Evaluation of stability according to spaces by anchor type

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ABSTRACT: The construction of small tunnels in urban underground structures greatly affects the stability of the structures installed with anchors to secure structural stability causing many problems in the stability of structures. In order to solve such a problem, numerical analysis was carried out to investigate the anchor force, which is changed by the interference between compression or tension anchors and the underground structure. The results of this study indicate that the maximum and minimum shear force ratios of tension anchors according to the spaces are relatively higher than those of compression anchors. In addition, the results indicated that, in the case of tunneling adjacent to a structure, compression anchors installed on the base surface should secure vertical spaces not smaller than 0.5D of the minimum tunnel radius and horizontal spaces not smaller than 0.75D and tension anchors should secure both vertical and horizontal spaces not smaller than 0.5D.

Keywords: compression and tension anchor, tunneling adjacent to a structure, space, numerical analysis

1 INTRODUCTION

In recent years, as the sizes of most of structures in urban areas have been enlarged, construction examples in which the lower part of the structure is installed in the ground are increasing, and many reinforcement methods for securing the stability of the structures are being applied. Among them, anchor and pile methods are methods that utilize underground stress. If the anchors are installed at the bottom of the foundations of structures to secure the stability of the underground structures, the underground stresses may become different from each other to affect the anchors causing problems in the stability of the existing structure. Since the characteristics of transitions to adjacent ground are different according to anchor types, the space between the anchors installed on the existing structure and the tunnel to be newly installed is a very important consideration. Therefore, this study is intended to investigate the anchor force changed by the interference between the anchors already installed and the underground structure (tunnel) through numerical analysis, and proposes proper spaces between the foundation already installed and the underground structure through the results of the study.

To review the trend of studies related to the foregoing, in the case of South Korea, as structures in downtown areas were constructed underground, attention to underground structure increased and studies applied with the numerical analysis method have been applied recently (Lee, 2012). In addition, Lee (2004), Ong et al. (2006), and Lee and Chiang (2007) analyzed the behaviors of underground structures and piles already installed using indoor model tests and centrifugal model tests and revealed that due to tunnel excavation, pile behavior varied according to the space between piles and the tunnel (Jacobsz, 2002).

2 NUMERICAL ANALYSIS CONDITIONS

Fig. 1 shows the modeling of cases where compression anchors, which are representative, were used performed to analyze the behavior of anchors due to tunnel excavation. The settlement length of the modeled compression anchors is 5.0 m each. As for the anchor and soil models, the MohrCoulomb model was applied to the soil and the elastic model was applied to anchors. Fig. 2 shows the analysis conditions for vertical and horizontal spaces of anchors and the tunnel. As shown in Fig. 2, the vertical and horizontal spaces applied are (0.25, 0.50, 0.75, 1.0) D of the tunnel diameter (D = 8.0m) based on the ends of the tunnel and anchor.

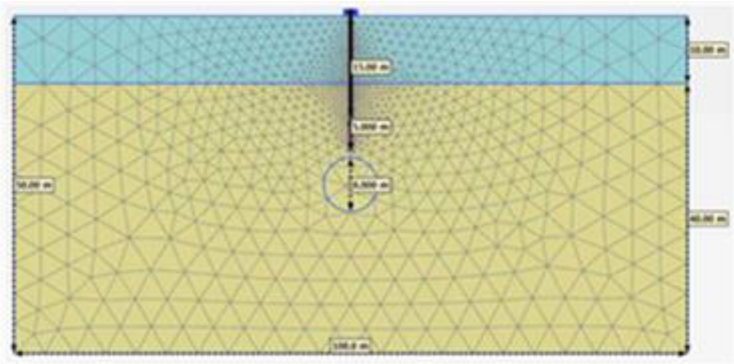


Figure 1. Modelling and mesh generation of compression anchor

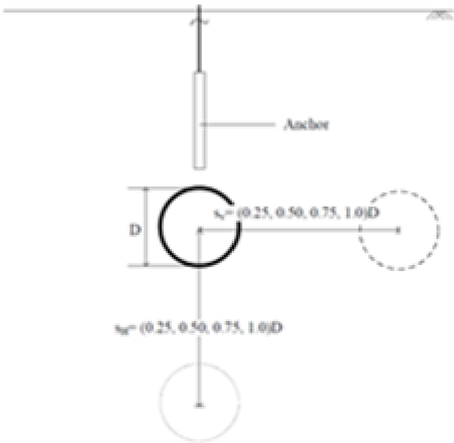
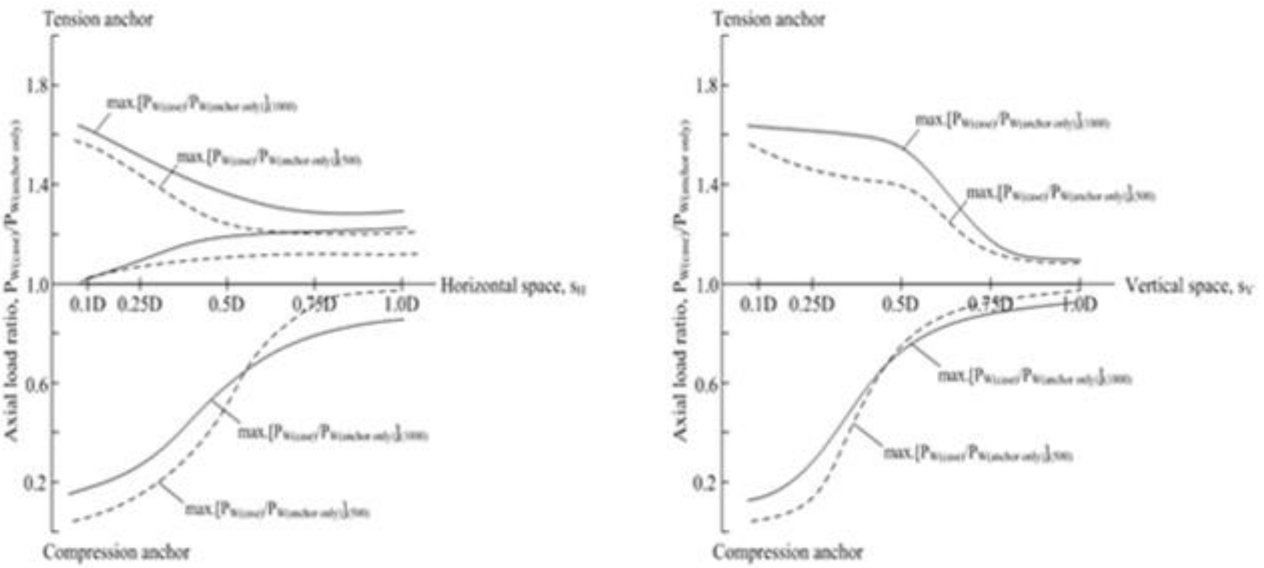


Figure 2. Analysis conditions

3 COMPARISON OF MAXIMUM AXIAL LOAD RATIOS

Fig. 3 shows changes in axial load ratios according to spaces by anchor type. In the case of compression anchors, as shown in Fig. 3 (a), when the vertical space was less than 0.5D, the axial load ratio of the initial prestressing force of 500kN was larger than that of the prestressing force of 1,000kN, and when the space exceeds 0.5D, the opposite result was shown. In addition, when the space was not smaller than 0.5D, the axial load ratio was constant. On the other hand, in the case of tension anchors, changes in axial load ratios were larger in cases where the initial prestressing force was 1,000kN and under both conditions, axial load ratios decreased from when the vertical space reached 0.5D and remained constant after the space reached 0.75 D. in addition, changes in axial load ratios of tension anchors were shown to be smaller than those of compression anchors.

When the horizontal space was 0.5D or smaller, as can be seen in Fig. 3(b), changes in the axial load ratio of compression anchors in cases where the initial prestressing force was 500 kN were larger than those in cases where the prestressing force was 1,000 kN identically to the cases of the vertical space. In addition, the axial load ratio was constant when the space exceeded 0.5D. In the case of tension anchors, changes in axial load ratios were larger when the initial prestressing force was large, and the axial load ratio changed constantly after the space reached 0.5D. In addition, changes in the axial load ratios of tension anchors were shown to be smaller than those of compression anchors.

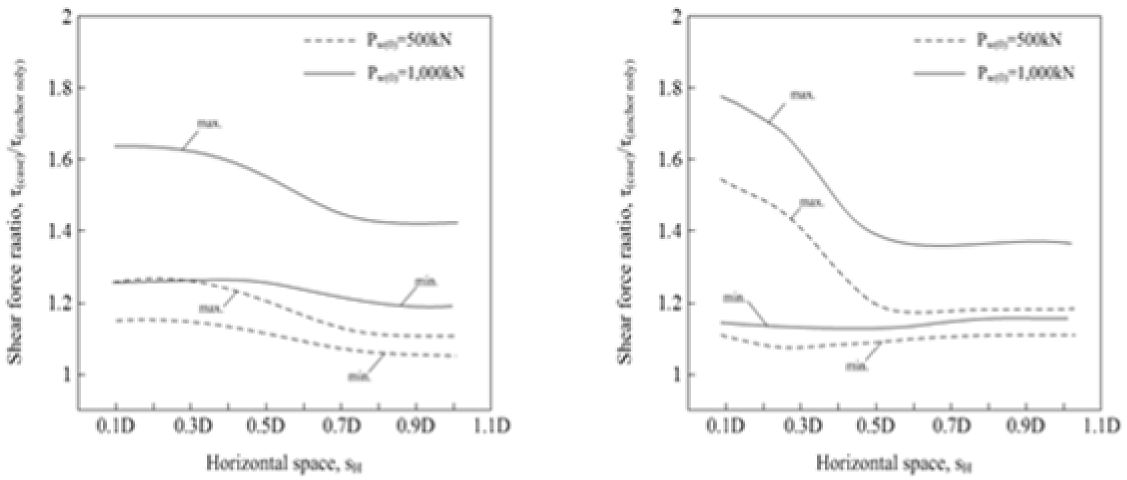


(a) Pw(case)/Pw(anchor only)) - sV (b) Pw(case)/Pw(anchor only)) - sH

Figure 3. Axial load ratio by space between tunnel and anchor

4 COMPARISON OF MAXIMUM, MINIMUM SHEAR FORCE RATIOS

Fig. 4 shows a comparison of shear force ratios according to the horizontal spaces by anchor types. As shown in Fig. 4 (a), the maximum and minimum shear force ratios of the compression anchors were shown to be larger when the initial prestressing force was 1,000 kN than when the initial prestressing force was 500 kN. Regardless of the magnitude of prestressing force, the difference between the maximum and minimum shear force ratios of compression anchors was large when the horizontal space between the tunnel and anchors was small, decreased as the space increased, and remained constant after the space reached 0.5D. In addition, in the case of tension anchors, as shown in Fig. 4 (b), the difference between the maximum and minimum shear force ratios of anchors was large when the horizontal space between the tunnel and anchors was small, decreased as the space increased, and remained constant after the space reached 0.5D.



(a) Compression anchor (b) Tension anchor

Figure 4. Comparison of shear force ratio with horizontal space

5 CONCLUSION

(1) In the case of tunneling adjacent a structure, the dangerous displacement area of tension anchors is larger than that of compression anchors, and the shear force generated at the boundary between anchors and soil, which is related to external stability, is also larger than in the case of compression anchors.

(2) In the case of tunneling adjacent a structure, the appropriate installation spaces for compression anchors

should be vertical spaces not smaller than 0.5D of the tunnel radius and horizontal spaces not smaller than 0.75D and the appropriate installation spaces for tension anchors should be both vertical and horizontal spaces not smaller than 0.5D of the tunnel radius.

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