Brian Genduso
Structural Option
Faculty Consultant – Dr. Linda Hanagan
University of Cincinnati Athletic Center
Cincinnati, Ohio

Courtesy of Bernard Tschumi Architects

Lateral System Analysis and Confirmation Design
November 14, 2003

Executive Summary

The University of Cincinnati Athletic Center will be an 8-story, multi-use facility located in the heart of the university's athletic complex. The gravity framing system consists of typical steel composite wide flange beams with composite metal decking supporting one-way slab diaphragms. The lateral system is an unusual combination of a triangulated perimeter frame system called a diagrid, braced frames, "V" columns, foundation shear walls, anchor rods, and floor diaphragms.

Gravity and lateral loads were calculated using the Ohio Basic Building Code and ASCE Standard 7-98. Typical floor dead load is approximately 2500 kips, live loads are usually 50 ksf. It was determined that West wind controls the lateral loading case for most but not all members.

Lateral load distribution through the building starts with the diagrid, which acts as a structural mesh, transferring forces in several directions. The rigid above-grade diaphragms help the diagrid carry shear down to the ground level, where it is picked up by the large V columns and braced frames. These two elements then transfer forces into the below-grade slabs and into the foundation shear wall and anchor rods, which safely spread the load into the surrounding soil.

A lateral analysis was performed with two separate computer programs. ETABS was used to find node displacement, V column support reactions, and member forces. STAAD was used to find braced frame stiffnesses. Results from both were combined through several spreadsheets and manual calculations to obtain stiffness element rigidities. The results of each individual analysis type are:

Analysis Type	Conclusion
Diagrid Story Drift	OK – High rigidity of the diagrid and its diaphragms. $\Delta_{actual} \approx ¼ \Delta_{allowable}$
Ground Floor Story Drift	OK – Braced frames provide most resistance. $\Delta_{actual} \approx ½ \Delta_{allowable}$
Torsion	OK – Elliptical shape of building is well-suited to torsional effects.
Total Building Drift	OK – Even with torsion considered $\Delta_{actual} \approx 1/3 \Delta_{allowable}$
Overturning	OK – Low building height and wide diagrid frame base prevent instability
Braced Frame Check	OK – Actual member size is slightly larger than calculated member sizes
Diagrid Member Check	OK – Max utilization factor of the evaluated members = 0.861 < 1.0

Overall, the building performs well under lateral loading conditions.