A B S T R A C T

25, March, 2011

TITLE Strength and Failure Simulations during Disasters of Historical Masonry Arch Bridges

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ABSTRACT

This study performed numerical simulations on failure mechanism of historical masonry arch bridges. In addition, the study investigated reinforcement of them based on the experimental results of bricks and mortar.

First, a masonry arch bridge was modeled using FEM, and the pushover analysis was conducted to estimate the validity of the simplified modeling method. The simplified model assumed homogenous material properties for all the automatically meshed elements. In addition, material nonlinearity was considered to estimate the failure mechanism of the arch bridge during ground deformations due to natural disasters. The results of the simplified model showed good agreement of lateral displacement and stress distributions with that of the detailed model in which every brick and mortar of the bridge was meshed.

Next, seismic behavior of a multi-span masonry arch bridge was investigated using the frame analysis. The bending moment-curvature relations based on the nonlinear finite element analysis was adopted in the frame analysis. Then the failure mode was indicated with the finite element analysis based on the maximum earthquake response deformation obtained from the frame analysis.

Furthermore, strength tests of the bricks, mortar and masonry specimens were conducted to obtain the material properties. Compressive strength of the masonry specimens were compared with the bricks and mortar. The results showed that the compressive strength of the masonry specimens except ones with the limestone were higher than that of the mortar and that the compressive strength of all masonry specimens were lower than bricks.

Finally, a fundamental analysis focused on the difference of the strength of the mortar was conducted. Experimental tests indicated that the difference in the mixing ratio of the mortar affected the strength of the mortar and masonry specimens. The results showed that the collapse of arch bridge consisting of mortar following JIS code was not severe compared with the case consisting of mortar with limestone which is typical to the old masonry arch bridges.