

## Water supply pipeline damage related with geomorphology and geology in Kashiwazaki-city

Kobe University   Student member of JSCE   ○Jérôme Blard  
 Kobe University   Regular member of JSCE   Yasuko Kuwata  
 Kobe University   Fellow member of JSCE   Shiro Takada

### 1- Abstract

This study mainly deals with the results of the GIS analysis of the damages that occurred to the water supply system of Kashiwazaki-city after the Niigata-ken Chuetsu-Oki earthquake, the 16<sup>th</sup> of July 2007. Pipeline information, geomorphology and damage location were taken into consideration for this study. Consequently the pipe damage ratio shows higher results near a place where different soils are encountered.

### 2- Water supply system in Kashiwazaki city

After the earthquake, 60,000 households were concerned by water outage (40,000 in Kashiwazaki). Many different kinds of materials were used for the distribution system, as it is pointed in Fig. 1. The total length of pipe is approximately 712.3 km, with also different diameters: 31% are less than 50 mm, 45% are between 75 and 100 mm, 17% are between 200 and 350 mm, and finally 7% are more than 400 mm. 98.7% of the smallest diameters are Vinyl Pipe (VP), whereas others mainly use Ductile Cast Iron Pipe (DCIP). Fig. 2 shows the damage ratio of pipeline due to material. In the case of this city, the damage of CIP and SGP are remarkable.

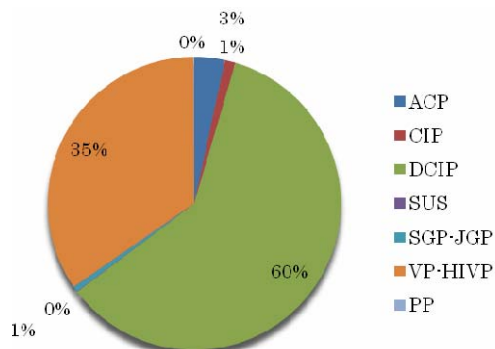


Fig.1: Materials used for the water supply system

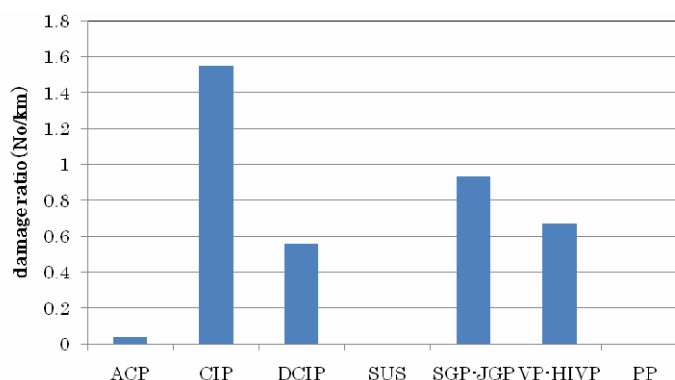


Fig.2: Damage ratio due to materials

### 3- GIS analysis of damage pattern

In order to combine geology and geomorphology, pipeline information and damage location is inventoried in a Geographical Information System (GIS). 423 failure points were recorded and identified to the different pipes of the system. Figs. 3 and 4 point two main areas where the damages are concentrated. In Fig. 4, geological data are also plotted: sand dune deposits and deposits of plains are mainly represented in the soil surface of Kashiwazaki-city, and they have different properties. Both of these areas are dated from the Holocene, so it means that from a geological point of view they were formed in recent geological age. 105 of the 423 recorded failure points to the distribution pipe are located near the boundary of the two different geological areas. Considering only the built area, a big part has been damaged: 32% for the sandy soil, and 18% for the plain deposits. The ratio has been calculated in terms of mesh (200\*200 meters). In this place, the waves have been amplified due to the fact that the

plain deposits have got quite soft properties compared to the sand deposits. To understand more, a comparison with the geomorphology is made in the following part.

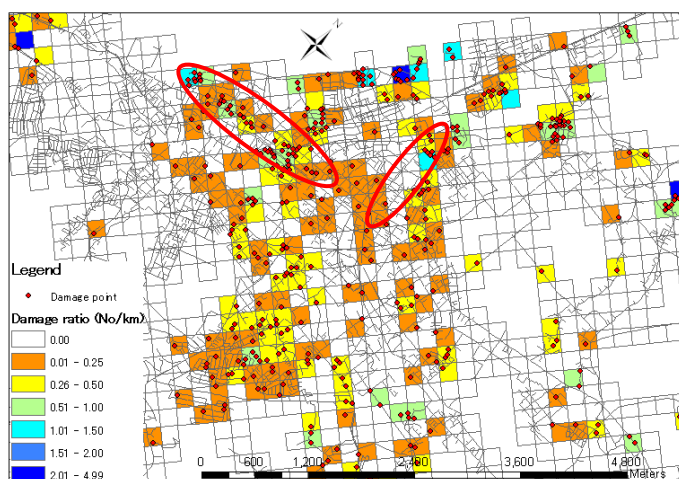


Fig.3: Map of the water supply system and result given by the damage ratio

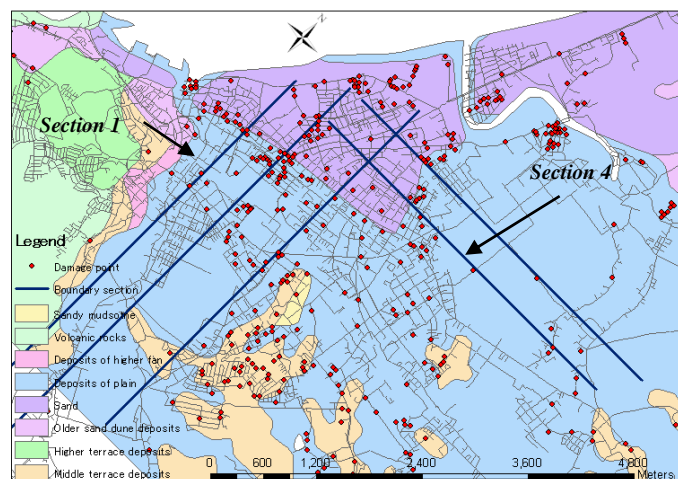


Fig.4: Geological map

#### 4- Comparison with the geomorphology

In this part, cross section lines are used to analyze and compare the previous results with the geomorphology. The section lines are represented in Fig. 4. Here, only two examples will be given (Figs. 5 and 6). Section 1 is oriented in the North-South direction, and Section 4 in the West-East section. According to the results, the boundary is located on the terrace, or just at the bottom of the slope. It is considered that shallow deposits on the stiff sand slide in the area. The same results are obtained for the other sections. This particular shape could be involved in the damages recorded here, rather than the soils properties itself.

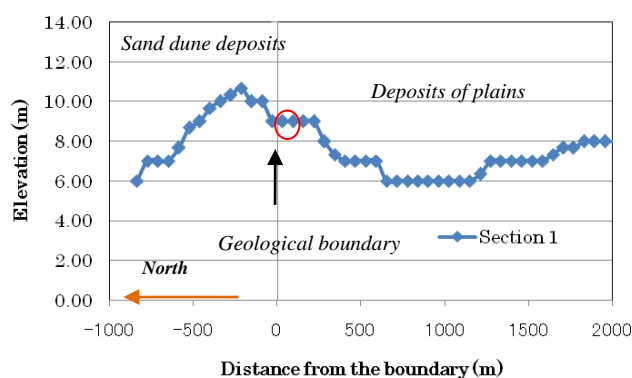


Fig.5: Topographical section, line 1

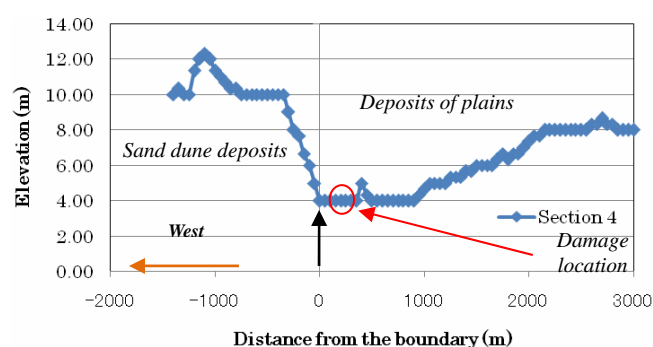


Fig.6: Topographical section, line 4

#### 5- Conclusions

As a conclusion, this study points several aspects of the earthquake damages. Firstly, the water supply system of Kashiwazaki is made with different materials, mainly in ductile cast iron and vinyl. In this city, the high damage ratio of CIP and SGP are remarkable. Secondly, the soils properties are responsible for a part in most important areas on the city, especially in place where the soil properties change. Finally, the local topography is also involved in the damages recorded there.

#### References

- 1) Kashiwazaki City: Water supply pipeline and its damage information