

ENGINEER'S DESIGN GUIDELINES

Contained herein, for your convenience, are a few of the most frequently used design items. For a more detailed list of code compliant design requirements, refer to our prequalification report ESR1275 report by ICCES.

Use of Deeper Frame Columns:

In order to achieve the most economical steel moment frame system possible in terms of lowest possible steel tonnage and steel fabrication costs, it is necessary to select a frame column that is proportioned like a rectangular section (e.g. deeper column like W21x or W27x) versus a square (e.g. W12x or W14x). Doing so results in a column that has the same structural stiffness when compared to a W14x column, but for half of the steel weight resulting in 1-3 lbs/square foot in overall steel tonnage savings.

Since the majority of moment frame columns occur around the perimeter of a building, the great majority of columns in the interior space will be gravity load resisting and can be sized appropriately (e.g. Square tube columns, W12x or W14x). However, depending on the overall building configuration and number of frame columns available in each direction, occasions do arise where interior moment frame columns are required. Such columns can be a combination of both deep and shallow without sacrificing economy.

Modeling:

Create the lateral model as customary for any project using steel moment frames. When selecting preliminary lateral beam and columns sizes, it is important to keep in mind the following two rules:

GEOMETRIC COMPATIBILITY: $b_{f-bm} + 2.0t_{f-bm} \leq b_{f-col}$

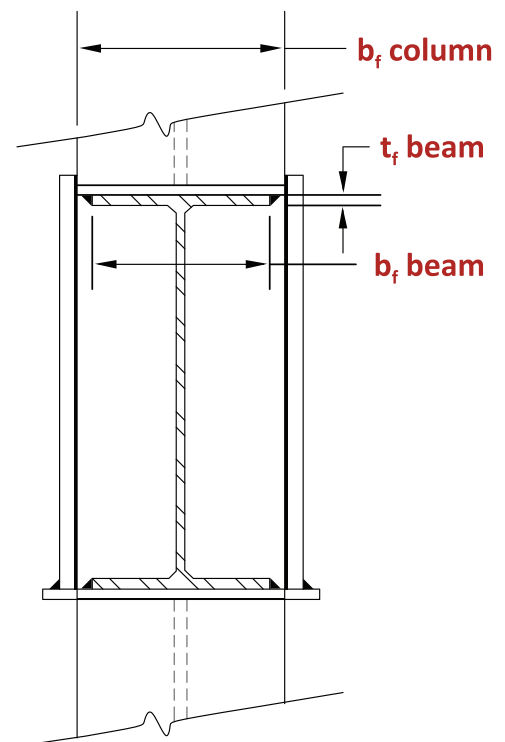
Background: The SidePlate connection typically consists of cover plates at the beam ends to bridge the difference between the beam flange width and the wider column flange width. The cover plates are fillet welded to the beam flange edges of which the top cover plate is detailed to be approximately the same width as the column flange width.

STRONG COLUMN

WEAK BEAM COMPLIANCE FOR R=8 SMF DESIGNS ONLY:

$\sum (Z_{x,col}) > 1.7 * \sum (Z_{x,bm})$ for 1-12 stories (rule of thumb)

Background: The above equation takes into account the latest Seismic Provisions equation for SCWB compliance of SMF connections, including an approximate allowance for reduction in column capacity due to axial loads as well as the pushing out of the plastic hinge into the beam.



Computer Modeling Tips:

To appropriately represent the connection stiffness properties of SidePlate®, the computer model must reflect the following two items:

100% PANEL ZONE

- RAM FRAME (v14.04+) – Automatically incorporated when SidePlate is assigned as the Frame Beam Connection Type (see below)
- RAM FRAME (v14.03 and older) – assign all frame beam and columns with a rigid end zone of a 0% reduction (refer to “*Connection Stiffness Implementation Procedure for RAM v12 & v13*”)
- ETABS & SAP 2000– Assign all frame beams and columns with a Rigid End Offset of “r=1”
- RISA – Assign Rigid End Offsets = 1.0

CONNECTION PROPERTIES BEYOND COLUMN FLANGE

The SidePlate connection typically extends horizontally beyond the face of column flange (DIM A) approximately 80%-100% of the nominal frame beam depth (e.g. typical ranges from 18”-30”) – see figure on next page. The connection properties are different for high seismic (inelastic) applications versus wind (elastic) and low seismic applications.

For R=8 designs, seismic displacement will typically govern the size of the lateral beams and columns. For R=3 designs, wind displacement will typically govern.

For **seismic displacement** controlled lateral members, modify the properties of the beam ends for a distance DIM A (use typical 80% of beam depth):

$$I_x = 3 * I_x \text{ of frame beam}$$

$$\text{Depth} = \text{nominal frame beam depth} + 3'' \text{ (e.g. SidePlate depth)}$$

$$S_x = (2 * (3 * I_x)) / (\text{Depth of SidePlate})$$

$$Z_x = 1.15 * S_x \text{ value (above)}$$

- RAM FRAME v14.04+ - Under Criteria, select SidePlate – Seismic Displacement (this automatically incorporates the appropriate properties). Then assign the moment connection type as SidePlate using the **Assign – Beams - Connection** command – refer to the PDF “*Specifying and Designing SidePlate® Moment Frames in the RAM Structural System*”
- ETABS – use built-in feature by assigning all frame beams to use “SidePlate” beam type
Note: The modified S_x portion is not included in the current ETABS built-in feature. If overstresses of 1.25 or less are encountered in the beams, the beams may not be overstressed when checked at the end of the side plates. In order to confirm this, non-prismatic beams will need to be utilized – refer to PDF “*Connection Stiffness Implementation Procedure for ETABS/SAP*”
- RISA/SAP 2000 – Insert a node along the frame beam located at approximately (½*frame column depth + 0.8*frame nominal beam depth). Assign a new member between centerline of frame column and new node that has the properties above.

For **wind displacement** controlled lateral members, modify the properties of the beam ends for a distance DIM A (use typical 80% of beam depth):

$I_x = 1 * I_x$ of frame beam

Depth = nominal frame beam depth + 3" (e.g. SidePlate depth)

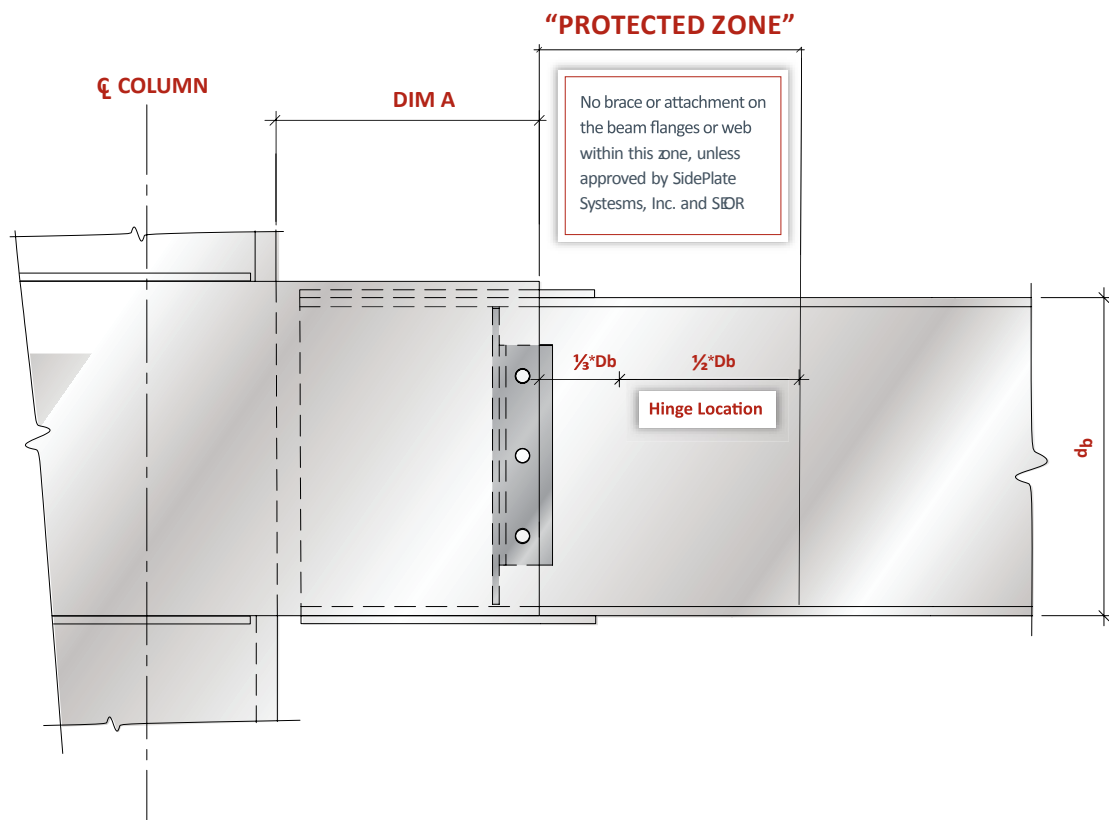
$S_x = (2 * (3 * I_x)) / (\text{Depth of SidePlate})$

$Z_x = 1.15 * S_x$ value (above)

- RAM FRAME v14.04+ - Under Criteria, select SidePlate – Wind Displacement (this automatically incorporates the appropriate properties). Then assign the moment connection type as SidePlate using the Assign – Beams - Connection command – refer to the PDF “Specifying and Designing SidePlate® Moment Frames in the RAM Structural System”
- ETABS – create a non-prismatic beam to create properties above – refer to PDF “Connection Stiffness Implementation Procedure for ETABS/SAP”
- RISA/SAP 2000 – Insert a node along the frame beam located at approximately ($\frac{1}{2}$ *frame column depth + 0.8*frame nominal beam depth). Assign a new member between centerline of frame column and new node that has the properties above.

Moment Frame Protected Zone (for IMF & SMF Applications Only):

AISC Seismic Provisions prohibit certain attachments in the protected zone for all Special and Intermediate Moment Frame applications. SidePlate’s protected zone is identified as shown:



Lateral Bracing of Beams (for IMF & SMF Applications Only):

EOR shall provide lateral bracing of the frame beam's bottom flange in accordance with the latest AISC Seismic Provisions, where the length of the beam is defined **as the distance between the ends of the side plates**. Supplemental top and bottom flange bracing at the expected hinge is not required since lateral bracing of the beam at or near the plastic hinge is provided by the side plates as proven by full-scale tests.

Lateral Bracing at Beam-to-Column Connections (for SMF Applications Only):

The SidePlate connection is composed of two parallel side plates that are welded to the outside edges of the column flanges for the full depth of each beam plus a certain length above. In addition, horizontal shear plates are welded to the inside edges of the column web at the top and bottom of each side plate. This configuration creates a 100% rigid panel zone and prevents the column flanges from buckling at the levels of top and bottom beam flanges and beyond. The connection also provides the adequate 2% lateral bracing at these levels.

All of the full-scale tests were completed without bracing of the column flange at top or bottom beam flange and all configurations had $SCWB \ll 2.0$. Test results showed no flexural yielding or lateral-torsional buckling in the column. Hence, the SidePlate® moment connection system is considered to be a Braced Connection in accordance with AISC Seismic Provisions Section 9.7.

Welding to Face of Side Plate:

It is acceptable to weld to the face of the side plates using the project approved minimum preheat as shown:

