Details of Design of Large Deflection Structure Building Enclosures

D.M. Campbell P.E.*, P.A. Gossen P.E. [a]

*Geiger Engineers - Principal
2 Executive Blvd, Suite 309, Suffern, NY 19001 USA
dmc@geigerengineer.com

[a] Geiger Engineers- Principal Emeritus
pag@geigerengineer.com

Abstract

Tension structures such as cablenets, cable trusses, tensegrity-type domes, and tension membrane structures have been employed in permanent buildings for six decades. All these structures rely upon large deformations to resist applied loads. These structural systems are employed in building structures for roofs, facades, atria and other building envelope systems. These flexibly supported envelopes must frequently be sealed at the boundaries between large and small deformation elements. Innovative flexible structural systems often require innovative connection and closure details which are important to the success of the design and yet get little recognition.

Roofs which cover enclosed conditioned buildings require attention to details as the building envelope must inevitably will be sealed to elements which are not subject to large deformations. Often flexible structures are clad with relatively stiff panels or cladding which present challenges for sealing the interfaces. While these structures are often lauded for their lightweight, expressive forms, and efficient use of materials, the success of roofs is ultimately judged by their water tightness.

Early examples of tension structure roofs were often clad with conventional relatively roofing or roofing systems. The surface was covered by multiple panels with flexible joints between. The execution of the flexible joints was key to the success of these buildings. Use of flexible tensile membrane cladding of flexible structures greatly reduced the reliance on such flexible seals but they are generally still required to seal the building envelope.

Ultimately successful buildings have durable, low maintenance, weather tight enclosures. In designing such building enclosures various strategies are employed. The structure can be stiffened to reduce the amplitude of service deformations. This tends to reduce the inherent efficiency of most large deflection structures. Designing the structure for strength without constraint on flexibility typically means that flexible closures will be required.

This paper examines reviews a variety of solutions employed in addressing these design challenges. A variety of examples, some successful, some not are presented.