

6.8.2 Subassembly Impact Analyses

Next, a series of simulations were performed for intermediate-sized sections of a tower. These subassembly analyses investigated different modeling techniques and associated model sizes, run times, numerical stability, and impact response. Six simulations were performed of an aircraft engine impacting a subassembly that included structural components from the impact zone on the north face of WTC 1, exterior panels, truss floor structures, core framing, and interior contents (workstations). One response of the structure to the engine impact is shown in Figure 6–17.

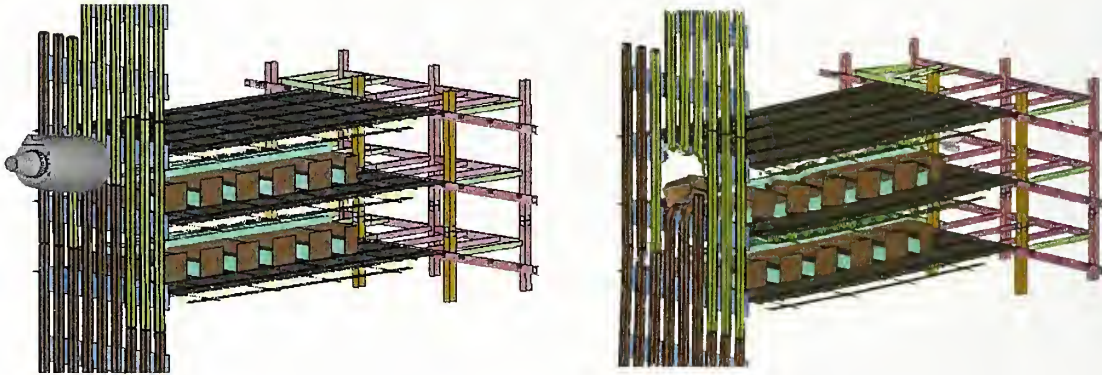


Figure 6–17. Response of a tower subassembly model to engine impact.

Typical knowledge gained from these simulations were:

- The mass of the concrete floor slab and nonstructural contents had a greater effect on the engine deceleration and subsequent damage than did the concrete strength.
- Variation of the failure criteria of the welds in the exterior columns did not result in any noticeable difference in the damage pattern or the energy absorbed by the exterior panels.

6.8.3 Aircraft Impact Conditions

From the NIST photographic and video collection, the speed and orientation of the aircraft (Table 6–4) were estimated at the time of impact. The geometry of the wings, different in flight from that at rest, was estimated from the impact pattern in the photographs and the damage documented on the exterior panels by NIST. United Airlines and American Airlines provided information on the contents of the aircraft, the mass of jet fuel, and the location of the fuel within the wing tanks.

Table 6–4. Summary of aircraft impact conditions.

Condition	AA 11 (WTC 1)	UAL 175 (WTC 2)
Impact Speed (mph)	443 ± 30	542 ± 24
Vertical Approach Angle	10.6° ± 3° below horizontal (heading downward)	6° ± 2° below horizontal (heading downward)
Lateral Approach Angle	180.3° ± 4° clockwise from Plan North ^a	13° ± 2° clockwise from Plan North ^a
Roll Angle (left wing downward)	25° ± 2°	38° ± 2°

a. Plan North is approximately 29 degrees clockwise from True North.