

Chapter 12

WTC GLOBAL COLLAPSE ANALYSIS

12.1 OVERVIEW

This chapter presents the description and analysis results of the global model, which was developed to determine the collapse sequence of the World Trade Center (WTC) 7 building and to test the leading collapse hypothesis presented in Chapter 8. The response of the full 47 story structure to initial failure events due to fire was analyzed to determine the events that led to the global collapse of WTC 7.

The nonlinear dynamic collapse analyses were performed using LS-DYNA, which was capable of explicitly modeling sequential failures, falling debris, and debris impact on other structural components. LS-DYNA was well suited for this type of analysis, since it can model dynamic failure processes, including nonlinear material properties, nonlinear geometry, material failures, contact between collapsing structural components, and element erosion based on a defined failure criterion. In addition, LS-DYNA has capabilities to include thermal softening of materials and thermal expansion.

The global LS-DYNA model had the following input data:

- Extent of initial damage to the building due to debris impact from the collapse of WTC 1 (Chapter 5).
- Mechanical properties of steel (Appendix E and NIST NCSTAR 1-3D) and concrete (NCSTAR NIST 1-6A) used in the construction of WTC 7.
- Temperature-dependent mechanical properties of steel (Appendix E and NIST NCSTAR 1-3D).
- Temperatures of structural components and connections, at the time when the ANSYS results were transferred to the LS-DYNA analysis (Chapter 10).
- Fire-induced damage to floor beams, girders, and their connections from the 16 story ANSYS analysis (Chapter 11).

The floor framing geometry, component sizes, connection details, and gravity loads were obtained from structural and architectural drawings, as well as erection and fabrication shop drawings of connections for the steel framing (Chapter 2). The global LS-DYNA model analyzed the effects of gravity and temperature loads. Gravity loads included: the dead load of the structure; superimposed dead loads consisting of the weight of ceilings, mechanical and electrical equipment, thermal insulation, and floor finishes; and service live load, which was taken as 25 percent of the design live load specified in the original design documents.

Four simulations were performed with the global LS-DYNA model.