AutoTight Tie-Downs

Commins Manufacturing, Inc.

Commins Manufacturing Inc. builds Tie-Down Systems for light frame buildings. AutoTight® tie-downs comply with all codes.

AutoTight® Cuts system deflection in half.
Self-adjusts for wood shrinkage and settling (up to 5 inches)
Has a wider installation tolerance (tested to 3 degrees).

We design systems for you or use our free design package.
Systems designed for **Strength, Elongation and Shrinkage** in **30 minutes**.

The following overview covers:

Code Requirements,
Model Tie-Down Specification
System design

Code Requirements

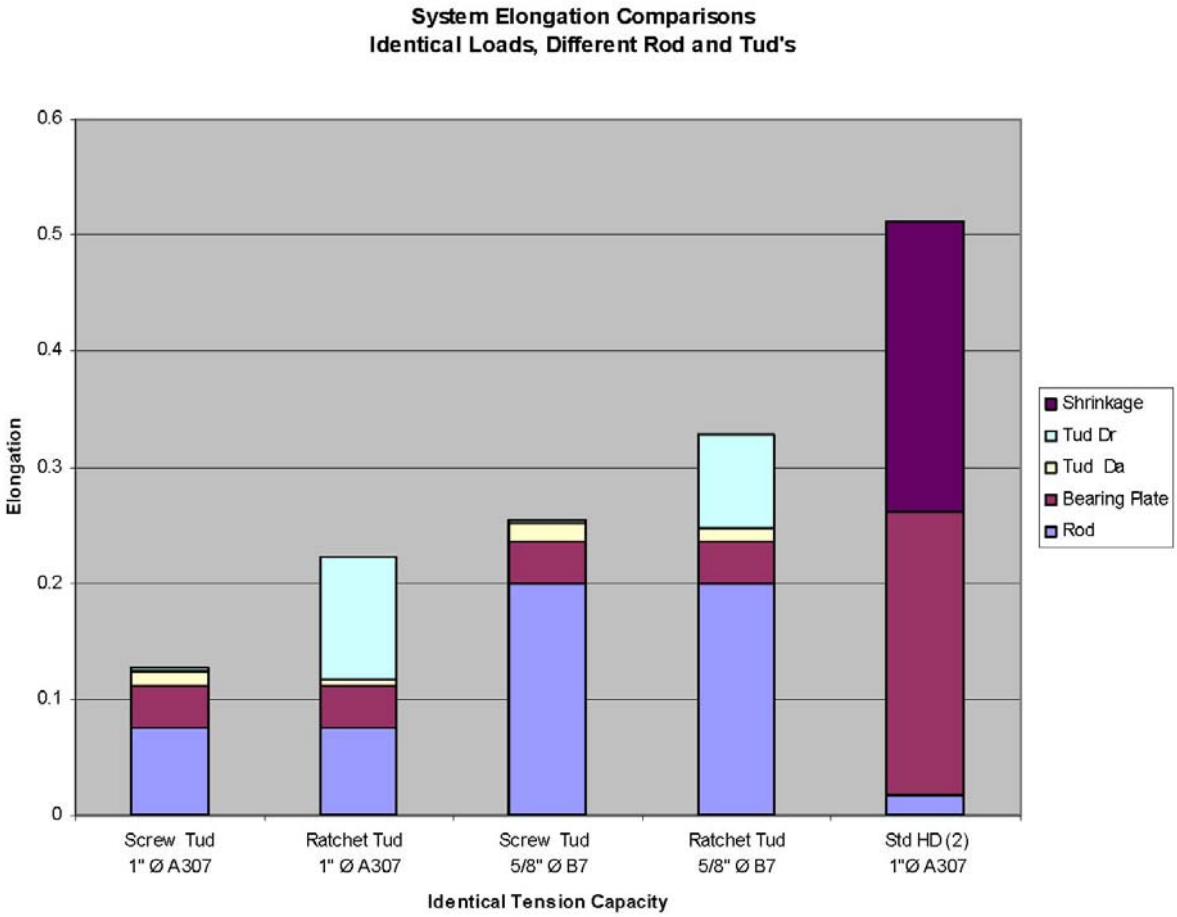
Shear walls using tie-down systems require elongation limits based on the aspect ratio of the shear wall. **IBC Section 2305.3**[1] limits shear wall drift per the following:

$$\Delta_{xe} = \frac{8vh^3}{EAb} + \frac{vh}{Gt} + 0.75he_n + \frac{h}{b}d_a$$

Each component in the equation contributes to overturning. Tie-Down elongation of the overturning anchorage, $\mathbf{d_a}$ is often the key to system performance. Some designers erroneously identify $\mathbf{d_a}$ as only the tie-down deflection. Jurisdictions that limit tie-down deflection vary elongation requirements from 0.125" (rod only) to system limits of 0.200". ICC ES AC 391 identifies items that need to be included as: rod elongation, plate deformation, tie-down deflection (count twice if across a floor system), wood shrinkage-settling and shrinkage compensator deflection. If items are missed the system may not perform.

An assumption is sometimes made that shrinkage/settling is not a factor if manufactured wood is used. Using the WWPA[2] expected average shrinkage gives shrinkage from 1/8" to ½" per floor. Either the shrinkage should be included as part of the anchorage movement or a shrinkage compensator should be used.

The following figure shows system elongation for five systems with identical conditions. Each system has 11 kips tension load, the same height and the same ¼" of shrinkage. All systems have a shrinkage compensator except the Standard Holdowns.



Elongation limits for seismic loads range from 0.125" to 0.200". A close examination of these five systems will provide a good understanding of different systems.

The first two system use a 1" diameter rod standard strength A307 rod. Elongation is a function of the rod diameter and length. Bearing is a function of the bearing area, wood capacity and plate bending. Both of these are held constant for the first two systems. The only difference is the Tud. The first Tud is a screw device and the second is a ratchet. This one item changes the system elongation from 0.127" to 0.222".

The next two systems change the rod to a 5/8" diameter B7. For the given conditions both systems will meet a "rod only" 0.200" elongation limit. Neither will meet the system limit.

The last system is a traditional tie-down. Only 2 feet of rod are used so rod elongation is minimal. Each Holdown has a tested deflection of 0.122" but two are used so the total is 0.244". A Tud is not used so the expected shrinkage of 0.250" must be added to the elongation of the rod and the two HD's. At 0.512" this combination will clearly introduce the most elongation.

Rod	Take-Up Device	Elongation					
		Rod	HD or Bearing	Shrinkage Compensator			
				Tud Δ_a	Tud Δ_r	Shrinkage	Total
1" rod A307	Screw Tud	0.075	0.036	0.014	0.002	0.000	0.127
1" rod A307	Ratchet Tud	0.075	0.036	0.006	0.105	0.000	0.222
5/8" Rod B7	Screw Tud	0.200	0.036	0.016	0.002	0.000	0.254
5/8" Rod B7	Ratchet Tud	0.200	0.036	0.011	0.081	0.000	0.328
1" rod A307	Std HD (2) No Tud	0.018	0.244	0.000	0.000	0.250	0.512

Tie-Down System Design

Designing tie-down systems that are tight and limit drift is difficult unless there is a **clear objective** and a **structured approach**. AutoTight provides the tight objective and the path. We design hundreds of tie-down systems each year. The Model Tie-Down specification that follows is recommended. It includes all code requirements. Use it as a starting point and include it in your design specifications.

Tie-Down System Specification

"The Tie-Down (Holdown) system shall be the AutoTight Rod System with ICC ESR # 1344 and/or COLA RR 24580, as manufactured by Commins Manufacturing Inc., Friday Harbor Washington 98250 (www.comminsmfg.com)

System Limits:

1. The system shall be designed for strength and elongation per the code[3].
2. The system shall provide a maximum of 0.200" (or 0.125" or 0.179") elongation between reaction points including all tension elements. Tension elements shall include rod, plate compression and shrinkage compensator deflections. Shrinkage compensator deflection shall include Δ_a plus Δ_r (Average Travel and Seating Increment)
3. The system shall provide a minimum out-of-plumb rating of 2 degrees.
4. The system shall provide a minimum of 1/4" (or 3/8", ½" or ¾") cumulative shrinkage compensation on every floor.
5. The system shall provide an independent (parallel) load path for each Tud at each reaction point." (i.e. each Tud connects a single reaction point.)
6. Each reaction point shall be connected through a Tud.
7. "Skipped Floors" are not allowed.
8. Straps may **not** be used with vertical connections.

With the prior written approval of the Engineer of Record, other systems may be used if the **IF** the system meets the stated requirements."

Highlighted items are the most commonly adjusted specification. Change as needed.

AutoTight Design

Commins Manufacturing Inc. provides templates that help design low cost tie-down systems that meet code requirements for strength, elongation and shrinkage.
The complete design includes.

1. Detailed Calculations for Run Tension Components.
2. Specific materials list
3. System stretch or rod only stretch (your choice)
4. Detail and Elevation drawing templates for parts and installation.

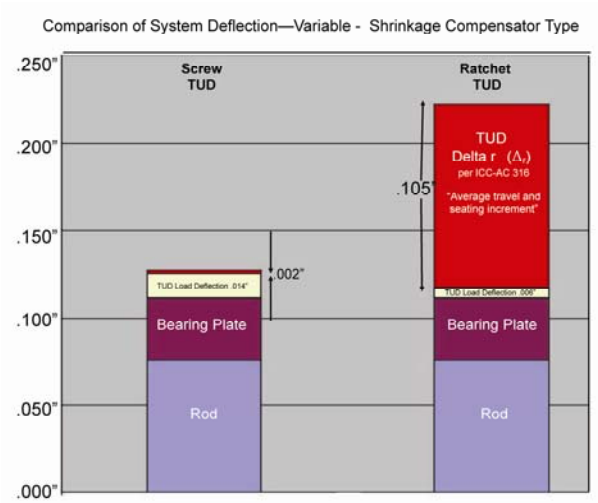
Systems are designed by automatically selecting the smallest rod, bearing plate and shrinkage compensator that meets the required strength.
Design Time 30 seconds per run.
Design includes U.S. and Canadian Codes.
Each floor (run segment) is evaluated for elongation based on the loads. If the elongation exceeds limits the designer increases the rod or bearing plate to meet elongation limits.

Enter the number (quantity) of each type run and the program automatically computes and lists a complete material list.

The calculation package converts the finished design into a document ready for review and signing by the EOR. Design Time 2 minutes.

To see a sample click: **AutoDesign Demonstration Sample Package** (18 Page PDF)

System Recommendations



The code requires tie-down systems to have required strength, limit deflection and to accommodate shrinkage/settling. Several problems result from loose systems. A loose connection will quickly degrade shear walls in a cyclic event. Systems may lose as much as 40% of their lateral strength with 0.200" of looseness[4]. Jurisdictions[5] have addressed this by limiting system elongation (stretch). System stretch limits vary but are as low as 0.125". System Stretch must include rod, shrinkage compensators, bearing plates and hold downs.[6] Loose systems will shift loads to tight walls and not share load. The result is tight walls will be loaded while loose walls will "float" perhaps resulting in a cascading failure.

All tie-down systems should have an elongation limit. Tighter limits will improve performance. Long walls (8' plus) may be adequately restrained with a limit of 0.200",

however short walls (4' +/-) may require a tighter specification for drift control. Some engineers have specified elongation limits of 0.200" for long walls and 0.125" for specific identified short walls. ICC ES AC 391 provides a method to evaluate the elongation of all items. A new item required under AC 391 is delta r (Δ_r) for shrinkage compensators. This is the looseness from reversing load direction of shrinkage compensators. Delta r can range from 0.000" to 0.105. It must be included in any evaluation. The graph above demonstrates two identical systems with different Tuds. One system has nearly twice the elongation of the other.

To see a video of looseness associated with Δ_r follow the link to the video page

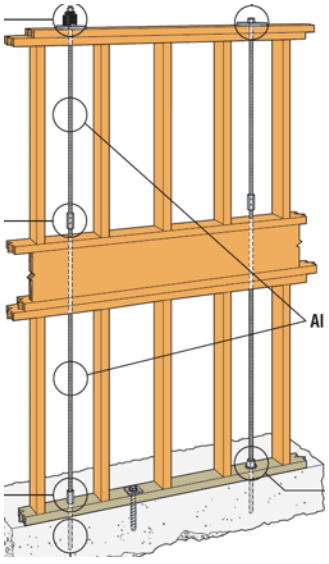
Out-of-Plumb

Self compensating tie-down systems use moving parts to compensate for shrinkage and settling. These parts can be sensitive to out-of-plumb and out-of-square installation. The industry test standard is set at 2 degrees. AutoTight products have been tested at an angle of 3 degrees, or 150% of the industry standard.

Shrinkage-Settling

All buildings shrink/settle. The shrinkage amount varies depending on several factors. We typically see specifications of ¼"-3/8" per floor for manufactured wood floors and ½"-3/4" for solid sawn floors. Wood shrinkage in a building is cumulative and must be addressed. See the AutoTight catalog for general recommendations. Recommendations derive from WWPA, Tech Notes No 10.

Looseness due to shrinkage-settling is "elongation without load". Some systems isolate reaction points without shrinkage compensators. Either the looseness must be considered in the calculations or a shrinkage compensator must be used.



Retro-fit buildings (older than 4-5 years) probably don't need shrinkage compensators if retrofitted with a rod tie-down system. The shrinkage/settling should be complete.

Load Path

A parallel load path for systems is recommended in the specification. Parallel load paths use a Tud on each floor working independently of each other. Series systems use coupler take-up devices. A series load path requires the entire load to be carried by the lowest shrinkage compensator. Series load paths lack redundancy. We recommend parallel load paths in tie-down systems.

Shrinkage Compensator

Shrinkage compensators vary greatly in tightness. Screw type shrinkage compensators have a Δ_r of between 0.000"-0.002". Ratchet type screw compensators have a Δ_r that ranges from 0.060" to 0.105". This Δ_r may use 50 to 90 % of the allowable elongation. We only recommend screw type shrinkage compensators.

Skipped Floors

Skipped floors carry the load across two or more floor systems. The specification allows no skipped floors. If properly detailed and if the deflection is kept within the specified limits skipped floors should work. Even people who claim you should not skip floors appear confused and actually skip the top floor.

Straps

Vertical straps have been extensively used with wood framed buildings. When buildings shrink/settle these straps often bulge, buckle and cause siding problems. This has commonly been considered just a minor architectural problem but it can result in two problems: excess shear wall movement and buckled/bent straps that break after several lateral cycles in a wind or seismic event. I have asked how "magic" straps accommodate shrinkage but have never received a comment other than:

"We sell both straps and shrinkage compensating systems. The engineer can select whatever he wants."

Our recommendation **don't use straps on vertical connections.**

"Magic" strap: freshly installed and after ¼" shrinkage/settling. We don't know how they can work.

Every wood frame building should have a tie-down specification.
Until the building departments develop and enforce their own, please take this model specification, change it for your use, and enforce the requirements.

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[1] IBC 2009, International Building Code, International Conference of Building Officials, Whittier California.
[2] WWPA Tech Notes Report #10, November 2002. Western Wood Products Association, Portland, OR
[3] (See appendix B TUCC requirements and ICC ES AC 391 for more information
[4] Report of a test Program of Light-Framed Walls with Wood-sheathed Panels, COLA_UCI et all, Dec 2001
[5] Tri-Chapter Uniform Code Committee, No 12, March 12, 2009.
[6] ICC-ES AC 391 July 2010