Investigation for inspections and lining design of road tunnels

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(Key words) tunnel, periodic inspection, lining design

1. Purpose of this study

We examined road tunnel inspection methods to improve their efficiency and simplify them. We also studied and examined ways to formulate design criteria by evaluating the performance of tunnel linings for newly constructed roads.

To obtain the basic data needed for such an examination, we analyzed the results of periodic road tunnel inspections, studied ways to apply the limit state design method to tunnel lining design, and examined the load for tunnel lining design.

2. Research contents

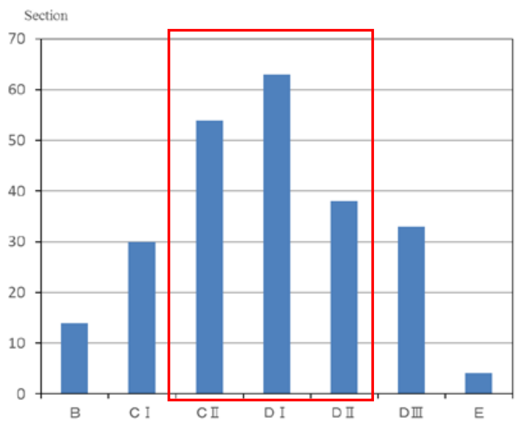
We organized the results of periodic road tunnel inspections for every span, and analyzed the relationship between the percentage of each cause of deformation, such as external forces, material degradation, and water leakage, and the judgment criteria.

For tunnels where inspections have been performed multiple times, we organized and analyzed the differences in the results due to different construction methods, elapsed years after construction, and changes in the judgment criteria.

By determining the relation between the natural ground classification (an index for the degree of excavation difficulty)[1] for lining by using the NATM construction method and the occurrences of cracks, we confirmed that cracks occur mainly under the natural ground classifications of D I, C II, and D II (Figure 1).

We examined the load to design a tunnel support structure. In particular, for tunnels where a standard support pattern is not applied because of a small overburden, we collected and analyzed the support patterns at the time of construction, along with the observation and measurement data (B measurement) during construction, and performed an analysis based on three methods: FEM analysis, FRAME analysis, and balance calculation focusing on the axial force of the side walls.

As a result, we found that even though these three methods gave three different values for the same cross section, there was a tendency for the height of the load obtained by the balance calculation to be smaller than those obtained by the other two methods. In addition, there was a case where we needed to consider the total load of the overburden as the design load, up to an overburden of approximately 1D, when we designed a support structure by using the FRAME analysis (Figure 2).



*Investigated the same consecutive natural ground classification as one section. Even when a section was long, if it was in the same natural ground classification, it was counted as one section.

Figure 1 Occurrences of cracks classified by natural ground classification

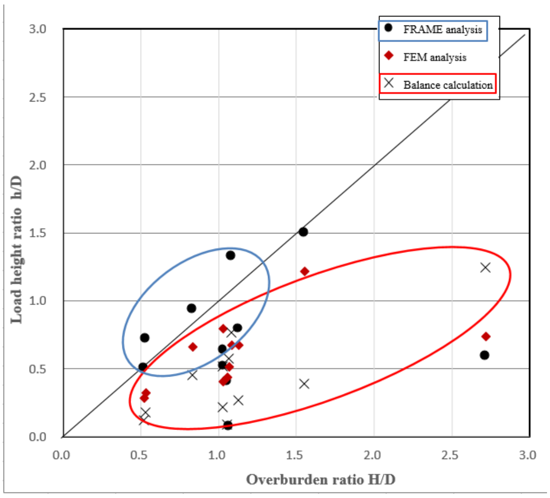


Figure 2 Relationship between overburden and height of load

3. Concluding remarks

Using the results of periodic road tunnel inspections, we will continue to determine the soundness of tunnels, analyze the causes for the occurrence of deformation, and examine ways to simplify and improve the efficiency of periodic tunnel inspections.

In addition, to examine the load on design tunnel linings, we plan to evaluate the load on a support structure and investigate and study these design methods.

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1) Technology criteria of road tunnels (structures), and explanation (November 2003), Japan Road Association (in Japanese)