











Hyogoken-Nanbu earthquake was selected as the objective box culvert. The Toyoura sand was assumed as the ground material and its mechanical behavior was described by the CM model.

At first, in order to verify the numerical method, the 1g shaking table test is simulated with 2D analysis in model scale. After then, in order to find an optimum pattern of ground improvement, 3D numerical analyses were conducted. In the 3D numerical analysis, the central column of Daikai station, that was the critical member during earthquake, was described by the AFD model. Four different cases were numerically investigated and the following conclusions can be given.

(i) The comparison between the 2D analysis and the shaking table test shows that the test results were well reproduced by the numerical analysis. Therefore, the numerical method proposed in the present study is able to predict reasonably the behavior of box culvert during an earthquake.

(ii) The assessment of Case-1 (basic case, without improvement) and Case-2, in which only the soil layer beneath the box culvert is improved, shows that the absolute displacement is reduced significantly due to the ground improvement but the relative displacement between the top and the bottom of the central column remains unchanged; implying that the seismic reinforcement effect is very limited.

(iii) Improvement of the soils around the side walls, proved to be very effective. The optimum pattern of the ground improvement is found to be Case-4, in which a partial ground improvement with a shape of downstairs at an inclined angle of 37° around the side-walls was used. In Case-4 the soil beneath the box culvert was also improved as well. It is found from the analysis that the relative horizontal displacement was reduced significantly; therefore, the column is in safe domain. In addition, the volume of the ground improvement around the side-walls in Case-4 is 35% smaller than Case-3, implying that Case-4 is the most cost-effective pattern.

In the future, the predicted results for the optimum patterns of the ground improvement for existing box culvert should be confirmed by the shaking table tests.

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