Summary of Final Report, Contract BC352-16
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ELASTOMERIC BEARING PADS UNDER COMBINED LOADING

BACKGROUND

The basic elements of a bridge are the deck (the superstructure) and the piers and foundation on which it rests (the substructure). In order to accommodate possible movement between these two main parts of the bridge, devices known as elastomeric (i.e., rubber) bearing pads are placed between them. The bearing pads are subjected to various loading forces that induce both vertical and horizontal deformation. The pads must be able to accommodate these deformations to ensure a safe transfer of the forces from the superstructure to the substructure while maintaining both short- and long-term bridge functionality and stability.

According to current AASHTO specifications, the bearing capacity of a steel reinforced elastomeric bearing pad subjected to rotation drops very rapidly as the dimensions increase and as the angle of rotation increases. The capacity obtained using the AASHTO equation is often found to be much less than the capacity observed in the field. Consequently, the Florida Department of Transportation (FDOT) suspended the use of the relevant article in the AASHTO specifications, stipulating the following in the FDOT Structures Design Guidelines: *"Until ongoing research is completed, delete Article 14.7.5.3.5 for Combined Compression and Rotation."* This report is part of the ongoing research.

OBJECTIVES

The purpose of this study was to study the behavior of steel reinforced elastomeric bearing pads under combined loading in order to develop a new design formula. Specific study objectives included the following:

- conduct combined loading tests on steel reinforced elastomeric bearing pads
- conduct analytical modeling of steel reinforced elastomeric bearing pads under combined axial and rotational loading
- use the results of the experimental and analytical studies to develop a new design formula

FINDINGS AND CONCLUSIONS

In this study, researchers subjected a number of bearing pads to axial loading combined with cyclic rotational loading, of up to a million cycles. The shear modulus, G, of the material plays an important role in determining the bearing capacity. Researchers developed and applied a nondestructive technique to determine the G value for the pads. They also utilized ANSYS, a commercially available finite element analysis software package, to create analytical models of the pads.

The analytical studies and pressure sensor readings in the testing indicated that there is a core at the middle of the pads where the stresses are the highest. The elastomer layers revealed bulging in the lower end of the rotation just as was evidenced in the test samples. These results suggest that the high compressive stress core moves toward the end subjected to the most compression. This behavior is in agreement with the experimental results, i.e., failure limited to the lower end of the rotation.

Based on these experimental and analytical studies, researchers developed a new design equation for pads with axial loads combined with rotation. The new equation was formulated under the assumption that the lower side of the rotation, i.e., the end subjected to the most compression, will fail and can be eliminated. Thus, an adjusted, smaller, pad can be used to achieve the needed capacity.

BENEFITS

This research resulted in the development of a new design equation that allows the use of a smaller bearing pad. A smaller bearing pad creates a ripple effect of design benefits: e.g., reduced bridge span, smaller pier caps, and less concrete. The ultimate result, then, will be that the cost of the superstructure may be reduced significantly. In addition, the results support proposing to AASHTO a revision to Article 14.7.5.3.5.

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