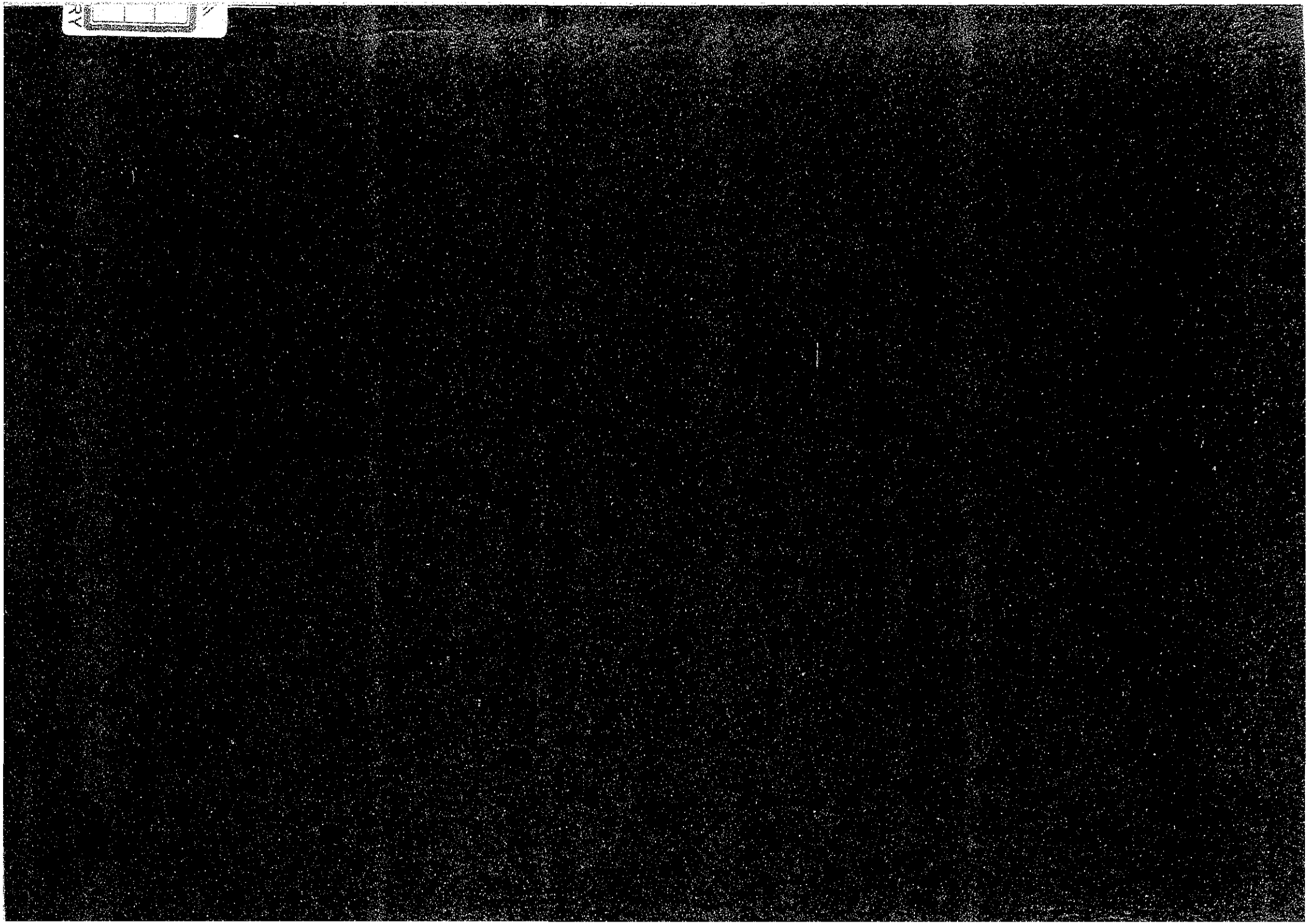


BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR PROVIDING EQUIPMENT
FOR
ROAD CONSTRUCTION AND REHABILITATION
IN THE SOUTH THAILAND RURAL AREAS
IN
KINGDOM OF THAILAND

JUNE 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a basic design study on the project for providing equipment for road construction and rehabilitation in the South Thailand rural areas and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Mr. Tetsumi Murata, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, from January 27th to February 15th, 1991.

The team held discussions with the officials concerned of the Government of Thailand, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Thailand in order to discuss a draft report and the present report was prepared.

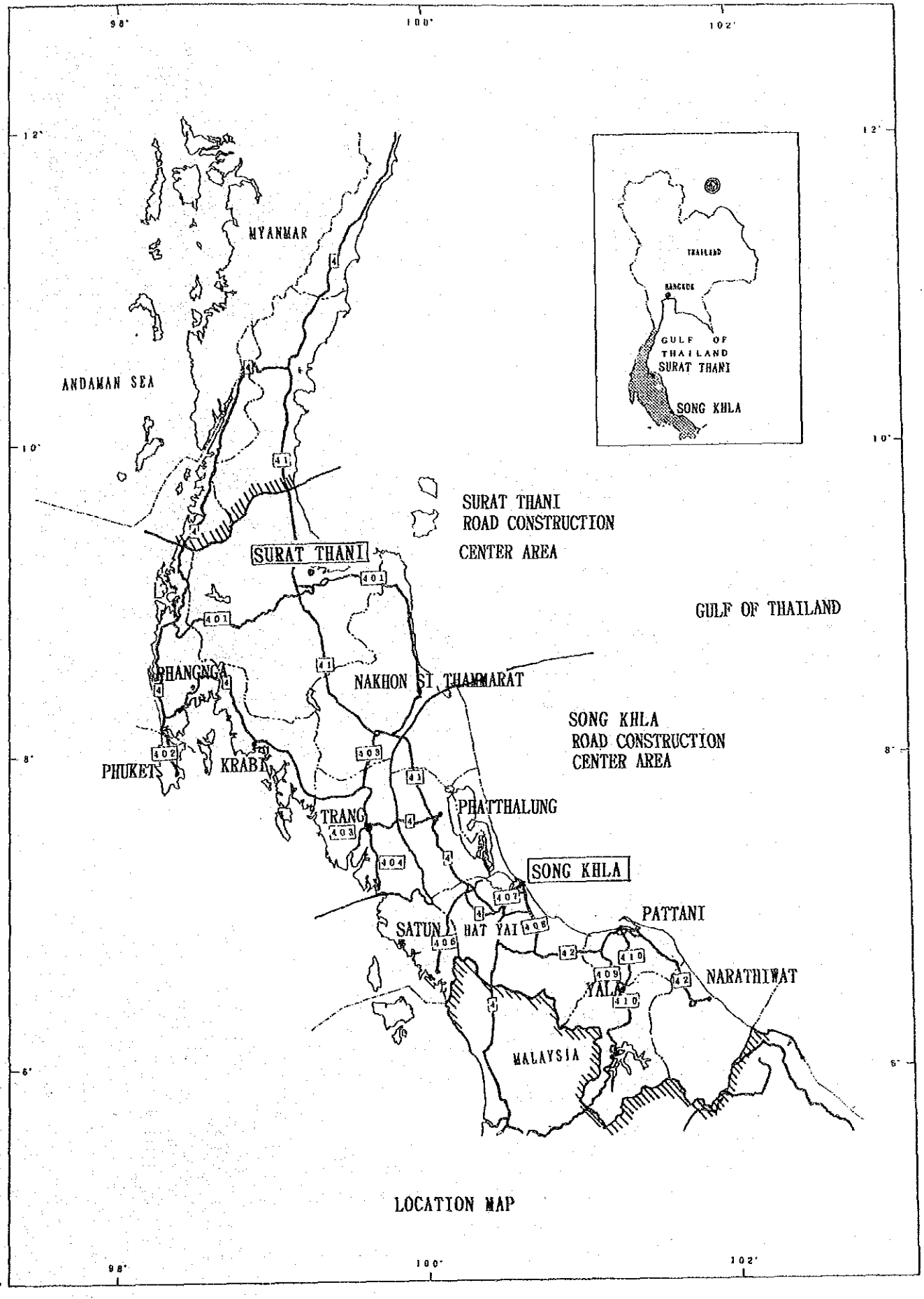
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

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

June, 1991

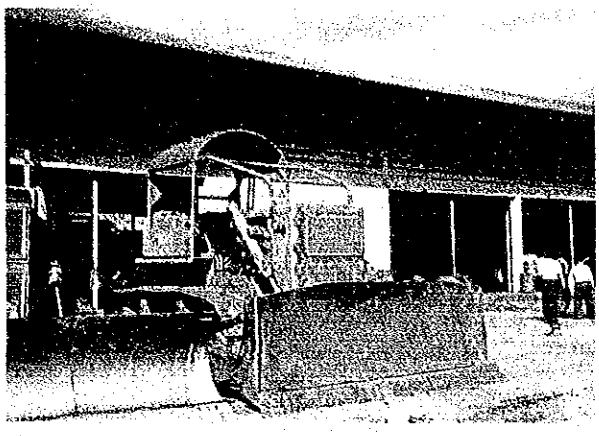
Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

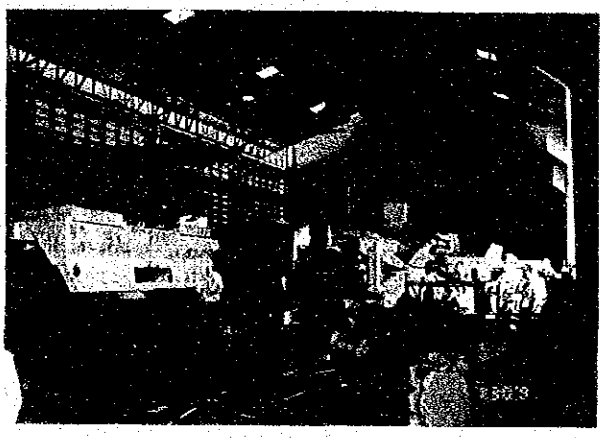

98°
100°
102°
12°
10°
8°
6°
MYANMAR
ANDAMAN SEA
THAILAND
BANGKOK
GULF OF THAILAND
SURAT THANI
SONG KHLA
SURAT THANI
ROAD CONSTRUCTION
CENTER AREA
GULF OF THAILAND
PHANGNGA
NAKHON SI THAMMARAT
SONG KHLA
ROAD CONSTRUCTION
CENTER AREA
PHUKET
KRABI
TRANG
PHATTHALUNG
SONG KHLA
PATTANI
SATUN
HAT YAI
NARATHIWAT
YALA
MALAYSIA
LOCATION MAP

SURAT THANI ROAD CONSTRUCTION CENTER AND WORKSHOP

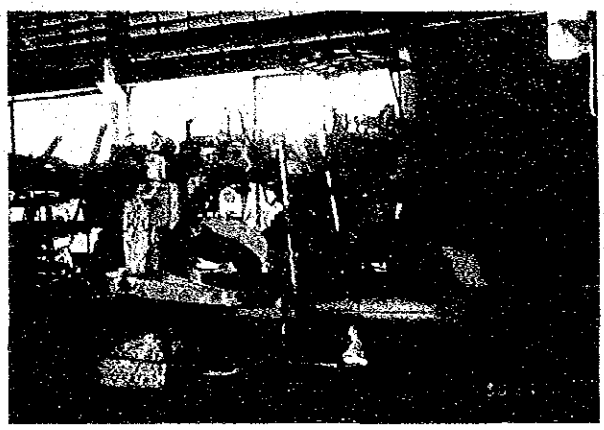
Surat Thani Road
Construction Center



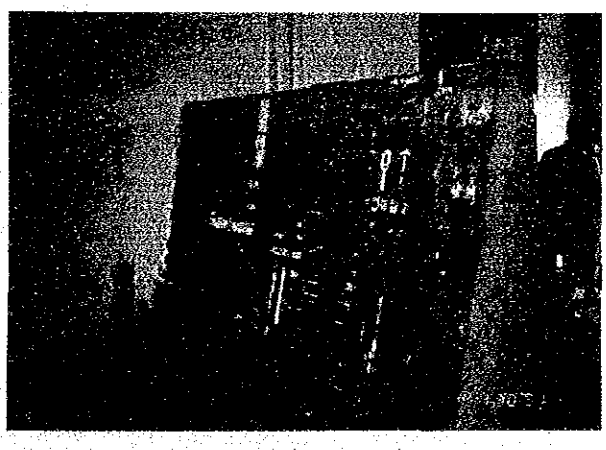
Bulldozer waiting for repair
at Surat Thani Workshop



Repairing of motorgrader
inside workshop



Repairing of motorgrader
inside workshop



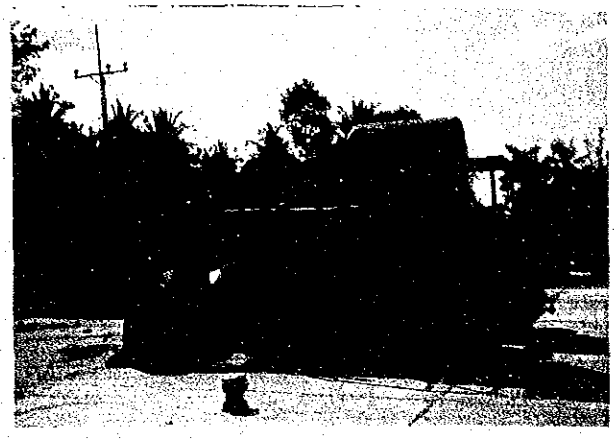
Keeping condition of tools,
Concentrated Control System

Keeping condition of spare parts

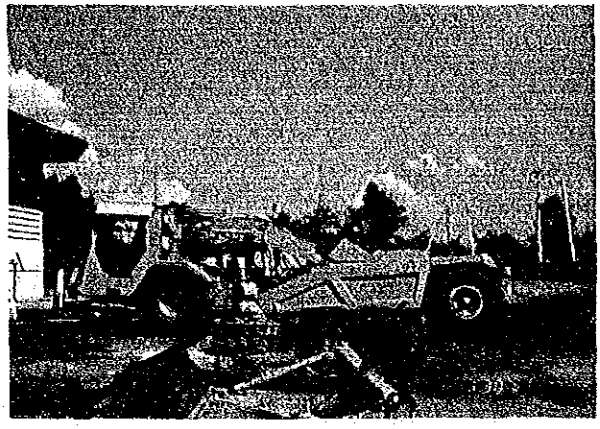
PHOTO— 1

CONSTRUCTION EQUIPMENT USED FOR MORE THAN 20 YEARS

(SURAT THANI)

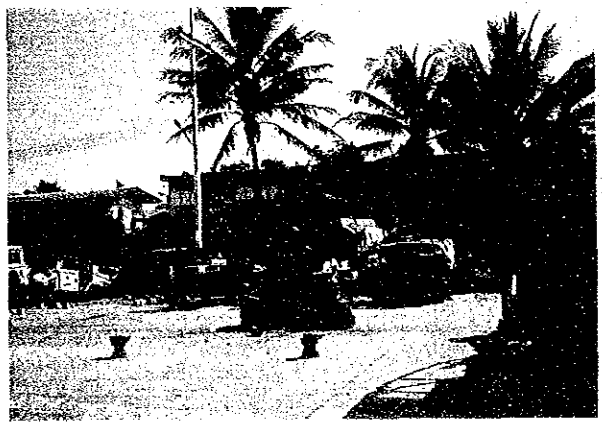


Komatsu D-80 ST/TIL

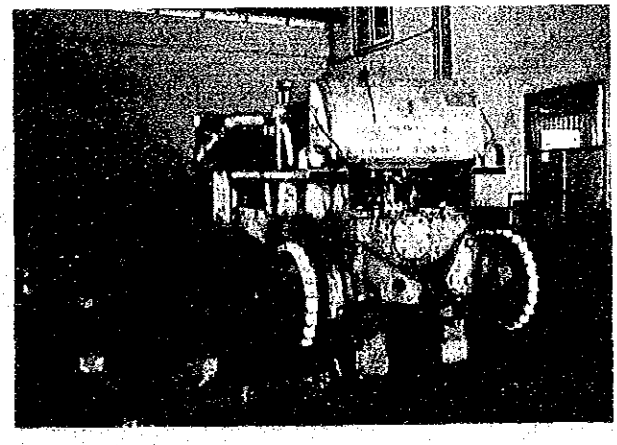


Motorscraper made by Johndear Corp.

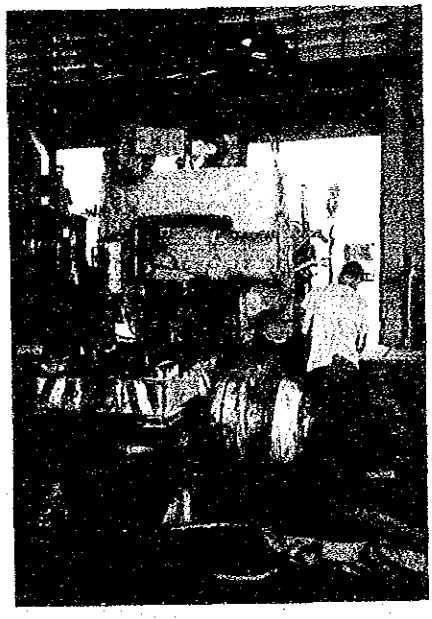
Engine repairing of motorgrader



Scrapped equipment



D-85 in periodical overhaul



GD37 in periodical overhaul

PHOTO- 2

Solidifying and spreading subbase course

Solidifying subbase course
by tamdem roller

Solidifying subbase course
by motorgrader

Solidifying subbase course
by rubber-tire roller

Cleaning by Watertruck
before asphalt pavement

ROAD CONSTRUCTION IN MOUNTAINOUS AREA

(SURAT THANI) 4/6

View of mountainous route

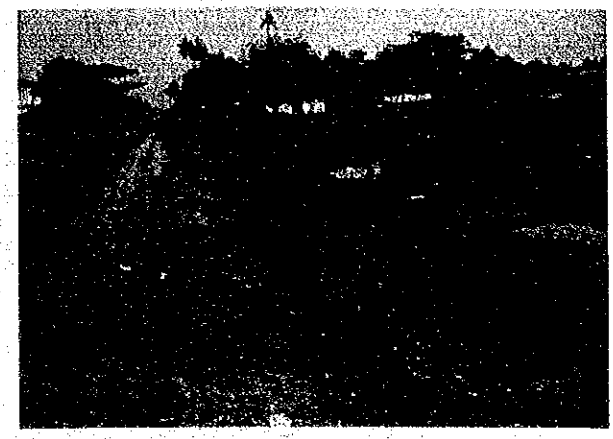
Slope cutting in mountainous area, digging by dynamite and buildozer

Construction equipment at site

Equipment used to fill subgrade (Buildozer, Wheel-Loader)

Wheel Loader at site

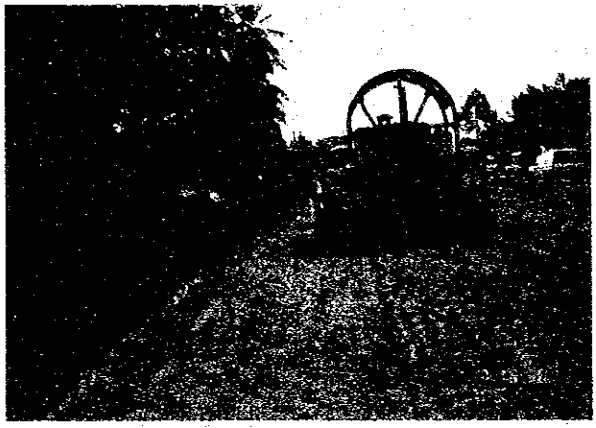
ROAD CONSTRUCTION IN SWAMP AREA (SURAT THANI)



Widening of Route 4016

Shifting roadside trees

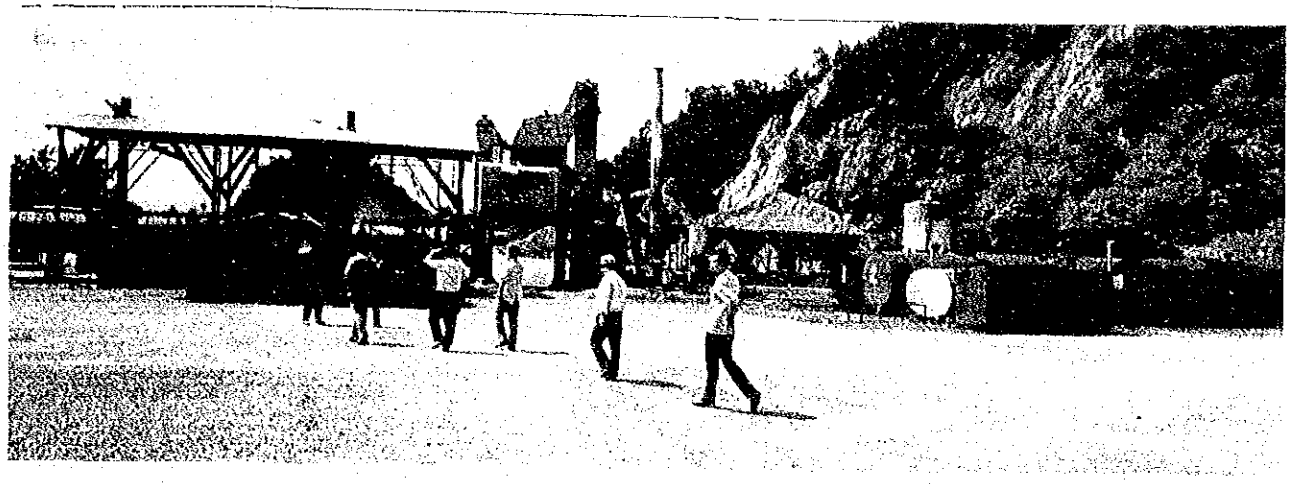
Traffic flow interruption at construction site



Bulldozer at work

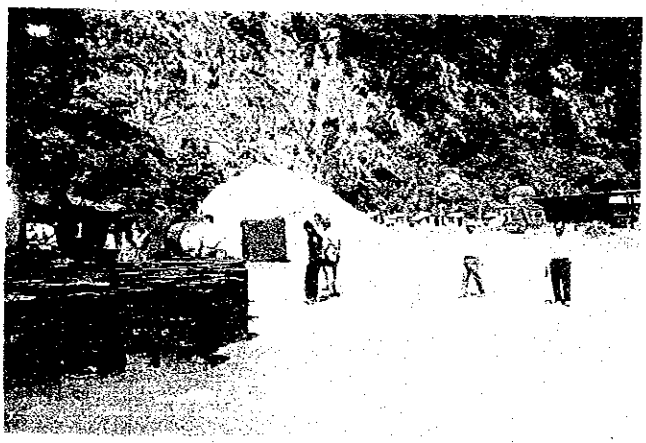
Bulldozer and sheep-foot stroller pulled by wheeltractor

PHOTO— 5

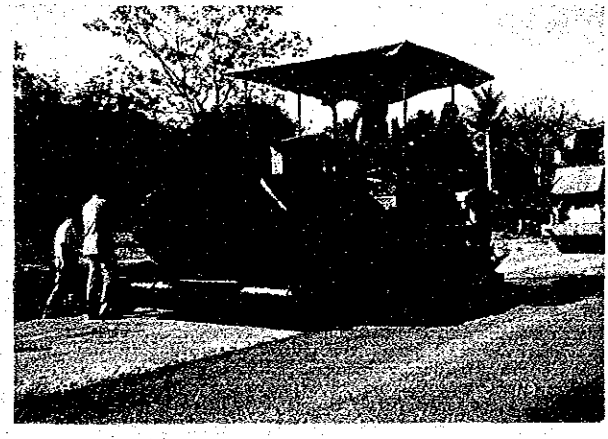


Asphat mixing plant

Drums of asphalt emulsion



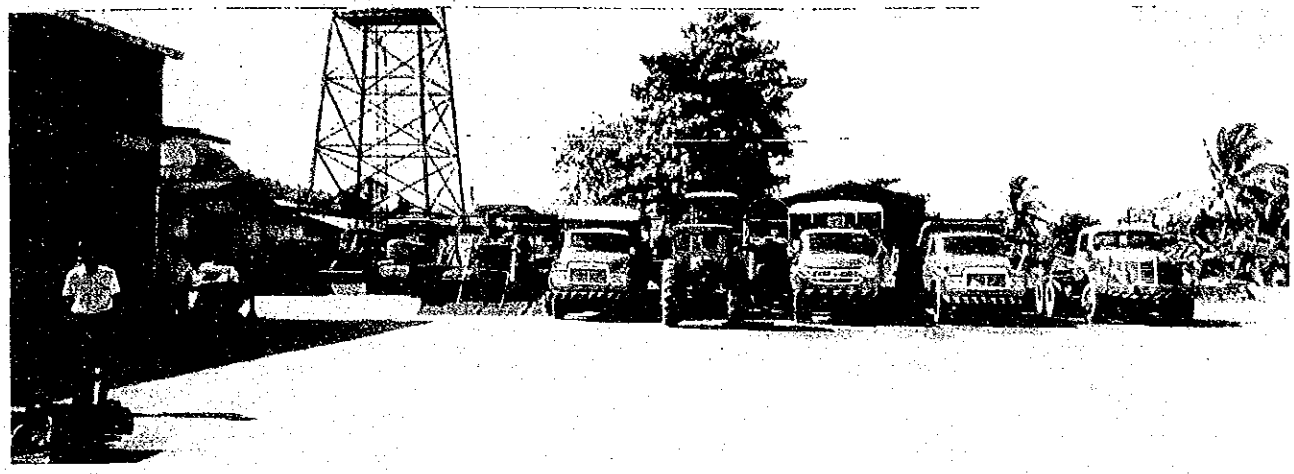
Drums of asphalt emulsion



Road construction
by asphalt finisher

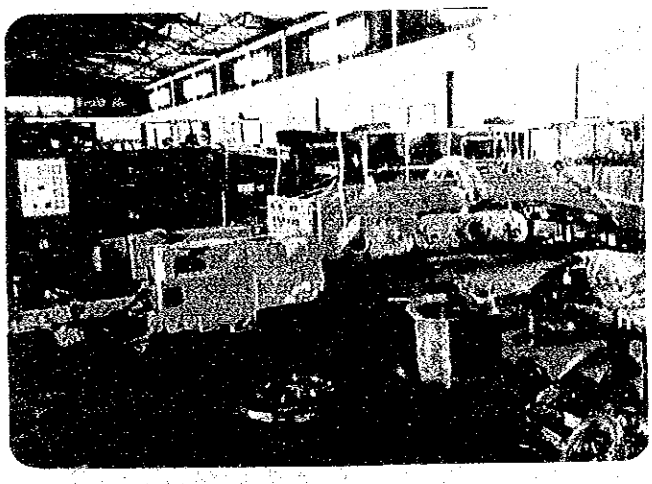
Road construction
by asphalt finisher

SONG KHLA ROAD CONSTRUCTION CENTER AND WORKSHOP

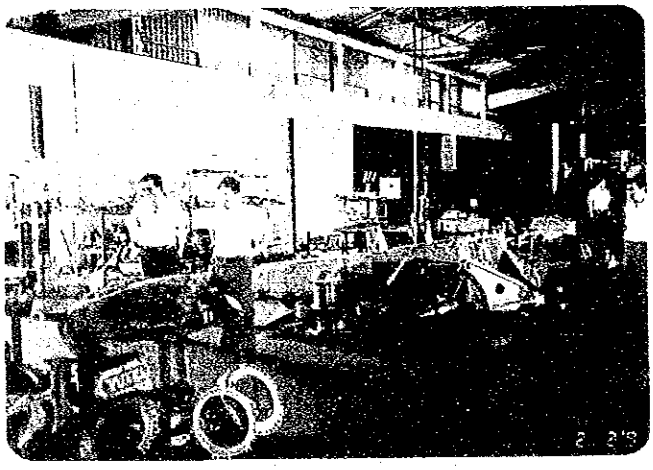


Construction equipment at the workshop

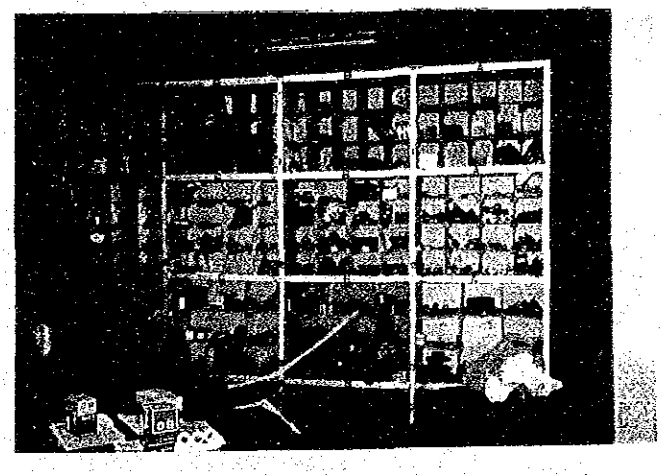
All equipment have been used for more than 20 years, and are waiting for repair



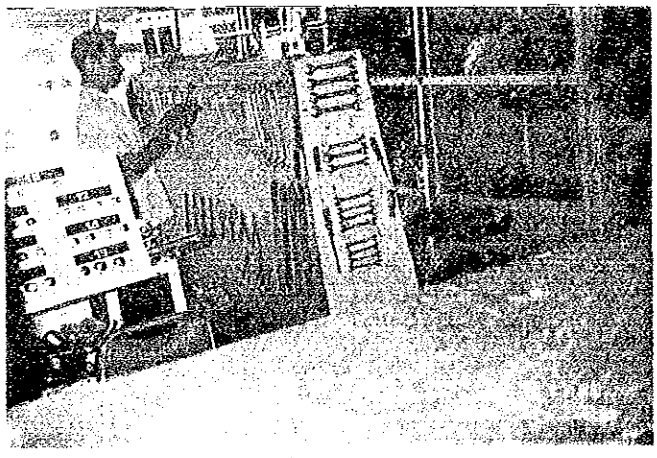
Inside workshop, overhaul of motorgrader



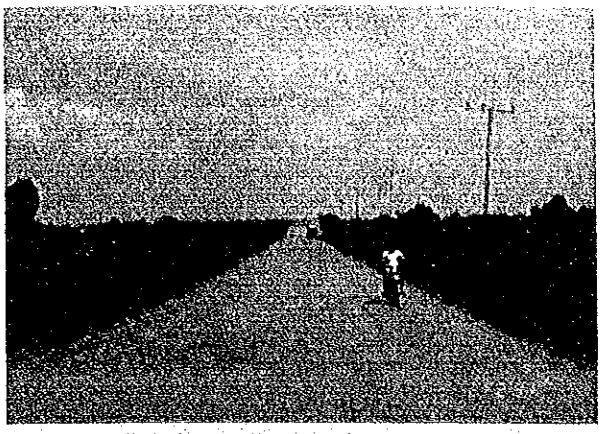
Inside workshop, overhaul of bulldozer



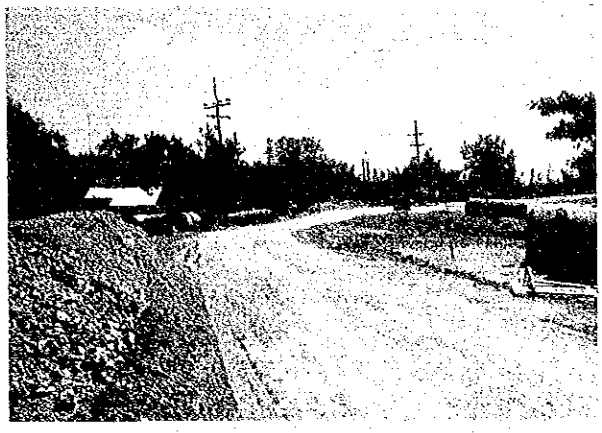
Keeping condition of spare parts



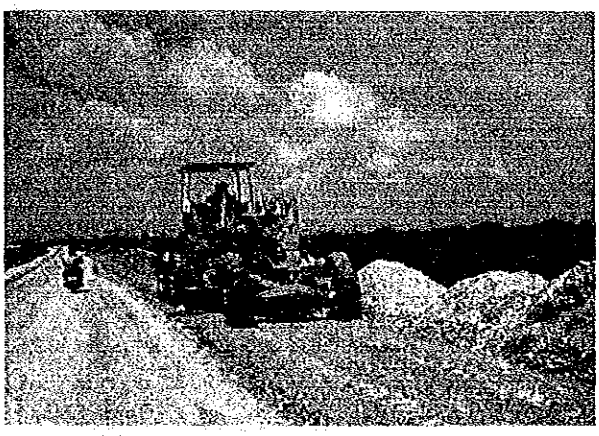
Keeping condition of tools



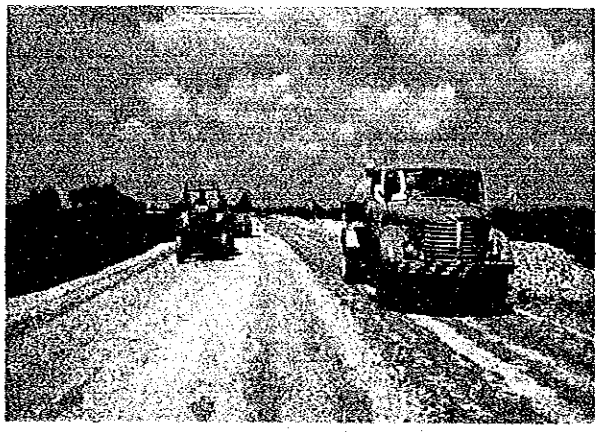
Existing road
before widening



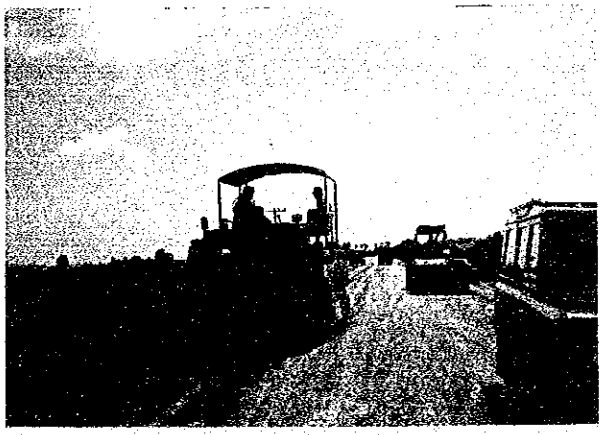
Storage of base materials



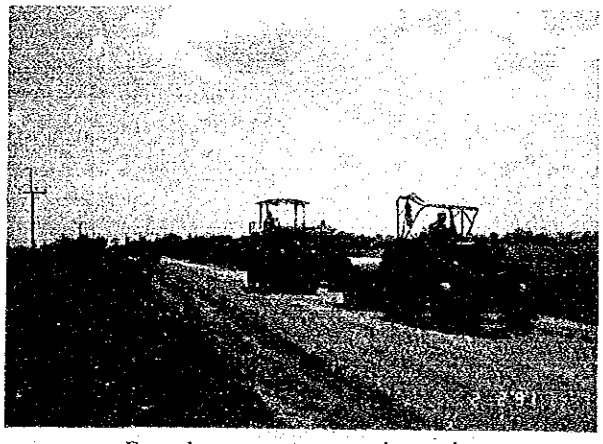
Road construction
by motorgrader



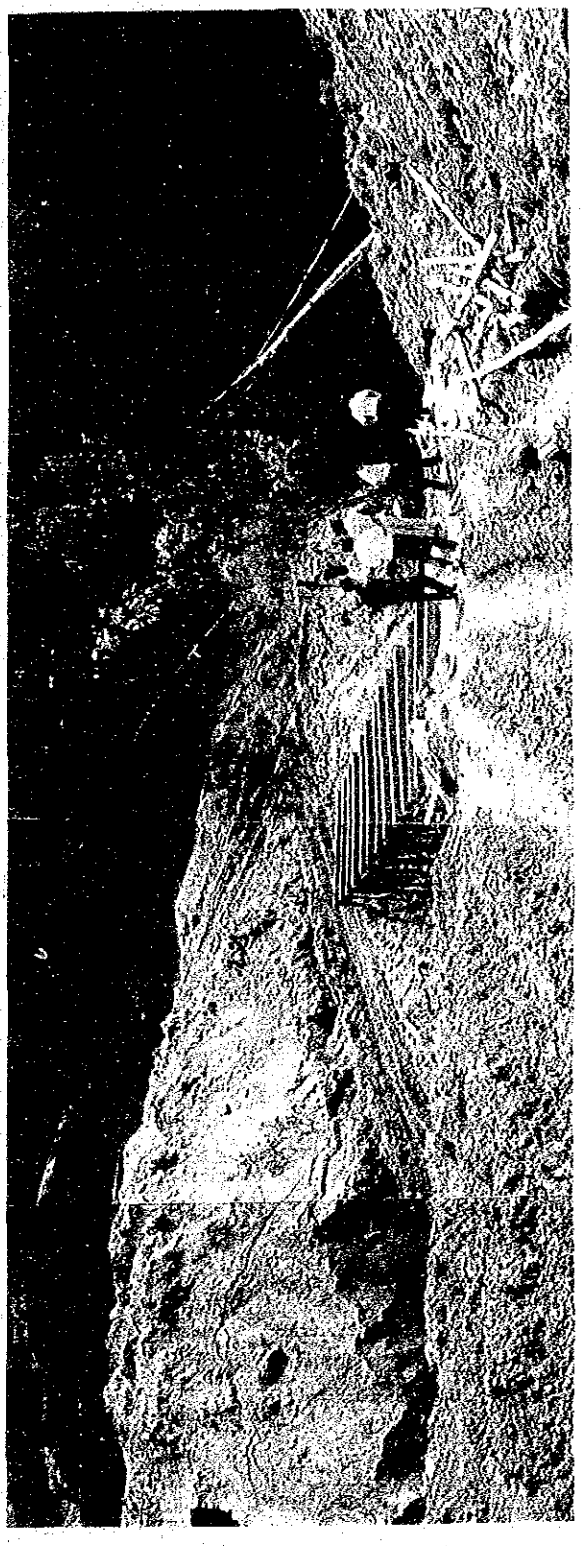
Road construction
by water truck



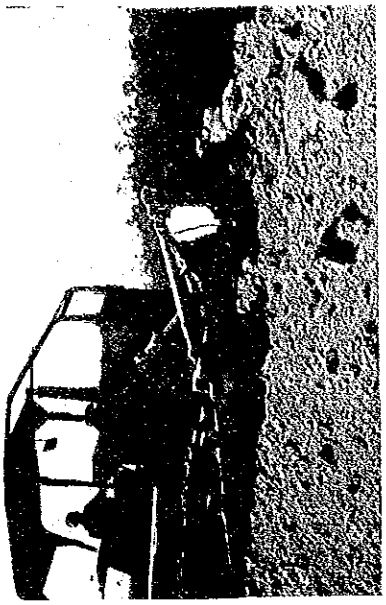
Road construction
by rubber-tire roller



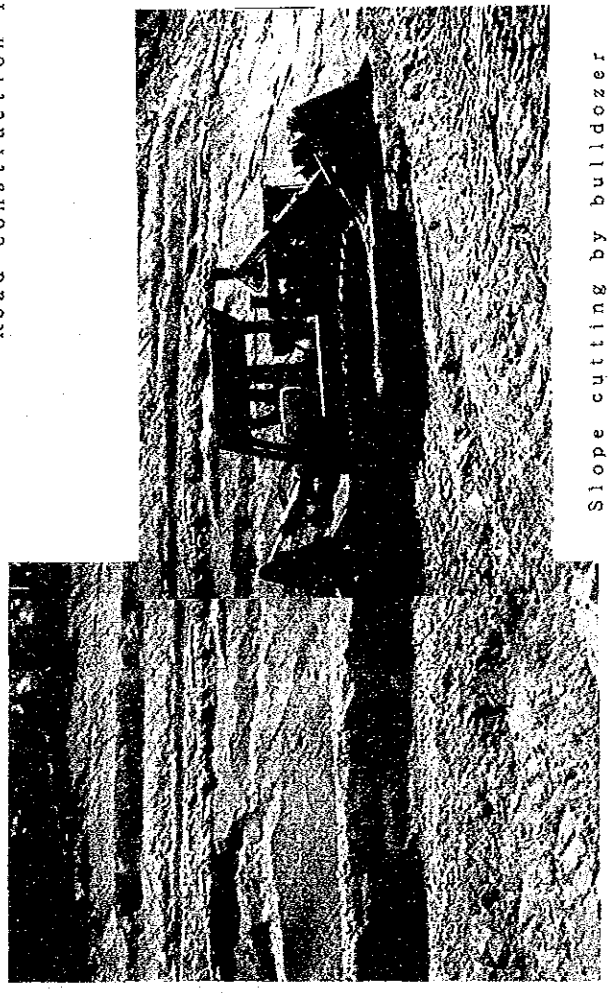
Road construction by
rubber-tire roller
and vibratory roller



Road construction in mountainous area



Working by bulldozer



Slope cutting by bulldozer

S U M M A R Y

The Kingdom of Thailand had a total population of about 55 million in 1988 with approximately an area of 510,000 square kilometer. The Kingdom was an agriculture country based mainly on producing rice, but the sectoral composition of the economy has been shifted toward manufactural orientation since the later half of 1980's.

The economic growth was substantially higher than the originally planned target. The development of the infrastructure, which supports the development of this economic growth, especially the roads which handle passenger and freight transport share of 85% - 90% of the grand total, was the most important policy of The Sixth National Development Plan.

Though national highways are developed, provincial highways in low developing areas are hardly enough either in qualities or quantities. The Southern Region in Thailand, which is the objective area of this study, can be specially considered as a low developing area. The development of provintial highways is an urgent theme for activating the socio-economic development in this region.

Rehabilitation and construction of provincial highways in the Southern Region are managed by Surat Thani and Song Khla Construction Centers of the DOH. These two centers execute the projects under the direct control. But almost all construction equipment, which these centers keep, are already old and not enough in absolute number. In the two centers, the construction equipment being used are in fact that construction equipment supplied by the Government of Japan between 1960's and 1970's. And not only provintial highway development plan is delayed exceedingly, but also it is difficult to execute the projects on schedule and it costs too much for repairing and maintaining the construction equipment.

In this context, the Government of the Kingdom of Thailand requested the Government of Japan to provide construction equipment to the above two construction centers. This aims at upgrading the capability of construction equipment, promoting the development of provintial highway in this region and training road engineers.

In response to the request of the Government of Thailand, the Government of Japan decided to conduct the Basic Design Study on the Project for Providing Equipment for Road Construction and Rehabilitation in the South Thailand Rural Areas, and Japan International Cooperation Agency (JICA) send to Thailand the Basic Design Study Team from January 27 to February 15, 1991.

The Study Team executed the field survey which consisted of reviewing the background of the requested contents of the project and importances of transport and traffic sector in the country considering the effects on the socio-economic development in the region, and the proprieties as Japan's Grant Aid. Also, the Study Team collected the necessary data for basic design of the project, and inspected the construction field.

Based on the survey and collected data, the Study Team carried out the analysis in Japan which consisted of reviewing the necessities, urgency, propriety, socio-economic impact and organization of existing agency for the project, selecting the type of required construction equipments and analyzing the number of required equipments.

JICA prepared the draft final report of the Basic Design Study based on the results of the field survey and the analysis, and dispatched the Explanation Team for explaining and discussing the report from April 23, to May 1, 1991.

The Study Team prepared the basic design considering road construction condition including geography, geology, kind and scale of work, natural conditions, and social environment condition. The Study Team also selected the required construction equipment which are reasonable for the ability of equipment maintenance and management by the Government of Thailand.

As a result of the basic design on the project, the selected construction equipment are presented bellow. The required equipment are divided into Rank A (short term supply) and Rank B (long term supply) from the view of the urgency of equipment type, implementation schedule and implementation budget. Rank A is judged to have higher priority and to be urgently supplied.

The time periods required for the detailed design, procurement and construction supervision are estimated as three (3) months, six (6) months and three (3) months, respectively.

Type of Equipment	RANK A			RANK B			Grand Total
	SURAT THANI Center	SONG KHLA Center	Total	SURAT THANI Center	SONG KHLA Center	Total	
1. Earth Moving Equipment	6	7	13	10	5	15	28
2. Earth Excavator	5	3	8	0	0	0	8
3. Earth Solidifying Equipment	6	2	8	2	3	5	13
4. Earth Transportation	7	6	13	8	4	12	25
5. Pavement Equipment	1	0	1	4	7	11	12
6. Material/Transportation Equipment	9	6	15	11	6	17	32
7. Multiple-Purpose Equipment	0	0	0	8	11	19	19
8. Inspection Car/Micro Bus	-	-	-	-	-	-	-
Total	34	24	58	43	36	79	137

The executing agency of the Government of Thailand for the project is the Department of Highways, Ministry of Transport and Communications. Surat Thani and Song Khla Road Construction Centers take charge of the project directly. Both centers use the supplied construction equipment for road construction, and maintaining the roads. The scale of the budget, organization of execution and condition of maintenance are judged that the supplied equipments are useful.

This project is to provide the construction equipment to two (2) road construction centers which suffer due to the deterioration of equipment and insufficiency in absolute number. Further the project is judged to contribute in developing the road network and in improving the ability of construction equipments in the two centers.

This project aims at contributing in the activation of regional socio-economics, improving the living standard and income, and distributing industries in the region. The region that will receive benefits has 12% of the total area of Thailand, 12 Changwats, about 6.4 million people, and an area of 61,400 square kilometer. The project will not only contribute in the development of the country, but also will activate regional socio-economics in view of the importance and scale of the influenced area. The mission judges that the project has the significance to be executed under Japan's Grant Aid.

TABLE OF CONTENT

Preface
Location Map
Photos
Summary

Page

CHAPTER 1 INTRODUCTION 1

CHAPTER 2 BACKGROUND OF THE PROJECT 3

2.1 PRESENT CONDITION OF TRANSPORTATION SYSTEM 3
2.1.1 Transportation Modes 3
2.1.2 Road Transport 4
2.1.3 Railway Transport 6
2.1.4 Coast Transport 6
2.1.5 Inland Water Transport 6
2.1.6 Air Transport 6

2.2 BRIEF DESCRIPTION OF ROAD CONSTRUCTION CENTER 7
2.2.1 Road Construction Centers in the Country 7
2.2.2 Surat Thani Road Construction Center 16
2.2.3 Song Khla Road Construction Center 22

2.3 OUTLINE OF THE REQUEST 26

2.4 OUTLINE OF THE PROJECT AREA 28
2.4.1 Socio-Economic Conditions 28
2.4.2 Natural Conditions 30
2.4.3 Transportation System 30
2.4.4 General Condition of Highways 32

CHAPTER 3 OUTLINE OF THE PROJECT 35

3.1 OBJECTIVE 35

3.2 STUDY AND EXAMINATION ON THE REQUEST 35
3.2.1 Examination on Necessity and Appropriateness of the Project 35
3.2.2 Study on Implementation Plan 38
3.2.3 Review of Other Related Projects 40
3.2.4 Review of Content of the Requested Equipment 40
3.2.5 Study on Need of Technical Assistance 43
3.2.6 Basic Policy for Cooperation 44

3.3 PROJECT DESCRIPTION 44
3.3.1 Executing Agency and Operational Structure 44
3.3.2 Operation Plan 47
3.3.3 Outline of Equipment 51

3.3.4 Management Plan 52

3.4 TECHNICAL COOPERATION 53

CHAPTER 4 BASIC DESIGN 55

4.1 DESIGN POLICY 55

4.2 STUDY ON DESIGN CRITERIA 55

4.3 BASIC PLAN 56
4.3.1 Selection of Types and Number of Equipment 56
4.3.2 Specifications of Proposed Equipment 59

4.4 IMPLEMENTATION PLAN 69
4.4.1 Implementation Policy 69
4.4.2 Procurement Plan 69
4.4.3 Construction and Supervisory Plan 70
4.4.4 Implementation Schedule 71
4.4.5 Scope of Work 72

CHAPTER 5 PROJECT EVALUATION AND CONCLUSION 75

APPENDIX

1. MEMBER LIST OF THE BASIC DESIGN TEAM
2. SURVEY SCHEDULE
3. LIST OF PERSONS MET
4. MINUTES OF DISCUSSIONS
5. LIST OF REQUESTED EQUIPMENT
6. LIST OF COLLECTED DATA
7. COUNTRY DATA
8. EQUIPMENT LIST OF 8-ROAD CONSTRUCTION CENTERS
9. ANALYSIS ON REQUIRED NUMBER OF CONSTRUCTION EQUIPMENT
10. THE COST TO BE SHOULDERED BY THAILAND

CHAPTER ONE

INTRODUCTION

CHAPTER 1

INTRODUCTION

The Government of the Kingdom of Thailand has been promoting the development of infrastructure, especially road network, in order to step up the regional development and industries in the low developing areas, as the most important policy to improve the living standard and for the development of regions in The 6th National Social and Economical Development Plan (1987-1991). As the Southern Thailand is a flooded and mountainous area and the development of road network is not yet sufficient, this region is the low developing area. Therefore, the development of the road network is the most rapid theme for the activation of regional socio-economics in this region.

Improvement and construction of provincial highways in the Southern Region are managed by Surat Thani and Song Khla Road Construction Centers of the Department of Highways, Ministry of Transport and Communications, and are executed under the direct control of both centers by using the construction equipment holden by the two centers. But the project schedule of road development was delayed because of the superannuation of equipment possessing and insufficient equipment. The Government of Japan had provided construction equipment for Song Khla Road Construction Center as Japan's Grant Aid in 1966, and for Surat Thani Road Construction Center in 1971. Now, these centers have been using these supplied equipment. Based on the background of the project, the Government of the Kingdom of Thailand requested the providing of construction equipment for road construction and rehabilitation as Japan's Grant Aid to the Government of Japan in order to promote the development of roads and to make a plan for the consolidation of the both centers.

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct the Basic Design Study on the Project for Providing Equipment for Road Construction and Rehabilitation in the South Thailand Rural Areas. Japan International Cooperation Agency (JICA) dispatched the Basic Design Study Team headed by Mr. Tetsumi Murata, Grant Aid Division Economic Cooperation Bureau, Ministry of Foreign Affairs to the Kingdom of Thailand from January 27th 1991 to February 15th 1991, for the field investigation.

The Basic Design Study Team reviewed the background, objectives and contents of the project, collected the related data and inspected the condition of both equipment maintenance and construction areas. As a result of the inspection and analysis of data in Japan, the study team executed the tasks of selecting the required construction equipment and the basic design, and reviewed the priority, rapidity and socio-economic impact of the project.

JICA prepared the Draft Final Report of the basic design study based on the results of the inspection and the analysis, and dispatched the mission for explaining the report, headed by Mr. Isamu Goto, Director, Construction Equipment Division, Economic Affairs Bureau , Ministry of Construction, to the Kingdom of the Thailand from April 23, 1991 to May 1, 1991.

As the result of investigation, analysis and explanation of the Draft Final Report mentioned above, this Final Report was compiled to include the implementation arrangement and evaluation of the project, on June 1991. The member list of study team, survey schedule, member list of concerning party in the Kingdom of Thailand, minutes of discussions and other informations are attached as the appendix of the report.

CHAPTER TWO

BACKGROUND OF THE PROJECT

CHAPTER 2

BACKGROUND OF THE PROJECT

2.1 PRESENT CONDITION OF TRANSPORTATION SYSTEM

2.1.1 Transportation Modes

The major domestic transportation modes in Thailand consist of road, railway, inland water, coast and air transports. Each transportation mode has been developed in such a manner to connect every part of the country with Bangkok.

Table 2.1-1 shows the modal split for domestic passenger and freight transports by transport mode.

Table 2.1-1 MODAL SPLIT FOR PASSENGER AND FREIGHT TRANSPORTS (1987)

	Passenger			Freight		
Mode	Passenger (million)	Passenger-km (billion)	Share (%)	Freight (million ton)	Ton-km (billion)	Share (%)
Road	N.A	93.3	90.5	160.0	26.7	84.0
Railway	78.0	9.1	8.8	5.6	2.6	8.2
Inland Water	-	-		10.1	1.5	4.7
Coast	-	-		2.1	1.0	3.1
Air	1.3	0.7	0.7	-	-	-

In the passenger transport, the road occupies 90.5% of the share in terms of passenger-km.

The road is also prominent in the freight transport and its share reaches 84.0% in terms of ton-km.

2.1.2 Road Transport

(1) Highway network

Table 2.1-2 shows that there are various types of roads in Thailand, which are constructed and maintained by various agencies. Total road length in the country increased from 156,000 km in 1981 to 176,630 km in 1988 at an annual growth rate of 3,000 km or 1.9 percent.

Table 2.1-2 LENGTH OF ALL ROADS (1981-1988) (1,000 Km)

Administrated by	Road Type	Length of Roads							
		1981	1982	1983	1984	1985	1986	1987	1988
DOH	National Highways	15.26	15.60	15.58	15.58	15.70	16.52	16.57	16.70
DOH	Provincial Highways	28.66	28.36	28.71	28.95	29.46	30.03	32.03	33.17
ARD	Rural	15.72	16.58	17.39	17.95	18.55	19.07	19.51	19.51
PWD	Rural	2.60	2.91	3.16	3.36	3.64	3.93	4.43	6.17
RID	Rural	3.56	3.89	4.20	4.60	4.87	5.17	5.17	5.17
BMA	Municipal	1.15	1.15	1.15	1.15	1.16	2.79	2.79	2.79
Local	Bodies Municipal	7.39	7.39	7.39	7.39	7.39	7.39	11.92	11.92
Others	Rural	81.65	81.65	81.65	81.65	81.65	81.65	81.65	81.07
ETA	Bangkok Expressway	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03
	Total	156.00	157.54	159.25	160.65	162.44	166.57	174.10	176.63

DOH : Department of Highways
ARD : Accelerate Rural Development Office
PWD : Public Works Department
RID : The Royal Irrigation Department
BMA : Bangkok Metropolitan
ETA : Expressway and Rapid Transit Authority of Thailand
Local Authorities : Municipalities & Sanitaries
Source : DOH

Among them, the DOH has responsibility for national and provincial highways which form a frame of the national road network.

(2) Highways under the DOH

The total length of the existing national and provincial highways reaches 49,868 km as in 1988, of which national highways are 16,698 km and provincial highways 33,170 km.

National highways are mostly paved at a ratio over 99 percent, while the ratio for provincial highways is 77 percent in 1988.

The Central Region has the highest road density of 0.123 in terms of road length per square kilometer including under construction sections, followed by the Southern Region's 0.118. In terms of road length per 1,000 population, the Northern Region shows the highest figure of 1.386, followed by the Southern Region of 1.220.

It may mean that the highway network in the Southern Region has been reasonably well developed comparing with other regions.

(3) Budget of the DOH

Figure 2.1-1 demonstrates the budget of the DOH. The figure shows that the budget was moderately increasing except in 1986 and 1987, but remarkably decreased when compared with the national budget.

This decrease may be due to the Government's policy against the second oil shock which put emphasis on development of water and railway transportation in view of saving fuel consumption. However, the Government recognizes the importance of highway transport which occupies a share of more than 90 percent in passenger transport and more than 80 percent in freight.

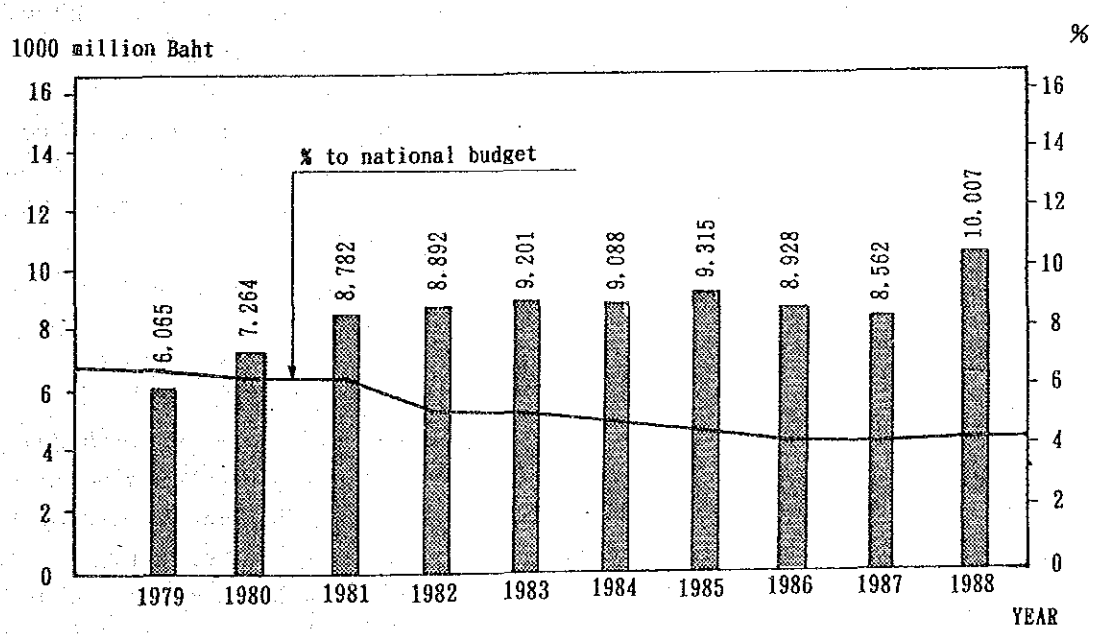


Figure 2.1-1 TREND OF BUDGET

2.1.3 Railway Transport

The State Railway of Thailand (SRT), owned by the Government, had a total network of 3,728 km (excluding Mae Klong Line) open to traffic in 1988. The railway system of a meter gauge radiates from Bangkok to Chiang Mai with 751 km in the north, Nong Khai with 642 km and Ubon Ratchatani with 575 km in the northeast, Aranyaprathet with 255 km in the east, and Sungai Kolok in the south with 1,199 km. The SRT network connects with Malaysian Railway at Padan Besar and Sungai Kolok.

The SRT network serves 41 provinces out of the total 73. In the Southern Region, there are nine (9) provinces, out of 14 provinces, which have railway services; Chumphon, Surat Thani, Phatthalung, Nakhon Si Thammarat, Trang, Song Khla, Yala, Pattani, and Narathriwat.

2.1.4 Coast Transport

The coast transport is mainly carried out between Bangkok and ports in Southern Region. The predominant amount of about 224,000 ton is carried between Bangkok and Song Khla, as of 1987.

2.1.5 Inland Water Transport

Main rivers utilized for the inland water transport are Chaophraya, Thachin and Meaklng rivers with their tributaries. Inland water ports are located along these rivers. The inland water transport still performs some role in freight transportations, especially for agricultural products and construction materials. The annual amount between Bangkok and Chai Nat is about 330,000 tons to 370,000 tons. However, the amount on upper part from Chai Nat is not more than about 40,000 tons.

2.1.6 Air Transport

Thai Airways International, owned by the Government, operates scheduled services radiating from Bangkok to all over the country. Total number of commercial airports reaches 22, including 3 international airports, Bangkok, Chiang Mai and Phuket. Considerable numbers of passengers are observed on lines from Bangkok to Chiang Mai, Hat Yai and Phuket.

2.2 BRIEF DESCRIPTION OF ROAD CONSTRUCTION CENTER

2.2.1 Road Construction Centers in the Country

(1) Objectives and organization

Road Construction Centers of Thailand were instituted from the beginning of 1960's with following objectives.

- Mainly, improvement and construction of the provincial highways in the district area.
- Maintenance, management and repairing of the construction equipment.
- Training and cultivation of the civil engineers and mechanical engineers.

The road construction centers belong to the Department of Highways, Ministry of Transport and Communications, and the Third Highway Construction Office of the Department of Highways administrates all centers as presented in Figure 2.2-1.

The Government of Thailand has eight (8) Road Construction Centers. They cover almost the whole country and carry out the tasks of construction and rehabilitation of provincial highways. Figure 2.2-2 shows the administrative areas of each road construction center.

(2) Budget

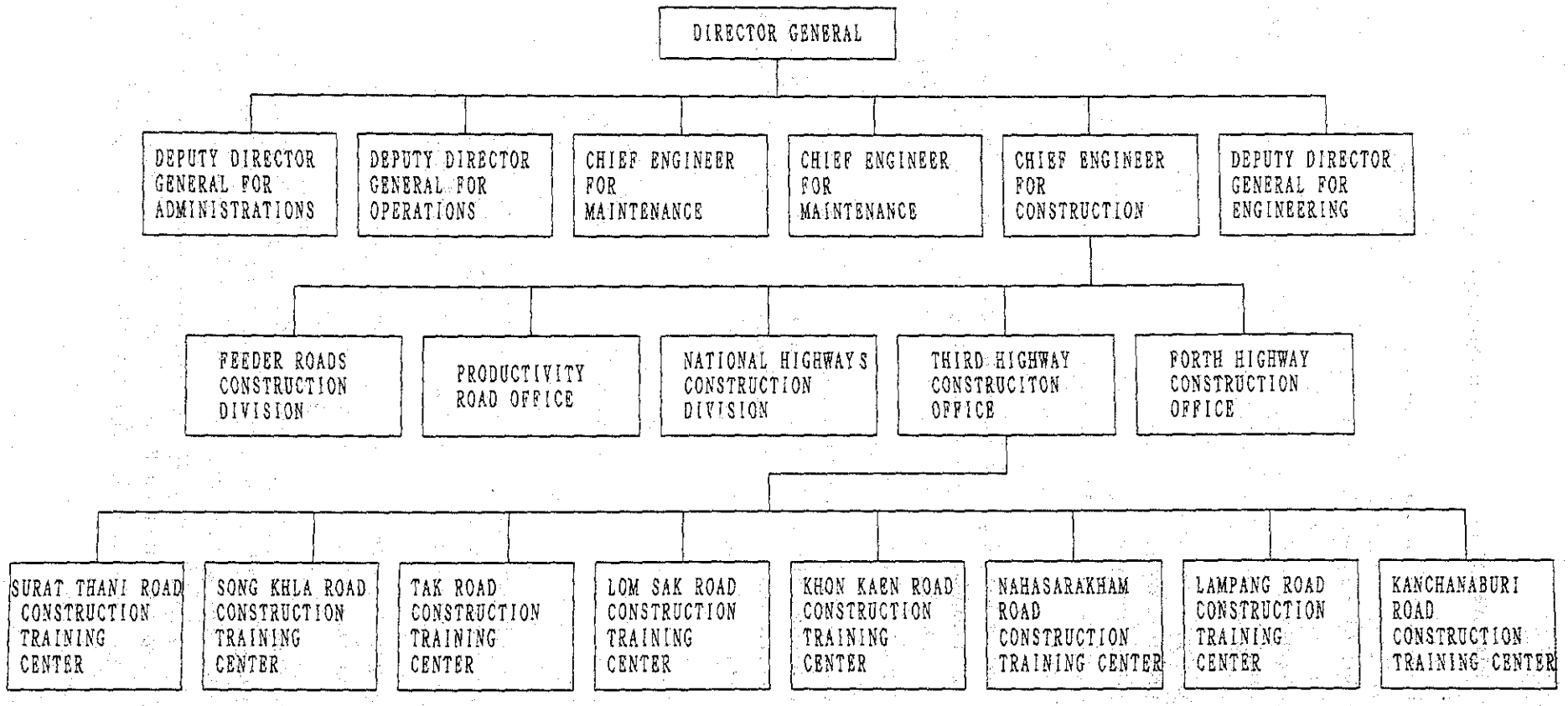
Figure 2.2-3 shows the change in the budget trend of each center from 1982 to 1991.

Based on Figure 2.2-3, each road construction center had an annual budget between 100 million Baht and 150 million Baht until 1987, after that the budget shows increased tendency and it is 150-240 million Baht in 1991.

Table 2.2-1 shows the budget of past three years and main donor countries of each road construction center.

Budget in 1991 of the Surat Thani Road Construction Center is rapidly increased to 311 million Baht. Song Khla Center had a budget of 105 million Baht in 1989 which was the most scantiest budget compared with the other seven (7) road construction centers. However, the budget was rapidly increased to 165 million Baht in 1990, and 222 million Baht in 1991. It seems that the Government of Thailand has the strong volition to the Southern

Figure 2.2-1 DEPARTMENT OF HIGHWAYS MINISTRY OF COMMUNICATIONS
FISCAL YEAR 1991



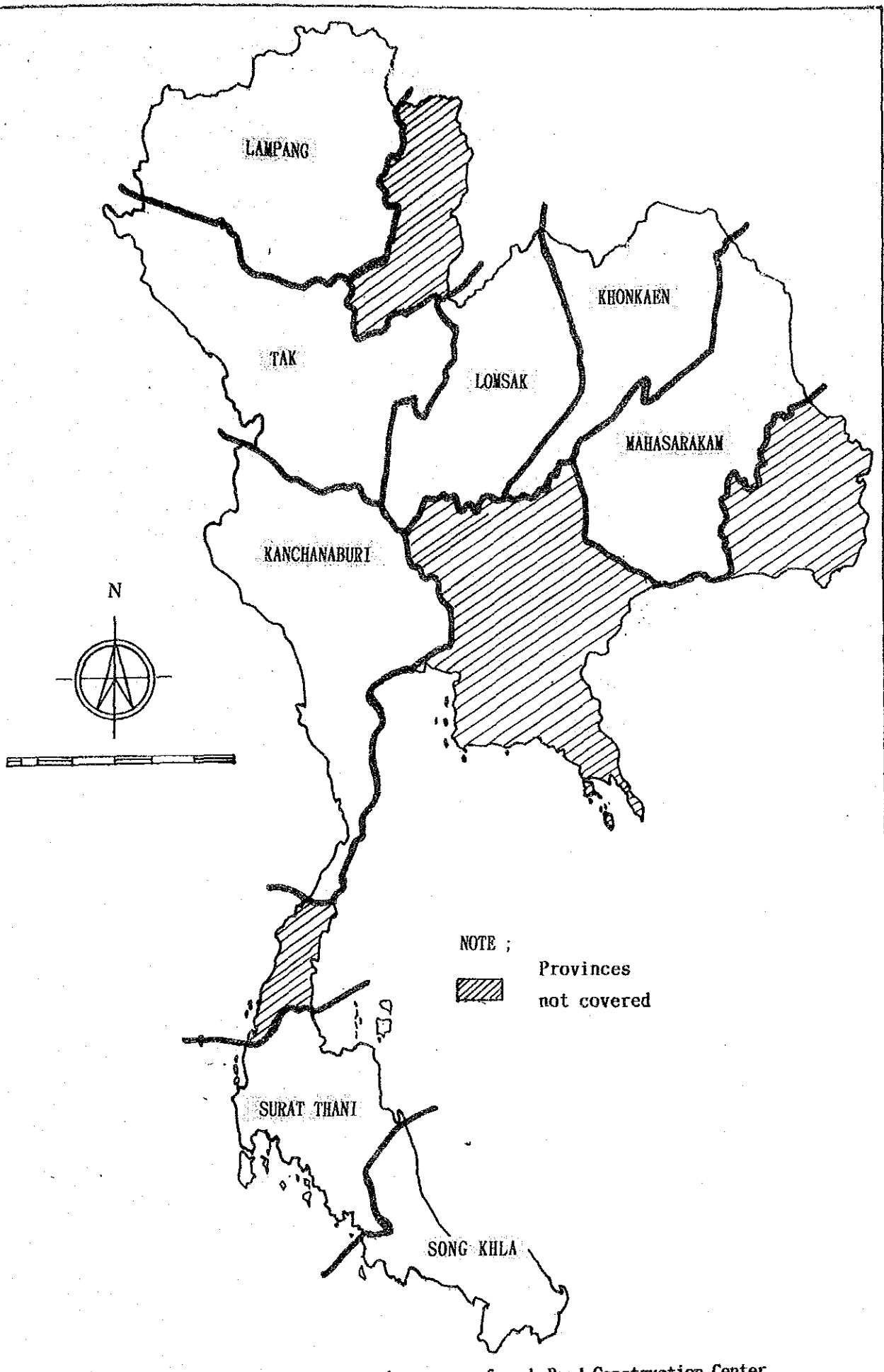


Figure 2.2-2 Administrative areas of each Road Construction Center

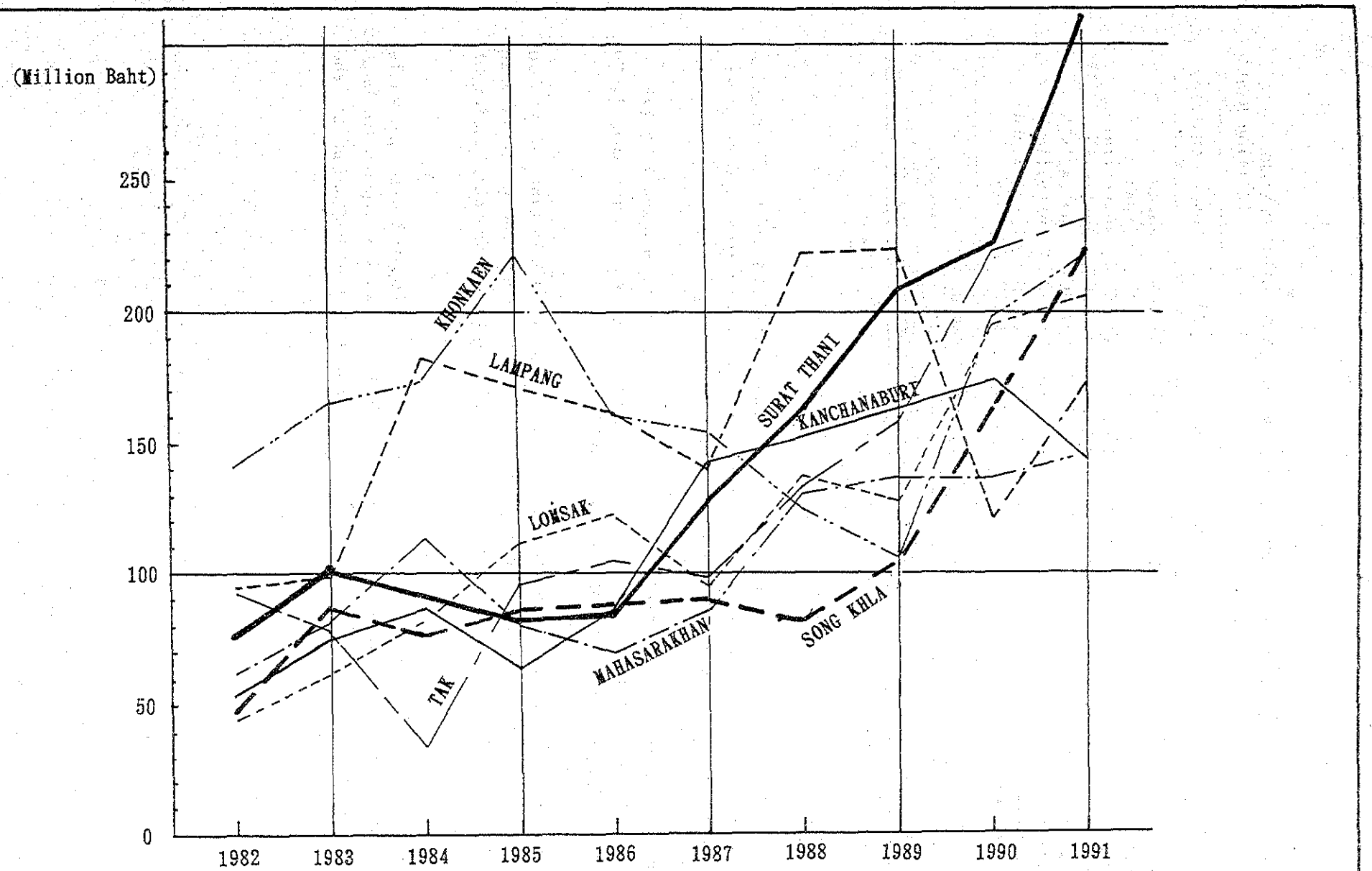


Figure 2.2-3 BUDGET TREND OF CONSTRUCTION CENTERS

Table 2.2-1 COMPARISON OF BUDGET AMONG 8-ROAD CONSTRUCTION CENTERS

(Million Baht)

Road Construction Center	1989	1990	1991	Donor Countries
Surat Thani	208.80	223.64	311.47	Japan
Song Khla	105.21	165.25	222.34	Japan
Lampang	256.65	120.67	174.97	Australia
Tak	159.50	222.00	236.36	Australia
Lomsak	119.98	196.78	207.00	Australia
Khonkaen	106.76	198.53	222.68	Australia
Mahasarakhan	137.04	136.75	146.70	New Zealand
Kanchanaburi	161.40	175.10	145.10	Japan
Total	1,255.34	1,438.72	1,666.62	
Average	156.92	179.84	202.33	

(3) Main construction equipment possessing

The type and number of construction equipment in each Road Construction Center are shown in Table 2.2-2. The detailed table of possession construction equipment is attached to Appendix-8.

The total number of construction equipment of the eight centers is 2,228 in which usable equipment (including under repairing equipment) are 1,689 (76%) and unusable equipment are 539 (24%).

Meanwhile, the total in Surat Thani Center is 287 consisting of usable equipment 95 (33%), and unusable equipment 192 (67%), and the total in Song Khla is 189 in which, usable equipment are 65 (34%), and unusable equipment are 124 (66%).

Usable equipment of both centers are very few when compared with the whole country's average. This figure proves the fact that many equipment in both centers were manufactured between the 1960's and the beginning of the 1970's.

Table 2.2-2 EQUIPMENT LIST OF 8-ROAD CONSTRUCTION CENTERS

	Surat Thani			Song Khla			Tak			Lomsak			Khonkaen			Mahasarakhan			Lampang			Kanchanaburi			Total		
	Usable	Un-usable	Total	Usable	Un-usable	Total	Usable	Un-usable	Total	Usable	Un-usable	Total	Usable	Un-unsable	Total	Usable	Un-usable	Total	Usable	Un-usable	Total	Usable	Un-usable	Total	Usable	Un-usable	Total
1. Earth Moving Equipment	35	18	53	18	25	43	78	13	91	35	1	36	80	8	88	50	16	66	65	42	107	42	5	47	403	128	531
2. Earth Excavator	1	1	2	0	1	1	2	1	3	3	0	3	3	1	4	0	0	0	2	0	2	1	0	1	12	4	16
3. Earth Solidifying Equipment	12	41	53	14	21	35	62	4	66	10	0	10	62	0	62	26	4	30	16	8	24	24	10	34	226	86	314
4. Earth Transportation	14	22	36	7	13	20	49	0	49	26	0	26	58	2	60	38	5	43	19	18	37	23	0	23	234	60	294
5. Pavement Equipment	0	14	14	2	7	9	13	5	18	6	0	6	16	1	17	2	2	4	11	1	12	4	2	6	54	32	86
6. Material/ Transportation Equipment	14	31	45	14	19	33	87	6	93	42	0	42	79	3	82	43	7	50	39	13	52	45	0	45	350	79	429
7. Multiple Purpose Equipment	7	24	31	5	23	28	26	5	31	20	0	20	55	4	59	15	5	20	21	6	27	12	5	17	163	72	235
8. Inspection Car/ Micro Bus	12	41	53	5	15	20	49	2	51	35	0	35	42	3	45	29	4	33	55	11	66	9	0	9	236	76	312
Total	95	192	287	65	124	189	366	36	402	177	1	178	395	22	417	203	43	246	228	99	327	160	22	182	1689	539	2228

(4) Utilization rate of equipment

Utilization rate of each center's equipment was presumed in comparison with the budget of 1991 and number of usable equipment of each center as presented in Table 2.2-3 and Figure 2.2-4.

Concerning the average rate of the eight centers, the average annual budget per one (1) equipment is 1.0 million Baht and road construction is planned to 0.4 km. As for the six centers, excluding Surat Thani and Song Khla, the average is 0.8 million Baht and 0.3 km per one (1) equipment.

In regard to the two centers of Surat Thani and Song Khla, the budget is 3.3 million Baht and road construction is expected to be 1.3 km per one (1) equipment. Namely, both centers' figures are about four (4) times when compared with the other six (6) centers.

Table 2.2-3 UTILIZATION RATE OF CONSTRUCTION EQUIPMENT

	Budget (1991) (Million Baht)	Planned Length of Road Construction (Km)	Number of Usable Equipments (Unit)	Budget per one Equipment (Million Baht)	Road Length per one Equipment (Km)
Surat Thani	311.47	115.44	95	3.3	1.2
Song Khla	222.34	82.34	65	3.4	1.3
Sub total	533.81	197.8	160	6.7	2.5
Average	266.9	98.9	80	3.3	1.3
Lampang	174.97	64.8	228	0.8	0.3
Tak	236.36	87.5	366	0.7	0.2
Lomsak	207.00	76.7	177	1.2	0.4
Khonkaen	222.68	82.5	395	0.6	0.2
Mahasarakhan	146.70	54.3	203	0.7	0.3
Kanchanaburi	145.10	53.7	160	0.9	0.3
Sub total	1,132.81	419.5	1,529	4.9	1.7
Average	188.8	69.9	255	0.8	0.3
Total	1,666.62	617.3	1,689	11.6	4.2
Average	208.3	77.2	211	1.0	0.4

Note : Planned length of road construction is estimated using a unit construction cost per kilometer of 2.7 million Baht and by applying the budget of 1991.

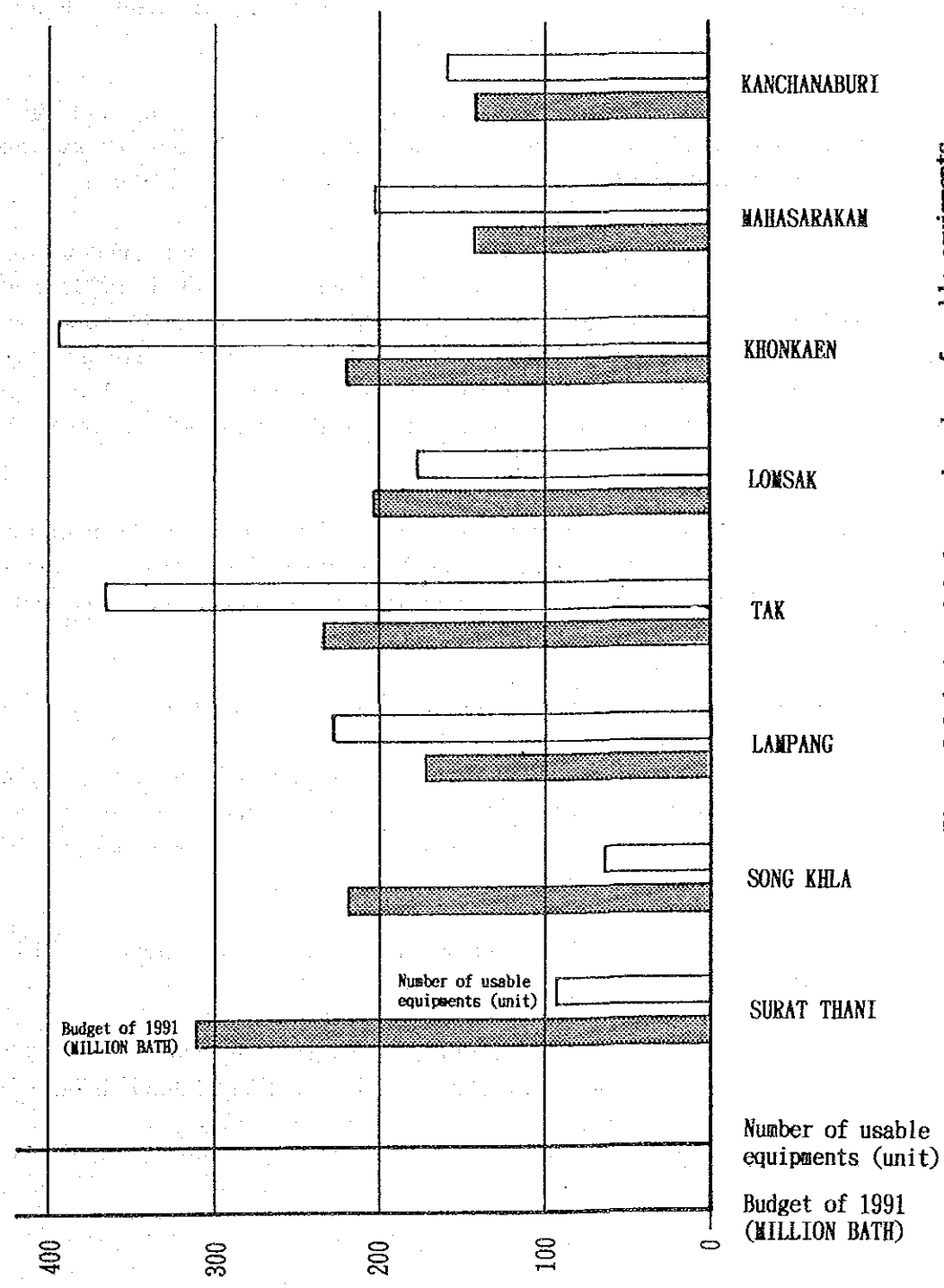


Figure 2.2-4 Annual budget and number of usable equipments

2.2.2 Surat Thani Road Construction Center

(1) History of the center establishment

After the aids of Japan to Song Khla Center who completed in the 1968, the Government of Thailand requested in 1969 the Government of Japan for new establishment of Surat Thani Road Construction Center in order to accelerate the road construction of Southern areas.

Objectives of the Government of Thailand were the construction of a secondary national highway from Surat Thani to Sichon (about 70 km) and the training and cultivation of construction and mechanical engineers.

The Government of Japan carried out the Preliminary Study regarding this request on May 1970 and the Implementation Study on October 1970. Based on the results of above studies, an agreement on the establishment of the technical cooperation center for road construction and training was concluded between the Government of Japan and the Government of Thailand. The term of the agreement was five (5) years. Main equipment procured by the agreement are shown in Table 2.2-4.

After that, an additional request of road construction from Sichon to Thasala (about 40 km) was proposed, and this extension road was constructed. The operation of Surat Thani Center was transferred to Thailand after the project was completed on November 1977.

(2) Construction equipment possession and source of supply

Usable equipment possessed by the Center and source of supply are shown in Table 2.2-5. Based on this table, the total usable equipment are 95 with 38 as procurement of the DOH, 32 as procurement of Japan and 25 as loan of private facilities.

Figure 2.2-5 shows chronological change in trend of equipment supplied by the Government of Japan.

Number of construction equipment supplied by Japan reached 146 in 1976, but the number decreased to only 32 in 1991. These equipment have been used for more than fifteen (15) years.

Table 2.2-4 LIST OF SUPPLIED CONSTRUCTION EQUIPMENT AT THE FIRST ESTABLISHMENT OF SURAT THANI CENTER

Equipment	Specification	70	71	72	73	74	75	76	Total
Bulldozer	11 t								0
Bulldozer	13 t PL	2							2
Bulldozer	21 t	9							9
Tractor Shovel	1.4 m^3		4						4
Tractor Shovel	1.3 m^3	2							2
Scraper	6 m^3								0
Motor Scraper	16 m^3			1	1				2
Motor Grader	3.7 m_3	1	4	1					6
Hydraulic Excavator	0.3 m^3	1							1
Power Shovel	0.6 m^3								0
Rubber Tire Roller	8 - 15 t	1	5	2			2		10
Macadum Roller	10 - 12 t		2						2
Tamdem Roller	8 - 10 t			1	1				2
Vibration Roller	5 t		3						3
Vibration Roller	0.9 t		2						2
Tamper		3							3
Dump Truck	6 t	9	5	6			4		24
Fork Lift	2 t	1							1
Asphalt Plant	40 t/h			1	1				2
Asphalt Finisher	4 m			1	1				2
Asphalt Distributor	4000 L		1					1	2
Soil Plant	150 t/h					1			1
Crashing Plant	60 - 100 t/h								0
CHP Spreader		4							4
Fuel Truck	7000 L	1		1					2
Fuel Truck		1		1					2
Water Truck	5800 L	1	3	3					7
Crane Truck	7 t	1							1
Crane Truck	3 t						1		1
Truck	6 t	2							2
Truck	2 t	1		2					3
Farm Tractor	60 p s		3						3
Road Stabilizer	2.2 m		2						2
Truck Tractor	20 t	1							1
Semi-Trailer	20 t	1							1
Self-Loading Truck	10 t	1							1
Generator	150 KVA			1	1				2
Generator	125 KVA					1			1
Generator	35 KVA	1							1
Generator	1 KVA	6							6
Water Pump	75 ø	5							5
Lane Maker			1						1
Asphalt Kettle	700 L		2						2
	4 x 4	1							1
Patrol Car	4 x 4	5		5		3	1		14
Patrol Car	4 x 2						2		2
Micro Bus	25 persons	1							1
Total		62	37	26	5	5	10	1	146

Source: The compositive report of Surat Thani Road Construction Center, 1978, JICA.

Table 2.2-5 USABLE CONSTRUCTION EQUIPMENT AND THE SOURCE (SURAT THANI)

	SOURCE			
	DOH	JAPAN	BORROWED	TOTAL
1. EARTH MOVING EQUIPMENT				
1.1 Bulldozer	2	11	5	18
1.2 Wheel Loader	2	1	0	3
1.3 Tractor Shovel	0	1	0	1
1.4 Motor Grader	3	4	2	9
1.5 Motor Scraper	4	0	0	4
Sub Total	11	17	7	35
2. EARTH EXCAVATION				
2.1 Hydraulic Excavator	1	0	0	1
Sub Total	1	0	0	1
3. EARTH SOLIDIFYING EQUIPMENT				
3.1 Vibratory Roller	3	0	0	3
3.2 Macadum Roller	0	0	0	0
3.3 Tandem Roller	1	0	0	1
3.4 Rubber Tire Roller	0	7	1	8
Sub Total	4	7	1	12
4. EARTH TRANSPORTATION				
4.1 Dump Truck	9	4	1	14
Sub Total	9	4	1	14
5. PAVEMENT EQUIPMENT				
---	-	-	-	-
Sub Total	-	-	-	-
6. MATERIAL/TRANSPORTATION EQUIPMENT				
6.1 Water Truck	3	2	1	6
6.2 Fuel Truck	2	0	0	2
6.3 Flat Bed Truck	3	0	2	5
6.4 Self-Loading Truck	0	1	0	1
Sub Total	8	3	3	14
7. MULTIPLE PURPOSE EQUIPMENT				
7.1 Farm Tractor	0	1	0	1
7.2 Diesel Generator	0	0	2	2
7.3 Others	2	0	2	4
Sub Total	2	1	4	7
8. INSPECTION CAR/MICRO BUS	3	0	9	12
Sub Total	3	0	9	12
GRAND TOTAL	38	32	25	95

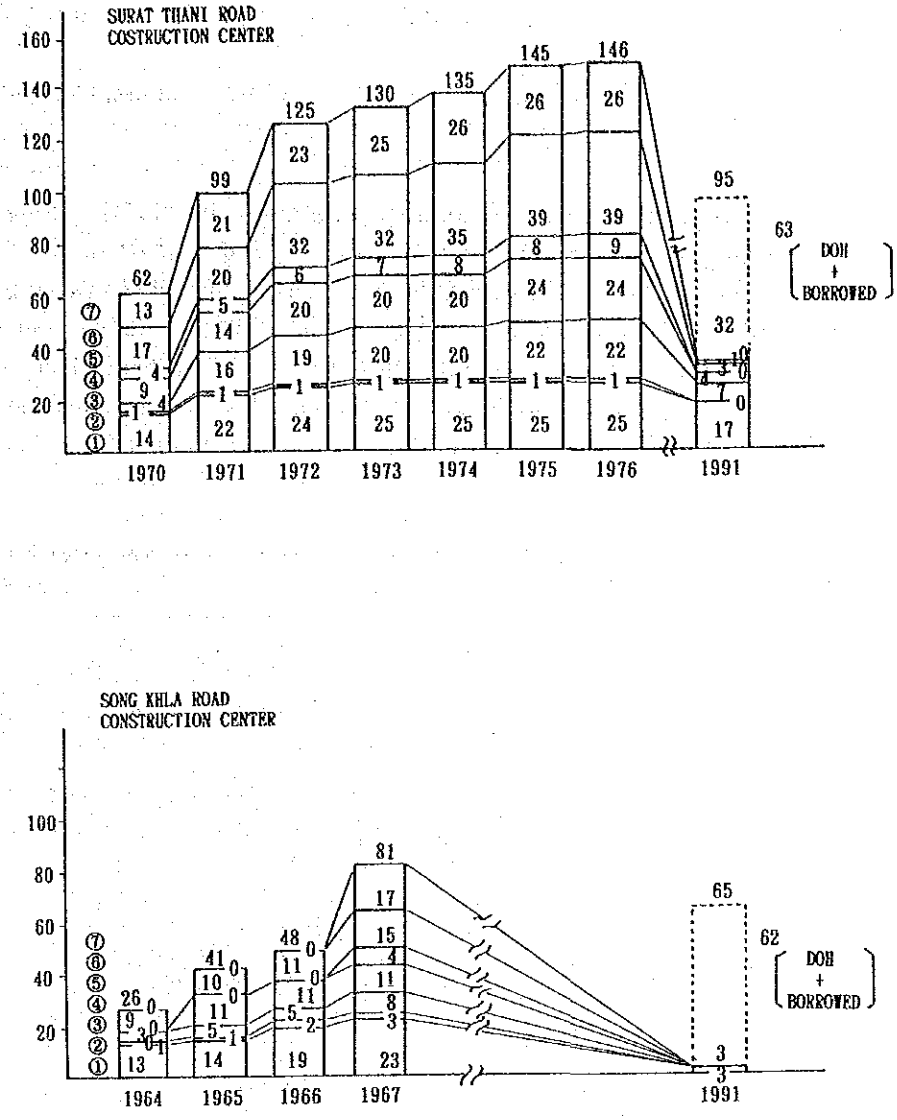


Fig. 2.2-5 TREND OF EQUIPMENT SUPPLIED BY JAPAN

Note:

1 Earth Moving Equipment
2 Earth Excavation
3 Earth Solidifying Equipment
4 Earth Transportation
5 Pavement Equipment
6 Material/Transportation Equipment
7 Multiple Purpose Equipment

(3) Budget and maintenance cost of construction equipment

Budget for the past four (4) years and its details are shown in Table 2.2-6.

Annual budget is distributed to personnel expenses by 7.8%, construction cost 84.9% and equipment maintenance cost 7.3%. The rate of 7.3% as the maintenance cost is considered comparatively high figure. It is supposed to be due to using old equipment made on the 1975's and 1980's. Table 2.2-7 shows the repairing cost, annual operating hours of construction equipment and a comparison by equipment. Further, it shows that each equipment needs 192.6 Baht as repairing cost to be operated for an average of one hour.

Table 2.2-6 BUDGET AND MAINTENANCE COST OF CONSTRUCTION EQUIPMENT (SURAT THANI CENTER)

unit: Million Baht

		1988	1989	1990	1991	Total
Administration/Labour		13.98 (8.5)	15.41 (7.4)	16.54 (7.4)	24.68 (7.9)	70.61 (7.8)
Construction Cost		137.86 (84.3)	178.14 (85.3)	188.45 (84.3)	266.51 (85.6)	770.96 (84.9)
Maintenance Cost of Equipment	A	11.81 (7.2)	15.25 (7.3)	18.65 (8.3)	20.28 (6.5)	65.99 (7.3)
Budget		163.65 (100%)	208.80 (100%)	223.64 (100%)	311.47 (100%)	907.56 (100%)
No. of Equipment	B	-	-	95	95	-
A/B		-	-	0.20	0.21	-

Note : A/B: Maintenance cost including repairing cost per equipment and spare parts.

Table 2.2-7 REPAIRING COST AND ANNUAL WORKING HOURS (SURAT THANI CENTER)

		1987	1988	1989	1990
1. Earth Moving Equipment	Repairing Cost A	852,009	1,510,270	1,738,714	2,485,239
	Annual operating hours B	6,041	6,232	7,206	8,838
	A/B	141.0	242.3	241.3	281.2
2. Earth Moving Equipment	Repairing Cost A	283,906	192,127	624,218	516,694
	Annual operating hours B	4,207	3,227	3,182	8,838
	A/B	106.1	45.7	193.4	162.4
3. Earth Solidifying Equipment	Repairing Cost A	240,680	158,240	544,778	373,986
	Annual operating hours B	3,521	4,627	4,752	5,509
	A/B	68.4	34.2	114.6	67.9
Total	Repairing Cost A	1,376,595	1,860,637	2,907,710	3,375,919
	Annual operating hours B	12,238	15,066	15,185	17,529
	A/B	112.5	123.5	191.5	192.6

Source : Surat Thani Road Construction Center, DOH

(4) Condition of equipment maintenance

After the Japanese experts returned to Japan in 1979, the Government of Thailand has been supplying many facilities to the Center in order to keep it in functional order. These include the following:

- Widening of workshop
- Introducing computer system for management of machine progress
- Producing some machines by own works
- Establishment of service workshop

Maintenance of equipment of this center is satisfactory. The arrangement of equipment and tools are in good order and much effort is done to extend the machines life. Moreover, the center has a repairing machine of lathe, welding machine, etc., and small repairing works are done beside changing of parts.

Overhaul of equipment is carried out in the Center periodically. Considering the results of analyzing the data of the Center, repairing cost of overhauled equipment is remarkably low. However, it can be considered as high when comparing with the normal repairing cost, due to the superannuated condition of existing equipment.

It can be concluded that Surat Thai Center bears high expenses on equipment repair and makes efforts to lengthen the equipment life, but the equipment workability and operational rates are still decreasing in the same time of increasing the Center's expenditures.

(5) Activities of the Center

The Center is responsible for the followings.

- Improvement and construction of provincial highways in the district area
- Maintenance, management and repairing of the construction equipment
- Training of civil engineers and mechanical engineers.

The double bituminous surface treatment (DBST) is generally applied for improvement and construction of provincial highways. The construction of this type of pavement requires a comparably high technique. Engineers and labours are considered skillful for this method judging from the construction performances which are acceptable in general. The road maintenance works are also well performed.

2.2.3 Song Khla Road Construction Center

1) History of Song Khla Road Construction Center

In 1963, the Government of Thailand requested Japan to establish a road construction center in Song Khla in order to develop the road network in the Southern Region. Objectives of this project aimed at constructing a road of total length 54 km between Song Khla and Hat Yai, which are two major cities in Southern Thailand, cultivating and training the civil and mechanical engineers, and developing the rubber industry in line with the development of Southern Thailand.

The Government of Japan carried out the Preliminary Study related to the proposal on September 1963, and the Basic Study on May 1964. In the same year, the Governments of Japan and Thailand signed the agreement regarding the establishment of Song Khla Road Construction Center. Through the agreement, the Government of Japan dispatched 10 experts in civil and mechanical engineering as Japan's technical cooperation and provided construction equipment and other needed equipment. The term of agreement was 3 years, and Table 2.2-8 shows the main equipment supplied by Japan.

280 Thai engineers were trained in the Song Khla Center and the construction of a national highway of total length 54 km was completed by November 1968. After that, the administration of the center was handed over to the Government of Thailand.

(2) Construction equipment possessing and the source

Table 2.2-9 shows the usable equipment possessed by the center and their source. In the table, the usable equipment of 65 units are composed of 54 units procured by the DOH, 3 by Japan and 8 units borrowed from private companies.

Figure 2.2-5 shows the trend of number of equipment procured by Japan. In 1967, the number of usable equipment was 81 units, but the number now is only 3 units which have been used for more than 24 years.

Table 2.2-8 LIST OF SUPPLIED CONSTRUCTION EQUIPMENT AT THE FIRST ESTABLISHMENT OF SONG KHLA CENTER

Equipment	Specification	1964	1965	1966	1967	Total
Bulldozer	17 t	5		1		6
Bulldozer	17 t	1		1		2
Scraper	6 m^3	2				2
Tractor Shovel	1.2 m^3	2	1			3
Bulldozer	12 t			1	2	3
Motor Grader	3.7 m	2		2	1	5
Motor Scraper	MS				1	1
Road Stabilizer		1				1
Power Shovel	0.6 m^3	1		1		2
Hydraulic Excavator	TY 45				1	1
Rubber Tire Roller	9 - 13 t	1	1		1	3
Macadum Roller	10 - 12 t	1	1			2
Tandem Roller	10 - 12 t				2	2
Sheep Foot Roller	10 t	1				1
Dump Truck	6 t		11			11
CHP Spreader	NCS-30				1	1
Distributor	DRHF				1	1
Crasher					2	2
Water Truck	5500 L	1				1
Trailer	20 t	1			1	2
Crane Truck	3 - 5 t	1			1	2
Vibration Roller	1.6 t			1		1
Fork Lift	2 t					
Fuel Truck	7000 L	1				1
Fuel Truck		1				1
Service Truck	2 t	1				1
Patrol Car		2	1		2	5
Passenger Car		1				1
Others	Water Pump,	1				1
Equipment for Workshop		1		1	1	1
Spare Parts		1		1	1	1
Screen					1	1
Generator	DC 30				1	1
Conveyor	HT 97				15	15

Source: The compositive report of Song Khla Road Construction Center, 1967, JICA.

Table 2.2-9 USABLE CONSTRUCTION EQUIPMENT AND THE SOURCE (SONG KHLA)

	SOURCE			
	DOH	JAPAN	BORROWED	TOTAL
1. EARTH MOVING EQUIPMENT				
1.1 Bulldozer	2	3	4	9
1.2 Wheel Loader	2	0	0	2
1.3 Tractor Shovel	-	-	-	-
1.4 Motor Grader	5	0	1	6
1.5 Motor Scraper	1	0	0	1
Sub Total	10	3	5	18
2. EARTH EXCAVATION				
2.1 Hydraulic Excavator	-	-	-	-
Sub Total	-	-	-	-
3. EARTH SOLIDIFYING EQUIPMENT				
3.1 Vibratory Roller	4	0	0	4
3.2 Macadum Roller	5	0	0	5
3.3 Rubber Tire Roller	5	0	0	5
Sub Total	14	0	0	14
4. EARTH TRANSPORTATION				
4.1 Dump Truck	7	0	0	7
Sub Total	7	0	0	7
5. PAVEMENT EQUIPMENT				
5.1 Asphalt Distributor	1	0	0	1
5.1 Concrete Mixer	1	0	0	1
Sub Total	2	0	0	2
6. MATERIAL/TRANSPORTATION EQUIPMENT				
6.1 Water Truck	3	0	0	3
6.2 Fuel Truck	-	-	-	-
6.3 Flat Bed Truck	5	0	3	8
6.4 Truck Trailer	2	0	0	2
Sub Total	10	0	3	13
7. MULTIPLE-PURPOSE EQUIPMENT				
7.1 Farm Tractor	5	0	0	5
7.2 Diesel Generator	1	0	0	1
7.3 Others	-	-	-	-
Sub Total	6	0	0	6
8. INSPECTION CAR/MICRO BUS	5	0	0	5
Sub Total	5	0	0	5
GRAND TOTAL	54	3	8	65

(3) Budget and maintenance cost of construction equipment

Table 2.2-10 shows the budget and its contents during the past 6 years. The annual budget is distributed in average as 3.6% for administration, and labour cost, 83.4% for construction cost and 13.0% for equipment maintenance cost.

Based on 2.7 million Baht/km of road construction cost in 1991, the annual road length under rehabilitation and construction was 30 km in 1987 and 50 km in 1990.

The share of maintenance cost of construction equipment is 13% of the budget, which is higher than 7.3% of Surat Thani Center. This can be considered due to most of Surat Thani equipment are manufactured between 1975 and 1980, while Song Khla equipment between 1965 and 1970.

Table 2.2-10 ANNUAL BUDGET AND MAINTENANCE COST FOR CONSTRUCTION EQUIPMENT (SONG KHLA ROAD CONSTRUCTION CENTER) (Million Baht)

	1986	1987	1988	1989	1990	1991	Total
Administration/ Labour	4.06 (3.9)	2.60 (3.7)	3.88 (4.7)	4.93 (4.7)	3.47 (2.1)	-	18.94 (3.6)
Construction Cost	87.57 (84.8)	60.23 (85.8)	68.60 (83.2)	81.25 (77.2)	142.11 (86.0)	-	439.76 (83.4)
Maintenance Cost of Equipment	11.71 (11.3)	8.18 (11.5)	10.00 (12.1)	19.03 (18.1)	19.67 (11.9)	-	68.59 (13.0)
Total	103.34 (100%)	71.01 (100%)	82.48 (100%)	105.21 (100%)	165.25 (100%)	222.340	527.29 (100%)
No. of Equipment	-	59	60	64	65	-	-
Maintenance Cost per Equipment	-	0.14	0.17	0.30	0.30	-	-

Note : Maintenance cost per equipment includes the repairing cost and spare part.

(4) Condition of equipment maintenance

To develop the facilities of the Center, the Government of Thailand has procured 54 units of construction equipment and extended the workshop area.

Management of equipment maintenance and handling equipment and tools in the Center are done in good order. Maintenance data shows that periodical overhaul is carried out regularly, and mainly during the rainy season. The Center has welding installations and crane, and also assembly facilities.

In conclusion, it is recognized that Song Khla Center, the same as Surat

Thani Center, is making all efforts to use the aged equipment, but it is clear that it is very difficult to improve the workability and operational performance of such equipment which went beyond the life limit.

(5) Activities of the Center

Song Khla Center is also responsible for improvement and construction of provincial highways as Surat Thani Center, and is positively performing the works.

2.3 OUTLINE OF THE REQUEST

The Government of the Kingdom of Thailand has been executing at present "The 6th National Economic and Social Development Plan (1987-1991)". One of the objectives of the development plan is to activate the socio-economics in rural areas, to improve income and living level, and to increase population and industries in rural areas. Based on the plan, the Government of Thailand established "The Sixth 5-Years Road Development Plan", and grappled importantly with road construction of provincial areas, especially low developing areas.

The Southern Region of Thailand is formed with flooded areas and mountainous terrains. Though plenty of rubber trees are cultivated in the region, it is said to be a low developing area. Primary and secondary highways in this region are developed well but provincial highways in the region are not developed. Further, many developed roads suffered damages by the flood in 1988. The Government of Thailand considers that road development of rural areas is an important and urgent theme.

Rehabilitation and construction of provincial highways in the Southern Region are executed by Surat Thani and Song Khla Road Construction Centers of the DOH, under direct control of the centers. The rehabilitation and construction of provincial highway in the region are different from the road development for urban and national highways. It is difficult for both centers to entrust the road construction to constructors because of the unfavorable construction conditions caused by climate and geography, hard accessibility to the field, insufficient of the contractors and limited budget.

The Government of Japan provided almost all construction equipment of Song Khla Center in 1964 and of Surat Thani Center in 1971 as Japan's Grant Aid. Maintenance of the equipment is done well, but many equipment cannot be

used because of oldness. For the Road Development Plan, number of needed equipment are insufficient. Both centers have been taking measures to borrow the construction equipment from private companies. But the absolute number of equipment is not enough so that road development of the region delayed.

In this context, the Government of the Kingdom of Thailand requested the Government of Japan, as Japan's Grant Aid, for Providing of construction equipment. This aims at the supplement of construction equipment required to road construction, as well as training and cultivation of civil and mechanical engineers of Thailand through practical experiment of road construction.

Table 2.3-1 shows the list of equipment required by the Government of the Kingdom of Thailand. The organization for the project is the Department of Highways, Ministry of Transport and Communications. Executing Agencies are Surat Thani and Song Khla Road Construction Centers.

Table 2.3-1 LIST OF REQUIRED EQUIPMENT

	Surat Thani Road Construction Center	Song Khla Road Construction Center	Total
1. Earth Moving Equipment	16	12	28
2. Earth Excavator	5	3	8
3. Earth Solidifying Equipment	8	5	13
4. Earth Transportation	15	10	25
5. Pavement Equipment	5	7	12
6. Material/Transportation Equipment	20	12	32
7. Multiple Purpose Equipment	8	11	19
8. Inspection Car/Micro Bus	10	7	17
Total	87	67	154

Type of Equipment:
1. Bulldozer, Wheel Loader, Motor Grader
2. Hydraulic Excavator
3. Vibratory Roller, Rubber Tire Roller, etc.
4. Dump Truck
5. Asphalt Distributor, Pavement Cutter, etc.
6. Water Truck, Fuel Truck, Flat Bed Truck, etc.
7. Farm Tractor, Diesel Generator, etc.
8. Micro Bus

2.4 OUTLINE OF THE PROJECT AREA

2.4.1 Socio-Economic Conditions

(1) Location

The Southern Region is administratively divided into 14 Changwats. The development of highways in 12 Changwats of this region is executed under the direct control by Surat Thani and Song Khla Construction Centers of the DOH. The study area of the project is the area under the supervision of the two centers.

The Southern Region is located in the Malay Peninsula with mountain ranges in the middle of the Peninsula, and surrounded by the Gulf of Thailand on the east and the Andaman Sea on the west. The southern part of this region borders on Malaysia as shown in Figure 2.4-1. This region stretches from north to south with a total length of 600 kilometers. The east-west width of the region is 250 kilometers at maximum and 100 kilometers at minimum.

(2) Population and main industries in the region

The study area has a population of about 6.4 million, i.e. 11.6 percent of the total population of the Kingdom of Thailand. The land area of this region is 12% of the total area of the country, and farm land is 11.6%. Density of population is the same as the average of the whole Kingdom. In comparison with the above percentages, Gross Provincial Product is 110.3 million Baht, which is about 8.9% of 1,234.0 million Baht of whole Kingdom. This fact shows that the productivity of this region is low.

Percentages of the main products in this region to the grand total of the whole Kingdom are 85.8% for smoked sheet rubber, 85.6% for palm oil, 60.1% for cashew nut, 45.6% for laang saad, 41.6% for rambutan and 37.9% for coconut.

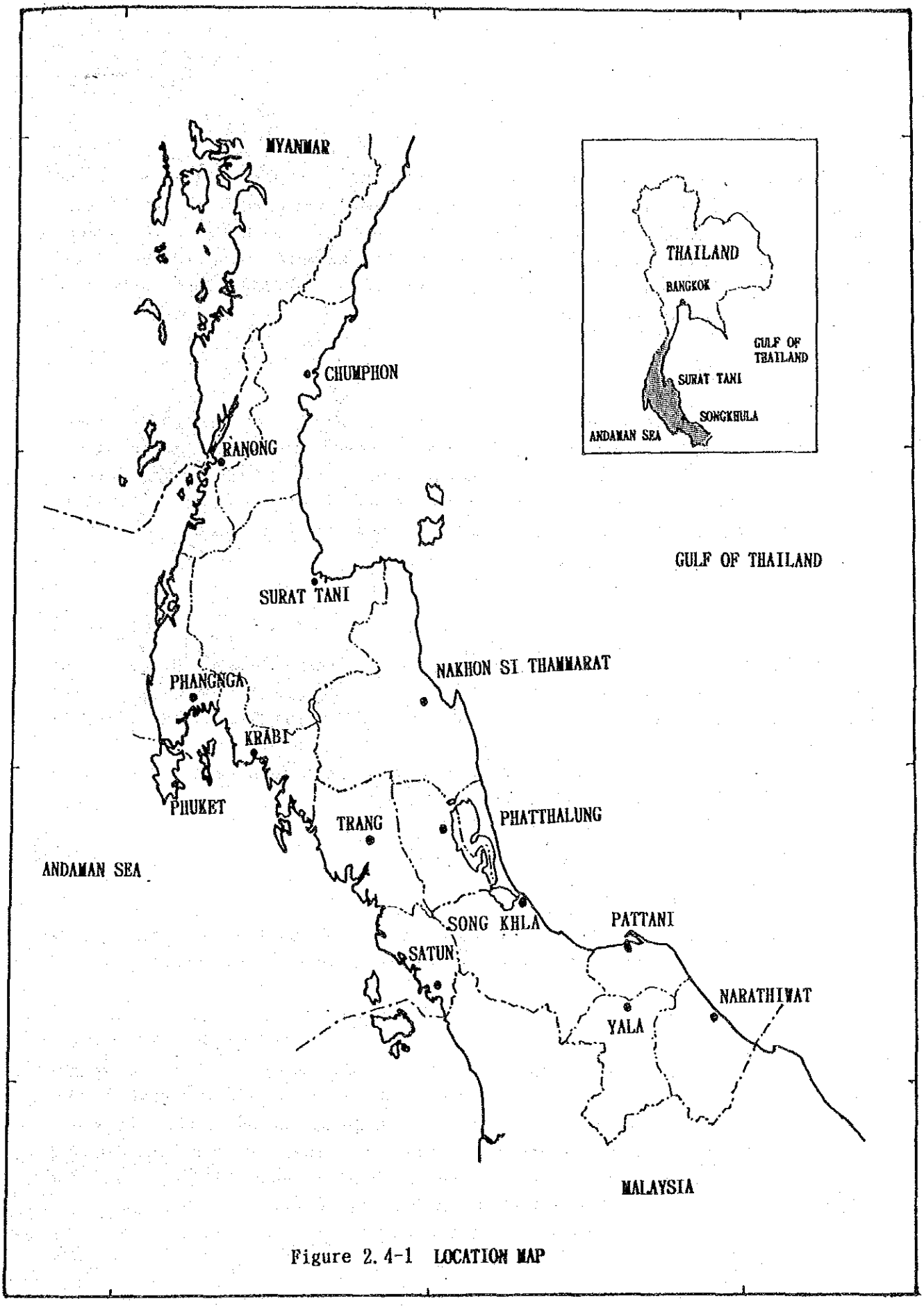


Figure 2.4-1 LOCATION MAP

2.4.2 Natural Conditions

(1) Geography

The topographical features of this region are flat areas on the coast and mountainous areas in the middle, and these mountainous areas are approximately 35% of the total area of the region. As main mountain ranges, there are the Phuket Mountain Range, Nakhon Si Thammarat Mountain Range and Sankalakhiri Mountain Range. The Sankalakhiri Mountain Range separates Thailand from Malaysia.

(2) Geology

Distribution of geology is different between coastal areas and mountainous areas. Allrium and terrace deposits are spread over major basins around the mouth of major rivers. Most of the mountainous and hilly areas is covered with sedimentary and metamorphic rocks composed of tertiary sediments, while igneous rocks such as granite cover some part of high mountainous areas.

(3) Climate

The region has only two seasons; hot season and rainy season. However, the period of rainfalls is quite different on the west and east coasts. On the east coast, the northeast monsoon from the South China Sea brings rainfall of 2,063 millimeters per year mostly from November to May. On the west coast, the southeast monsoon from the Indian Ocean brings rainfall of 2,322 millimeters per year mostly from May to October.

2.4.3 Transportation System

The major domestic transportation modes in Southern Thailand consist of road, railway, coast and air transports as shown in Figure 2.4-2.

(1) Road transport

Road network in the Southern Region acts a vital role for both passenger and freight transport and is judged to be well structured. It covers most parts of the east and west costs and some highways connect the two costs together. Provincial centers are connected each other at possible shortest distance, and rural roads extend to the depth of inland. To the south, the network is connected to the Malaysian highway systems.

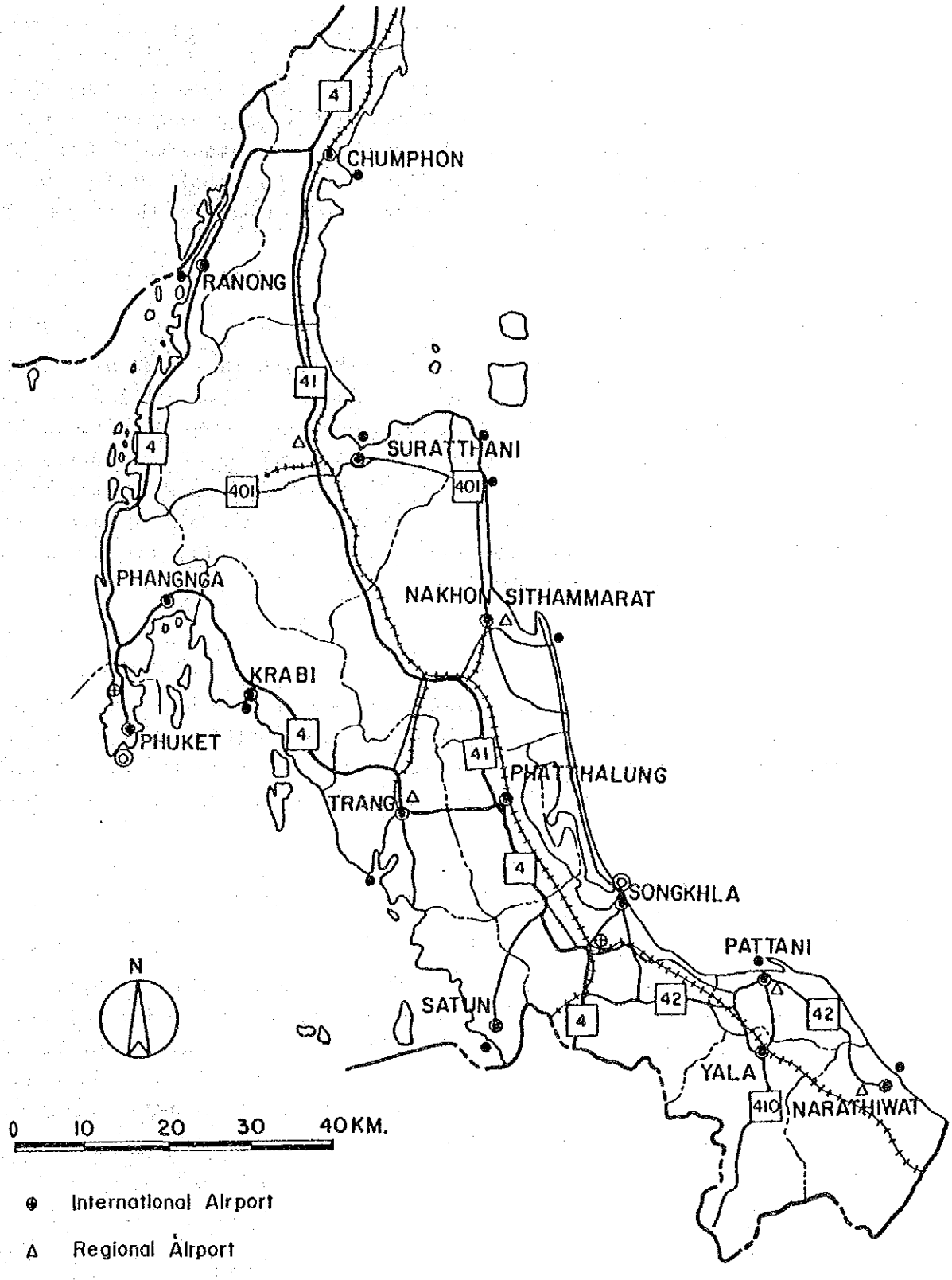


Figure 2.4-2 Transport Network in the Southern Region

(2) Coast transport

In addition to eighteen coastal ports, the harbor facilities of Song Khla and Phuket, as deep sea ports, are important for coast transport in this region. Song Khla Deep Sea Port is designed to accommodate 20,000 GRT vessels with total berth length of 510 meters (-9m, 3 berths), while Phuket Deep Sea Port accommodates 15,000 GRT vessels with total berth length of 360 meters (-10m, 2 berths).

(3) Air transport

In the Southern Region, there are seven airports which have regular flight services. These airports have a share of 4.0 million of 7.7 million as the total number of passengers in the whole airports under the Department of Aviation in 1987, i.e. about 52 percent. The total number of passengers in southern airports was about 2.1 million in 1984, and the annual growth rate is 24.3 percent. This is higher than the average growth rate of 6.5% for the whole Kingdom, which means the ambition of developing the Southern Region by the Government of Thailand.

(4) Railway transport

The State Railway of Thailand (SRT) system serves 41 provinces out of the total 73 in the whole Kingdom of Thailand. In the Southern Region, there are 9 provinces which have railway services. The total length of railway lines in the region is about 946 km, which is 25.4% of the total SRT network.

2.4.4 General Condition of Highways

The total length of national highways in the Southern Region is 3,151 km with 3,105 km of paved roads, and is well developed. Provincial highways have a total length of 5,216 km with 3,504 km of paved roads, 973 km of unpaved roads and 739 km of under constructing roads. Table 2.4-1 gives the length of both national and provincial highways under the responsibility of Surat Thani and Song Khla Centers in 1990.

Table 2.4-1 LENGTH BY CLASS OF ROADS AND BRIDGES (1990)

Area Of	Highway District	National Highways		Provincial Highways		Total	
		Roads (Km)	Bridges (m)	Roads (Km)	Bridges (m)	Roads (Km)	Bridges (m)
Song Khla Construction Center	Song Khla	349	5,440	130	218	479	5,658
	Yala	195	2,253	300	2,789	495	5,042
	Pattani	160	2,390	260	1,942	420	4,332
	Phatthalung	100	1,066	295	2,388	395	3,454
	Narathiwat	57	2,746	481	3,796	538	6,542
	Satun	116	380	192	1,827	308	2,207
	Total	977	14,275	1,658	12,960	2,635	27,235
Surat Thani Construction Center	Nakhon Sithammarat	178	2,092	518	3,946	696	6,038
	Trang	187	1,211	327	1,355	514	2,566
	Krabi	133	962	519	2,325	652	3,287
	Phuket	309	2,670	177	1,420	486	4,090
	Surat Thani	250	2,901	552	3,392	802	6,293
	Pangnga	171	1,370	521	1,853	692	3,223
	Total	1,228	11,206	2,614	14,291	3,842	25,497
Grand Total		2,205	25,481	4,272	27,251	6,477	52,732

CHAPTER THREE

OUTLINE OF THE PROJECT

CHAPTER 3

OUTLINE OF THE PROJECT

3.1 OBJECTIVE

Rural road development in the Southern Thailand has been executing under direct control of Surat Thani and Song Khla Road Construction Centers. Both Centers have accomplished many construction projects to fulfill the increased recent traffic demands. However, the equipment of both Centers have been aged and work capacity and efficiency has remarkably decreased and maintenance cost increased. Due to this situation, rural road network development plan has been extensively delayed from the planned schedule.

The Project aims at providing road construction equipment to both Centers to contribute to the road development of the southern Thailand and improve the construction capability of both Centers.

3.2 STUDY AND EXAMINATION ON THE REQUEST

3.2.1 Examination on Necessity and Appropriateness of the Project

Although the rural road development in the Southern Thailand is an urgent theme as described in Chapter 2 , equipment capability of Surat Thani and Song Khla Centers is insufficient in both quantity and quality.

The necessity, propriety and socio-economical impact of the Project are summarized as follows.

Necessity of the Project

- In spite that southern Thailand is a low developing region and the road development in the region is an urgent theme, the construction has been delayed due to the equipment deterioration and shortage.

- In Surat Thani Center there are many equipment manufactured in 1975-1980 which exceeded ordinary equipment life limit. Its capacity and efficiency has decreased and the maintenance cost has increased.

- The equipment of Song Khla, most of them were manufactured in 1965-1970, exceeded ordinary equipment life limit. The equipment capacity and efficiency has decreased and the maintenance cost has increased.

- Of the total 287 equipment of Surat Thani Center, 95 equipment (33.1%) are usable. Of the total 189 equipment of Song Khla, 65 equipment (34.4%) are usable. These figures are lower than that of the average of other six Centers; of the total 292 equipment, 255 equipment (87.2%) are usable as shown in Table 3.2-1. The number of equipment of Surat Thani and Song Khla Centers is considered very few comparing with the proposed road construction.

- Annual budget of Surat Thani in 1990 is 223.6 million Baht and Song Khla is 165.3 million Baht. Average budget of other six Centers is 175 million Baht.

- Comparing the usable equipment to the budget, the number of usable equipment of both Centers to the budget is remarkably smaller than the average of other Centers.

- Based on the above situations, even if the road development demands in both Centers remain at present level, smooth implementation of the road construction will be hampered due to the equipment shortage. The Supplement of equipment is considered necessary and urgent.

Table 3.2-1 EQUIPMENT SITUATION IN ROAD CONSTRUCTION CENTERS

	Total Number of Construction Equipment	No. of Unusable Equipment (Unit)	No. of Usable Equipment (Unit)	Description of Usable Equipment			Annual Budget (Million Baht)		Annual Road Construction Length (Km)	
				DOH	JAPAN	Borrowed	Amount	Per One Equipment	Total Length	Per One Equipment
Surat Thani	287	192(66.9)	95(33.1)	38	32	25	223.6	2.35	155.4	1.64
Song Khla	189	124(65.6)	65(34.4)	54	3	8	165.3	2.54	51.3	0.79
Six Road Construction Centers	1,752	223(12.8)	1529(87.2)	-	-	-	1,049.8	0.69	729.0	0.48
Eight Road Construction Centers	2,228	539(24.3)	1689(75.7)	-	-	-	1,438.7	0.86	935.7	0.56

1) Annual budget 1990
2) Annual road construction length on six Road Construction Centers were estimated from the actual result of Surat Thani Road Construction Center.
3) ( ) : %

Propriety of the Project

- The Project has the urgency and necessity to contribute to the construction of reliable transportation facilities.

- The beneficiary of the Project is the residents of Southern Thailand and beneficial population is many.

- The Project contributes to the improvement of income and living standard of the residents.

- In view of the present equipment management situation, the operation and maintenance of the Aid equipment can be managed properly by the present organization and technical level of Thailand.

- There will be no difficulty in implement the Project within the scope of Japan's Grant Aid program.

Socio-economic Impact

- To promote the regional socio-economic activities.

- To improve the living level of residents and contribute to the level up of income of residents.

- To facilitate the distribution of population and industries to rural sides.

- To contribute to the distribution and equalization of income.

- The area received the benefit directly and indirectly will cover 12 provinces with population of approximately 6.4 millions and land of about 61,400 square kilometers.

3.2.2 Study on Implementation Plan

The responsible organization of the Government of Thailand is the Department of Highways, Ministry of Transport and Communications. Surat Thani and Song Khla Road Construction Centers are executing organization for the implementation of the Project directly. The proposed equipment are provided to both Centers and utilized for the road construction under the direct control of the Center.

Tables 3.2-2 and 3.2-3 show the budget of past five years, the length of annual road construction and the number of equipment of both Centers.

From the Tables, the results of road construction in 1990 by both Centers are as follows.

Surat Thani Center

- Number of usable equipment	95 unit	
- Annual budget	223.6 mill. Baht	2.35 mill. Baht/unit
- Length of annual road construction	155.4 km	1.64 km/unit

Song Khla Center

- Number of usable equipment	65 unit	
- Annual budget	165.2 mill. Baht	2.54 mill. Baht/unit
- Length of annual road construction	51.3 km	0.79 km/unit

Regarding the above situation, when providing only the Rank A equipment (34 unit for Surat Thani Center and 24 unit for Song Khla Center) which are

nearly half of the number of requested equipment, the necessary budget is assumed as follows.

Necessary budget of Surat Thani Center:
2.35 x (95 + 34) = 303.2 million Baht

Necessary budget of Song Khla Center:
2.54 x (65 + 24) = 226.1 million Baht

Annual budget in 1991 of Surat Thani Center is 311.5 million Baht, and Song Khla Center is 222.3 million Baht. These amounts are almost same as the above assumed necessary budget.

Therefore, when providing the Rank A equipment and the road construction plan is in the same level of 1990, the increase of much amount of budget is considered to be not necessary.

The organization and personnel to receive the Proposed equipment are mentioned in Clause 3.3.1.

Table 3.2-2 BUDGET, ROAD CONSTRUCTION LENGTH AND NO. OF EQUIPMENT
SURAT THANI ROAD CONSTRUCTION CENTER

	1987	1988	1989	1990	1991
Annual budget (million Baht)	129.3	163.7	208.8	223.6	311.5
Annual road construction length (km)	62.5	59.6	134.6	155.4	-
No. of usable construction equipment (unit)				95 1)	-
No. of required construction equipment (unit)				-	34 2)

1) DOH : 38, Japan Grant's Aid : 32, Borrowed : 25
2) Rank A : 34

Table 3.2-3 BUDGET, ROAD CONSTRUCTION LENGTH AND NO. OF EQUIPMENT, SONG KHLA ROAD CONSTRUCTION CENTER

	1987	1988	1989	1990	1991
Annual budget (million Baht)	90.1	82.5	105.2	165.2	222.3
Annual road construction length (km)	41.4	15.7	36.7	51.3	-
No. of usable construction equipment (unit)				1) 65	-
No. of required construction equipment (unit)				-	2) 24

1) DOH : 54, Japan's Grant Aid : 3, Borrowed : 8
2) Rank A : 24

3.2.3 Review of Other Related Projects

In Southern Thailand, following other two projects are now being planned and executed. However, the Project aims at providing the equipment for rural road construction under Surat Thani and Song Khla Road Construction Centers. Therefore, the other two projects are not directly related to the Project.

(1) Road development study in the Southern region

This study was conducted by JICA in 1990. The object of the study is:
- Preparation of the master plan of road development project in the Southern region in 1996, 2001 and 2006.
- Study of Krabi - Khanom road.
- Study of high priority roads.

(2) Southern seaboard development programme (SSDP)

This is fully described in the Sixth National Economic and Social Development Plan, 1987-1991.

3.2.4 Review of Content of the Requested Equipment

Table 3.2-4 shows the list of the equipment requested by the Government of the Kingdom of Thailand. The detailed lists are attached with Appendix-5.

The requested equipment are for road construction works as shown below and the equipment which are presently short in both Centers. The supplement of these equipment is considered to be indispensable for the improvement of the equipment capacity of both Centers.

- Earth Moving Equipment	28
- Earth Excavator	8
- Earth Solidifying Equipment	13
- Earth Transportation Equipment	25
- Pavement Equipment	12
- Material/Equipment Transportation Equipment	32
- Multiple Purpose Equipment	19
- Inspection Car/Micro Bus	17
Total	154

It is considered that the supplement of inspection car and micro bus needed for supervising of construction is not urgent compared with other equipment. Therefore, the supplement of inspection car and micro bus by the Government of Thailand is anticipated.

Table 3.2-4 LIST OF REQUESTED EQUIPMENT (1/2)

EQUIPMENT	SURAT THANI	SONG KHLA	TOTAL
1. EARTH MOVING EQUIPMENT			
1.1 Crawler Tractor (Bulldozer)	10	7	17
1.2 Wheel Loader	2	2	4
1.3 Tractor Shovel	0	0	0
1.4 Motor Grader	4	3	7
1.5 Motor Scraper	0	0	0
Sub Total (1)	16	12	28
2. EARTH EXCAVATOR			
2.1 Hydraulic Excavator	5	3	8
Sub Total (2)	5	3	8
3. EARTH SOLIDIFYING EQUIPMENT			
3.1 Self-Propelled Vibratory Roller	4	3	7
3.2 Macadum Roller	0	0	0
3.3 Tandem Roller	0	0	0
3.4 Rubber Tire Roller	4	2	6
3.5 Vibration Rammer	0	0	0
Sub Total (3)	8	5	13
4. EARTH TRANSPORTATION EQUIPMENT			
4.1 Dump Truck	15	10	25
Sub Total (4)	15	10	25
5. PAVEMENT EQUIPMENT			
5.1 Asphalt Finisher	0	0	0
5.2 Asphalt Plant	0	0	0
5.3 Asphalt Distributor	1	1	2
5.4 Pavement Cutter	2	2	4
5.5 Chip Spreader	0	2	2
5.6 Line Marker	2	2	4
Sub Total (5)	5	7	12