Lateral Loading Experiments on Thrust Restraint for Shallowly Buried Pipelines using Geogrids

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ABSTRACT

This paper discusses the investigation on the lateral resistance against thrust force generated at pipelines bend when a pipeline is installed shallowly. We proposed that the method of shallowly buried pipeline is installed at a pipeline bend and we carried out the model pit tests in order to verify the effectiveness of this method. The model pipe was loaded at 1.0 mm/min laterally after backfilling to simulate the thrust force. The results show that the lateral resistance in the proposed method has been increased.

KEY WORDS: Pipe bend; Thrust force; shallowly buried pipelines

INTRODUCTION

Pipelines for agricultural water supply are subjected to internal water pressure. In such pipelines, thrust force is generated at the bends. If the thrust force is larger than the soil passive resistance, the joints of the pipelines are separated. For this reason, in the current Japanese design for irrigation pipelines, concrete block is generally installed at a bend. However, the concrete block is a heavy weight structure whereas an adjacent pipe is a lightweight structure. Differential settlements occur on liquefied ground in the event of an earthquake. The concrete block becomes the weak points in pipelines system when earthquake occurs. The method of shallowly buried pipeline has been adopted in order to reduce the construction costs at various locations in the past. Mohri et al. (2000) conducted the laboratory test for buried pipe using FRPM (fiberglass reinforced plastic mortar) pipe having 1100mm diameter. Five cases of backfilling methods were used. From the test results, it was found that the method using geogrid and gravel as backfill material increased the uplift resistance of buried pipes. But the tests only clarified the effectiveness geogrid in enhancing the uplift resistance of buried pipes against uplift force by buoyancy. The tests did not investigate the effectiveness of lateral force, such as the thrust force.

In addition, thrust force is generated at pipelines bend due to internal pressure. If the thrust force is larger than the passive resistance of the soil, the joints of the pipelines would be separated. For this reason, methods of the thrust restraint are required. Kawabata et al. (2005) proposed a light weight thrust restraint using geosynthetics and an anchor plate. In this method, it is found that the passive resistance acting on the anchor plate, pull-out resistance of the geogrid and passive resistance acting on the bend can be expected. Furthermore, Sawada (2007) estimated the lateral resistance of the bend in order to establish the detail design for proposed method. Kawabata et al. (2008) conducted full scale field test for buried pipe using steel pipe of diameter 3500mm. Five cases of methods were applied. From the test results, it is found that the behavior of buried pipe was potentially influenced by the stiffness of backfilling method.

However, the detail mechanism of this method of shallowly buried pipeline was not fully understood. In this paper, static tests were conducted and the effectiveness of the method of shallowly buried pipeline against lateral force is investigated. In addition, the mechanism of the method of shallowly buried pipeline is clarified with the investigation on the progress of the rupture surface. Figure 1 is a schematic diagram of the method of shallowly buried pipeline and Figure 2 shows an actual construction site.

![Fig. 1 schematic diagram of the method of shallowly buried pipeline](image-url)

Fig. 1 schematic diagram of the method of shallowly buried pipeline