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Results of Monitoring and Simulation Analyses for Deep Excavation

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Summary

1A anchorage foundation of the Akashi-Kaikyo Bridge had the deepest excavation whose scale was 64m depth and 80.6m inner-diameter, which had not experienced before. And, there was also some concern about bottom ground failure due to the groundwater pressure. Accordingly, we monitored behavior of the retaining wall as well as condition of bottom ground by using more than 500 instruments. And also we estimated wall deflection and ground movement by simulation analysis in order to predict and check the stability of them during the excavation. The paper describes results of monitoring of the retaining wall and the bottom ground and simulation analyses in this excavation work.

1. Abstract of deep excavation work

The excavation work of 1A anchorage foundation of Akashi-Kaikyo Bridge has characteristics as follows.

① The excavation work inside a cylindrical earth retaining wall is larger by 20% in diameter and deeper by 40% than any excavation in the past that Japan had experienced before.

② The ground water level (TP±0m) is high to the final excavation level(TP-61m).

③ The slurry wall for retaining and cut-off wall is not penetrated into impermeable layer. Overall-view of excavating condition is shown in fig.1.

2. Results of monitoring and simulation analyses

2.1 Displacement and concrete compressive stress of earth-retaining wall

The displacement distribution of the retaining wall is shown in fig.2. The maximum displacement was measured at final excavation stage. The measured value was 1.2~1.5cm, although the design value was 1.8cm. While, the maximum of circumferential concrete compressive stress was generated at same stage too. The measured value was 9MPa, although the design value was 13.5MPa. The reason why measured value showed two third of the design value was concluded that external force acting on the wall was smaller than design value. (see fig.3)

2.2 Heaving and hydro-fracturing of the bottom ground

We evaluated permeability of Kobe stratum correctly by using measured results of groundwater pressure and simulation with 3 dimensional FEM seepage flow analysis.

Fig.4 shows the accuracy of simulation analysis of groundwater pressure at final excavation stage. It is found that the simulated value is very similar to the measured value. The occurrence of hydro-fracturing was evaluated by local-safety factor, which used Mohr-coulomb's failure criterion. Fig.5 shows distribution of the local safety factors in the bottom ground. The minimum value was 1.24. The excavation work was judged to be in safety by these analyses before the excavation as having been shown later..

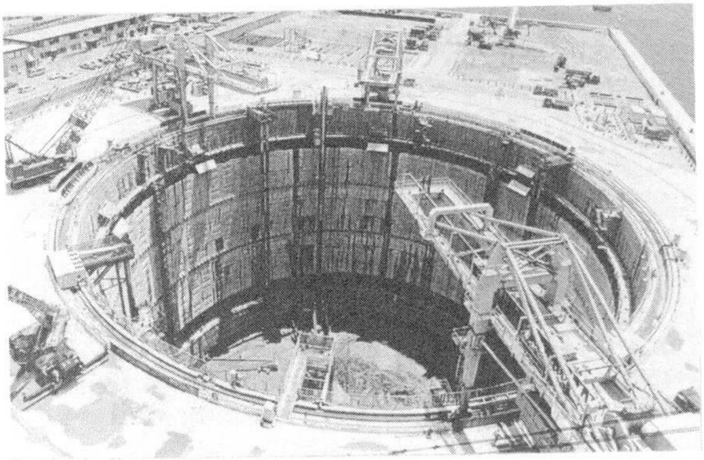


Fig1:Overall-view of excavating condition (Current depth of excavation = TP-54m)

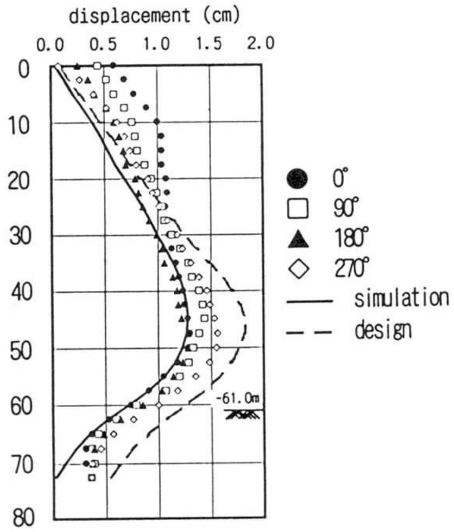
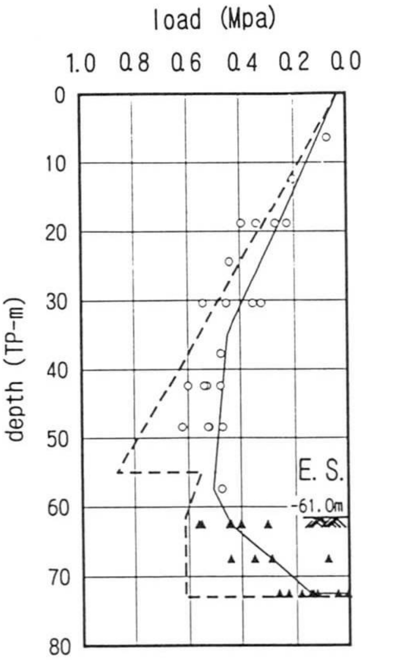
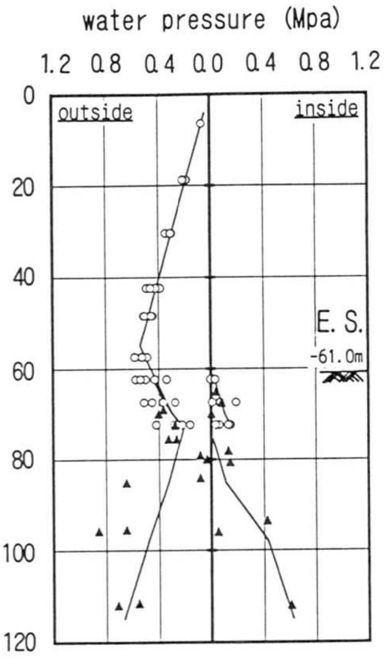


Fig2:Horizontal displacement of earth retaining wall



○ measured lateral pressure
▲ measured water pressure
____ value for simulation
..... design value

Fig3.:External load acting retaining wall



E.S. : Excavated surface
○ measured value in the wall
▲ measured value in the ground
____ value for simulation

Fig4.:Groundwater pressure distribution

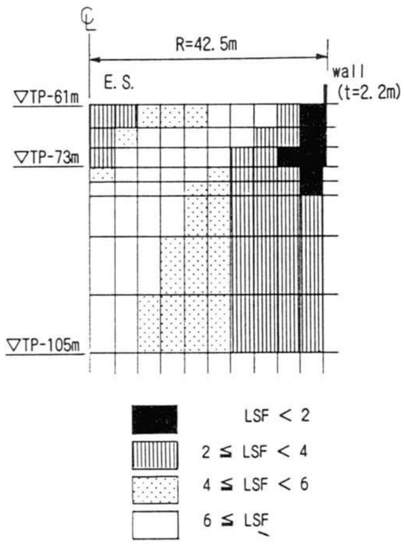


Fig5.:Local safety factor distribution in the bottom ground