

- The NIST-measured properties of the steels (strain rate, impact toughness, high-temperature yield and tensile strengths) were similar to literature values for other construction steels of the WTC era.
- The creep behavior of the steels could be modeled by scaling WTC-era literature data using room temperature tensile strength ratios.

8.3.3 Aircraft Impact Damage Analysis

- Both towers withstood the significant structural damage to the exterior walls, core columns, and floor systems due to the aircraft impact. WTC 2 was the more severely damaged building and the first to collapse. WTC 2 displayed significant reserve capacity, as evidenced by a post-impact rooftop sway that was more than one-third of that under the hurricane force winds for which the building was designed. The oscillation period of this swaying was nearly equal to that calculated for the undamaged structure. (Such an analysis was not possible for the less severely damaged WTC 1 due to the absence of equivalent video footage for the analysis.)
- American Airlines Flight 11 impacted the north wall of WTC 1 at a speed of $443 \text{ mph} \pm 30 \text{ mph}$, banked $25 \text{ degrees} \pm 2 \text{ degrees}$ to the left (left wing downward) and with the nose tilted slightly downward. United Airlines Flight 175 impacted the south wall of WTC 2 at a speed of $542 \text{ mph} \pm 24 \text{ mph}$, banked $38 \text{ degrees} \pm 2 \text{ degrees}$ to the left (left wing downward) and with the nose pointed slightly downward and to the right.
- The aircraft impact on WTC 1 caused extensive damage to the north wall of the tower, principally in the regions impacted by the fuselage, engine, and fuel-filled wing sections. Photographic evidence showed that 34 perimeter columns were completely severed, while four columns were heavily damaged, and two columns were moderately damaged.
- The impact simulations of WTC 1 indicated that three to six core columns were severed, and three to four columns were heavily damaged. The floor trusses, core beams, and floor slabs experienced significant impact-induced damage on floors 94 through 96, particularly in the path of the fuselage. The wing structures were fragmented at the exterior wall, and aircraft fuel was dispersed on multiple floors. Aircraft debris substantially damaged the nonstructural interior partitions and the workstations and dislodged insulation in its path. The bulk of the fuel and aircraft debris was deposited in floors 93 through 97 with the largest concentration on floor 94.
- The aircraft impact on WTC 2 caused extensive damage to the south wall of the tower and to the regions impacted by the fuselage, engine, and fuel-filled wing sections. Photographic evidence showed that 29 perimeter columns were completely severed, one was heavily damaged, and three were moderately damaged. Four perimeter columns on the north wall also were severed.
- The impact simulations of WTC 2 indicated that five to ten core columns were severed and up to four columns were heavily damaged. The rupture of some column splices on floors 77, 80, and 83 contributed significantly to the failure of the core columns. The floor trusses, core