

WTC - THE TWIN TOWERS

1. Basic information:

The World Trade Center- The twin towers

Height: 1,368 and 1,362 feet (417 and 415 meters)

Owner: Port Authority of New York and New Jersey

Architect: Minoru Yamasaki, Emery Roth and Sons consulting

Engineer: John Skilling

Ground Breaking: August 5, 1966

Opened: 1970-73; April 4, 1973 ribbon cutting

2. History and the structure

The Twin Towers were born of the space age. During their construction, man walked on the moon, and supersonic travel became reality. In 15 short years, Space Shuttle flights became the norm and the computer revolution was re-defining how the world does business. When the Twin Towers were built, we aimed high and took to the sky and beyond. Today, in the Twenty-First Century we are faced with a decision. We can continue to fly high by rebuilding the Twin Towers, or we can conform to views who don't believe as we do.

The World Trade Center was more than its signature twin towers: it was a complex of seven buildings on 16-acres, constructed and operated by the Port Authority of New York and New Jersey (PANYNJ). The towers, One and Two World Trade Center, rose at the heart of the complex, each climbing more than 100 feet higher than the silver mast of the Empire State Building.

Construction of a world trade facility had been under consideration since the end of WWII. In the late 1950s the Port Authority took interest in the project and in 1962 fixed its site on the west side of Lower Manhattan on a superblock bounded by Vesey, Liberty, Church and West Streets. Architect Minoru Yamasaki was selected to design the project; architects Emery Roth & Sons handled production work, and, at the request of Yamasaki, the firm of Worthington, Skilling, Helle and Jackson served as engineers.

The Port Authority envisioned a project with a total of 10 million square feet of office space. To achieve this, Yamasaki considered more than a hundred different building configurations before settling on the concept of twin towers and three lower-rise structures. Designed to be very tall to maximize the area of the plaza, the towers were initially to rise to only 80-90 stories. Only later was it decided to construct them as the world's tallest buildings, following a suggestion said to have originated with the Port Authority's public relations staff.

Yamasaki and engineers John Skilling and Les Robertson worked closely, and the relationship between the towers' design and structure was clear. Faced with the difficulties of building to unprecedented heights, the engineers employed an innovative structural model: a rigid "hollow tube" of closely spaced steel columns with floor trusses extended across to a central core. The columns, finished with a

silver-colored aluminum alloy, were 18 3/4" wide and set only 22" apart, making the towers appear from afar to have no windows at all.

- ALSO unique to the engineering design were its core and elevator system. The twin towers were the first supertall buildings designed without any masonry.
- THE ENGINEERS were worried that the intense air pressure created by the buildings' high speed elevators might buckle conventional shafts, so they designed a solution using a drywall system fixed to the reinforced steel core.
- FOR THE ELEVATORS, to serve 110 stories with a traditional configuration would have required half the area of the lower stories be used for shaftways.
- OTIS ELEVATORS developed an express and local system, whereby passengers would change at "sky lobbies" on the 44th and 78th floors.
- THIS WAY, they halved the number of shaftways.

- CONSTRUCTION began in 1966 and cost an estimated \$1.5 billion. World Trade Center was ready for its first tenants in late 1970, though the upper stories were not completed until 1972. World Trade Center was finished in 1973.
- EXCAVATION TO BEDROCK 70 feet below produced the material for the Battery Park City landfill project in the Hudson River.
- WHEN COMPLETE, the Center met with mixed reviews, but at 1,368 and 1,362 feet and 110 stories each, the twin towers were the world's tallest and largest buildings until in 1974 the Sears Tower surpassed them both.

3. Why did it collapse

The structural integrity of the World Trade Center depends on the closely spaced columns around the perimeter. Lightweight steel trusses span between the central elevator core and the perimeter columns on each floor. These trusses support the concrete slab of each floor and tie the perimeter columns to the core, preventing the columns from buckling outwards.

After the initial plane impacts, it appeared to most observers that the structure had been severely damaged, but not necessarily fatally.

It appears likely that the impact of the plane crash destroyed a significant number of perimeter columns on several floors of the building, severely weakening the entire system. Initially this was not enough to cause collapse.

However, as fire raged in the upper floors, the heat would have been gradually affecting the behavior of the remaining material. As the planes had only recently taken off, the fire would have been initially fuelled by large volumes of jet fuel, creating potentially enormously high temperatures. The strength of the steel drops markedly with prolonged exposure to fire, while the elastic modulus of the steel reduces (stiffness drops), increasing deflections.

Modern structures are designed to resist fire for a specific length of time. Safety features such as fire retarding materials and sprinkler systems help to contain fires, help extinguish flames, or prevent steel from being exposed to excessively high

temperatures. This gives occupants time to escape and allow fire fighters to extinguish blazes, before the building is catastrophically damaged.

One of the possible theories for the demolition is that the blaze, which was started by jet fuel, generated fire conditions significantly more severe than those anticipated in a typical office fire. These conditions may have overcome the building's fire defenses considerably faster than expected.

Eventually, the loss of strength and stiffness of the materials resulting from the fire, would have caused a failure of the truss system supporting a floor. Subsequently the perimeter columns would be allowed to buckle outwards. That would have resulted in the complete collapse of at least one complete story at the level of impact.

Once one story collapsed, all floors above would have begun to fall. The huge mass of falling structure would gain momentum, crushing the structurally intact floors below, resulting in catastrophic failure of the entire structure. The gigantic impact forces caused by the huge mass of the falling structure landing on the floors below traveled down the columns like a shockwave faster than the entire structure fell.

The only evidence so far are photographs and television footage. The extent to which the internal parts were damaged during the collision may be evident in the rubble if any forensic investigation is conducted. Perimeter columns, several stories high, and still linked together, lie amongst all the debris on the ground. Since the mass of the combined towers is close to 1000000 tons, finding evidence will be an enormous task

4.The future

More than two years after the Sept. 11, 2001, terror attacks, eight prospective memorial designs were unveiled as finalists Wednesday. Winnowed from 5,200 entrants from around the world, including design professionals as well as ordinary people, the finalists produced a collection of designs that represent a wide array of methods for remembering and revering the dead.

The winning plan for rebuilding the World Trade Center site was designed by architect Daniel Libeskind, who proposed a 1,776-foot- tall tower, symbolizing the year of American independence. The plan will leave large portions of the 70-foot-deep Ground Zero pit open, exposing the concrete foundation walls that survived the towers' collapse.

The World Trade Center is going to be replaced with five towers of increasing heights, arranged from south to north so that they rise in a spiral. This is how the new complex is going to look like. The offices rise up to the 70th floor. The top floors are filled with botanical gardens, as well as a restaurant and observatory deck on the 110th floor. The buildings has 880,000 square feet of office space. A television antenna tops the slender tower. Building Libeskind's spire would make it the 10th time that New York City has constructed the tallest structure in the world.

The green, grassy area, with the footprints of the original Twin Towers marked in lighter green, will be used as the space for a memorial competition. The space is sunk

30 feet below street level, exposing a section of the "slurry walls" which keep back the Hudson River and withstood the September 11 attacks.

The design was modified to better support the exposed foundations of the original World Trade Center towers and make room for the underground station and other infrastructure, including a proposed underground bus terminal. Many victims' family members are opposed to a bus terminal in this space, saying that the area where remains were found is sacred, all the way down to bedrock.

The sunken memorial area is 4.7 acres. The memorial space is "protected by the museum buildings and cultural buildings that frame it," Libeskind said in his presentation.

Visitors would be able to arrive down to the memorial area by several different paths, including walking through the 9/11 museum itself. The center building is to be a museum about September 11. The tracks, which ran underneath part of the north tower and much of the south tower before the attacks, are being rebuilt in the same location, although an extra train platform may be added. The station is slated to open in November 2003.

Mayor Michael Bloomberg was reportedly impressed with the Libeskind's design.

The end

The only way to discover the limits of the possible is to go beyond them into the impossible."

--Arthur C. Clarke