Numerical evaluation of the effects of ground reinforcement method in double-deck tunnel junction

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1 INTRODUCTION

Construction of double-deck tunnel have gradually increased over the world to optimizing tunnel space and solving urban traffic problem. Network-type tunnel and double-deck tunnel is needed for constructing underground junction. Closed twin tunnel is needed for saving construction cost and environment. As a result, there is a zone of weakened ground at cross section, pillar of junction and portal.

The weakened zone is needed reinforcement method because it is weakened by a stress concentration due to the interference effect. This paper focuses on evaluation of the effects of new developed ground reinforcement methods in double-deck junction. The values of reinforcement determined from the existing and developed methods were compared to each other by numerical simulation.

2 REINFORCEMENT METHOD

The loop-type steel wire reinforcement method is applied to binding a multi-axial direction in pillar between main tunnel and branch tunnel for stability of pillar using loop-type steel wire. The sequence of construction is ‘Excavation of main tunnel – Drilling of steel wire insertion hole – Insertion of steel pile and grouting – Excavation of branch tunnel – Installing of loop-type steel wire and binding (Lee et al. 2015).

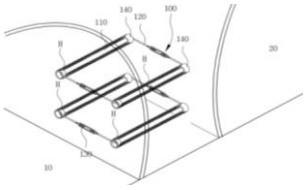

Figure 1. Loop-type steel wire reinforcement method

3 NUMERICAL ANALSIS

3D analysis was performed to consider the characteristics of multi-axial direction reinforcement using loop-type wire and the variation of pillar width between main tunnel and branch tunnel. Analysis range was set in consideration of the excavation impact area. It was applied to the standard support pattern of Korea Highway Corporation that generally applies in domestic.

The stability of the 3-grade, 4-grade rock conditions according to the pillar width was studied to calculate the strength/stress ratio based on the rock failure criteria using the major principal stress acting on the pillar obtained by the numerical analysis.

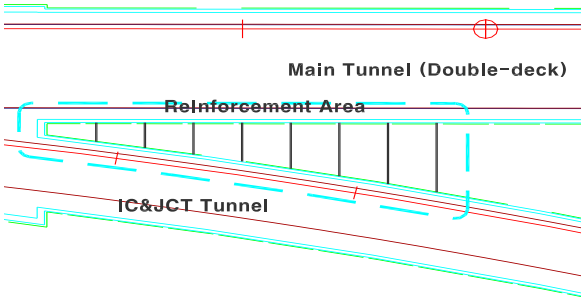

Figure 2. Floor plan of double-deck tunnel junction

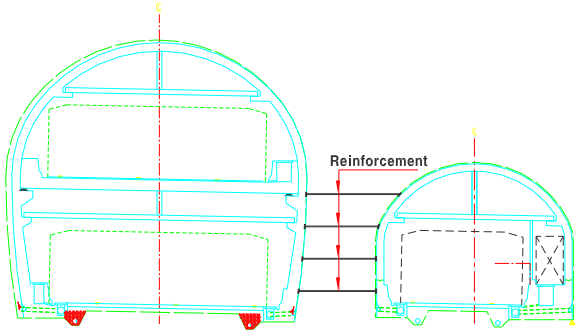

Figure 3. Cross section of double-deck tunnel junction

KEYWORDS: Double-deck tunnel, weakened pillar, ground reinforcement method, numerical simulation
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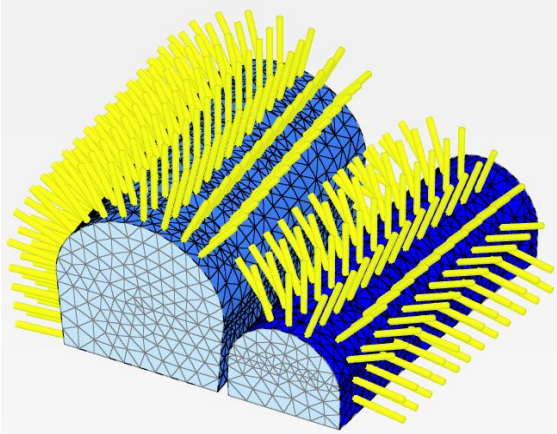

Figure 4. Simulation model

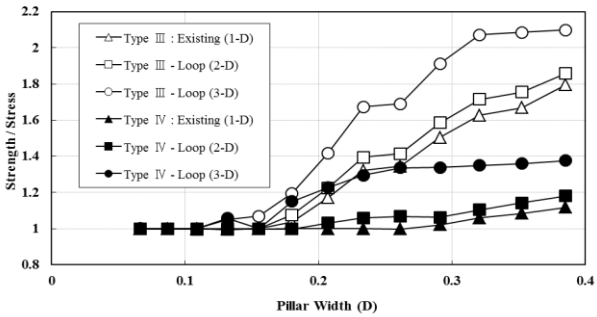

Figure 5. Strength/stress ratios of pillar width

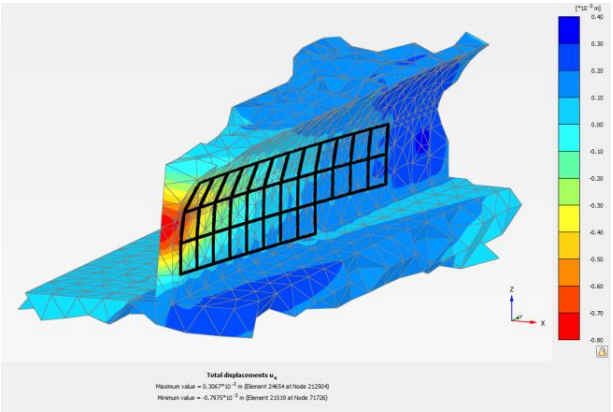

Figure 6. Horizontal displacement of pillar: Loop-type (3-D)

4 CONCLUSION

In this paper, 3D analysis was performed to consider the characteristics of multi-axial direction reinforcement using loop-type wire and the variation of pillar width between main tunnel and branch tunnel. The values of reinforcement determined from the existing and developed methods were compared to each other by numerical simulation. According to the results, the following conclusions can be drawn.

1. Reinforcement effect of loop-type method was better than its existing method for all rock grades.
2. 3-D loop-type reinforcement method considerably increased the safety factor.
3. In less than 0.2D rock pillar width, regardless of the conditions, strength/stress ratio was about 1.0, it was shown unstable.
4. It was shown that since more than 0.2D showing a tendency to increase the strength/stress ratio, and 3-grade rock of strength/stress ratio increased significantly than 4-grade.
5. Deformation of pillar occurred in the direction of the main tunnel due to difference of tunnel sections.

5 ACKNOWLEDGEMENTS

This study was carried out in the 2014 construction technology research projects of the ‘Development of Design and Construction Technology for Double Deck Tunnel in Great Depth Underground Space’ research project group (14SCIP-B088624-01) of Korea Agency for Infrastructure Technology Advancement (KAIA) under Ministry of Land, Infrastructure and Transport (MOLIT). Thank you for supporting research.

6 REFERENCES

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