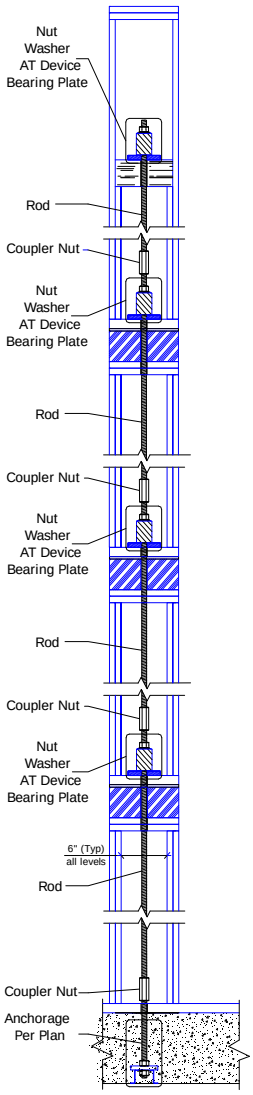
Tie-Down System Elongation Limits-an Introduction

By Alfred D. Commins August 24, 2012

Typical System



ICC Evaluation Service has established an elongation limit of 0.200" for Tie-Down systems used with overturning forces.[1] The limit specifically requires that total vertical displacement include "…steel rod elongation and the shrinkage compensating device deflection … (and) …"all sources of vertical displacement". This paper looks at the 0.200" elongation limit, defines required components and compares several systems.

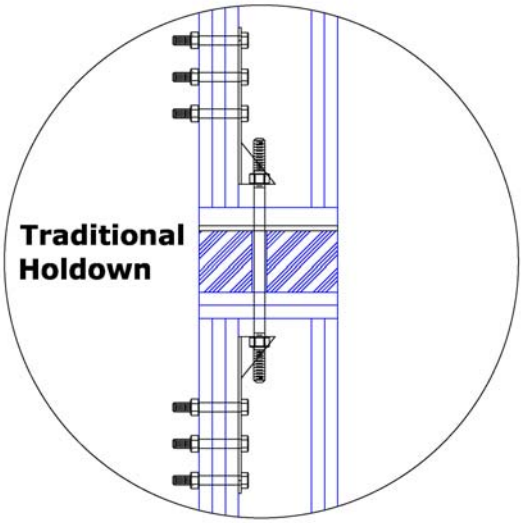
Historically tie-downs have been designed for strength only. Elongation has often been overlooked. Even when not overlooked, elongation elements are often missed. The code and ICC ES now specify uplift elongation Δ_A to not exceed 0.200". This component is included in the shear wall drift equation:

$$\delta_{sw} = \frac{8vh3}{EAb} + \frac{vh}{1000G_a} + \frac{h\Delta_a}{b}$$ [2]

Elements to be evaluated in determining Δ_A include, but are not limited to: Threaded rod, bearing plates or tie-downs, system shrinkage and shrinkage compensator deformation. For comparative purposes four systems designed for the same strength are evaluated and the elongation compared.

System assumptions are: Floor height =12', carpet-to-carpet. Uplift load = 11,500 pounds, Shrinkage/settling = ¼", and Plate-mudsill material: Douglas-fir.

The four systems Evaluated are:



1. 5/8" B7 rod, No TUD[3]
2. 5/8" B7 rod, Screw Type Tud
3. 7/8" A307 rod, Screw Type Tud
4. Standard Hold Downs (2 ea), 7/8" A307 rod, No Tud (Across a floor system)

[1] ICC ES AC 316, Section 6.9, June 2012, Effective April 2013

[2] *2012 NDS* American Wood Council, National Design Specification, 2011 Section 4.3.2 Deflection Eq. 4.3.1. As referenced in the *2012 International Building Code*.

[3] TUD = Take-Up Device = Shrinkage Compensator

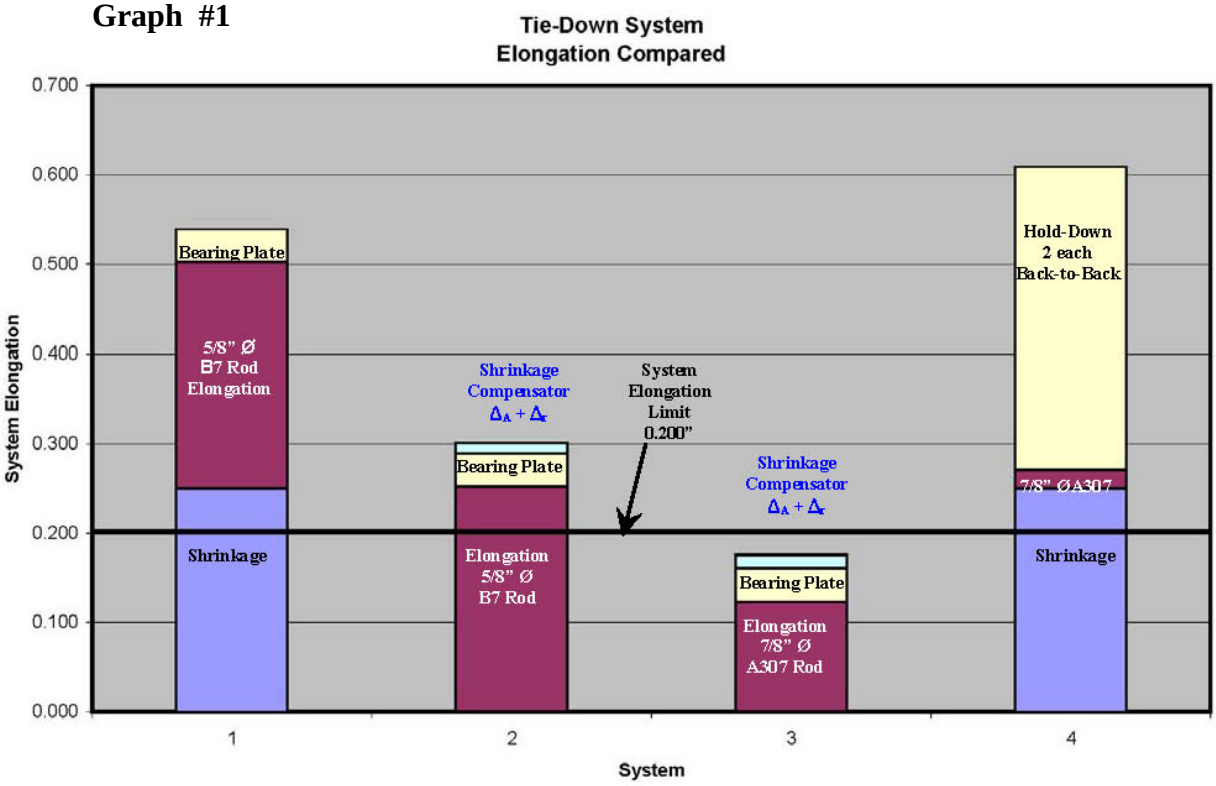
System elongation is the sum of the elongations of the tension elements. Table 1 lists the four systems side-by-side, and lists each system component and code listed values. The number needed for shear wall design, Δ_A, is the total elongation at the bottom.

Table #1

			System			
			1	2	3	4
	Strength		12,360	12,360	12,360	12,100
Rod		Elongation	0.252	0.252	0.123	0.021
Holdown			0.037	0.037	0.037	0.338
Shrinkage Compensator	Δ_A		NA	0.012	0.015	NA
	Δ_r		NA	0.000	0.002	NA
Shrinkage			0.250	0.000	0.000	0.250
Total Elongaton			0.539	0.301	0.177	0.609

Graph #1 shows how the system components stack-up and compare.

Graph #1



The bar chart demonstrates relative system performance of the four systems and the ICC ES elongation limit. All systems include ¼" of shrinkage. Systems 1 and 4 do not have shrinkage compensators. Shrinkage is "elongation without load". So loading can only begin after the system moves the ¼" lost with shrinkage. Systems 2 and 3 both use a screw type shrinkage compensator that solves shrinkage. System 3 uses a 7/8" diameter rod and is tighter than system 2 with a 5/8" diameter rod.

Rod System with Shrinkage Compensator (Screw Tud) Example #3

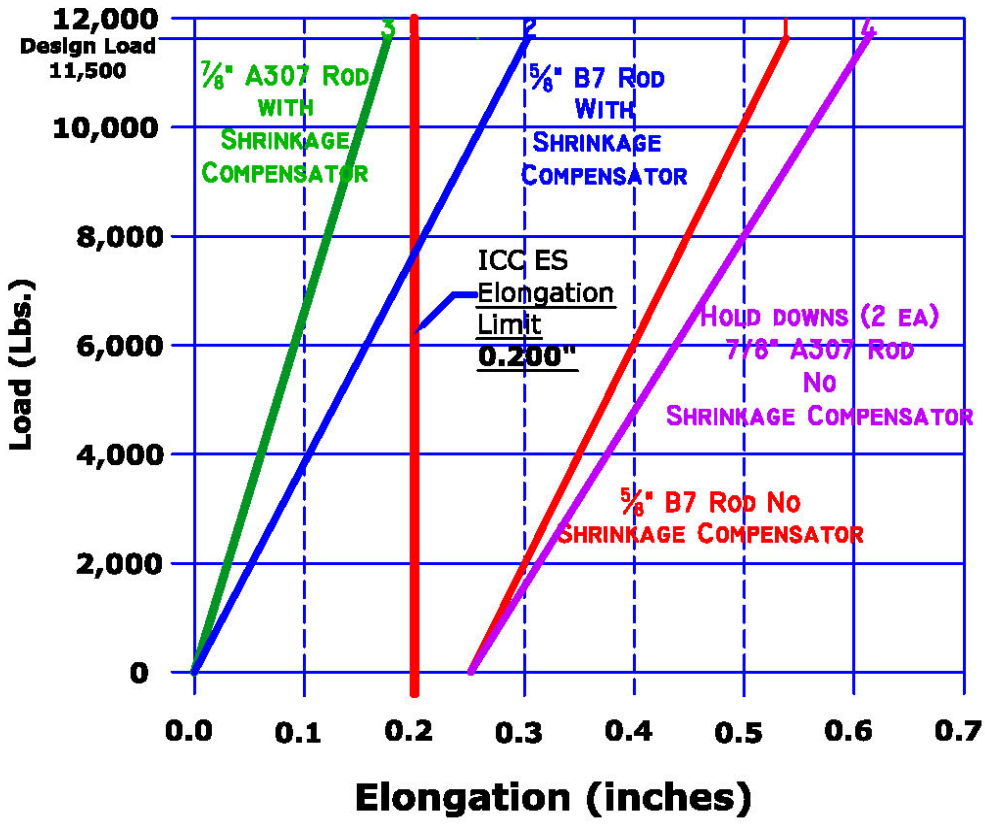
Table #2

	Size	Description	Capacity		Adjusted
			Lbs.	Elongation	
Rod	7/8" A307	7/8" -9 NC X 144"	13,530	0.121	**0.123**
Bearing Plate	S12	Plate 5/8" X 3-1/4" X 6"	12,360	0.040	**0.037**
Shrinkage Compensator	AT100	Fits 7/8"-1" dia. Rod	25,300	0.032	**0.015**
		delta r	NA	0.002	**0.002**
Shrinkage		1/4"	NA	0.000	**0.000**
System Elongation $\triangle_a$					**0.177**

Table 2 lists components from example #3 and demonstrates how elongation adjustments.

To design systems that meet the new elongation requirement first establish your tie-down system specifications. See Technical Note #11 (Commins Manufacturing Inc.) for a template that you can modify and use. Then contact your tie-down supplier with your system requirements.

Graph #2 **Tie-Down Systems Elongation Compared**



Technical note #17 (Pending) demonstrates how to calculate code required elongation considering rod strength and elongation, bearing plate compression, shrinkage and shrinkage compensator deflection. It also demonstrates how to "tune" a system to meet elongation limits. TN #17 is scheduled for release September 1, 2012.