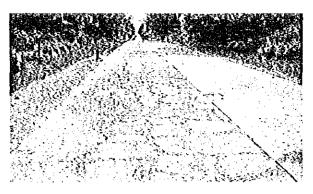
ANDANAN BRIDGE. SERIOUSLY DETERIORATED SUPERSTRUCTURE WITH DEEP LOCAL SCOURING AT PIERS. TOTAL RECONSTRUCTION.



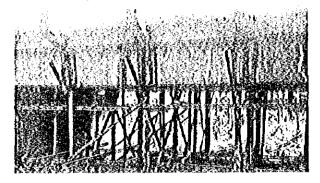
EMBANKMENT SLOPE FAILURE. ONE LANE AFFECTED. SLOPE PROTECTION WITH SURFACE AND SUBSURFACE WATER CONTROL.



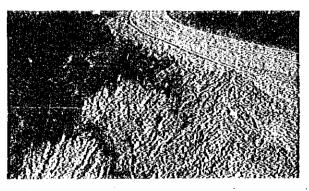
BURIED PIPE CULVERT WITHOUT INLET FACILITY. REPLACEMENT WITH NEW PIPE CULVERT.



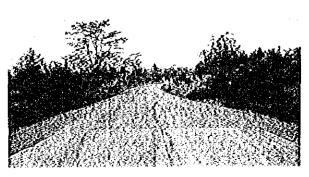
CONCRETE PAVEMENT IN BAD CONDITION WITH PARTIALLY BROKEN SLABS REPLACEMENT OF BROKEN SLABS WITH CONCRETE PAVEMENT AND AC OVERLAY.



BAYUGAN BRIDGE. SERIOUSLY DETERIORATED SUPERSTRUCTURE. REPLACEMENT OF SUPERSTRUCTURE.



EMBANKMENT SLOPE FAILURE. SHOULDER AFFECTED. SLOPE PROTECTION.



GRAVEL SECTION AT SOFT GROUND AREA. AC PAVEMENT AFTER PRE-LOADING.

PART IV COST ESTIMATES AND TENDER DOCUMENTS

CHAPTER 13	PREPARATION OF CONSTRUCTION PLAN	
13.1	Basic Principles	13-1
13.2	Basic Principles	13-1
13.3	Construction Method	13-4
13.4	Construction Materials	13-6
13.5	Construction Equipment/Plants	13-10
13.6	Work Program and Construction Period	13-11
CHAPTER 14	COST ESTIMATES	
14.1	Unit Cost Analysis	14-1
	Estimated Construction Cost	
14.3	Right-of-Way Acquisition and Compensation Cost	14-10
	Consulting Services Cost for Construction Supervision	14-10
	Project Cost	14-10
CHAPTER 15	PREPARATION OF TENDER DOCUMENTS	
15.1	Prequalification Documents	15-1
	Tender Documents	
		1.7 1
PART V	PREPARATION FOR PROJECT IMPLEMENTAT	
PART V	PREPARATION FOR PROJECT IMPLEMENTAT	
PART V CHAPTER 16	PREPARATION FOR PROJECT IMPLEMENTAT ENVIRONMENTAL IMPACT STATEMENT	ION
PART V CHAPTER 16 16.1	PREPARATION FOR PROJECT IMPLEMENTAT	ION 16-1
PART V CHAPTER 16 16.1	PREPARATION FOR PROJECT IMPLEMENTAT ENVIRONMENTAL IMPACT STATEMENT ECC Along the Existing Alignment	ION 16-1
PART V CHAPTER 16 16.1 16.2 CHAPTER 17	PREPARATION FOR PROJECT IMPLEMENTAT ENVIRONMENTAL IMPACT STATEMENT ECC Along the Existing Alignment EIS Along New Alignment: Monkayo Bypass PROJECT IMPLEMENTATION PROGRAM	ION 16-1 16-1
PART V CHAPTER 16 16.1 16.2 CHAPTER 17 17.1	PREPARATION FOR PROJECT IMPLEMENTAT ENVIRONMENTAL IMPACT STATEMENT ECC Along the Existing Alignment EIS Along New Alignment: Monkayo Bypass	ION 16-1 16-1 17-1
PART V CHAPTER 16 16.1 16.2 CHAPTER 17 17.1 17.2 CHAPTER 18	PREPARATION FOR PROJECT IMPLEMENTAT ENVIRONMENTAL IMPACT STATEMENT ECC Along the Existing Alignment EIS Along New Alignment: Monkayo Bypass PROJECT IMPLEMENTATION PROGRAM Current Status on Preparation for Project Implementation Implementation Program PROJECT EVALUATION AND RECOMMENDATIONS	ION 16-1 16-1 17-1 17-1
PART V CHAPTER 16 16.1 16.2 CHAPTER 17 17.1 17.2 CHAPTER 18	PREPARATION FOR PROJECT IMPLEMENTAT ENVIRONMENTAL IMPACT STATEMENT ECC Along the Existing Alignment	ION 16-1 16-1 17-1 17-1

 $(1-\delta)^{-1} = \frac{1}{2} \left(\frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right)^{-1} + \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right)$

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us Briefender biske

TABLES		PAGE
CHAPTER 2		:
2.1-1	Pavement Distress Survey Result	2-4
2.1-2	Example of Accomplished Field Survey Format	
2.1-3	Example of Accomplished Field Format-1	
CHAPTER 3		
3.2-1(1/2)	Future Traffic Volume by Section	3-4
(2/2)	Future Traffic Volume by Section	
CHAPTER 5		
CHAFTER 5	n fan en de ferste ser fan de ferste ser ster fan de ferste ser ferste ser fan de ferste ser ferste ser ser se An en de ferste ser ferste ser ferste ser ferste ser ser ser ser ser ser ser ser ser se	
5.3-1	Geotechnical Investigation at Bridge Sites	5-3
CHAPTER 6		: .
6.3-1	Inventory of Rainfall Data	63
6.3-2	Annual Maximum Daily Rainfall and Annual Rainfall	
6.4-1	Rainfall Intensity of Three PAGASA	0-3
	Climatological Station	6.6
6.4-2(1/4)	Rainfall Depth - Duration Curves	
(2/4)	Rainfall Depth - Duration Curves	6.10
(3/4)	Rainfall Depth - Duration Curves	0.10
(4/4)	Rainfall Depth - Duration Curves	
6.4-3	Equation of Rainfall Duration Curves	6.13
6.5-1	Model Hyetograph by Method of Soil Conservation	
	Services	6-16
CHAPTER 7		
	and the state of the	and t
7.2-1	Contract Package Name and Construction Limits	7-2
:		• =
CHAPTER 8		
8.2-1	Geometric Design Standards Originally Adopted	
0,2-1	for Pan-Philippine Highway	0 1
8.2-2	Geometric Design Standards for Pan-Philippine Highway	0-1
	(Mindanao Section)	8-3
8.3-1	Initial Performance Period for the Project	
8.3-2	Design Requirements	8-7
8.3-3	Recommended Bus and Truck Factors	
8.3-4	Bus and Truck Factor Based on Axle Load Survey	8-8
8.3-5	Traffic Loading Class	8-8
8.3-6	MR AND K-VALUE	8-11
8.3-7	Required PCC Slab Thickness: PCC Reconstruction	
8.3-8	Required Structural Number: AC Reconstruction	8-20
8.3-9	Required AC Overlay Thickness,	
	Pavement Condition (Very Bad)	8-21
		-

8.3-10	Required AC Overlay Thickness,	
8.3-11	Pavement Condition (Bad) Required AC Overlay Thickness,	8-22
0.5 11	Pavement Condition (Fair)	8-23
8.3-12(1/2)	Summary of Selected Pavement Rehabilitation Method	
8.3-12(2/2)	Summary of Selected Pavement Rehabilitation Method	
8.7-1	Bridge Approach Embankment Slope Stability	
	and Consolidation Settlement	
8.7-2	Estimated Consolidation Settlement	
CHAPTER 9		
9.1-1	Summary of Proposed Works for Culverts	9-6
9.1-2	Summary of Culvert Improvement/Rehabilitation by Package	
9.2-1	Summary of Scope of Work for Side Ditches and	
· ·	Under Drain	9-9
CHAPTER 10	(1, 2, 2, 2, 3, 2, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3,	
· .		and the second
10.1-1(1/3)	Summary of Bridges	10-3
(2/3)	Summary of Bridges	
(3/3)	Summary of Bridges	10-5
10.2-1	Bridge Rehabilitation Methods and Their	
· .	Application Criteria	10-11
10.3-1	Acceleration Coefficient (A) For Total	La Bar
	Reconstruction Bridges	10-21
10.4-1	Summary of Scope of Work for Bridges	10-23
10.4-2(1/2)	Scope of Works for Each Bridge	
10.4-2(2/2)	Scope of Works for Each Bridge	10-26
10.4-3	Justification and Outline of New Structure	
	of Total Reconstruction and New Bridges	10-27
$a_{\mu} = \frac{1}{2}$ (1)		
CHAPTER 11		
		· · · .
11.1-1(1)	Generally Applicable Slope Protection Works to	
	Each Type of Slope Failure	11-2
(2)	Generally Applicable Slope Protection Works to	
(A)	Each Type of Slope Failure	11-3
(3)	Generally Applicable Stope Protection Works to	
10	Each Type of Stope Failure	11-4
(4)	Generally Applicable Slope Protection Works to	112
	Each Type of Slope Failure	11-5
11.2-1	Summer of Grans of Work For Stone Destantion	11.6
	Summary of Scope of Work For Slope Protection	11-0
11.2-2	Causes of Embankment Slope Failure and Slope Protection Works	110
11.2-3	Protection Works Scope of Work for Each Slope	11*0 11_10
11,4*3		11-10
· · ·		
ga tata ang		
	an ann an an	
÷		• •

CHAPTER 12

Criteria for Assessment of Flood Severity	12-1
Countermeasures Against Flood of Each Flood Section	
	1917 - ¹
	Criteria for Assessment of Flood Severity Countermeasures Atong Road Countermeasures Atong River Countermeasures Adopted Countermeasures Against Flood of Each Flood Section Countermeasures Against Flood of Each Flood Section

and a second second

CHAPTER 13

13.2-1	Application of Method for Maintenance of Traffic	13-2
13.3-1	Major Works	13-4
13.3-2	Major Equipment Used for Work	13-5
13.4-1(1/2)	Material Sources	13-6
13.4-1(2/2)	Material Sources	13-7
13.6-1	Work Schedule for Reconstruction of Short Bridge (L < 30m).	13-12
13.6-2	Work Schedule of Middle Bridge (L=30 ⁻⁶⁰ m)	13-12
13.6-3	Work Schedule of Andanan Bridge (L=180m)	13-12
13.6-4	Work Schedule For Construction of Monkayo Bypass No. 2	4
	Bridge (L=146m)	13-13
13.6-5	Work Schedule of New Gov. Miranda Bridge (L-650m)	13-13
13.6-6	Work Program of Contract Package 1	13-15
13.6-7	Work Program of Contract Package 2	13-15
13.6-8	Work Program of Contract Package 3	13-15
13.6-9	Work Program of Contract Package 4	13-16
13.6-10	Work Program of Contract Package 5	13-16
13.6-11	Work Program of Contract Package 6	13-16
13.6-12	Work Program of Contract Package 7	13-17
13.6-13	Work Program of Contract Package 8	13-17
13.6-14	Work Program of Contract Package 9	13-17
13.6-15	Work Program of Contract Package 10	13-18
13.6-16	Work Program of Contract Package 11	13-18
13.6-17	Work Program of Contract Package 12	13-18
13.6-18	Work Program of Contract Package 13	13-19
13.6-19	Work Program of Contract Package 14	13-19
13.6-20	Work Program of Contract Package 15	13-19
13.6-21	Work Program of Contract Package 16	13-20
13.6-22	Work Program of Contract Package 17	
13.6-23	Work Program of Contract Package 18	13-20
13.6-24	Work Program of Contract Package 19	13-19
CHAPTER 14		
	en e	
14 1-1	Cost Companent For Selected Construction Itoms	14.2

CHAPTER 14

14.1-1	Cost Component For Selected Construction Items	14-3
14.1-2	Equipment Rental Rates	-
	(ACEL RATES As of November 1992)	14-5
14.1-3	Cost of Commercial Materials	14-7
14.1-4	Labor Rates	
14.2-1	Summary of Construction Cost	14-9

14.3-1 14.5-1	-	i Cost	
СНАРТ	ER 16		
16.2-1	Probable Impacts and Pr	oposed Mitigating Measures	16-3
CHAPTI			
17.2-1	Implementation Schedule	e and Annual Fund Requirement	t 17-4
	an a		
			:
4 - ⁻	an a		
1 · ·			
	in the second		
		n fra de la constante de la sector de la constante de la constante de la constante de la constante de la const Na constante de la constante de	
			an dan di san ger

.

FIGURES	PAG	Æ
· · · ·		
CHAPTER 1		·
1.5-1	Study Flow Diagram 1-3	3
1.6-1	Organization Chart 1-4	ł
CHAPTER 2		 f
2.1-1	Legends Used for Sketching Pavement Distress 2-2	2
2.1-2	Example of Accomplished Field Survey Format 2-3	3
2.1-3	Legends Used for Accomplishing Field Format 2-5	
2.1-4	Example of Accomplished Field Survey Format-2 2-8	-
2.1-5	Classification of Headwall Types 2-9	>
2.3-1(1)	An Example of Detailed Dimension Survey	2
(2)	An Example of Detailed Dimension Survey 2-1	
2.3-2	An Example of Crack Survey 2-1	
CHAPTER 3		
3.1-1	Traffic Survey Stations 3-2	2
3.1-2	AADT (1994) and Average Travel Speed 3-3	
CHAPTER 5		
5.7-1	Borrow Sources Investigated 5-6	5
5.7-2	Base/Subbase Material Sources Investigated	1
5.7-3	Concrete Aggregate Sources Investigated 5-8	
CHAPTER 6		
6.1-1	Flow Chart of Hydrological Analysis 6-1	l
6.4-1	Comparison of Calculated Result With PAGASA'S DATA 6-7	I j
6.5-1	Hydrograph at NIA WEIR IN SIMULAO RIVER 6-1	8
6.7-1	Three Dimensional Chart in Simulao Inundation Area 6-2	
6.7-2(1/2)	Inundation Area of Simulao River 6-2	27
(2/2)	Inundation Area of Simulao River 6-2	28
6.8-1	Relation Between Maximum Scoured Depth and Elow Water Depth	0
6.9-1	Flow Water Depth 6-2 Peak Discharge Volume of Legaspi River	
6.9-2	Arega River and Its Surroundings	
6.9-3	Liboganon River Bank Elevation	
CHAPTER 8		•
8.3-1	Traffic Loading Class	•
	Traffic Loading Class and Contract Packages	
8.3-2		

	8.3-4(1)	Total Discounted Cost	8.16	
	· ·	Total Discounted Cost		
	(2)			
	(3)	Total Discounted Cost		
	8.3-5	Proposed Paymeent Structure: Package 5		
	8.5-1	Typical Roadway Cross-Section: ACO Type-1		
	8.5-2	Typical Roadway Cross-Section: ACO Type-2		
	8.5-3	Typical Roadway Cross-Section: PCC Type-1	8-39	
	8.5-4	Typical Roadway Cross-Section: PCC Type-2	8-40	
	8,5-5	Typical Roadway Cross-Section: PCC Type-5	8-41	
	8.5-6	Typical Roadway Cross-Section: PCC Type-6	8-42	
	8.5-7	Typical Roadway Cross-Section: ACO Type-1	8-43	
	8.6-1	Present Condition of Monkayo Town Area		
	8.6-2	Possible Corridors For Bypass Alignment		
	8.6-3	Alternative Alignments For Monkayo Bypass		
	8.7-1	Typical Cross-Section at Bridge Approaches		
	0.7-1	Typical Cluss-section at Druge Approaches	0-21	
	CITANERD A			
	CHAPTER 9			
	~ • •			
	9.1-1	Procedure of RCPC/RCBC Capacity Analysis	9-2	
	9.1-2(1)	Discharge Capacity of Culvert: Pipe	9-3	
	(2)	Discharge Capacity of Culvert: Box	9-4	
	(3)	Discharge Capacity of Culvert: Box	9-5	
	9.2-1(1)	Discharge Capacity of Side Ditches		
	(2)	Discharge Capacity of Side Ditches		
	(3)	Discharge Capacity of Side Ditches		
	(*)		/	
	CHAPTER 10			
	10.1-1	Location of Existing Bridges	10.2	
	10.4-1		10-2	
	10.4-1	Bridges To Be Rehabilitated/Improved	10.04	
	10.4.0	Under This Project	10-24	
	10.4-2	Alternative Schemes For Andanan Bridges	10-31	
	10.4-3	Alternative Schemes For Monkayo Bypass 2 Bridge	10-33	
	10.4-4(1/2)	Alternative Schemes For Gov. Miranda Bridges	10-35	
	10.4-2(2/2)	Alternative Schemes For Gov. Miranda Bridges	10-36	
	CHAPTER 11			
	11,2-1	Stopes for Protection Works	11-7	
· ·	11.2-2	Slope Protection Work at Km. 1240+150		
	11.2 2		11.7	
	CHAPTER 12			
	CHAFTER 12			
			10 4	
	12.2-1	Flood Sections Needing Countermeasures	12-6	
	12.2-2(1/2)	Simulao River Flood Area		
	12.2-2(2/2)	Simulao River Flood Area		
	12.2-3	Countermeasures For Liboganon River	12-12	
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CHAPTER 13

13.2-1Monkayo Bypass13.4-1Material Sources: Aggregate for Concrete13.4-2Material Sources: Subbase/Base Course		13-8

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ABBREVIATIONS

<u>ABBREVIA</u>	IONS	
AADT	: Annual Average Daily Traffic	
AASHTO	: American Association of State Highway and Transportati	on Officials
AC	: Asphalt Concrete	
ACEL	: Associated Construction Equipment Lessors, Inc.	
ADB	: Asian Development Bank	
ADT	: Average Daily Traffic	
ARMM	: Autonomous Region for Muslim Mindanao	
AWP	: Annual Work Program	
B/C	: Benefit/Cost	
BOE	: Bureau of Equipment	
BOM	: Bureau of Maintenance	
CAR	: Cordillera Autonomous Region	
CBR	: California Bearing Ratio	·
CEO	: City Engineering Office	
DEO	: District Engineering Office	
DENR	: Department of Environment and Natural Resources	
DPWH	: Department of Public Works and Highways	-
ECA	: Environmentally Critical Area	
ECC	: Environmental Compliance Certificate	
ECP	: Environmentally Critical Project	
EIA	: Environmental Impact Assessment	· · · ·
EIS	: Environmental Impact System	
EMB	: Environmental Management Bureau	
EMK	: Equivalent Maintenance Kilometer	
EO		
ESAL	: Equivalent Single Axle Load	a 1
FWD	: Falling Weight Deflectometer	
FYB	: First Year Benefit	
GDP	: Gross Domestic Product	
GNP	: Gross National Product	
GOJ	: Government of Japan	
GOP	: Government of the Philippines	· · ·
GPDP	: Gross Provincial Domestic Product	1
GRDP	: Gross Regional Domestic Product	
GVA	: Gross Value Added	
HCM	: Highway Capacity Manual	·
IACEP	: Inter-Agency Committee on Environmental Protection	
IBRD	: International Bank for Reconstruction and Development	
IEE	: Initial Environmental Examination	
IRI	: International Roughness Index	
IRF	: Immediate Response Fund	
IRR	: Internal Rate of Return	
JICA	: Japan International Cooperation Agency	
LOI	: Letter of Instruction	
LTO	: Land Transportation Office	
MBA	: Maintenance By Administration	
MBC	: Maintenance By Contract	
MTPDP	: Medium Term Philippine Development Plan	
MTPIP	: Medium Term Public Investment Program	

NCR	: National Capital Region	
NCSO	: National Census and Statistical Office	
NDT	: Non-Destructive Test	
NEDA	: National Economic and Development Authority	
NEPC	: National Environmental Protection Council	
NIA	: National Irrigation Administration	
NPV	: Net Present Value	
NRR	: Net Reproduction Rate	
NSCB	: National Statistical Coordination Board	
NSO	: National Statistical Coordination Board	
NTCP	: National Traffic Count Program	
OD	: Origin-Destination	
OECF	: Overseas Economic Cooperation Fund	
PAGASA	•	
INUASA	 Philippine Atmospheric, Geophysical and Astronomical Se Administration 	a vices
PB	: Performance Budget	
PCC	: Portland Cement Concrete	
PCDG		
PDD PD	: Prestressed Concrete Deck Girder	
РД Р.Д.	: Philippine Description	
	: Presidential Decree	
PHIVOLCS	: Philippine Institute of Volcanology and Seismology	
PHMMS	: Philippine Highway Maintenance Management System	
PPP	: Philippine Population Projection	. · · · ·
PSI	: Present Serviceability Index	• .
PSR	: Present Serviceability Rating	
RCBC	: Reinforced Concrete Box Culvert	
RCDG	: Reinforced Concrete Deck Girder	2
RCPC	: Reinforced Concrete Pipe Culvert	· ·
RES	: Reinforced Equipment Service	
ROW	: Right-of-Way	
RRI	: Rehabilitation Requirement Index	1 a t
RRR	: Rehabilitation Requirement Rating	1 . <i>1</i>
SN	: Structural Number	· · ·
SPT	: Standard Penetration Test	
VOC	: Vehicle Operating Cost	
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PART I

INTRODUCTION

CHAPTER 1 INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The Government of the Philippines, in the Medium-Term Philippine Development Plan, 1993-1998, puts emphasis on the infrastructure development to support the productive sector growth and reduce the regional disparities.

The Pan-Philippine Highway is the most important trunkline in the country's road network running through the four major islands of Luzon, Samar, Leyte and Mindanao with a total length of 2,100 km. The construction of the Highway, which was then a long-cherished desire of the country to attain the national targets such as regional development, industrial growth, preservation of peace and order, national unification, etc., was started in 1969 and completed in 1979.

Now, in 17 to 26 years after opening to traffic, the Pan-Philippine Highway suffers various problem such as progress of pavement deterioration, repeated slope failures in the mountainous areas, damage of bridges and so on.

To cope with the said problems, the Government of the Philippines conducted the following studies with technical assistance provided by JICA: Feasibility Study of Philippine Road Disaster Prevention Project (June 1984), Feasibility Study of Philippine Road Disaster Prevention Project, Stage II (July 1985), Feasibility Study of the Road Improvement Project on the Pan-Philippine Highway (September 1987), and Feasibility Study on Rehabilitation and Maintenance of Bridges along Arterial Roads (June 1989). These studies cover the Luzon, Samar and Leyte sections of the Pan-Philippine Highway and the rehabilitation projects formulated therein are now being implemented.

Mainly for the reason of peace and order problem, rehabilitation of Mindanao section of the Highway has been left behind although it is of urgent necessity to promote the development of Mindanao. In the restoration of peace and order situation, the Government of the Philippines has decided to start the rehabilitation of the Mindanao section of the Highway and conducted the Feasibility Study on Pan-Philippine Highway Rehabilitation Project (Mindanao Section) from March 1994 to May 1995 with technical assistance provided by JICA.

In view of the priority and urgency of the project, the Government of the Philippines further sought a technical assistance from the Government of Japan for the conduct of the DETAILED ENGINEERING DESIGN STUDY ON PAN-PHILIPPINE HIGHWAY IMPROVEMENT PROJECT (MINDANAO SECTION) (the Study).

In response to the request of the government of the Philippines, the Government of Japan decided to conduct the Study. JICA, the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, organized a study team to be engaged in the Study. The JICA Study Team, in close collaboration with the DPWH Counterpart Team, commenced work in August 1995 and completed the Study in March 1997.

1.2 **OBJECTIVE OF THE STUDY**

The objective of the Study is to prepare the detailed engineering design and tender documents for the Pan-Philippine Highway Improvement Project (Mindanao Section).

1.3 STUDY ROAD

The Study Road is the Pan-Philippine Highway from Lipata Ferry Terminal (Km. 1,113+397) up to the end of the Davao City Diversion Road (Km. 1,515+949) with a length of 403.4 km.

1.4 SCOPE OF THE STUDY

In order to achieve the objective mentioned above, the Study covered the following items:

First Period of the Study

- Collection and Review of Relevant Studies
- Detailed Investigation on Existing Road Condition
- Topographic Survey and Mapping
- Geotechnical Investigation
- Hydrological Investigation
- Detailed Design (1) *

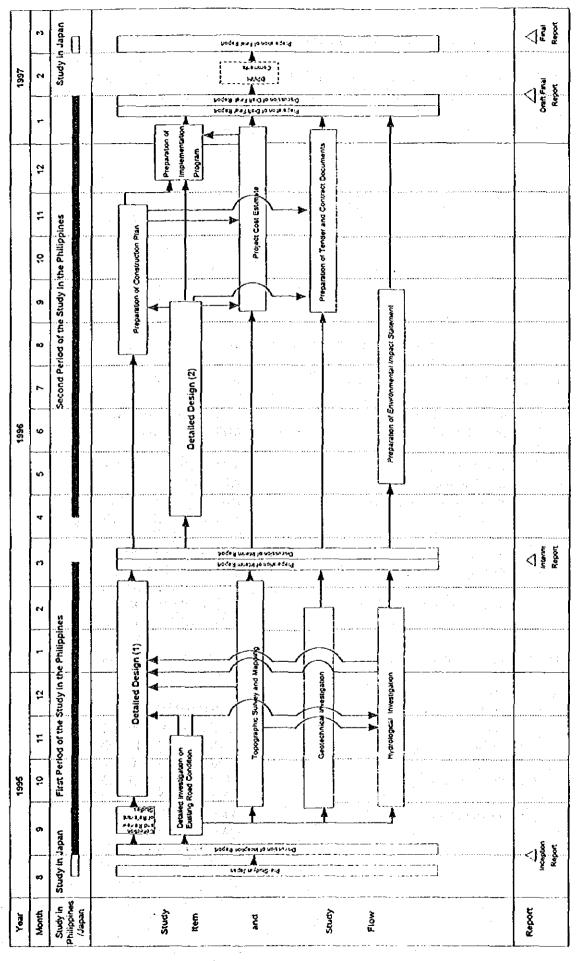
Second Period of the Study

- Detailed Design (2) *
- Preparation of Environmental Impact Statement
- for the Monkayo Bypass Construction Project
- Preparation of Construction Plan
- Project Cost Estimate
- Preparation of Implementation Program
- Preparation of Tender and Contract Documents
- * Note: Detailed Design (1) covers 11 contract packages with higher priority out of 19 packages in total (see Chapter 6 as for contract packaging), while Detailed Design (2) covers the rest packages.

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1.5 STUDY FLOW

The Study flow of the whole work is schematically shown in Figure 1.5-1. FIGURE 1.5-1 STUDY FLOW DIAGRAM



1-3

1.6 ORGANIZATION OF THE STUDY

JICA organized a Study Team and DPWH organized a Counterpart Team and a Steering Committee. The Study was carried out jointly by the JICA Study Team and the DPWH Counterpart Team under the guidance of the DPWH Steering Committee. The organization chart is shown in Figure 1.6-1.

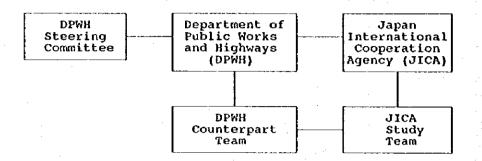


FIGURE 1.6-1 ORGANIZATION CHART

The JICA Study Team was composed of the following members:

	Team Leader/Highway Planner :	KUNIHIKO SAWANO
0	Deputy Team Leader/Highway Engineer 1:	MITSUO HATAKEYAMA
0	Highway Engineer 2 :	KEIJI AOKI
•	Bridge Engineer 1 :	MOUSHUN YABIKU
۲	Bridge Engineer 2 ;	AL HILER
6	Slope Protection Engineer :	RICHARD PURSER
	Drainage Engineer :	MITSUNORI MIZUISHI
0	Geotechnical Engineer :	SHIGERU KOBAYASHI
6	Survey Engineer :	SYUNICHI USAMI
•	Hydrological/Hydraulic Engineer :	SUSUMU HONDA
•	Environmental Engineer :	KAZUHIRO HASEGAWA
•	Construction Engineer/Cost Estimator :	MASARU IWAKI
0	Specification Engineer :	TERUMI MOCHIZUKI

The DPWH Counterpart Team was composed of the following members:

A. Key Staff:	<u>A. K</u>	eγ	Sta	uff£: -	
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- Team Leader
- Project Coordinator
- Highway Engineers
- Bridge Engineers
- CAD Engineers

: GERONIMO ALONZO
: JUANITO ALAMAR
: GENEROSO ALCONIS CORAZON ARCETA
: REMEGIO CALEZE ANTONIO YAPTANGCO
: ARTURO FLORES CASAN BUSRAN ARIEL GAYO

• Stope Engineer	: GENEROSO JOVES
Drainage Engineers	: FILOMENA VALES
	FRANCIS ESCOBAR
B. Supporting Staff:	
• Draftsmen	: ROMEO NAUNGAYAN
	ANTONIO VALENZUELA
	ANTHONY CASTUERAS
	DIOSDADO DIEGO
Bookkeeper/Secretary	: MA. LOURDES SANTOS
Typist/Word Processor	: JASMIN FIGUERAS
J I	ESPERANZA AGUSTIN
• Xerox Machine Operator	: RICARDO TING
 Utilityman 	: DANTE ZAMORA

The DPWH Steering Committee was composed of the following members:

• Chairman	: TEODORO T. ENCARNACION
	Undersecretary
• Member	: MANUEL M. BONOAN
	Assistant Secretary
 Member 	: BIENVENIDO LEUTERIO
	Director, Bureau of Design
 Member 	: CLARITA BANDONILLO
	Director, Bureau of Construction
• Member	: DOMINADOR Y. SANTOS
	Director, PMO-PJHL
 Member 	: JOSE P. GLORIA
•	Project Manager III, PMO-FS
Member	: JUAN D. LUALHATI
	Director, Planning Service
 Member 	: ERNESTO SILVELA
	Director, Region XI
 Member 	: CONRADO REPATO
	Director, Region XIII
Member	: TAKAAKI KUSAKABE
	JICA Adviser for Highway Engineering

1.7 REPORTS

The following reports were prepared during the Study:

- Inception Report (September, 1995)
 Interim Report (March, 1996)
 Implementation Program (August, 1996)
- Environmental Impact Statement
 - For Monkayo Bypass Construction (October, 1996)
- Draft Final Report (January, 1997)

The final report is organized with the following:

- Executive Summary
- Main Text
- Appendix
- Drawings
- Design Analysis Reports
- Pre-qualification Documents
- Tender and Contract Documents
- Cost Analysis Report
- Quantity Calculation Reports

PART II

ENGINEERING SURVEY

CHAPTER 2	EXISTING ROAD CONDITION SURVEY
CHAPTER 3	TRAFFIC SURVEY
CHAPTER 4	TOPOGRAPHIC SURVEY
CHAPTER 5	SOILS/MATERIAL AND GEOTECHNICAL INVESTIGATION
CHAPTER 6	HYDROLOGICAL INVESTIGATION

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CHAPTER 2

EXISTING ROAD CONDITION SURVEY

2.1 ROADWAY AND DRAINAGE SURVEY

2.1.1 Pavement Condition Survey

Pavement condition survey was undertaken for the entire stretch of the Study Road. Pavement distresses of the following were sketched on the field survey sheet for each slab:

Pavement Distress Surveyed

- Cracks (open cracks as well as sealed cracks)
- Cracks with faulting
- Potholes
- Scaling
- Depression
- Pop-out
- Patching

Other Information

- Pavement with overlay
- Section under construction
- Gravel section
- Location of kilometer post
- Bridge section

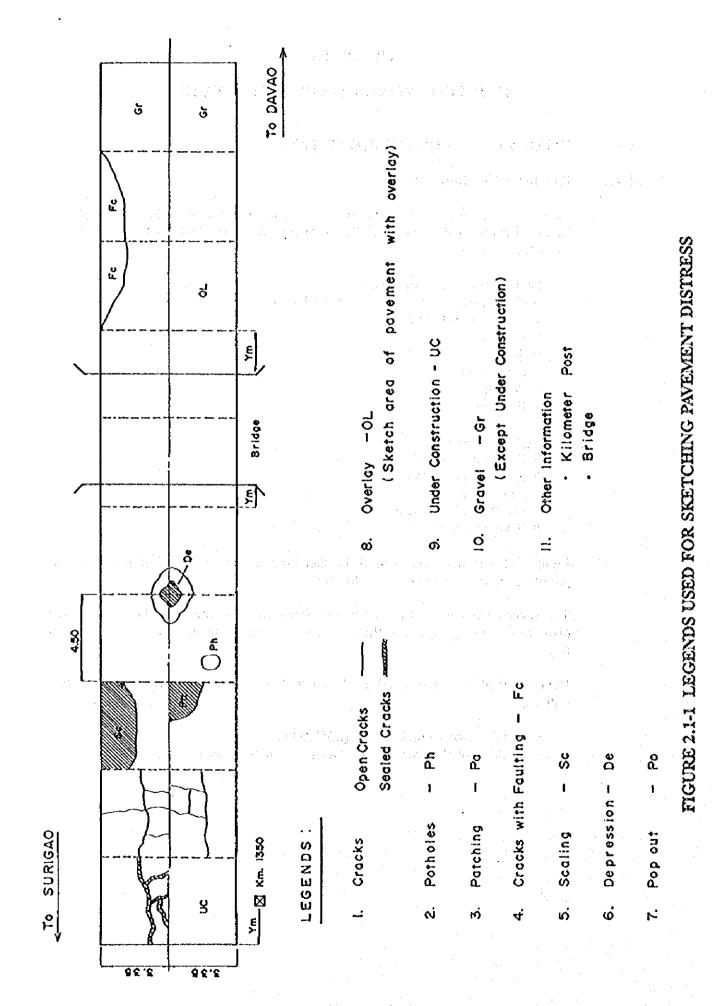
Figure 2.1-1 shows legends used for sketching and Figure 2.1-2 shows an example of accomplished field survey format.

The survey team walked all along the Study Road in order to sketch pavement distresses. Average speed of the survey of one survey team was about 10 km per day.

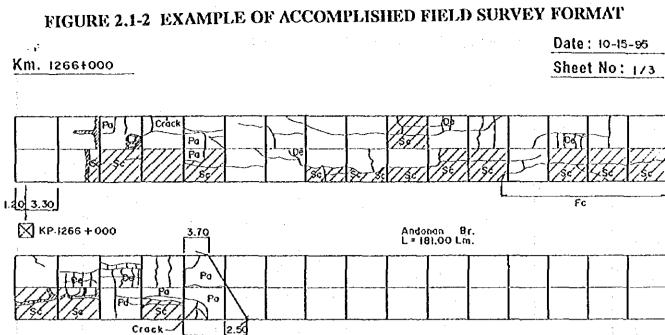
Data obtained were processed as shown in Table 2.1-1, using the following two indices:

• Crack ratio = crack length (m)/1,000 sq.m.

Number of slabs with depressions and cracks with faulting.

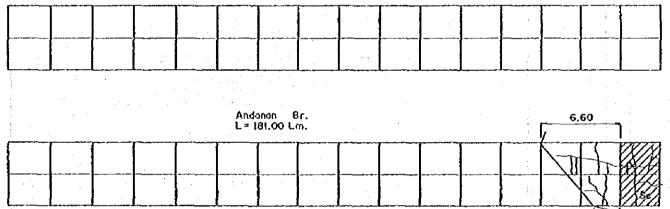


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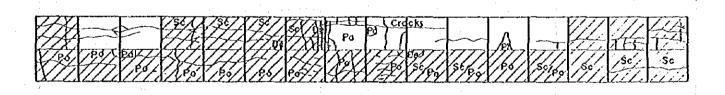


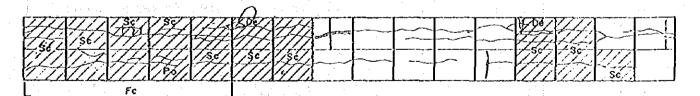


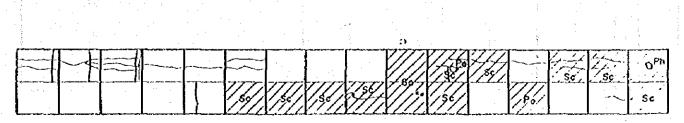
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TABLE 2.1-1 PAVEMENT DISTRESS SURVEY RESULT

				prinse the total stars in	******	Cracks	*****		-	
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1			· .						0 sq.m	
			1	esev (m)	Longitudinal Cracks (m)	Biock/Alligator Cracks (m)			Ratio (m/1000 sq.m.)	
		Length (m)	Area (sq.m.)	Transverse Cracks (m)	Longitudina Cracks (m)	Block/Alliga Cracks (m)	(m)	Sec.	Ratio	
Km.	1	71.4	478 4	3.4	49.5	0	52 9	110 5	-	
1246	2	72	482.4	6.7	9.0	0	15.7	32.5		
	3	72	482.4	0	18.0	0	180	37.3		
	4	72	482.4	3.4	27.0	: 0	30.4	629		
	5	72	482 4	0	22.5	C	22.5	46.6		
	6	72	482 4	6.7	135	0	20 2	41.9		
	7	72	482 4	30.2	0	44	739	153.2		
	8	72	482.4	33.5	94.5	0	128 0	265.3		
	9	72	432 4	0	215.0	0	216.0	447.8		
	10	72	492 4	13.4	63.0	36	112 4	233.0		
	11	72	482.4	23 5	103.5	88	215.0	445.6		
	12	12	482.4	16.8	117.0	0	133.8	277.3		
	13	_12	482.4	20.1	72.0	0	921	190.9		
	14	22 5	150.7	20.1	_45.0	0	65.1	432 0		
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	17				·					
	Total		6,417.9	177.6	850.5	167.8	1195 8	185 3		100 200 300 400 500
Km,	1	72	452.4	30.2	143.5	31.5	210.2	435.6		
1247	2	72	482.4		94.5	_27.0	198 6	411.6		
	3	72	482.4	6.7	103.5	0	1102	228.4		
	4	72	482.4	20,1	36.0	0	56.1	116.3		
	5		482.4	0	0	0	0	0		
	δ	72	482.4	13.4	13.5	0	26.9	55.8		
	7	72	482.4	0	0	0	0	0		
	8	72	482.4	0	0	0	0	0		
	9	72	482.4	0	36.0	26.8	62 8	130.2		
	10	72	482.4	36 9	121.5	60.3	2187	453 3		
	<u>11</u>		482.4	20.1	40.5	0	60.6	125.6		
	12	72	482.4	23.5	81.0	9.0	113.5	235 2		
	13		432.4	16.8	108.0	23.5	143.2	307.2		
	14	53.7	<u>359 8</u>	23.5	72.0	0	95.5	265.3	_	
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2.1.2 Shoulder and Side Ditch Survey

Shoulder and side ditch survey was undertaken along the entire stretch of the Study Road. Following were surveyed for each 100-m section:

Shoulder

• Existing shoulder material

• Present condition

Proposed shoulder improvement

Side Ditch

- Cross-section type of road (to judge need of side ditch)
- Side ditch material
- Dimension of side ditch
- Present condition of side ditch
- Water flow direction
- Present condition of side ditch
- Proposed side ditch improvement

Legends used for accomplishing field survey format are shown in Figure 2.1-3 and an example of the accomplished field survey format is shown in Table 2.1-2.

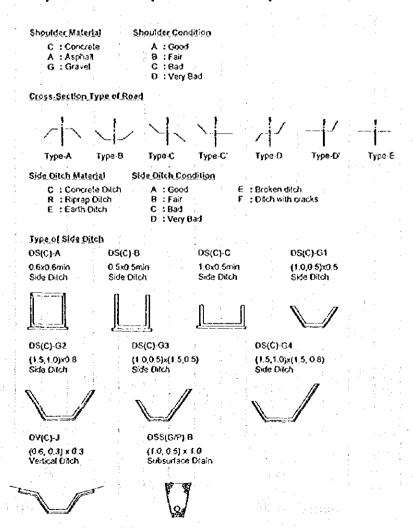


FIGURE 2.1-3 LEGENDS USED FOR ACCOMPLISHING FIELD FORMAT

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2.1.3 Pipe/Box Culvert Survey

All pipe/box culverts were surveyed their present conditions and possible improvement measures for each of the following portions:

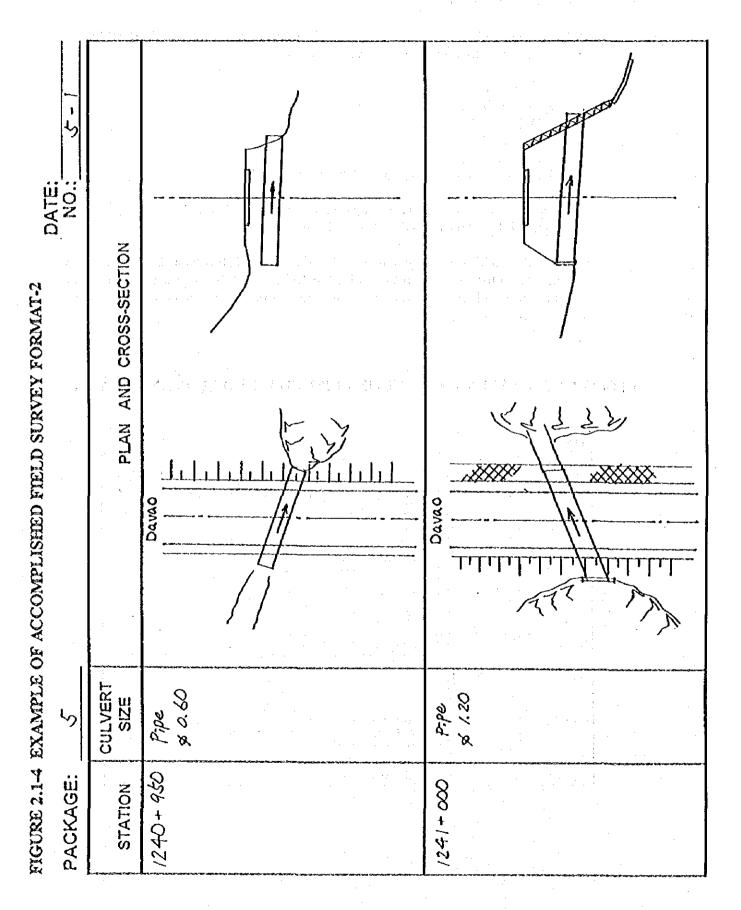
- Inlet facility
- Culvert itself
- Outlet facility
- Upstream
- Downstream
- Others such as nearby embankment, etc.

Two field survey formats were prepared as shown in Table 2.1-3 and Figure 2.1-4. Figure 2.1-5 shows classification of headwall types.

During the field survey, maintenance engineers and foremen of District/City Engineering Offices accompanied with the JICA Study Team to assist in locating the pipe/box culverts as well as to provide information on conditions during heavy rain.

TABLE 2.1-3 EXAMPLE OF ACCOMPLISHED FIELD SURVEY FORMAT-1

ACKAGE: 5		PAGI	E: <u>6-1</u>
LOCATION (STATION)	CULVERT SIZE	CONDITION/RECOMMENDATION 1 INLET 2 CULVERT 3 OUTLET 4 UPSTREAM 5 DOWNSTREAM	A 6 OTHERS
1240+950	Ø = 0.60m	1. No headwall, clogged with debris (100%)/catch basin, cleaning 2. /Change to Ø = 1.20m 3. No headwall/Headwall Type B 4. Clogged 5. /Vertical Ditch 6	
1241+000	Ø = 1,20m	 No headwall, clogged with debris (30%)/Headwall Type A, Cleaning No damage Riprap headwall - Vertical ditch, Concrete foundation - 	
1241+050	Ø = 0.90m	 Riprap headwall damaged, Clogged with debris (50%)/Catch basin, C Damaged Culvert (2 0m) (Outlet)/Change to Ø = 1.20m No headwal/Headwall Type B - Wertical ditch with foundation - 	Jeaning
1241+200	Ø = 1.20m	 No headwall, Clogged with debris (60%)/Calch basin, cleaning Damaged curvert (2.0m) (Outlet)/Replacement of culvert (Outlet) No headwall/Headwall Type A 	



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2.8

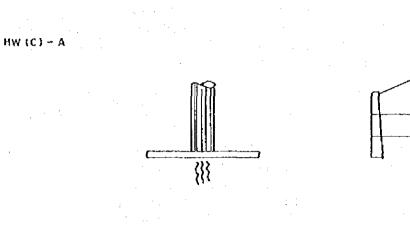
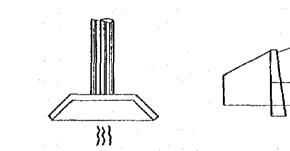


FIGURE 2.1-5 CLASSIFICATION OF HEADWALL TYPES

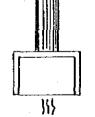


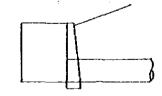




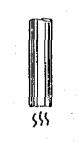


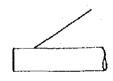












2.2 SLOPE SURVEY

The field survey team revisited all damaged slope sections reported in the feasibility study and made supplimentary observations and additional measurements. Of the original 76 selected slope sites, 6 sites were undergoing rehabilitation at the time of the site inspections and another 9 sites had been completely restored. an additional 26 extra slope sites were noted with various forms of damage. Three of these had completed restoration works. Those slopes which had been completed, or were undergoing restoration at the time of site inspection were as follows:

ot)- (· ·	Type of	
<u>Slope Number</u>	Location	Disaster	<u>Status</u>
1-04	Km 1116+200	C-F	Completed
2-07	Km 1173+430	E-F	
2-08	Km 1177+000	Debris	88
2-09	Km 1177+200	Debris	11
5-01	Km 1378+500	E-F	
5-07	Km 1401+850	E-F	17
5-19	Km 1445+700	E-F	47
E-26	Km 1449+700	E-F	
E-27	Km 1449+950	E-F	50
1-03	Km 1115+800	E-F	On-going
1-07	Km 1135+150	E-F	ii C
5-02	Km 1378+800	E-F	
5-05	Km 1395+800	E-F	U .
5-13	Km 1430+950	E-F	13
E-25	Km 1449+400	E-F	H
· · · · · · · · · · · ·			

The underlying causes of the damage was reappraised and the geology was checked. The size of each area of damage was remeasured to check on any changes since the feasibility study site inspections. All previously identified sites were re-photographed and the extra sites were comprehensively measured as well as photographed.

2.3 BRIDGE SURVEY

All bridges along the Study Road were re-visited to re-check and update bridge conditions as well as to obtain additional data required for the detailed design. Field survey formats accomplished during the feasibility study were updated, if there are any changes in condition occuring in the interim period between the feasibility study and the detailed design.

Additional data gathering were concentrated mainly on the following:

- Detailed dimension survey of Structural Members
- Crack survey of RC/PC beams

Detailed Dimension Survey of Structural Members

Detailed dimension survey of structural members was undertaken for bridges to be rehabilitated or reconstructed. An example of survey result is shown in Figure 2.3-1.

Crack Survey of RC/PC Beams

Crack survey of RC/PC beams was undertaken for critical bridges. Cracks were classified as follows:

Hairline (or thin) crack (T)	: Less than 0.2mm
Medium crack (M)	: 0.2 to 0.6mm
Large crack (L)	: More than 0.6mm

An example of field measurement of cracks is shown in Figure 2.3-2.

2-11

Photographs of the bridge portions where damaged or deteriorated were taken.

All bridges were re-assessed their structural soundness based on the data obtained in the field.

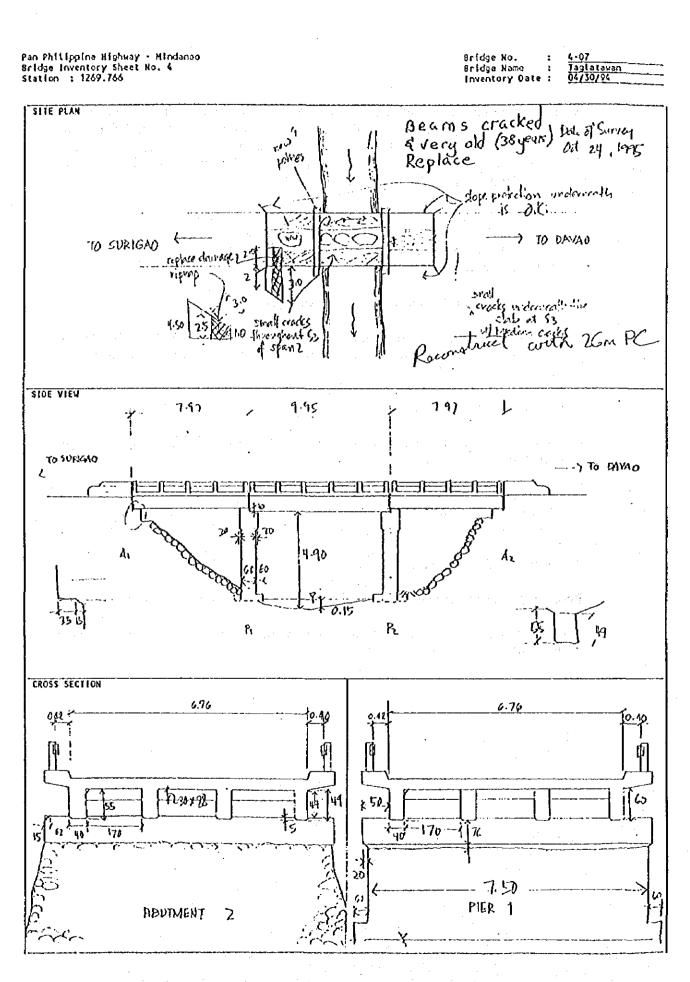
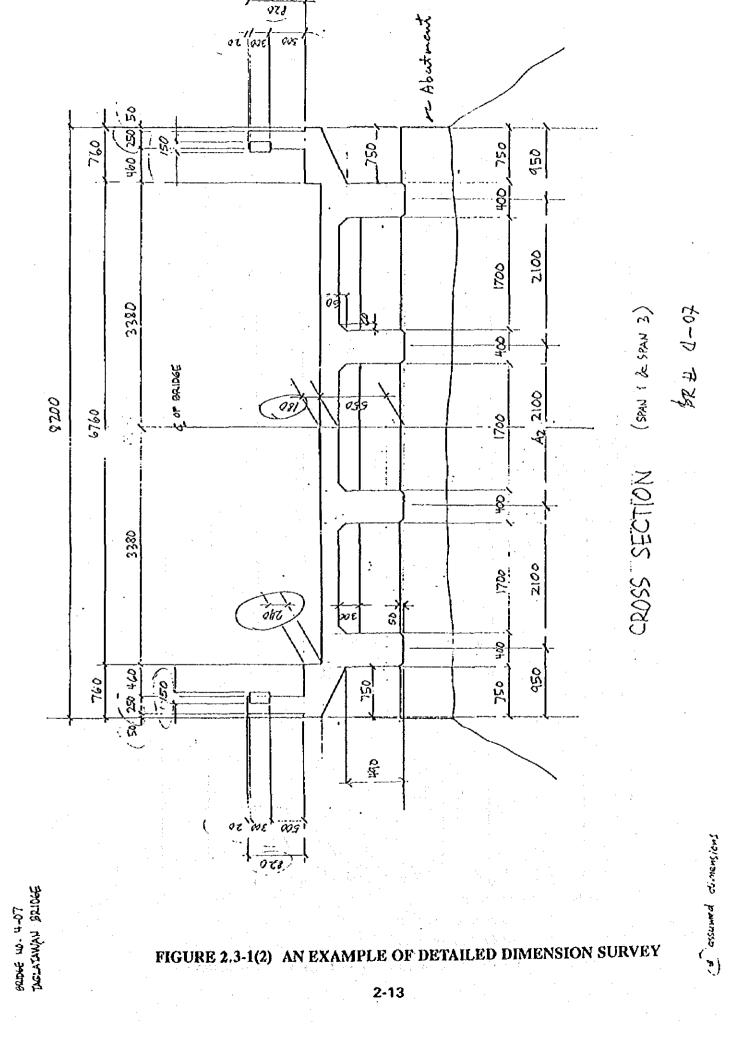
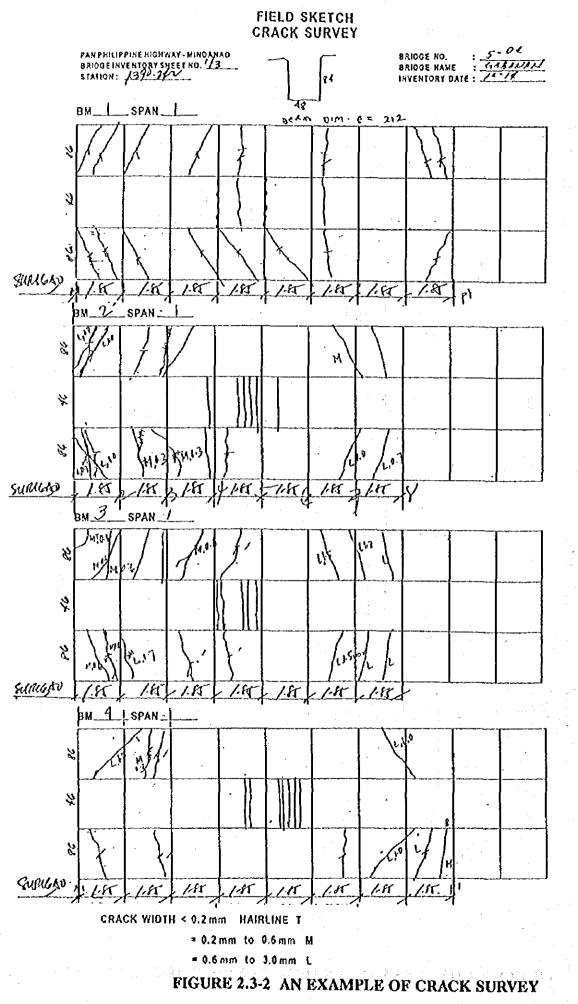


FIGURE 2.3-1(1) AN EXAMPLE OF DETAILED DIMENSION SURVEY





CHAPTER 3

TRAFFIC SURVEY

3.1 TRAFFIC SURVEY

No traffic survey was undertaken, as the extensive traffic survey was undertaken during the feasibility study of which results were utilized under this Study.

The traffic surveys undertaken during the feasibility study were as follows:

- Traffic count survey at 24 stations
- Travel speed survey along the Study Road
- Axle load survey at 4 stations
- Commodity OD survey at 4 stations

Traffic survey stations and AADT (1994) are shown in Figure 3.1-1 and 2, respectively.

3.2 ESTIMATED FUTURE TRAFFIC

Future traffic estimated by the feasibility study was utilized under this Study. Estimated future traffic is shown in Table 3.2-1.

						ł												
PROVINCE/CITY	i Surigao City	-	Surigge del Norte	Vorte 1		A	Agusan dei Narte	Vorte		- Burvan City					Agu	Aguagn del	Sur	
KILOMETRAGE	1120 1130	1 140	051	1 160 1	11 ozii	60 1	1190 1200 1	0/21 Q	1220	, 1230	12.40	12 20 13	12,60	1270	1280	1290	8	2 2
MAJOR TOWNS	TO: City Proper	Surigo Siaon	Surigoo-Oavoo Coontal Rd. 20.n Tubad	bostaf Rá. Tubad Alagria			Sartlago	ŝ	Cabadbaran		- -	ឆ	Sibagat	Bayugan		Prosperidad	San Francisco ridad	nclaco
& INTERSECTIONS	Lipata Ferry Terminal		¢	Tec Mainir	Kitcharao	Ta: Jabanga	b	To: Tubey	RTR		To: Chy Proper		•	To:Esperanza	b Lu c	To: Talacapon	cotor	
TRAFTIC COUNTS	510. 1 L (Km.117)	Sra.2 ▲ (Km.1134)		510.5 A (Xm.1163)		Sto. 4 Å (Km.180)	Ste. 5 6. (Km. 1999)	n ŝ	\$10. 6 ▲ (Xm.1216)	sro.c sro.7 Sro.a sro.s ▲ ▲ ▲ ▲ ▲ (xm.l216) (xm.l265) (xm.l23	8 510.9 ▲ ▲ (Xm.1235)	_	510,10 A (Km.126	sta, 10 Å (Km.i262)	5 51 (C 3	sta, 11 Å (Km.1265)	510.12 Å (Km.1302)	_
TRAVEL SPEED SURVET	29 29 c. 1	Section 2	×	Section 3	250	Section 4		Section 3		(Km.i Sacrion 7	(Km.1232+900)	00) Section 8	2*ction 9		Section 10		Section 11	346.12
AXLE LOAD SURVEY				L-1 •	ŝ					~	L-2 A (Km.1235)	۰.	·				·	
COMMODITY O.D. SURVEY				с-1 А (Км. 11653)	a		·				c-2 ▲ (xm.1235)	:			. · ·			-
PROVINCE / CITY	Aguson del	el Sur			-				Daveo	Davas del Norre						Devee CIT	7 0	
KILOMETRAGE	13.30	1340	1350 13	1360 1370	0951	0601	14 00	14 10	14,20		1440	8 1	094	1	- 0 - 0 - 1	96-1	1500	
MAJOR TOWNS BINTERSECTIONS	Rosario	â	Bundwan	Tranto		0						Surigoe-Davido Coestol Ad.	lo Coestol 1		- Pronote		Dares City Proper	2
				To: Sta. Jasefa	e fa	M on kayo	gye -	Montevisio	Ngbuniway		dowom	l augo T	۲ ۲	H Copecol	k ll To: Dapecol Ta Ste Tomas			-
TRAFFIC COUNTS	512 13 •	570, 14 Å (Km. 134)	ΩŽ	ŝre,l5 ▲ (Xm.l36!)		510, 16 ▲ (Km.1392)	200 200	510,16 S10,17 S10,18 ▲ ▲ ▲ ▲ ▲ ▲ ▲	Ste. 18 A (Xm. 14)8)	51a. 19 8 (Km1431)		Sta. 20 A (Km.H3t)	Sto.21 A (Km.146	21 519.22 A A	5to.Zt. Sto.ZZ. Sto.ZS A A (Km.1460)(Km.1452) (Km.14622)		Sra. 24 Sra. 25 ▲ ▲ (Km.1501+500) (Km.1506)	ŝ
TRAVEL SPEED SURVEY	Sec. 12 5ecn.	Section 13	Section 14		Section 15		Saction 16		Section 17 5	Section 1 C	Section 19		Section 20	5 - C	Section 22		Sec23 Section24	S
AXLE LOAD SURVEY						L-3 A (Xm.t3921500)	1005		:		i.			•	"∟_^ (Km.1462)			
COMMODITY O.D. SURVEY						C= 5 A (Km.1592+500)	005	÷	:						C- ▲ (Xm 1482)			
COTTO-TO-																		

FIGURE 3.1-1 TRAFFIC SURVEY STATIONS

SOURCE: F/S Report

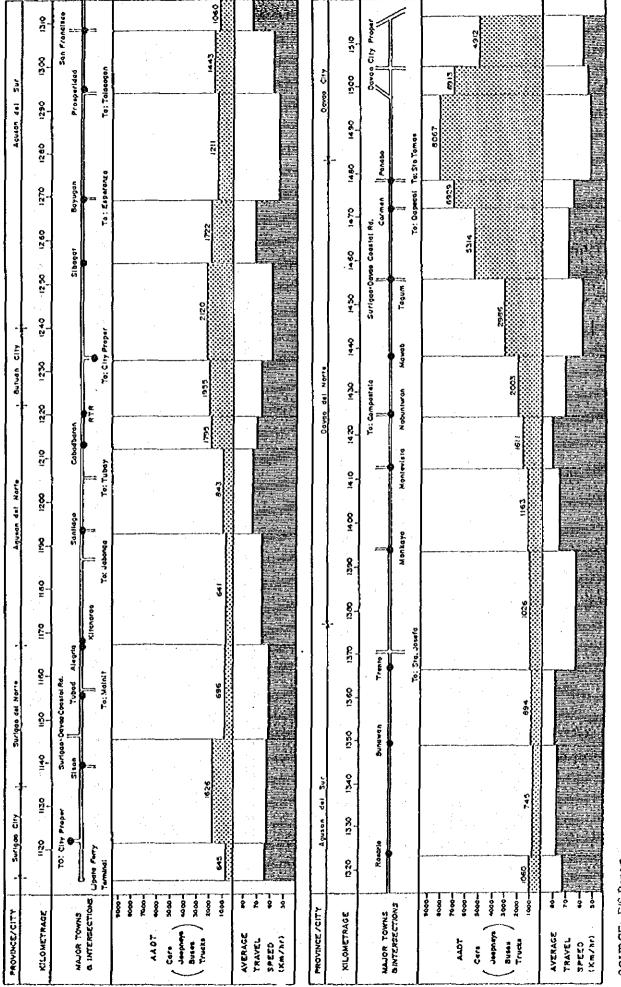


FIGURE 3.1-2 AADT (1994) AND AVERAGE TRAVEL SPEED

SOURCE: F/S Report

TABLE	3.2-1	(1/2)	FUTURI	E TRAI	FIC VC	LUME BY	SECTION		
Section	Year	Vehi	cles with	14 or	more w	leels	Othe	ers	Total
		Car	Jeepney	Bus	Truck	Sub-Total	Tricycle	M'cycle	
1	1994	251	115	41	238	645	449	199	1,293
	2000	383	179	67	364	993	663	308	1,964
	2010	686	323	119	739	1,867	1,192	538	3,597
	2020	1,098	514	186	1,271	3,069	1,933	864	5,866
2	1994	372	595	61	596	1,624	16	134	1,774
	2000	571	898	103	922	2,494	24	218	2,736
	2010	1,024	1,617	177	1,863	4,681	44	371	5,096
	2020	1,635	2,601	282	3,239	7,757	70	588	8,415
3	1994	236	241	68	153	698	5	82	785
	2000	383	384	120	222	1,109	8	144	1,261
	2010	674	687	201	443	2,005	15	235	2,255
	2020	1,061	1,092	318	720	3,191	23	368	3,582
4	1994	200	194	61	186	641	7	49	697
•	2000	339	320	113	274	1,046	9	95	1,150
	2010	588	569	183	533	1,873	21	147	2,041
	2020	914	899	290	863	2,966	30	229	3,225
5	1994	252	312	73	206	843	4	91	938
	2000	428	508	140	304	1,380	8	168	1,556
	2010	739	904	219	586	2,448	12	270	2,730
	2020	1,154	1,448	351	942	3,895	20	420	4,335
6	1994	612	673	70	440	1,795	73	238	2,106
	2000	985	1,067	137	649	2,838	110	396	3,344
· ·	2010	1,753	1,907	210	1,252	5,122	199	676	5,997
	2020	2,801	3,085	339	2,047	8,272	327	1,067	9,666
7	1994	771	636	74	475	1,956	40	186	2,182
· · ·	2000	1,237	1,024	145	692	3,098	63	331	3,492
	2010	2,216	1,836	222	1,315	5,589	116	551	6,256
	2020	3,568	2,986	359	2,117	9,030	190	858	10,078
8	1994	712	782	164	462	2,120	39	250	2,409
	2000	1,157	1,258	308	667	3,390	61	435	3,886
11 - 11 - 14	2010	2,076	2,295	492	1,252	6,115	115	744	6,974
	2020	3,350	3,763	801	2,005	9,919	191	1,180	11,290
9	1994	547	495	189	491	1,722	134	195	2,051
	2000	905	817	349	696	2,767	211	348	3,326
	2010	1,598	1,460	567	1,296	4,921	412	581	5,914
	2020	2,558	2,373	931	2,058	7,920	701	914	9,535
10	1994	459	225	184	343	1,211	6	156	1,373
-	2000	770	394	343	491	1,998	9	287	2,294
	2010	1,342	668	553	931	3,494	18	465	3,977
	2020	2,143	1,053	907	1,486	5,589	31	726	6,346
11	1994	554	293	175	421	1,443	33	291	1,767
•	2000	924	501	327	594	2,346	53	507	2,906
	2010	1,640	881	525	1,094	4,140	102	882	5,124
· .	2020	2,651	1,416	857	1,724	6,648	175	1,427	8,250
12	1994	386	264	115	295	1,060	72	794	1,926
	2000	658	456	215	422	1,751	113	1,306	3,170
	2010	1,131	797	345	794	3,067	225	2,447	5,739
÷.,	2020	1,794	1,283	561	1,267	4,905	385	4,090	9,380
	Sector of the		DO ALLER DE LA CARTE DE LA	descent and the		Act of Concernance			

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SOURCE:

Feasibility Study Report

TABLE	3.2-1	(2/2)	FUTURE	TRAFFIC	VOLUME	BY	SECTION

TABLE	3.2-1	(2/2)	FUTUF	(F. TRAI	FIC V	OLUME BY	SECTION		
Section	Year	Vehi	cles wit	h 4 or	more w	heels	Othe	ers	Total
		Car	Jeepney	Bus	Truck	Sub-Total	Tricycle	M'cycle	
13	1994	334	101	119	191	745	8	178	931
	2000	572	191	219	278	1,260	13	322	1,595
	2010	981	303	357	530	2,171	25	531	2,727
	2020	1,547	462	580	860	3,449	43	837	4,329
14	1994	371	151	120	252	894	20	549	1,463
	2000	632	273	218	368	1,491	34	911	2,436
	2010	1,090	455	360	684		60	1,652	4,301
	2020	1,724	707	586	1,110	4,127	100	2,697	6,924
15	1994	405	113	153	355		202	633	1,861
	2000	679	208	274	516	1,677	315	1,041	3,033
	2010	1,190	339	459	924	2,912	588	1,889	5,389
	2020	1,888	516	748	1,478	4,630	964	3,059	8,653
16	1994	489	126	183	358	1,156	11	450	1,61
10	2000	809	227	323	527	1,886	22	753	2,663
	2010	1,434	377	549	934	3,294	33	1,349	4,670
	2010	2,292	583	891	1,508	5,274	55	2,170	7,499
17	1994	649	<u> </u>	305	500	1,611	80	511	2,202
17	2000	1,061	274	529	733	2,597	128	847	3,572
	2010	1,900	467	910	1,284	4,561	232	1,523	6,31
		3,055				-			•
10	2020		733	1,474	2,047	7,309	370	2,457	10,13
18	1994	855	157	318	673	2,003	20	605	2,62
	2000	1,380	271	542	990	3,183	36	989	4,20
	2010	2,500	466	944	1,713	5,623	60 0.5	1,797	7,48
10	2020	4,030	743	1,528	2,704	9,005	96	2,899	12,00
19	1994	1,029	332	488	1,137	2,986	1,050	1,110	5,14
	2000	1,644	548	811	1,674	4,677	1,640	1,777	8,09
	2010	3,005	980	1,442	2,862	8,289	3,020	3,255	14,56
	2020	4,854	1,568	2,326		13,206	4,827	5,242	23,27
20	1994	2,368	515	905	1,526		153	947	6,41
	2000	3,739	833	1,469	2,281	8,322	243	1,522	10,08
	2010	6,901		2,658	-	15,046	450	2,791	18,28
	2020	11,134	2,431	4,289		24,068	719	4,507	29,29
21	1994	2,807	957	1,043	2,122	6,929		1,596	9,54
	2000	4,425	1,527	1,675		10,842	1,603	2,538	14,98:
	2010	8,205	2,805	3,060	5,666	19,736	2,973	4,689	27,39
	2020	13,238	4,513	4,947	8,901	31,599	4,770	7,566	43,93
22	1994	3,284	1,733	940	2,110	8,067	147	651	8,86
	2000	5,188	2,759	1,502	3,208	12,657	236	1,045	13,93
	2010	9,639	5,117	2,768	5,680	23,204	433	1,922	25,55
	2020	15,581	8,263	4,479	8,931	37,254	694	3,113	41,06
23	1994	2,666	2,237	442	1,568	6,913	15	858	7,78
	2000	4,217	3,558	706	2,388	10,869	28	1,368	12,26
	2010	7,841	6,628	1,302	4,228	19,999	45	2,537	22,58
	2020	12,675	10,725	2,107		32,148	73	4,114	36, 33
24	1994	2,475	0	291	2,146		265	806	5,983
	2000	3,923	0	460	3,310		424	1,281	9,398
	2010	7,309	0	860		14,086	790	2,387	17,263
÷		11,827	0	1,391		22,557	1,279	3,870	27,700

SOURCE:

Feasibility Study Report

CHAPTER 4

TOPOGRAPHIC SURVEY

Following four kinds of topographic survey were undertaken:

- Route survey along the whole stretch of the Study Road
- Topographic survey at bridge sites, slopes and flood-prone areas
- River profile and cross-section survey
- Aerial photographic survey and mapping

4.1 ROUTE SURVEY

The route survey was undertaken for the entire stretch of the Study Road (or about 403 km) and for the proposed alignment of the Monkayo Bypass (about 2.5km) in accordance with the following procedure:

- GPS Survey
- Traverse Survey
- Establishment of Temporary Bench Marks (TBMs)
- Centerline Survey
- Centerline Stake-out Survey
- Profile Survey
- Cross-Section Survey
- Topographic Survey
- Preparation of Topographic Maps, Profiles and Cross-Sections

All data obtained in the field surveys were stored in the diskettes and mapping/drafting works were done by using computer softwares.

1) GPS Survey

GPS stations were established at about 10 km. interval, which were used as the control points for the traverse survey. An average of six satellites were observed. In order to check accuracy of the survey as well as to tie to National GPS Stations, five GPS stations established under the Philippine Geodetic Network were also measured. A total of 50 GPS stations were measured.

2) Traverse Survey

The traverse points were established at an interval of 200 to 1,000 meters. The traverse route was tied to GPS stations established under this project.

3) Establishment of TBMs

TBMs were established at about 500m interval and tied to the National Bench Marks.

4) Centerline Survey

The centerline survey was undertaken in order to determine the existing centerline alignment. Coordinates along the longitudinal joint of PCC pavement were measured. Curve elements were determined by using computer software developed by the JICA Study Team.

Problems encountered were as follows:

- The existing centerline at a curved section was not always follow a certain radius of curvature. Errors or deviations from the designed centerline were oftenly observed. This may be due to construction error and/or errors during PCC slab reconstruction.
- Thus, it was impossible to determine radius which exactly follows the existing centerline which is the alignment along the existing longitudinal joint of PCC pavement.
- Therefore, the Study Team selected radius which was least error to the existing centerline. Thus, the centerline alignment established by the Study Team was the nearest alignment to the existing alignment and there are minor deviation from the existing centerline.
- 5) Centerline Stake-out Survey

Centerline stake-out was undertaken at the interval of 20 meters and at points of beginning and end of each curve.

6) Profile Survey

Elevation of centerline stakes established at 20m interval and other points of inclination was measured. Levelling was tied to TBM and closed.

7) Cross-Section Survey

Cross-section survey was undertaken at 20m interval and other points of topographical changes. Distance covered by the survey was as follows:

Flat terrain	: 30m either side from the centerline
Rolling terrain	: 50m either side from the centerline
Mountainous terrain	: 60m either side from the centerline

8) Topographic Survey

All structures such as houses, buildings, electric posts, side ditches, crossdrainage facilities, existing Km posts, and all other man-made facilities as well as topographic changes such as small vallies, creeks, etc. were measured. The topographic survey was so undertaken that the contour interval of Im was attained. 9) Preparation of Topographic Maps, Profiles and Cross-Sections

Following maps/drawings were prepared:

<u>Topographic Map</u> Seale Contour interval

: 1/1,000 : 1m

Profile 1

Scale : H = 1/1,000V = 1/100

Cross-Section Scale

: 1/100

4.2 TOPOGRAPHIC SURVEY AT BRIDGE SITES, SLOPES AND FLOOD-PRONE AREAS

Topographic survey for the following sections:

- 10 slopes which remarkably failed scale : 1/500 with contour interval of 1 meter.
- 71 bridge sites proposed to be rehabilitated/ improved/reconstructed scale : 1/200 for short bridges and 1/500 for long bridges with contour interval of 1 meter

2 flood-prone sections scale : 1/1,000 with contour interval of 1 meter

4.3 RIVER PROFILE AND CROSS-SECTION SURVEY

River profile and cross-section survey was undertaken for 39 rivers which require detailed hydraulic analysis and/or dredging/rechanneling.

Scale : Profile H = 1/1,000V = 1/100Cross-Section 1/100

4.4 AERIAL PHOTOGRAPHIC SURVEY AND MAPPING

For the purposes of detailed hydraulic analysis, route selection of a proposed bypass road, and dike planning, etc., aerial photographic survey and mapping was undertaken for the following three flood-prone areas:

• Simulao River Flood Area

Area covered = $10 \text{km} \times 3 \text{km} = 30 \text{ sq.km}$ Scale : 1/5,000 with contour interval of 1 meter

Monkayo Bypass Construction Site

Area covered = 2.5km x 2.5km = 6.25 sq.km Scale : 1/2,000 with contour interval of 1 meter

• Liboganon River Flood Area

Area covered = 16km x 4km = 64 sq.km Scale : 1/5,000 with contour interval of 1 meter

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CHAPTER 5

SOILS/MATERIAL AND GEOTECHNICAL INVESTIGATION

The following investigations were undertaken:

- Geotechnical investigation for pavement rehabilitation design
- Geotechnical investigation for slope protection design
- Geotechnical investigation for bridge foundation design
- Soils investigation for soft ground sections
- Soils investigation for Sianib Section
- Soils investigation for Liboganon River bank design
- Material sources investigation

5.1 GEOTECHNICAL INVESTIGATION FOR PAVEMENT REHABIL-ITATION DESIGN

Following investigations were undertaken:

- Concrete pavement coring
- Test pitting
- Auger boring
- 1) Concrete Pavement Coring

In order to examine PCC slab thickness and concrete strength, coring of PCC slabs was undertaken basically at 1 km interval for 214 km sections where pavement rehabilitation was proposed. A total of 197 concrete specimen were sampled and subjected to compressive strength test after measurement of thickness.

2) Test Pitting

In order to examine soil layer composition under PCC slab and characteristics of each soil layer including bearing capacity, test pitting to a depth of 1.5 meters was undertaken basically at 0.5 km interval for 214 km sections proposed for pavement rehabilitation. Test pitting was also undertaken for Monkayo Bypass section. A total of 414 test pittings were undertaken. Two soil samples per test pit were basically obtained. In-situ density tests were undertaken during test pitting. Soil samples obtained were subjected to the following laboratory tests:

- Soil classification
- Natural moisture content
- Sieve analysis
- Atterberg limits
- Moisture-density relation
- CBR

3) Auger Boring

In order to examine soil layer composition under PCC slab and characteristics of each soil layer, auger borings to a depth of 1.5 meters were undertaken basically at 0.5 meters were undertaken basically at 0.5 km interval for 214 km sections proposed for pavement rehabilitation. Auger borings were also undertaken for Monkayo Bypass section.

A total of 434 auger borings were conducted and basically two samples per auger boring were collected. Soil samples were subjected to the following laboratory tests:

Soil classification

Sieve analysis

• Natural moisture content

Atterberg limits

5.2 GEOTECHNICAL INVESTIGATION FOR SLOPE PROTECTION DESIGN

One boring test per slope was undertaken at two embankment slopes which have already slided. Location of two slopes is as follows:

• Km 1282 + 500

• Km 1283 + 400

Total drilling length was 20.9 meters.

5.3 GEOTECHNICAL INVESTIGATION FOR BRIDGE FOUNDATION DESIGN

Geotechnical investigation was undertaken at 19 bridge sites and 42 borings with a total drilling length of 1,235.8 meters were conducted (see Table 5.3-1).

Bridge Name	Km	No. of Bore Hotes	Drilling Length (m)
	1100 + 157		20.0
1. New Camalig	1180+157	3	29.0
2. Guinoyoran	1197+535	1	37.0
3. Sanghan	1217+339	2	78.8
4. Ampayon	1232+785	11 I. 1	55.4
5. Andanan	1266+097	4	87.3
6. Taglatawan	1269+766	2	42.6
7. Lagcogangan	1320+472	a 1	50.5
8. Tagbayagan	1323+317	1. T. L. 🚺	42.5
9. Wasian	1330+888	. 2 :	95.6
10. Gabanan	1390+242	3	36.3
11. Tina	1397+365	2	34.7
12. Banlag	1398+108	2	32.5
13. Nabunturan	1424+698	2	64.7
4. Liboganon	1465+285	1	57.4
5. Ilang	1494+420	1	37.0
6. Monkayo Bypass N		2	46.7
7. Monkayo Bypass N		4	55.3
8. Monkayo Bypass N		2	26.7
19. New Gov. Miranda		6	330.8
	-	-	
Fotal		42	1,240.8

TABLE 5.3-1 GEOTECHNICAL INVESTIGATION AT BRIDGE SITES

5.4 SOILS INVESTIGATION FOR SOFT GROUND SECTIONS

Soils investigation for soft ground sections was undertaken at six locations as follows:

• Km 1303+900		ø	Km	1333+500
• Km 1322+800	1. j. k	 0	Km	1346+100
• Km 1333+350		•	Km	1357+300

One boring test per location was undertaken and total drilling length was 92.7 meters.

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SOILS INVESTIGATION FOR SIANIB SECTION

Sianib Section (about Km 1280 - Km 1283) has been suffering very fast pavement deterioration and slope failures. At about Km 1281+600, PCC pavement constructed in 1994 during the Feasibility Study Stage, had already severe cracks with faulting in 1995. In order to examine soil layers and their characteristics, three borings were undertaken with the total drilling length of 31.4 meters.

5.6 SOILS INVESTIGATION FOR LIBOGANON RIVER BANK DESIGN

For the purposes of examining soil conditions and analysis of the river bank stability, two borings were undertaken with a total length of 51.9 meters.

5.7 MATERIAL SOURCES INVESTIGATION

Prior to selection of material sources to be investigated, all possible material sources were identified based on DPWH material sources maps, information from contractors, etc., and visited to assess accessibility to each sources and to estimate approximate volume of materials. Number of material sources identified and visited were as follows:

Borrow Sources	: 30
Base/Subbase Sources	: 34
Aggregate Sources for Concrete	: 25

To be noted is that aggregate sources for concrete in Agusan del Sur are scarce and aggregates for concrete are expected to be hauled for a long distance in the Province.

Material sources to be investigated were selected from above possible material sources and following investigations were conducted:

1) Borrow Sources

A total of 19 sources were investigated (see Figure 5.7-1). One test pitting per source was undertaken. Two samples per test pit were collected and the following field/laboratory tests were conducted for each sample;

In-situ density

- Atterberg limits
- Soil classification
- Moisture-density relation
- Natural moisture content
- Sieve analysis

• CBR

Base/Subbase Sources 2)

> A total 19 sources were investigated (see Figure 5.7-2). Two test pittings per source or 38 test pittings were undertaken. Two samples per test pit or a total of 76 samples were collected and subjected to the following laboratory tests:

- Sieve analysis
 - CBR Law Adv. of grant and all
- Atterberg limits Los Angeles abrasion (base material Moisture - density relation only)

3) Concrete Aggregate Sources

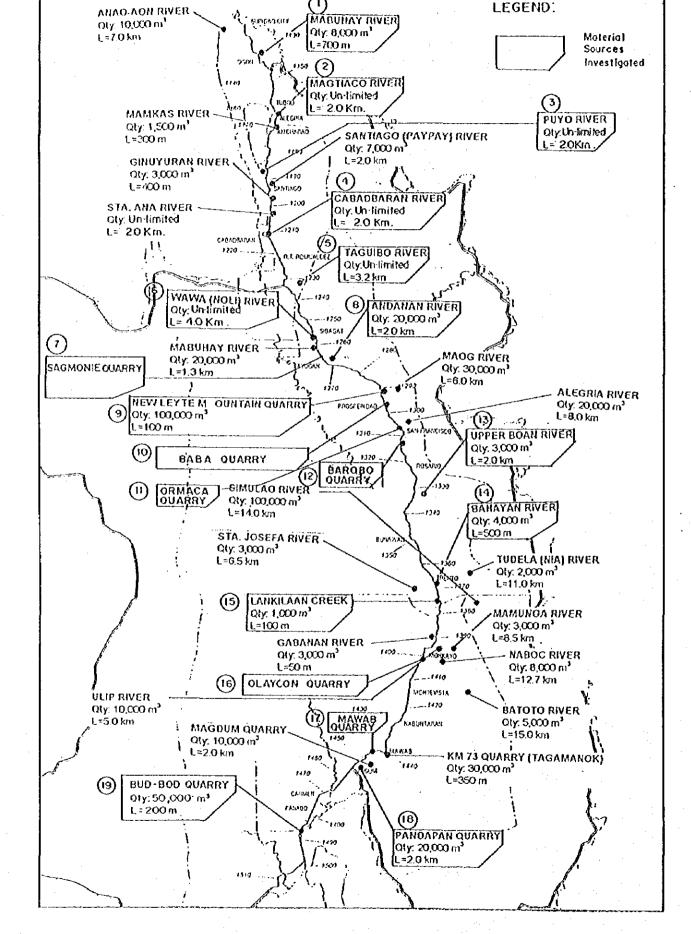
A total of 19 sources were investigated (see Figure 5.7-3). Two test pittings per source or 38 test pittings were undertaken. Two samples per test pit or a total of 76 samples were collected and the following laboratory tests were conducted:

- Sieve analysis
- Los Angeles abrasion
- Specific gravity
- Absorption
- Soundness
- Flakiness index

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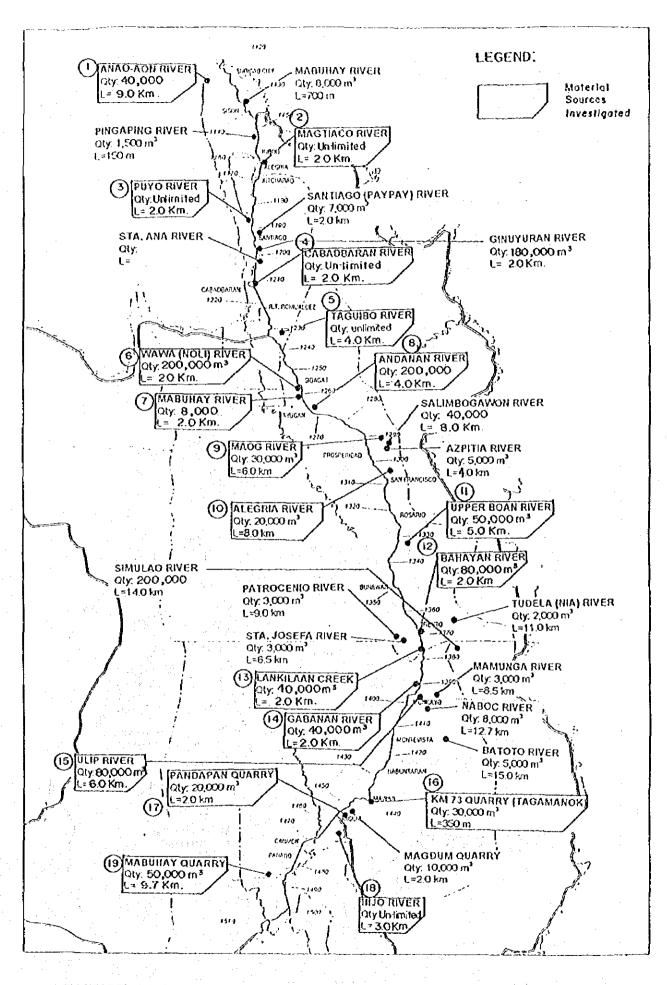


FIGURE 5.7-2 BASE/SUBBASE MATERIAL SOURCES INVESTIGATED

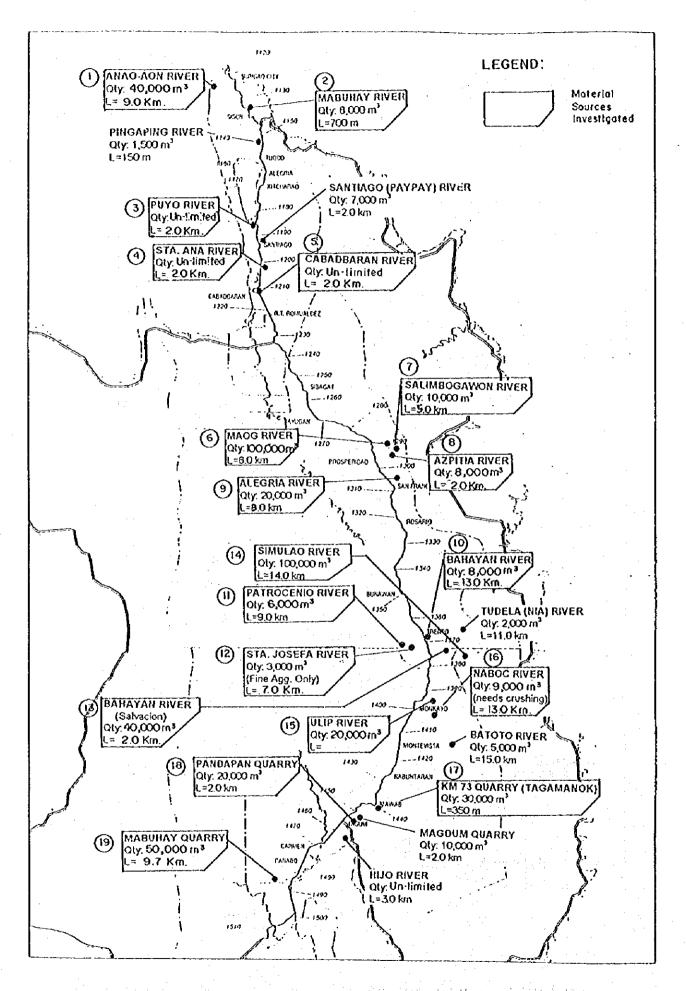


FIGURE 5.7-3 CONCRETE AGGREGATE SOURCES INVESTIGATED