

Analytical Modeling of Connections Using Break Elements

A connection model was developed for each of the following connection types, using the break elements in Table 11–5 in series or in parallel, as needed, to model the appropriate failure modes:

- Single shear plate
 - Fin (beam-to-girder)
- Double angle shear connections
 - Knife (beam or girder-to-column)
 - Header (beam-to-girder or girder-to-column)
- Seat with web clip (SWC) connection
 - Seat with web clip (core beam-to-core girder)
- Seat with top plate (STP) connections
 - Seat connection at columns on the east face (beam or girder-to-exterior column)
- Seat with top clip (STC) connections
 - Seat connection at columns on the north and south face (beam or girder-to-exterior column)
 - Seat connection at Columns 79 and 81 (girder-to-interior column)

The floor area where failure of floor framing connections and shear studs³ was modeled with break elements on Floors 8 to 14 is shown in Figure 11–9. This area is east of the north-south line passing through Column 76 and the core area east of Column 73.

Outside the selected area, structural damage—such as buckling of the steel frame and crushing and cracking of the concrete slab—was modeled over the entire floor, but connection failures were not modeled. The extent of the area with detailed connection models was based on the results of single floor fire simulations, where connection damage west of Columns 73 through 76 were not found to contribute to an initial failure event on the east side of the structure. The area where break elements were modeled was selected to reduce the model size without biasing the results for simulating the initial failure event.

³ The shear stud capacity was scaled so that the total capacity of the modeled studs equaled the total capacity of the actual number of studs for each floor beam. For instance, if a floor beam in ANSYS had 17 shear stud connections (due to mesh sizing), the capacity of each stud connector would be scaled by 28/17, because the floor beam as constructed had 28 shear studs.