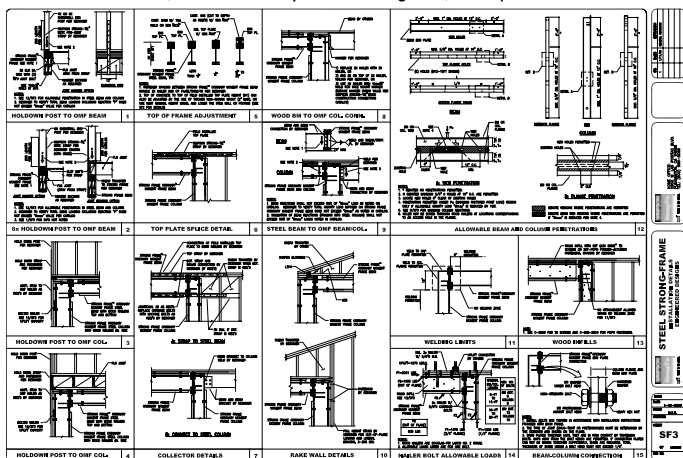


# Design Information

## Simplified Design

Simpson Strong-Tie® Strong Frame™ ordinary moment frames are pre-engineered and simplify design for a wide variety of applications:

- Beams are designed as unbraced – no beam bracing required within the span.
- Frame designed assuming pinned-base condition.
- Allowable loads applicable to wind and seismic loads – no need to convert.
- Use in the same manner as any other ordinary steel moment frame – can be used in vertical and horizontal combinations with other lateral-force-resisting elements in accordance with the IBC and ASCE 7-05.
- Designs are based on calculation – no test reports required; easily adaptable to alternate installations. Calculation packages are available for each frame, contact Simpson Strong-Tie, if required.



- Details are provided (in this catalog) to adjust the height of the top of the frame when the frame height does not match the structure.
- Details are provided (in this catalog) to allow additional beam and column penetrations to simplify the installation of utilities.
- Frames may be used as an alternative to braced-wall panels required by the IBC and IRC. For more information, see the Strong Frame “Wall Bracing” section at [www.strongtie.com](http://www.strongtie.com).

## Using this Catalog as a Design Tool

The selection of a complete moment frame design solution is easy using the Strong Frame ordinary moment frame. A step-by-step description of the design process is included in this catalog on pages 19–21, and design examples on pages 48–51 provide further information. After completing these steps, Designers will have all of the information necessary to properly specify the Strong Frame ordinary moment frame and detail its installation:

- Appropriate Strong Frame model
- Bolt tightening requirements (snug-tight or pretensioned)
- Appropriate fasteners for the top-plate-to-nailer connection
- Anchorage assembly
  - Type – OMFSL or OMFAB
  - Strength – standard or high strength
  - Anchor bolt rod length – 14", 18", 24", 30", or 36"
  - Extension kit (where required)
- Minimum footing width and embedment depth for anchorage
- Inside and outside end distances for OMFSL anchorage assembly
- Tie or hairpin reinforcement for OMFAB anchorage assembly

For additional detailed information on the design and proper use of Strong Frame ordinary moment frames, see General Notes on page 6 and General Instructions for the Designer on page 7.

## Bolt Tightening Requirements

In order for the Strong Frame ordinary moment frame to achieve its rated capacity, the connection plates must have firm contact and the bolts must be properly tightened. Bolts shall be tightened in compliance with the *Specification for Structural Joints Using ASTM A325 or A490 Bolts*, published by the Research Council of Structural Connections (RCSC). The Designer shall specify whether the installation requires snug-tight joints or pretensioned joints.

- For design of structures assigned to Seismic Design Category D, E, or F, pretensioned bolts are required.
- For design of structures assigned to Seismic Design Category A, B, or C, snug-tight bolts may be used when seismic design is based on  $R \leq 3$ .
- For design of structures assigned to Seismic Design Category A, B, or C, pretensioned bolts are required when seismic design is based on  $R > 3$ .

The Direct Tension Indicator (DTI) washers provided with each frame make verification of proper bolt installation easy for both snug-tight and pretensioned bolts and are recommended for all installations. If the DTI washers are not used in connections that require pretensioned bolts, an alternate pretensioning method must be specified by the Designer, including pre-installation verification testing of the complete fastener assembly and inspection procedures. For detailed information on the use of the DTI washers provided, see page 15.



## Base Plates and Non-Shrink Grout

The Strong Frame ordinary moment frame has been designed to accommodate a 1 1/2" grout pad below the column base plates in order to facilitate plumbing and leveling of the frame. Proper performance of the base connection and anchorage of the frame requires that non-shrink grout with a minimum compressive strength of 5,000 psi be placed below the column base plates. The thickness of the grout pad may vary based on field conditions, but must be a minimum of 3/4" thick and no more than 2" thick. Frame height dimensions throughout this catalog are based on a grout thickness of 1 1/2" and must be adjusted for other grout pads. The Designer may specify installation of base plates directly on concrete (without grout) provided they are set level, to the correct elevation, and with full bearing.

Base plate design is based on 5/8" diameter anchor rods, which are included with the Simpson Strong-Tie OMFSL and OMFAB anchorage assemblies. Base plate holes are 7/8" diameter to allow for tolerances in placement of the anchor rods. The Designer must evaluate the effects of the oversized hole and provide plate washers with 1/16" diameter holes, welded to the base plate where required.

## Design Information

### Anchorage Design

Simpson Strong-Tie offers pre-engineered anchorage solutions to simplify the design process. Pages 39–44 provide solutions for both tension and shear anchorage for all of the Strong Frame™ ordinary moment frame models.

- **Tension Anchorage**

Anchorage solutions for tension loads provide minimum anchor rod embedment and footing size. Where additional uplift from wind occurs, Table 1.2 on page 39 may be used to design an anchorage solution.

- **OMFSL and OMFAB Anchorage Assemblies**

Simpson Strong-Tie offers two different pre-assembled anchorage assemblies. The OMFSL anchorage assembly places the frame flush with the edge of concrete allowing it to fit into a standard 2x6 wall without bump-outs or furring. The OMFAB anchorage assembly with additional concrete reinforcement is an economical alternative for applications where 2½" (or greater) edge distance exists.



- **Flexible Anchorage Solutions**

Both Simplified and Detailed options are provided for anchorage design in order to allow ease of design and specification as well as refined design for project-specific load conditions. For simplified anchorage solutions, after selecting a frame, all that is needed to determine the required anchorage is the column size and nominal frame height. For cases where more economical anchorage is desired, Detailed anchorage solutions provide capacities of the anchorage assemblies. Simply use the maximum reactions tabulated in the allowable load tables for the selected frame, and find the required anchorage with a capacity that exceeds the reactions. For even further economy, select an anchorage solution using reactions calculated for project-specific loads as described in the footnotes of the allowable load tables

- **Anchorage Design Notes**

The steel strength calculations for anchor shear and anchor tension are per ACI 318-05 and 318-08 Appendix D. Tension and shear anchorage are designed as follows:

Element	Code Section
Anchor rod strength in tension	ACI 318, D.5.1
Anchor breakout strength in tension	ACI 318, D.5.2
Anchor pullout strength in tension	ACI 318, D.5.3
Anchor rod strength in shear	ACI 318, D.6.1
Embedded plate bending strength	AISC Chapter F
Concrete shear strength – shear lug	AISC Design Guide 1
Concrete shear strength – tied anchorage	ACI 318, chapter 10

Anchorage Designs are based on LRFD loads. For designs under the 2006 IBC, tension anchorage for seismic loads complies with ACI 318-05 Appendix D; design includes application of 0.75 factor on concrete strengths (Section D.3.3.3) and the strength is governed by a ductile steel element (Section D.3.3.4) or is based on 2.5 x factored loads (Section D.3.3.5 with modifications contained in 2006 IBC section 1908.1.16). For designs under the 2009 IBC, tension anchorage for seismic loads complies with ACI 318-08 Appendix D; design includes application of 0.75 factor on concrete strengths (Section D.3.3.3), and strength is governed by a ductile steel element (Section D.3.3.4) or is based on 2.5 x factored loads (Section D.3.3.6).

Anchorage designs are based on embedment for tension into the foundation, while shear design is based on resistance within the curb or slab. For other conditions, the designer must consider the interaction of tension and shear concrete failure surfaces.

### Inspections

Inspection requirements for the Strong Frame ordinary moment frame are no different than for any other ordinary steel moment frame. The Designer must designate what inspections are required in accordance with the local code, based on building occupancy, concrete strength, requirements of the local building official, and other considerations.

Because the Strong Frame ordinary moment frame includes pre-manufactured components, all welding inspections are completed during the manufacturing process. Welding of the frame members is performed on the premises of a fabricator registered and approved in accordance with the requirements of IBC Section 1704.2.2 for fabricator approval, so special inspections contained in IBC Section 1704 are not required. Special inspection for seismic resistance required by IBC Section 1707 for welding is completed during the manufacturing process.

If required, inspection of fastener assemblies (high-strength bolt, DTI washer, hardened washer, and heavy hex nut) for the bolted beam-to-column connections is easy. Fastener assembly lots are randomly sampled and pre-installation verification testing is performed to confirm installation procedures and performance of the fastener components. The easy-to-use Direct-Tension-Indicator (DTI) washers included with every Strong Frame moment frame installation kit make it easy to verify proper bolt pretensioning in the field – see page 15 for further information on use of the DTI washers. For projects where inspection of the bolts is required, Certificates of Conformity for the fastener assemblies may be obtained for each hardware kit lot number under Lot Control for Structural Fastener Assemblies on the Strong Frame Moment Frame page at [www.strongtie.com](http://www.strongtie.com). The lot number is located on the beam and on the hardware box.

### Additional Information

For additional information on the design and use of Strong Frame ordinary moment frames, see Installation Details on pages 53–65, and Frequently Asked Questions in the Strong Frame moment frame section at [www.strongtie.com](http://www.strongtie.com).