

Damage of Houses and Residential Areas by Niigata Prefecture Earthquakes (Part2)

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ABSTRACT

The earthquakes of Chuetsu (2004) and Chuetsu offshore (2007) in Niigata Prefecture, caused liquefaction at many locations, and also caused damages on the residences and the residential areas due to the failure of ground. In the future, the judgment of liquefaction on housing site will become important and it will be thought that the upgrade of soil investigation and liquefaction countermeasure is necessary. In Japan, Swedish weight sounding (SWS) has been widely used in soil investigation on residential areas. Based on the result of SWS, the bearing capacity of ground can be obtained. However, the judgment of liquefaction is not obtained.

This paper reports results of SWS, boring investigation, standard penetration test (SPT), and three component cone penetration test (CPT) on the housing site which caught the liquefaction damage by the earthquake of Chuetsu offshore (2007) in Niigata Prefecture. In addition, it reports the applicability of the CPT on the housing site of Japan.

KEY WORDS: Soil investigation; cone penetration test; Swedish weight sounding; liquefaction; residential areas.

INTRODUCTION

The Building Standard Law of Japan says that "It is necessary for the ground with the fear of the liquefaction by an earthquake to confirm that the harmful damage, transformation, subsidence to the part of a building do not produce". It can be said that the examination of the liquefaction is essential because this law is applied to the private housing without exceptions. The problem of the liquefaction on the housing sites in Japan is viewed easily from a documentary search such as "maps for liquefaction sites", because the SWS are common. In addition, it is difficult to take a liquefaction countermeasure by a private housing financially, and this is a factor to take a liquefaction judgment easy.

The simple judgment method of liquefaction based on soil investigation

has a judgment method based on the SPT (N-value) and the CPT (q_c). In Japan, a judgment method based on the SPT is common. It is a big factor that a Japanese design system based on N -value is established. However, it is rare that the SPT is performed for the soil investigation on housing areas because the SPT is expensive. On the other hand, the CPT is not common in Japan. This cause is in the Japanese ground where there is gravel carried by the fast flowing stream river from the hilly district to the estuary. Therefore, soil investigation using the CPT is difficult in Japan. However, the CPT is economical in comparison with the SPT and laboratory soil test. In addition, the CPT gives us soil classification, bearing capacity, consolidation of the ground, and the position of groundwater level without the sampling of soil. In this respect, the CPT is effective in the soil investigation on housing sites. Most of this investigation is used by the SWS first. Therefore, it is thought that the trouble that a cone cannot be penetrated get fewer because it can estimate the penetrated power of cone based on the result of the SWS.

This paper reports a result of the SWS, boring investigation, grain size analysis, the SPT, the CPT on the housing site that had been caught the liquefaction damage by the earthquake of Chuetsu offshore (2007) in Niigata Prefecture. In addition, it reports the current status of the seismic performance evaluation and the applicability of the CPT to the residential areas of Japan.

PLAN FOR GROUND INVESTIGATION

The investigation place is two housing sites (Kashiwazaki- Matsunami and Kashiwazaki-Hashiba) that caught the liquefaction damage by the earthquake of Chuetsu offshore (2007) in Niigata Prefecture (Fig. 1). The magnitude (M) of this earthquake was 6.8; the peak horizontal acceleration at the ground surface (a_{max}) generated by this earthquake was about 400 gal. The sand boil due to liquefaction was remarkably generated on the both housing sites, and differential settlement was caused in the houses. We investigated the three soundings of the SWS, the CPT, and the SPT in this both sites. Moreover, the grain size distribution was analyzed and the soil classification was examined using the soil samples obtained from boring holes.