

floor beams due to thermal expansion effects. Any beam connected to a girder that lost vertical support also lost vertical support at the girder, and is indicated with a red line.

Graphics are presented in Sections 11.3.1, 11.3.2, and 11.3.3 to describe key observations for the building response to gravity loads (Figure 11–20 and Figure 11–21), Case B temperatures at 3.5 h (Figure 11–22 through Figure 11–29) and 4.0 h (Figure 11–30 through Figure 11–37), and Case C temperatures at 4.0 h (Figure 11–38 to Figure 11–45). The Case B temperatures at 4.0 h resulted in significant damage to the floors subjected to fires relative to the damage at 3.5 h. The Case C temperatures at 4.0 h show how the structural response was similar to the Case B response, but with a time lag.

Section 11.4 has a general discussion of results for Case B at 3.5 h and 4.0 h and for Case C at 4.0 h.

11.3.1 Analysis of Building Response to Gravity Loads

The structural response to gravity loads was the same for all tenant floors in the ANSYS model. Figure 11–20 shows the vertical displacements in the floor framing and slab, the axial stresses in the floor framing and columns, and the in-plane strains of the floor slab for Floor 8.

Displacements. The typical vertical floor displacement on the tenant floors was about 3.5 in., as shown in Figure 11–20a. The maximum vertical deflection of 4.5 in. occurred in the northwest corner of the tenant floor. The floor beams were shown to be cambered from 1.0 in. to 2.75 in. in the design drawings. Beam camber could not be modeled in ANSYS. Thus, the actual vertical floor displacements would have been about one to two inches, if the camber was subtracted from the computed displacements.

Axial stresses from axial forces in the floor beams and in-plane slab strains were small, as expected for gravity load conditions. The stress in the floor beams due to axial loads was less than 1 ksi (floor beams had a nominal yield strength of 50 ksi). The in-plane slab strains were less than -5×10^{-5} (concrete failure strain in compression was -4×10^{-3} and failure strain in tension was 1.5×10^{-3}).

Axial column stresses (Figure 11–20c) ranged from 15 to 28 ksi in the interior columns and in exterior Columns 44 and 55 on the north face. The axial column stress in the other exterior columns ranged from 8 to 15 ksi.

Column Forces. The column forces at Floor 8 are presented for comparison to the column forces at 3.5 h and 4.0 h of heating, which are presented at the end of Sections 11.3.2 and 11.3.3. Axial forces in the columns at Floor 8 are shown in Figure 11–21. The size of the circle at each column indicates the magnitude of the load. The maximum column force of 7,525 kip was at Column 79. The axial force ranged from 2,000 kip to 5,000 kip in the rest of the interior columns and 1,000 kip to 3,000 kip in the exterior columns. The sum of all column forces was 176,500 kip, with the interior and exterior columns carrying these forces in about equal parts. Based on the design drawings, the sum of all column forces for a loading condition of dead loads and service live loads was 174,100 kip.