DAMAGE OF STRUCTURES DUE TO THE 1974 IZUHANTO-OKI EARTHQUAKE

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SYNOPSIS

The southern part of Izu-peninsula in Japan was shaken at 8:33 a.m., May 9, 1974 by a strong earthquake. The landslides were observed here and there and they caused most considerable damage to houses and human lives, especially at Nakagi district. The destruction of houses due to movement of foundation and ground was observed mainly at Irozaki and Iruma district. At Irozaki, it was due to fault, but, at Iruma, to slide of the surface of sand. The damage of structures due to vibration of themselves was not so heavy, but slip of roof tiles was observed at many houses.

INTRODUCTION

The severe earthquake which attacked in southern part of Izu-peninsula in the morning on 9th May, 1974 harmed many houses, roads and human lives. The damage of the earthquake gathered especially at Minami-Izu town, Shimoda city, Higashi-Izu town, Nishi-Izu town and Matsuzaki town in the southern part of Izu-peninsula.

The Building Research Institute dipached three research groups of field survey of damage to houses in the quake-stricken area. The intention of this report is to classify the states of damaged structures, and to investigate the problems which are on the prevention of disaster and on the earthquake engineering.

OUTLINE OF EARTHQUAKE

The parameters of this earthquake reported by Japan Meteorology Agency are as follows:

Name; 1974 Izuhanto-oki Earthquake
Date; 8:33 A.M., May 9, 1974
Epicenter; 34.6°N, 138.8°E (nearby Irozaki meterological observatory)
Depth; 20 km
Magnitude; M = 6.8

The seismic intensities by the scale of Japan Meteorology Agency were mapped as shown in Fig.1. The seismic intensity was reported 5 in the south region of Izu-peninsula, but it seems that it was 6 in certain area from the state of the damages. The observation of the aftershocks indicates that the epicenter is in the vicinity of Iruma or Mera district.

DOMINANT CAUSES OF DAMAGE

Geophysical aspect in this quake-stricken area is very complicated. There are many cliffy places with many faults where igneous and sedimentary rocks cross each other. Especially, along south-west coast line, there exist many steep bluffs which form Rias coast, and each district as shown in Fig. 2 is located on the narrow alluvial deposit in each creak. Most of the exposed rocks are considerably weathered for a long time.

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The state of the damage of this earthquake is summarized in Table 1. The tendency of this table seems that the districts in western area such as Nakagi, Iruma and Irozaki heavily suffered, but the eastern area such as Oose, Minato, Shimoda and so on lightly suffered comparatively.

The characteristics of this disaster are as follows.
1) The earthquake occured just below the damaged area.
2) The geographical and geological conditions are bad in this area.

Main causes of the damage are as follows:
1) Collapse of houses due to landslide
2) Destruction of houses due to movement of foundation and ground
3) Fall of houses due to vibration.

The cause which damaged the houses and human lives most heavily is 1). The typical example is the landslide at Nakagi district. The damages due to the cause 2) were observed at Iruma and Irozaki district. In this case the damage of houses was also heavy, but human lives were scarcely damaged. The degree of damage due to cause 3) was not so heavy.

STATE OF DAMAGE OF THE VARIOUS STRUCTURES

1. Retaining wall, Stone wall

The construction methods of retaining wall and stone wall in these regions are incomplete. There isn't the embedment into the ground, and the weep drain and the counterfort are not constructed too. Moreover these structures are constructed by nonprofessional persons. As a natural consequence it follows that they would cause the lack of horizontal resistance and then the structures would be collapsed by such an earthquake motion. (Photo 1) It is important that the proper construction methods such as backfill, embedment, drainage and counterfort should be done.

2. Wooden structure

A big number of houses in the affected region were of wooden structure. The causes of damage of wooden structures were divided into three types, which were due to fault, slide of the surface of sand and the other.

Most of the houses just above the fault were heavily damaged. The shear failure of continuous footing, slipping down of wooden column from boulder foundation, torsion of whole structure and movement or falling down of roofing tiles were observed in them. This type of failure were observed at Irozaki district. (Photo 2, 3, 7)

At Iruma district, the houses are built on the sand leveled with retaining wall. Due to the vibration of the earthquake, the surface of the sand slided with the foundations of the structure, and the houses were destructed. Especially, the structures whose retaining walls and foundations were not constructed solidly were heavily damaged. (Photo 4, 5)

Mixed structures which consist of wooden and reinforced concrete block or masonry were built here and there. In most of these structures, the failure occured due to the difference of rigidities between wooden part and the other. The superannuated wooden houses were also heavily damaged as observed in the other earthquake.

3. Reinforced concrete structure

The number of the reinforced concrete building were few. The damages of relatively large scale building were slight. Only hair cracks were observed at about shelter stairs and discontinuity part such as the joint between one storied structure and three storied structure. The small scale housing structures were also slightly damaged except two structures which were a store of framed structure at Mera district and a dwelling of wall structure at Nakagi district. However, it seems that these two structures did not destructed if these were constructed under the standard specification of construction.

4. Steel structure

Large spanned steel structure for green house at Irozaki district, were slightly destructed in main structure except the destruction of finishing materials such as glasses. Two or three storied apartment house and store house with mortar finishing walls were many at Shimoda district. Most of these structures were damaged of exfoliation of finishing mortar. (Photo 8) And some cases of rupture and laxity of braces were observed. In the case of light gaged steel structure, the representative destruction was observed in the detached house with pilotis at Shimogamo district. (Photo 9)

It seems that the damages of main structure of steel constructions would be slight at such a scale of earthquake, being designed and constructed according to the standard design manual and standard specification of construction. However, the serious consideration to the dasign of non-structural member such as finising material is seemed to be important from a viewpoint of the security of the lives of peoples and the estates. The steel structure should be carefully designed to have not only the strength but also the rigidity which does not exceed the deformation capacity of the interior and exterior finishing materials.

5. Reinforced concrete block structure, Masonry structure, Dozo*

Most of these structures which were heavy and massive, and still more, were designed with no aseismatic consideration were completely collapsed. The reinforced concrete block structures designed with aseismatic consideration were not damaged.

THE PROBLEMS OF DAMAGED AREA

The problems noticed through our survey are as follows.

1) Slopes of land

The villages damaged by this earthquake are situated at the narrow area which are surrounded by mountains and seashores. In such type of villages, the grounds for houses are seeked for up to the steep area according to their development. The risk at the disasters such as earthquakes and fires in such area is larger than in the flat area.

2) Accumulated area of wooden houses

The accumulation of wooden houses is increasing at Mera, Koura and Iruma district. This shows us the necessity of adaptation of the group requirement of Japanese Building Code.

Many engineers supported our research. We acknowledge their collaboration.

* Dozo: Warehouse made of soil

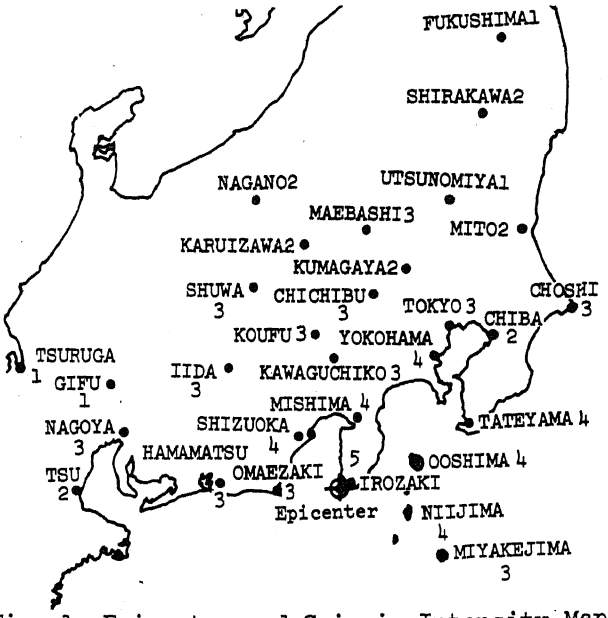

Fig. 1. Epicenter and Seismic Intensity Map

Photo 1. Crack in the ground caused by collapse of retaining wall (Iruma)

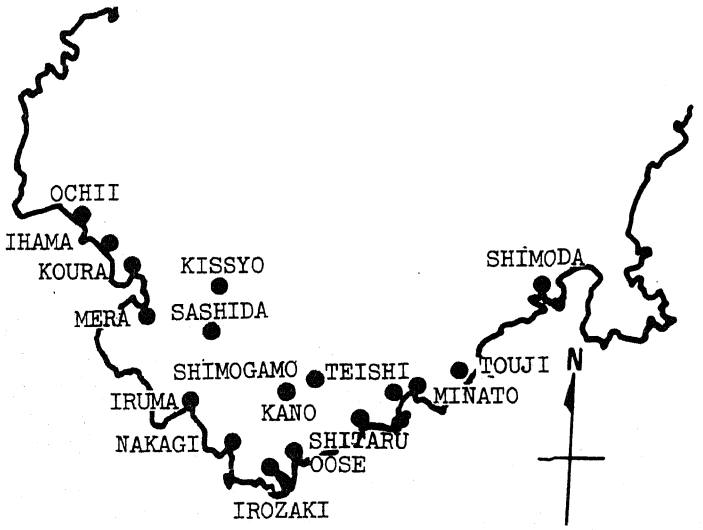

Fig. 2. The map of Southern part of Izu-Peninsula

Photo 2. Fault occured at the ground under the wooden house (Irozaki)

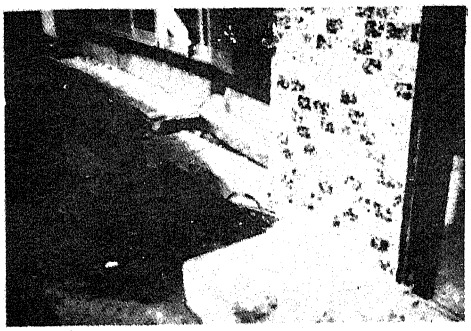

Photo 3. Collapse of footing caused by fault (Irozaki)

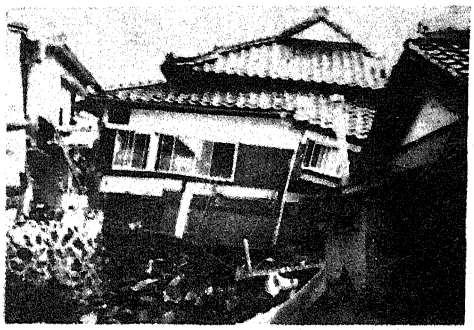

Photo 4. Destructed house caused by collapse of retaining wall (Iruma)

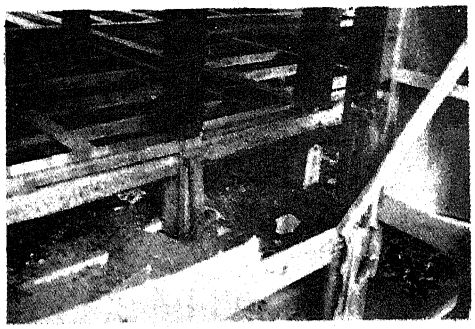

Photo 5. column slipped down from boulder foundation (Iruma)

Photo 6. Damage of wooden house with reinforced concrete block wall (Iruma)

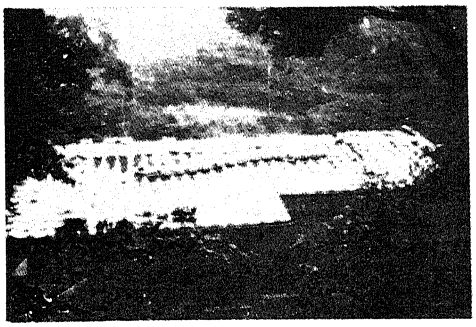

Photo 7. Movement of ridge roofing tile of wooden house (Irozaki)

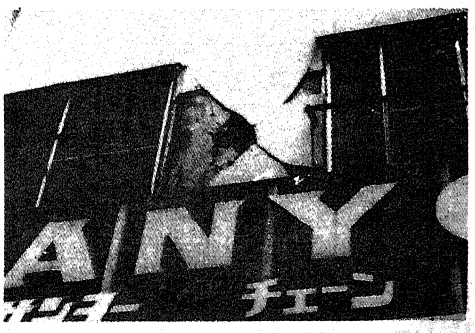

Photo 8. Crack of mortar finish on metal lathed steel structure (with ALC interior finish) (Shimoda)

Photo 9. Completely destructed house caused by destruction of light gauged steel structure at the first floor (Shimogamo)

Photo 10. Damage of reinforced concrete block house (Iruma)

Table 1. State of damage from Izuhanto-oki earthquake (1974.5.31)

Town (District)	Damage of Human Lives		Damage of Houses			Damage of Road	Land-slide
	Dead	Injured	Complete	Partial	Slight		
Minami-Izu	30	38	104	198	447	50	46
Nakagi	27	8	23	10	24	11	1
Iruma		2	31	22	12	1	3
Ihama	1	1	1	14	29	5	3
Ochii		6	1	1	2	1	2
Mera			1	11	60	2	
Koura	1	2	11	45	23	5	3
Irozaki		8	25	21	44	1	12
Shimogamo		4	3	19	40		6
Oose	1		1	6	45	4	6
Minato		3		10	18	2	
Kano			2	17	32	1	1
Sashida				1	10	3	2
Shitaru		1			1	1	5
Teishi		2		9	44	1	
Kissyo		1	4	10	27		
Other Dist			1	2	36	12	2
Shimoda		34	23	42	1118	9	25
Higashi-Izu					17		18
Nishi-Izu				1	8	3	4
Matsuzaki		8		6	277	19	1
Kawazu		2			55	5	7
Total	30	82	127	247	1922	86	101