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Multi-story structures present complicated design challenges. Frequently, the structures have larger windows and door openings, providing less space for traditional restraint systems. For all these reasons, there is increased need for restraint systems that can meet multi-story structural demands without sacrificing installation efficiency or cost considerations.

Continuous rod tiedown systems are able to answer these demands by restraining both lateral and uplift loads, while maintaining reasonable costs on material and labor. Instead of using metal connector brackets as in a holdown system, continuous rod tiedown systems consist of a combination of rods, coupler nuts, bearing plates and shrinkage-compensation devices. These all work together to create a continuous load path to the foundation.

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**What is the Load Path?**

Traditional Shearwall Load Path

A traditional shearwall relies either on holdowns or straps attached to posts to transfer the net shearwall overturning forces to the foundation.

Lateral forces are transferred from the floor/roof to the plywood sheathing. The following steps describe the traditional load path:

Step 1. Nails are typically used to transfer loads from the sheathing to the wall framing.

Step 2. The outermost framing boundary elements transfer the tensile forces, resulting from the net overturning, to the holdown that is attached to the post at the boundary.

Step 3. The holdown system then transfers the load in tension to an anchor that is embedded into a concrete foundation.

**Continuous Rod Tiedown System Load Path**

A continuous rod tiedown system utilizes a combination of threaded rods with bearing plates and take-up devices at each level to transfer the forces to the foundation. The following steps describe the continuous rod tiedown system load path:

1. The end posts deliver the sheathing load to the top plates and bearing plate.

2. Bearing plate transfers the load through a nut into the rod system.

3. Rod system transfers the load from the plate through tension in the rods to the foundation.

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**Wood Shrinkage**

2015 International Building Code® (IBC) Section 2304.3.3 requires that Designers evaluate the impact of wood shrinkage on the building structure when bearing walls support more than two floors and a roof. It is important to consider the effects of wood shrinkage when designing any continuous rod tiedown system. As wood loses moisture, it shrinks, but the continuous steel rod does not, which potentially forms gaps in the system.

ICC-ES AC316 limits rod elongation and shrinkage compensating device deflection to 0.20" at each level or between restraints unless shearwall drift is determined to be within code limits. Rod diameter and take-up device choice are obviously important. Simpson Strong-Tie take-up devices (TUDs) and aluminum TUDs (ATUDs) have very little deflection (ΔA + ΔR) and therefore minimize the contribution of device displacement to the 0.20" deflection limit, which allows for smaller rod diameters.

See strongtie.com/srs for additional information regarding wood shrinkage and how Simpson Strong-Tie® take-up devices mitigate wood shrinkage within an Anchor Tiedown System for shearwall overturning restraint. To access our Wood Shrinkage Calculator, visit strongtie.com/software.

**Rod Elongation**

A continuous rod tiedown run will deflect under load. The amount of stretch depends on the magnitude of load, length of rod, net tensile area of steel and modulus of elasticity.

In a continuous rod tiedown system designed to restrain shearwall overturning, the rod length is defined since it is tied to the story heights and floor depths. The modulus of steel is also a constant (29,000 ksi for steel) and steel strength does not affect elongation. The only variables then per run are the load and rod net tensile area, which will be controlled by:

• Quantity, location and length of shearwalls provided to support the structure.

• Choice of rod diameter, which will be used in determining the rod net tensile area, Ae.

Note: It is important to use the net tensile area, Ae, for determining rod elongation. Gross rod area, Ag, will be used for the strength calculation.

Access the Simpson Strong-Tie Rod Elongation Calculator by visiting strongtie.com/software.

**Anchorage by Designer**

Many variables affect anchorage design, such as foundation type, concrete strength, anchor embedment and edge distances. Design tools, such as the Simpson Strong-Tie® Anchor Designer™ Software, are available to help the Designer navigate the complex anchorage provisions contained in the ACI 318 reference design standard. Anchor products, including the Pre-Assembled Anchor Bolt (PAB), are also available to simplify specification.

An elevated concrete slab over parking, commonly referred to as a podium slab, is a common anchorage/run start type for mid-rise, light-frame construction. These slabs pose a significant challenge to designers when anchoring the continuous rod tiedown system above.

In designing light-frame structures over concrete podium slabs, understand that lateral loads from the structure above will produce large tensile overturning forces whose demands often far exceed the breakout capacities of these relatively thin slabs. Simpson Strong-Tie has thoroughly researched and tested practical solutions that achieve the expected performance in order to provide Designers with additional design options. The use of the special detailing of anchor reinforcement shown in ACI 318, Anchorage Provisions, will greatly increase the tensile capacities of the anchors.

The concrete podium slab anchorage was a multi-year test program that commenced with grant funding from the Structural Engineers Association of Northern California and was applied toward the initial concept testing at Scientific Construction Laboratories, Inc. Following that test, a full-scale, detailed testing was completed at the Simpson Strong-Tie® Tye Gilb Laboratory. The design approach follows code calculation procedures supported by testing of adequately designed anchor reinforcement specimens. Based on the empirical test data, the inner concrete breakout cone plus the added anchor reinforcement each provided a percentage contribution to the measured peak capacity of the entire anchorage assembly. These contributions are distributed to the overall anchorage capacity and the concept is then utilized for each installation condition being considered for the calculation.

For assistance with your design, visit strongtie.com/srs for suggested anchorage-to-podium slab details, slab design requirements and Shallow Podium Slab Anchor Kit product information. Also visit our Structural Engineering Blog at seblog.strongtie.com for more information.