



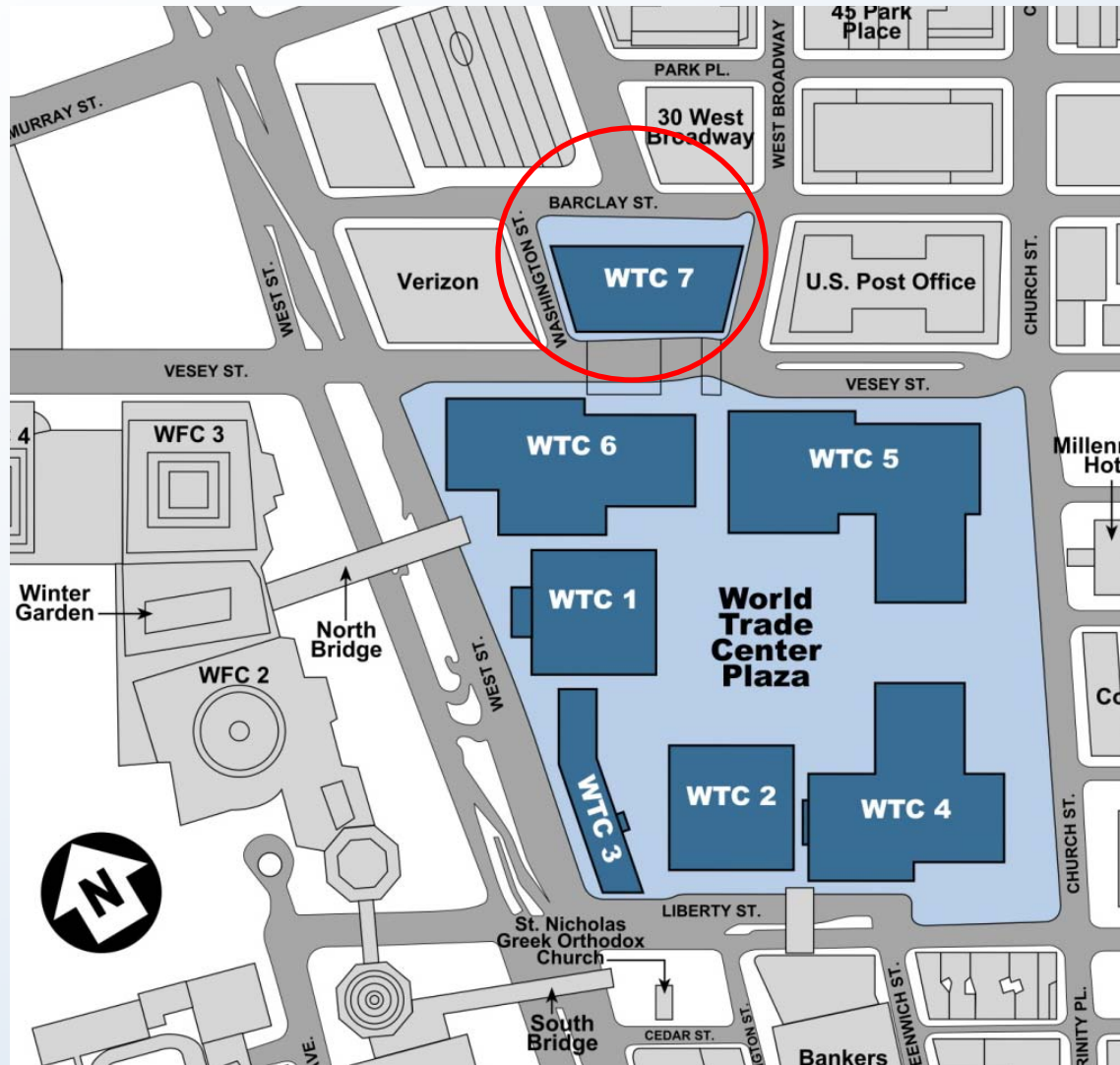
NIST Response to the World Trade Center Disaster

**Federal Building and Fire Safety Investigation
of
the World Trade Center Disaster**

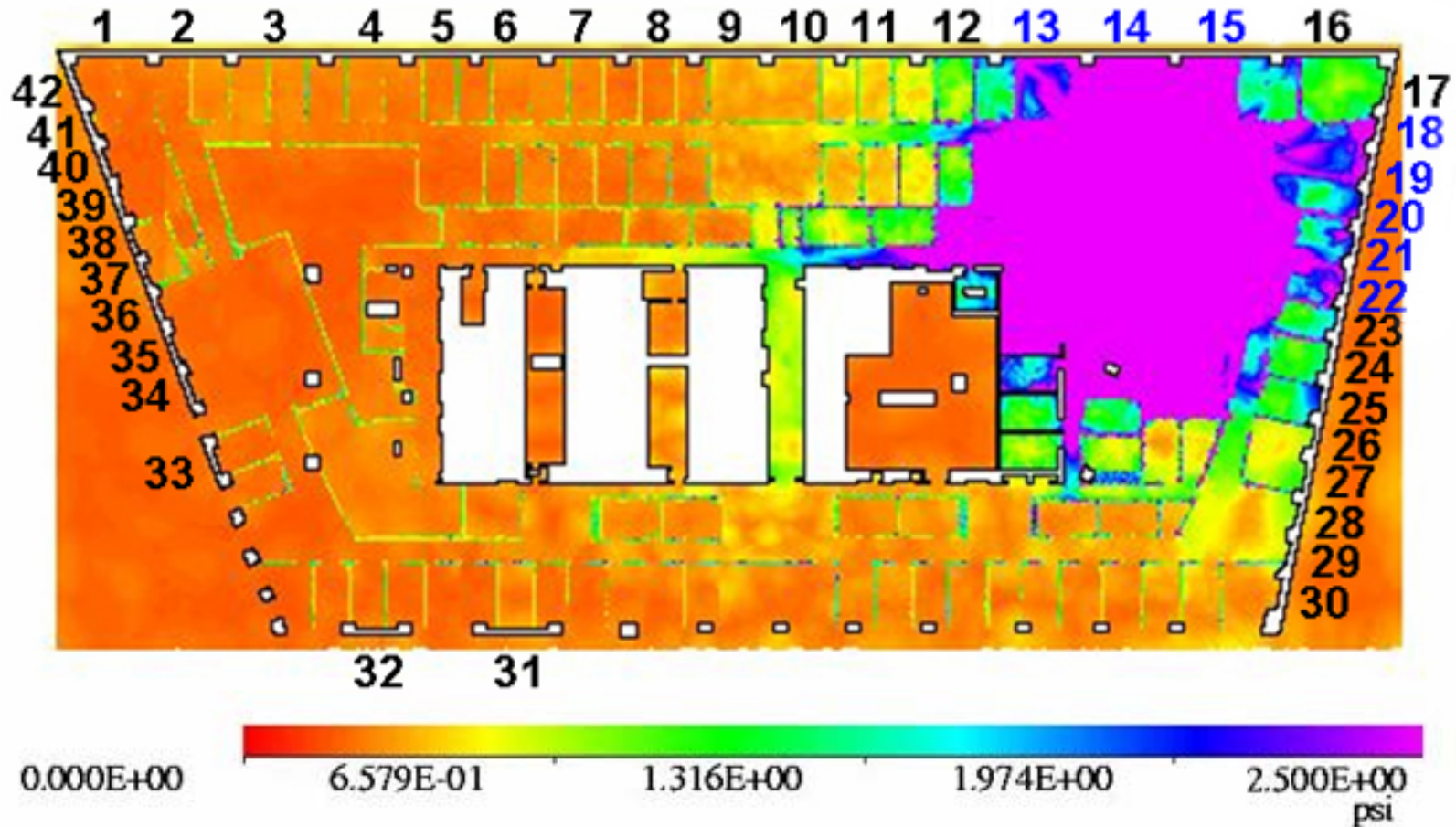
August 21, 2008

**Dr. S. Shyam Sunder
Director and Lead Investigator
Building and Fire Research Laboratory
National Institute of Standards and Technology
U.S. Department of Commerce**

World Trade Center 7 Location



Hypothetical Blast Simulations



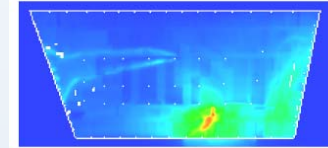
Peak over pressures for 9 lb shaped charge.

Fire Growth and Spread

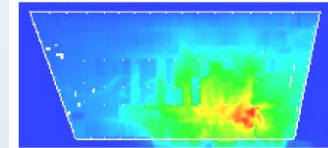


Progression of fires
on Floor 12

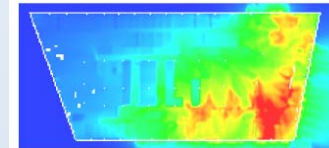
1:00 pm



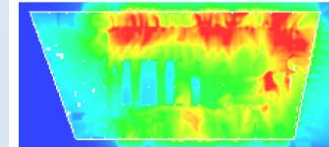
2:00 pm



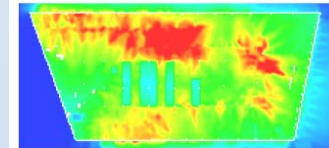
3:00 pm



4:00 pm



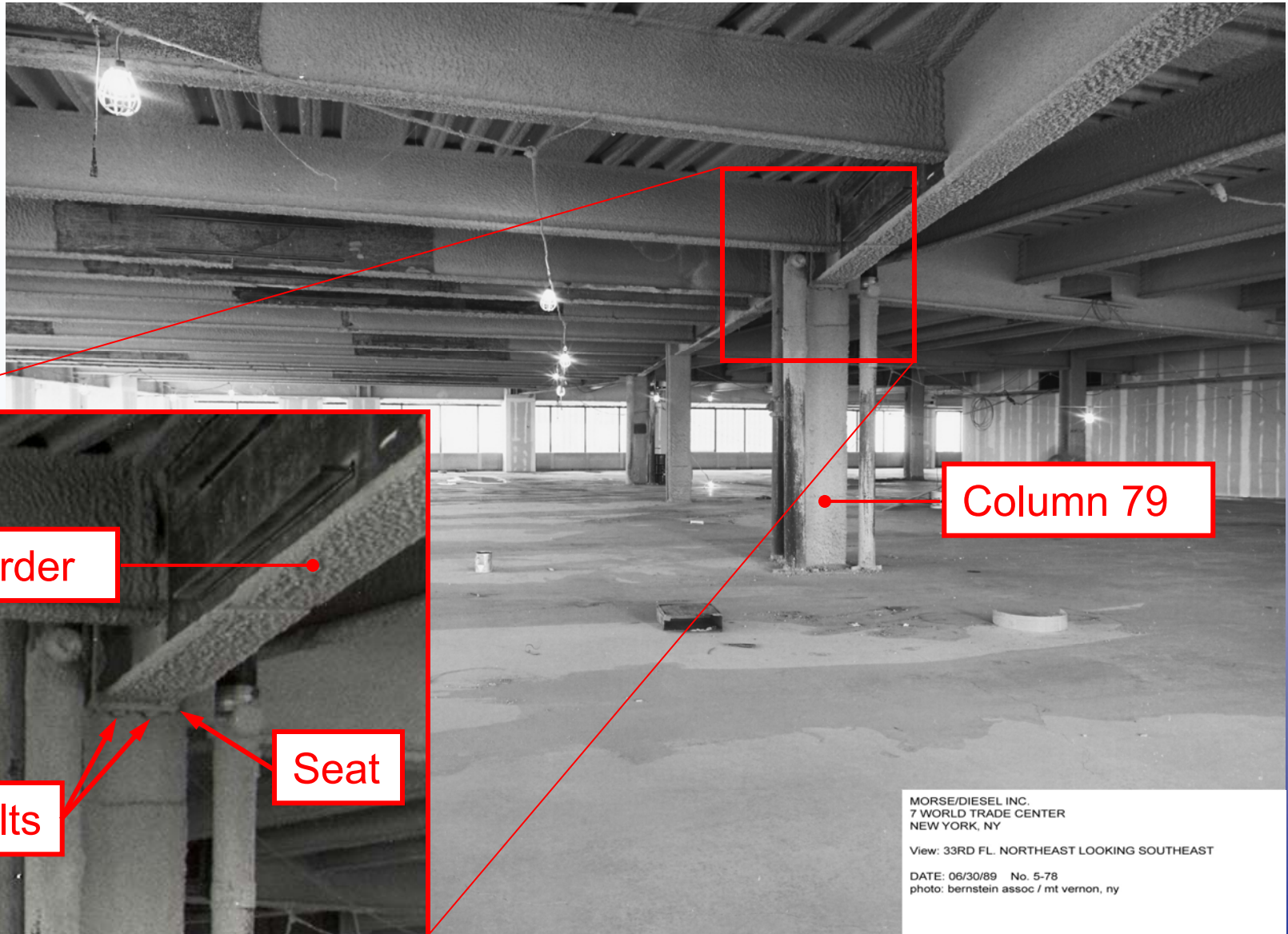
5:00 pm



Slice
temp
C



North East Floor System Near Column 79



Column 79

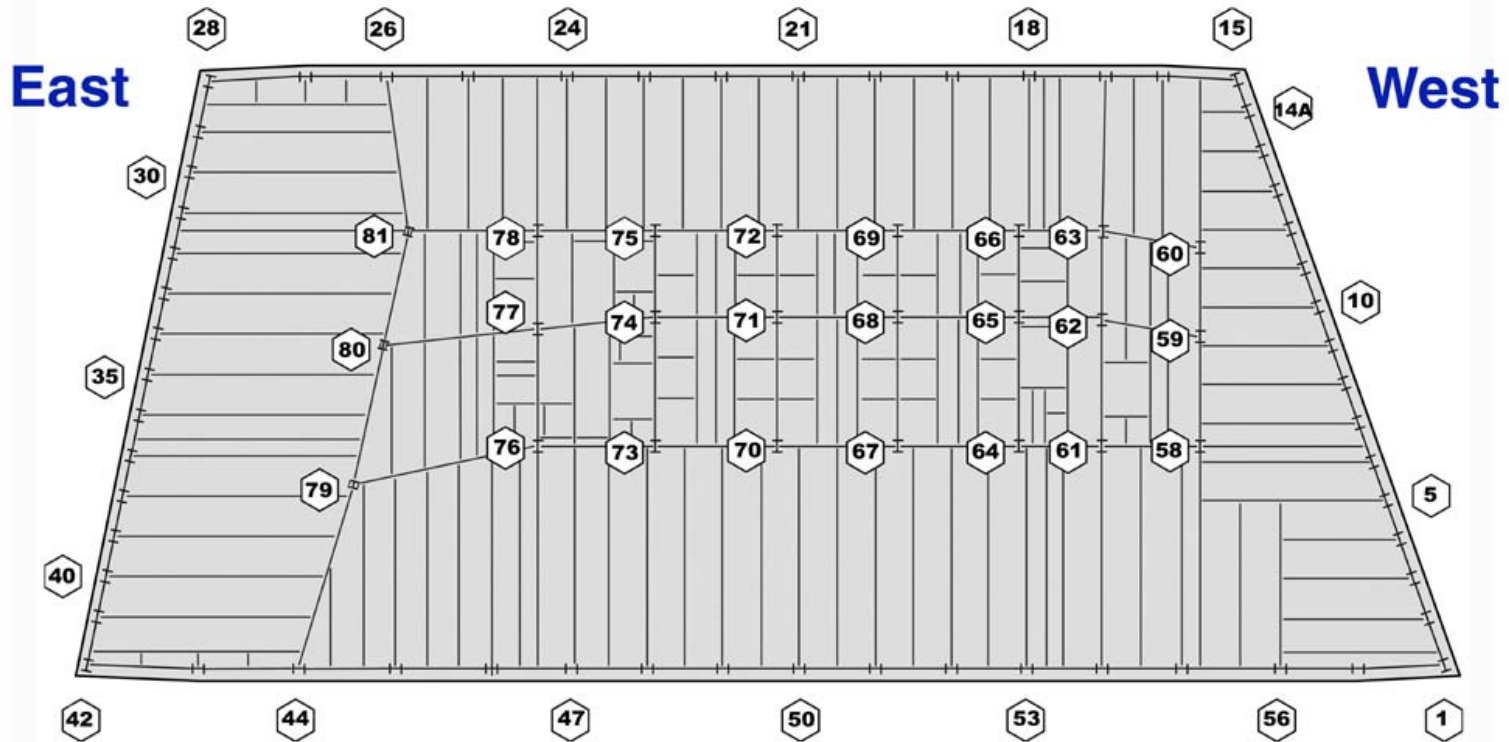
Girder

Bolts

Seat

MORSE/DIESEL INC.
7 WORLD TRADE CENTER
NEW YORK, NY
View: 33RD FL. NORTHEAST LOOKING SOUTHEAST
DATE: 06/30/89 No. 5-78
photo: bernstein assoc / mt vernon, ny

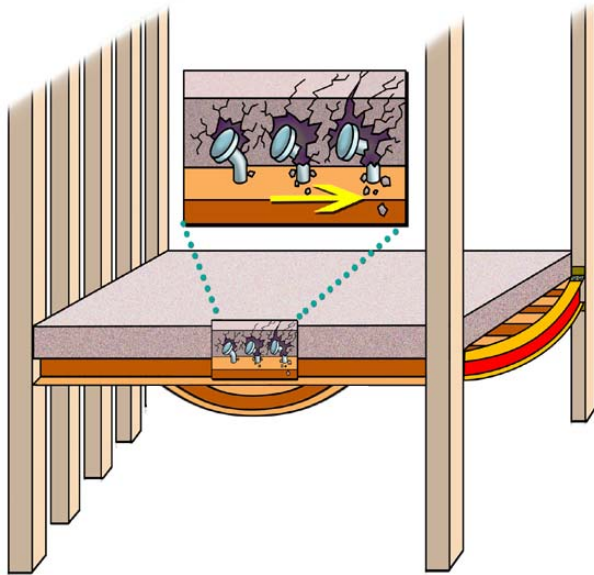
Typical Layout: Interior Columns, Floor Framing



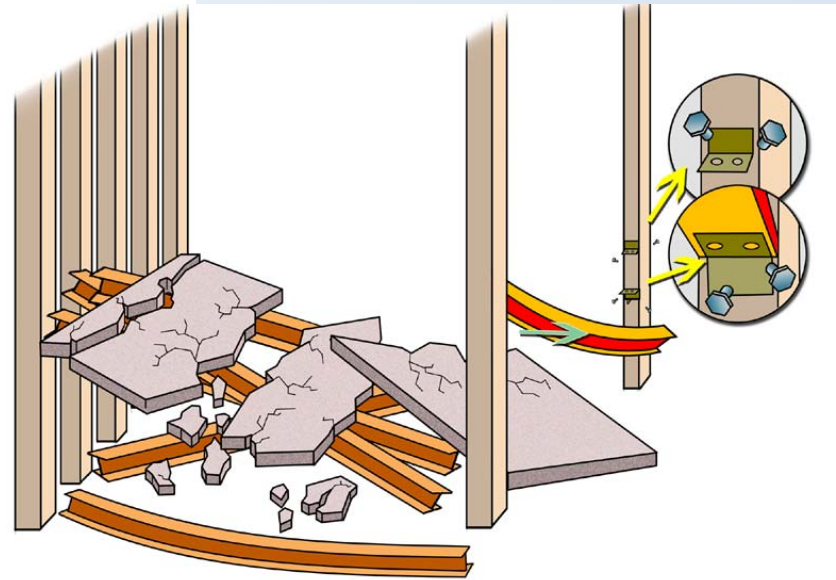
WTC 7 Typical Floor

Thermal Expansion Causes Floor Failures

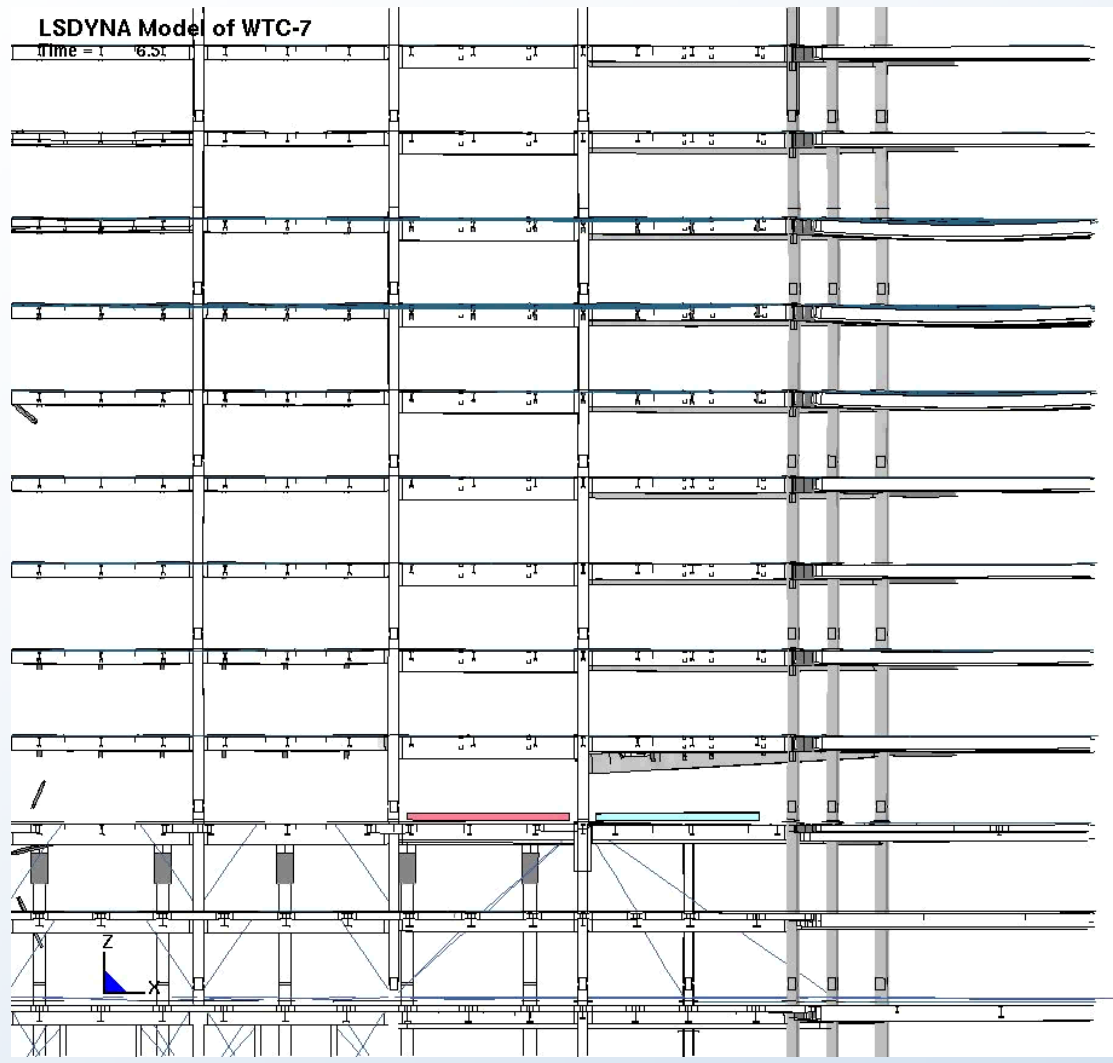
exterior
columns



interior
columns



Collapse Initiation– Physics-Based Model



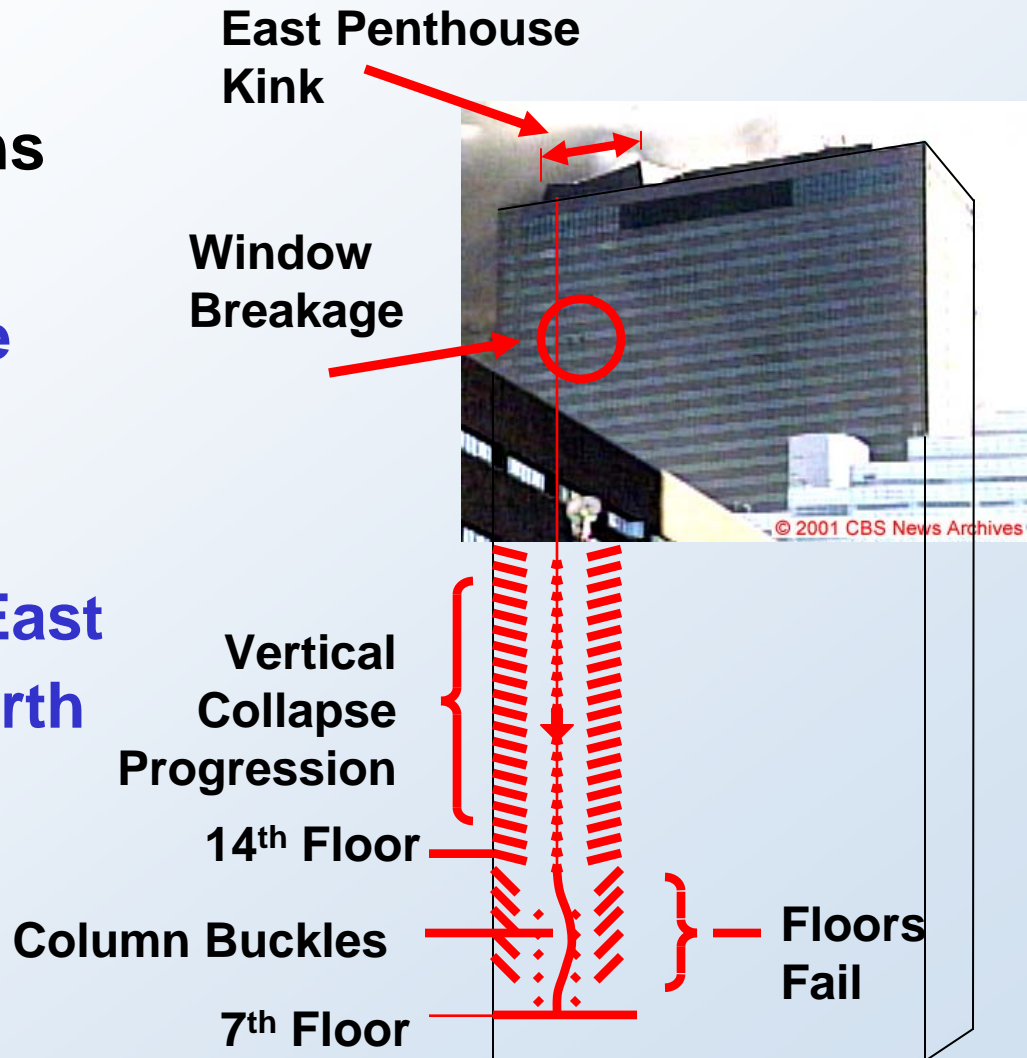
View from
South

Collapse Initiation Observations

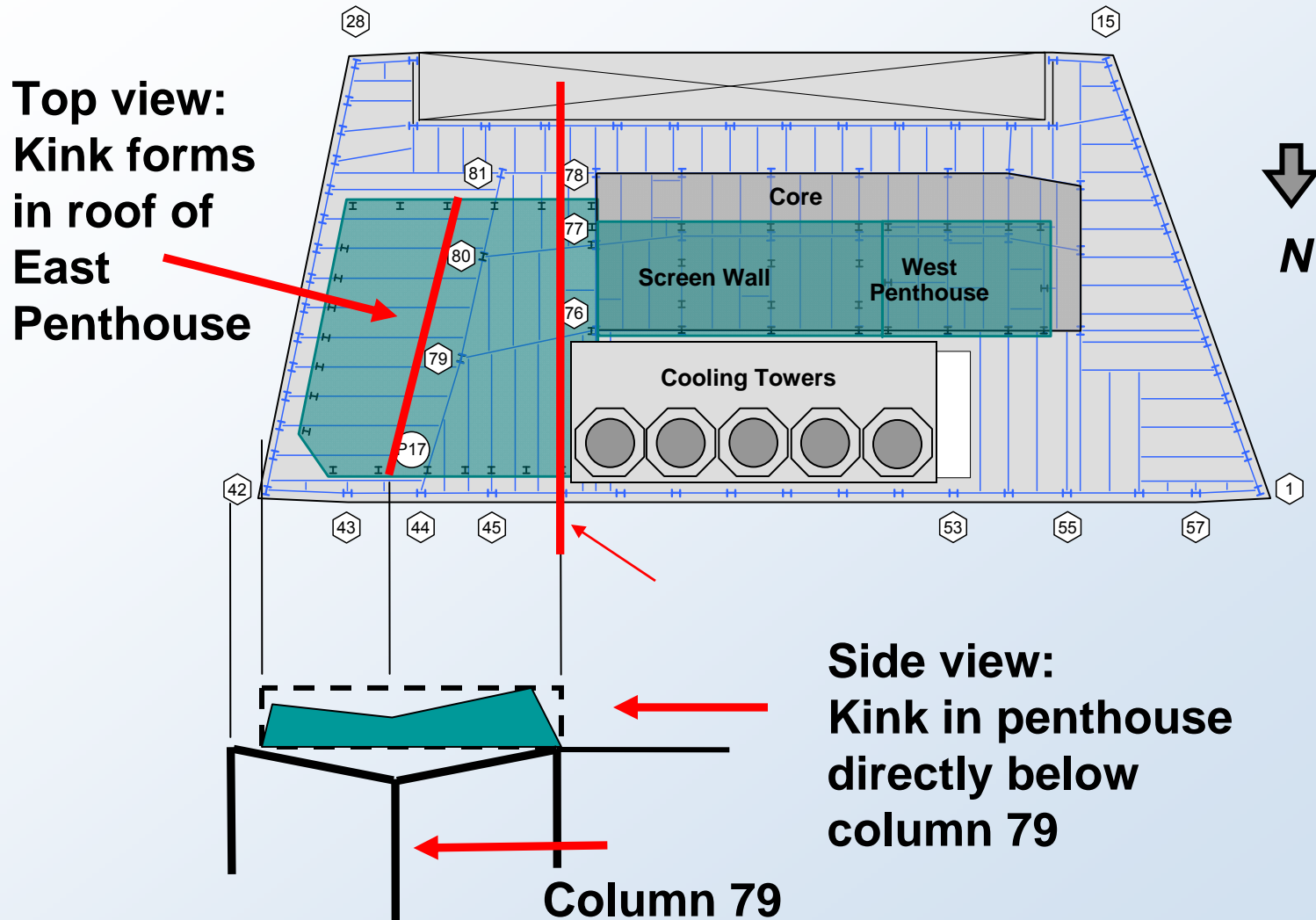
Exterior Observations

- East Penthouse Kinks

- Windows break on East Side of North Face



Penthouse Layout Overlaid on Floor Framing

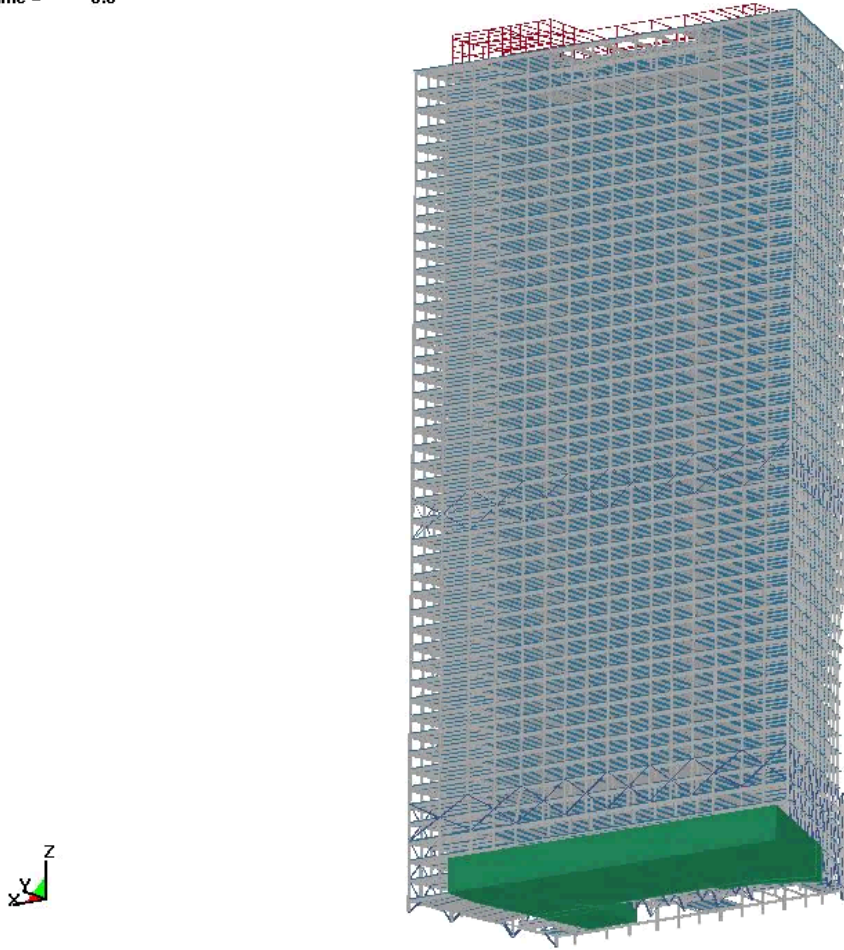


Comparison of Visualization and Video



Visualization Model of WTC Collapse

LSDYNA Model of WTC-7
Time = 8.5



© 2001 CBS News Archives



Key Recommendation

Building owners, operators and designers should evaluate fire performance of structural systems, especially

- **Long-span floor systems;**
- **Connections not designed for thermal effects**
- **Asymmetric floor framing**
- **Composite floor systems**

Possible Options for Developing Retrofits

If thermal effects concerns are identified in a building:

- **Strengthen connections**
- **Strengthen floor framing**
- **Increase structural redundancy**
- **Add additional fireproofing in vulnerable areas**

Take Away Messages

- **The reason for the collapse of World Trade Center 7 is no longer a mystery**
- **WTC 7 collapsed because of fires, fueled by office furnishings**
- **It did not collapse from explosives or from fuel oil fires**

Questions and Answers