



JICA TECHNOLOGICAL COOPERATION PROJECTS ON ESTABLISHMENT OF EARTHQUAKE DISASTER PREVENTION RESEARCH INSTITUTIONS

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ABSTRACT: As a result of the Japan International Cooperation Agency (herein after referred to JICA) technological cooperation projects conducted by the Building Research Institute (herein after referred to BRI) in earthquake damage prevention research and related areas since the 1980s, earthquake damage prevention research institutions have been founded in Indonesia, Peru, Mexico, Chile, Turkey, and on every other continent in the world. This paper provides a brief description of these projects, and discusses the issues which remain to be addressed in international technological cooperation in this area.

Key Words: JICA technological cooperation projects, ODA of Japan, earthquake damage prevention research institutions

INTRODUCTION

For over twenty years since 1980, working in conjunction with JICA the BRI has, together with universities, private organizations, and other entities, played an active role in providing technological cooperation in seismological and earthquake engineering technologies to developing nations which include Indonesia, Peru, Mexico, Chile, Turkey, Egypt, Kazakhstan, Romania, and many other earthquake-prone countries throughout the world. This paper describes the nature of the technological cooperation and discusses the problems inherent in providing technological cooperation as a form of international aid together with problems to be addressed for the future.

JAPAN-PERU EARTHQUAKE DISASTER MITIGATION CENTER PROJECT

The Japan-Peru Earthquake Disaster Mitigation Center Project was implemented over the period from June 1986 to June 1991. The objectives of this project were to establish the Peru-Japan Center for Earthquake Engineering Research and Disaster Mitigation (CISMID) within the Peru National University of Engineering and to conduct systematic research and development work on science and technology to develop improved means for the mitigation of earthquake disasters in Peru.

The work performed in this project consisted of research and development, training, and dissemination activities. The research and development work consisted of the development of technologies for providing improved seismic performance of buildings in Peru through the structural testing and analysis of building structures, safety analyses of urban areas under earthquakes, and research on disaster mitigation technologies. The training consisted of basic education and training in seismology and earthquake engineering, including earthquake engineering as a part of urban disaster prevention planning. Dissemination activities consisted of the holding of seminars and the use of other channels to provide information on the results of research to other research institutions, educational institutions, and government organizations so that the research results could be put to use in actual practice.

The following equipment and materials were provided for use in this work.

- (1) Structural testing actuators, hydraulic jacks, universal testing machine, shaking table, reaction frame, measuring instruments, cranes, forklifts, and tools
- (2) Soil quality testing equipment
- (3) Seismographs and strong-motion seismographs
- (4) Personal computers and other research, educational, and office materials and equipment

A total of thirteen personnel including team leaders, coordinators, and long-term (over one year stay) specialists were sent to Peru over the term of the project. 31 short-term (less than one year stay) specialist personnel in testing equipment installation and inspection, geotechnical engineering, urban disaster prevention planning, structural testing, and earthquake engineering were also dispatched. The BRI and other organizations accepted 23 persons from Peru for training in Japan, with the length of the training periods for such trainees ranging from a short-term period of just two weeks to a relatively long-term period of about nine months.

While an assessment of the project performed by JICA at the time of its termination found that the project had for the most part been implemented according to plan, it was also noted that some delays in the transfer of technology had occurred as a result of a worsening of economic conditions and public safety in Peru. Since then, the center has continued performing its work and is now the center of earthquake engineering research in Peru.

EARTHQUAKE DISASTER MITIGATION RESEARCH PROJECT IN CHILE

The Earthquake Disaster Mitigation Research Project aimed to provide cooperation in terms of both knowledge and know-how and equipment and materials for use in research on methods of evaluation of the dynamic soil characteristics to be used in seismic design standards for buildings and foundations, evaluation of the seismic performance of reinforced concrete and reinforced masonry buildings, and the evaluation of the strength of earthquakes to be used in seismic design standards for the city of Santiago, Chile. This project was conducted over one three-year period from December 1988 to November 1991 followed by another three-year period from October 1995 to September 1998 at the Catholic University of Chile.

To meet the objectives of the project the Catholic University was provided with (i) strong-motion seismographs, micro-tremor seismographs, personal computers and personal computer analysis software, (ii) actuators, reaction frames, and measuring instruments for performing structural testing, and (iii) soil composition testing equipment and other materials and equipment, and a total of three long-term specialists and twenty short-term specialists in the field of earthquake disaster prevention were sent to work in Chile. Five persons from Chile underwent training in Japan, with the length of the training period for each of these five persons lasting about one month. Through this project a large number of research results were published as academic papers or academic theses, and the research results were also presented at seminars held during the project term. Some of these results were also used in the proposals for revisions to be made in seismic design standards for buildings and other

related standards in Chile.

MEXICAN EARTHQUAKE DISASTER PREVENTION PROJECT

The Mexican Earthquake Disaster Prevention Project was implemented over the seven years from April 1990 to March 1996. The main focus of this project was the establishment of CENAPRED, i.e., the National Center for Disaster Prevention (Centro Nacional de Prevención de Desastres) in Mexico.

This project aimed to found the CENAPRED using grant aid provided by Japan, to take the steps needed to ensure that the center could function as an independent and ongoing organization involved in research, training, and dissemination of earthquake disaster prevention technologies, and to thereby improve the overall level of earthquake disaster prevention technology in Mexico and in the nations of Central America and the Caribbean.

The work performed in this project consisted of research on structural engineering, seismological observations, the dissemination of research results, and public education and training. The research on structural engineering performed covered a wide range of research which included research using different types of structural testing equipment in a large-scale structure testing laboratory to study the seismic behavior of the frame and brick structures which are the most common type of building structures found in Mexico and the Central American and Caribbean areas, and research on methods for the repair and strengthening of damaged buildings, research on building foundations, and research on soil composition.

The work in seismological observation included the construction of a network of seismological observation stations between Mexico City and Acapulco and a seismological observation network within Mexico City, and it also included a wide range of research such as the use of strong-motion seismological observations to study the transmission of seismic waves, research on systems for the early evaluation of seismic intensities using seismic observation data, research on microzoning as a means of preventing earthquake damage, and research on micro-seismic monitoring as a means of studying building characteristics.

The work on public education and training included the holding of training programs directed towards government officials and ordinary citizens in evacuation and recovery procedures to be used at times of earthquakes in accordance with the guidelines for such provided in the Mexican Secretariat of the Interior's *National System for Civil Protection*, training for professionals in architecture and construction on earthquake engineering and disaster prevention technologies developed for building structures as a result of this project, and public education through the dissemination of related information in the form of posters and pamphlets. Of particular note was the training directed at architecture and construction professionals, where training sessions were held many times during the extension period of the project.

The following equipment and materials were provided to ensure the effectiveness of this work.

- (1) Structural testing materials & equipment: Actuators, measuring instruments, hydraulic jacks, pressure applicator, forklifts, tools
- (2) Strong-motion observation materials & equipment: Strong-motion seismometers, seismometers, data processing and analysis equipment, soil composition testing equipment
- (3) Training, public education materials and equipment: AV equipment, printing equipment, transport vehicles, copiers, personal computers

During the term of the project, in addition to project leaders and coordinators, there were also two long-term specialists always assigned to the project for a total of 22 persons dispatched overall, and the number of specialists sent for short-term stays came to a total of 86 persons. From Mexico, a total

of 22 persons were sent to undergo training in Japan, with the training provided at the BRI and other organizations being conducted over a short period of 1 to 2 months. Once each year (for a total of six times in all), an instruction and inspection tour team was dispatched to Mexico to provide instruction and advice on the project's progress.

In regards to the research performed, the results using the provided equipment and materials were fully satisfactory, and CENAPRED is now becoming one of the most important research institutes of its kind amongst the nations of Central America and the Caribbean. In regards to the training and public education, in seminars it was found that the training and public education could be seen to have been effective, with pamphlets and reports describing research results and Japanese technologies being distributed broadly amongst the participants.

EARTHQUAKE DISASTER PREVENTION RESEARCH CENTER PROJECT IN TURKEY

The objectives of the Earthquake Disaster Prevention Research Center Project were to establish and operate an earthquake disaster prevention research center which could, through testing and research, help accumulating a body of the basic technologies needed to establish methods for reducing the damage from the large numbers of earthquakes occurring in Turkey, particularly in terms of the numbers of deaths. The project began in April 1993 and ended in March 2000. The Earthquake Disaster Prevention Research Center is comprised of the Strong Seismic Motion Observation Sub-center (of the Earthquake Research Department, General Directorate of Disaster Affairs of the Turkish Ministry of Public Works and Settlement), the Earthquake Engineering Sub-center (of Istanbul Technical University), and the Education and Training Sub-center.

The work performed at the Strong Seismic Motion Observation Sub-center involved the creation of a local monitoring station in Samsun, a city located on the shores of the Black Sea, and seven outlying monitoring stations around the city as part of a test system designed to transmit records of strong tremors instantly by telephone to the Ankara Strong Seismic Motion Observation Sub-center at times of earthquakes and to analyze the transmitted data to estimate the scope and scale of damage occurring. This test system is to be used to gather basic data and to learn what needs to be done to apply a similar system for use in planning rescue operations in the future.

The work performed at the Earthquake Engineering Sub-center consisted of the performance of the tests needed in order to gain an understanding of the behavior of building structures and soils at times of earthquakes to gather the basic data and gain the experience needed to reinforce and repair structures and formulate seismic design standards. The building structures studied here consisted of reinforced concrete structures, the most common type of structure found in Turkish cities, and also a type of structure which has proven vulnerable to heavy damage in earthquakes in recent years.

The following equipment and materials were provided for use in this work.

- (1) Strong motion seismometers and seismographs, data recording and data transfer equipment, data analysis equipment, earthquake data transfer control software, and other equipment and materials
- (2) Actuators, hydraulic jacks, measuring instruments, and personal computers for use in data processing and analysis
- (3) Micro-tremor seismographs, personal computers and analysis software for use in data processing and analysis
- (4) Seismic wave detectors, shear testers, and dynamic tri-axial testing system for use in testing soil composition

During the term of the project, in addition to project leaders and coordinators, there were also four long-term specialists always assigned to the project, and the number of specialists sent for short-term

stays came to a total of 57 persons. From Turkey, a total of 16 persons were sent to undergo training in Japan. A number of people, mostly young researchers, were sent from the Earthquake Engineering Sub-center to the BRI and Tokyo University and underwent training over periods from six to nine months. A team of short-term specialists was sent on an instructional tour in 1995, somewhere near the middle of the project term, to provide instruction on the progress of the project. By the end of the project, the objective of ensuring that the sub-centers could function as centers of testing and research was achieved. Progress was particularly significant in the case of the Earthquake Engineering Sub-center, where many research reports were presented at academic conferences and in other forums and where the progress made in terms of the development of young researchers was particularly favorable.

ROMANIAN EARTHQUAKE DAMAGE MITIGATION PROJECT

The objectives of the Romanian Earthquake Damage Mitigation Project include the creation of an Earthquake Damage Mitigation Center together in cooperation with Bucharest Polytechnic University and the Romanian Building Research Institute which will then play the role for the continued transfer of Japanese earthquake engineering technologies improving the seismic performance of buildings in Romania to mitigate the amount of damage caused by earthquakes. Scheduled to last over a period of five years from October 2002 to September 2007, this project is still currently underway.

The following work is scheduled to be performed as part of the work to be done to meet the project's objectives.

- (a) Development of seismic strengthening technologies and improved seismic design standards
While using Japanese earthquake engineering technologies as a basis for the strengthening of existing buildings against earthquakes, low-cost reinforcement technologies will also be developed and applied to existing buildings. At the same time, support will also be provided towards the creation of improved seismic design building standards.
- (b) Dissemination of information on seismic strengthening technologies and related technologies amongst structural engineers
Seminars are to be held to provide information on seismic strengthening technologies and related ones developed to structural engineers.
- (c) Education of general public in disaster prevention procedures for use at times of earthquakes
Seminars and published materials are to be used to disseminate information designed to increase awareness of disaster prevention procedures.

The equipment and materials to be provided consist of those related to structural testing, strong seismic motion observation, and soil testing:

- (1) Hydraulic jacks, measuring instruments, reaction frames, tools
- (2) Strong-motion seismometers and data processing and analysis equipment
- (3) Boring machine, geophysical prospecting system, soil testing equipment, truck

Throughout the entire term of the project there will always be one project leader, long-term specialist, and coordinator assigned to work locally in Romania together with about six short-term specialists to be dispatched each year. Plans call for about four persons each year to be called from Romania to undergo training in Japan. In addition to this, one person per year is to participate in the regular training course offered at the International Institute of Seismology and Earthquake Engineering, the BRI (length of training period: 11 months) to help foster the development of young personnel.

PROBLEMS IN TECHNOLOGICAL COOPERATION PROJECTS

Since the ultimate objective of all of the technological cooperation projects described thus far is that of improving the seismic performance of building structures in developing nations, the nature of the types of technological cooperation being provided in all these cases have the following points in common. All of these projects involve the provision of testing devices and equipment for structural testing, strong-motion seismic observation, and soil testing, and in order to ensure sufficient levels of expertise in the operation of these devices and equipment and in other aspects of technological transfer of structural testing methods, specialists must be dispatched from Japan and researchers from the target countries must undergo technical training in Japan. No matter what the project, vast amounts of funding are being expended towards these ends, and the reason for this is because in technological cooperation of this kind the development of personnel is the most important issue which must be addressed and because it is absolutely essential to the success of these projects that large numbers of highly skilled personnel be developed and continue to play a central role within the associated organizations in the target nations instead of moving to other locations or moving to other places or lines of work. It is often the case that the cause of the loss of skilled personnel lies in the compensation they are given by associated organizations in target countries, and while such losses serve as obstacles to the execution of the projects themselves, at the very least such personnel would be wished to contribute to the improvement of earthquake disaster mitigation in developing nations.

With respect to technological cooperation and the transfer of technologies in testing methods, it would be best if the levels of specialized knowledge in the fields covered by the experts sent from Japan met with the demands of the target nations, but in many cases it is extremely difficult to ensure that this is so.

In all of these projects, state-of-the-art testing equipment has been provided and a great deal of time and effort has been expended in ensuring that the users of this equipment are properly trained in its use and have a proper knowledge of testing methods. Regular maintenance is absolutely essential to ensure that this equipment may continue to be used on an ongoing basis. In actual fact, however, not only do all of the associated organizations in the target countries lack the money to perform regular maintenance, but they also face great difficulties in obtaining the funding needed in order to perform the needed and essential maintenance. In consideration of circumstances such as these, rather than providing advanced, high-performance, state-of-the-art testing equipment, it would probably be better to provide instead simpler devices and equipment which not only have less chance of breakdown but which would also cost less to maintain, even if the equipment in question were a generation earlier than the state of the art.

ISSUES WHICH REMAIN TO BE ADDRESSED IN THE PROVISION OF INTERNATIONAL TECHNOLOGICAL COOPERATION FOR SEISMOLOGY AND EARTHQUAKE ENGINEERING TECHNOLOGIES

As noted above, JICA technological cooperation projects have resulted in the founding of organizations dedicated to earthquake disaster prevention research in developing nations in North and South America, Southeast Asia, and West Asia, and these organizations have come to play a central role in their respective regions in such research. There are several problems, however, common to earthquake disaster prevention in developing nations. One example of this is that the structures of most buildings are weak and vulnerable to seismic damages, i.e., the structures of the buildings found in these regions consist of reinforced concrete with columns and beams and walls made out of brick or structures with walls made entirely out of adobe or other forms of brick, and in all of these cases work should therefore be done to improve the structural design methods and to develop methods of evaluating seismic performance and methods for strengthening of existing buildings. For problems such as these, rather than having each individual country attempt to solve these problems on their own,

it would probably be more effective to recognize such problems as problems common to all the nations concerned and work together in cooperation towards their solution. To achieve such a level of cooperation, I believe that the earthquake disaster prevention organizations founded as a result of JICA's technological cooperation programs ought to work together and that the best direction for future international cooperation to take would be for specialists from Japan to provide their assistance to this cooperative effort. In other words, what is needed is for specialized personnel from Japan to provide their assistance to an independent association of persons from developing nations involved in earthquake disaster prevention activities.

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