

impact, some of the floor beams separated from the floor deck and others separated at the welded connection.

Significant impact damage to WTC 5 is shown in Figure 4-12. The damage was concentrated on the west side of the building.

4.2.2 Fire Damage

Figure 4-13 shows WTC 5 on fire. The source of ignition has not been identified. It is likely that it was due to flaming debris entering the building from WTC 1 and WTC 2. There was a complete burnout of all combustibles from the 5th floor and above. Some steel beams supporting the roof were deformed due to the heat, as illustrated in Figure 4-14, and some local buckling occurred as well. Roof tar entered the floor through the drains. There is no indication that this roof tar played a major role in the fires. One area below the roof at the 8th floor collapsed onto the 7th floor and then both onto the 6th, and so on, down to the 4th floor.

The structural damage due to the fires closely resembled that commonly observed in test assemblies exposed to the ASTM E119 Standard Fire Test. After testing, the deformed shapes of beams, girders, and columns are similar to the structural damage that occurred in these buildings. The damage also resembled the fire damage associated with the fire incident at the unsprinklered One Meridan Plaza, a steel-framed building in Philadelphia, and damage observed at experiments conducted at Cardington by the Building Research Establishment (BRE) and British Steel in 1995. These fires are discussed in greater detail in Appendix A, Section A.3.1.3.

Discrete sections of the steel framing were warped or twisted. There was no evidence of weakened connections in the areas of the building that were inspected. Some studs were missing and others were still in place in some areas, even in floor sections that had collapsed. In many deformed beams, there was no evidence of damage at openings cut into the beams, suggesting that web penetration reinforcement design worked as intended, although some localized buckling in beams and girders was observed throughout the burned-out regions.

There was significant fire damage on floors 4 through 8. On some floors, the interior had been completely gutted by fire; on others, the fire damage was severe, but there was still evidence of office partition frames and other light-gauge metal products, except for the 6th floor, which suffered near



Figure 4-10 Impact damage to the exterior façade of WTC 6.