Experimental Replication of Masonry Arch Bridge Spandrel Wall Collapse

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Abstract:

Although a large testing program for masonry arch bridges has been conducted over the previous two decades, the tests were intentionally configured to produce a four-hinge collapse mechanism in order to assist in the assessment of the capacity of the bridge in the span direction. However, it has recently been noted that the capacity of an arch bridge perpendicular to the span direction is at least as important, and that a large number of recent failures of masonry arch bridges have been the result of deficient spandrel wall capacity. In order to account for this effect, a 1.5 meter span brick masonry arch bridge has been constructed and subjected to testing under a concentrated load adjacent to one of the spandrel walls. In this testing program, the bridge failed by collapse of the spandrel wall at a load of approximately 132 kN, while the arch barrel remained undamaged. An analytical model of the bridge has been developed using a commercially available three-dimensional non-linear finite element computer program. The analytical model predicts the pattern of cracks preceding the failure of the structure and the eventual failure mode, provides a good estimate of the failure load (135 kN), and achieves acceptable predictions of the deflections of the arch barrel and spandrel wall. The model also predicts order of magnitude and trends in the strains of the brick masonry arch bridge system.

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