JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF SETTLEMENT AND REGIONAL DEVELOPMENT
THE REPUBLIC OF INDONESIA

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

FINAL REPORT

COMPONENT B: JATIBARANG MULTIPURPOSE DAM CONSTRUCTION

VOLUME V CONSTRUCTION PLANNING

AUGUST 2000

CTI ENGINEERING INTERNATIONAL CO., LTD.
IN ASSOCIATION WITH
PACIFIC CONSULTANTS INTERNATIONAL
AND
PASCO INTERNATIONAL INC.

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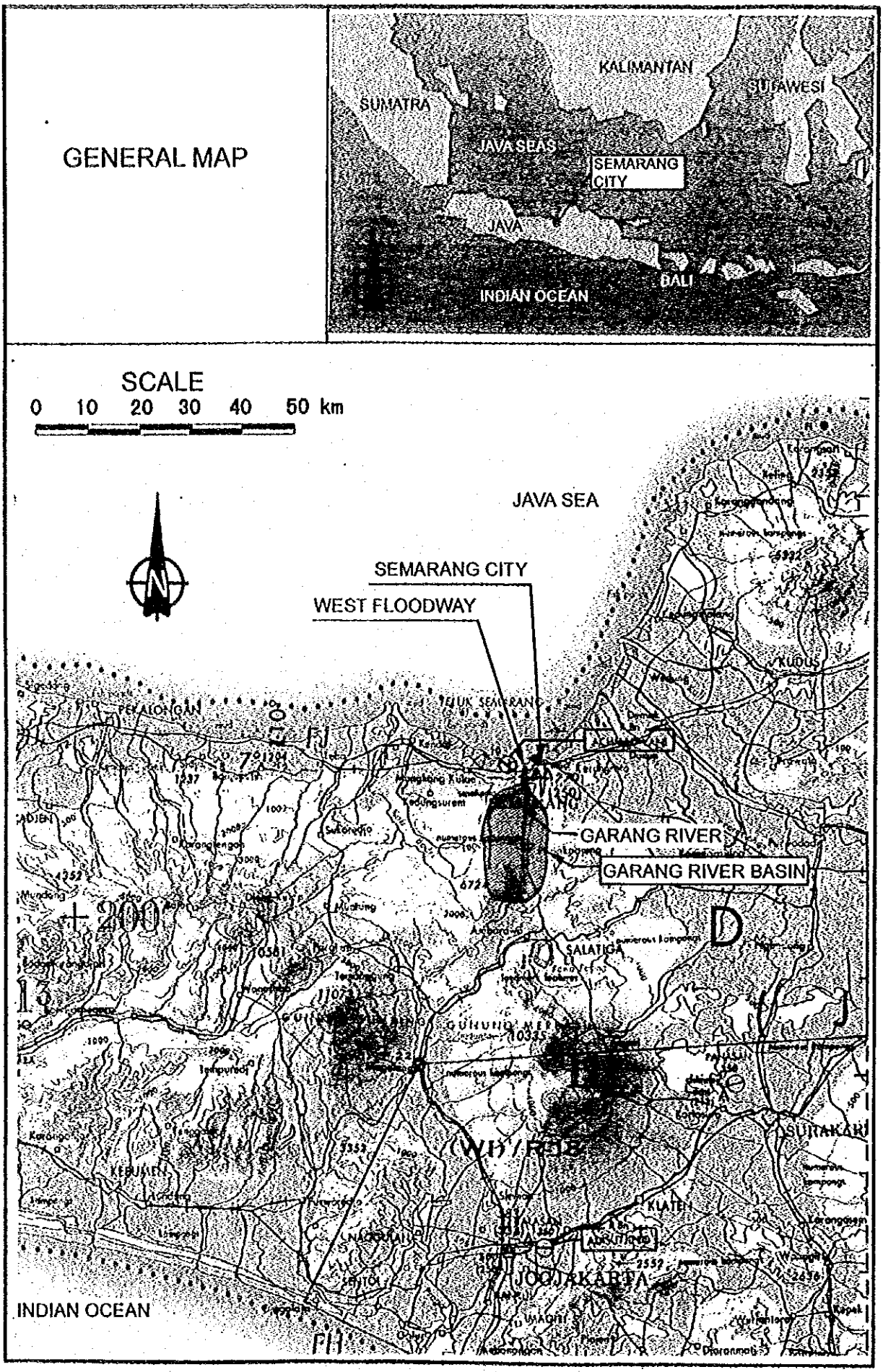
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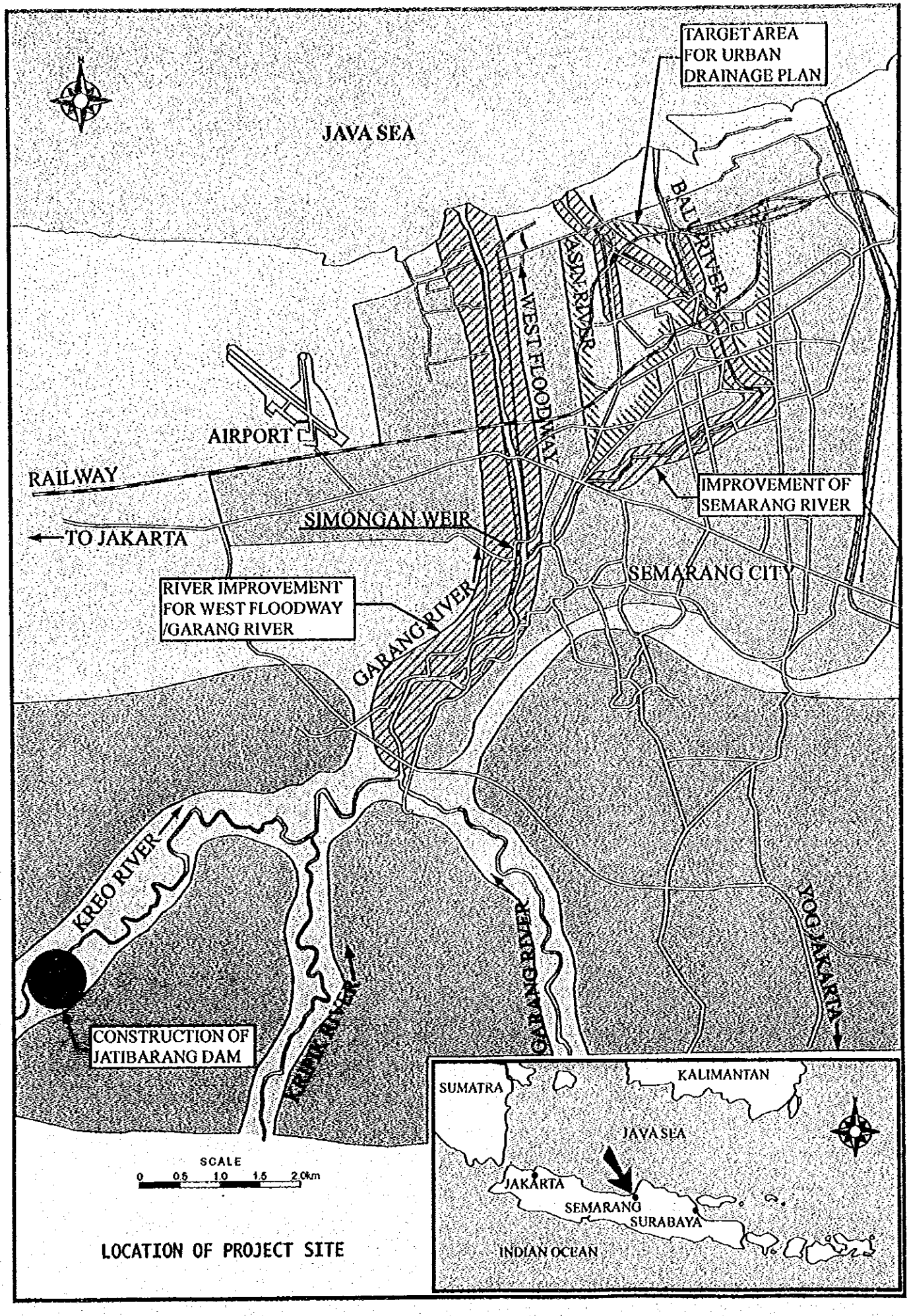

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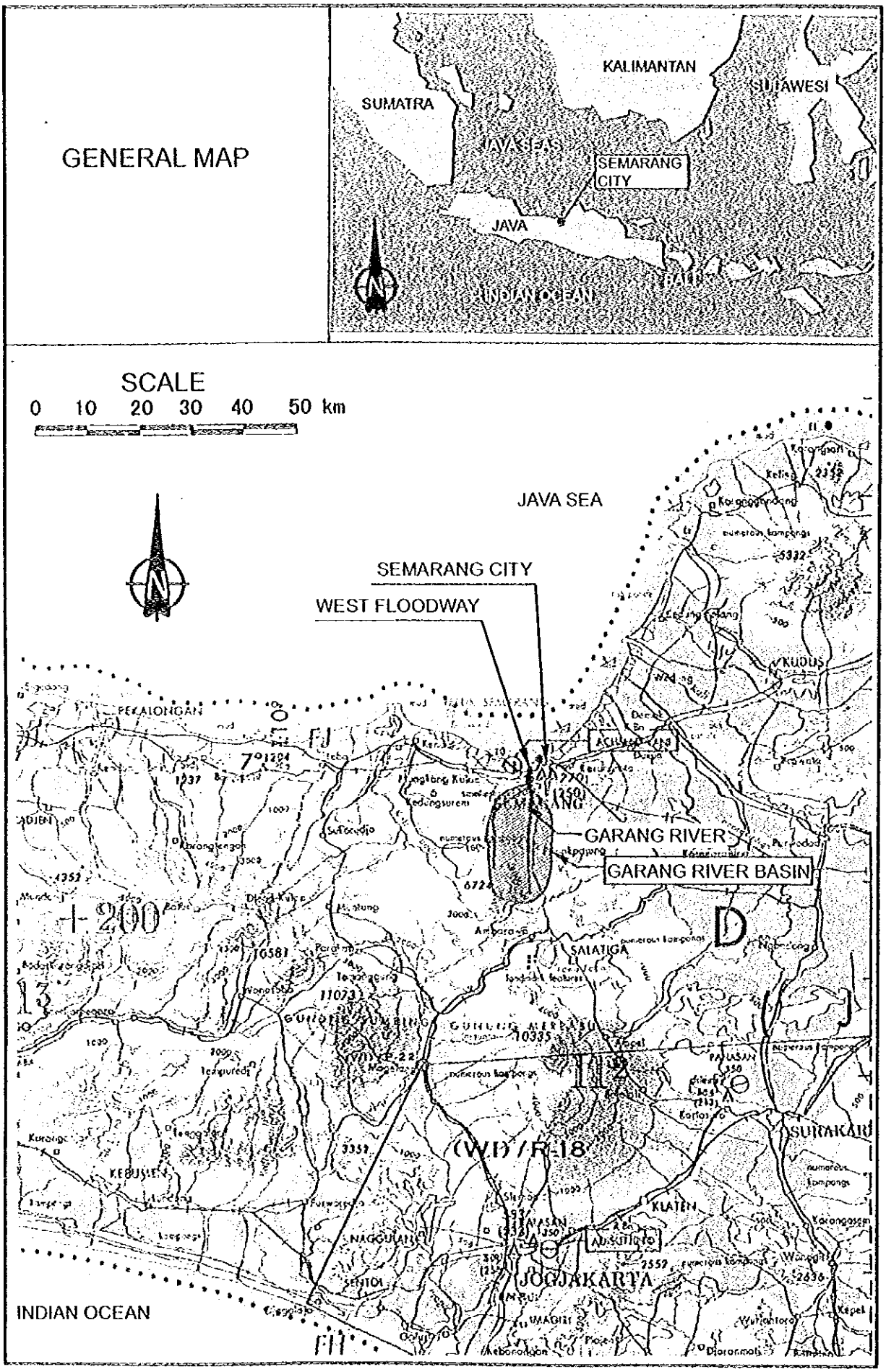
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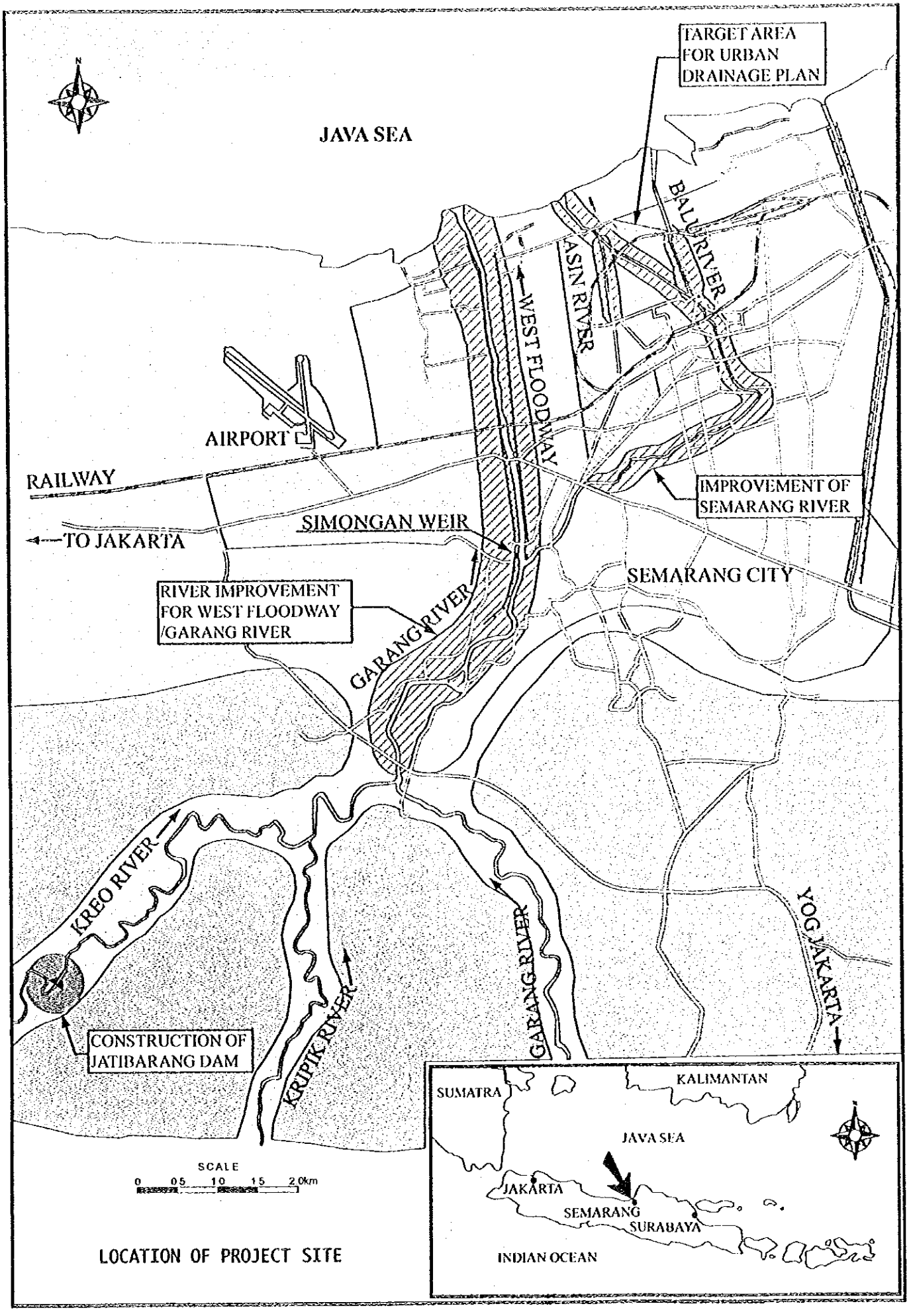

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VOLUME V CONSTRUCTION PLANNING

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TERMS AND ABBREVIATIONS

1. INDONESIAN GOVERNMENT AGENCIES AND ORGANIZATIONS

GOI	:	Government of Indonesia
BAPPENAS	:	Badan Perencanaan Pembangunan National (National Development Planning Board)
BAPPEDA	:	Badan Perencanaan Pembangunan Daerah (Provincial Development Planning Board)
BINAMARGA	:	Directorate General of Road and Bridge, Ministry of Public Works
BAPEDAL	:	Badan Pengendalian Dampak Lingkungan (Environmental Impact Assessement Board)
BPN	:	Badan Pertanahan Nasional (National Land Agency)
BPP	:	Balai Penyuluhan Pertanian (Agricultural Extension Center)
DPU	:	Departemen Pekerjaan Umum (Ministry of Public Works)
DGWRD	:	Directorate General of Water Resources Development, Ministry of Public Works
DGCK	:	Directorate General of Cipta Karya (Housing, Building and Urban Development, Ministry of Public Works)
DGRD	:	Directorate General of Research and Development, Ministry of Public Works)
DOR	:	Directorate of Rivers
DPUP	:	Dinas Pekerjaan Umum Propinsi (Provincial Public Works Services)
IHE	:	Institute of Hydraulic Engineering (Bandung)
PJKA	:	Perusahaan Jawatan Kereta Api (Railway Company, Old Name)
PERUMKA	:	Perusahaan Umum Kereta Api (Indonesian Railway Public Corporation, New Name)
PDAM	:	Perusahaan Daerah Air Minum (Water Works Company)
PMG	:	Pusat Meteorologi dan Geofisika (Center of Meteorology and Geographysics)
PLN	:	Perusahaan Listrik Negara (State Electricity Corporation)
P3SA	:	Proyek Pengembangan dan Penyelidikan Sumber-Sumber Air (Water Resources Development and Investigation Project)

2. JAPANESE GOVERNMENT / INTERNATIONAL ORGANIZATIONS

GOJ	:	Government of Japan
JICA	:	Japan International Cooperation Agency
MOC	:	Ministry of Construction, Japan
JEM	:	Japan Electric Machine Industry

ADB	:	Asian Development Bank
IBRD	:	International Bank for Reconstruction and Development (World Bank)
UNDP	:	United Nations Development Program
WMO	:	World Meteorological Organization
ASTM	:	American Society for Testing and Materials
ASME	:	American Society of Mechanical Engineer
USASI	:	United States of America Standards
IEC	:	International Electrotechnical Committee
NEMA	:	National Electrical Manufacturers Association

3. MEASUREMENT UNITS

(Length)			(Weight)		
mm	:	millimeter(s)	g, gr	:	gram(s)
cm	:	centimeter(s)	kg	:	kilogram(s)
m	:	meter(s)	t, ton	:	tonnage (s)
km	:	kilometer(s)			
(Area)			**(Time)**		
mm^2	:	square millimeter(s)	sec., s	:	second(s)
cm^2	:	square centimeter(s)	min	:	minute(s)
m^2	:	square meter(s)	h (hrs)	:	hour(s)
km^2	:	square kilometer(s)	d (dys)	:	day(s)
ha(has)	:	hectare(s)	y, yr(yrs)	:	year(s)
(Volume)			**(Discharge)**		
cm^3	:	cubic centimeter(s)	l, ltr	:	liter(s)
m^3	:	cubic meter(s)	EL., El.	:	Elevation

(Combined Units)

Speed/Velocity

cm/sec, cm/s	:	centimeter per second
m/sec, m/s	:	meter per second
km/hr, km/h	:	kilometer per hour

Stress

kgf/cm^2	:	kilogram per square centimeter
tf/m^2	:	ton per square meter
N/mm^2	:	newton per square millimeter
Mpa	:	mega pascal

Discharge

ltr/sec, l/s	:	liter per second
m^3/sec, m^3/s	:	cubic meter per second
m^3/yr, m^3/y	:	cubic meter per year

(Note : Other combined units may be constructed similarly as above)

Electricity

MW	:	megawatt	GW	:	gegawatt
MWh	:	megawatt hour	GWh	:	gegawatt hour
kV	:	kilovolt			

4. MONETARY TERMS

¥	:	Japanese Yen
US$	:	United States Dollar
Rp.	:	Indonesian Rupiah

5. INDONESIAN TERMS

JKT	:	Jakarta
Jawa	:	Java
Propinsi	:	Province
Kabupaten, Kab.	:	District (Regency)
Kotamadya, Kodya	:	Municipality
Kecamatan, Kec.	:	Sub-District
Desa	:	Village (Rural Area)
Kampung, Kp.	:	Village (Rural Area)
Kelurahan	:	Village (Urban Area)
Kali, Sungai	:	River
Gunung	:	Mountain
Rawa	:	Swamp
Danau	:	Lake
Laut	:	Sea
PT.	:	Incorporated or Limited
PPT	:	Panitia Pembebasan Tanah (Land Acquisition Committee)
KOMPUS	:	Komisi Pusat (Central Committee for Environmental Impact Assessment)
KA-ANDAL	:	Terms of Reference of Environmental Impact Statement
ANDAL	:	Environmental Impact Statement
RKL	:	Environmental Management Plan

RPL	:	Environmental Monitoring Plan
AMDAL	:	Environmental Impact Assessment
BPPM2	:	Semarang Port Bench Mark
SPB	:	Semarang Peil Baru (New Semarang Level)
TTG	:	Tanda Tinggi Geodesi (National Bench Mark)

6. OTHERS

JRATUNSELUNA PROJECT : Water Resources Development Projects for Jragung, Tuntang, Serang, Lusi and Juwana Rivers

SSUDP	:	Semarang and Surakarta Urban Development Program
IUIDP	:	Integrated Urban Infrastructures Development Program
SWL	:	Surcharge Water Level
DFWL	:	Design Flood Water Level
PMP	:	Probable Maximum Precipitation
PMF	:	Probable Maximum Flood
EIRR	:	Economic Internal Rate of Return
JIS	:	Japanese Industrial Standard
USASI	:	United States of America Standards
SWR	:	Shadow Wage Rate
CIF	:	Cost, Insurance and Freight
VAT	:	Value Added Tax.

CHAPTER 1 GENERAL

1.1 Summary of Construction Works

Jatibarang Multipurpose Dam is constructed for flood control, water supply and hydropower generation purposes. The damsite is located on the middle reaches of Kreo River, about 13 km upstream from the confluence of the main stream of Garang River and about 23 km upstream from the river mouth. The dam is constructed in a deep V-shaped gorge of which riverbed width is approximately 15 m at EL. 90.0 m.

Zoned Rockfill Dam is proposed as the best type of Jatibarang Multipurpose Dam and the spillway, gallery, outlet facilities and diversion tunnel are designed as the main appurtenant structures. The work quantities for the main work items are summarized below:

Work Item	Work Quantity
Dam Excavation	174,000 m³
Spillway Excavation	453,500 m³
Foundation Treatment	20,200 m
a) Blanket Grouting	2,000 m
b) Curtain Grouting	16,200 m
Dam Embankment	802,000 m³
a) Impervious Zone	119,000 m³
b) Semi-pervious Zone	82,000 m³
c) Inner Pervious Zone	96,000 m³
d) Outer Pervious Zone	505,000 m³
Concrete Works	57,000 m³
a) Spillway	52,000 m³
b) Outlet Facilities	2,300 m³
c) Gallery	5,700 m³
Tunnel for Outlet Facilities	393 m
Diversion Tunnel	441 m

1.2 Geological Condition

The base rock of the damsite consists of two strata of pyroclastic rock units and three strata of sedimentary rock units, which are evaluated as soft rocks. The design shear strength of lower pyroclastic rock unit (CM-H) distributed at the riverbed was expected to be only 50 tf/m².

CHAPTER 2 PREPARATORY WORKS

Preparatory works such as mobilization of construction equipment, plants and materials, electric power and water supply facilities, lighting facilities, communication facilities, temporary material storage yards, blending areas, and a concrete plant, a motor pool, a repair shop and temporary field buildings shall be prepared near the construction site prior to the commencement of the permanent works. An aggregate plant is constructed near the rock quarry where is located at Mt. Mergi, about 17 km southeast of the damsite.

The detail of a concrete plant and an aggregate plant including the operation of quarry are described in Chapter 8.

2.1 Temporary Construction Roads

Routes of construction roads shall be selected to ensure the most economic transportation routes considering the hauling distance, traveling speed and surface condition as well as traffic safety. Since both the left and right abutments of the dam are very steep, to construct approach roads to the riverbed of the damsite will take much cost. The routes connecting excavation areas, disposal areas, material sources and temporary facilities are planned as shown in Fig. 2.1.1. The following table shows the dimensions of the temporary construction roads at the damsite:

RouteNo.	Location	Destination	Distance (m)	Width (m)	Gradient (max.%)	Remarks
R – 1	Right Bank Main Road	Public Road Powerhouse	2,345	4	10	Bridge
R – 2	Right Bank Dam Crest	Dam EL.157m	207	4	0.3	
L – 1	Left Bank Main Road	Spillway	858	4	10	
US – 1	Upstream Side Road	L-1 EL.172	1,260	5	10	Bridge *
US – 2	Upstream Side Road	Spillway EL.145	740	5	10	
US – 3	Upstream Side Road	U/s Cofferdam Crest	600	3 - 5	5	
DT – 1	Diversion Tunnel Inlet	EL.125	90	5	10	
DT – 2	Diversion Tunnel Inlet	EL.100	430	5	10	
DA – 1	Right Bank Dam	EL.145	170	5	10	
DA – 2	Left Bank Dam	EL.135	310	5	10	
IT – 1	Intake Inlet	EL.111	120	5	2	
DS – 1	Downstream Side Road	EL. 85	550	5	10	Bridge *
SW – 1	Spillway EL.145	Disposal Area 2-B EL.153	340	3	10	
SW – 2	Spillway EL.125	Disposal Area 2-A EL.140	270	3	3	
RB – 1	U/Stream River bed	EL.110-EL.90	160	5	10	
RB – 2	River bed	EL.90-EL.83	390	7	5	
PB – 1	Pedestrian Bridge	EL.170-EL.145	240	3	10	
Total			9,080			

Note *: Temporary bridge shall be provided to cross Kreo River.

The route connecting the rock quarry and damsite are planned as shown in Fig. 2.1.2 and the distance is calculated as shown below:

Route	Public Road or Temporary ConstructionRoad	Distance (m)
Quarry - G	Partly public road and partly temporary construction road	4,600
G - F	Public road	9,000
F - E	Public road	8,000
E - H	Public road	5,400
H - H-1	Temporary construction road (to dam right abutment)	800
H-1 - Dam	Temporary construction road (Average Distance of Right/Left Approach)	1,700
Total		29,500

2.2 Disposal Areas

The total waste volume extracted from the required excavation for the construction of the dam, spillway, outlet facilities and other appurtenant structures are estimated to be as much as 820,000 m^3 including the excavation volume for the construction road in bank condition. Unsuitable materials removed from the rock quarry shall be disposed of at a disposal area near the quarry, of which volume amounts to approximately 250,000 m^3 in bank condition.

Several disposal bank areas with adequate capacity to accommodate the waste materials shall be prepared taking account of hauling distance and topographic features. The following table shows the capacities and Fig 2.1.1 shows locations of the proposed disposal areas, other temporary yards and construction roads:

Capacity of Disposal Areas at Damsite

Area No.	Location	Area (m^2)	Capacity (m^3)
Disposal Area			
DA – 1	Upstream of Dam, EL.165m	57,600	316,700
DA – 2	Downstream Left Bank of Dam, EL.153m	26,700	133,700
DA – 3	Right Bank of Dam, EL.177m	26,000	194,400
Sub Total	Disposal Areas at Dam Site		644,800
Use for Dam Embankment Cofferdam, Yard and Construction Road			
Dam Embankment	Dam Embankment from Required Excavation	-	100,000
Cofferdam	Upstream Coffer Dam, EL.113m	2,000	20,000
	Downtream Coffer Dam, EL. 87m	700	3,000
TY – 1	Plant, StockYard at Upstream Right Bank	40,000	92,600
R – 1	Right Bank Main Road, l=2,400m, w=10m, t=0.5m	24,000	12,000
L – 1	Left Bank Main Road, l=800m, w=10m, t=0.5m	8,000	4,000
RB – 1	Up/S of River Bed access Road, l=300m, w= 5m,	6,200	56,000
Sub-Total	Temporary Yard and Road		287,600
Total in fill volume	Damsite		932,400
Total in bank volume	Damsite, assuming Conversion Fcator C = 1.1		847,600
			820,000

In respect of the construction roads listed above, the waste materials from the required excavation, if suitable for the sub-grade, will be used.

All disposal areas and other temporary yards shall be cleared and grubbed prior to disposing work. An under-drainage system along a valley, sodding for slope protection and surface drainage shall be provided for total stability of disposal areas. DA-1 is exclusively used to dispose the waste materials from the spillway excavation. The slope gradient in the disposal areas shall be gentler than 1.0 vertical to 3.0 horizontal, but the slope facing the reservoir shall be gentler than one 1.0 vertical to 5.0 horizontal considering the influence of the fluctuation of reservoir water level.

2.3 Temporary Facilities

Temporary facilities such as contractor's offices, stuff's quarters, labourer's of quarters, motor pool, warehouses, carpenter's house and so on are prepared at the dam site area. Yards for these facilities are constructed in the upstream side of the dam which becomes reservoir area. Motor pool yard and ordinary facility's yard is constructed at EL.125.0 m and batcher plant yard at EL.130.0 m. In consideration of embankment schedule, the disposal area DA-1 is used as blending yard of impervious material and semi-pervious material.

The capacity and number of the equipment for preparatory works are as below.

- Backhoe	:	0.35 m^3	x 5 units
- Dump Truck	:	10 t	x 10 units
- Bulldozer	:	15 t	x 2 units
- Bulldozer	:	21 t	x 3 units
- Bulldozer	:	32 t	x 1 unit
- Giant Breaker	:	600/800 kg	x 1 unit
- Tamper	:	60/100 kg	x 3 units
- Vibrating Roller	:	10 t	x 1 unit
- Generator	:	5 kVA	x 2 units
- Generator	:	60 kVA	x 2 units
- Generator	:	125 kVA	x 1 unit
- Crawler Crane	:	50 t	x 1 unit
- Truck Crane	:	20 t	x 2 units
- Truck with Crane	:	6 t	x 2 unit

CHAPTER 3 DIVERSION WORKS

Diversion works consist of the diversion tunnel and the inlet facilities. In consideration of topographical conditions and the construction schedule, the diversion tunnel portion will be commenced first and the inlet portion follows. A river diversion will be carried out at the beginning of the second year dry season after completion of the Inlet facilities.

3.1 Diversion Tunnel

Diversion tunnel is located at the left bank of the damsite with total length of about 441 m, hose shoe section of the internal diameter of 5.60 m and longitudinal gradient of the tunnel is 1/30.

3.1.1 Preparatory Works

Considering the layout and the longitudinal gradient of the diversion tunnel, excavation works will be carried out from the downstream side to the upstream side. Before the commencement of the excavation works, an access road with temporary bridge reaching to the downstream entrance should be constructed in order to the mobilization of the tunnel equipment and hauling of the excavated materials.

For the access to the power station site at EL. 97.0 m, a permanent access road R-1 will be constructed and a temporary access road DS-1 is branched from R-1 to access the downstream side of the tunnel. (refer to Fig. 2.1.1)

After construction of a temporary entrance of the diversion tunnel, excavation works will be commenced.

3.1.2 Excavation Works

In consideration of geological condition and a size of the diversion tunnel section, a procedure of excavation will be divided into upper-half section and lower-half section.

Excavation for upper-half section is commenced first from the downstream side by a load header and load haul dump trucks. After the completion of the upper-half section excavation for the whole length of the tunnel, the lower-half section excavation works follows by the same combined equipment as the upper-half section. Progress of 1 cycle of excavation works is 1.0 m at the upper-half section and 2.0 m at the lower-half section respectively. Excavated material which is hauled out by load haul dump trucks is dumped and stocked at temporary stock yard.

Stocked material loaded by backhoe 0.60 m³ to dump truck 10 t at temporary stock yard is hauled to the disposal area DA-1 or DA-3 through DS-1 and R-1.

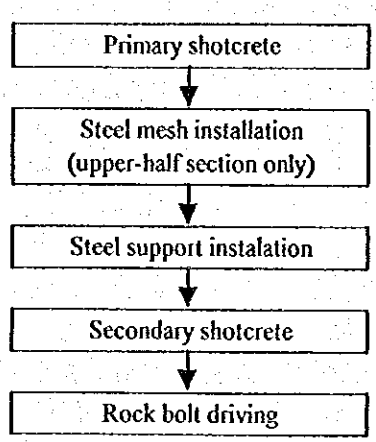
A generator for the load header will be applied in order to prevent a trouble of electric interruption of a main generator.

The capacity and number of the equipment for tunnel excavation work are as below.

- Load Header	:	90 kW	x 1 unit
- Load Haul Dump Truck	:	1.7 m³	x 3 units
- Backhoe	:	0.60 m³	x 1 unit
- Dump Truck	:	10 t	x 2 units
- Ventilator	:	150 m³/min	x 1 unit
- Submersible Pump	:	150 mm	x 2 units
- Generator	:	150 kVA	x 1 unit

3.1.3 Supporting Works

Procedure of supporting work of the diversion tunnel is shown in below.



Considering the tunnel length and shotcrete volume, a dry type shotcrete machine is applied to the diversion tunnel and installed at the downstream side. Shotcrete carried out by a shotcrete robot to keep high working efficiency and safety.

Steel mesh is installed between a primary shotcrete and a secondary shotcrete by using the drill-jumbo for staging. Steel supports of H-beam (H-125x125x6.5x9) installation works and secondary shotcrete works follows.

After completion of a secondary shotcrete work, rock bolt driving work is commenced. Rock bolt is made of deformed bar (D 25) of 3.0 m long. Drilling of rock bolt holes and driving of

rock bolts are carried out by drill-jumbo. Cycle time of supporting and excavation works is shown in Table 3.1.1.

The capacity and number of the equipment for supporting work are as below.

- Shotcrete Machine	:	15 kW	x 1 unit
- Shotcrete Robot	:	5.5 kW	x 1 unit
- Concrete Mixer	:	15 m³/h	x 1 unit
- 2 Boom Drill Jumbo	:	20 t	x 1 unit
- Ventilator	:	150 m³/min	x 1 unit
- Submersible Pump	:	150 mm	x 2 units
- Concrete Transfer	:	1.7 m³	x 1 unit

3.1.4 Concrete Lining Works

After completion of the excavation work with supporting, invert concrete lining work is commenced from downstream side and arch-sidewall concrete lining work follows.

Concrete placing length of one cycle is 18 m for the invert lining and 9 m for the arch-sidewall lining and carried out by concrete pump which sets nearly at the upstream entrance.

The capacity and number of the equipment for concrete lining work are as below.

- Slide Centre	:	9 m	x 1 unit
- Concrete Pump	:	40 m³/h	x 1 unit
- Agitator Truck	:	4.5 m³	x 2 units
- Truck with Crane	:	4 t	x 1 unit
- Ventilator	:	150 m³/min	x 1 unit
- Air compressor	:	7.5 m³/min	x 1 unit
- Submersible Pump	:	150 mm	x 2 units

3.2 Diversion Inlet Facilities

3.2.1 Preparatory Works

Access road DT-1 will be constructed to have access to the upper portion of the diversion inlet from the temporary access road US-2, and excavation of the inlet facilities is commenced. Excavated material will be dumped to the riverbed directly by backhoe 0.35m³ or 0.60 m³ and hauled out to the disposal area DA-1 through the temporary access road DT-2 which is to be constructed at the left side of the river bed area.

3.2.2 Structural Excavation and Concrete Works

After the construction of the temporary coffering made by earthfill, structural excavation works will be commenced. A combination of the backhoe 0.35m³ and a giant breaker is applied to the excavation in the inlet considering the geological condition and excavated material is hauled out by dump trucks 10t through the temporary access road DT-2.

Concrete is placed up to the elevation higher than the estimated flood water level before the commencement of the diversion tunnel concrete work and the remained concrete placing will be completed before the river diversion. Concrete placing works are carried out by a combination of a concrete pump, chute and/or bucket to match working conditions.

The capacity and number of the equipment for Diversion Inlet work are as below.

-Backhoe	:	0.35 m³	x 1 unit
-Backhoe	:	0.60 m³	x 1 unit
-Bulldozer	:	21 t	x 1 unit
- Bulldozer	:	32 t	x 1 unit
-Giant Breaker	:	600/800kg	x 1 unit
-Dump truck	:	10 t	x 3 units
-Agitator Truck	:	4.5 m³	x 3 units
-Concrete Pump	:	40 m³/h	x 1 unit
-Truck with Crane	:	4 t	x 1 unit
-Submersible Pump	:	200 mm	x 4 units
-Submersible Pump	:	150 mm	x 4 units
-Generator	:	150 kVA	x 1 unit

3.3 Temporary Cofferdam

Upstream and downstream cofferdams are constructed for the river diversion. Preparation work of sufficient stockpiling of embankment material is important as well as the decision of river diversion execution date.

3.3.1 Upstream Temporary Cofferdam

Upstream cofferdam is designed by earthfill type and embanked up to the EL. 113.0 m. Before the river diversion, excavated material from construction of the temporary access road US-3 is stocked at the sandbar of right bank and excavated material from the ridge which is excavated and gathered by bulldozer 21 t ~ 32 t class is stocked at the upper area of the diversion point of

the left bank. After the river diversion, the embankment material for cofferdam is hauled into the site from the disposal area SA-1.

3.3.2 Downstream Temporary Cofferdam

After confirmation of the diverted water through the diversion tunnel, the construction of the downstream temporary cofferdam is commenced by earthfill type. Selected riverbed deposit material is used for embankment first and excavated material from the main dam excavation works used.

The capacity and number of the equipment for the cofferdam works are as below.

- Backhoe	:	0. 35 m³	x 1 units
- Backhoe	:	0. 60 m³	x 1 units
- Bulldozer	:	21 t	x 2 units
- Bulldozer	:	32 t	x 2 units
- Dump truck	:	10 t	x 4 units

3.4 Dewatering Works

After completion of the construction of both sides of cofferdams, dewatering works are commenced. Dewatering works in this project is very important because the closed length between both cofferdams becomes almost 700 m, and the amount of ground water which come out of the site will be big. Therefore, enough numbers of pumps are installed for the dewatering system.

The capacity and number of the equipment for the dewatering works are as below.

- Submersible Pump	:	200 mm	x 6 units
- Submersible Pump	:	150 mm	x 4 units
- Turbine Pump	:	150 mm	x 2 units
- Water Tank	:	1.0 m³	x 1 units
- Generator	:	150 kVA	x 2 units

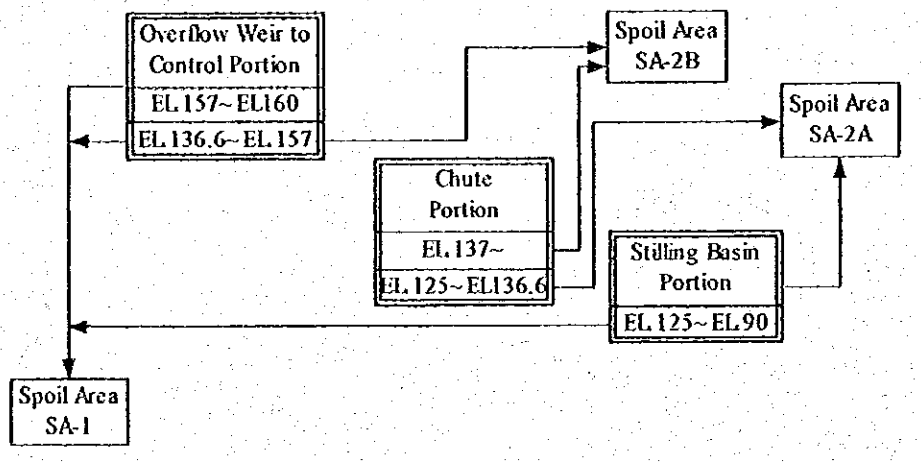
CHAPTER 4 SPILLWAY

Spillway consists of five (5) portions as the overflow weir, the side channel and the control portion, the chute portion and the stilling basin portion. The construction schedule of each portion of the spillway has tight relationship with another. Construction schedule of the main dam excavation and the concrete placing of the gallery is closely related with the overflow weir and the control portion. The main dam embankment schedule is also closely related to the chute portion, concrete placing of the powerhouse and the main dam embankment schedule has a relation with the stilling basin portion each. It is very important to adjust these construction schedules by considering the whole construction schedule.

4.1 Excavation Works

In working sites which have enough space for heavy equipment operation, excavation and loading works are carried out by bulldozer 32 t and backhoe 0.6 m³ class basically. In narrow areas, excavation and loading works are mainly carried out by backhoe 0.35 m³ class and bulldozer is regarded as an assist equipment of excavation works. Dump truck 10 t class is applied to the hauling work by ground conditions. In case of excavation by ripping of bulldozer at hard rock areas, blasting method is employed under the carefully operation.

Procedure of the spillway excavation is shown below.



4.1.1 Excavation higher than EL.136.6 m

Estimated excavation volume higher than EL.136.6 m which is the bottom of the control portion foundation elevation, becomes about 250,000 m³. Excavated material higher than EL. 157.0 m is hauled to the disposal area DA-1 through the permanent road L-1, and temporary access road

US-1 which is branched from L-1. The most part of the excavated material between EL.136.6 m and EL.157.0 m is hauled to DA-1 also through the temporary access US-2 which is connected EL.145.0 m and US-1. The remain is hauled to DA-2 B through SW-1.

4.1.2 Excavation between EL. 125.0 ~ EL.136.6 m

Excavated material at the upper part of the chute portion is estimated about 52,000 m³ and hauled to the disposal area DA-2 A through the temporary access road SW-2 which is connected at EL. 125 m of the chute portion foundation.

4.1.3 Excavation below EL. 125.0 m

Excavated material below EL. 125.0 m becomes about 152,000 m³, dumped to the river bed directly and hauled to the disposal area DA-1 through the temporary access roads RB-1 and RB-2 which are constructed on the river bed. During the main dam embankment period, excavated material which meets the specification is hauled to the embankment area directly and others are hauled to SA-1 through temporary access road DS-1 and the permanent road L-1.

The capacity and number of the equipment for excavation work are as below.

- Backhoe	:	0.35 m³	x 1 units
- Backhoe	:	0.60 m³	x 5 units
- Bulldozer	:	21 t	x 3 units
- Bulldozer	:	32 t	x 2 unit
- Dump truck	:	10 t	x 16 units
- Crawler Drill	:	5 t	x 1 unit
- Air Compressor	:	20 m³/min	x 1 unit
- Giant Breaker	:	600/800 kg	x 1 units

4.2 Concrete Works

In principle, concrete placing work is carried out by concrete pump, but direct placing by agitator truck, bucket and chute placing are adopted in accordance with the placing conditions.

4.2.1 Control Portion

A part of the gallery crosses under the foundation structure of the spillway, the adjustment between both schedules is necessary and important. A concrete pump is set on the excavated foundation EL. 145.0 m and the most of the concrete placing of the control portion is carried out from this elevation.

Wall heights are very high in many blocks and steel forms are applied in order to keep high work efficiency. Sliding of forms and loading of reinforcement bars and others are carried out by truck crane 25 t.

4.2.2 Chute Portion

After the completion of the concrete placing for the most upstream side block of stilling basin, concrete placing for the chute portion is commenced. The slab concrete of both sidewalls are preceded first and invert concrete between the sidewall's slabs follows by using sliding form. Winch 21 kW class is set on the foundation of the control portion in order to lift up the sliding form. On the other hand, the heights of the sidewalls are not so high, so small forms are applied to and carrying forms and material are done by truck crane 25 t which is set on the dam embankment area basically. A concrete pump is set on the slab concrete of the control portion or on the main dam embankment area, and pipes for concrete placing are distributed.

4.2.3 Stilling Basin Portion

Two blocks of sidewalls of the stilling basin become a part of the powerhouse wall and the behinds of these walls are backfilled up to the EL.97.0 m. The coordination between these construction items is required. The height of the sidewall becomes 15.5 m, steel forms are applied to the upper portion of the concrete placing work.

The capacity and number of the equipment for concrete works at the spillway are as below.

- Concrete Pump	:	40 m^3/h	x 2 units
- Agitator Truck	:	4.5 m^3	x 3 units
- Winch	:	21 kW	x 1 unit
- Truck with Crane	:	4 t	x 2 units
- Generator	:	60 kvA	x 1 unit
- Ordinary Truck	:	10 t	x 1 unit
- Air Compressor	:	7.5 m^3/min	x 1 unit
- Truck Crane	:	25 t	x 2 units

4.3 Backfill Works

Behind a part of downstream sidewalls of the chute portion and the stilling basin walls, the excavated area is backfilled step by step up to EL. 97.0 m to match the concrete placing schedule. A temporary access road is prepared in order to the embankment of the main dam at the right bank side which the powerhouse is constructed. The tight coordination between the

schedules of the concrete placing for the powerhouse, the spillway and embankment the main dam is required. All material for backfill is selected under the specification, stocked in the disposal areas DA-1 and/or DA-3, and hauled into the backfill area through the permanent road R-1 and the temporary access road DS-1.

The capacity and number of the equipment for the backfill works are as below.

- Backhoe	:	0.60 m³	x 1 unit
- Dump Truck	:	10 t	x 4 units
- Bulldozer	:	21 t	x 1 unit
- Bulldozer	:	32 t	x 1 unit
- Vibrating Roller	:	10 t	x 2 units
- Tamper	:	60/100 kg	x 4 units

CHAPTER 5 MAIN DAM

The main dam construction works consist of many kind of works like excavation, foundation treatment by grouting, gallery construction and embankment. Moreover these work schedules are complex and the progress of the grouting work is very important. Therefore, grouting works for foundation treatment are described in this chapter, even though that is executed in the spillway also.

5.1 Procedure of Whole Works

The construction works of the dam are basically executed in the order of the followings in the form of series or in parallel.

(1) dam and gallery excavation works

(2) concreting works for gallery

(3) grouting works

(4) dam embankment works

5.2 Dam and Gallery Excavation

Excavation works of the main dam is commenced after the river diversion was completed at the early dry season of the second year. Following construction items which concern with the main dam occupy the most percentage of the critical path on the whole construction schedule of the Package-1.

Excavation works of the spillway have close relationship to the main dam excavation works. Concrete placing work of the gallery at the riverbed area, the stilling basin and the powerhouse are related to the main dam embankment works. Therefore, the dam construction planning is required to consider these relations.

A combination of equipment which consists of excavation and gathering by bulldozer 21 t ~ 32 t class, loading by backhoe 0.60 m^3 class and hauling by dump truck 10 t, is applied to the dam excavation works basically. In case of the excavation of sound rock, ripping work, crushing by giant breaker and/or blasting methods are adopted. Excavation by manpower with pick hammer is required in the finished stage to avoid damages to the rock foundation.

5.2.1 Right Bank Excavation

(1) Excavation higher than EL.145 m

The temporary access road DA-1 for the excavation work is constructed at EL. 145 m of the dam axis from EL.157.0 m of the top the intake structure. The combination of bulldozer 32 t, backhoe 0.60 m^3 and dump truck 10 t is applied basically to the excavation works down to EL. 145 m and excavated material is hauled to the disposal area DA-1 through the temporary access road DA-1 and the permanent roads R-2 and R-1.

(2) Excavation between EL.130 m ~ EL.145 m

Bulldozer 32 t class executes the excavation between EL.145 m and EL.130 m. A slope of the right bank becomes very steep below EL. 130 m. The excavated material is dropped to the river bed directly by backhoe 0.60 m^3 or 0.35 m^3. The droped material is loaded to dump truck 10 t by backhoe 0.60 m^3 at the river bed and hauled to the disposal areas DA-1 and/or DA-3 through the river bed temporary access roads RB-2, RB-1, US-3 and US-1.

(3) Excavation below EL.130 m

Same excavation methods mentioned above in sub-clause (2) are adopted. However between EL. 105 m and EL. 113 m, rock material classified CM-H is anticipated, so giant breaker and/or blasting will be required.

5.2.2 Left Bank Excavation

(1) Excavation higher than EL.145 m

Excavation higher than EL.145 m is included in the spillway excavation.

(2) Excavation between EL.125 m ~ EL.145 m

The temporary road DA-2 is constructed from EL.110 m to EL.125 m in parallel with the river course. Between EL.145 m and EL.125 m, bulldozers 32 t class are applied for excavation and gathering works, loading to dump trucks 10 t is done by backhoes 0.60 m^3. Excavated material is hauled to the disposal area DA-1 through the temporary access roads DA-2, US-2 and US-1.

(3) Excavation below EL.125 m

Since the slope of the left bank becomes steep below EL. 115 m, excavated material is droped down to the river bed directly by backhoe 0.60 m^3 or 0.35 m^3. Between EL. 105 m and EL. 118 m, rock material classified CM-H is anticipated same as the right bank, so giant breaker and/or blasting will be required. The droped material is loaded to dump trucks 10 t by backhoes 0.60 m^3 on the river bed and hauled to the disposal areas DA-1 and/or DA-3 through the river bed temporary access roads RB-2, RB-1, US-3 and US-1.

The capacity and number of the equipment for excavation are as below.

- Bulldozer	:	32	t	x	2	units
- Bulldozer	:	21	t	x	2	units
- Backhoe	:	0.60	m^3	x	5	units
- Giant Breaker	:	600/800	kg	x	2	units
- Dump Truck	:	10	t	x	14	units
- Motor Grader	:	2.8	m	x	2	units
- Vibrating Roller	:	10	t	x	2	units
- Water Truck	:	8	m^3	x	3	units

5.3 Gallery

The gallery consists of three portions by construction standpoint as the right abutment portion, the riverbed portion and the left abutment portion. Since the level section of the left bank upper portion is designed as a crossing structure under the spillway slab, this level section has priority over other portions in order to keep the spillway construction schedule. The riverbed portion of the gallery becomes critical path work prior to the dam embankment works, therefore concrete placing of this portion has the first priority together with the dam excavation works.

5.3.1 Excavation Works

Excavation of the gallery is executed at the same time with the dam excavation to keep better work efficiency from the upper portion to the lower portion. Careful operation of giant breaker and/or blasting shall be carried out in the finishing excavation stage, and if need manpower with pick hammer is applied to. Most of excavation areas lower than EL. 130 m, excavated material is dumped to riverbed directly, an arrangement between lower portion's working area and time is required. The surface of finishing excavation will be protected temporarily by shotcrete after getting the inspection of rock foundation and removed just before concrete placing.

5.3.2 Concrete Works

First, the level section of the left bank upper portion concrete placing is carried out to keep the spillway construction schedule. The riverbed section is followed after the completion of the excavation works and finally both abutments portion's concrete work are carried out from the lower section.

In the abutment portions of the gallery, different construction methods are adopted to the uniform gradient section and to the variation section each. In the uniform gradient section, invert concrete is placed with sliding form first and the arch and the side wall portions on which concrete is placed using sliding form follows. In the variation section, separated metal forms are used for the invert, the arch and the side wall portions in order to meet the complicated shape. Lifting up of sliding form is done by a winch which is installed on the berm.

Material, forms and reinforcement bars are loaded by truck crane 25 t. However, considering the steep working area and tight schedule, light cableway is prepared as subordinate facilities at where a truck crane can not operate with normal arm length.

Concrete is placed by concrete pump in principal, placing method with chute and bucket are adopted depending on the working conditions. During construction period at the riverbed area, enough numbers of drainage pumps are required.

The capacity and number of the equipment for the gallery works are as below.

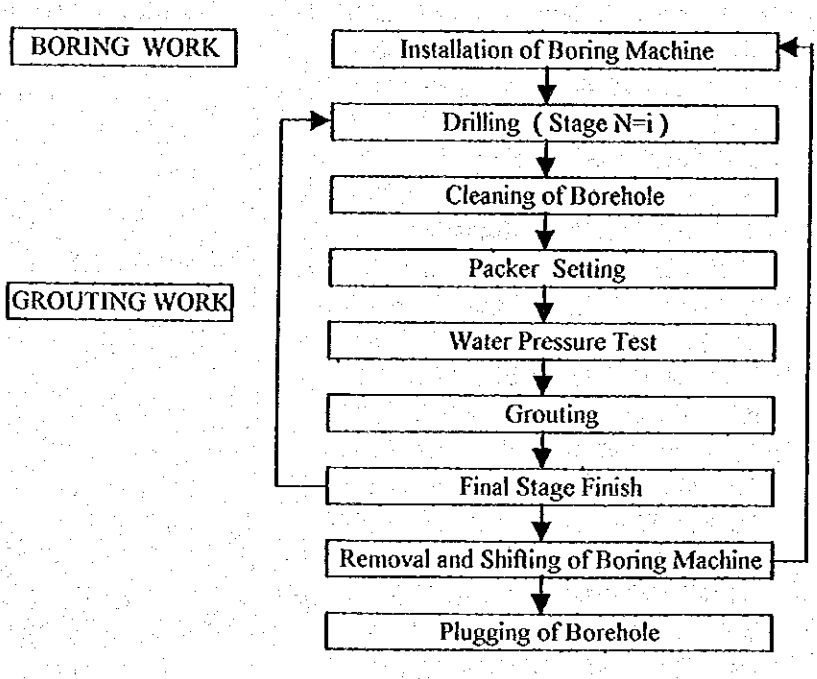
- Shotcrete Machine	:	10	m^3/h	x 1	units
- Truck with Crane	:	6	t	x 1	unit
- Winch	:	21	kW	x 2	units
- Truck Crane	:	25	t	x 1	unit
- Bucket	:	1.0	m^3	x 1	units
- Light Cableway	:	2.9	t	x 1	unit
- Slide Centre	:	6	m	x 2	units
- Slide Form	:	6	m	x 2	units
- Ordinary Truck	:	10	t	x 1	unit
- Concrete Pump	:	40	m^3/h	x 1	unit
- Agitator Truck	:	4.5	m^3	x 3	units
- Air Compressor	:	7.5	m^3/min	x 2	units
- Generator	:	125	kVA	x 2	unit

5.4 Grouting Works

Grouting works in this package consist of contact grouting, blanket grouting and curtain grouting in accordance with the purpose of grouting. Contact grouting is executed from the top elevation of spillway's slab concrete (EL.139.60 m) and around the inspection gallery. Blanket grouting is carried out at the bottom area of the impervious zone and curtain grouting is executed at the dam axis and the upstream end of the spillway.

5.4.1 Work Procedure

Contact grouting is carried out from structural concrete into the surrounding foundation. Blanket grouting is executed from the surface of the foundation at 10 m deep. Curtain grouting is performed at the inspection gallery with 5 m interval. The following diagram shows the work procedure for the stage grouting.



5.4.2 Drilling

Rotary boring machines are used and the diameter of boreholes are Ø 66 mm for pilot and check holes and ϕ 46 mm for normal holes. Work platform shall be provided at the abutments using scaffolding.

5.4.3 Grouting

Staged grouting method is adopted and the depth of each stage is 5 m. Mixing and delivery of the cement milk is performed and controlled in a central plant. In consideration of the site ground condition, the central plant for grouting is located at EL.160.0 m of the dam management complex construction yard during blanket grouting and curtain grouting at the left bank ridge. After the completion of the backfill up to EL.157.0 m behind the spillway, the central plant is removed here in order not to hamper the building works of the management complex and carried out the contact grouting for the side wall of the inspection gallery and curtain grouting for the slab of the gallery.

The capacity and number of the equipment for drilling and the grouting works are as below.

- Boring Machine	:	7.5	kW	x 7	units
- Grout Pump	:	95/200	l/min	x 3	units
- Grout Mixer	:	200 x 2	ltr	x 2	unit
- Grout Recorder	:			x 3	units
- Truck Crane	:	20	t	x 1	unit
- Truck with Crane	:	6	t	x 1	unit
- Ordinary Truck	:	10	t	x 1	unit
- Winch	:	11	kW	x 2	units

5.5 Dam Embankment

Embankment material of the outer pervious zone and the riprap is hauled directly from the rock quarry. Material of semi-pervious zone which is mixed under specified gradation is hauled from the aggregate plant installed near the quarry site. Since impervious material is required to mix the excavated material from the dam site with fine sand and gravel, a part of the disposal area DA-1 is used as a blending yard. Material of the inner pervious zone is accepted by hauling directly from the dam site and rock produced at quarry which meets the specifications.

Bank slopes on both sides are very steep at the dam site and the width of the river bed is as narrow as 20 m ~ 30 m. Therefore, two features described below are pointed out on the Jatibarang Multipurpose Dam.

① Embankment speed becomes very high at the lower portion until the middle portion of the dam body.

② Temporary hauling roads should be constructed on the embankment slope many times.

5.5.1 Embankment between River Bed ~ EL. 90 m

Embankment material is hauled into the site from the up and down stream sides through the riverbed temporary access roads RB-1 and RB-2.

5.5.2 Embankment between EL. 90 m ~ EL. 112 m

All material for embankment is hauled into the site from the downstream side only, because of the shortage of approach length of the temporary access roads from the upstream side. Raising up the downstream temporary access road is limited by the placed concrete of the powerhouse, an access road is constructed on the dam embankment slope at the latter half.

5.5.3 Embankment between EL. 112 m ~ EL. 118 m

The temporary access road IT-1 which connects EL.111.5 m of the intake structure can be used and construction of a temporary access road on the embankment slope at the upstream side follows. At the downstream side, a temporary access road constructed on the embankment slope described in Sub-Clause 7.2.2 is extended step by step until EL.118 m.

5.5.4 Embankment between EL. 118 m ~ EL. 125 m

Hauling length from the downstream side through the embankment slope becomes very long when it reaches to EL. 118 m. All embankment material is hauled into the site from the upstream side higher than EL.118 m and a hauling road on the slope is extended to EL.125 m.

5.5.5 Embankment EL. 125 m ~ EL. 145 m

The temporary access road DA-2 constructed for the excavation works at EL.125 m is used as hauling road of material also. When DA-2 reaches to the limit in height, another hauling road is constructed on the embankment slope and extended to EL. 145 m.

5.5.6 Embankment between EL. 145 m ~ EL. 157 m

The excavated foundation of the spillway control portion at EL. 114 m is used as a hauling road and hauling road on embankment slope is extended stage by stage until the dam crest EL. 157 m.

Spreading and grading of unloaded embankment material is carried out by bulldozer 15 t ~ 21 t. Kinds of equipment of compaction and number of passes are decided by field rolling trials finally, vibrating roller 10 t class and tamping roller 20 t class are selected temporarily in this report.

The capacity and number of the equipment for embankment are as below. However, numbers of dump trucks of hauling from the quarry site and aggregate plant are described in CHAPTER 8 Concrete and Aggregate Plant.

- Bulldozer	:	21	t	x	3	units
- Bulldozer	:	15	t	x	2	unit
- Backhoe	:	0.60	m^3	x	1	units
- Dump Truck	:	10	t	x	2	units
- Tamper	:	60/100	kg	x	4	units
- Vibrating Roller	:	10	t	x	2	units
- Tamping Roller	:	20	t	x	1	unit
- Truck with Crane	:	4	t	x	1	unit
- Motor Grader	:	2.8	m	x	2	units
- Water Truck	:	8	m^3	x	2	units

5.5.7 Blending

(1) Impervious Material

A part of the disposal area DA-1 is used as blending yard. Excavated material from the dam site and fine sand and gravel from the aggregate plant is spread by bulldozer 15 t layer by layer under the specified thickness after material blending trial test. After getting specified moisture content, sandwiched material is carefully excavated by backhoe 0.60 m^3 class by cutting in vertical direction. To get the enough amount of material, at least three sets of blending area will be prepared.

(2) Semi-pervious Material

Source material of the semi-pervious zone is produced at the aggregate plant near the quarry site. After gradation test, fine and coarse material is mixed by bucket number under designated ratio in stockyard prepared at aggregate plant.

The capacity and number of the equipment for blending are as below.

- Bulldozer	:	21	t	x	1	unit
- Backhoe	:	0.60	m^3	x	2	units
- Dump Truck	:	10	t	x	9	units
- Wheel Loader	:	1.7	m^3	x	1	unit
- Motor Grader	:	2.8	m	x	1	unit
- Water Truck	:	8	m^3	x	1	unit

CHAPTER 6 OUTLET FACILITIES

The outlet facilities works consist of the outlet tunnel and the intake. In consideration of locations of each structure, construction method and construction schedule of the outlet tunnel is commenced first and the intake follows.

6.1 Outlet Tunnel

The outlet tunnel is located at the right bank of the dam site with the total length of about 400 m and the internal width and height of the tunnel are 2.40 m each. The longitudinal gradient of the tunnel is 1/14.65.

6.1.1 Preparatory Works

The upstream end elevation of the outlet tunnel is 20 m higher than the riverbed elevation and the longitudinal gradient of the outlet tunnel is very steep as 1/14.65. In consideration of these conditions, excavation works will be carried out from the downstream to the upstream side. Therefore, a part of the temporary access road DS-1 which is constructed for the diversion tunnel works is used again and excavated material is hauled to the disposal area DA-1.

6.1.2 Excavation Works

After the construction of temporary entrance of the outlet tunnel, excavation works will be commenced. Considering geological condition and the size of the tunnel section, the excavation works will be carried out with full-face section at 2.0 m progress per one cycle.

Combination of a small size load header and a load haul dump truck 1.7 m^3 is applied to the excavation works in the outlet tunnel. Since the internal tunnel width is not enough to accommodate two dump trucks, one truck should wait at the entrance during another one is working in the tunnel. Excavated material which is hauled out by load haul dump trucks is dumped and stocked at a temporary stock yard. Stocked material is loaded by a backhoe 0.60 m^3 to dump trucks 10 t and hauled to the disposal area DA-1 through the temporary access road DS-1 and the permanent road R-1. A generator for the load header will be employed to avoid troubles of electric supply suspension by a main generator.

The capacity and number of the equipment for excavation work are as below.

- Load Header : 90 kW x 1 unit
- Load Haul Dump Truck : 1.7 m^3 x 3 units

- Backhoe : 0.60 m³ x 1 unit
- Dump Truck : t x 2 units
- Generator : 150 kVA x 1 unit
- Ventilator : 150 m³/min x 1 unit
- Submersible Pump: 100 mm x 2 units

6.1.3 Supporting Works

Supporting works consist of shotcrete, rock bolt driving and installation of steel support. The same method and equipment for shotcrete with the ones of the diversion tunnel are applied. However, since tunnel section area is small, the shotcrete nozzle is operated by manpower instead of a shotcrete robot and rock bolt drilling works are carried out by manpower with leg hammer instead of a drill jumbo. After the completion of shotcrete lining, steel support of H-beam (H-100x100x6x8) installation work follows. Cycle time of supporting and excavation works of the outlet tunnel is shown in Table 6.1.1.

The capacity and number of the equipment for the supporting works are as below.

- Shotcrete Machine : 10 m³/h x 1 unit
- Concrete Mixer : 15 m³/h x 1 unit
- Concrete Transfer : 1.7 m³ x 1 unit
- Leg hammer : 30 kg x 2 units
- Air compressor : 7.5 m³/min x 1 unit
- Ventilator : 150 m³/min x 1 unit
- Submersible Pump : 100 mm x 2 units

6.1.4 Pipe Installation and Backfill Concrete Works

After the completion of excavation and supporting works, steel pipe installation and backfill concrete works are commenced. The temporary access road IT-1 is constructed at the ground of EL.111.50 m of the intake, so that steel pipes can be transported into the tunnel inside from the upstream side. A slope around the intake site is very steep to construct the temporary access road IT-1, some parts of the road are constructed by staging using steel material which is used for the temporary bridge of DS-1.

Steel pipes are carried from a trailer to a trolley by a truck crane 25 t on a temporary staging. A piece of steel pipe of 6.0 m long fixed on a trolley is hauled to a specified point by winch operation and set on a temporary stand (refer to Fig. 6.1.1). After three units of steel pipes are

installed, welded and inspected by x-ray test and so on, backfill concrete placing is executed for this block. Concrete is supplied by concrete pump which is installed on a temporary staging.

The capacity and number of the equipment for the pipe installation and backfill concrete works are as below.

- Trolley	: 5 m	x 2 units
- Winch	: 11 kW	x 1 unit
- Truck Crane	: 25 t	x 1 unit
- Concrete Pump	: 40 m³/h	x 1 unit
- Agitator Truck	: 4.5 m³	x 2 units
- Ventilator	: 150 m³/min	x 1 unit
- Submersible Pump	: 150 mm	x 2 units

6.2 Intake

The intake is located at the right bank and the upstream of the dam body about 160 m far from the dam axis and includes the inlet portion of the outlet tunnel and emergency gate, bulkhead gate and trash rack installation works.

6.2.1 Excavation Works

The permanent road R-2 is connected at EL.157.0 m of the top of the intake. However, it is difficult to construct an access road at the top of the intake without mass excavation because the ground slope around the intake is very steep. Therefore, excavation works are carried out from upper to lower portions step by step by backhoe 0.35 m³ and manpower with pick hammers and excavated material is dropped to the riverbed. Collected material at the riverbed by bulldozer and/or wheel loader 1.7 m³ is hauled to the disposal areas DA-1 and/or DA-3. Since the riverbed area is used as the temporary access road RB-1 to haul the main dam excavated material, arrangement of working time between dam excavation and intake excavation is required.

The capacity and number of the equipment for the excavation works are as below.

- Backhoe	: 0.35 m³	x 1 unit
- Bulldozer	: 21 t	x 1 unit
- Wheel Loader	: 1.7 m³	x 1 unit
- Dump Truck	: 10 t	x 3 units
- Air Compressor	: 7.5 m³/min	x 1 unit

6.2.2 Concrete Works

Gradient of the intake structure is steep as one 1.0 vertical to 1.4 horizontal and keep uniform section from the bottom to the top. Separated metal forms are used at the lower portion combined with the inlet of the outlet tunnel and sliding form is handled at the uniform portion, since sliding form has a merit of execution with safety and high efficiency of work at high elevation and narrow area.

Most of concrete placing works are carried out by a concrete pump which is set on the temporary access road IT-1 or on a temporary staging, placing concrete by bucket or chute is adopted depending on the working conditions.

The capacity and number of the equipment for the concrete works are as below.

- Sliding Centre	: 2 m	x	1 set
- Winch	: 15 kW	x	1 unit
- Truck Crane	: 25 t	x	1 unit
- Concrete Pump	: 40 m³/h	x	1 unit
- Agitator Truck	: 4.5 m³	x	3 units
- Truck with Crane	: 4 t	x	1 unit
- Air Compressor	: 7.5 m³/min	x	1 unit
- Generator	: 125 kVA	x	1 unit

6.2.3 Gates and Trash Rack Installation

After the completion of the operation room slab concrete, preparatory works for gate installation are commenced. Winches for gate operation are installed first and these winches are used to install guide rails, gates and trash rack. Emergency gate, bulkhead gate and trash rack are installed orderly.

The capacity and number of the equipment for the installation works are as below.

- Winch	: 15 kW	x	1 unit
- Truck Crane	: 25 t	x	1 unit
- Truck with Crane	: 6 t	x	1 unit
- Ordinary Truck	: 10 t	x	1 unit
- Air Compressor	: 7.5 m³/min	x	1 unit
- Generator	: 125 kVA	x	1 unit

CHAPTER 7 POWERHOUSE

One sidewall of the powerhouse structure becomes a part of the stilling basin right sidewall, and a temporary hauling road for dam embankment is constructed beside the powerhouse. Moreover, the hauling road is raised up by step in accordance with the progress of backfill around the powerhouse. Therefore, the construction schedule of the powerhouse needs the adjustment with the stilling basin concrete placing and the main dam embankment.

7.1 Excavation Works

Excavation for the powerhouse is proceeded together with the stilling basin excavation and operation by giant breaker and/or blasting method are anticipated because of deep excavation which is 5 m lower than the existing riverbed. Excavated material is loaded to dump truck 10 t by backhoe 0.35 m³ and hauled to the disposal areas DA-1 and/or DA-3 through the temporary access road DS-1 and the permanent road R-1. Dewatering system becomes very important against deep excavation works.

The capacity and number of the equipment for the excavation works are as below.

- Backhoe	:	0.35 m³	x 2 units
- Giant Breaker	:	600/800 kg	x 1 units
- Dump Truck	:	10 t	x 6 units
- Crawler Drill	:	5 t	x 1 unit
- Air Compressor	:	20 m³/min	x 1 unit
- Generator	:	125 kVA	x 1 unit
- Submersible Pump	:	200 mm	x 1 units
- Submersible Pump	:	150 mm	x 1 units

7.2 Concrete Works

The left sidewall of the powerhouse becomes walls of the No. 16 and No.17 blocks of the stilling basin, therefore the concrete placing schedule of the powerhouse is required to coordinate with the stilling basin. Separate metal forms are applied to the slab and the lower portion of the sidewalls, however slide forms are used at the upper portion to keep high work efficiency. Lifting of forms and carrying of construction material are carried out by a truck crane 25 t.

In principle, concrete placing is carried out by a concrete pump which is set on the excavated ground surface or on the backfill area around the powerhouse. But placing method by concrete bucket or chute is adopted depending on the work conditions.

The capacity and number of the equipment for concrete work are as below.

- Truck Crane	:	25	t	x	1 units
- Truck with Crane	:	6	t	x	1 unit
- Concrete Pump	:	40	m^3/h	x	1 unit
- Agitator Truck	:	4.5	m^3	x	3 units
- Air Compressor	:	20	m^3/min	x	1 unit
- Generator	:	125	kVA	x	1 unit
- Submersible Pump	:	200	mm	x	1 units
- Submersible Pump	:	150	mm	x	1 units

7.3 Equipment Installation

Heavy equipment like a turbine, a generator and a main transformer are hauled into each floor and installed by a travelling crane installed in the powerhouse superstructure. Secondary concrete is placed by a concrete bucket after completion of the installation of equipment at designated positions.

The capacity and number of the equipment for the installation works are as below.

- Truck Crane	:	25	t	x	1 units
- Truck with Crane	:	6	t	x	1 unit
- Concrete Bucket	:	0.5	m^3	x	1 unit
- Agitator Truck	:	4.5	m^3	x	2 units

CHAPTER 8 AGGREGATE AND CONCRETE PLANTS

The crushing and aggregate plants are provided at the quarry site to minimize a handling cost of row materials in view of a loss of waste material such as dust. The location of the concrete plant yard is determined at the right bank in the reservoir area taking into consideration of temporary access roads, water and power supply, topographical condition and the efficient distribution routes of concrete materials (refer to Fig. 2.1.1).

8.1 Preparatory Works

The rock quarry is located at Mt. Mergi about 17 km southeast of the damsite and is located about 1.0 km north side of the main road connecting Semarang and Solo. There is a village between the quarry site and the main road. All roads in the village are with very poor pavement and narrow for hauling of big amount of material. Widening and modification of the alignment of these roads are difficult because of existing many houses. Therefore, it is better to construct a new access road at southeast of the quarry about 1.0 km long. This temporary access road will be connected with an existing plantation road which is required improvement by 300 m long.

8.2 Quarry Site Development and Operation

8.2.1 Development Quantity

The rock quarry shall be developed to obtain rock material for the dam embankment and row materials for aggregate production. The required work quantity is given as shown below:

Material	Required Excavation (m^3, bank)	Utilized Quantity (m^3)	Waste Quantity (m^3)
Top Soil	200,000	0	200,000
Unsound Rock	160,000	110,000	50,000
Sound Rock	500,000	500,000	0
- Embankment (a)		339,000	0
- Crushed Rock (b)		132,000	0
- Aggregate (c)		48,000	0
Sub Total (a)+(b)+(c)		519,000	0
Temporary Works (Road Sub-Base)		1,000	0
Total	880,000	630,000	250,000

8.2.2 Development of Quarry Area

A large part of the village is located south of the rock quarry, and the distance between the quarry site and the nearest house is estimated almost 200 m at present. Considering village location and required big amount of blasting volume, the quarry site should be selected at the northern part of the quarry area and blasting operation is carried out from north to south in order to minimize the influence from explosion.

A temporary access road is constructed from existing road to the terrace whose elevation is about EL.505 m through the east side of the quarry. This terrace is very useful for loading area of blasted material at the beginning stage.

8.2.3 Development Method

Topsoil, common material and unsound rock, which are unsuitable for dam embankment or row material for aggregate, shall be removed by backhoes and/or bulldozers. They are loaded by backhoes or wheel loaders, hauled by dump trucks to spoil areas prepared in the quarry site. After removing the overburden, sound rock shall be yielded by a bench-cut blasting method using crawler drills.

The drilling and blasting patterns are determined in respect of rock size, work efficiency and safety. Two typical patterns are employed to obtain large sized rock for embankment and smaller sized rock for feeding to aggregate plant. 10 m high bench is provided for production of large sized rock and 5 m bench is for smaller sized rock, which are supposed to be practicable for drilling and blasting operation. Blasted rocks are loaded by wheel loaders or backhoes supported by bulldozers. Giant breakers are allocated to break oversized rocks.

According to the quarry operation schedule (refer to Table. 11.1.1), the required rock production is calculated as follows:

For dam embankment,

- Total rock volume : Q = 191,000 m^3 + 563,000 m^3 + 10,000 m^3 = 764,000 m^3
- Operation period : T = 16 months = 304 days
- Average daily volume : Qd = Q / T = 764,000 / 304 = 2,513 m^3/day

For aggregate and other temporary purposes,

- Total rock volume : Q = 47,200 m^3 + 4,800 m^3 = 52,000 m^3
- Operation period : T = 32 months = 585 days
- Average daily volume : Qd = Q / T = 52,000 / 585 = 89 m^3/day (average demand in 32 months)

Therefore, the daily rock production required is:

$$Qd = 2,513 + 89 = 2,602 \text{ m}^3/\text{day}$$

8.2.4 Equipment for Quarry Operation

As the hauling distance from the quarry to the dam site is almost 30 km, a sufficient number of dump trucks shall be employed to meet the planned volume.

The required dump truck's numbers are 130 trucks as estimated below:

- Hauling capability : $q = 21.1 \text{ m}^3$ per day per no.
- Daily hauling volume required : $Q = 2,602 \text{ m}^3/\text{day}$
- Required number of dump trucks : $N = Q / q = 2,602 / 21.1 = 124$ nos.

The following equipment is used for the quarry operation, hauling and temporary works:

- Backhoe	: 0.35 m³	x 1	unit
- Backhoe	: 0.60 m³	x 11	units
- Bulldozer	: 21 t	x 6	units
- Wheel Loader	: 1.7 m³	x 2	units
- Dump Truck	: 10 t	x 22	units (around the quarry)
- Dump Truck	: 10 t	x 124	units (hauling to the dam site)
- Crawler Drill	: 125 ps	x 5	units
- Giant Breaker	: 600/800 kg	x 2	unit
- Air Compressor	: 7.5 m³/min	x 1	unit
- Motor Grader	: 2.8 m	x 1	unit
- Vibrating Roller	: 10 t	x 1	unit
- Water Truck	: 8 m³	x 2	units
- Fuel Truck	: 4 t	x 1	unit
- Truck with Crane	: 4 t	x 1	unit
- Repair Car	: 4 t	x 1	unit
- Generator	: 125 kVA	x 1	unit
- High Washer	: 2.2 kW	x 2	units

8.3 Aggregate Plant

According to the estimated total production quantity of coarse and fine aggregate, and whole construction schedule, the required capacity of the aggregate plant is estimated as follows:

- Monthly demand volume : $Q5 = 19,000 \text{ m}^3/\text{month}$ (average biggest demand of 7 month)
- Average production days : $T5 = 23$ days/month

- Average daily demand : Qd = Q5 / T5 = 19,000 / 23 = 826 m^3/day
- Average daily production : qp = Qd x 1.15 = 826 x 1.15 = 950 m^3/day (maximum demand)

When the plant is operated for 10 hours (day shift basis including three (3) hours overtime) on an average, the required hourly quantity to be produced by the plant is as follows:

- Required hourly production :

$$Qh = 950 \times 1.65\ (*^1) / \{(1-0.02(*^2)) \times 0.90\ (*^3) \times 10\ hr\} = 177.7\ t/hr$$

*1 : Assumed unit tonnage per 1 m^3 aggregate
*2 : Assumed percentage of total loss
*3 : Assumed coefficient for work efficiency of plant

Therefore, the capacity of the aggregate plant shall be not less than 180 t/hr.

Considering the operation period and daily operation time, it is better that the aggregate plant's location is far from the village side to prevent the friction about operation noise. Therefore, northeast of the quarry is better for the plant location in this stage.

8.4 Concrete Plant

According to the concrete work schedule (refer to Table. 11.1.1), the required capacity of the concrete plant is calculated as follows:

- Average monthly concrete volume : Q = 3,200 m^3 /month (average demand of 6 month)
- Average placing days per month : T = 21 days/month
- Average daily concrete volume : Qd = Q / T = 3,200 / 21 = 152.4 m^3/day
- Maximum daily volume assumed :

$$Qd(max) = 152.4\ m^3 \times 1.2(*^1) / \{(1-0.01(*^2)) \times 0.75(*^3)\} = 246.3\ m^3/day$$

Assuming that the plant operation is 8 hours in average, the required hourly quantity to be produced by the plant is as follows:

- Required hourly production : Qh = Qd(max) / 8hr = 246.3 x 1.2 (*1) / 8 = 36.9 m^3/hr

*1 : Assumed coefficient to calculate a required maximum quantity
*2 : Assumed percentage of total loss
*3 : Assumed coefficient for work efficiency of plant

Therefore, the capacity of the concrete plant shall be not less than 40 m^3/hr.

CHAPTER 9 APPROACH BRIDGE TO GOA KREO CAVE

9.1 Outline of Bridge

The approach bridge to Goa Kreo consists of four (4) spans with the span length of each 17.0 m.

9.2 Preparatory Works

The temporary access road PB-1 is branched from the permanent road R-1 in order to construct two abutments and three numbers of piers of the bridge. The removal works of the existing gate of Goa Kreo is commenced at the same time.

9.3 Construction of Substructures

Foundations of the abutment slabs and piers are excavated down to a sound rock layer by backhoe 0.35 m^3 and if necessary giant breaker is used. Excavated materials are stocked at near the site for the material of backfilling and embankment, the remainder is hauled to the disposal area DA-1 through PB-1 and R-1. Shape of foundation excavation should be made to keep space for scaffoldings of substructures and supports for superstructure construction.

Concrete works are executed one by one from the right bank to the left bank side in principal. A truck crane 25 t is applied to unloading construction materials and lifting forms and others. Concrete placing is carried out by concrete pump set on the right bank, and placing method by bucket or chute is selected also depending on the site conditions.

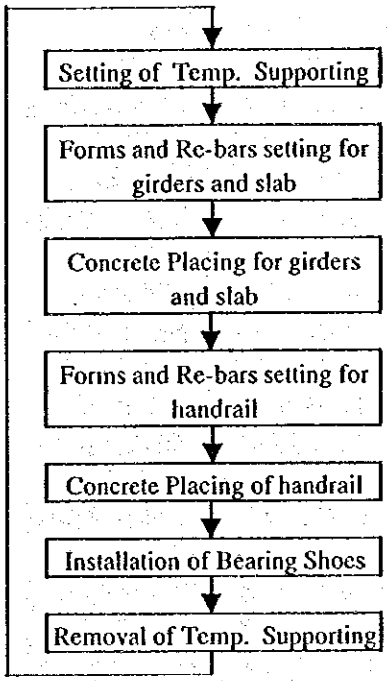
The capacity and number of the equipment for the substructure works are as below.

- Backhoe	:	0.20 m^3	x 1 unit
- Backhoe	:	0.35 m^3	x 1 unit
- Giant Breaker	:	600/800 kg	x 1 unit
- Dump Truck	:	10 t	x 2 units
- Ordinary Truck	:	10 t	x 1 unit
- Bulldozer	:	15 t	x 1 unit
- Tamper	:	60/100 kg	x 2 units
- Vibrating Roller	:	10 t	x 1 unit
- Concrete Pump	:	40 m^3/h	x 1 unit
- Agitator Truck	:	4.5 m^3	x 2 units
- Portable Mixer	:	0.2 m^3	x 1 unit

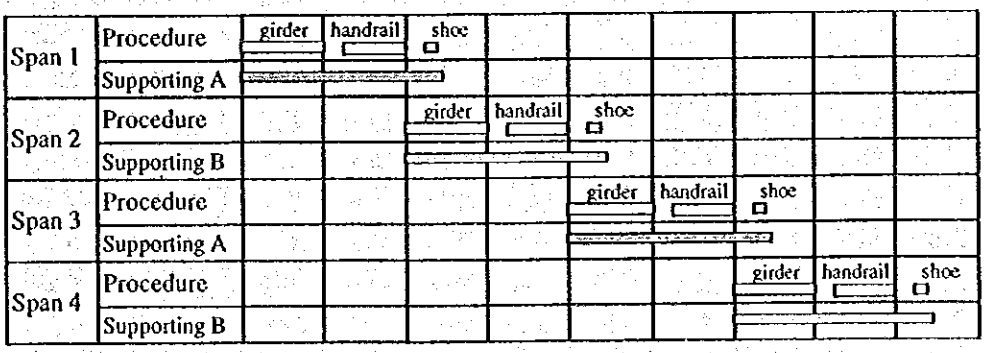
- Truck Crane : 25 t x 1 unit
- Air Compressor : 7.5 m³ x 1 unit
- Generator : 60 kVA x 1 unit
- Truck with Crane : 6 t x 2 units

9.4 Construction of Superstructures

After the completion of the substructure works, a temporary supporting for the first span of the superstructure is installed at the right bank side. The superstructure is designed as RC type consisting of girders, a slab and handrail portions. The construction procedure of the superstructure works is shown below.



The construction procedure of each span is as follows.



A truck crane 16 t is applied to unloading construction materials and lifting forms and others. Concrete placing is carried out by a concrete pump set on the right bank same as the substructure construction.

Four (4) numbers of bearing shoes to be installed at each span are inserted under the lifted girders by hydraulic jacks after enough curing time for the placed concrete.

The capacity and number of the equipment for the superstructure works are as below.

- Concrete Pump	:	40	m^3/h	x 1 unit
- Truck Crane	:	16	t	x 1 unit
- Hydraulic Jack	:	50	t	x 5 units
- Agitator Truck	:	4.5	m^3	x 2 units
- Air Compressor	:	7.5	m^3/min	x 1 unit
- Generator	:	60	kVA	x 1 unit
- Truck with Crane	:	6	t	x 1 unit

CHAPTER 10 DAM MANAGEMENT COMPLEX

10.1 Outline of Buildings

Dam management complex consists of a dam administration building, staff houses, a mushola and external facilities. The area and number of the buildings of the complex are shown below.

Work Item	Type/Size	Unit
Administration Building	3 Story 594.01 m^2	1
Staff House (Guest House)	1 Story 74.42 m^2	1
Staff House	1 Story 49.11 m^2	4
Mushola	1 Story 72.30 m^2	1
External Facilities	Foundation,grading, fence, drain-cover, retaining wall, concrete-paving, etc.	1 L.S.

Location of this complex is on the left bank spillway and the area for the complex will be prepared at EL. 160.0 m ~ EL. 165.0 m in Package-1. The land preparation is commenced in the middle of the first year and completed at the beginning of the dry season of the second year. Considering the whole construction schedule of the Package-1 and specially hydropower station schedule, the dam management complex works are commenced in the latter half of the third year following the approach bridge works to Goa Kreo.

10.2 Building Works

The land preparation is executed in Package-1, so equipment in this work is limited for building construction. Considering the workload of each buildings and the seasonal workable conditions, a whole construction schedule is prepared is shown in the Table. 11.4.3.

The capacity and number of the equipment for building works are as below.

- Backhoe : 0.20 m^3 x 1 unit
- Dump Truck : 10 t x 1 unit
- Concrete Pump : 40 m^3/h x 1 unit
- Agitator Truck : 4.5 m^3 x 2 units
- Truck Crane : 16 t x 1 unit
- Air Compressor : 7.5 m^3/min x 1 unit
- Portable Mixer : 0.2 m^3 x 1 unit
- Generator : 60 kVA x 1 unit

- Truck with Crane : 4 t x 1 unit

10.3 External Works

External works consist of many kind of working items and work schedule is affected by the progress of the building works. Therefore, some kinds of equipment for external works should be kept at the site.

The capacity and number of the equipment for external works are as below.

- Backhoe	:	0.35 m^3	x 1 unit
- Dump Truck	:	10 t	x 2 units
- Bulldozer	:	15 t	x 1 unit
- Tamper	:	60/100 kg	x 3 units
- Vibrating Roller	:	4 t	x 1 unit
- Portable Mixer	:	0.2 m^3	x 1 unit
- Air Compressor	:	7.5 m^3/min	x 1 unit
- Generator	:	90 kVA	x 1 unit
- Ordinary Truck	:	10 t	x 2 units
- Truck with Crane	:	6 t	x 1 unit

CHAPTER 11 CONSTRUCTION TIME SCHEDULE

11.1 Planning Condition

11.1.1 Workable Days

(1) Dry and Rainy Seasons

Dry Season : April to November (8 months)

Rainy Season : December to March (4 months)

(2) Construction Mode

Construction works are possible to be done even in the rainy seasons by employing dewatering systems. However, earth works handling soil materials, which are susceptible to weather condition, are to be performed mainly in the dry seasons taking account of workability and moisture content control.

(3) Suspension of Works by Precipitation

The suspension duration of works by precipitation (R mm) depends on the work items and the amount of precipitation, and it is assumed as shown below:

Excavation Works		R ≥ 15 mm/day	One (1) day suspension
		R ≥ 30 mm/day	Two (2) days suspension
Embankment Works	Impervious Zone Semi-Pervious Zone	R > 0 mm/day	One (1) day suspension
		R ≥ 30 mm/day	Two (2) days suspension
	Pervious Zone	R ≥ 15 mm/day	One (1) day suspension
		R ≥ 30 mm/day	Two (2) day suspension
Concrete, Grouting Works and Other Structure Works		R ≥ 15 mm/day	One (1) day suspension

11.1.2 Seasonal Workable Days

Since construction works are much influenced by rainfall, the construction period and workable days are estimated based on the rainfall data at the Semarang station for 10 years starting from 1987. In addition, national holidays and religious events are considered. Seasonal workable days for each major work are calculated as shown in Table 11.1.1 and summarized as below:

Monthly Workable Days

Work Items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Excavation	11	11	15	18	20	23	25	24	25	24	17	12	225
Embankment - Impervious - Semi-Pervious	4	5	8	13	17	20	24	22	23	20	11	5	172
Embankment - Pervious	11	11	15	18	20	23	25	24	25	24	17	12	225
Concrete, Grouting, other Structure Works	16	15	19	20	22	24	25	24	25	25	19	18	252

Seasonal Workable Days

Work Items		Dry Season (Apr.-Nov.)	Rainy Season (Dec.-Mar.)	Through a Year
Excavation Works		176 days/8 mths = 22 days/mth	49 days/4 mths = 12 days/mth	225 days/year = 18 days/mth
Embankment Works	Impervious Semi-Pervious	150 days/8 mths = 19 days/mth	22 days/4 mths = 6 days/mth	172 days/year = 14 days/mth
	Pervious	176 days/8 mths = 22 days/mth	49 days/4 mths = 12 days/mth	225 days/year = 18 days/mth
Concrete, Grouting Works and other Structure Works		184 days/8 mths = 23 days/mth	68 days/4 mths = 17 days/mth	252 days/year = 21 days/mth

11.2 Daily Workable Hours

Construction works except tunnel work are carried out under a single shift basis or two shifts basis as shown below:

Work Items	Day Shift	Night Shift	Total
	9 hours incl. 2 hours overtime	9 hours incl. 2 hours overtime	18 hours incl. 4 hours overtime
Excavation Work *	o	-	9 hours
Dam Embankment	o	o	18 hours
Grouting Work	o	o	18 hours
Concrete Lining Work	o	o	18 hours
Other Concrete Work	o	-	9 hours

Notes : o : Work, - : No Work
Excavation is executed during a day shift for safety reason.

11.3 Procurement of Construction Material and Equipment

The construction material and equipment can be procured from Semarang City, Indonesia and overseas countries as shown in the table below:

Item		Domestic		Other Countries
		Semarang	Indonesia	
Construction Equipment		o	o	o
Construction Material	- Sand, Gravel, Cobble Stone	o	-	-
	- Ready Mixed Concrete (applied to Small Structure)	o	-	-
	- Reinforcing Bar	o	o	-
	- Steel Material	-	-	o
	- Concrete Products	o	o	-
Water Control Facilities		-	o	o

Note : o : Available - : Not available

11.4 Construction Time Schedule, Mobilization and Demobilization of Construction Equipment

11.4.1 Package-1

Whole construction period of Package-1 becomes four years and many kinds of construction work items are connected each other and have tight relationships also. Therefore, construction time schedule of Package-1 is prepared by consideration of relationships between the main dam and other works (refer to Table 11.4.1). Mobilization and demobilization of construction equipment is shown in Table 11.4.2.

11.4.2 Package-2

Package-2 consists of an approach bridge to the Goa Kreo and the construction of buildings and the external works in the dam management complex. Basically, these works are independent from Package-1, however land development for the dam management complex area is carried out by the Package-1 contractor. In consideration of these conditions, the construction schedule of Package-2 is prepared as shown in Table 11.4.3 and the schedule of mobilization and demobilization of construction equipment is shown in Table 11.4.4.