Enforcing methods of existing old bridges on soft ground for a very large Earthquake (In-Cap Method)

Shioi Yukitake [1)] , Aoyagi Mamoru [2)] , Ooya Tsutomu [3)] ,
Kato Koji [4)] , Fukada Hisashi [4)] ,

ABSTRACT

About the aseismicity of foundation structures to the level 2 earthquake motion in existing old bridges, the insufficient aseismicity of existing bridges cannot be denied. So we propose "the anti-seismic reinforcement method of the existing foundations on soft ground ". This construction method expects increase of the horizontal and vertical resistance, by driving underground walls around the existing foundation and consolidating the inside.

We executed several analyses such as frame analysis and FEM and showed that both the maximum moment and the horizontal displacement generated to a pile, can be decreased also. We are planning the static experiment by centrifugal model equipment, and want to examine a consolidation between the results of experiment and this analysis technique.

1.Introduction

About the aseismicity of foundation structures to the level 2 earthquake motion in existing old bridges, when the earthquake motion taken into consideration by revision of an design code is improved, or their functions are expanded, the insufficient aseismicity of the existing bridges cannot be denied.

As the foundation reinforcement work generally requires the great construction cost and the time because of several conditions such as narrow space under superstructures, and tends to become comparatively large-scale, these works are not so many compared with past other reinforcement works.

However, on the other hand, a generation of the Kanto,the Tokai, the Tonannkai, or the Nankai earthquake is anxious in the first half of this century. Since presently the countermeasures to prevent disaster for various kinds of civil structures are reexamined, development of the efficient anti-seismic enforcing method for existing foundations is inevitable. Then, we decided to propose "the anti-seismic reinforcement method of construction of the existing foundations on soft ground " which can attain reduction of cost and time necessary for completion to the foundation and also can be easily applied in a narrow space.

This method of construction expects increase of the horizontal and vertical resistance, by driving underground walls around the existing foundation and consolidating the inside. By this process we aim that the improved area with the surrounding underground walls performs as a

---

1) : Hachinohe Institute of Technology
2) : Shiraishi Corporation
3) : Nittoc Construction Co. ,Ltd
4) : Fudo Construction Co. ,Ltd

foundation.

This paper describes the results of two-dimensional static frame analysis, two-dimensional dynamic FEM and three-dimensional static FEM analysis prior to three-dimensional dynamic analysis in order to examine the effects of the proposed method.

2. The outline of proposed method

The process of this reinforcing method is composed of driving steel sheet piles up to the given depth to surround the existing foundation on soft ground, and consolidating the inside of sheet pile wall using soil improvement method. The outline is shown in Fig.-1.

By this process increase of the horizontal and vertical resistance are expected. The outline of the mechanism of a resistance is shown in Fig. -2 and Table -1 .

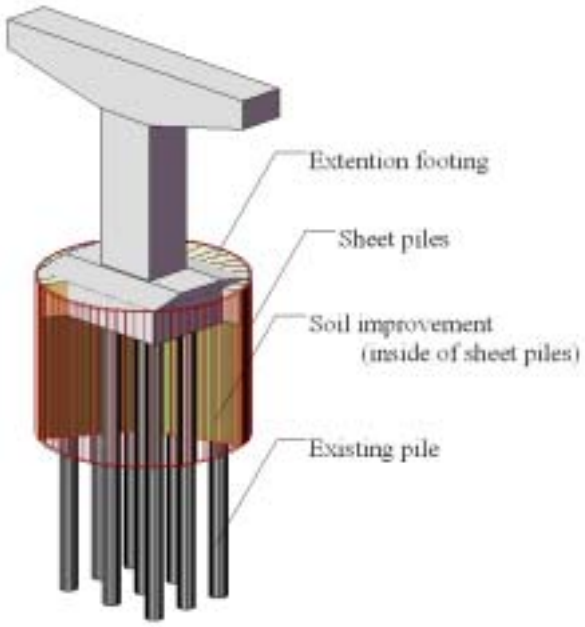

Fig-1 The outline of this method

Table-1 Resistance elements of this method

		effect	mechanizm of reinforcement
horizontal resistance	increase of resistance area	○	originated in improved soil and sheet pile
	strength increase of resistance element	×	
vertical resistance	increase of resistance area	○	originated in friction of sheet pile
	strength increase of resistance element	○	originated in friction between improved soil and pile
rigid increase in base body		×	

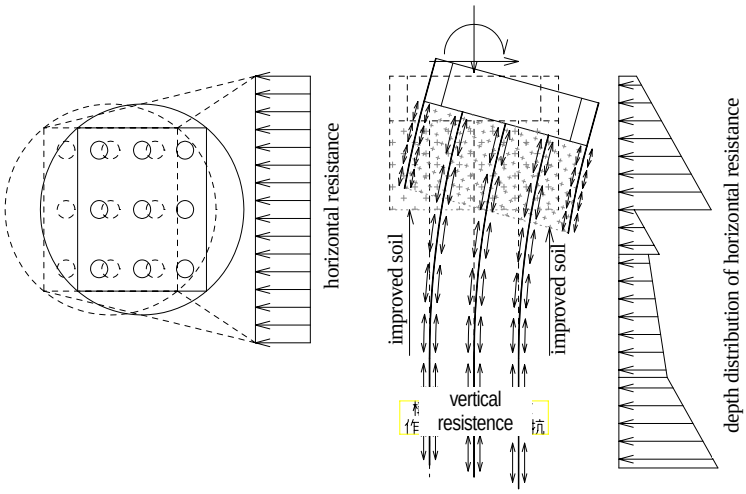

Fig-2 The mechanism of a resistance element

3. Two-dimensional static frame analysis

In this paper, the target of existing structure is a pile foundation structure currently mentioned to "Reference-Data of Japan Highway Association about Reinforcement of the Existing Highway Bridge Foundation" as an example of a design, and it reinforces the bridge pier of which the seismic performance was judged insufficient by the revision of Design Codes of Japan Highway Bridge. The figures of a structure are shown in Fig. -3.

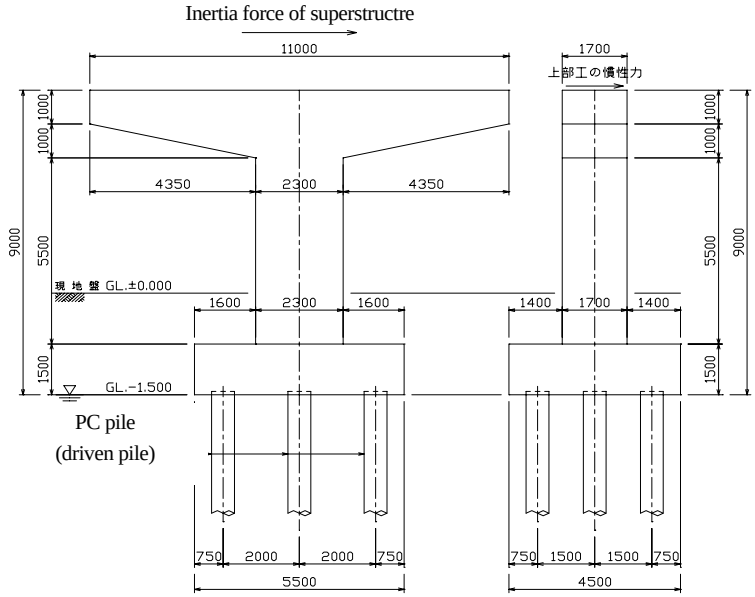

Fig-3 The target existing structure

The design strength of the foundation computed from the resistance of the bridge pier after reinforcement in case of the level 2 earthquake, are Pu=3734 kN and Mu=31345 kNm.