SHEAR WALL HOLD DOWNS AND ANCHORAGE DESIGN GUIDE

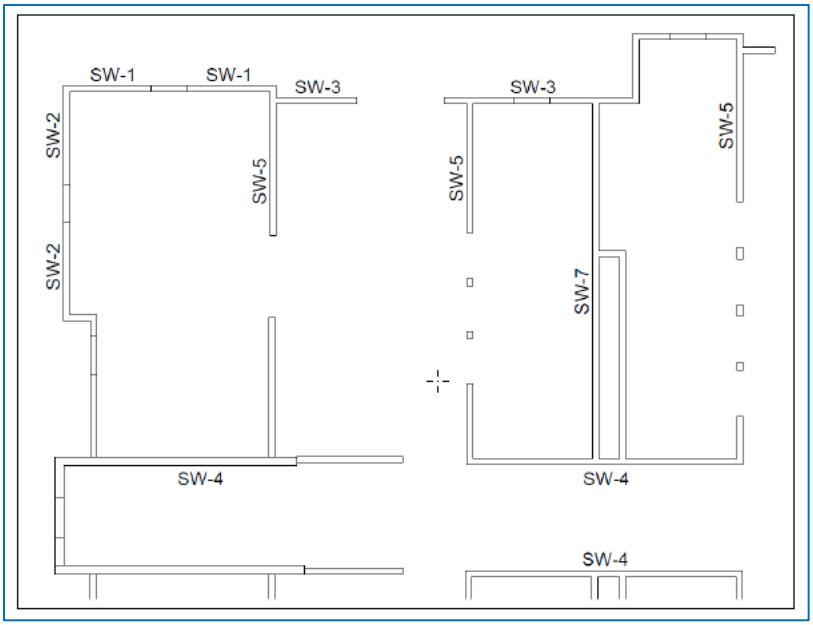
By Khalid Arafeh, PE; Andy Owens, PE; Paul Malcom, PE

Deferring the engineering of the shear wall tie down system to the rod supplier can simplify your hold down design and save you valuable design and review time. This guide will help you provide all the information necessary for a successful deferred design.

STEP 1

Specify Shear Walls and Hold Downs

- Locations of shear walls and hold downs
- Whether the shear wall extends to openings or is the entire length of the wall
- If shear walls apply to one or both sides of a party wall



Ex. Shear wall Layout Page

We recommend that a single shear wall type be used at all levels in lieu of changing shear wall designations at each level. In the above example, a “SW-1” remains “SW-1” at the level shown and all levels above. “SW-1” indicates the location is to be designed for 17k at the first level, 10.6k at the second, 5.3k at the third and 1.7k at the top level. This would require only a single shear wall layout plan.

EOR to determine the sheathing thickness and grade, nailing schedule and all other hardware required per the applicable building code.

STEP 2

Provide Tension Loads and Compression Members

- Allowable tensile load (ASD) at each floor for each shear wall type in a table format
- Elongation or deflection limitations, shrinkage estimates and/or the levels requiring shrinkage compensating devices

CLP Systems uses tension loads to optimize the rod design and make it user friendly for the job site.

MARK	LEVEL	CONT. ROD TENSION (k) *	Compression Members Each Side of Tie-down Rod
W - 1	4th	1.7	(2) 2x4
	3rd	5.3	(3) 2x4
	2nd	10.6	(3) 2x4
	1st	17.0	(4) 2x4
W - 2	4th	6.4	(2) 2x4
	3rd	12.4	(3) 2x4
	2nd	19.7	(4) 2x4
	1st	27.4	(5) 2x4
W - 3	4th	2.8	(2) 2x4
	3rd	5.4	(3) 2x4
	2nd	8.5	(3) 2x4
	1st	11.8	(4) 2x4

Incremental Loading Table

Bearing plates will be designed for the incremental load between floors and the full load at the highest level where the hold down terminates. In this example, the bearing plate between the first and second level on SW-1 will be designed for 17k-10.6k = 6.4k.

Things to consider:

In order to optimize installation accuracy and time, we recommend that compression post design at the ends of the shear walls be delegated. This allows installation crews to see the configuration of the rods relative to the compression posts on a single set of drawings. The compression force due to the overturning moment is assumed to be equal and opposite of the tension force in the rod according to Section 4.3.6 of the Special Design Provisions for Wind &

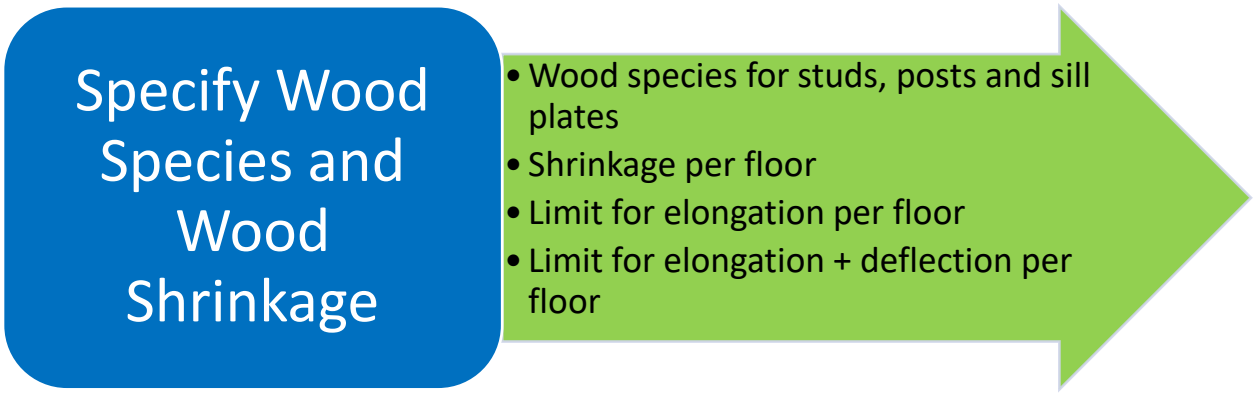
Seismic (AF&PA SDPWS). If compression posts are to be designed for a greater force than the tension force, you can provide compression loads at each level for each shear wall next to the tension loads on the shear wall load table.

Compression studs should be located at a maximum distance on both sides of the rod. If the bearing plates are on a double top plate, the maximum distance should be 3” to fall within the 45-degree bearing zone. If the bearing plates are at sill plates, squash blocks should be added between floors to ensure a 4.5” cavity between floors. Plate bending and shear need to be analyzed if the studs do not fall within the bearing zone.

Read CLP Systems Online Article: Triple Your Hold Down Capacities with Threaded Rod Systems

CLP Systems does not consider overall structural design of the building or determine the overturning forces. CLP Systems will provide design calculations directly to the EOR upon request.

STEP 3

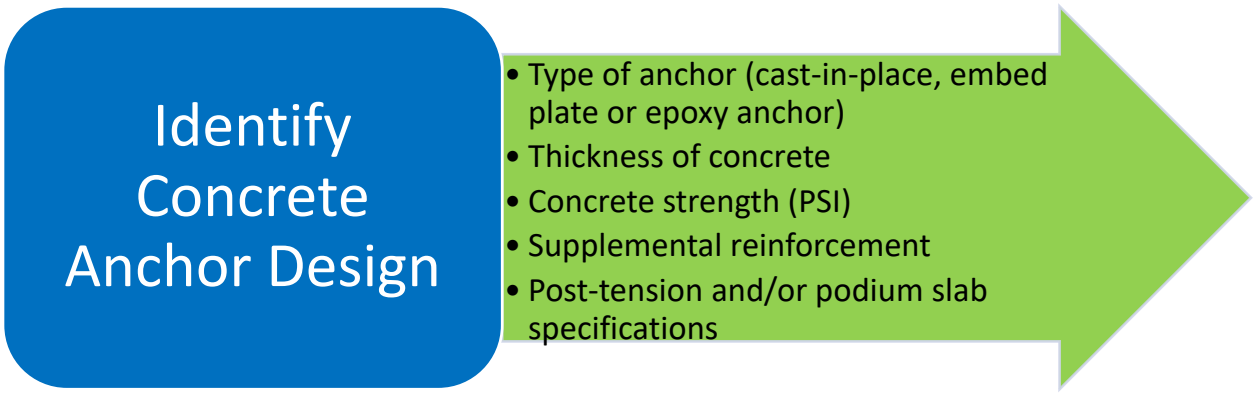


Clearly note the species of studs, posts, sill and sole plates as well as floor system type and depth. Determine and note the estimate of wood shrinkage per level on structural plans. Typically, this is identified in the general notes on the structural documents.

Shrinkage must be accounted for in any building supporting more than two floors and a roof according to the IBC. The AC 316 provides a conservative limit for total shrinkage compensating device deflection and rod elongation of 0.2" per floor (unless your drift analysis allows for more movement). Therefore the plans should specify deflection and elongation requirements or include a note to follow AC 316 requirements. A detail should also be included in the structural plans to visually show a shrinkage compensating device or an adequate note to ensure the requirement is not missed during estimating. This will also ensure that bids stay competitive among suppliers while maintaining structural quality.

CLP Systems uses the architectural drawings to identify wall heights.

STEP 4



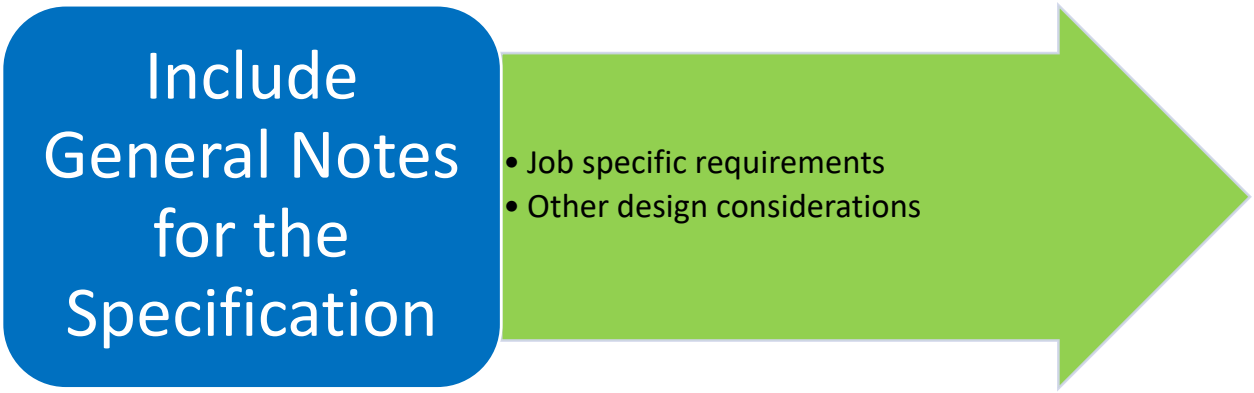
The structural EOR typically determines concrete anchorage at each hold down location. Anchors are to be designed in accordance with the Anchoring to Concrete chapter in the ACI 318-14, or note “anchors to be designed by hold down supplier” on the shear wall schedule or anchor detail. CLP Systems can help determine the anchor size and type.

Our design team aims to limit the continuous rod system to 3-4 rod diameters to simplify the installation process and improve on-site material management.

Things to Consider:

Cast-in-place anchors on slab-on-grade (SOG) foundations are difficult to locate during the concrete pour. We recommend embed plates or increased concrete depth and width be used for higher loads and post-installed epoxy anchors for smaller loads at SOG foundations. Cast-in-place anchors are feasible for an elevated slab but embed plates may still be needed for higher loads. Also, if the anchor design is deferred to the hold down designer, we recommend you include a note that concrete requirements need to be provided by the hold down designer prior to setting concrete.

STEP 5



1. The continuous rod tie-down system shall be CLP Systems for shear wall overturning restraint.

2. The continuous rod tie-down system shall be designed and installed at the end of each shear wall per supplier's specification to meet tensile capacity forces provided in the shear wall schedule.

3. Shop drawings and calculations shall be submitted by CLP Systems for review and approval prior to installation. Substitutions must provide shop drawings and calculations for review and approval by the EOR.

3. If shop drawings and structural plans contain discrepancies, the structural plans always govern. Notify CLP Systems of any discrepancies.

4. The continuous rod tie-down shall be restrained at each level. Take-up devices shall be provided as recommended by CLP Systems to account for shrinkage, elongation, and deflection. Where a take-up device is not required, the contractor shall re-tighten the nuts above the bearing plates at each restraint point after the building is completely loaded.

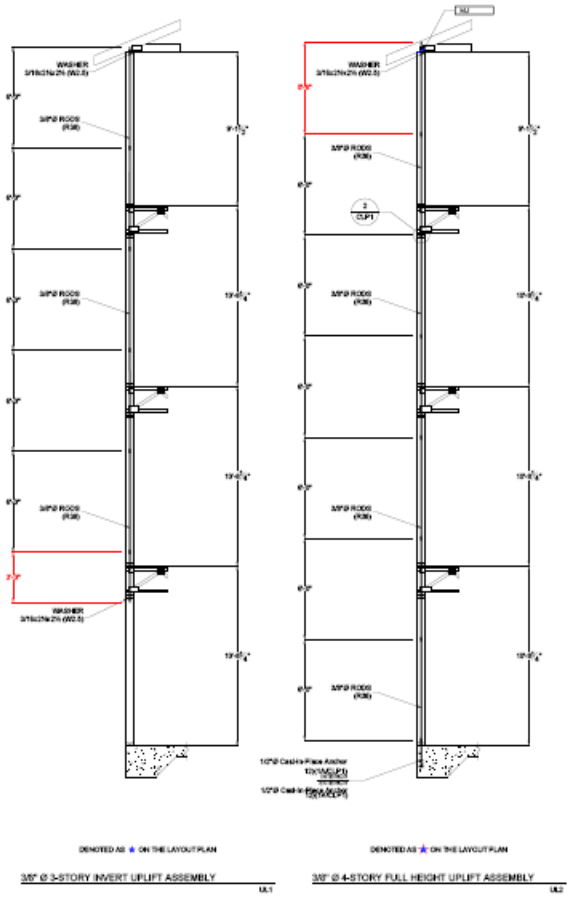
5. Compression posts design and configuration shall be provided by CLP Systems, using a compressive force equal and opposite the tension force unless noted otherwise by the EOR.

6. A pre-construction meeting is recommended to review anchorage requirements and installation procedures.

WIND UPLIFT DESIGN

The engineer of record (EOR) determines the requirements for wind uplift by performing a wind analysis per the ASCE requirements to estimate the uplift reactions. The EOR then determines the number of stories required to counter the uplift reactions using 60% of the dead load of the walls and floor systems (as applicable). You may determine that the top stories need to be tied together with inverted rods or that all stories are needed to counter the uplift. Spacing requirements are dependent on the reactions and top plate bending analysis.

We recommend invert rods be used wherever possible to eliminate anchor issues, especially at post-tensioned slabs.



When a tie-down system is required for uplift resistance, CLP Systems will use the approved roof truss submittals to design the uplift resistance system. The roof truss submittals include the roof truss profiles of each truss and the layout of the roof truss bearing walls.

The roof truss uplift reactions are used to determine the diameter and maximum spacing of the uplift rods.

The layout of roof truss bearing walls are used to provide the locations of the uplift rods on shop drawings. Framing conflicts and locations of concern are noted on the shop drawings for the EOR to review.