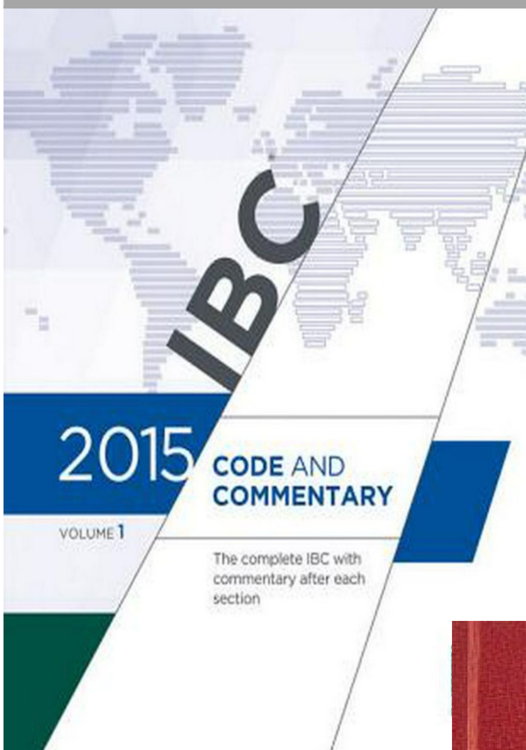
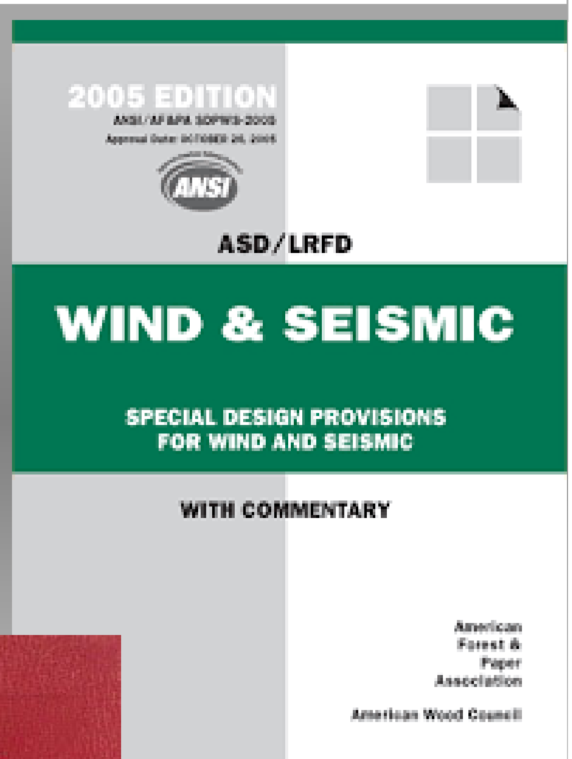
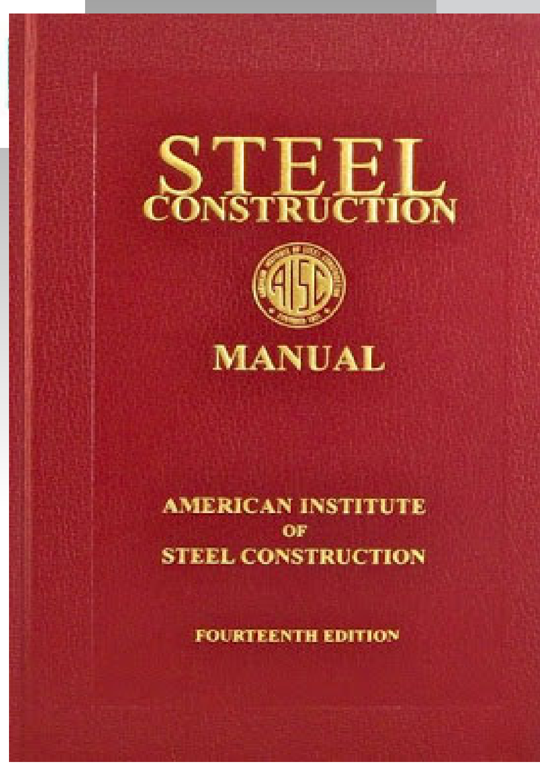
AutoTight® CATALOG 2020-21

CODE REFERENCES

FOR ATS SYSTEM DESIGN







INTERNATIONAL CODE COUNCIL
ICC EVALUATION SERVICE

SELF-ADJUSTING MULTI-STORY TIE-DOWN SYSTEMS

FOR HIGH WIND AND SEIMIC PERFORMANCE

COMMINSMFG.COM
(360) 378-9484

CODE REFERENCES

TABLE OF CONTENTS

SECTION -7

References you need for designing Tie-down Systems

Plan sets refer to model building codes such as "The International Building Code 2015 shall be followed". The code then often refers to other documents that evaluate and rate specific materials or methods. The quantity of references and sources can easily balloon out of control. The result is that projects may miss key code required information and thus not properly follow the code.

This section references the various code sources that must be followed to properly connect shear walls to meet code strength and elongation limits.

Commins Manufacturing Inc doesn't supply shear walls. We supply the tie-down materials to help make the shear walls properly perform to code.

Reference materials in this section are the key to shear wall tie-down performance. You should have a copy or have access to each referenced publication and you should review each requirement. This section tells you what to look for, where it is located and some of the most common errors.

Thank you!

Alfred D. Commins, President,

Commins Manufacturing Inc

INTERNATIONAL BUILDING CODE 2018

SECTION 102 APPLICIBILITY

"102.1 General. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable. Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern."

Designers in the State of California see CBC 2015 section101.7.3

COMMENTARY

Different codes references may conflict to the extent that material strengths are over stressed by 16%. In addition, some elongations may be understated by 36%. Unless the designer understands the conflict and uses the most conservative approach, the customer & building owner will not receive the required performance.

1604.4 (LOAD) ANALYSIS

Load effects on structural members and their connections shall be determined by methods of structural analysis that take into account equilibrium, general stability, geometric compatibility and both short-and long-term material properties.

Members that tend to accumulate residual deformations under repeated service loads shall have included in their analysis the added eccentricities expected to occur during their service life.

Any system or method of construction to be used shall be based on a rational analysis in accordance with well-established principles of mechanics. Such analysis shall result in a system that provides a complete load path capable of transferring loads from their point of origin to the load-resisting elements.

1604.4 (LOAD) ANALYSIS

The total lateral force shall be distributed to the various vertical elements of the lateral force-resisting system in proportion to their rigidities, considering the rigidity of the horizontal bracing system or diaphragm. Rigid elements assumed not to be a part of the lateral force-resisting system are permitted to be incorporated into buildings provided their effect on the action of the system is considered and provided for in the design. A diaphragm is rigid for the purpose of distribution of story shear and torsional moment when the lateral deformation of the diaphragm is less than or equal to two times the average story drift.

Where required by ASCE 7, provisions shall be made for the increased forces induced on resisting elements of the structural system resulting from torsion due to eccentricity between the center of application of the lateral forces and the center of rigidity of the lateral force resisting system.

Every structure shall be designed to resist the overturning effects caused by the lateral forces specified in this chapter. See Section 1609 for wind loads, Section 1610 for lateral soil loads and Section 1613 for earthquake loads.

INTERNATIONAL BUILDING CODE 2018

SECTION 2303.7 SHRINKAGE

Consideration shall be given in design to the possible effect of cross-grain dimensional changes considered vertically which may occur in lumber fabricated in a green condition.

SECTION 2304.3.3 SHRINKAGE

Wood walls and bearing partitions shall not support more than two floors and a roof unless an analysis satisfactory to the building official shows that shrinkage of the wood framing will not have adverse effects on the structure on any plumbing, electrical or mechanical systems or other equipment installed therein due to excessive shrinkage or differential movement caused by shrinkage, The analysis shall also show what roof drainage system and the foregoing systems or equipment will not be adversely affected or, as an alternative , such systems shall be designed to accommodate the differential shrinkage or movements.

COMMENTARY

Hardware looseness of 1/2" to 1" or more is often introduced into buildings of 1 or 2 stories. Any system looseness results in increased drift in direct proportion to the looseness. Always use a TUD and examine walls for shrinkage and drift.

NDS SPECIAL DESIGN PROVISIONS FOR WIND AND SEISMIC

2015 EDITION ANSII/AWC SDPWS-2015

SECTION 4.3.2 DEFLECTION

Calculations of shear wall deflection shall account for bending and shear deflections, fastener deformation, anchorage slip, and other contributing sources of deflection.

The shear wall deflection, δ^sw, shall be permitted to be calculated by the use of the following equation.

$$\delta_{sw} = \frac{8vh^3}{EAb} + \frac{vh}{1000G_a} + \frac{h\Delta_a}{b}$$

Where:
b = shear wall length, ft.

Δa = total vertical elongation of wall anchorage system (*including fastener slip, device elongation, rod elongation, etc.)* at the induced unit shear in the shear wall, in.

E = modulus of elasticity of end posts, psi.

A = area of end post cross-section, square in.

Ga = apparent shear wall shear stiffness from all slip and panel shear deformation, kips/in (from Column A, Tables 4.3A, 4.3B, 4.3C, 4.3D)

h = shear wall height, ft.

v = induced unit shear, lbs/ft

δ ^**sw**= maximum shear wall deflection

COMMENTARY

In many cases wall drift governs the shear wall performance. This equation requires the designer to include **all** sources of vertical movement in the tie-down. This means:

System elongation = Σ of all items under load

The TUD compensates for shrinkage but adds elongation.

Either shrinkage is added or a TUD is used.
If used then TUD $\Delta_A + \Delta_R$ must be included.

ICC ES AC 155 ACCEPTANCE CRITERIA FOR HOLD-DOWNS ATTACHED TO WOOD MEMBERS
May 2015

SECTION 6.2.7.3

Hold-downs used in series shall account for the cumulative deformation of all hold-downs (tie-downs) within said series.

COMMENTARY

Requires elongation from multiple hold-downs in series be included. Floor-to-floor connections often overlook the requirement to include the elongation of both hold-downs.

ICC ES AC 316 SHRINKAGE COMPENSATING DEVICES JUNE 2015

8. In the footnotes, under the table that lists the device Δ_A and Δ_R, a footnote shall be added that states: "The device average travel and seating increment, Δ_R, and the deflection at allowable load, ∆A describe the total movement of the device at allowable load, ∆T, and are additive. For design loads, PD, less than the allowable load, PA, the total movement of the device, ∆T, is calculated as follows: ∆T= ∆R + ∆A(PD/PA).

9. When the devices are used in continuous rod systems that resist light shear wall overturning forces, calculations shall be submitted to the code official confirming that the total vertical displacement, which would include steel rod elongation and the shrinkage device deflection is less than or equal to the 0.20 inch (5 mm) vertical displacement limit.

AC 316 (CONT.)

This 0.20-inch (5.mm) vertical displacement limit may be exceeded when it can be demonstrated that the shear wall story drift limit and the deformation compatibility requirement of IBC Section 1604.4 are met when considering all sources of vertical displacement.

INTERPRETATION

This section requires the deflections of shrinkage compensators be included in elongation calculations. The deflection includes the Δ_R used in full, and the Δ_A determined proportional to the load.

It may seem odd that we suggest you include a ∆R factor that varies from 0.000 to 0.002". But since other suppliers have a ∆R that may exceed 0.150" we feel that all suppliers should include this information.

OPINION

Having tested a large number of competitive TUDs I believe the Δ_R derivation of ratchet TUDs is seriously flawed. Δ_R is an **average** of a series of tests. Depending on the ratchet position, some tests may show a ratchet increment of 0.020" while the next may show 0.150". The average may truly be 0.062" because individual tests vary widely from the average.

The result, one wall moves much more than the others (due to introduced ratchet slack), and shear walls can't work together. One wall will be forced to carry the majority of the load (and may fail prematurely) while others won't be loaded at all. This may lead to a cascading system failure.

Suggestion: Ask the supplier to provide the maximum and minimum movements or avoid ratchets.

AISC 360 14TH EDITION- Calculating Rod Strength

ALLOWABLE ROD STRENGTH

ICC ES AC 391 specifies rod strength is per AISC 360, 14th ed.

Tie-down design requires knowing the strength and elongation characteristics of every rod, plate and TUD. This section addresses each component, identifies the code basis for design, and describes typical calculations. Once strength and elongation properties are determined, lookup tables are generated with strength and elongation properties.

See Catalog Section 3 for the working values assigned to AutoTight products.

ROD DESIGN VALUES-ASD

Allowable Threaded Rod tensile strength is Per AISC 360, 14 ed. Table 7-2, Page 7-23, P16.1-124, Eqn. J3-1 and table J3.2.

P = 0.75 * F_u * nominal area / 2

The IBC and AC391 uses this strength derivation.

Example: a 1-1/4" Ø, A307 rod is rated:

P = .75*60000*(3.1416*(0.625*0.625))/2
P = 27,612 lb.

ASTM Tensile Rod Strength Properties		
ROD GRADE	**Fu kips**	**Fy kips**
ASTM F1554-A307	60	43
ASTM F1554 Gr.55	75	55
ASTM A108-C1045	120	92
ASTM A193-B7	125	105
ASTM F1554 Gr. 105	125	105

AutoTight Rod shown in section 3 tables follows the detailed IBC allowable strength derivation.

Note: ICC ES AC 391 defines ASTM rod material strength: Threaded rod shall be calculated in accordance with AISC 360 (AC 391 3.2.1.1)

ALTERNATIVE STRENGTH DERIVATIONS-NOT ALLOWED

Some tie-down suppliers use methods for calculating rod strength that give values higher than allowed by ICC ES AC 391 and AISC 360.

ALTERNATE METHOD #1:
Threaded Rod Capacity =
{(0.75*F_u Ase*0.7) per ASCE7, Section 2.4}

Example: 1-1/4" Rod, A307 = 30,530 lbs. Calculated strength is 11% higher than AISC 360 allows. Research on this equation was unable to confirm validity.

ALTERNATE METHOD #2:
Threaded Rod Capacity
P = 0.75 * F_u * nominal area / 2

Example: 1-1/4" Rod, A307 =32,214 lb.

P = 0.75*70,000*(3.1416*(0.625*0.625))/2
P = 32,214 lbs.

This uses the AISC 14th Edition equation but assigns 70,000 psi to ASTM A307 steel (F_u=70,000 psi).

AC391 1.3.8 references A307-04e01

The ASTM steel standard specification for A307 steel assigns a 60,000-psi tensile strength. Calculated strength capacity is 16% higher than if AISC 360 is used.

Note: Neither alternate method follows AISC 360. If these alternate methods are followec verify compatibility.

AC 391-CALCULATING ROD ELONGATION

SECTION 3.3.1.1 THREADED ROD

The ASD steel ***tension load capacity*** shall be calculated in accordance with AISC 360 using ***Gross Area*** of the rod (nominal tensile stress area).

Rod elongation shall be based on the ***net tensile area***. Rod elongation is a function of the load (**P**), Rod Length (**L**), net tensile area (**A_n**) & elastic modules of 29,000,000 (**E**).

ROD NET TENSILE AREA

EQUATION 1: Δ Rod = PL/A_nE

Where:

P=Load
L= Rod length,
A_n=0.7854 $(D-0.9743/n)^2$
D = nominal rod diameter
n = threads per inch, (Ref. ASME B1.1)
E = elastic modulus = 29,000,000.

Rod Diameter & Thread (TPI)	Rolled Thread		Cut Thread		Elongation Increase (ΔL)
	Effective Diameter (blank)	Net Tensile Area A_n	Full Diameter (OD)	Gross Rod Area A_g	
1/2"-13 UNC	0.425	0.142	0.500	0.196	38.13%
5/8"-11 UNC	0.536	0.226	0.625	0.307	35.84%
3/4"-10 UNC	0.652	0.334	0.750	0.442	32.34%
7/8"-9 UNC	0.768	0.462	0.875	0.601	30.09%
1"-8 UNC	0.878	0.606	1.000	0.785	29.54%
1-1/8"-7 UNC	0.986	0.763	1.125	0.994	30.28%
1-1/4"-7 UNC	1.111	0.969	1.250	1.227	26.63%
1-3/8"-6 UNC	1.213	1.155	1.375	1.485	28.57%
1-1/2"-6 UNC	1.338	1.405	1.500	1.767	25.77%
1-3/4"-5 UNC	1.555	1.899	1.750	2.405	26.65%
2"-4.5 UNC	1.784	2.498	2.000	3.142	25.78%

1.) Rod Diameter and thread pitch (TPI).
2.) Rod diameter before thread rolling. Calculated from item #3
3.) AC391, 3.2.1.1 defines the Net Tensile Area and requires using this area for rod elongation.
4.) Full diameter rod OD (outside diameter).
5.) Calculated area of full diameter rod. $A = \pi r^2$
6.) Actual rod elongation if full rod diameter is calculated and standard (roll) thread is used. Except as noted, per code AutoTight uses rolled thread rod and the actual elongation.

AC 391-CONTINUOUS ROD TIE-DOWN

EQUATION 2: Δ Rod = PL/AE

This equation **does not** consider the tension material lost through using an undersized bar and raising the thread through thread rolling. Most (99%?) threaded rod is rolled from a reduced diameter rod blank. The smaller net cross section area of threaded rod results in greatly increased elongation. "Smooth Shank" rod (with threaded rod ends) is no better. While the ends are threaded the full rod is made from a reduced diameter blank.

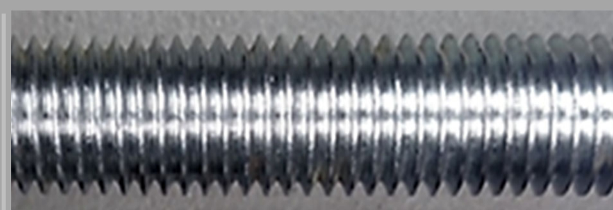
The table shows net tensile area for both full diameter and reduced diameter rolled thread rod Side-by-Side. If a reduced dia. rod is used but is calculated at full diameter, **elongation may be understated by 30% or more.**

The only way to verify is to look at the material on the job. Side-by-side the diameter difference is obvious. But if they are alone on a job site you need a caliper or micrometer to tell the difference

Three Rods: *Same nominal diameter* BUT different area and elongation

#1 "All-Thread" Rod

Uses Reduced Diameter Rod. 100% of rod is roll threaded to Nominal size.



#2 "Shanked End" Rod

Uses reduced diameter rod where only the ends of the rod are threaded.

#3 "Full Diameter" Rod- Thread Ends

Rare and expensive, full diameter threaded rod was once the standard. Today, unless you specifically ask for this rod, it will not be available.