8. Postscript

One can say that the Philippine Islands, like the Japanese Islands, are under environments where major earthquakes are liable to occur. Though the recurrence interval of major earthquakes is somewhat longer than in Japan, structures should have much the same seismic resistance as in Japan. Under these circumstances, the earthquake observation network and the seismic resistance of structures, particularly modern buildings, have not yet been adequately improved although considerable earthquake countermeasures have been implemented during the past period of more than 20 years. Moreover, the technology of post-earthquake response is inadequate in such respects as determining degrees of damage to structures after earthquake. We cannot but point out the above as conclusions from the rehabilitation technical cooperation we have rendered during our brief stay.

Earthquake countermeasures are not merely a technical issue but require consideration of the economic and social conditions of the respective countries. Thus, many matters must be finally decided by the Philippine side but we hope that they will implement our foregoing recommendations for the future as soon as possible. At the same time, we keenly feel that Japan, as another Asian earthquake country with many disaster experiences, should extend technical cooperation and aid to the Republic of Philippines in the future, whenever possible.

It is desirable for Japan to dispatch a second team soon to help determine degrees of damage to stricken structures and carry out emergency rehabilitation. We are certain that this will be very effective for early rehabilitation from the recent disaster and minimize the impact of this damage on economic activities since the impact is likely to continue for some time to come.

When we think of all the officials concerned who welcomed us and made all necessary arrangements for us and when we remember the kind faces of local people we met everywhere; they invited us to lunch at their homes or laid aside their work to show us to the sites of faults ... when we think of all this, we cannot help

feeling that, to learn a true lesson from the recent disaster, which occurred in the starting year of the International Decade for Natural Disaster Reduction, it is high time that all human beings worked together beyond the borders of nations and draw on their resources for their mutual benefits.

Appendices

Appendix 1. Materials Provided by Philippine Side

1) Preliminary Estimates of Repair/Rehab of Infrastructure Damaged by 16 July 1990 (DPWH).

2) Statistics on Damage in Bengued State (From the state governor).

3) Statistics on Damage in Baguio (addition) (From DPWH District Office).

4) Statistics on Damage in Manila (DPWH).

5) Map with names of buildings in Dagupan City (From Dagupan city hall).

6) Aftershock map (From Philippine Institute of Volcanology and Seismology).

7) Seismic intensity scale map (From Philippine Institute of Volcanology and Seismology).

8) Distribution of Earthquake Generators in the Philippines (From Philippine Institute of Volcanology and Seismology).

9) Distribution of Active and Inactive Volcanoes in The Philippines (From Philippine Institute of Volcanology and Seismology).

10) Boring chart for Manila Radial Line No. 10 (From Pacific Consultant).

11) Standard Specifications Vol. II, Highways, Bridges & Airports, 1988.

12) Design Guidelines Criteria and Standards Vol. I and II, DPWH.

13) National Structural code of the Philippines, Vol. II Bridges, Association of structural Engineers of the Philippines, 1987.

14) J.P. Hollings: Earthquake Engineering for the ILIGAN-BUTUAN ROAD in the Island of MINDANAO-PHILIPPINES, ADB, 1972.

15) A Course on Aseismic Design and Construction of Structures, Asian Disaster Preparedness Center AIT, 1987.

16) Design data (Carmen, Calvo, Aringay and Bauang Bridges).

17) Photographs taken after the earthquake (17-21 July) (From Manila office of Kumagai Gumi Co., Ltd.).

18) Videotape of the above (Being prepared).

19) Maps of different places (Dagupan, Baguio, Manila and whole of the Philippines).

20) Measured values of the time of the earthquake (Exceeding the range of measurement).

21) Philippine geological maps (whole of the Philippines, Baguio, Dagupan, Lingayen, Agoo and Manila).

22) The Study on Flood Control and Drainage Project in Metro Manila (by JICA Report, Feb. 1990).

23) The NATIONAL BUILDING CODE of the Philippines and its implementing rules and regulations.
The law to Enhance Mobility of Disabled Persons with implementing rule and regulations, Philippine Law Gazette.

24) National Structural Code of the Philippines Volume 1, Buildings, Towers and other Vertical Structures, 3rd Edition Sept, 1988 by Association of Structural Engineers of the Philippines.

25) Structural Design Data and Specifications by A.B. Corrillo 6th edition, may 1983 (KEN Incorporated).

26) Newspaper clippings of period after the earthquake.

27) Boring data of Dagupan city (4 places).

28) Earthquake and Tsunami. Philippine Institute of Volcanology and Seismology.

29) Preliminary Estimates of Repair/Rehab of Infrastructure Damaged by 19 July 1990 Earthquake DPWH, as of 26 July 1990.

30) Situation Report (Pangasian).

31) Socio-Economic Profile of Dagupan city.

32) Estimate of Daily Losses and Assessment of Bank Institutions in Pangasian.

33) Boring data of Dagupan (Boring map and geologic column diagram).

34) Photographs taken along the "KENNON Road," July 16, 1990.

35) Photographs of the KENNON Road taken from a helicopter.

36) Marcos highway, Location Affected by Earthquake and Straight Line Diagram.

37) Straight Line Diagram
Along . Baguio-Bancay Road
. Kennon Road
. Marcos Highway
. Baguio-Bontoc Road

38) Naguilian Road, Summary of Quantities (Slide volume etc.) and straight line diagram.

39) Calamity Report of Embassy of Japan.

Appendix 2. Materials Provided to Philippine Side

1. Earthquake Disaster Countermeasures in Japan (1988, National Land Agency)

2. Report (Outline) of The Japanese Technical Study Team for the Loma Prita Earthquake (1990, The Japanese Technical Study Team for the Loma Prita Earthquake)

3. A seismic design code in Japan

4. Example of repair & strengthening of damaged Building (by Hirosawa, IISEE lect. textbook)

5. Evaluation of the result obtained by the Japanese missions to SSR of Armenia (by Okada, et al,)

6. A seismic evaluation of existing buildings supporting documentation
   (Fema: federal emergency management agency 1989, May)

7. Techniques for seismically rehabilitating existing buildings (preliminary)
   (Fema: 1989)

8. Rapid visual screening of buildings for potential seismic hazard; a handbook (July 1988)

9. Records of restoration of damaged buildings due to 1964 Niigata Earthquake by architectural institute of Japan (April 1966)

10. Standard for evaluation of seismic capacity of existing reinforced building 1977, association of Japan building disaster prevention

11. Report from international emergency rescue team on Spitak Earthquake in Armenia in USSR, June 1989, JICA

12. Earthquake Damage evaluation for reinforced concrete buildings by M. Murakami and T. Okada, symposium "Urban Disaster Mitigation" Tangshan, China, Sept. 1988

13. Recommendation on damage evaluation, repair and strengthening for buildings damaged by September 19-20, 1985 Mexico Earthquakes
- Report submitted to the department of federal district of Mexico by the Japan International Cooperation Agency Mission Dispatched to Mexico from October 19 to November 22, 1985
(The Japan International Cooperation Agency Mission)

14. Manual for Repair Methods of Civil Engineering Structures Damaged by Earthquakes, PWRI/NCEER 1986

15. Soil Liquefaction Studies in Japan: state-of-the art, by Tosio Iwasaki, Soil Dynamics and Earthquake Engineering Vol.5 No.1, 1986

Appendix 3. Related Agencies in Philippine

(1) Agencies related to the Philippine Government

. Department of Public Works and Highways (DPWH)

(Secretary) Fiorello R. Estuar 47-31-80
40-35-52
(Telex) 2335 MPHPU

(Under Secretary) Teodoro T. Encarnacion

(Assistant Under Secretary) Manuel M. Bonoan 40-15-51

. Philippine Institute of Volcanology and Seismology (PHILVOLCS)

(Director-General) Paymundo S. Punongbayan 712-4669
(FAX) 711-30-77
(Telex) 65587 IOVASPN

Takashi Nakata
(Hiroshima University, Assistant Professor)

. Department of Transportation and Communications (DOTC)
631-8666 to 86

. National Housing Authority (NHA) 99-45-61
. National Irrigation Authority (NIA) 96-15-20

(2) Local administrative authority on Philippine side

. Baguio

(City Mayor) Jaime Bugnosen

. Dagupun

(City Mayor) Hon. Liberato LI. Reyna. Sr. 41-96
42-52

(3) Cooperative Japanese Experts

. Kuniaki Nakamura

DPWH, Bureau of Research & Standards 96-28-31
EDSA Diliman, Quezon City

. Tetsuaki Iwakiri
DPWH, Planning Service 48-94-29

. Ryoji Hagiwara
DPWH, Planning Service 48-94-80

. Tatsuo Takeuchi
DOTC, Transportation Planning Service 631-8666 to 86
631-6229

. Koichiro Hirai
NHA, Estates Group 899-4561

(4) Embassy of Japan 818-9011

(Ambassador) Tsuneo Tanaka
(In Charge) Takuya Ikeda

(5) JICA office 88-30-81

(Resident Representative) Moriya Miyamoto
(In Charge) Kenji Matsumoto

(6) Cooperative Japanese Enterprises

. Katahira Engineering International Co. 818-3492
. Nippon Koei Co. 818-5980
. Kumagai Gumi Co. 815-1197
815-4660
. Tobishima Corporation 818-3493
. Taisei Corporation 819-5214
. Nishimatsu Construction Co. 818-5110
. Takenaka Komuten, Co., Ltd.

Appendix 4. Memorandum of Briefing Meeting/Tentative Report - July 16, 1990 EARTHQUAKE

Briefing Memorandum

Place: Department of Public Works and Highways
Time: 14:00 - 16:30, August 6, 1990
Attendance:

(From Japanese) Secretary Ikeda of the Japanese Embassy in Manila
Leader Okada and all members of the expert team
Long-term expert in Manila
Persons cooperating in activities of the Japan Disaster Relief Team from Japanese companies operating in Manila

(From Philippines) Secretary Estuar, Undersecretary Encarnacion, Assistant Undersecretary Bonan, and engineers from the Department of Public Works and Highways, PHILVOLCS
NIA, NPC,
USAID and CODA Constructionist Association, Consultant Association, etc.
Total attendance: about 60 persons

Outline of Briefing:

The briefing was presided over by Mr. Undersecretary Encarnacion. After introduction of those present, Mr. Okada, leader of the team, made a summary report on rehabilitation as well as on what had been found from their field explorations. Then, the team members made somewhat more detailed reports, using slides and OHP (overhead projector).

In the meantime, the attendant from the Philippines side, occasionally asked questions concerning their briefings. Mr. Secretary Estuar showed great interest, particularly in the

causes of the damages in Baguio City and in the liquefaction induced damages in Dagupan, asking questions about these.

The reports of the expert team did not only described the status of the damages and provide an analysis of it from the scientific viewpoint, it also included recommendations on the possibilities for reuse of remaining facilities, for methods of repair and for reinforcement of damaged structures, and for other specific emergency measures, and even made recommendations concerning the direction of long-term measures. Secretary Estuar expressed his thanks and spoke of his hopes for the early completion of the final report of the expert team.

Preliminary Report

JULY 16, 1990 EARTHQUAKE

- Preliminary Investigation and Recommendations -

by

Japanese Expert Team

as dispatched by the Japanese Government

through Japan International

Cooperation Agency (JICA)

August 6, 1990

T A B L E O F C O N T E N T S

1. Introduction

This report describes briefly the activities of the Japanese Expert Team dispatched by the Japanese Government thru Japan International Cooperation Agency (JICA) to cooperate with the Department of Public Works and Highway, Philippines in the rehabilitation of damaged structures brought about by the July 16, 1990 earthquake.

The report also includes preliminary recommendations for the rehabilitation of the damaged structures and the earthquake preparedness in future.

A final report will be prepared later based upon detail analysis of the data since the stay in Philippines is quite limited.

2. Itinerary and Members

7/29	(Sun.)	Arrival Manila
7/30	(Mon.)	Preparation for Field Survey, Courtesy call
7/31	(Tues)	* Field Survey on geological condition,
8/01	(Wed.)	* soil condition, roads, bridges, dams, rivers,
8/02	(Thur)	* buildings in earthquake affected area
8/03	(Fri.)	* (Baguio, Dagupan, Tarlac, Agoo, Villasis,
8/04	(Sat.)	* San Jose, Digdig, Bayombong, Rizal,
		* Cabanatuan, Manila, Pantabangan, Tabbo)
8/05	(Sun.)	Preparation for the briefing
8/06	(Mon.)	Briefing at the DPWH
8/07	(Tues)	Leave Manila for Tokyo

* Being taken at the same time

MEMBERS

Team Leader:	Tsuneo OKADA	-	Univ. of Tokyo
	Toshiro YAMADA	-	Disaster Prevention bureau National Land Agency.
	Akiomi SHIMAZU	-	Public Works Research Institute, Ministry of Constructions.
	Yasushi SASAKI	-	- do -
	Michio OKAHARA	-	- do -
	Shinsuke NAKATA	-	Building Research Institute, Ministry of Construction
	Yoshihiro KINUGASA	-	Geological Survey of Japan, Ministry of Trade and Industry.
	Yoshiharu YONEYAMA	-	JICA

a) Philippine Counterparts

1.	Engr. Crispin B. Banaag Jr.	-	Gen. Inspectorate Group
2.	Engr. Roger F. David	-	Road I Group
3.	Engr. Zosimo G. Alberto	-	Road I Group
4.	Engr. Simplicio Pestano	-	Road II Group
5.	Engr. Joel Surot	-	Bridge Group
6.	Engr. Virginia Damaso	-	- do -
7.	Engr. Armenio E. Ayson	-	- do -
8.	Engr. Nelson Livara	-	River Structure and dam
9.	Engr. Domingo	-	- do -
10.	Engr. Wilfredo Lopez	-	Building Group
11.	Engr. Rogelio Isturis	-	- do -

b) Long Team JICA Expert

Mr. Kuniaki Nakamura	(DPWH, BRS)
Mr. Tatsuo Takeuchi	(DOTC)
Mr. Ryoji Hagiwara	(DPWH, Planning Service)
Mr. Tetsuaki Iwakiri	(DOWH, Planning Service)
Mr. Koichiro Hirai	(NHA)

3. General Description of the Earthquake and Extent of Damage

The movement of the Digdig Fault, a part of the Philippine Fault System, was observed. This involved a left lateral dislocation of about 5 meters horizontally: 1 to 1.5 meter vertically: and extending about 40 km long from the south of the Municipality of Rizal up to the north of Digdig Carranglan, all in the Province of Nueva Ecija. Judging from the observation the fault dislocation, damage to structures ground failure and the information from Philvocs, the earthquake was caused by the movement of the Digdig Fault.

The earthquake affected area is spread very widely. However, the severely damaged area was basically limited within a triangular zone connecting Baguio, Dagupan and Carranglan, as well as the damage on the roads along Dalton Pass, Puncan down to Bongabong and the three major roads from Baguio to the west coast of Ilocos Region.

The earthquake intensity map based upon the data obtained by the Japanese Expert Team is show in Figure 1. The damage to the structures can be classified into the following types:

1. Collapsed of buildings due to ground shaking which was observed mostly in Baguio and Agoo including those in Cabanatuan and Umingan, Pangasinan.

2. Tilting, sinking and/or floating of buildings due to "soil liquefaction" observed mostly at Dagupan City.

3. Collapsed of dwelling houses due to land slip observed in Baguio City, and many towns along Naguilian Road, Dalton Pass etc.

4. Falling or failure of bridge decks due to the movement of bridge piers caused by "soil liquefaction" and many pile-bent type abutments on soft ground damaged due to earth pressure of high backfill and strong earthquake force.

5. Some surface slope failure, sinks and cracks on dams due to ground shaking were observed.

6. Extensive number of slope failure of roads due to strong earthquake motion was observed in mountainous terrain routes at Pan-Philippine Highway, roads to Baguio (Kennon, Marcos and Naguilian).

7. Secondary damages due to rainfall such as mud flow, timber piling up at some bridges were also observed along the mountainous roads.

8. Severe damage on river structures such as earth dike, revetment and parapet wall were observed especially along the Agno River and Pampanga River.

4. Activities

In order to carry out the damage investigation of the disaster areas mentioned above and to execute the field survey efficiently with in a limited time, six sub-groups have been organized, to wit:

1. General Inspectorate Team (Okada, Kinugasa, Yoneyama)
2. Road Inspection Team 1 (Shimazu)
3. Road Inspection Team 2 (Sasaki)
4. Bridge Inspection Team (Okahara)
5. River and Dam Inspection Team (Yamada)
6. Building Inspection Team (Nakata)

Each subgroup was complimented with one or two engineers from DPWH and engineers from Japanese Construction corporations currently operating in the Philippines. Besides the damage investigation, each group has discussed with local authorities and engineers about the rehabilitation of damaged structures.

5. Findings and Preliminary Recommendations

Findings and preliminary recommendations of each subgroup are reported as follows:

1) Geology and Seismology (by General Inspectorate Team)

The General Inspectorate Team investigated overall damage, geological and seismological features. Since the overall damage is described in the previous section, the geological and seismological features are reported here including recommendations.

(1) Activities

7/29 Leave NARITA
Arrive MANILA

7/30 Visit to Japanese Embassy
Visit to JICA
Visit to DPWH
Visit to PHIVOLOS

7/31 Leave MANILA (Courtesy of Philippine Air Force)
Arrive SAN FERNANDO, LA UNION
Meeting with Director of DPWH Regional Office I
Dir. Alfredo M. Parayno.
Leave SAN FERNANDO, LA UNION
Arrive BAGUIO CITY
Inspection of damage to buildings in Baguio
Courtesy call to the Mayor of Baguio City
Meeting with the CAR Regional Director of DPWH Dir.
Alberto S. Blancas

8/01 Inspection of damage to buildings in BAGUIO
Meeting with the Governor Andres R. Bugnosen of the
Province of Benguet
General observation of earthquake damages along the
route from BAGUIO to DAGUPAN CITY

8/02 Observation of damages in the central part of DAGUPAN and POGO GRANDE district
Courtesy call to the Mayor of Dagupan City, Hon. Liberato D. Redyna Sr.
Inspection of CALVO Bridge and CARMEN Bridge
Observation of damage at UMINGAN, PANGASINAN
Observation of the earthquake surface fault along the route from SAN JOSE CITY TO DIG-DIG, CARRANGLAN

8/03 Observation of the earthquake fault, slope failures along the route from SAN JOSE CITY to km 194 of Daang Maharlika
Inspection of the upper Talavera River in SAN JOSE CITY
Observation of the earthquake fault in RIZAL, NUEVA ECIJA
Brief inspection of the Christian College in CABANATUAN CITY
Arrive MANILA

8/04 Observation of the earthquake fault between DIG-DIG and BONGABON using helicopter (KINUGASA and YONEYAMA)
Preparation for briefing.

8/05 Preparation for briefing

8/06 Briefing at DPWH

8/07 Leave MANILA for TOKYO

(2) Effects of Geology on Damages

It is evident that most of the damages were controlled by local geologic condition, such as:

- Geologic/Topographic conditions being a part of the cause of the building damage in Baguio City;

- Liquefaction at Dagupan City;

- Displacement of road and cracking due to faulting.

In this connection, geological condition should be taken into account for reconstruction and future development and also, in the stage of rehabilitation.

(3) Earthquake Fault

Fault breaks and dislocation of various objects were observed along the trace of Digdig fault, one of the segment of the Philippine Fault System, from Digdig, Carranglan up to the Municipality of Rizal, all in the Province of Nueva Ecija. Fault trace further north is obscure due to massive slope failures. In the South, between Rizal and Bongabon, fault trace was observed from air by helicopter.

Left-lateral offset up to 5 m had been measured throughout the observed trace. The sense and amount of vertical offset are different from place to place. On the area where the road is paved, cracky zone of 2 to 5 m wide is quite observable.

Damages due to vertical displacement of the fault, such as displacement of the level of paddyfield and irrigation systemsre also observed. Massive slope failure along the fault trace is evident.

Detailed survey on the location and the amount of the displacement of the fault is needed for rehabilitation and reconstruction, and hence recommended. Since active faults such as the Digdig Fault and many other fault segments of Philippine System are considered to be the earthquake generators in-depth studies are recommended.

(4) Research on Earthquake

Although earthquake prediction is still in the state of the art throughout of the world, public education and awareness on earthquake phenomena based on the scientific observation and research are very effective procedure to minimize the future earthquake damage. In this connection, intensification of monitoring the seismicity of the Philippines and basic research on earthquake are recommended.

(5) Installation of Observation Network for Strong Motion

Since no data is available on strong motion of earthquake in the Philippines, it is highly recommended that an observation network for strong motion be installed to established the seismic design for the country.

2) Road 1

(1) Activities (for Pan Philippine Highway)

July 30 (M) Leave Manila to Cabanatuan and stay there

July 31 (T) Leave Cabanatuan to San Jose
Site Inspection from San Jose (km 160) to Digdig (km 181) by Inspection car, come back to San Jose and stay there

Aug. 01 (W) Leave San Jose to Digdig
Site Inspection from Digdig (km 181) to Aritao (km 236) by Inspection car, by walk (from km 192 to km 206) and by chartered car. Proceed to Bayombong and stay there.

Aug. 02 (TH) Leave Bayombong to Aritao
Site Inspection back from Aritao (km 236) to San Jose (km 160) by chartered car, by walk, and by Inspection car. Leave San Jose to Tarlac and stay there.

Aug. 03 (F) Leave Tarlac back to Manila via Dagupan.

(2) Damages inspected along Pan-Philippine Highway (San Jose - Aritao).

On the route of Pan-Philippine Highway, gigantic disasters are concentrated in San Jose - Aritao section (76 kms long) which passes through mountaneous terrain. The road section has been closed for traffic mainly due to quite large number of slope failures (cuts and embankments). Above the failure along the road, large number of natural mountain slopes in these section area also suffered by same scale of failures. These failures occurred along the high and steep gradient slopes in slipping down manner (shallow types surface failure of loosen weathered part). On the other hand, failures have hardly found in the low and gentle base foundation (such as retaining walls).

The major damages are categorized as slope failures (Cut and Embankment), road shoulder settlement, pavement destruction and other (secondary disasters).

(a) Slope failures

Accumulated road length of approximate 12 km have been damaged. Total number of fallen cut slope is estimated to be more than 200. Inspected results are tabulated in Appendix 1 as summary of disaster spots.

(b) Pavement failures

Pavements are also damaged at the portion of settled embankment, rock fall, thrust up movement. Also pavement where fault crosses are heavily crushed.

(c) Other (Secondary disasters)

Due to following rainfall after the earthquake, mud flow which is produced from loosely collapsed sediment of natural

mountain valley over-flowed through load way to close traffic.
Along rivers, large number of timber have been washed away ti pile up at bridge site causing another danger condition.

Typical type of disasters on the route is summarized in Appendix 2 as Surface failure (talus, rock). Rock fall, Embankment failure (Shoulder, shallow) and Pavement failure (thurst up, fault).

(3) Recommendation

The earthquake has brought extensive number of newly exposed slope to be protected. The fresh slope surface will rapidly be weathered and loosen through severe atmosphere of heavy rainfall, and will become further difficult origin of continuous product of slope failure.

Quick introduction of slope protection work will strongly be recommended for securing safe and smooth craffic activity. Following three steps procedure will be recommended.

(a) Urgent Restoration Procedure for Road Recovery

- Secure stable slopes on removing loosen collapsed sediment. It is advisable not to force to open too wide.
- Avoid to use filling part for traffic lane.
- Inspect Secondary collapsed which might be brought by open cracks on the top part of slopes.
- Traffic control for coming heavy rainy season.
- Re-cut to stable slope gradient/Rounding upper slope shoulders.
- Protect foot of slope by structures such as catch wall (stone masonry wall, gabion, concrete gravity wall, etc.)
- Protect foot of embankment by structures (gabion etc.) against scoring.
- Fill open cracks on road shoulder.
- Set up obstacle structures on upper valley against mud flow.

(b) Improvement Procedure

- Carry out engineering survey (topographical, geological) for condition of stability of slopes.
- Proper Design for stable slope condition.
- Introduce slope protection works

for example:

for soft rock surface	:	concrete spraying
for talus surface	:	sodding, berm, drainage ditch, crib work
for embankment	:	sodding, stone pitch, stone mosonry wall.

(c) Mid to Long Term Procedure

The section which has quite high and deep sloping topography not allowing room space on road way and has weak composite material will not be applied by common re-cut technique. And in such terrain condition, slope protection itself becomes costly and more takes much maintenance. In such section, like Dalton Pass, etc., realignment of roadway, introducing bridges or tunnel will be worth considering for future economic development.

Apart from problem caused by the earthquake to highway, applicability of Sabo works which reduce debris flow into the flat area might be worth to be checked for keeping sound terrain and river condition in these area.

3) Road 2

(1) Activities

The Road-2 Group visited the following sites.

7/30 Manila to Dagupan through Manila North
visited sites are;
* North Expressway Viaduct on Pampanga river
* San Isidro Bridge

7/31 in Dagupan City
visited sites are;
* City Engineer's Office
* Task Force Rehabilitation Office
* Magsisi Bridge
* Barangay Pugo
* Carmen Bridge

8/1 Dagupan - San Fernando through Longas, Amlang, Rosario and Agoo
visited sites are;
* Mangueragday Bridge
* Longas Bridge
* Cayanga Bridge
* Kennon Road up to STA 224
* Marcos Highway up to KM 273

8/2 San Fernando - Baguio - San Fernando
visited sites are;
* DPWH Regional Office I
* Naguilian Road
* Marcos Highway up to KM 277
* Kennon road up to Benguet Mining

8/3 San Fernando - Manila

8/5 Manila-Baguio-Manila by helicopter
visited sites are;
* Kennon Road
* Maharlika Highway

(2) Damages Inspected

Main points obtained from the reconnaissance by this group are summarized as follows.

(a) Damages to infrastructures were observed at fairly wide area along the surveyed routes.

(b) Many sites were clearly affected by the soil liquefaction of the ground.

(c) Damages seen on the road are categorized into (1) damages to bridges, (2) damage to embankments and pavement, and (3) the road side slope unstability.

(d) The road side slope unstability caused the severe disaster to three (3) major roads leading to Baguio City from the west coast area. Likewise, some places in the City of Baguio were damaged by landslide.

(e) Rainfall causes difficulty in the conduct of the rehabilitation work in these three (3) major routes as well as the enormous mass of fallen rocks and soil.

(3) Recommendations

(a) Introduction of guidelines to assess the damage to infrastructures.

- For this purpose, the "Technical Manual for Repair Methods for Civil Engineering Structures Damages by Earthquake" (of Ministry of Construction Japanese Gov.) can be used with modifications to be applied to Philippine structures.

- Some of the damaged bridges have been assessed by the Bridge Group of this team. However, it should be noted that this assessment has some limitation due to lack of data, and the shortage of time.

(b) Introduction of guideline to assess the seismic susceptibility of infrastructure facilities and to strengthen the existing bridges based on this assessment.

(c) The alignment of Kennon Road is recommended to be re-examined.

- High possibility of landslides occurrence along the road alignment makes it impossible to be maintenance-free even if it were opened.

- Mountain slope tends to slide continuously during fairly long period of rainfall, loosening the top soil that caused the cracks due from shaking.

(d) Re-development is recommended to rehabilitate the damaged area of the Dagupan City.

- Some part of the City sank due to soil liquefaction causing the difficulty of repairing the drainage function.

- Surveying and boring test result will be the essential information to decide the recommended area to be relocated.

- The soil condition of the surface layer up to 20-30 m is essential for the vulnerability against liquefaction.

(e) The slid area inside the Baguio City should be monitored to avoid the secondary disaster.

- Those failed slopes in Baguio City are facing the residential area.

- Extension of the slope failure due to rainfall may cause the secondary disaster.

(f) Strengthening of disaster prevention measure of Naguilian Road and Marcos Highway will be needed, even though they are fully opened to traffic.

4) BRIDGE

(1) Field inspection of 30 bridges (additionally photo inspection of 9 bridges) damaged by the earthquake was executed by Japan - Philippine Joint Team headed by M. Okahara, Japanese Expert, from July 30 to August 3, followed by the itinerary of Appendix-IV(1).

(2) Judgement of calamity regarding bearing force of load for the damaged bridges have been classified in Appendix-IV(2).

(3) Recommendations of temporary and permanent restoration have been proposed in Appendix-IV(3) for 7 seriously damaged bridges and 3 bridges which need emergency actions to secure mobility; Sison (Carmen) Bridge, Calvo Bridge, Magsaysay Bridge, Cupang Bridge, Tabora Bridge, Rabon Bridge, Manicla Bridge, Embarcadero Bridge, Aringay Bridge and Sicsican Bridge.

(4) Recommendations for newly constructed or existing bridges have been proposed as follows:

(a) Bridge fall prevention methods such as installation of bracket to substructure, connection of two girders and the expansion of shoe seat to maintain distance enough from shoe to the end of substructure shall be adopted in order to prevent bridge from falling.

(b) The necessary penetration depth and rigidity of (pile) foundation shall be considered in its design to maintain the stability of the foundation constructed at potential area of soil liquefaction caused by earthquake.

(c) The foundation of abutment loaded by earth pressure of high backfill and constructed on soft ground shall not be a pile-bent type foundation.

(d) The specification shall be revised to improve earthquake resistance capacity of bridges.

(e) Necessary number of emergency portable bridges shall be reserved for emergency actions.

5) River Structure and Dam

(1) Activities

Date	Destinations
July 30 (Mon)	- NIA Head Office, Q.C. - NIA UPRIS Office at Cabanatuan City
July 31 (Tue)	- NIA UPRIS Office, Dislocation site at Rizal, Nueva Ecija Diversion channel No. 1 of UPRIS - Pantabangan Dam (NIA) - Aya Dam (NIA) - Masiway Dam (NIA)
Aug. 01 (Wed)	- Paniqui (Tarlac river) - Agno River Flood Control system Office (DPWH) - Bayambang-Urbistondo earth dike (Agno River) - Villasis-Bayambang earth dike (Agno River) - Dagupan City
Aug. 02 (Thu)	- Pampanga Delta Flood Control System Project Office (DPWH) - Frances Flood Gate (Pampanga River) - Sapang-Maragul Flood Gate and Navigation Lock at Bebe-San Esteban C.O.C. Apalit-Arayat setback levee (Pampanga River) - Arayat-Cabiao ring levee (Pampanga River) - Angat Dam (NAPOCOR)
Aug. 03 (Fri)	- Binga Dam (NAPOCOR) - Ambuklao Dam (NAPOCOR)

(2) Damage Observed

2.1 River Structures

2.1.1 Earth dike

The earthquake brought various damage to the earth dike. Those are considered in the nature of the soil, conditions of the interior and riverside of the dike. The main features of the damage are cracking, sinking and sliding of the earth dike.

2.1.2 Revetment

The foot protections, wet masonry and access revetment to the bridges were destroyed.

2.1.3 Parapet wall

Parapet walls were damaged in many places.

2.1.4 Other river structures

Other river structures such as flood control gates, drainage gates and water gauge stations were damaged.

2.2 Dams

2.2.1 Ambuklao Dam

(1) The crest sinks approximately 50 centimeters.
(2) Many cracks and surface slides were observed on the upstream slope.
(3) Cracks are also present at the crest. However, these are no longer visible because repair work was undertaken during the inspection and these cracks were already covered with filling material.
(4) The downstream slope looks stable.

(5) No severe damage in the spillway except for the opening of the expansion joint at the separate wall.
(6) Landslides on the slope around the spillway occurred.

2.2.2 Binga Dam

(1) Sinking of the crest is not observed visually
(2) Many longitudinal cracks are observed on the crest (mainly at the upstream side and both edges of the crest).
(3) Lateral cracks are observed on the crest near the spillway.
(4) Riprapping on the upstream slope is fairly stable.
(5) No severe damages are observed on the down stream slope except for small landslides on the roads being used during the construction of the dam.
(6) Lnadslides are observed at the right side abutment and left side cut slope adjacent to the spillway.
(7) Gate No. 2 is not operational.

2.2.3 Pantabangan Dam and Aya Dam

(1) At least 50 centimeters sinking is observed on the right portion of the crest of Pantabangan Dam.
(2) Slopes of the both dams look stable.
(3) No damages in the spillway.
(4) Large scale leakage is observed through the vacuum relief values on the gate chamber.

2.2.4 Masiway Dam

(1) Sinking of about 1 meter is observed on the crest.

(2) Several longitudinal cracks are observed on the crest (max. depth 2.5 meters)
(3) Surface slope failures are observed on the upstream and downstream slopes.
(4) Slope failure is also observed on the upstream slope of Fuse Dike.
(5) No damages in the spillway.
(6) Cracks are observed on the revetment at the right abutment.

2.2.5 Angat Dam

(1) No cracks are observed on the crest, the upstream and the downstream slope.
(2) Riprapping on the upstream slope looks stable
(3) No observed damage in the spillway.

(3) Recommendations

3.1 River Structures

3.1.1 In case of the dikes extremely damaged due to cracking, sinking and sliding, replace the damaged part of the dikes and reconstruct the embankment compactly. Seriously damaged dikes should be protected as soon as possible by the sandbags in order to prevent the flooding.

3.1.2 In case of the dikes damaged due to cracking only at the upper part, replace the damaged upper part and reconstruct it compactly.

3.1.3 In case of the dike sliding, replace the sliding part and afterward cutting the slope of the remaining dike like as stairs, build the embankment compactly.

3.1.4 In case of the dikes damaged by the direct attack of the river flow, construct the spur dike just upper stream of the damaged earth dike in order to change the direction of the river flow.

3.1.5 Materials for rehabilitation, especially the wire cylinder and gabion, are effective for tentative/urgent rehabilitation of the river structures.

3.2 Dams

3.2.1 Countermeasures against cracking

Stage 1: Cover the cracks with the vinyl sheets or sandbags in order to prevent the seepage of the rain.

Stage 2: After investigating the depth, width and location of the cracks, dig or excavate the necessary range (at least to the bottom of the cracks) and fill again with soil. The cracks already covered tentatively should be treated as above.

3.2.2 Countermeasures against sinking

Stage 1: Heap up the sandbags up to the original height.

Stage 2: Afterwards repair the crack on the crest, fill up again to the original height. If the height of the core is short, build the core up to the original height.

3.2.3 Countermeasures against slope failure

Stage 1: Heap up the sandbags at the failure site

Stage 2: Build the embankment as it was. However, if the safety factor against sliding of the dam is not enough, build the embankment with stable gradient. Build the riprap enough to cope with the erosion due to water wave action.

3.2.4 Countermeasures against cut slope failure

Implement the shotcreet, if necessary.

3.2.5 Others

Observe the seepeage and survey the deformation of the dam in order to analyze the safety of the dam.

6) Building

(1) Activities

July 29th TOKYO - MANILA PR 431

30th Preparatory Meeting (Embassy of Japan and JICA)
Courtesy call to Ambassador Tanaka
Detailed Discussion on Survey Schedule

31st 4:15 AM Left Manila for Dagupan by car

8:15 AM Arrived at Dagupan
Surveyed Damaged Buildings in Dagupan
Visited; Dagupan City Hall, City Engineer's Office, Damage Counter Measure Center

15:00 AM Arrived at Baguio
Visited; Mayor of Baguio City, City Engineer
Surveyed; Five (5) Collapsed Buildings (RC)

August 1st Surveyed; 16 Buildings and some of their Structural Drawings, Observation of Severely Damaged Housings

Travelled from Baguio to Manila by car

2nd Courtesy call to Bureau of Design, DPWH
Rapid visual damage screening of 4 buildings in Manila

3rd Rapid visual damage screening of 7 buildings in Manila, Quezon City and Pasay City

4th Rapid visual damage screening of 2 buildings
Arrangement of Data Sheet for each surveyed buildings

5th Preparation of the Report to DPWH,
Arrangement of Data Sheet

6th Completion of the Report

(2) Observed Damage

DAGUPAN CITY

- Soil liquefaction was observed in the west side of Pantal River.
- Settlement and inclination of buildings were due to soil liquefaction.
- The damaged buildings were concentrated along Perez Blvd., Fernandez Avenue., (both E-W direction) and Lizarez Ave.
- The flood depth was about 0.5M - 1.5M. Therefore, causing inconvenience from the viewpoint of city's sanitation.

Buildings (including 5 story RC building) at some area between two city roads (E-W direction) were not damaged by soil liquefaction.

BAGUIO CITY

Within a limited time schedule, the team surveyed nine (9) reinforced concrete collapsed buildings, two (2) severely damaged buildings, two (2) medium damaged buildings and twelve (12) non-damaged buildings.

The reasons why such extensive damaged occurred, will be held in abeyance because no data and materials until this time are available. As to the steps to be taken, given the present condition the following items should be carefully surveyed in detail.

1. Ground Motion
2. Horizontal load carrying capacity and ductility of buildings
3. Construction Workmanship
4. Soil condition in relation to earthquake

METRO MANILA

For two days, the team conducted damage inspection of thirteen (13) reinforced concrete buildings.
Among those buildings we found one (1) with medium damage; two (2) with small damage; and thirteen (13) slightly damaged.

In 1968, (M=6.9)
In 1970, (M=6.8)
In 1984, (M=6.8)

Most of the above mentioned 13 buildings have withstood these quakes and some of these buildings were strengthened or renovated during these earthquake.

The team conducted rapid visual damage screening on these buildings using Japanese guidelines, and found on several buildings, destruction of expansion joint, exfoliate of finishing elements on column, beam and wall and cracks on

these elements, after the latest earthquake occurred on July 16th 1990. It seems these damages are all repairable and buildings are re-usable with the magnitude of the past experienced earthquakes.

However, one building which we were not able to inspect the interior, showed buckling of longitudinal reinforcement of column.

(3) Recommendations

3.1 Rehabilitation

DAGUPAN

According to our experience of Niigata earthquake in Japan way back 1964, settlement and inclination of these buildings seems can be solved by using several number of oiljacks (100 ton). However, a more careful attention should be taken in using the method.

BAGUIO

There is no other way but to demolish those collapsed or heavily damaged buildings.
Other buildings which suffered medium or slight damages are repairable. It is recommended that those who lost their residential houses be provided with temporary housings, deep well and adequate drainage facilities as soon as possible.

METRO MANILA

If the expected intensity of earthquake ground motion is as large as the past earthquakes, buildings which are conventionally repaired can be used safely. However, if such a ground motion as occurred in Baguio took place, it will be required that new strengthening work be adopted.

Technology developed in Japan can be used extensively for that purpose with some modification.

3.2 Research Needs

Considering the Philippines seismic activities, it is required that seismic design criteria be reviewed with respect to the damage caused by the earthquake especially in case of Metro Manila. Earthquake intensity should be investigated and discussed in the earliest stage. Furthermore, it is requested that the design method for permanent seismic strengthening of existing buildings should be developed in accordance with above mentioned scale of earthquake intensity.

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