Excavation simulation analysis of shallow tunnel in multilayered ground by DEM

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Abstract

In this study, we tried excavation simulation of shallow tunnel by using distinct element method with high utility for a discontinuous ground. The focus of our research is actual collapse accident of tunnel, and we examined the presence of the collapse by setting conditions of underground water and the invert support, etc. As a result of the simulation, an analysis model collapsed when underground water exists and invert is not closed as the actual phenomenon.

1. INTRODUCTION

It is difficult to set a clear standard concerning the design, because tunnels are excavated in various geotechnical conditions. Therefore, in general, the design is carried out still experientially, so it is required that analytical method that can appropriately reproduce the mechanical behavior on the natural ground. In this study, we tried excavation simulation analysis of shallow tunnel in multilayered ground using DEM, and the purpose of our research is established the analytical simulator in multilayered ground.

2. EXPERIMENTAL PROCEDURE

In this study, we decided the value which can reproduce the natural ground, the supporting made of concrete, and invert by examining simulation of biaxial compression test and uniaxial compression test before excavation simulation. We established the simulation model using packing simulation by fall method. We did excavation simulation by using an analytical model. Then we considered some conditions which are underground water, invert support, overburden and stiffness of weak layer.

3. RESULTS AND DISCUSSION

The tunnel collapsed in Case1 which assumed the actual phenomenon, and the collapse was not caused in Case2 in which invert was closed. Moreover, though the tunnel was transformed, collapse did not occur when assuming earth covering H=1.5D and 2.0 D(Case3,Case4). When paying attention to the tc-s and the tc-c, the tunnel collapsed in Case5 that increased cohesion in the tc-s that have low-stiffness, and the collapse was not caused in Case6 that increased cohesion in the tc-c.

4. CONCLUSIONS

We analyzed an actual collapse accident of tunnel, and presumed the collapse mechanism. The collapse factor is ①undergrd water had existed from the levee crown of tunnel to the upper surface in the tc-c ② non-closeing invert ③earth covering is too small ④tc-c that have low-stiffness distributed. The opinion similar to the actual phenomenon was able to be obtained.

5. REFERENCES

Japanese tunneling association：Research of design construction of Tohoku Shinkansen tunnel, 2006.