REPORT

OF

THE MISSION FOR EARTHQUAKE-PROOF RESEARCH AND DESIGN

ON

HYDRAULIC STRUCTURES IN INDONESIA

October, 1978

Japan International Cooperation Agency

CONTENTS

P R E F A C E

In response to the technical assistance requested by the Government of the Republic of Indonesia, as of March 23, 1978, for the services of three senior experts in Earthquake-proof Research and Design to assist the Directorate General of Water Resources Development, Department of Public Works the Japanese Government dispatched an ad hoc survey mission to Indonesia from July 16 through 30, 1978.

This is the report prepared by the mission represented by three members listed below:

Eiichi Kuribayashi,	Public Works Research Institute, Ministry of Construction.
Koji Hojo,	do.
and Hideaki Oda,	River Planning Division, River Bureau, Ministry of Construction.

In cooperation with the counterparts and their alternatives listed below:

Mr. Ibnu Kasiro,	Hydraulic Structures Section, IHE in Bandung.
Mr. T.F. Najoan,	Hydraulic Structures Section, IHE in Bandung.
Mr. C.L. Nugroho,	Engineering Geology Section, IHE in Bandung.

Oct., 1978

Eiichi Kuribayashi,

Head of the Mission of Earthquake-proof Research and Design for Hydraulic Structures.

1. OBJECTIVES

The mission was dispatched to Indonesia to assist on aseismic design of Hydraulic Structures for two weeks from the middle of July 1978 as stated in the preface.

At the beginning of the activity of the mission in Indonesia Mr. Suyono Sosrodarsono, Director General of Water Resources Development of the Department of Public Works gave constructive suggestions to the mission.

He asked the mission to include the following in the preparation of the proposal for the assistance of the Japanese Government to the Indonesian Government on Earthquake-proof Design for the Hydraulic Structures:

(1) Preparation of codes and manuals for the aseismic design.

(2) Training programms.

2. ITINERARY

The itinerary of the mission from 16 to 30 July, 1978 is as follows:

16 Sun.	Flight from Tokyo to Jakarta.
17 Mon.	Courtesy call on Japanese Embassy.
18 Tue.	Courtesy call on Ir. Suyono, Director General of Water Resources Development and meeting with him at his office with the attendance of Mr. Nakao, first Secretary of Japanese Embassy and Mr. A. Hamamori, Coordinator of Colombo Plan.
19 Wed.	Travel from Jakarta to Bandung. Meeting with Mr. Rachmat Tirtotjondro, Director of Institute of Hydraulic Engineering, and his staff
20 Thu.	Meeting with our counterparts, Ir. I. Kasiro, Head of Hydraulic Structures Branch and Mr. Susmarjanto, Staff of Engineering Geology Branch.
21 Fri.	Visit to Geological Survey and meeting with Mr. Sutisna and others. Visist to I.T.B. (Institute of Technology Bandung) and discussion with Prof. M.T. ZEN. Discussion with Prof. Y. Tsuchiya.
22 Sat.	Visit to Institute of Building Research and meeting with Ir. A. Kartahardja, Director of the Institute of Building Research, and his staff. Travel from Bandung to Jakarta to inspect Jatiluhur Dam.
23 Sun.	Flight from Jakarta to Yogyakarta.
24 Mon.	Visit to the office of Sala River Basin Development Project and meeting with Ir. Suminto, Project Manager, and his staff, arranged by Mr. Oshiki, Colombo Plan Expert. Inspection of Wonogiri Dam guided by Mr. Sawaya, Team leader of Nippon Koei Ltd. for Wonogiri Dam construction office.

25 Tue. Inspection of Widas Dam and Selorejo Dam.

Inspection of the sand pocket of the Sabo works at Mt. Kelud arranged by Mr. Takanashi, Colombo Plan Expert.

26 Wed. Visit to the Kali Brantas Multipurpose Project Office and meeting with Ir. Putra Duarsa, Project Manager of Kali Brantas Multipurpose Project and his staff.

Inspection of Karangkates Dam, Lohor Dam, Lodoyo gate weir and Wlingi Dam arranged by Mr. Marusugi, Coordinator of Brantas Project.

27. Thu. Inspection of Lengkong barrage, and several important river structures of the Kali Surabaya River Improvement Project and meeting with Ir. Roedjito, Project Manager of Kali Surabaya Project, and his staff arranged by Mr. Ebihara, team leader of Nikken Ltd. for the Kali Surabaya River Improvement Project.
Flight from Surabaya to Jakarta.

28. Fri. Visit to Meteorological and Geophysical Institute and meeting with Drs. R.P. Sudarmo D., Seismologist.

Visit to Directorate of Water Resource Development and meeting with Mr. Isbandi SH.

29 Sat. Final Discussion with Ir. Suyono and his staff with attendance of Mr. Nakao.

30 Sun. Flight from Jakarta to Tokyo.

3. PRESENT STATUS OF EARTHQUAKE-PROOF RESEARCH AND DESIGN ON HYDRAULIC STRUCTURES IN INDONESIA

3.1 Organizations and Resources Concerned with Earthquake-Proof Research and Design

The Department of Research and Technology (DRT) coordinated all activities of research on earthquakes since 1976. Some institutes from other departments are expected to take part in this program although they will work separately.

These institutes are:

- The Institute of Meteorology and Geophysics (IMG), Department of Transportation and Communication, has already observed or recorded the earthquake occurences. The seismograph network was installed during the Dutch colony and improved since then. Another network with a strong motion accelerograph has also been installed since the last three years and will be improved with the support of UNESCO.

- Department of Education & Cultures will take care of the education and training to supply the required man-power from some of the universities.

- The Geological Survey of Indonesia (GSI), Department of Mining & Energy will study the geodynamics phenomena and volcanic activities.

- The Department of Public Works (DPW) is expected to provide the codes and manuals for the aseismic design of buildings, highways and hydraulic structures. The Institute of Building Research (IBR) established the National Working Group to prepare aseismic design codes for building and housing structures with the assistance of the Government of New Zealand. The members of the group are composed of researchers coming from the IBR, IMG. GSI and ITB (Institute of Technology Bandung). The seismicity map will be completed in October 1978 and the next task will be zoning. And the code will be prepared afterwards.

The Institute of Hydraulic Engineering (IHE) and the Institute of Highway Research (IHR) are expected to prepare codes for hydraulic structures and highway structures as quikcly as possible.

3.2 Standardization Concerned

The concrete design code for building structures has been available since 1955 and was revised in 1970 (the Indonesian Concrete Specification). This code includes the Indonesian Loading Code (NI - 18, 1970) as guidance for static design loading only. The code of dynamic loading for building structures is now being prepared by IBR. However, this code cannot be applied to dams and other hydraulic structures.

Laboratories for testing materials, especially concrete and steel, are available in the IHR, some universities, enterprises and the Institute for Testing Materials (ITM), Department of Industry in Bandung.

Laboratories for soil mechanics are available in IHE, IHR, some project offices, universities and enterprises. Rock mechanics laboratories are available only in IHE and GSI. A laboratory for soil dynamics will be established by IHE as the first in the whole country. Although this laboratory will have very limited equipment, IHE will be capable of helping the engineers in pursuing the dynamic analyses especially for homogeneous embankment dams and soil foundations.

Since the standard for soil testing has not yet been established, the standard issued by the American Society for Testing Materials (ASTM) has been generally applied.

3.3 Education and Training Concerned:

The Department of Mathematic & Physics, ITB, conducts the education for the masters degree on geophysics, while the Academy of Meteorology & Geophysics conducts the education for the bachelor's degree. Personal educated at these two agencies make up the official staff for the Institute of Meteorology and Geophysics.

Education on earthquake engineering has not been conducted in Indonesia except for a few universities. The faculty of engineering of some universities gives lectures on the subject of structural dynamics for buildings, but it provides only a very limited number of well-educated engineers. This causes one of the constraints for earthquake engineering research. To alleviate this lack in education, the Government of the Republic of Indonesia sends the engineers to continue their education or training abroad. Twenty-one Indonesian officials have been trained in the International Institute of Seismology and Earthquake Engineering (IISEE) in Tokyo for one year. But only three of them work in the Directorate General of Water Resources Development (DGWRD), Department of Public Works. One official engineer from IHE has already received his master degree on soil dynamics at the Asian Institute of Technology (AIT) in Bangkok.

4. SEISMOLOGICAL INFORMATION

(1) Seismological Observation Network in Indonesia

In Indonesia there are two kinds of seismological observation networks. One is operated by the Meteorological and Geophysical Institute, Department of Transport & Communication and composed of 20 existing stations. Two of them have been installed at dam sites for dam monitoring. The network will be extended by installing 11 more stations with UNESCO cooperation.
The other is responsible for volcanological survey and is operated by the Geological Survey, Department of Mining Energy and composed of 17 existing stations at 14 active volcanos.

(2) Instrumentation

The network of the Meteorological & Geophycial Institute is composed of 7 stations equipped with teleseismics and strong motion accelerographs, 12 stations equipped with teleseismics and 1 station equipped with only a strong motion accelerograph. On the other hand, the network of the Geological Survey is composed of seismographs at all stations.

(3) Data Processing

Data of all teleseismics and strong motion accelerographs will be analyzed by the Meteorological and Geophysical Institute, while data processing of all seismographs for volcanological survey are done by the Geological Survey.

(4) Utilization of Seismological Information

All the seismological information obtained by both networks up to now has been utilized to make seismic zoning and a seismic design code for buildings, however, such a code has not yet been established for hydraulic structures.

Seismological information from nearby stations at proposed sites will be very useful for aseismic designs of hydraulic

structures. However, the number of the existing stations at present is so limited that installation of more accelerographs would be desirable.

(5) Seismicity of Indonesia

The islands of Indonesia are located in the Circum-Pacific Seismic Belt and Trans-Asia Seismic Belt. There are some major tectonic zones wuch as the Sorong Fault zone and volcanic lift zone which are associated with destructive earthquakes. It can be seen that Indonesia belongs to a high seismic zone. About 400 earthquakes ($M > 5$) are recorded yearly, and 10 could be mentioned as major earthquakes ($M > 6$). Fortunately, only a few have originated in the land area, where there are very few important hydraulic structures. Many of them are submarine earthquakes or of deep origin, which are harmless. This is probably the reasons why there has been no record of severe earthquake damage to hydraulic structures in Indonesia. However, in the near future, the Indonesian Government will build many dams and other hydraulic structures in a highly seismic active area.

In order to construct hydraulic structures capable of withstanding the potential destructive earthquake forces, it is extremely important to undertake seismic zoning and establish seismic design codes by employing thorough research efforts on the seismicity in Indonesia.

For a special site, an intensive study is required.

5. GEOLOGY AND GEOPHYSICS

5.1 Geotectonic Feature of Indonesia

The Indonesian Archipelago straddles the collision margins of the Indian - Australian, the Pacific and the Eurasian plates. These active margins are characterized by trenches, gravity anomalies arc-trench gaps, volcanic arcs and young mountain ranges, together with earthquake hypocenters along dipping Benioff zones.

Quaternary and historical earth deformations in the Indonesian Archipelago demonstrate the close relationship that exists between neotectonics and seismic zones.

Most earthquakes in Indonesia can be assigned to the contacts between the Eurasian, Indian - Australian and Pacific Plates. The contact between the Eurasian and Indian-Australian Plates is the Indonesian Arc, which expresses the subduction of the Indian-Australian Plate beneath the Sunda Shelf. The Philippine Arc is the expression of the subduction of the Pacific Plate. The subduction of the Pacific Plate beneath the Indian-Australian Plate continues the line of the Indonesian Arc to the east but with a reversed curvature.

These three subduction zones meet in the Banda Sea region which gives rise to an area of great structural complexity and extremely high seismicity. The belts of earthquakes that follow the boundaries of the plates are continuous, but in detail some subdivisions can be recognized while their seismic characteristics are very different.

5.2 Seismotectonic Units in Indonesia

Attempts had been made to divide the Indonesian Archipelago into several seismotectonic units.

The latest study by Beca Carter Hollnigs & Ferner Ltd. recognized the following units:

1. Highly Active Arcs

Magnitude 8 shocks are known, and shocks above magnitude 7 are frequent. Geological indications of frequent earth deformations are present.

This unit incorporated the following areas:

a. Sumatra and Timor Segments of the main Indonesian Arc.
b. Halmahera Arc.
c. East Banda Arc (Buru, Ceram, East Banda Sea).

2. Active Arcs

Indications of highly Active Arcs are present. No shocks are known to have reached magnitude 8, but it is possible for infrequent shocks of this intensity to occur.

This unit incorporated the Java segment of the main Indonesian Arc and the Minahassa Peninsula.

3. Active Continental Margins

Seismic characteristics are similar to the Active Arcs.

This unit runs along Northern Irian Jaya and the Berau Peninsula.

4. Folded and Fractured Zones

Shocks of magnitude 7 are frequent, but none are known to have reached magnitude 8. Analogy suggests that they are unlikely. Geological indications of frequent deformations are present. These zones are found in the Sulawesi Island (except the Minahassa Peninsula) and the Aru island.

5. Folded and Fractured Zones with no shocks known to have exceeded magnitude 7 which incorporated the Eastern and Northern Kalimantan. The eastern boundary of this unit requires further study.

6. Active Ridges with geological evidences of deformations. No shocks above magnitude 7 are known, but analogy with other regions suggests that the largest shocks may exceed magnitude 7 1/2. The Berau Peninsula and Sangihe Ridge belong to this unit.

7. Areas within or marginal to stable shocks where infrequent small earthquakes have been reported. The largest shocks are unlikely to exceed magnitude 5 1/2. Central Kalimantan, Western Banda Sea, the Sulawesi Basin, southern margin of the Sunda Shelf and South China Sea north of Kalimantan belong to this unit.

8. Areas with evidences of geological deformations but no record of earthquakes. Infrequent shocks may reach magnitude 5 1/2. The Kei stable block and the Sula Islands belong this unit.

9. Stable Regions with no record of earthquakes and no evidence of geological deformation. The Sunda Shelf (except Kalimantan), the Timor Sea and the Arafuru Sea belong to this unit.

5.3 Geological Features of Indonesia

Large horizontal as well as vertical motions have occured in the Indonesian Archipelago as indicated by geological evidence. There are two major tectonic zones in which evidence of post Quaternary strike-slip motion has been observed. The Sorong fault zone strikes in an easterly direction across the westernmost peninsula of Irian and a volcanic rift zone traverses the islands of the Inner Sunda Arc. This rift zone is well developed in Sumatra and Java, and associated with destructive earthquakes. A strike-slip offset by several meters which occurred during an earthquake along this zone in 1822, was observed in North Sumatra.

The Sumatra-Java rift zone deserves more attention since several hydraulic structures are likely to be constructed in this zone, while this zone is associated with destructive earthquakes. The Wai Sekampung-Wai Seputih project in Lampung Province, the Teluk Lada project in Banten, West Java and the Maung Project in the Serayu River Basin, Central Java are close to or in the above-mentioned strike-slip fault zone. These projects incorporate the construction of dams.

6. CONSTRUCTION AND MANAGEMENT OF HYDRAULIC STRUCTURES

The construction process consists of various stages. The steps of the process are as follows:

- Planning is executed by the Directorate of Water Resources Development Planning (DWRDP)
- Study of the project is executed by the DWRDP itself or with the assistance of foreign consultants.
- Investigation and survey is done by IHE, universities and enterprises.
- The design is executed by the project office with the assistance of IHE and foreign consultants.
- In the construction stage, the construction is done mostly by local constractors and only a few projects are executed by foreign consultants (Sempor Dam) or by the project office (Wonogiri Dam).
- After completion of small projects, the project is passed to the Provincial Government, Department of Interior. The Local Public Work Office executes the management, the maintenance and operation on behalf of the Provincial Government. For high dams, the project office is still responsible for a certain number of years to manage, maintain and operate the whole system (Brantas River project). There is also an authority to do those jobs for Jatiluhur Dam.

7. STRUCTURAL ANALYSES AND TESTING OF MATERIALS

7.1 Structural Analyses

At the present time no standardized method is available for static and dynamic analyses of hydraulic structures in Indonesia. The method of analyses is usually based on standards from different countries such as the USA, Japan and Europe depending on the educational background of the designers. Therefore, in order to standardize the method of analyses for hydraulic structures a design manual should be issued. It is in this respect that IHE in Bandung has been appointed by the D.G.W.R.D. to prepare standards and design manuals for static and dynamic analysis of hydraulic structures.

7.2 Testing of Materials

The procedure for testing materials is mostly based on A.S.T.M.. No dynamic testing for materials (Soil, Rock, Concrete) are available at this moment. It is expected that in 1979 the I.H.E. will obtain soil dynamic testing equipment from the Government. This will be very valuable for further research in earthquake engineering.

7.3 Computer Programs

There are several computer programs available at the I.H.E. which are obtained from foreign consulting firms (E.C.I.) and universities (University of California in Berkeley). These programs have been modified so that it can run on the IBM 1130 or IBM 370 computers. The following programs are available:

(a) Slope stability analysis using the Fellinius and Morgenstern-Price method.

(b) One dimensional method of dynamic response analysis of soil layers using the wave propagation method.

(c) Two dimensional method of dynamic response analysis of soil layers and earthfills using the finite element method.

(d) Stress-strain analysis of foundation and embankment dams using the finite element method.

(e) Stochastic analysis for earthquake risk potential.

8. RECOMMMENDATIONS

1. Standards and manuals of aseismic design for hydraulic structures are required to be compiled.

2. In Indonesia, however, earthquake engineering for hydraulic structures is still a new field of study and have not been taught popularly in the universities.

   Therefore, with the cooperation of Indonesia and Japan the following is recommended to establish the standards and manuals:

   1) Study and planning (for preparation) at site in Indonesia by Japanese experts.

   2) Training of Indonesian engineers in Japan in the fields of soil dynamics, structural dynamics and engineering geology.

3. For the study of aseismic design, instruments such as strong motion accelerographs, soil dynamic testing equipment, etc., will be required.

ACKNOWLEDGEMENTS

At the beginning of the acknowledgements, we would like to extend our profound thanks to Ir. Suyono SOSRODARSONO, Director General of Water Resources Development, for his advice, without which we could not have pursued and completed the duty of our mission.

We appreciate the adequate suggestions made by Ir. RACHMAT TIRTOTJONDRO. Director of the Institute of Hydraulic Engineering, on our work schedule, the useful explanations given by Ir. A. KARTAHARDJA, Director of the Institute of Building Research, and the kindness of Ir. PUTRA DUARSA, Project Manager, Brantas Multipurpose Project, who served as an excellent guide during our visit to the important hydraulic structures in the Brantas Multipurpose Proejct.

We also wish to express our thanks to all the members listed in Appendix I who helped us in carrying out our tasks during our stay in The Republic of Indonesia, especially to our counterparts, Ir. I. KASIRO, Head of the Hydraulic Structures Branch, who thoroughly supported us even though he was bereaved by the death of his mother-in-low during the mission.

Finally we thank Mr. A. HAMAMORI, Colombo Plan Coordinator, and the Colombo Plan experts listed in the same Appendix as mentioned above, who assisted us with their best efforts, especially Mr. NAKAHIRO, who accompanied us during the entire field trip with permission from Ir. Y. SUDARYOKO, Director of the River Division, Directorate General of Water Resources Development, and who helped us with his proficiency in the Indonesian language.

REFERENCES

(1) A Brief Outline of Seismicity & Earthquake Engineering Problems in Indonesia by T. Boen, Wiratman Wangsadinata, Directorate of Irrigation, Republic of Indonesia.

(2) Indonesian Earthquake Study. Volume I, A Review of Existing Indonesian Seismic Provisions & Practices, by Beca Carter Hollings & Ferner Ltd. The Indonesian counterpart Team.

(3) Indonesian Earthquake Study. Volume 2, Earthquake Risk in Indonesia Collection of Seismological & Geological Data by Beca Carter Hollings & Ferner LTD & The Indonesian Counter part Team.

(4) Indonesian Earthquake Study, Volume 3, Seismic Zones for Building Construction in Indonesia, by Beca Carter Hollings & Ferner LTD & The Indonesian Counterpart Team.

(5) Gravity and Geological Studies in Java, Indonesia, by Ministry of Mines, Directorate General of Mines, Geological Survey of Indonesia, 1978.

(6) Status Report on Engineering Seismology and Earthquake Engineering in Indonesia, by Indonesian National Working Group on Engineering Seismology and Earthquake Engineering.

LIST OF REFERENCES DONATED BY THE MISSION

From JICA

(1) Introduction to Earthquake Engineering by Shunso Okamoto

(2) Earthquake Resistant Design for Civil Engineering Structures, North Structures & Foundations in Japan by the Japanese Society of Civil Engineers.

(3) Design Criteria for Dams by the Japanese National Committee on Large Dams.

To:

(1) Library of Directorate General of Water Resources Development.

(2) Library of River Bureau.

(3) Library of Institute of Hydraulic Engineering.

(4) Library of Bengawan Solo Proejct.

(5) Library of Kali Brantas Multipupose Project.

From Ministry of Construction to I.H.E.

(1) Present Concept on Dynamic Stability Analysis of Fill Dams by Japanese National Committee on Large Dams and 9 other papers.

APPENDICES

Appendix I : List of Persons

Directorate General of Water Resources Development:

Ir. SUYONO SOSRODARSONO	Director General

Directorate of River:

Ir. Y. SUDARYOKO	Director
Mr. ISBANDISH	
Mr. SOENJOTO	

Division of Administration for Foreign Assistance

Mr. AZIS BOCKING	Chief

Institute of Hydraulic Engineering

Ir. RACHMAT TIRTOTJONDRO	Director
Ir. WILLY HARYONO	Head of Hydraulic Structures Division
Ir. IBNU KASIRO Dipl. H.E.	Head of Hydraulic Structures Branch
Ir. SUPARDIJONO	Head of Engineering Geology Branch
Ir. SUSMARJANTO	Staff of Engineering Geology Branch
Ir. TH. F. NAJOAN M. ENG	Staff of Hydraulic Structure Branch
Ir. C.L. NUGROHO	Staff of Eng. Geology Branch

Sala River Basin Development Project Office:

Ir. SUMINTO	Project Manager
Ir. SUTANTO Dipl. H.E.	Chief of Design Section
Ir. SUDARTO	Chief of Operation Section
Ir. DIAH ISNADI Dipl. H.E.	Chief of Laboratory
Ir. BAMBANG	Staff of hydraulic laboratory
Ir. MARDIKAYANTO	Staff of hydraulic laboratory
Ir. RUKIYATI	Staff of soil laboratory

Kali Brantas Multipurpose Project Office:

Ir. PUTRA DUARSA	General Manager
Ir. SOEMARTO Dipl. Hidrol	Deputy Chief of Planning Department

Karangkates Project Office:

Kr. SUJITNO	Deputy Manager

Wlingi Project Office

Ir. A. MADJID Dipl. H.E.	Project Manager
Ir. NURHONO M. Eng.	Deputy Manager

Kali Surabaya Project Office:

Ir. DM ROEDJITO Dipl. H.E.	Project Manager
Ir. SOCHEH Dipl. H.E.	Deputy I Manager
Ir. NURACHIN	Deputy II Manager

Bandung Institute of Technology:

Prof. M.T. ZEN	Professor on Geology

Geological Survey of Indonesia

Ir. W. SUTISNA	Staff of geophysics section
Ir. A. SUDRADJAT	Head of Vulcanology Division
Ir. SURATMAN, P	Staff of Vulcanology Division

Institute of Building Research

Ir. A. KARTAHRADJA	Director
Ir. M. MUNANDAR	
Ir. A.S. TRIHADI	

Meteologycal and Geophysical Institute

Drs. R.P. SUDARMO	Head of Research Division

U.N. Consultant in IHE, Bandung

Prof. Y. TUCHIYA	Professor of Kyoto University

Embassy of Japan

Mr. T. NAKAO	First Secretary

Colombo Plan Expert

Mr. A. HAMAMORI	Coordinator of river and Sabo team Expert
Mr. NAKAHIRO	Expert assigned to Directorate of Rivers
Mr. KONG	- do -
Mr. WATANABE	- do -
Mr. FUJIE	- do -
Mr. OSHIKI	Expert at Sala
Mr. OGUCHI	- do -
Mr. MISHIMA	Expert at Yogya
Mr. TAKANASHI	Expert at Kediri
Dr. D. UNO	Expert at Bandung
Mr. YAMADA	- do -
Mr. FUJIMORI	- do -
Mr. GOTO	Expert assigned to Housing Division
Mr. SASAGAWA	- do -
Mr. TANAKA	- do -

JICA

Mr. Mr. MIYAMOTO	Director of JICA office in Jakarta
Mr. SHINOURA	Assistant Director

Nippon Koei Ltd.

Mr. Y. MARUSUGI	Manager of Malang Office
Mr. K. SAWAYA	Manager of Wonogiri Dam Construction Office
Mr. SUMIKAWA	Manager of Wlingi Dam Construction Office

Mr. I. MISHINA	Assistant Manager
Mr. SISIDO	Civil Engineer
Mr. MOTOORI	Civil Engineer

Nikken Consultant Inc.

Mr. J. EBIHARA	Team leader for the Kali Surabaya River Improvement Project.

Appendix II Hydraulic Structures

Inspected during Field Trip of Mission

1.	Jatiluhur Dam	Jatiluhur Authority
	Rockfill Dam, Height:	100 m
	Morning-glory Spillwas and Intake:	90 m in Diameter
2.	Wonogiri Dam	Bengawan Solo Project
	Rockfill Dam. Height:	39.5 m
3.	Bening Dam (Widas Basin)	Brantas Multipurpose Project
4.	Konto Sand Pond	Brantas Multipurpose Project
5.	Selorejo Dam	Brantas Multipurpose Project
	Zoned Fill-type Dam. Height:	46 m
6.	Karangkates Dam	Brantas Multipurpose Project
	Rockfill Dam. Height:	72 m
7.	Lohor Dam	Brantas Multipurpose Project
	Rockfill Dam. Height:	72 m
8.	Lodoyo Dam	Brantas Multipurpose Project
	Gate Weir	
9.	Wlingi Dam	Brantas Multipurpose Project
	Rockfill Dam. Height:	44 m
10.	New Lengkong Dam	Brantas Multipurpose Project
	Gate Weir	
11.	New Gunungsari Dam	Brantas Multipurpose Project
	Gate Weir	
12.	Mlirip Gate	Brantas Multipurpose Project
13.	Jagir Dam	Brantas Multipupose Project