Seismic Performance of Steel Spatial Structures Incorporating Energy Dissipation Members

Toru Takeuchi, Professor, Tokyo Institute of Technology

This paper studies the application of energy dissipation techniques to various types of spatial structure, such as truss structures, tension structures, and latticed domes, as well as latticed shells. Although this concept is already popular in multistory buildings, broader application has been limited, owing to difficulties in evaluating seismic response and cumulative energy capacity in these less common sorts of spatial structures.

First, detailed cumulative energy dissipation performance of the axial members composing such structures is reviewed. We introduce a strain amplification factor index reflecting various buckling phenomena and propose a convenient evaluation method of predicting cumulative energy dissipation capacities until the fracture for divers axial members, including Buckling Restrained Braces.

Next, the application of energy dissipation members to both truss and tension structures is discussed. For tension structures, visco-elastic materials were introduced and an additional damping system (maintaining its pre-tension forces) was proposed. The systems under study have been applied to various realized structures, where their validity has in all cases been confirmed by experiment.

Finally, response control techniques for latticed domes and shells are investigated. Certain easy evaluation methods for roof seismic response are proposed, introducing response amplification factors that reflect the behavior of supporting substructures. The effects of energy dissipation members are discussed as part of previously proposed methods, including our seismic index proposals for school gymnasia retrofits.