Structural Characteristics of New Continuous Arch Bridges

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Summary

Three new types of continuous steel arch bridges are proposed and the structural characteristics are studied: the continuous arch bridge (model-A), the S-shaped arch bridge (model-B), and the double arch bridge (model-C). The continuous arch bridge has upward arch ribs. The S-shaped arch bridge has upward and downward arch robs. The double arch bridge has both upward and downward arch ribs. The arch ribs and the girders are all continuous on these bridges, which improves seismic resistance. It also eliminates expansion joints which improves drivability and reduces noises and vibrations. These three continuous arch bridges are studied in two stages. First, the member cross sections are determined for the dead and design live loads by the allowable stress method, and then the structural characteristics are studied. The S-shaped arch bridge has a larger vertical displacement than the other bridges. The vertical displacement and bending moment of the arch ribs and the girder of the double arch bridge are smaller than the others. Second, elastic plastic large deformation analysis is conducted to find the ultimate strength of the new arch bridges. It is found that the lateral buckling is critical in all the models. The initial imperfection is also considered by inclining the arch planes. This non-linear analysis shows that the proposed bridges have sufficient ultimate strength. Finally, the construction cost of these new arch bridges is estimated, finding that model-C requires more steel by 15% than model-A and model-B. In conclusion, the proposed new bridges are found to be feasible.

Keywords: continuous arch bridges; S-shaped arch bridge; double arch bridge; elastic plastic large deformation analysis; lateral buckling; ultimate strength.

1. Introduction

Arch bridges are usually simply supported at both ends. There are some cases when a couple of arch bridges are constructed next to next but in most cases each arch bridge is constructed independently and the girders and arch ribs are disconnected at the end supports. In this paper three new types of continuous steel arch bridges are proposed (Table 1): the continuous arch bridge with lower girders (model-A), the S-shaped arch bridge (model-B), and the double arch bridge (model-C). The continuous arch bridge with lower girders has upward arch ribs. The S-shaped arch bridge has upward and downward arch robs. The double arch bridge has both upward and downward arch ribs. This type of bridges has been constructed before such as the Royal Albert Bridge in UK and South Kawachi Bridge in Japan. The arch ribs and the girders are all continuous on these bridges, which improves seismic resistance by preventing the girder falling down. It also eliminates expansion joints which improves drivability and reduces noises and vibrations.

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