Elongation Limits

Buildings perform to full uplift capacity only when the tie-down systems are tight and are designed for low stretch. Tight shearwalls are much stronger. In 2001 the City of Los Angeles, the Structural Engineers of Southern California and the University of California at Irvine ran a series of tests that provided a look at the performance of loose walls. The testing showed systems can lose as much as 40% of their lateral strength with just 0.200" of looseness.

System Limits.

ICC ES has adopted AC 391. AC 391 defines the strength and elongation requirements needed to satisfy wind uplift. High Wind system elongation must not exceed 0.250". Items to be considered are: **Rod** elongation, **bearing plate** crushing, **holdown** deformation (doubled if two are used, spanning a floor) and **shrinkage compensator** movement. Shrinkage compensator movement must include deformation at the specified load (Δ**a**) and an item called Δr. Delta r is the lost motion (slack) in inches as a device reveres direction. Added to AC 316 in November of 2009 this item has a huge affect on system performance.

Example: System Elongation per ICC AC391
This calculation demonstrates required steps to determine system elongation in a 10' - 1" high floor

Rod elongation **Δrod = PL/AnE** (AC 391 Eq.1)

Rod Stretch = 16000*121"/0.58198*29,000,000 = 0.110"
Where An = 0.7854(1-0.9743/8)2 = .606 sq in

Bearing Plate Compression is limited to 0.040" at 8,241 lbs.
Wood Compression = 0.040 * 4,800/8,241 = 0.0233"

TUD (Shrinkage Compensator) deflection includes Δ**a** and Δ**r**

TUD Δ**a** is adjusted based on actual vs. capacity.
Defl. = 0.032 * 4,800/25,300 = 0.0061"

TUD Δ**r** is looseness in the TUD during reversed cyclic loading based on testing. AC 316 section 1.4.7 calls this "Average travel and seating increment". This number ranges from 0.000 to 0.180". Δ**r** is independent of load and is always added in full (AC391 section 3.1.1) For the AutoTight AT100, Δ**r** = 0.002"

Total system deflections compare as follows:

Deflections:	Screw Tud	Ratchet Tud
Rod	0.110	0.110
Bearing Plate (S8)	0.023	0.023
TUD (Load/Deflection)	0.006	0.014
Δ**r**	0.002	0.090
Total Deflection	0.141	0.249

Tie-Down System Elongation Limits

System strength is per the code and typically refers to AISI 360 for strength. Elongation is another matter. Some jurisdictions use rod elongation only with limits that vary from 0.125" (City of San Diego) to 0.200" (City of Los Angeles) and some use system elongation. Other California jurisdictions have adopted the following.

> Maximum rod or cable elongation shall not exceed 1/8 inch per floor or 1/8 inch between connectors/restraints under the CBC prescribed allowable load (Allowable Stress Design). Under no circumstances shall the total vertical movement exceed 0.2 inch per floor or 0.2 inch between connectors/restraints. The accumulation of the vertical movement shall include rod or cable elongation, bearing plate-grain deformation, looseness due to take up/shrinkage compensating devices, and other components of the tie-down system resisting the uplift forces.

The City of San Francisco has adopted a **system** deflection limit of 0.179". Some engineering offices have adopted a deflection limit of 0.125 including all components.

The elongation of several systems is shown to the right. All systems meet the tension requirement but elongation ranges from 0.151" up to 0.512". When a severe wind or seismic event hits the building performances will range widely.

AutoTight AutoDesign

Page 5 details how to compute the required elongation of all components. Of course you need to know how the engineering provides the numbers but there is a better method. AutoTight offers a free software package that allows you to design complete systems, up to 6 stories and up to 25 different run types. The system first designs for strength, computes the elongation (rod only or system) and highlights out-of-spec stretch. You can then manually change the components to meet the elongation limits. Design time can be as low as 20 to 30 minutes.

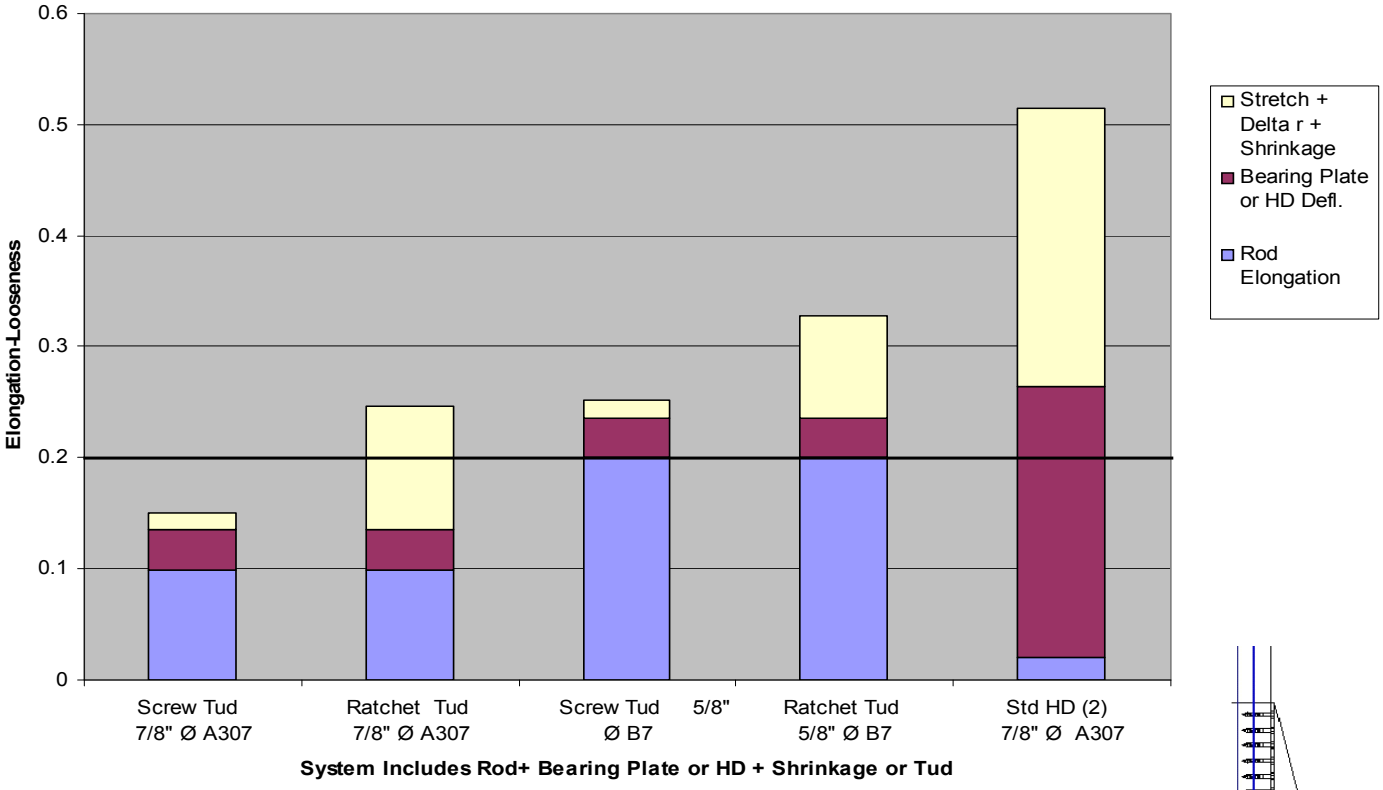
The System also provides a ready to review and sign calculation package for every component and every run. We also offer Detail and Elevation Drawing templates to complete the process.

If you enter the quantity of each run type the program automatically computes the materials per run and the total material package.

For more information open and review the Distributor Bid Package Training (3MB) PDF. This package includes a step-by-step training package on a single project. It shows the design software output, calculations and detail drawings.

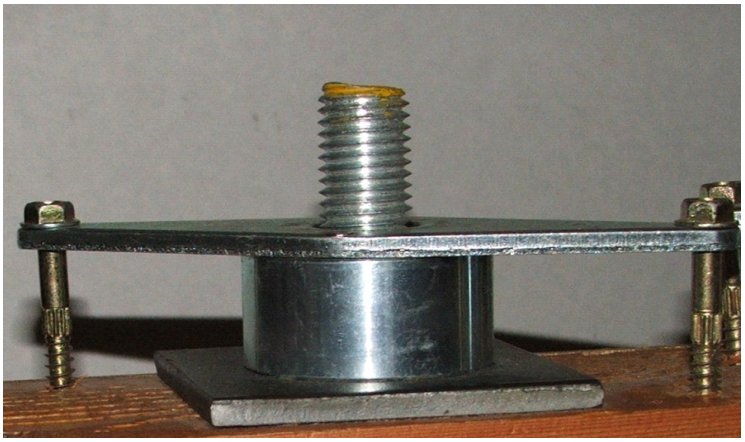
To Sample the design software call or email the factory. Detailed instructions to aid your design are available. Call or email the factory.

Single Story 11 kip Systems
Comparing Elongation + Shrinkage

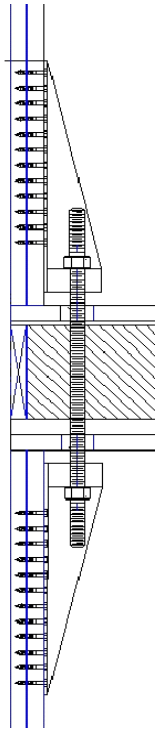


Systems Evaluated per AC 391, AC 155 and AC 316

Screw TUD System



Ratchet TUD System



Standard Hold downs