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The Collapse World Trade Center Building 7

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ABSTRACT: This is the final report of the National Bureau of Standards (WTC 7) investigation into the collapse of World Trade Center Building 7 (WTC 7), under the National Building Safety Team Act. The report states that fires have followed the impact of debris since the collapse of WTC 1 (north tower) led to the collapse of WTC 7; building transport inspection and emergency response procedures; what processes and procedures were used in construction, construction, operation, and maintenance of the building; and locations in current building and fire codes, standards, and processes that authorize reviews. More details can be found in the accompanying reports, NIST NCSTAR 1-9 and NIST NCSTAR 1-9A.

And in this report is a summary of how NIST reached its conclusions. NIST is installed inside the house technology and technology specialists in the private sector; amassed a collection of articles, photographs, and videos of disaster; conduct first-person interviews with building occupants and emergency responders ;analyze the evacuation and operation of emergencies within and around WTC 7; performed a computer simulation of WTC 7 conduct on September 11, 2001; and aggregated the acquired information into a possible sequence of wraps.

KEYWORDS: building evacuation, emergency response, fire safety, structural collapse, tall buildings, World Trade Center.



I. INTRODUCTION

During the events of September 11 2001, the WTC 1 and WTC 2 each were hit by a commercial plane. With all the WTC buildings so close together, debris from the twin towers caused extensive damage to the surrounding buildings, many of which collapsed. WTC 7 is located north of WTC 1 and has had very little damage that did not endanger its structural integrity. The debris, however, ignited more than ten floors inside WTC 7 and diverted the attention of the first responders away from the building [1]. After seven hours of fire burning on the floor in a row and crossing the

perimeter of the building, the building finally came to terms with what seemed to be a root failure when the roof over the building began to sink into the building followed by an outer frame. As the first tall building with a steel frame that collapsed as a result of fire alone, WTC 7 has gained a reputation as a major incentive to raise public awareness of potential fire hazards in buildings. Despite this, the fall of WTC 7 is not as well understood as one might think considering its importance in the field. After years of research by the world's leading experts in both fire and building engineering, there is still a lot of speculation about how a building should behave and fail due to fire. The authors of this article believe that there is an important scientific merit in reviewing this study closely and consider the big picture when the worst case scenario actually took place. This paper begins with the introduction of the WTC 7 structure, its unique backup power systems, and the events that led to its complete collapse. An overview of previous specialist investigations and their findings and submissions, focusing on how they analyzed the fire and structure. Finally, a separate hypothesis of wrapping.



II. STRUCTURAL

The layout of WTC 7 was a unique building in one of the world's most expensive markets. Created as the latest addition to the World Trade Center Complex, WTC 7 was erected over an existing power station that provided Manhattan landing power and had to make the most of the trapezoidal segment it was on. The tower had 47 floors and was 186 meters high making it the third tallest building in the complex after WTC1 and 2 respectively. Its impact was greater than that of one of the twin towers with a trapezoidal plan with dimensions of North, South, East and West $100\text{ m} \times 75\text{ m} \times 43\text{ m} \times 45\text{ m}$ respectively as shown in Figure 1 which also highlights the eastern port that will be. the focus of many wrap-around ideas. The first four floors from the ground floor include a power station, a reception area for the building, and another functional area such as a dining room and conference room. In addition, the first floor had emergency power system pumps. The fifth and sixth floors were mainly air-conditioning equipment and other equipment. Eleven of the fifteen electric generators comprising an integral part of the emergency plan of the building referred to in the next section are also located on the fifth floor and a small "day tank" of diesel. The more than six storeys comprised mainly of both open-air and cultural office spaces. The gravitational system consisted of wide flange beams and columns supporting a 140 mm thick steel-deck concrete mix with the base frame using head shavings. Lateral load resistance is provided by a temporary resistance connection near the perimeter frame and truss systems with two upper tier belts between the 22nd and 24th floors and the 5th and 7th floors. Core bracing below the 7th floor resists the lateral loads transmitted to it by the ground diaphragm. Many low-frame connections included a variety of shear connections including fin plate, knife, and a wide variety of seated connections [2]. SFRM (fire-resistant materials) is a type of fire protection used in parts of the building with an average of 3 hours in columns and a 2 hour

decking of steel and beams, exceeding the required 2 fire protection and 1.5 hours- columns and beams respectively . The entire building was also covered with fountains fed from the city's main plumbing from the ground up to the 20th floor, and included working water tanks on the 21st floor and above. To transfer the load from the building to the columns and foundation while the bridge over the Con Edison power station below, a transmission system was comprised of three trusses, eight cantilevered belts, and three transfer belts between the 5th and 7th floors.

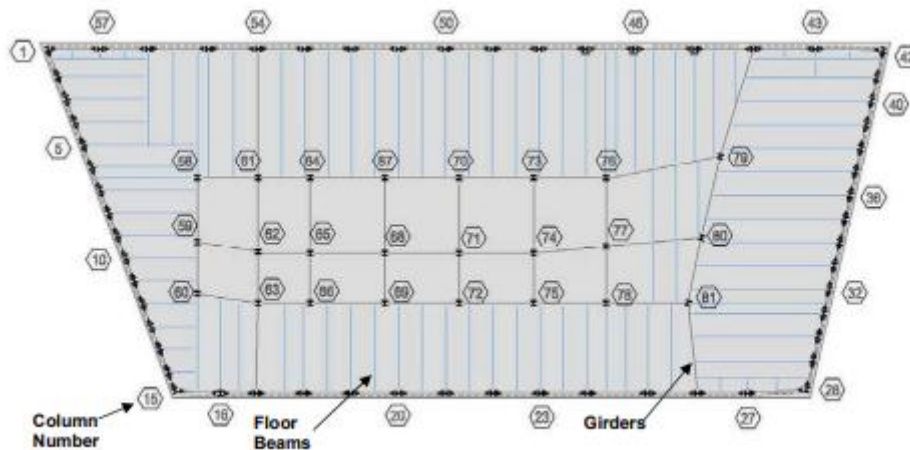


Fig. Showing Columns , girders and beams

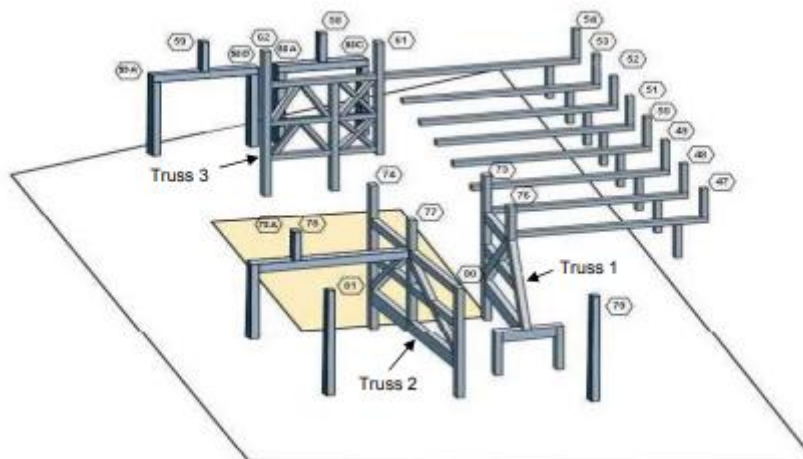


Fig.3D schematic view of transfer trusses and girders between Floors 5 and 7.

Fire

According to the NIST investigation, the worst fires are those that occur on floors 7 to 9 and 11 to 13 [1]. Fires on some floors may not have had much of an impact because they were only temporary and not visible in the video. On the 7th to 9th floor most open plan offices have a fuel load of 20 kg / m² mainly consisting of office supplies and paper. This fuel load is achieved by considering the fire rate in the videos and comparing the calculated value based on the load. The upper floors of the fire, 11 to 13, had many traditional offices divided into partitions and attached to a false ceiling. The paper load on these floors was high so the fuel capacity of the NIST it reached was 32 kg / m² [1]. With this data, NIST used Fire Dynamics Simulator (FDS) to generate a model for each fire floor. The 7th, 8th, and 12th floor models are rated based on the appearance of flame and broken glass in the videos. The 9th floor fire models are taken from the 8th floor model, while the 11th and 13th floor models are based on the 12th floor model due to the lack of sufficient images to measure each model. Using the gas temperatures found in the FDS, NIST then calculated the building temperature in the members of the building and changed it by + / - 10% to create three envelopes that could include a new building envelope and a certain degree of uncertainty in modeling [4,7].

. To use the FDS simulation for structural analysis, a desirable but consistent temperature setting of 1 hour at 800 ° C and 1 hour cooling at 20 ° C was used [9]. This method was based on the level of the ceiling level in most monitoring areas throughout the eastern region of the navel, and despite its simplicity, it calculated the type of fire movement, pre-heating, and energy conservation. Considering the fire protection used, especially considering that the space between the ribbed floor slab and gutters was left blank with SFRM, heat transfer analysis was performed at the University of Edinburgh.



Collapse hypothesis

The collapse of WTC 7 according to NIST models and the investigation launched primarily, due to the failure of the connection. The connection between the inner column 79 and the belt connecting it to the perimeter 44 column failed with the release of the belt during the heating phase. East of column 79, many lower beams have lost direct support or lateral torsional flexion. Heavy heat and restricted expansion of the floor slab caused the rest of the floor to lose its strength by crushing the concrete, and severely weakened the fire floors resulting in a small, unstoppable collapse and led to the collapse of the floor that left column 79 unsupported. The 9 floors that cause its failure to collapse caused the kink seen in the folded video. The binding of column 79 was followed by the same failures of columns 80 and 81, as well as the further collapse of the adjacent column lines. The obvious installation of the interior of the building was followed by a perimeter failure from the area near the entrance of the major WTC1 damage to the southwest of the building. The circular columns failed in rapid succession and complete structural failure occurred.

III. CONCLUSIONS

The collapse of WTC 7 remains a unique event to this day in the history of building fire engineering. Despite what has happened almost two decades ago, there is no real way of knowing what really caused its failure. Many expert teams have investigated the disaster and are trying to recreate the various incidents that have led to the ongoing failure of the framework. With so much rubbish gone, professional teams had to rely on photographs, videos, and numerical comparisons to put together their own different ideas. FDS and explicit FEM have played a key role in each of the investigative team's approach, demonstrating a tendency for more computer-based approaches to formal analysis of fire-retardant structures. By reviewing the various modeling methods and investigators' assumptions some important details about the case can be gleaned.



1. There is consensus among investigators about the two main aspects of WTC7 collapse: fire was the main cause of failure, and failure that started on the east side of the building somewhere on the ground floor 14.
2. FDS simulation of the affected floors 7-9 and 11-13 rated videos produces comparable temperatures in parts of the building. Even slight variations in temperature, however, may result in different effects depending on the type of structure model.

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