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Optimization of Flexible Supports for Seismic Response Reduction of Long-Span Structures

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Abstract

An optimization approach is presented for design of flexible supporting structures of long-span structures such as arches and domes. The maximum displacement and/or acceleration in tangential or normal direction of the curved upper structure are reduced by optimizing the supporting structure, which is modeled using truss elements. We consider two cases with and without geometrical nonlinearity.

When geometrical nonlinearity is not considered, the cross-sectional areas of supporting truss structure attached to an upper structure are optimized using an NLP approach. The seismic response of the upper structure is evaluated using the response spectrum approaches such as SRSS method and CQC method.

When geometrical nonlinearity is considered, the cross-sectional areas of a supporting structure are optimized under static load equivalent to the expected reaction force from the upper structure. The optimized supporting structures are attached to the upper structure to carry out time-history analysis to verify that response under horizontal loads of the upper structure can be reduced by utilizing flexible symmetric large deformation of the supporting structure.

The effectiveness of the proposed approach is demonstrated using a latticed arch supported by two column-type structures. It is shown that displacement and acceleration of a curved upper structure can be controlled by optimizing the support structure, and deformation can be reduced by utilizing the self-weight of the upper structure.