THE 35TH ANNUAL
AGC NYS
INDUSTRY CONFERENCE

AGC NEW YORK STATE

How The Towers Fell – Part 2/3
WTC Twin Towers and Seven WTC Collapse from the 9-11 Attacks

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HNTB Corporation

Wednesday December 8, 2021, 12:45 PM Workshop
Saratoga Hilton Hotel
534 Broadway, Saratoga Springs, NY 12866

HNTB

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Agenda (Learning Points)

- Post WTC Bombing Safety and Security Improvements and Silverstein Properties Acquisition
- The 9-11 Attacks and Description of Damage
- Engineering Community and Public Agency Response to Attacks
- Findings of FEMA and NIST Reports and Silverstein's Insurance Case Defense
- Lessons Learned From the NIST Investigation
- Recovery and Site Cleanup Efforts
- Economic Impact on Lower Manhattan and Restoration of PATH Service

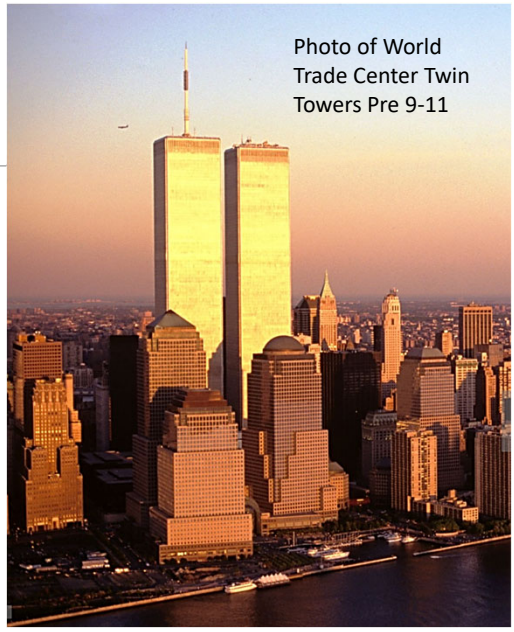

Photo of World Trade Center Twin Towers Pre 9-11

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Acknowledgements

1. This lecture is intentionally technical in nature to understand the engineering aspects of this monumental tragedy. To do that we must first acknowledge all of the lives that were tragically lost, including innocent people going about their daily business reporting to work or traveling by plane, the heroic first responders who sacrificed their lives to conduct a rapid evacuation of the site, the lower Manhattan residents whose lives and physical health were forever impacted and the construction workers, police, firefighters, and National Guard troops who occupied the hazardous damage zone during the long recovery effort.
2. In July 2001, Silverstein Properties, took over the WTC properties as operator in a lease-purchase agreement with the Port Authority reported to be $3.2 Billion.
3. The Port Authority of NY & NJ continued as the owner of the WTC land and operator of PATH system infrastructure.
4. Michael Burton, the Manager of Construction for the 9-11 WTC Site Clear Up and Recovery project received the 2002 ENR Award of Excellence in recognition of his efforts.

Note: The technical information and professional opinions presented represent the recollections of the author supported by information collected from published references and are provided in the interest of sharing this information with the audience to make a positive contribution to the public's understanding of events.

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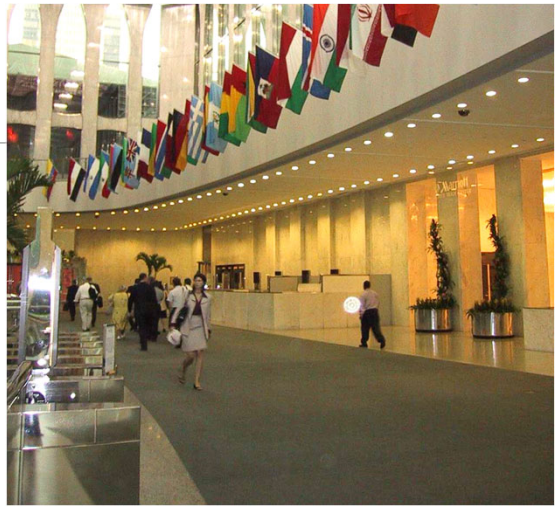
Post WTC Bombing Building Safety and Security Improvements

Building lobbies in the WTC Complex were renovated to add a security access control system. It included the following:

- Security guard staffing 24/7
- Visitor security screening desk
- Phone call to host tenant to confirm each individual visitor
- Photograph taken of each visitor and issuance of a temporary access pass
- Physical barriers with turnstiles activated by a valid employee or visitor pass for access to elevator



Visitor Security Desk at WTC Tower Lobby Shown at Right and Turnstile Barrier Shown at Left

Source: U.S. Fire Administration/Technical Report Series, The World Trade Center Bombing: Report and Analysis, New York City, New York, USFA-TR-076/February 1993

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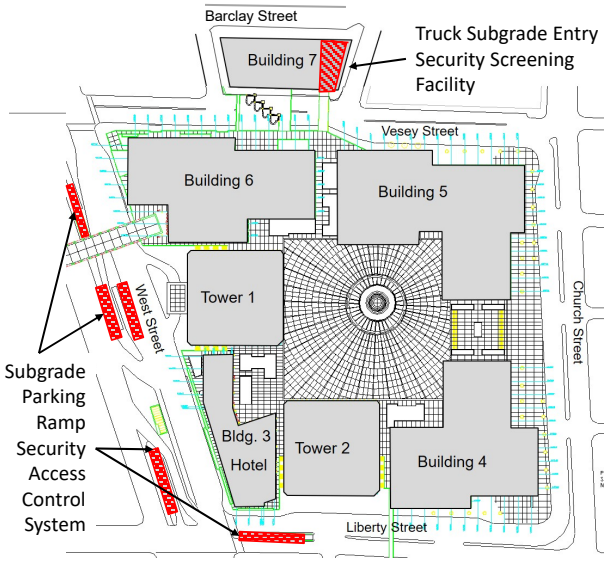
Post WTC Bombing Subgrade Safety and Security Improvements

A security access control system was added for all vehicles and persons who entered the subgrade levels of the entire WTC complex . It included the following:

- No visitor parking. Valet service inspects and park vehicles for Building 3 Hotel guests.
- Vehicle anti-ram barriers at parking ramps activated by tenant or employee magnetic cards
- Facility at Barclay St. for security screening post of all trucks entering subgrade by security guards
- Access control system for all doors to enter subgrade parking or subgrade back of house spaces for maintenance purposes
- Electronic monitoring of subgrade access control system
- Site-wide street furniture was used to block vehicle access to plaza.



Source: U.S. Fire Administration/Technical Report Series, The World Trade Center Bombing: Report and Analysis, New York City, New York, USFA-TR-076/February 1993

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Post WTC Bombing Tower Safety and Security Improvements

- **1,600 emergency battery-powered lighting units installed** in exit stairwells, elevator lobbies, and elevator cabs.
- **Secondary backup generators** made available in case primary and backup generators fail.
- A New Jersey **PSE&G utility feeder cable was routed through PATH tunnels to provide an additional backup** if New York electrical service is interrupted.
- **Phosphorescent signs installed in fire stairwells** to guide the way to floor entry doors.
- **Phosphorescent tape-paint applied to stair threads**, handrails, and the perimeters of doorways in the fire stairwells.
- **Vertical patrols instituted** (personnel responsible for checking obstructions, safety hazards, and systems throughout stairwells and corridors) were created.
- **Evacuation chairs** to assist mobility-restricted people made available.
- **Six satellite communications command & control stations**, staffed by deputy fire safety directors put into operation.
- **New addressable fire alarm systems** installed with the redundant command stations
- **Radiax cable and antenna installed** so that FDNY can use its radios in the towers.
- **Cellular phones issued** to each fire floor warden **as backup to the public address system**.
- **Battery backup system for the elevator car position indicator** to enable passengers to see which floor they're on if the express elevator gets stuck.
- **Battery power supply added in elevator cars to enable communication** with trapped elevator passengers.

Source: U.S. Fire Administration/Technical Report Series, The World Trade Center Bombing: Report and Analysis, New York City, New York, USFA-TR-076/February 1993

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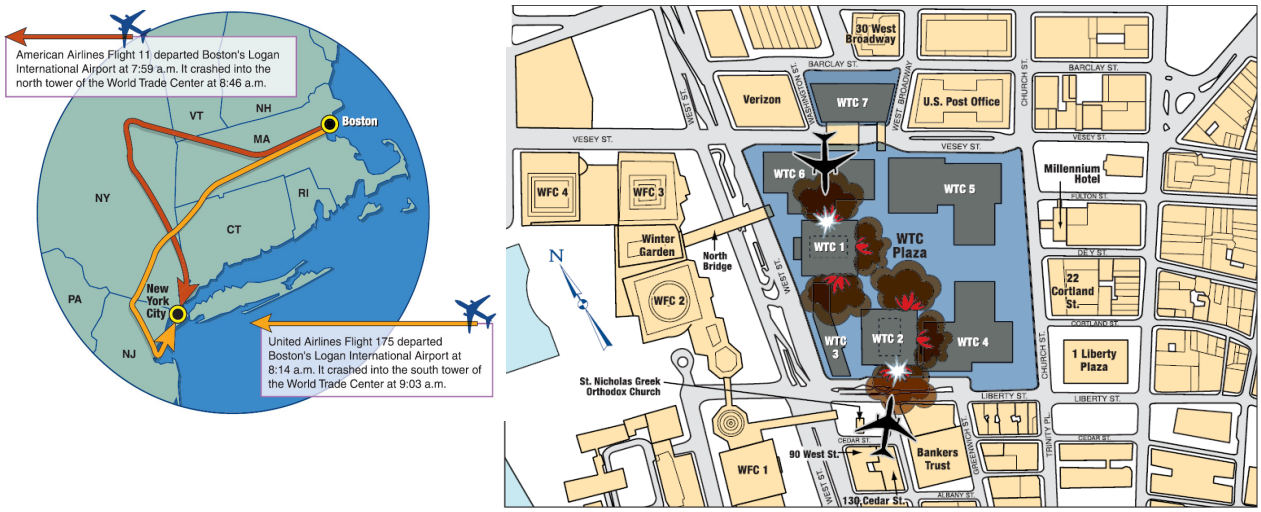
The 9-11 Attacks and Description of Damage



Approximate Path of Highjacked Plane Flights Shown at Left and Tower Impacts Shown at Right

Source: World Trade Center Building Performance Study: Data Collection, Preliminary Observations, and Recommendations, FEMA 403/ May 2002

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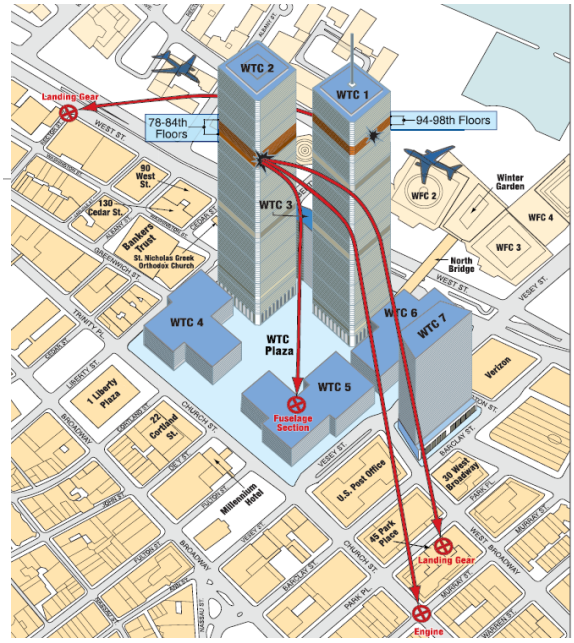
The 9-11 Attacks and Description of Damage and Timeline

- Both flights, destined for Los Angeles, were Boeing 767-200ER series aircraft loaded with fuel
- The estimated speed of impact:
  - North Tower: 410 knots (470 mph)
  - South Tower: 510 knots (590 mph)
- The floors with physical impact damage:
  - North Tower: 94th to 98th Floors
  - South Tower: 78th to 84th Floors
- The impact locations:
  - North Tower: Near center at slight tilt of wings
  - South Tower: Off center toward East at significant angle and tilt of wings
- The damage to far side of tower:
  - North Tower: Landing gear penetrated south face
  - South Tower: Landing gear, fuselage section and engine penetrated north face near east corner



Source: World Trade Center Building Performance Study: Data Collection, Preliminary Observations, and Recommendations, FEMA 403/ May 2002

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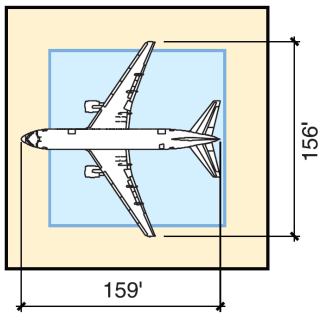
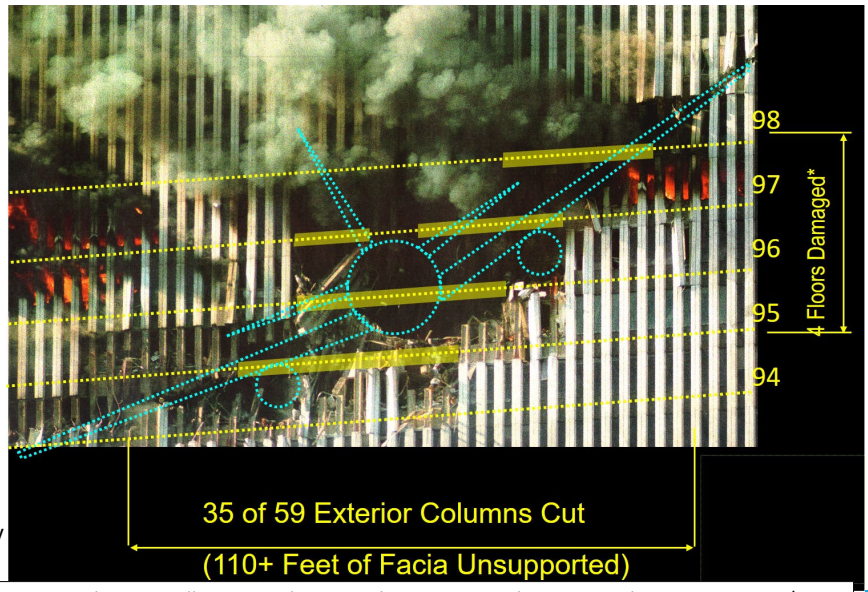
The 9-11 Attacks and Description of Damage

B767-200ER



- 395,000 lb. Maximum Takeoff Wt.
- 23,000 gal. Maximum Fuel Capacity
- 607 mph. Cruising Speed



Sources: World Trade Center Building Performance Study: Data Collection, Preliminary Observations, and Recommendations, FEMA 403/ May 2002 (Left) and NIST NCSTAR 1 Federal Building and Fire Safety Investigation of the World Trade Center Disaster (Photo right).

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The 9-11 Attacks and Description of Casualties

Loss of Life (All Numbers Approximate Estimates)
87 percent of the 17,400 occupants of the two towers, and 99 percent of those located below the impact floors, evacuated successfully.
1,355 people were trapped and perished in the upper floors of Tower 1 (all exist stairs were destroyed by impact).
Before the second aircraft struck Tower 2, 3,000 people in the building were able to evacuate.
The aircraft impact destroyed 3 of the 4 evacuation stairs in Tower 2 and 18 people above the impact evacuated. 619 people above the impact perished.
The buildings were only one-third to one-half occupied at the time of the attacks. If fully occupied at 40,000 (20,000/Tower), then 14,000 could have perished (egress limited by stair capacity).

Start Time[2]	Signal Duration	Magnitude (Richter Scale)	Event
8:46:26 EDT (12:46 UTC)	12 seconds	0.9	WTC 1 (the north tower) was hit by American Airlines Flight 11, a hijacked 767-200ER commercial jet airliner.
9:02:54 EDT (13:02 UTC)	6 seconds	0.7	WTC 2 (the south tower) was hit by United Airlines Flight 175, also a hijacked 767-200ER jet.
9:59:04 EDT (13:59 UTC)	10 seconds	2.1	WTC 2 began collapsing after 56 minutes, 10 seconds. Large debris from the collapse fell on WTC 3 and WTC 4, 130 Cedar Street, 90 West Street, and Bankers Trust. WTC 3 suffered a partial collapse. Fire was initiated in WTC 4 and 90 West Street.
10:28:31 EDT (14:28 UTC)	8 seconds	2.3	WTC 1 began collapsing after 102 minutes, 5 seconds. Large debris from the collapse fell on WTC 3, 5, 6, and 7; the Winter Garden; and the American Express (World Financial Center 2) building. WTC 3 collapsed to the 3rd floor, and fires were initiated in WTC 5, 6, and 7.
17:20:33 EDT (21:20 UTC)	18 seconds	0.6	WTC 7 began collapsing.

Sources: WTC BPS FEMA 403 (Right) and NIST NCSTAR 1 Federal Building and Fire Safety Investigation of the WTC Disaster (Left).

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The 9-11 Attacks and Description of Damage – Tower 2 Collapses



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World Trade Center Building Performance Study (BPS): Data Collection, Preliminary Observations, and Recommendations, FEMA 403/ May 2002

- The study was sponsored by the Federal Emergency Management Agency (FEMA) and the Structural Engineering Institute of the American Society of Civil Engineers (SEI/ASCE).
- Well known members of ASCE who were experts in the structural design of buildings offered their time on a volunteer basis.
- Members of SEAoNY also provided on site engineers to assist first responders in searching the site for survivors by advising on the stability of damaged infrastructure.
- In conducting the study, the BPS Team received tremendous cooperation from the State of New York, the New York City Department of Design and Construction (DDC), the New York City Office of Emergency Management (OEM), the Port Authority of New York and New Jersey (hereafter referred to as the Port Authority), the National Institute of Standards and Technology (NIST), and the Structural Engineers Association of New York (SEAoNY).
- In addition, after the attacks many engineers from around the country and the whole world including those in esteemed engineering academic institutions offered theories to explain how and why the towers collapsed.

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Purpose of the NIST Investigation Report of WTC 9-11 Attack (To Be Discussed in More Depth in Part 3 of Presentation)

The goals of the investigation of the WTC disaster by NIST were:

1. Investigate the building construction, the materials used, and the technical conditions that contributed to the outcome of the WTC disaster.
2. Serve as the basis for:
   - Improvements in the way buildings are designed, constructed, maintained, and used;
   - Improved tools and guidance for industry and safety officials;
   - Recommended revisions to current codes, standards, and practices; and
   - Improved public safety.

Specific objectives were:

1. Determine why and how WTC 1 and WTC 2 collapsed and why and how WTC 7 collapsed;
2. Determine correlation between injury and fatality levels and their location, including all technical aspects of fire protection, occupant behavior, evacuation, and emergency response;
3. Determine procedures and practices were used in the design, construction, operation, and maintenance of WTC 1, 2, and 7; and
4. Identify, as specifically as possible, areas in current building and fire codes, standards, and practices that warrant revision.

Note: Similar to the way that the NTSB investigates every significant transportation accident to explain the cause, the damage and the casualties, NIST investigates every significant building collapse due to weather events, seismic events, or other causes. In both cases these reports lead to recommendations for safety improvements.

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Silverstein Properties: 9-11 Attacks Were Two Separate Attacks

- Prior to the 9-11 attack on the WTC there was pressure on the Port Authority to divest itself of owning and operating the WTC real estate complex because it did not align with the transportation Mission of the Agency.
- As a result, the Authority advertised the competitive opportunity for a real estate developer to lease the commercial real estate properties in the WTC complex.
- In July 2001, Silverstein who owned and operated 7 WTC, and several minority investors won the contract for a 99-year lease on the Twin Towers for $3.2 billion (including debt).
- Just six weeks later, on 9-11, the buildings were destroyed by terrorists. Silverstein Properties lost four employees in the attacks, and 7 World Trade Center crumbled in the post attack collapse as well, although the building was safely evacuated before it did.
- Silverstein Properties claimed that the 9-11 attacks were two separate attacks each covered by his insurance and the insurance companies involved went to court to contest it.

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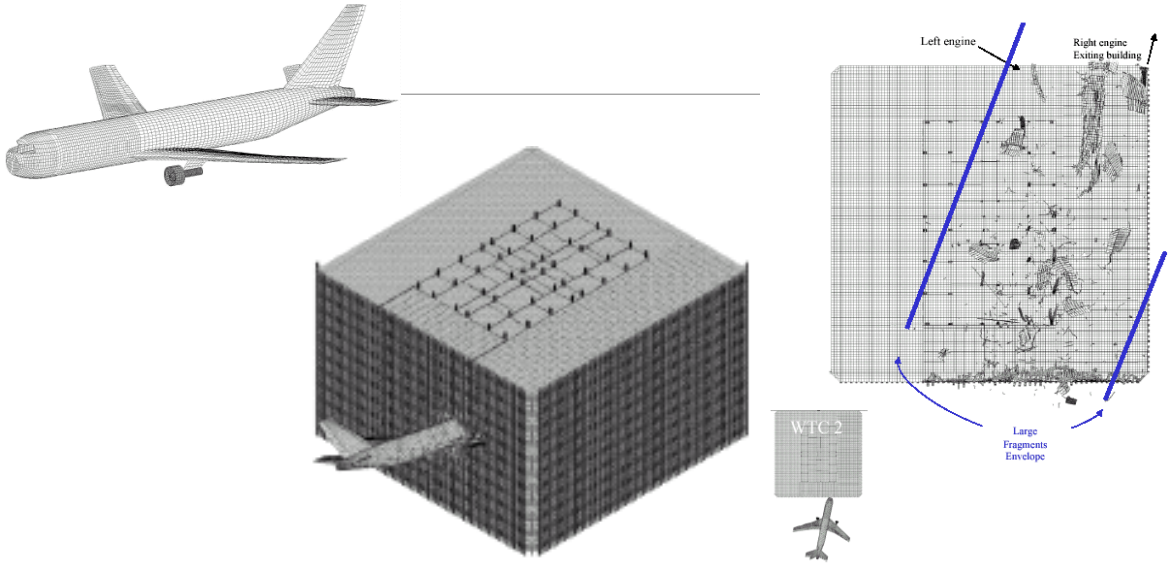
Dynamic 3D Computer Simulation of Tower 2 Collapse



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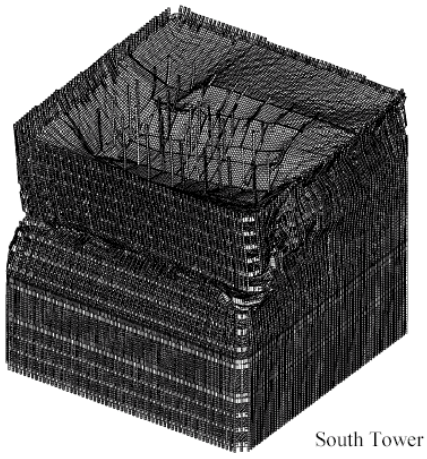
Dynamic 3D Computer Simulation of Tower 2 Collapse

- A dynamic computer simulation completely independent from the FEMA and NIST investigations also supported the conclusion that a combination of structural impact and severe fires led to the collapse of the Twin Towers.



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Independent Observations on the Conditions Leading to Collapse of Twin Towers

- The two aircraft hit the towers at high speed and did considerable damage to principal structural components (core columns, floors, and perimeter columns) that were directly impacted.
- The structural system redistributed loads from places of aircraft impact, avoiding larger scale damage upon impact.
- The robustness of the perimeter frame-tube system and the large size of the buildings helped the towers withstand the impact.
- Within the towers there was dislodged insulation (fireproofing) and multi-floor fires continuing to burn.
- The hat truss, a feature atop each tower prevented earlier collapse of the building core.
- In each tower, a different combination of impact damage and heat-weakened structural components contributed to the abrupt structural collapse.

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Difference Between WTC Fire and "Design" Fire for Buildings

- Crash Impact
- Fire Ball
- Jet Fuel

Physically Damaged Critical Structural Members and Destroyed Fireproofing, Sprinkler System, Fire Stopping and Compartments to Limit Fire Spread

Spread Fire Over Large Area and Jet Fuel Pool Fires Exposed Steel Members to Higher Temperatures than UL Fire Tests for Building Systems

Not Part of UL Fire Test for Building Systems

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Assessment of Learning 1 of 3

1. Name three security improvements made to the World Trade Center complex after the 1993 Bombings:
   1. Visitor parking in the subgrade parking garage was eliminated
   2. All visitors to the office buildings go through a security check
   3. Several redundant power and communication systems were added
   4. An access control system for the WTC complex subgrade was installed
2. Name an organization that was involved in the FEMA Building Performance Study Report:
   - State of New York (NYS)
   - New York City Department of Design and Construction (DDC)
   - New York City Office of Emergency Management (NYC OEM)
   - Port Authority of New York and New Jersey (PANYNJ)
   - National Institute of Standards and Technology (NIST)
   - Structural Engineers Association of New York (SEAoNY).

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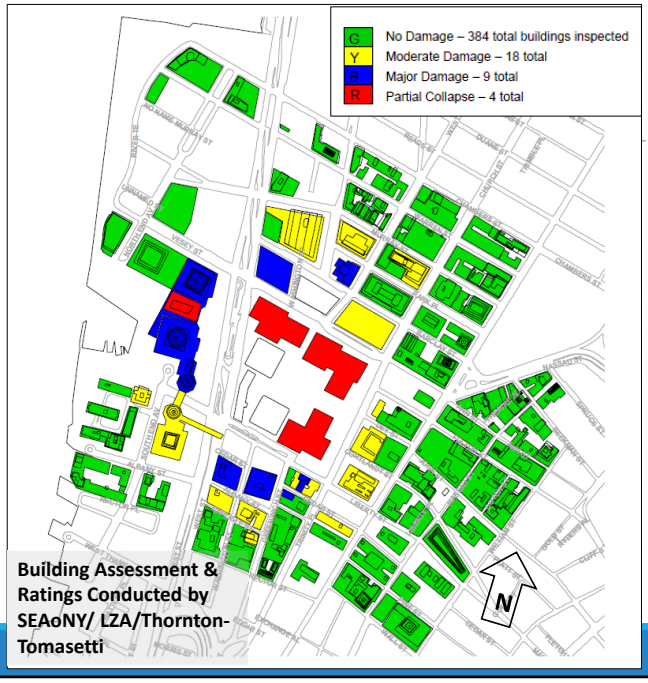
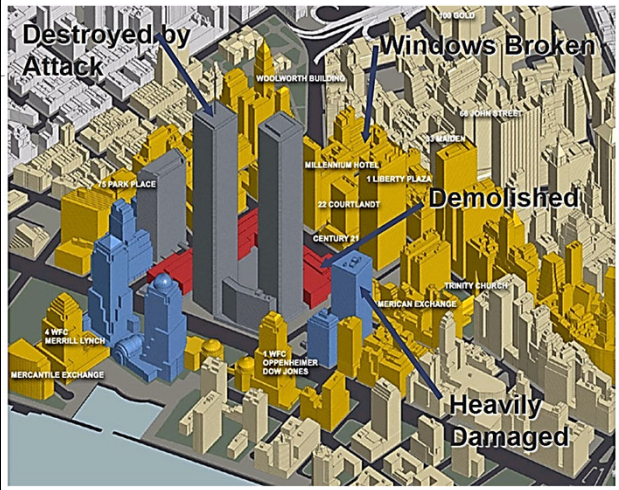
NYC DDC/DoB Cooperative Building Damage Assessment 9-22-2001



Building Assessment & Ratings Conducted by SEAoNY/ LZA/Thornton-Tomasetti

Level of Building Damage in Lower Manhattan
NYC DDC



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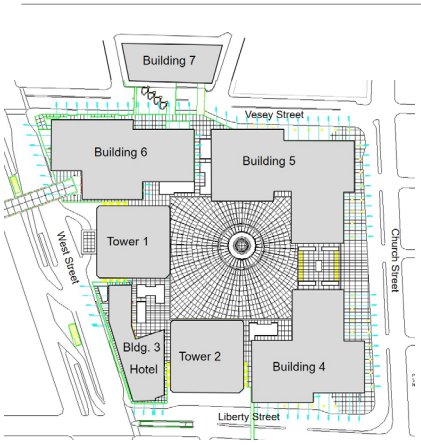
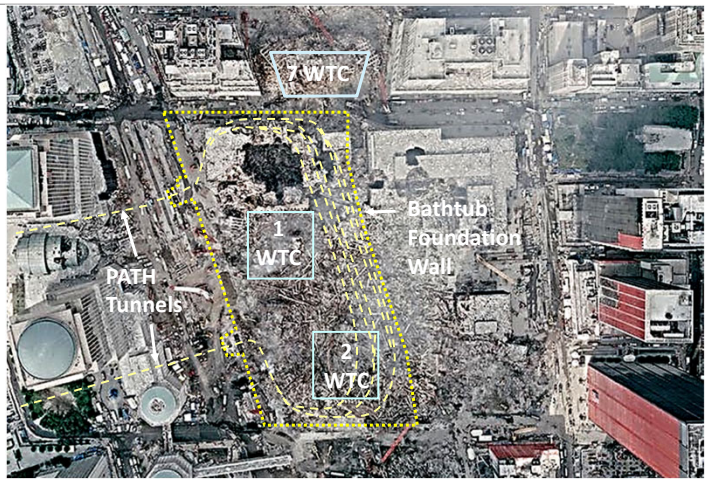
WTC Site Physical Damage





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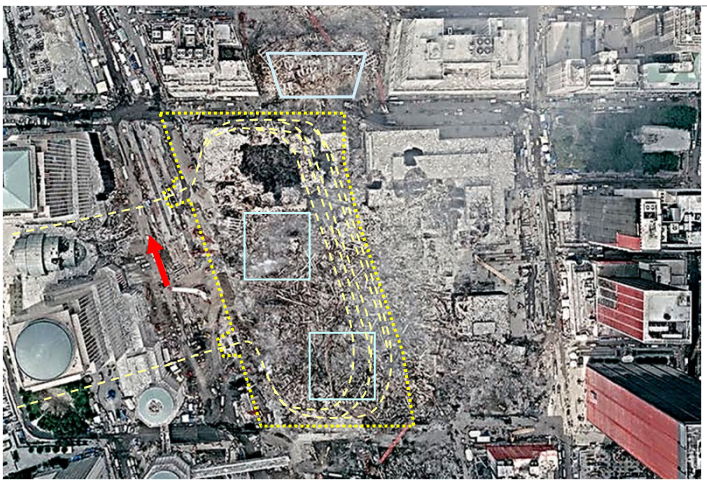
Debris and Collapsed Pedestrian Bridge Looking North on West St.



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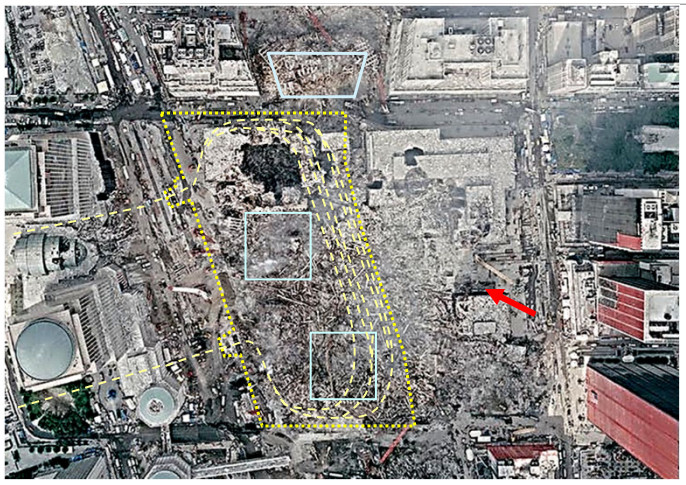
Plaza Collapsed Looking West With Fountain And Remains of Tower 1 Beyond



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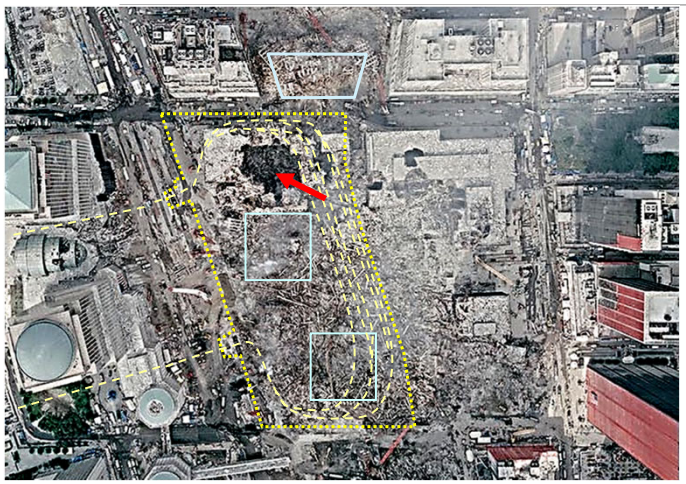
Aerial View of Collapsed Center of Bldg. 6 (U.S. Customs House/Commodity Exchange)



Core of Damaged Building

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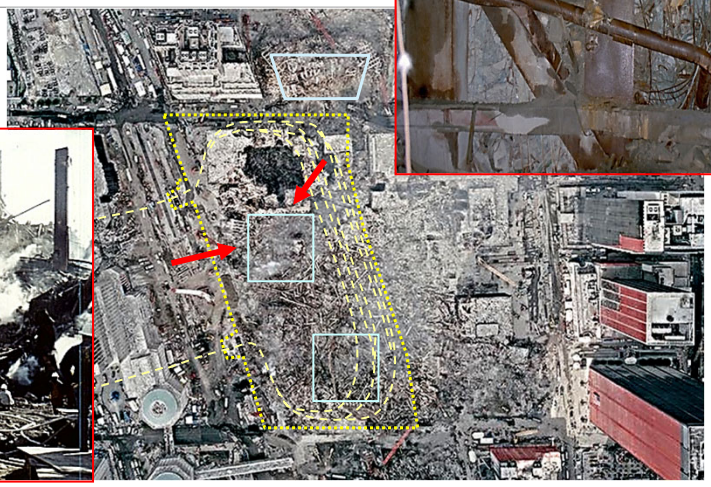
Tower 1 Interior Viewed From PATH Tracks

Remains Of Tower 1 Looking From West St.



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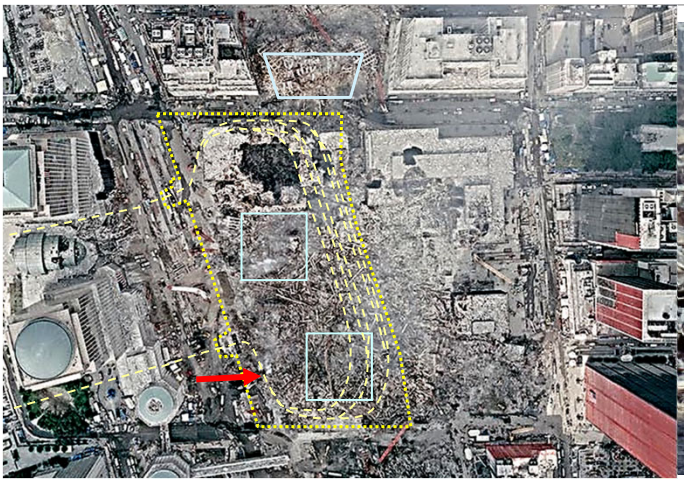
Marriott Hotel (Building 3) West St. Entrance



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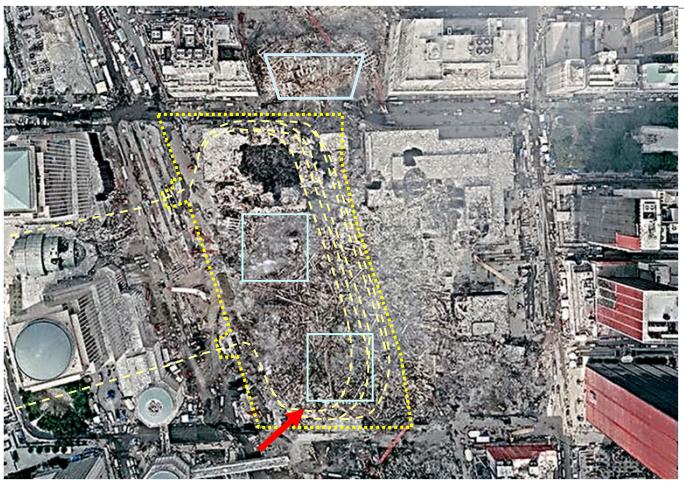
Remains Of Tower 2 Facade Columns Viewed From Liberty St. At Corner Of West St.



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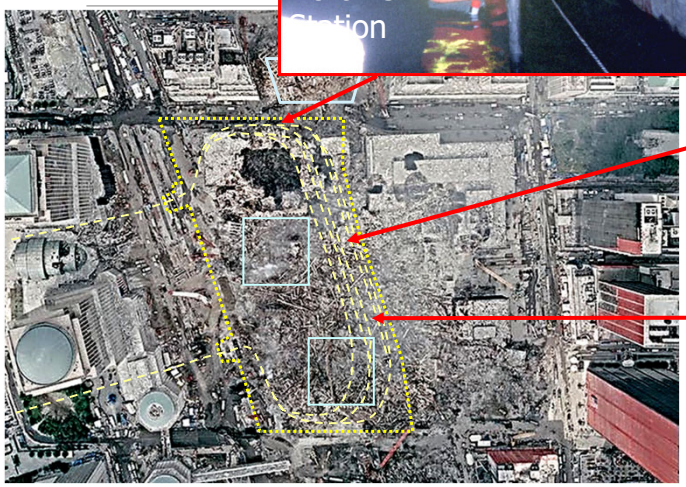
PATH WTC Station: Platform And Track Level



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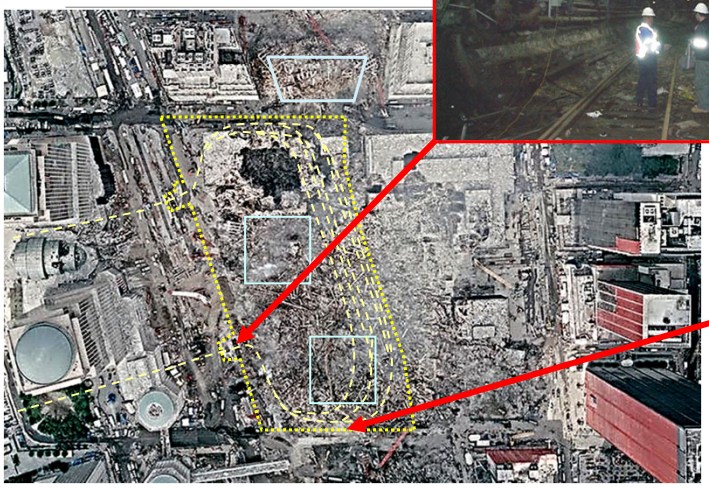
Inside WTC Bathtub at PATH Tunnel Portal



Bathtub Slurry Wall Exposed and Unstable

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Fire and Collapse of 7 WTC: (7 WTC was hit by heavy debris from the Tower 1 Collapse and Caught Fire)

7 WTC Survived Collapse of Both Towers

7 WTC Burned for Over 6 Hours and Collapsed Vertically in a Heap

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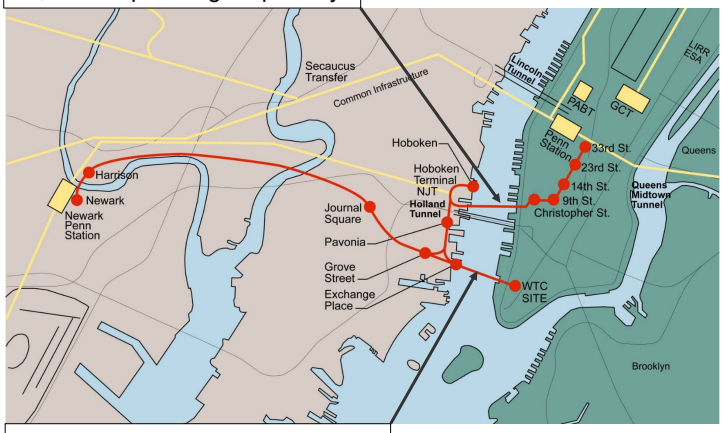
Economic Impact on Lower Manhattan from 9-11 Attacks

Pre-9/11 Midtown Service –
50,000 RT passengers per day



Pre-9/11 Downtown Service –
67,000 RT passengers per day

9-11 Attack and Loss of WTC:

- 85,00 jobs lost – 28,000 relocated
  - 57,000 secondary impact

Impact Due To Loss of PATH to WTC Alone:

- Carried 67,000 commuters each day
- 103 firms, 1.1 million SF office space, and 11,700 jobs relocated from lower Manhattan to NJ

Disaster Recovery PATH Alone:

- 2 years to restore service
- Over $500 million program cost
- 2004 Ridership: 39,000 average per day

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WTC Site Debris Removal and Restoration of PATH Service

NYC DDC Estimate – Structures Damaged in 9-11 Attack

Recovery of Remains and Debris Removal

Site Square Footage Area of Office Space Affected = 16,668,500 SF

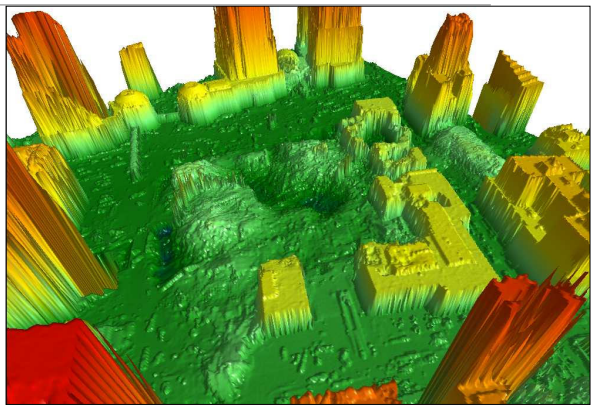
Equivalent to the total SF of office space available in the cities of Dallas, Cincinnati or Atlanta.

Concrete	=	379,000 Tons - 36%
Steel	=	241,000 Tons - 24%
Miscellaneous	=	420,000 Tons - 40%
Total	=	1,040,000 Tons

Total Debris Estimated to be Removed = 1,500,000 Tons

(Approximately 250,000 Tons of imported material –stabilize walls and build ramps)

Topographic Computer Image Of Debris
(Looking West)



Note: Everything removed from the site was transported to Fresh Kills Landfill in Staten Island for Further Examination
Everything removed was observed and tracked and inspected by FBI because it contained evidence for prosecutors

Source: R Santowski, NYC Department of Design and Construction

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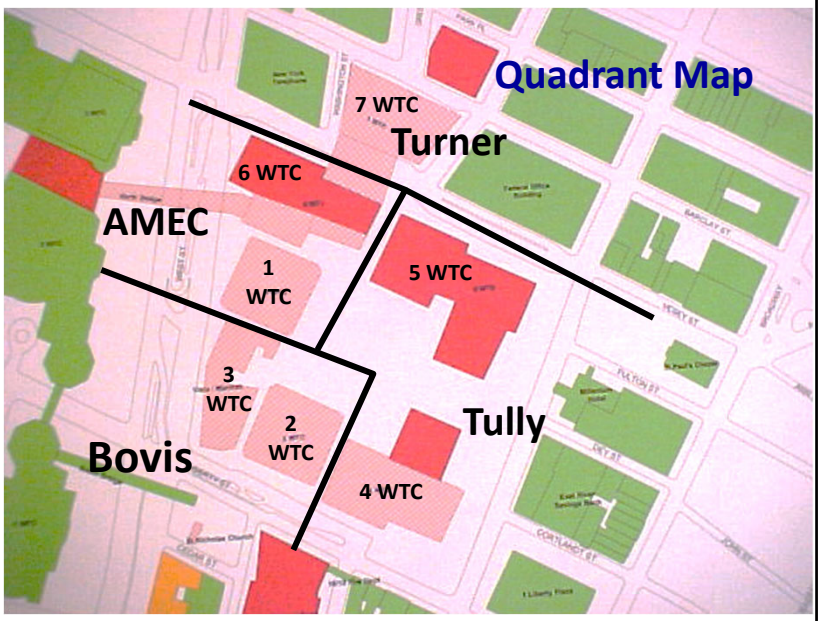
Construction Management and Contracting at Site

Michael Burton PM for NYC DDC
Peter Rinaldi PM for PANYNJ

- FEMA Funding with USACOE Oversight and Construction Support
- Utilized the Stafford Act
- Started with Time and Materials Basis: 72-hour waiver
- Activities Continuing as T&M payments:
  - Recovery of Bodies
  - Fire Control
  - Site Utility Work
- Lump Sum Payment Activities:
  - Trucking and Barging
  - Installation of Slurry Wall Tiebacks
  - Building Demolition
  - Construction Ramp for Bathtub Access

Source: R. Santowski, NYC Department of Design and Construction



Four Heavy Construction Contractors Who Were Already Working in the Immediate Vicinity Were Engaged and the Site Was Divided Up

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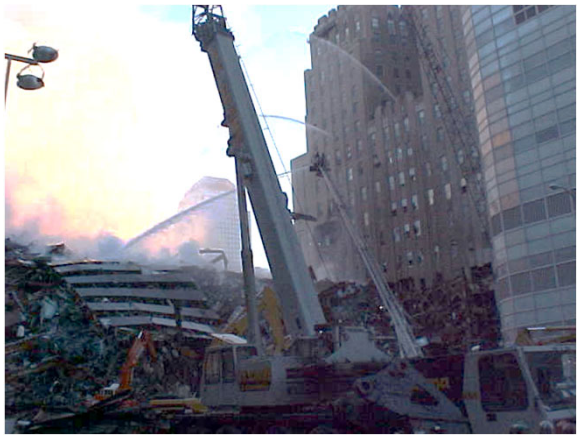
WTC Site Debris Removal and Restoration of PATH Service



September 15, 2001 (Day four): World Trade Center Building 7 (lower left) still burning.

Source: R. Santowski, NYC Department of Design and Construction

September 16, 2001 (Day 5): Dredging south of Pier 25, near bulkhead, for preparation of transfer site for debris removal to Fresh Kills Landfill, Staten Island, NYC.

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WTC Site Debris Removal and Restoration of PATH Service

Sept 17, 2001 (Day 6): Rescue teams search in voids for victims among debris from Tower 1.

Source: R. Santowski, NYC Department of Design and Construction

Sept 20, 2001 (Day 9) : Grillage was placed to support 310-ton crane, placed above concourse level, between Bldgs. 4 & 5. Northeast Plaza Building (Bldg. 5) in background.

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WTC Site Debris Removal and Restoration of PATH Service

Sept 26, 2001 (Day 15): Tower 1 still burning. Sub-basement 6 flooded. Temperature at sub-basement 5 measured at 1.200 degrees F. Sub-basements 4, 3, 2, & 1 collapsed. Site is changing from recovery to a demolition project.

Sept 26, 2001 (Day 15): Demolition of Southeast Plaza (Bldg. 4) begins.

Source: R. Santowski, NYC Department of Design and Construction

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Damaged Fire Trucks and EMS Trucks From Ground Zero Taken to Fresh Kills Landfill in Staten Island and Number of First Responders Who Perished

Total number of people who perished in attacks in New York: **2,753**
Number of firefighters and paramedics: **343**
Number of NYPD officers: **23**
Number of Port Authority police officers: **37**
Number of other Port Authority civilians: **47**

Sources: Statistics: NY Magazine, Updated September 2014. 2 Photos from Professor Jonathan Barnett, WPI

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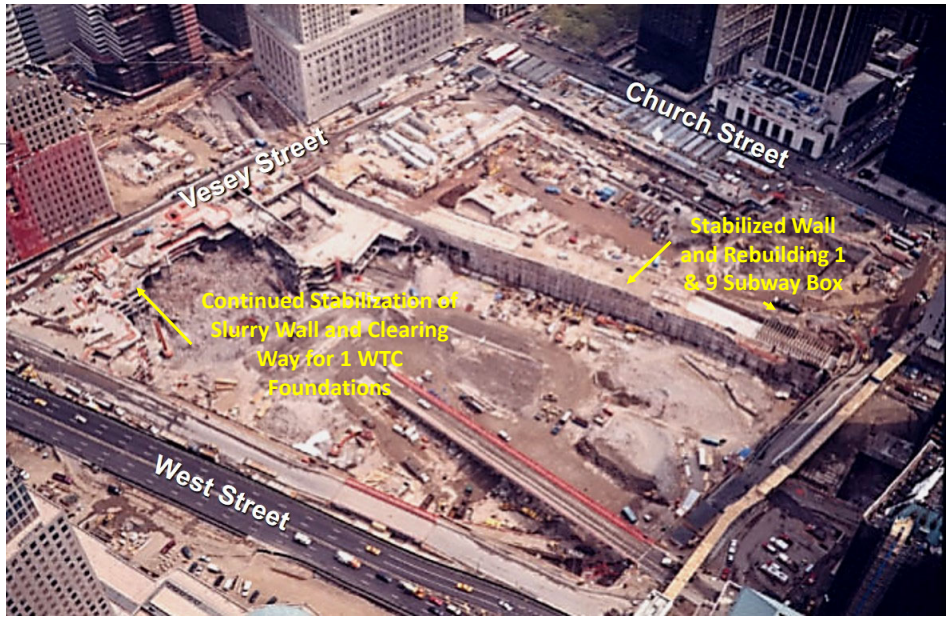
WTC Site Cleanup Nearing Completion



Source: Port Authority of NY & NJ

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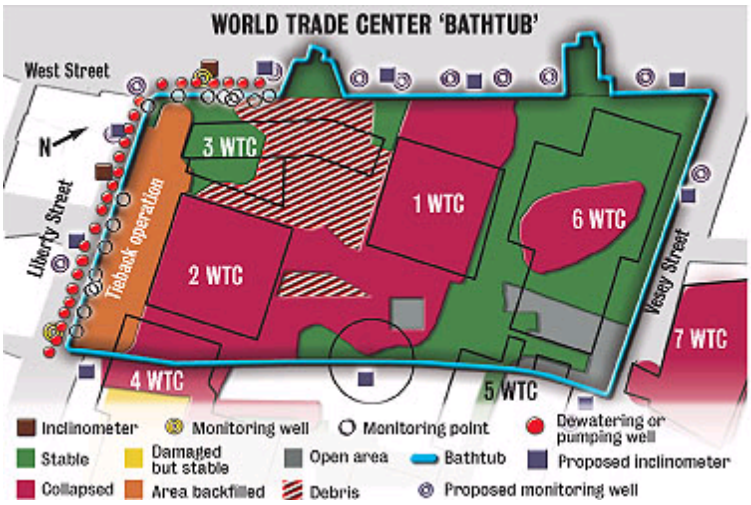
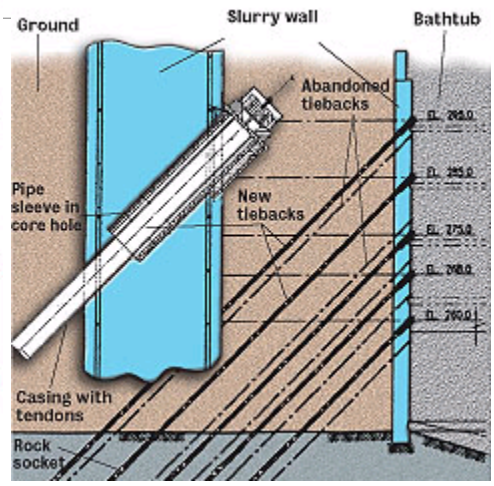
Monitoring and Stabilization of Slurry Wall Tie-Backs Coordinated with Removal of Debris





Source: Port Authority of NY & NJ

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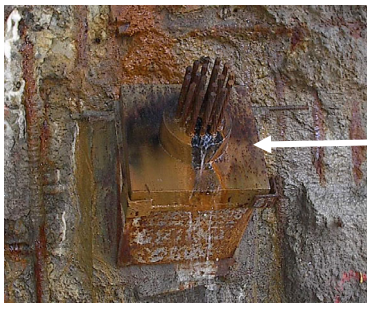
Installation of Bathtub Slurry Wall Tie Back System

- Strand anchors, with corrosion protection
- Strand bundles are set in a hole drilled into bedrock (~30 ft)
- Bundles have grout hose attached to them
- Cement grout tremied from the bottom of bundle to top of the casing
- After grout set (2 to 3 days) the tendons were tensioned



Source: Port Authority of NY & NJ

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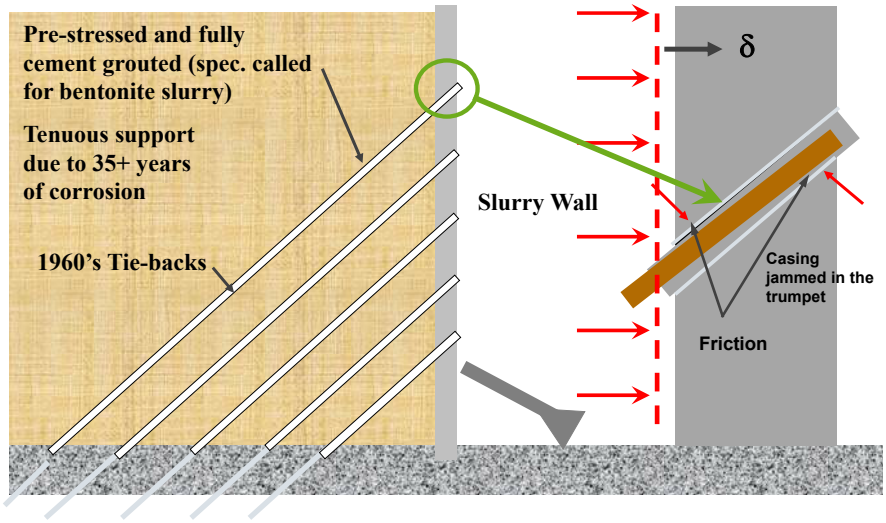
Why the WTC Walls Stood after 9/11

Ray Sandiford's Explanation of Why The Old Anchors Held: Dumb Luck, Insubordination and Friction



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Restoration of PATH Service

Phase I

- Removal of PATH Tunnel Plugs at Exchange Place
- PATH Tunnels E & F Restoration
- Exchange Place Improvements
- Construction of Temporary PATH Terminal at WTC

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PATH Downtown Restoration Program

"Phase 1" Projects:

- Temporary Terminal
- Tunnel E & F Restoration
- Removal of Tunnel plugs
- Exchange Place Improvements

Source: Port Authority of NY & NJ

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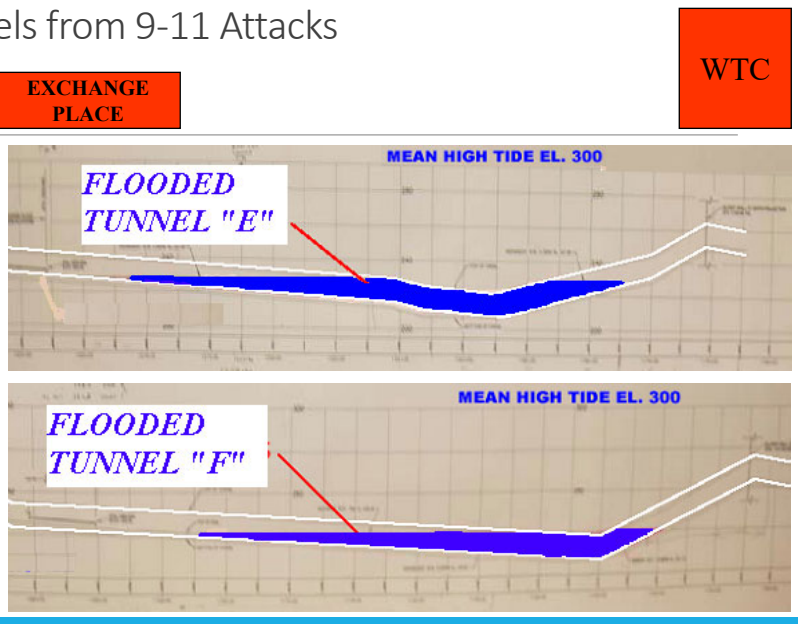
Flooding of PATH Tunnels from 9-11 Attacks

- PATH Tunnels E & F began to flood after the 9-11 Attack due to heavy water flows from WTC fire hoses
- Water flow was reaching the Exchange Place Station tracks and was being pumped and discharged up to street level to control water level
- Tunnel plugs were installed to mitigate flooding of the entire PATH System if the unstable WTC Bathtub slurry wall ever collapsed



Source: Port Authority of NY & NJ

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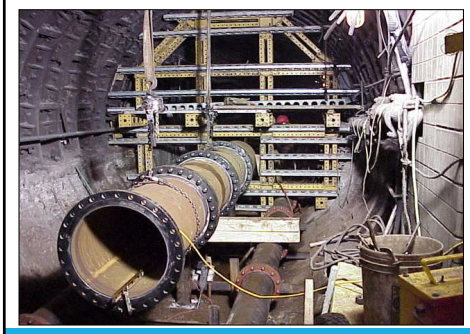
Removal of Tunnel Plugs at Exchange Place after WTC Slurry Wall was Stabilized

Right: Sandbags Installed when inflow of water at PATH Exchange Place Station track level began to exceed the pumping capacity



Left: Placement of formwork for a concrete plug with sealable person access door (large pipe with bolted flange cover). Right: completed plug.

Source: Port Authority of NY & NJ

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PATH Tunnel Conditions After 9/11 Flooding

Deteriorated Duct Bank Cables at Splice Chamber

Contaminated Track Ballast after Flooding

PATH Tunnel Rehabilitation and Renewal Construction After 9/11

Photos Clockwise Starting Above:

1. Deteriorated electrical duct banks were removed, new ducts installed, and concrete formed
2. Deteriorated track bed removed and new concrete duct banks cast
3. Installation of direct fixation concrete track bed and rails.

Source: Port Authority of NY & NJ

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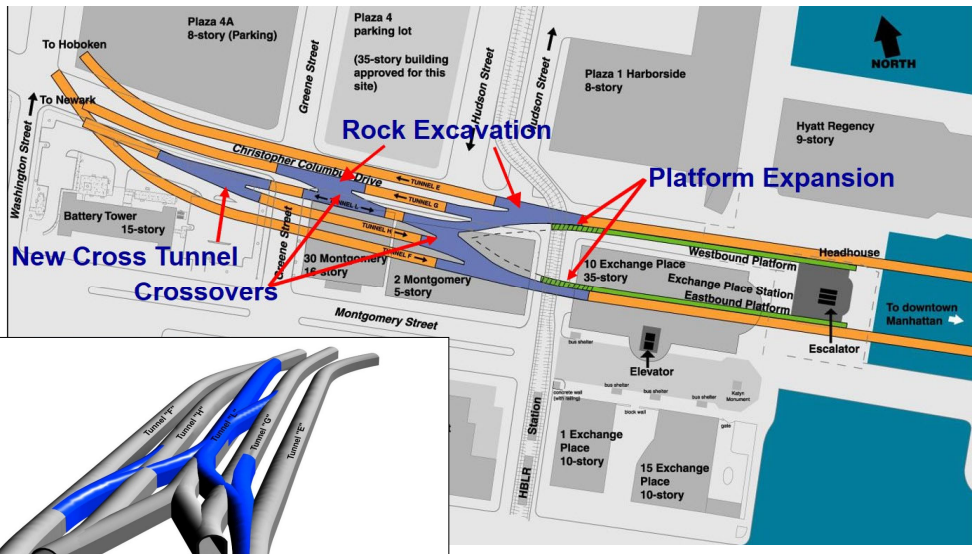
Exchange Place Improvements

- These improvements allowed PATH service to be restored to Exchange Place prior to completion of the WTC Temporary PATH Station.
- This allowed the station to reopen 6 months before the PATH service was restored to the WTC.
- It also extended the platforms to accommodate 10 car train service from JSTC to WTC.



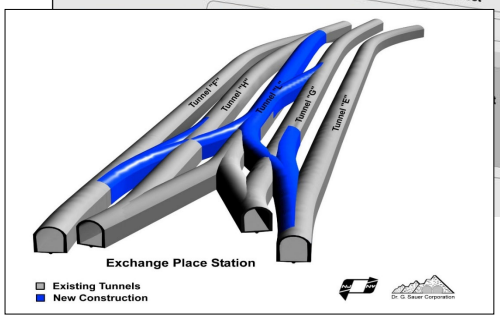


Diagram Left: Blue tunnels were excavated into rock 80 feet below street level and enabled Exchange Place to operate as a "terminal station".

Source: Port Authority of NY & NJ

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PATH Rock Tunnel Mining and Tunnel Liner Construction at Exchange Place Station

Above: Installing Rock Anchors In Newly Mined Tunnel Cross-section

Right: Roadheader Rock Excavator Used for Rock Tunneling

Right: Tunnel Mined in Mica Schist Rock

Right: Installation of Lattice Support Girders with Shotcrete

Source: Port Authority of NY & NJ

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Temporary PATH Station – Steel Erection

Source: Port Authority of NY & NJ

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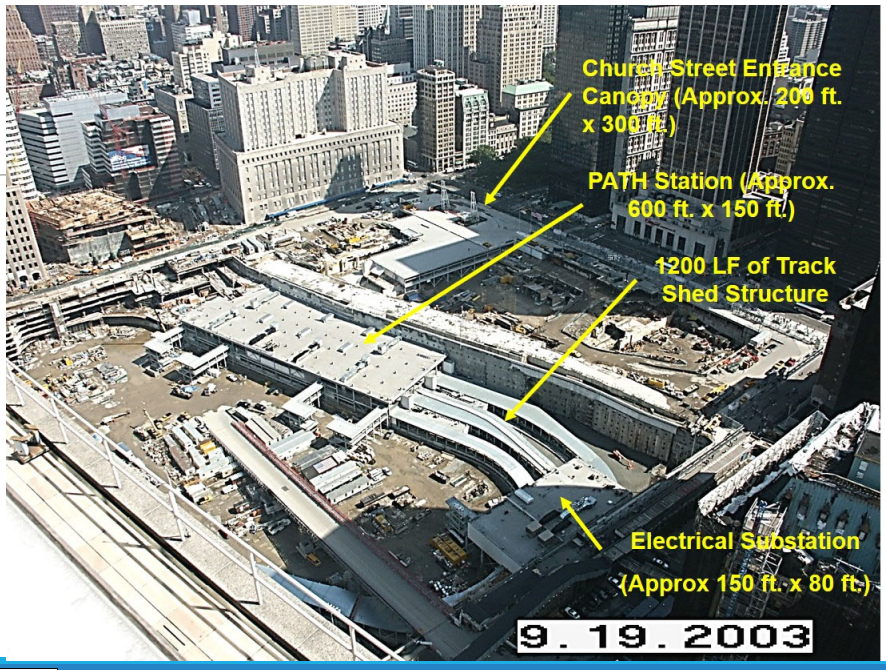
Temporary WTC PATH Terminal



Source: Port Authority of NY & NJ

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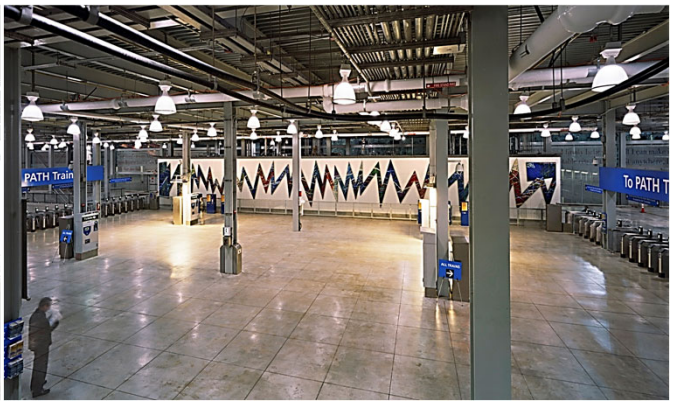
Temporary WTC PATH Station:

Platform/Track Level

Fare Zone/ Mezzanine Level



Source: Port Authority of NY & NJ

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Temporary PATH Station Church Street Entrance Canopy

Source: Port Authority of NY & NJ

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Local E & A Firms Involved in the Downtown Recovery Effort

- Overall Coordination and E&A Design – PANYNJ Engineering Department
- Golder Associates
- Dr. Alfred Hendron
- Dr. Sauer Corporation
- Gannett Fleming Engineers and Architects
- Louis Berger Group, Inc
- William Nicholas Bodova and Associates
- Severud Associates Consulting Engineers
- Leslie E. Robertson Associates
- Parsons Transportation Group
- Domingo Gonzales
- Parsons Brinckerfhoff Quade and Douglass (PBQD)
- HNTB Corporation
- The RBA Group
- The Ives Group
- Pentagram
- Kinetic Media, Inc
- GraphicSense, LLC
- John Bartelstone Photography
- Voorsanger and Associates Architects, PC

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Assessment of Learning 2 of 2

1. Where were the 1.5 Million Tons of Debris from the WTC site taken for examination after removal:
    1. The Fresh Kills land fill in Staten Island.
2. What event eventually led to the collapse of 7 WTC, when did it collapse from the event (Immediately, shortly after, or more than 6 hours later), and what physically caused the collapse?
    1. The event that led to the collapse of 7 WTC was flying debris from the collapse of WTC Tower 1.
    2. It collapsed more than 6 hours later.
    3. It collapsed from a fire.

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How The Towers Fell – Part 2/3
Twin Towers and Seven WTC Collapse from the 9-11 Attacks

Questions?

HNTB

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