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RELATIONSHIP BETWEEN DISTRIBUTION OF BUILDING DAMAGE AND SITE

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SUMMARY

It is known that the situation of the occurrence of the building damage due to the earthquake is greatly controlled by the characteristic in the region from of old. It is clarified that the change in the ground property of the narrow band is a cause of a big difference of this damage situation of the occurrence according to the investigation of the building damage due to the earthquake in recent years. This thesis reports on the result that examines the relation between the damage of the building and the ground property in the region about the damage case by the large earthquake. The damage case is two. The first examined the damage of Hachinohe City in the 1994 Far-off-Sanriku Earthquake, and the second examined the damage of Fukuroi City in the 1944 Tounankai Earthquake.
There was a lot of damage of the 1944 Tounankai Earthquake in the place where the soft ground was thick as said in general. However, the 1994 Far-off-Sanriku Earthquake resulted the opposite.

INTRODUCTION

It is known that the situation of the occurrence of the building damage due to the earthquake is greatly controlled by the characteristic in the region from of old. It is clarified that the change in the ground property of the narrow band is a cause of a big difference of this damage situation of the occurrence according to the investigation of the building damage due to the earthquake in recent years.
This thesis reports on the result that examines the relation between the damage of the building and the ground property in the region about the damage case by the large earthquake. The damage case is two. The first examined the damage of Hachinohe City in the 1994 Far-off-Sanriku Earthquake, and the second examined the damage of Fukuroi City in the 1944 Tounankai Earthquake.

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THE 1994 FAR-OFF-SANRIKU EARTHQUAKE, DAMAGE, AND HACHINOHE CITY

The coast of Sanriku was made a hypocenter on December 28, 1994 and the earthquake of magnitude 7.5 occurred. It is a 1994 Far-off-Sanriku Earthquake.
Damage concentrated on Hachinohe City located in the east part of Aomori Prefecture due to this earthquake. Big damage was received to not only the building but also the road, the railway, the bridge, and the lifeline, etc. due to the earthquake. The dead were three people. The number of damage of buildings in Hachinohe City was 53 complete collapse houses, 226 half collapse houses, and 10,756 partial failure damage houses. This numerical value is what the Hachinohe city office examined it.
Hachinohe City is located in the Pacific coast in Aomori Prefecture in the Mainland north end of Japan.
It is a port of 250,000 people or less. Geographical features is divided into an alluvial plain formed with two rivers and rolled plateau.

THE 1944 TOUNANKAI EARTHQUAKE, DAMAGE, AND FUKUROI CITY

The Kumano open sea offing was made a hypocenter on December 7, 1944 and the great earthquake of magnitude 7.9 was generated. It is a 1944 Tounankai Earthquake. This earthquake vibrated Japanese whole land in the south from the southern part of the Tohoku region in Japan. Especially, Tounannkai region received big damage with a big shake due to this earthquake. The dead were 1,202 people. The number of damage of buildings is reported to be 16,380 complete collapse houses and 34,635 half collapse houses according to the investigation.
There is Fukuroi City about Shizuoka Prefecture in the Mainland in Japan almost located at the center. It is located from the Pacific coast to several-kilo inland, and the town of about 60,000 people. The alluvial plain formed with Oota river is enclosed to geographical features by a smooth plateau.

DISTRIBUTION OF DAMAGE AND GROUND FEATURE

We invested the building damage distribution and the relation to the following site effects.

Damage distribution

Case of 1994 Far-off-Sanriku Earthquake
The data used is 53 complete collapse houses, 226 half collapse houses, and 10,756 partial failure damage houses. The number of partial failure damage buildings in a constant district (375mx275m) was divided by the number of all buildings.

Case of 1944 Tounankai Earthquake
The data used is 1580 complete collapse houses, and 649 half collapse houses. The percentage of total collapse of each village was used. "Record of the 1944 Tounankai Earthquake" was used.

Topographic feature

The borderline of the plateau and the alluvial plain was pulled to the topographical map of Geographical Survey Institute. The boundary is shown in each distribution map.

Thickness of surface layers

The thickness of surface layers was obtained from depth where N-value of the boring log becomes about 50. It exemplifies it to Fig. 1. The depth shown by H was assumed to be a thickness of surface layers in figure. The decision of H was difficult often.

Predominant period by microtremor
The number of measurement points is Hachinohe 433 point, and Fukuroi 51 point. The predominant period of Hachinohe City is an investigation of several years. The predominant period was decided from the spectrum of the horizontal motion in Hachinohe City. The predominant period was decided from the H/V spectrum in Fukuroi City.

DISTRIBUTION AT RATE OF BUILDING DAMAGE, TOPOGRAPHIC FEATURE, THICKNESS OF SURFACE LAYERS, AND PREDOMINANT PERIOD

Case of 1994 Far-off-Sanriku Earthquake

Distribution of partial failure damage rate in Hachinohe City
Fig. 2 shows the distribution map of the partial failure damage rate in Hachinohe City. The interval of the contour line is damage rate 10%.Damage rate 0%-10% occupies half of areas from Fig. 2. Most is 10% or less in the alluvial plain, and damage in the alluvial plain is little.

Distribution of thickness of surface layers in Hachinohe City
Fig. 3 shows the distribution map of the thickness of surface layers in Hachinohe City. The thickness of surface layers of the alluvial plain of the coast of Nida river and Mabchi river was deep. Depth had the site where 30m was exceeded. Depth was about 15m in plateau.

Distribution at predominant period in Hachinohe City
Fig. 4 shows the distribution map of the predominant period in Hachinohe City. The interval of the contour line is predominant period 0.1sec. A dark range in Fig. shows the alluvial plain.

Distribution of partial failure damage rate and topographic feature
To make the distribution of damage easy to see, Figure was divided according to the damage rate. Fig. 5 made Fig. 2 the damage rate distribution map of 10% or more, 20% or more, 30% or more, 40% or more, 50% or more, and 60% or more. The damage rate is still almost distributed in the plateau by 30% or more and 20% or more. However, the damage rate came to be seen a little more the alluvial plain. The damage rate of 10% more than the damage rate of 20% was distributed in the alluvial plain.

Distribution of partial failure damage rate and thickness of surface layers
The thing that damage has concentrated on thickness of surface layers 10m-15m is understood from Fig. 2 and Fig. 3. The following are understood from Fig. 2 and Fig. 3. In the damage rate 20% or more, the predominant period is distributed in 0.2-0.6sec. It concentrates on a short region of the predominant period. In the damage rate 40% or more, the predominant period is distributed in 0.3-0.5sec. Therefore, the range of the predominant period is 20% narrower. In the damage rate 60% or more, the predominant period is distributed in 0.3-0.4sec.

Case of 1944 Tounankai Earthquake

Distribution of percentage of total collapse in Fukuroi City
Fig. 6 shows the distribution map of the percentage of total collapse in Fukuroi City. The borderline of the plateau and the alluvial plain is shown with chain line. The damage rate is from Fig. 6 in the alluvial plain

to 40% or more. Moreover, it is 10% or less in the plateau. There is a lot of damage in the alluvial plain. Damage is a little in the plateau.

Distribution of thickness of surface layers in Fukuroi City
Fig. 7 shows the distribution map of the thickness of surface layers in Fukuroi City. The borderline of the plateau and the alluvial plain is shown with chain line. From Fig. 7The thickness of surface layers of the alluvial plain exceeds 40m or less. The thickness becomes shallow by becoming from the point far away. Though there is a shallow place, the thickness of the alluvial plain is roughly 20m or more. In the plateau, the thickness is thickness of about 5-20m. In a deep point, there was a place where 30m was exceeded.

Distribution at predominant period in Fukuroi City
Fig. 8 shows the measurement position of the predominant period in Fukuroi City. A rough predominant period at the position is shown by the sign. The predominant period is 0.2-1.2sec. The predominant period is from about 0.6 to 1.2sec in the alluvial plain. It is about 0.4sec or less in the plateau.

Distribution of percentage of total collapse and thickness of surface layers
The following are understood from Fig. 6 and Fig. 7. The shape of distribution looks like well. The damage rate increases as the thickness of surface layers becomes deep. The damage rate reaches 100% around in the thickness maximum.

Distribution of percentage of total collapse and predominant period
Damage is large from Fig. 6 and Fig. 8 at predominant period 0.6-0.8sec. Fig. 9 shows the relation between the damage rate and the predominant period in the predominant period measurement point in Fig. 8. Damage is larger than Fig. 9 in predominant period 0.6-0.8sec.

Relation between damage and site by two case
There is a lot of damage in the plateau in Hachinohe. There is a lot of damage in thickness of surface layers 10m-15m in Hachinohe. Damage has decreased as the thickness becomes thick.
However, in Fukuroi, there is a lot of damage in the alluvial plain. There is a lot of damage in thickness 30m-40m in Fukuroi. Damage has increased as the thickness becomes thick.

CONCLUSION

Case of 1994 Far-off-Sanriku Earthquake

1) The damages occurred on plateau and its near field, but occurred hardly on alluvial plain.
2) The damages were focusing on the site of the particular thickness (10m-15m) of surface layers.
3) The predominant periods in the damage area were 0.3-0.4 sec.

Case of 1944 Tounankai Earthquake

1) The damages occurred on alluvial plain and its near field, but occurred hardly on plateau.
2) The damages were focusing on the site of the particular thickness (30m-40m) of surface layers.
3) The predominant periods in the damage area were 0.7-0.8 sec.

There was a lot of damage of the 1944 Tounankai Earthquake in the place where the soft ground was thick as said in general. However, the 1994 Far-off-Sanriku Earthquake resulted the opposite. As for the factor of this difference, the following are thought.

1) Difference of ground property.
2) Difference of building structure by architectural age.
3) Difference of seismic character.

The reason for the difference will be examined in the future.

REFERENCES

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2. Shizuoka Prefecture General Affairs Department seismic countermeasure section. "Shizuoka Prefecture seismic countermeasure basic material - boring log collection (west) -" Shizuoka Prefecture General Affairs Department seismic countermeasure section, 1997

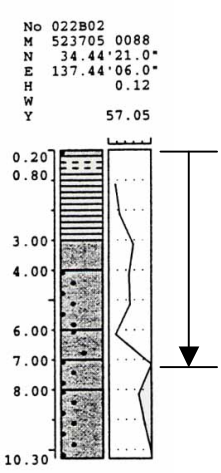

Fig. 1 Example of thickness of surface layer

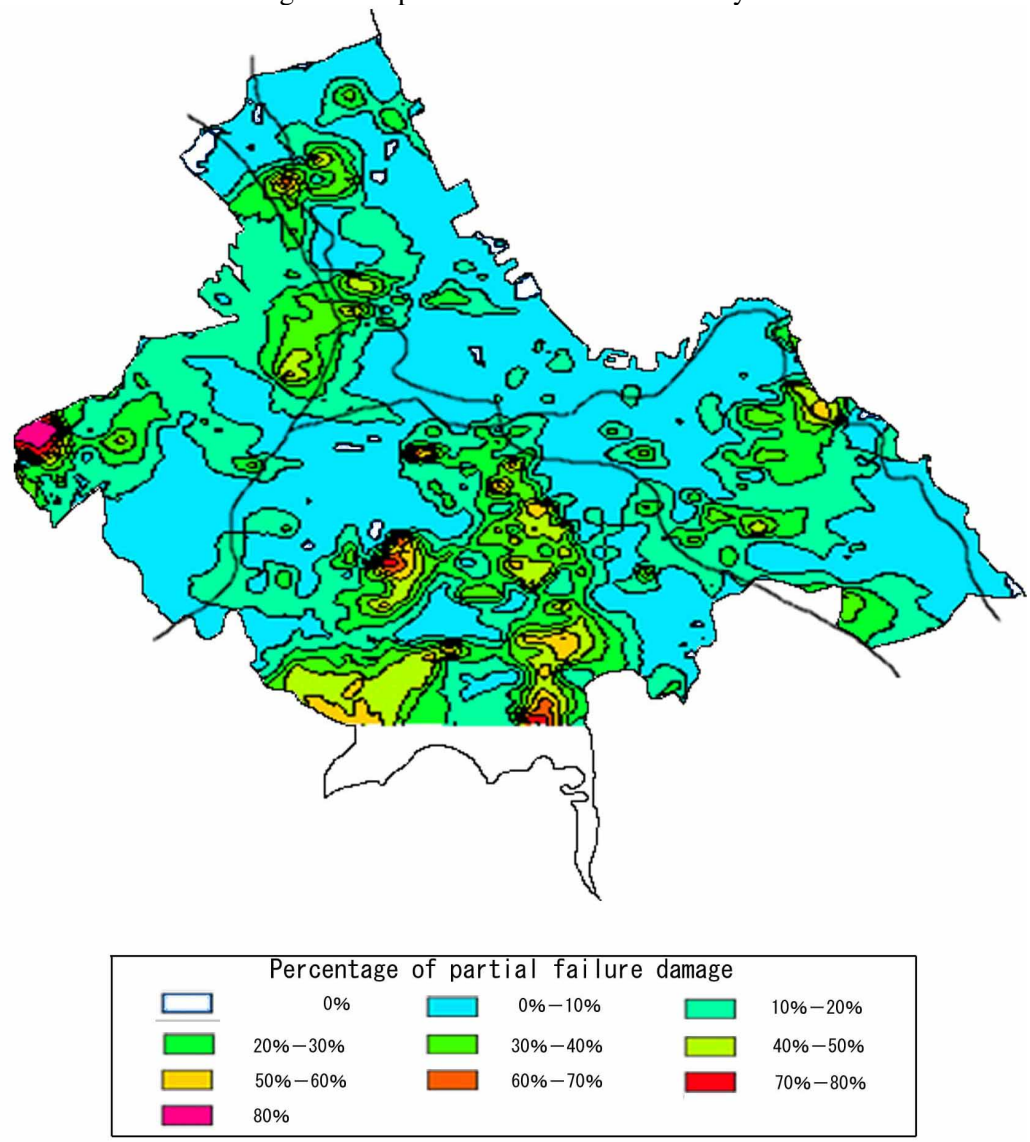

Fig. 2 Distribution map of percentage of partial failure damage in Hachinohe City

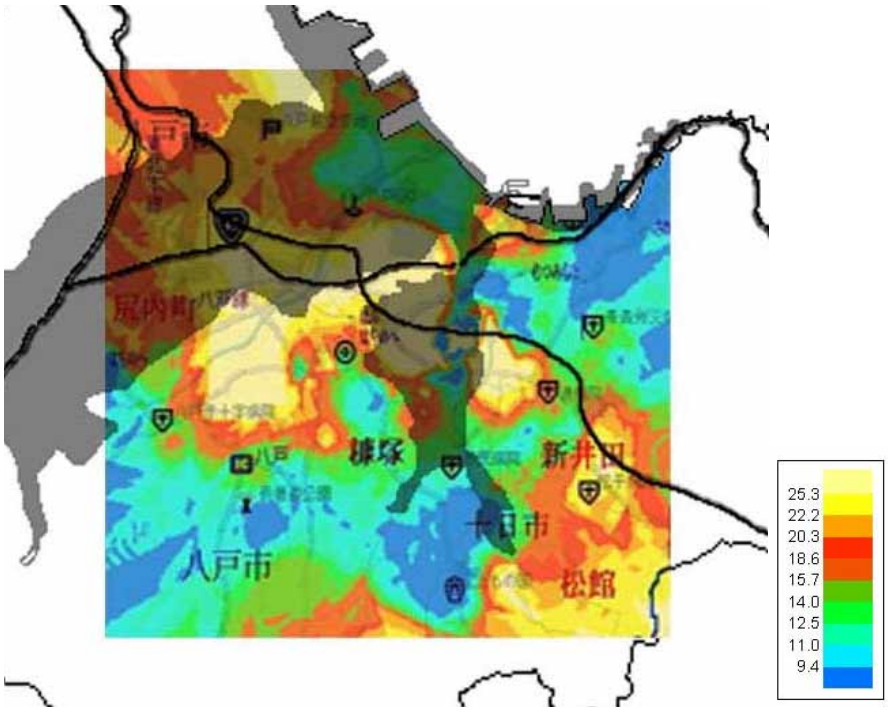

Fig. 3 Distribution map of thickness of surface layer in Hachinohe City

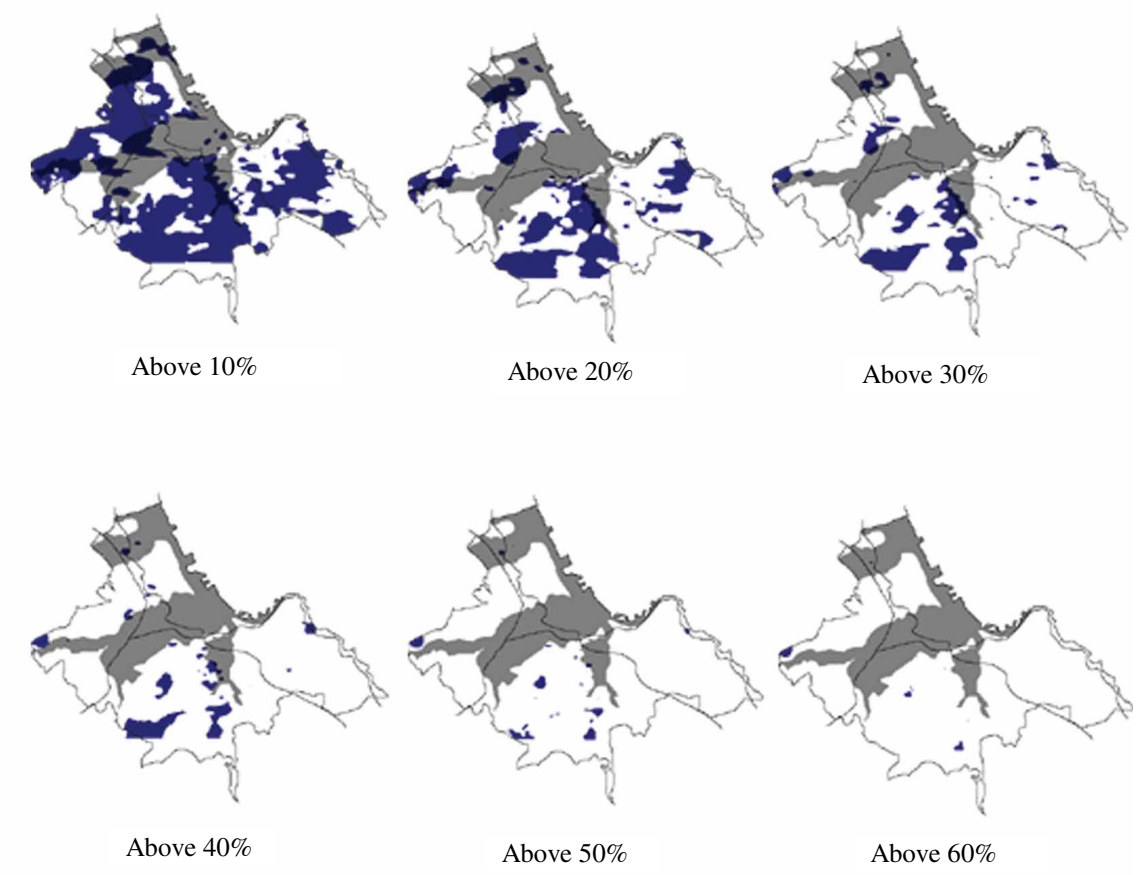

Fig 5 Relation between distribution of partial failure damage rate and topographic feature in Hachinohe City

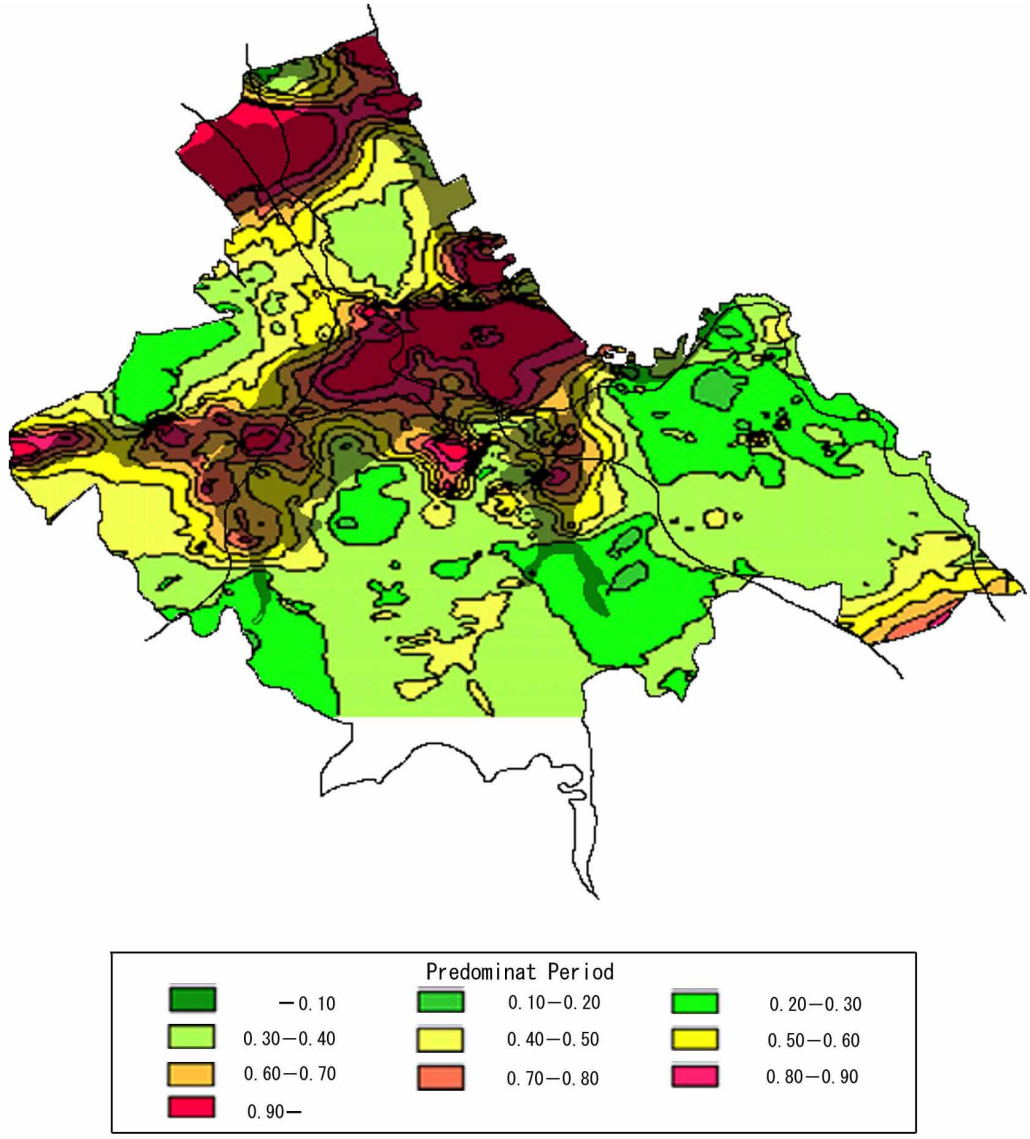

Fig. 4 Distribution map of predominant period in Hachinohe City

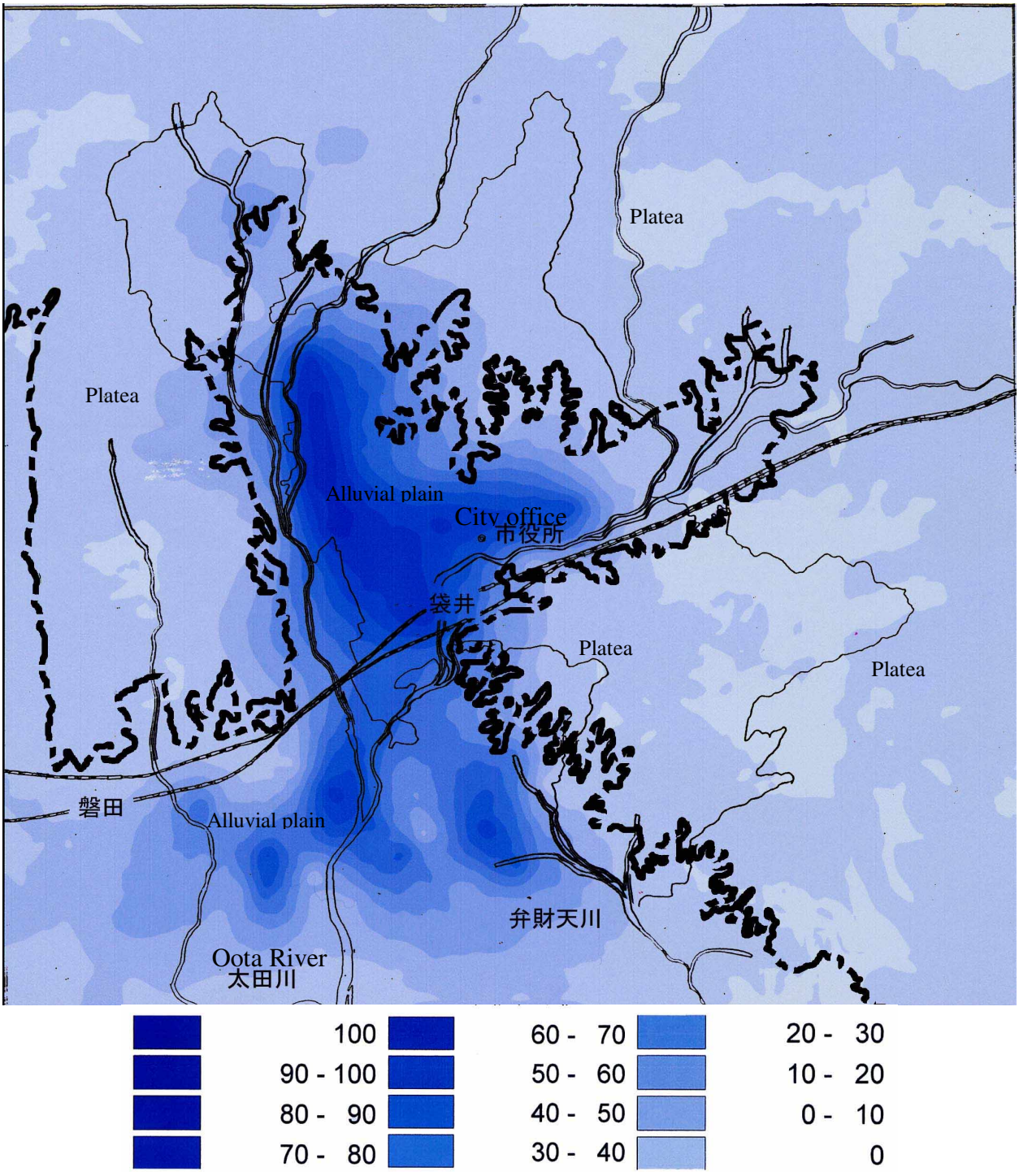

Fig. 6 Distribution map of percentage of total collapse in Fukuroi City

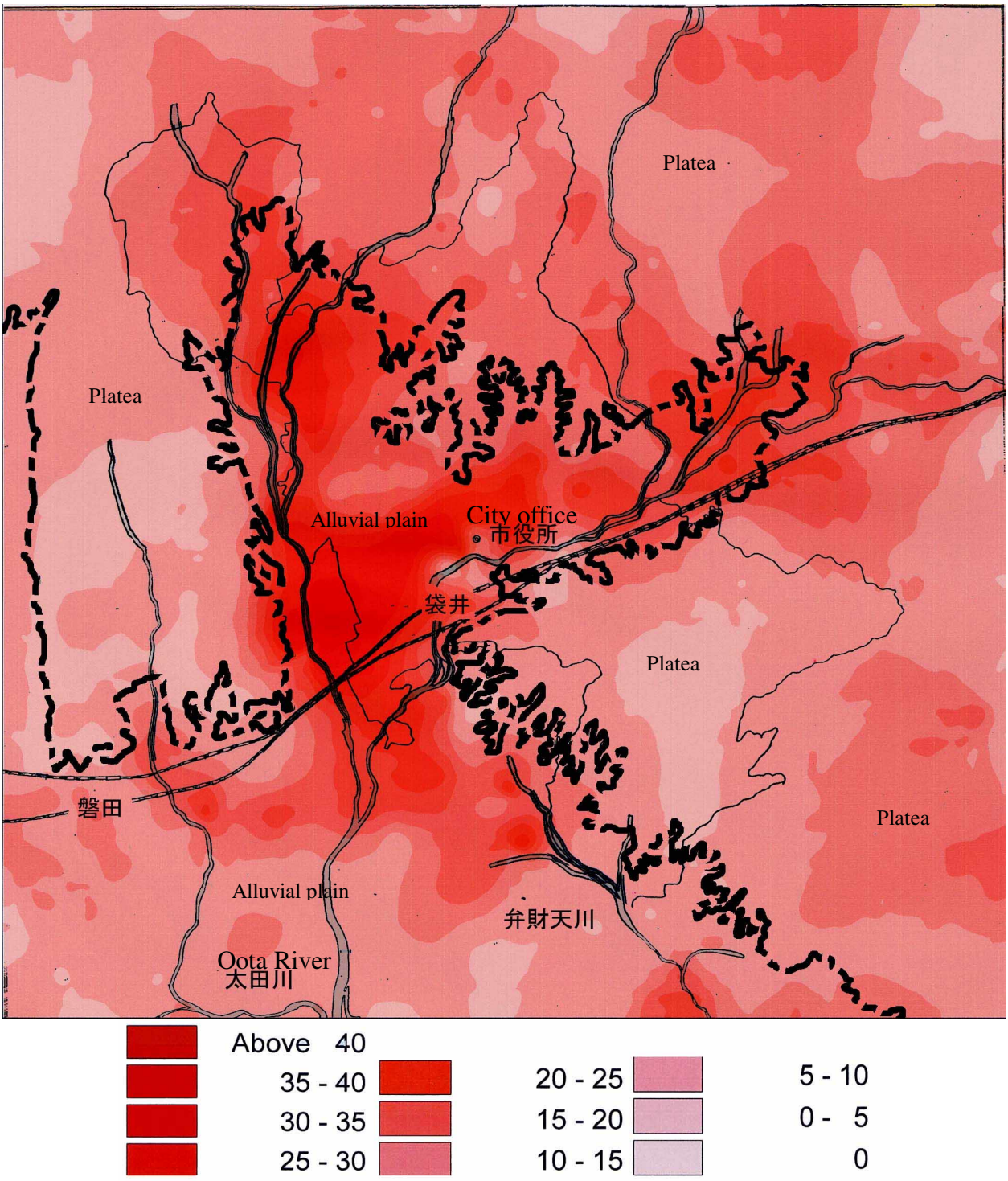

Fig. 7 Distribution map of thickness of surface layer in Fukuroi City

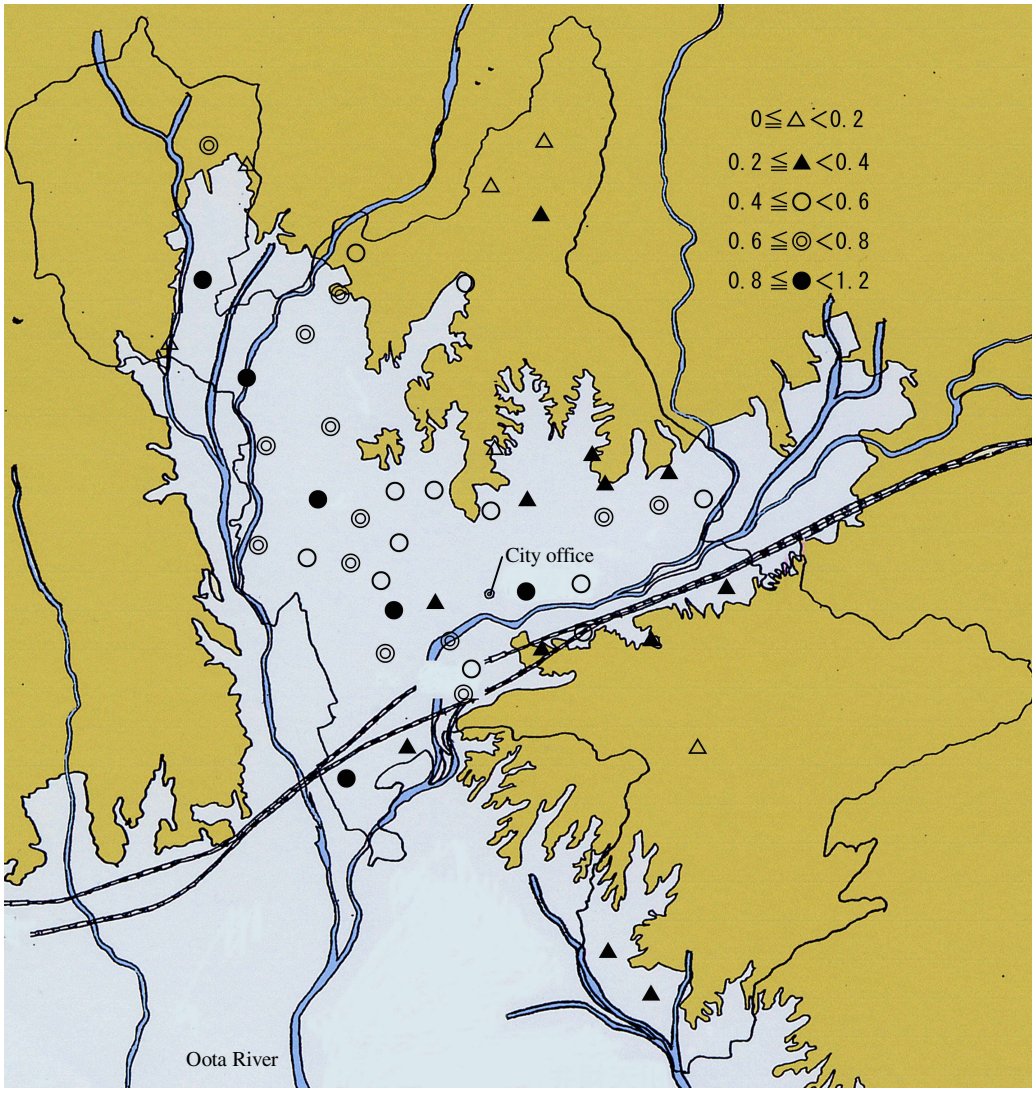

Fig. 8 Scatter chart of predominant period in Fukuroi City

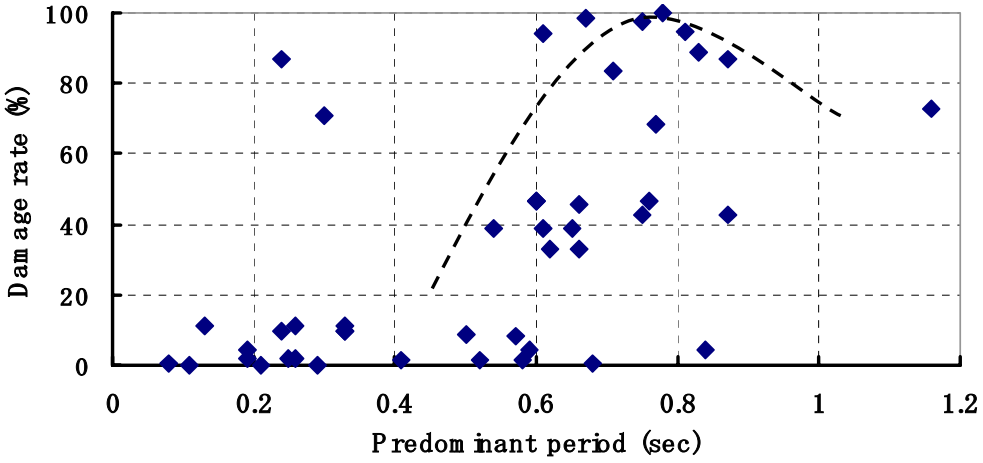

Fig. 9 Relation between damage rate and predominant period in Fukuroi City