CONSTRUCTION OF A DATA BASE SYSTEM FOR IRRIGATION DAMS

TANI SHIGERU[1]

SUMMARY

The Hyogo-Ken Nambu Earthquake damaged many earthen structures. The Japanese Society of Civil Engineers stated that databases are needed to help determine the earthquake resistance of public structures in the second proposal for earthquake resistance. This paper describes the database on agricultural high dams at least 15m in height., which was recently created to provide information for quickly inspecting dam safety after earthquakes. Previous studies on earthquake damage revealed that there is a relationship between magnitude and epicentral distance within which damage may occur. The system is based on this relationship for listing dams requiring inspection after an earthquake. When the epicenter is inputted, the seismograph database can be used to output a list of dams where seismographs are installed. The system was proved effective by actual inspections conducted after several earthquakes. The objective of the recently developed database on agricultural high dams is to provide information of dams that need urgent inspection after an earthquake. We are improving the database to allow direct collection of seismic information from observation points and to improve the accuracy of earthquake inspections.

INTRODUCTION

In Japan, there are 1,796 agricultural irrigation dams of at least 15 m in height. Fill dams account for 90%, concrete dams for 9%, and composite dams for the remaining 1%. There are various kinds of information about dams, such as dam height, storage and other specifications. The Hyogo-ken Nambu Earthquake damaged many earthen structures but destroyed no high dam. The Second Proposal of the Japanese Society of Civil Engineering stated that databases are needed to help determine the earthquake resistance of dams. This paper describes a database system for agricultural dams, which we created to provide information for quickly inspecting dams after earthquakes.

OUTLINE OF DATABASE

The database covers agricultural dams of at least 15 m in height, and treats data, such as dam height, spillway specifications, and data from seismographs and other instruments installed at dam sites to maintain and prevent damage to the dams. A schematic diagram of the database is shown in Figure 1, which consists of 1) basic data, 2) instrument data, 3) seismograph data, 4) geographic information, and 5) other information. The content and function of each database component are described in the following sections.

[1] *National Research Institute of Agricultural Engineering, Tsukuba City , Japan*
Email; stani @ nkk.affrc.go.jp

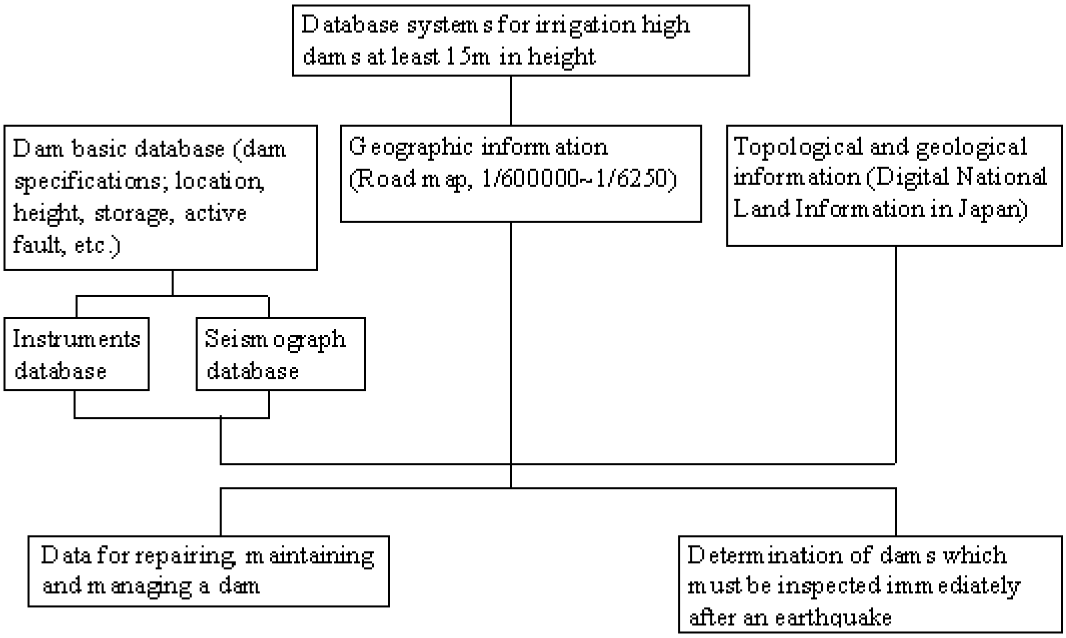

Figure 1; Outline of the database on agricultural high dams

CONTENTS AND FUNCTION OF EACH DATABASE

Geographic information and other public data

The database uses 1) maps, 2) national-land numerical (topographic and geological) information, 3) data on active faults, 4) , seismic intensity maps, and 5) data concerning regions designated by each municipality under a government ordinance. Maps are important for knowing the locations and routes to dams. The previous database for earth dams has used the national-land numerical information. The new database loads maps sold on the market for on-vehicle navigation systems. The maps, which can be displayed and scrolled at any scale between 1/600,000 and 1/6,250, contain property data, such as roads, roadside facilities, railroads, public facilities, municipality names, rivers, and large buildings.

The topography and geology are classified and recorded for each 1-km mesh of the land. Topography is classified into five groups, which are mountains, volcanoes, hills, plateaus, and low land. The surface soil is classified into nine groups, which are 1) sand, 2) clay, 3) peat, 4) gravel, 5) sediment of mud, sand and gravels, 6) consolidated or semi-consolidated sediment, 7) shirasu, 8) Ioam, and 9) rocks.

The active-fault information and its resultant digital maps of 1/200.000 in scale for active faults (Geo Supply Co., Ltd.) are used. The system displays the location, certainty, and the activity of an active fault based on road information. Seismic intensity classes that are prescribed by the road bridge specifications(1996) are used. The regions that are designated by municipalities under a government ordinance is requiring special attention (during an earthquake, for heavy snow fall, for depopulation, for frequent typhoons, or peninsula or mountain villages), and the names of locations of public (national, prefectural, or municipal) facilities are also included in the database.

Dam basic database

The dam basic database covers 1,796 agricultural dams of at least 15 m in height and stores approximately 560 kinds of data for each dam, such as dam specifications (height, crest length, storage, etc.), accessory facilities (spillway, intake facilities, etc.) and facilities for monitoring the dam. The database uses common road maps, facility codes, and dam property information with the instrument and seismograph databases, which will be described below. Users can search dams by item (name, height, prefecture, etc.), epicentral location, address, or distance from an active fault (active-fault search). By inputting an epicentral location, the system outputs a list of dams in order of epicentral distance.

Figure 2 plots the mean epicentral distance of each municipality against the percentage of small earth dams damaged. The solid line in the figure should show the maximum percentage of small earth dams damaged estimated from the mean epicentral distance. An epicentral distance of damage ratio = 0, and damage ratio = o at first is decided as critical distance (•), and distance (•) respectively. This relationship could be effected by the conditions of the foundation and embankment. The solid line in the figure represents an approximate limit of damage. Critical distance (•) is applicable to small earth dam based on soft foundation. Critical distance (•) applies to fill dam based on rock foundation. Since the dam conditions were not considered, the maximum damage ratio was adopted to make a safer judgment. By studying the relationshipbetween the ground conditions and damage in more detail, It may be possible to accurately predict damage.This studies on earthquake damage revealed that there is a fixed relationship shown in Figure 3 between magnitude and epicentral distance within which small earth dams of smaller than 15 m in height may be affected either seriously or slightly. Since agricultural dams of at least 15 m in height (either fill dams or concrete dams) have scarcely been damaged, the relationship should slide to the safer side.

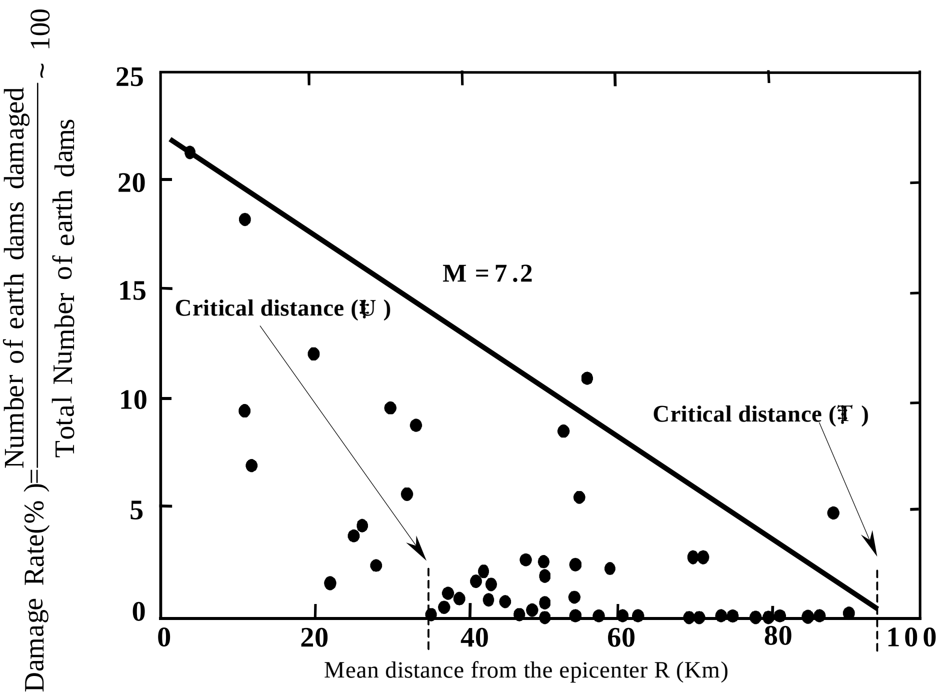

Figure 2; Mean distance from epicenter and ratio of earth dams damaged by the Hyogo-ken Nambu Earthquake

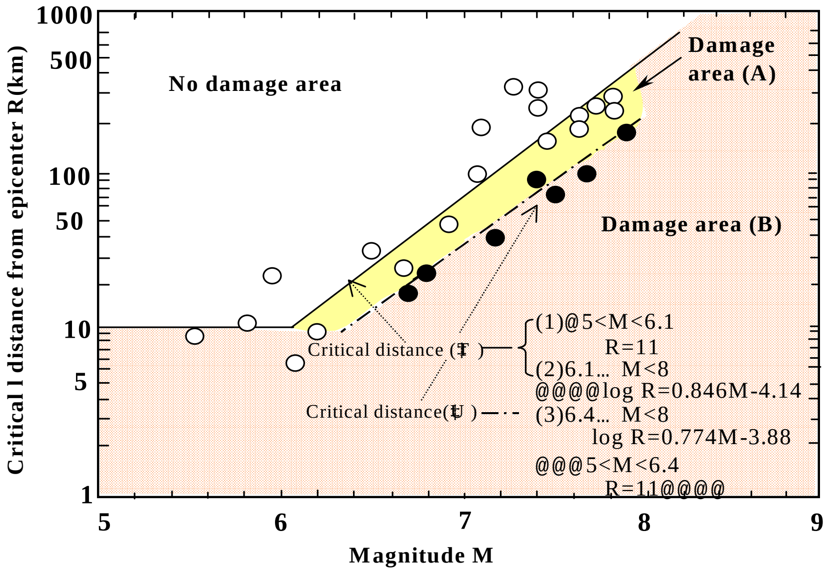

Fig.3 Relationship between magnitude M and critical distance R

We adopted this relationship as the standard for listing dams that should be inspected during an earthquake. Figure 4 shows a display of an epicentral-location search during the Hyogo-ken Nanbu Earthquake. The seismic intensity was not just determined by the seismic distance, but soil conditions were involved. We downloaded the acceleration data from K-NET of the National Research Center for Disaster Prevention, Science of Technology Agency, and used the acceleration data for making a list of dams to be inspected by displaying the estimated acceleration at each dam site on maps as shown in Figure 5. Since the GPS kit is integrated into the system, users can check their current position with a lap-top computer and know the position in relation to the target dam and routes to the dam. This helps them check the positions of dams during earthquakes and obtain information about various facilities.

INSTRUMENT DATABASE AND SEISMOGRAPH DATABASE

The instrument database collects data from the principal 52 agricultural dams. The kinds of data collected are listed in Table 1. The detailed information about instruments, such as the types and measurement ranges, is stored as images of cards. The locations of instruments are also stored as image data as shown in Figure 5

Seismographs are installed at 154 agricultural dams. Some of the seismographs are old, and their detailed data are not in the database. For the other 58, the specifications, such as the type, recording type, and trigger levels, are recorded in the database.

Table 1 shows an output of a seismograph record. The location of the instrument is shown in the order of planar, vertical, and horizontal locations. For example, "dam body (center, crest, halfway)" signifies that the device is installed along the center line of the dam body, at the crown, and hallway between the sides. Operational status is "•" for those that are operating"×" for those that are not working and "•" for unidentified. When an earthquake occurs, the system quickly outputs a list of dams on which seismographs are installed just by inputting the epicentral location. K-NET estimates automatically the acceleration near dams, but our system requires users to input acceleration data, which are displayed on maps.

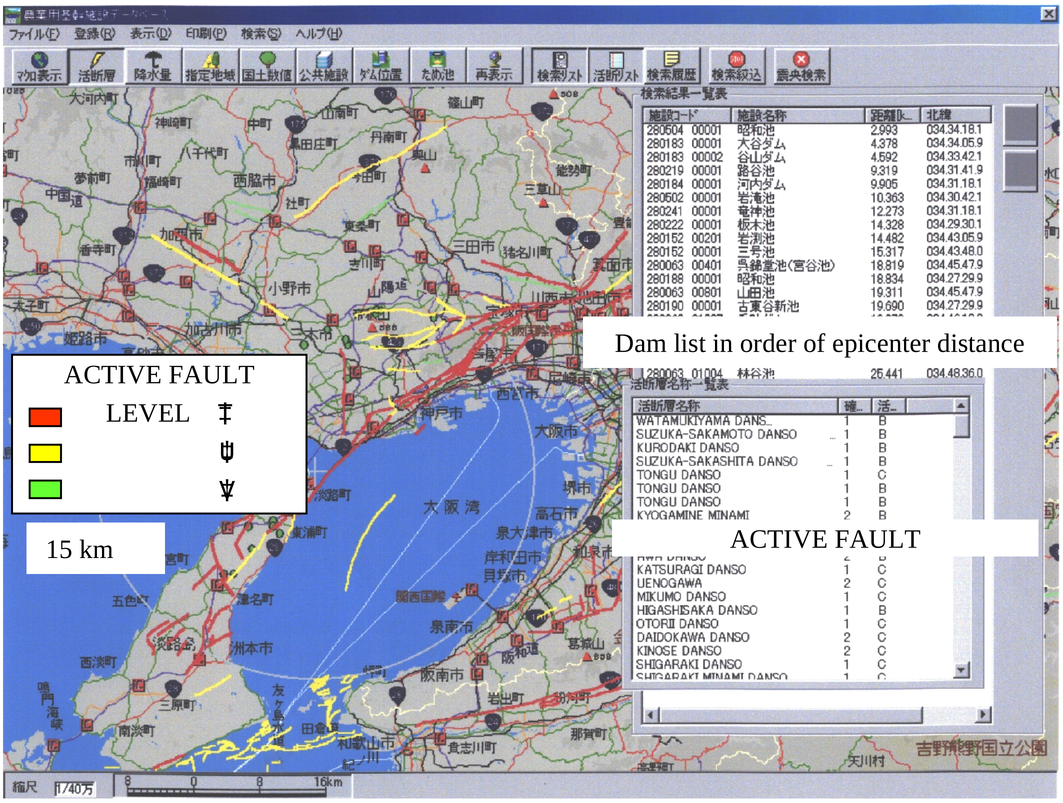

Figure 4; Output of epicentral search of the agricultural-dam database (Display of damsand active faults within 30 km from the epicenter)

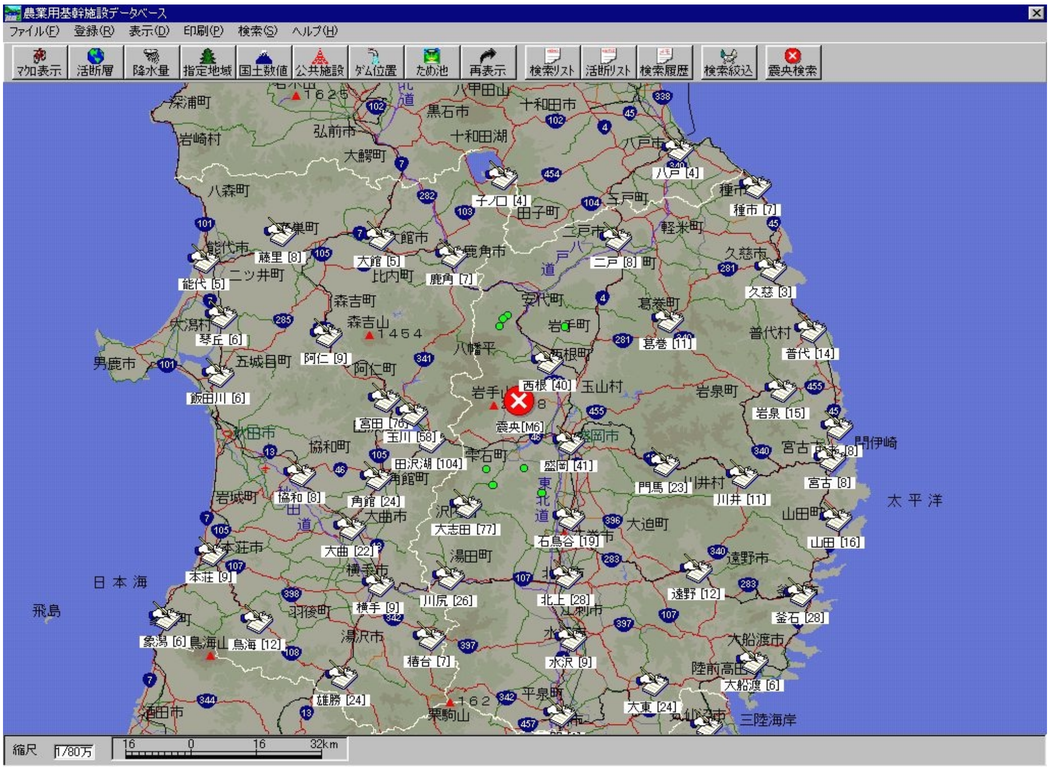

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Figure 5; Output image of the instrument database (Locations of instruments)

Code	07401022	DANE NAME	NICYU DAM	FILE NAME	40100221.GIF	TYPE OF IMAGE DATE	Drawing
COMENT		CROSS SECTION (A),					

Location of instruments

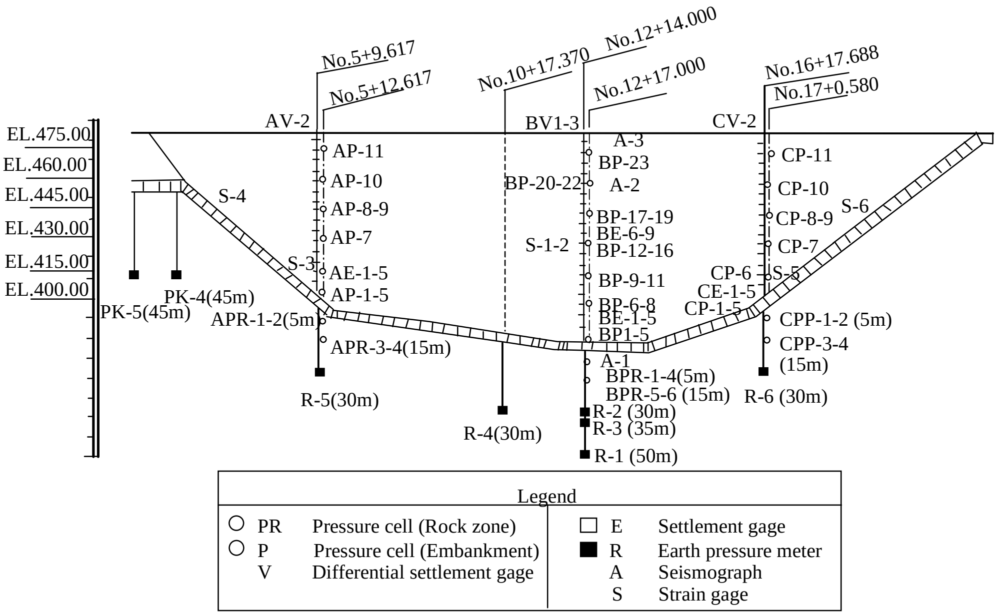

Figure 6; Output image of the instrument database (Locations of instruments)

Table1; Output of a seismograph record

Seismograph ••• ••••• INSTRUMENT ACTIVE •CHANNEL . ••• Location ••• NAME CONDATION • NO. • ••X Y Z	
EMBANKMENT	CREST AE-123 ••••×• • 1 2 3 FOUNDATION AE-456 • •••••• • 4 5 6
FOUNDATION	Dam AF-789• ••×•• 7• 8 9 Foundation
ABUTMENT	Right AA-ABC • ••×•••••11 12 13 Left AA-DEF•••×•••• ••14 15 16

FUTURE TOPICS

The main objective of this developed database on agricultural high dams is to provide information for quickly inspecting the safety of dams during earthquakes. This system is not yet fully operational but will be improved by directly incorporating more earthquake information to help precise earthquake-resistance inspection. The database, which is now operating only within the National Research Institute of Agricultural Engineering, will be distributed throughout all sectors involved and will be utilized during earthquakes. Finally, we thank the Agricultural Structure Improvement Bureau of the Ministry of Agriculture and Forestry for providing us the basic data for our database.

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