

Survey Study concerning Liquefaction Phenomena Accompanying Ground Movements

Whole term

2004.1 ~ 2006.3

(Purpose)

The Niigata Prefecture Chuetsu Earthquake, which occurred in October 2004 following the Hyogo Prefecture Nambu Earthquake, caused large scale damage to sewerage facilities. Damage was particularly extensive in pipeline facilities, with manhole heaving and subsidence occurring at more than 1,400 locations, virtually all of which was caused by liquefaction phenomena in backfill.

In this investigation, the characteristics of damage to sewerage facilities in large scale earthquakes including and since the Hyogo Prefecture Nambu Earthquake were compiled. Also, the characteristics of the surrounding ground, the degree of compaction of backfilled areas, and the relationship to earthquake motions, etc., were surveyed for liquefaction phenomena accompanying earthquake motions. Damage mechanisms were investigated and countermeasures against liquefaction were examined.

(Results)

1 . Characteristics of damage to sewerage pipeline facilities

A database of damage to sewerage pipeline facilities and the cause of damage was compiled. The results showed that in the Hyogo Prefecture Nambu Earthquake, damage such as rupture of joints and cracks in main pipes were predominant. However, in the Western Tottori Prefecture Earthquake, the Tokachi-oki Earthquake, and the Niigata Chuetsu Earthquake, damage caused by liquefaction such as manholes protruding, misalignment of pipelines, and uplift were predominant.

2 . Causes of liquefaction

For the Niigata Prefecture Chuetsu Earthquake, Swedish weight sounding, longitudinal and cross-section surveying, and borehole surveys were carried out in the three locations where liquefaction damage was particularly prominent: Nagaoka City, Ojiya City, and Kawaguchi Town. The survey showed that the main factors that explained the differences observed between areas where manholes protruded (deformed areas) and areas where they did not protrude (undeformed areas) were 1. groundwater level, 2. particle size distribution of the backfill material, 3. degree of compaction of the backfilled areas, and 4. depth to bedrock. The deformed areas had the following characteristics compared with the undeformed areas. In Nagaoka City and Kawaguchi Town, deformation of backfill material occurred in impermeable clay ground.

- a. The level of groundwater in the backfill soil was high.
- b. The backfill soil had particle size distributions that made them susceptible to liquefaction.
- c. The backfilled areas were not well compacted.
- d. The depth to bedrock was deep.

Based upon the above results of damage and factors affecting liquefaction, a flowchart for determining where liquefaction damage to pipelines occurs and does not occur was constructed.

3 . Investigation of Countermeasures against Liquefaction

Regarding definitions in the "Guide to seismic measures for sewerage facilities and commentary, 1997 edition", it is proposed that pipelines currently defined as "other pipelines" which are located in areas where they might affect relief activities and disaster recovery activities be classified as "important trunk lines, etc.". Construction methods that provide countermeasures against liquefaction were also proposed.

Research Particulars

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key words

Niigata Prefecture Chuetsu Earthquake, earthquake damage, liquefaction countermeasures, borehole survey