Establishment of Database for Seismic Damage to Sewer Pipeline

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1. Introduction

In the 2011 Off the Pacific coast of Tohoku Earthquake, many sewerage facilities suffered damage. Therefore, prompt establishment of earthquake countermeasures, such as earthquake-proofing of sewerage systems or preparation of BCP, is required for expected massive earthquakes. The National Institute for Land and Infrastructure Management (NILIM) has established a database of seismic damage to sewer pipeline, which enables damage trend analysis of sewer pipeline facilities under various seismic conditions in order to advance efficiently and effectively earthquake-proofing of the sewers in local governments, which is urgently required but needs a lot of budget and time.

2. Creation of the database of seismic damage to sewer pipeline

To create this database, we re-examined the information collected from separate viewpoints each time an earthquake occurred, and unified the items of data, and organized data in an integrated manner. The earthquakes studied were the following major earthquakes: 2007 Noto Hanto Earthquake, 2007 Mid Niigata Prefecture Earthquake, 2011 Off the Pacific coast of Tohoku Earthquake, and 2011 Northern Nagano Prefecture Earthquake. For the information of damage from the last two earthquakes, we organized the information based on the disaster assessment data, and for the other earthquakes, we organized the information based on the existing damage investigation data by NILIM and the Public Works Research Institute ("PWRI"). Information registered in the database consists of the data on spans (upstream manholes, downstream manholes, and pipeline between them) that were damaged in part or whole, specifications of pipeline facilities for each span (pipe type, depth, etc.), damage information (damage situation and uplift of sewage manholes), and earthquake information related to them (measured seismic intensity, microtopographical classification, etc.) (Table 1). At present, the information on about 5,000 spans is registered in this database.

3. Damage trend analysis using the database

Table 1. Items of Database

Basic information	Earthquake name	Information of damage to pipeline facilities	Damage of pipe
	Date of occurrence		Deformation of pipe
	Municipality name		Loose / meandering pipe
Pipeline facility specifications	ID		Pipe joint displacement
	Upstream manhole number		Crack in pipe
	Downstream manhole number		Infiltration water
	Pipe diameter (mm)		Mounting pipe projection / defective connection
	Pipe type		Upstream manhole stagnant water depth (cm)
	Form		Downstream manhole stagnant water depth (cm)
	Extension (m)		Upstream manhole uplift (cm)
	Upstream manhole type		Downstream manhole uplift (cm)
	Downstream manhole type	Earthquake relevant information	Microtopography classification (Reclaimed ground, hill, valley bottom plain, etc.)
	Upstream manhole depth (m)		Measured seismic intensity
	Downstream manhole depth (m)		SI (kine) (Indicator representing the extent of turbulence by earthquake in general structures)
	Upstream sewer earth covering (m)		
	Downstream sewer earth covering (m)		

Utilization of this database allows analysis of the damage trend of sewer pipeline facilities under various seismic conditions. For example, with regard to the damage ratio of sewer pipeline facilities, as the result of comparison between the 2011 Off the Pacific coast of Tohoku Earthquake, which was a subduction-zone earthquake with longer frequency and duration time, and the 2007 Mid Niigata Prefecture Earthquake, etc., which is an epicentral earthquake [1], the damage ratio was slightly large in the epicentral type when the measured seismic intensity was smaller than 5.3, and was large in the subduction-zone type when the measured seismic intensity was larger than 5.3 (Figure 1). We will continue to conduct more detailed trend analysis and examine damage contributing factors.

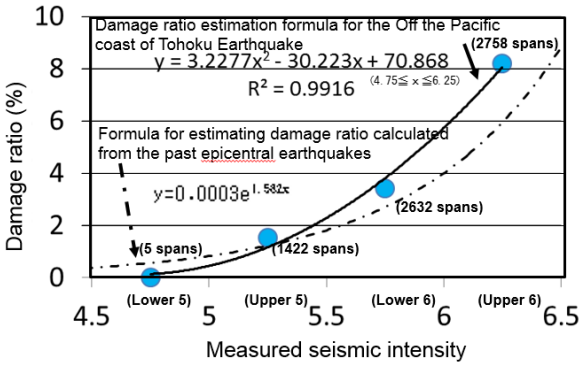

Figure 1. Measured Seismic Intensity and Damage Ratio

4. Conclusion

In this research, we organized the information of seismic damage on sewer pipeline as a database and analyzed damage trend. We also plan to improve the damage database and use it for examination of method for seismic damage risk assessment for sewer pipeline facilities and establishment of method for evaluating the priorities of earthquake resistant measures. Release of this database to the public is expected to promote earthquake research in local governments, universities, and private sector researchers and to develop technologies for earthquake resistant measures for sewer pipeline facilities.

[Reference]

1) Working Committee for Estimating Damage to Sewers by Large-scale Earthquake: Manual for Method of Estimating Damage by Large-scale Earthquake and Method of Utilizing Estimation Results, March 2006