A Study of Evacuation Behavior in the World Trade Center Explosion

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Abstract
This paper is an analysis of five interviews conducted after the World Trade Center explosion on February 26, 1993, in New York City. Five people who were among those evacuated from the towers reported their experiences. The testimonies were analyzed according to the number of evacuees, occupants' awareness and knowledge of the emergency, behavior until egress, behavior in stairways, reverse flow of evacuees, and time to egress. According to the study, characteristics of human behavior become apparent in mass and simultaneous egress.

Introduction
The interviews were conducted from April 10 to 18, 1993, by the Ministry of Construction in Japan. Five Japanese business people who worked in the World Trade Center towers were interviewed. They were among those forced to evacuate by the explosion on February 26, 1993. Though the testimonies concern only a part of the incident, they can help us recreate the World Trade Center's egress and fire safety features (see Figure 1). The author was one of the interviewers, and all names have been changed.

In the Parking Garage on the B3 Level
At the time of the explosion, Nagata, an office manager from the 90th floor in Tower 1 (North Tower), was in the parking lot on level B3.

"I came to a parking lot on the B3 level near Tower 2 (South Tower) to get a document in my car. Suddenly, as I was sitting on the seat, the car shook strongly, as if another car collided with it from behind. I saw floor slabs shaking furiously, and all the other cars were shaking, too. I heard an alarm. The lights turned off immediately. However, since car alarms in many cars activated and headlights flashed, the parking area wasn't completely dark. I searched for a stairway with the help of the car lights. The stairway I used might have been the one in Tower 2, which led me onto Liberty Street.

"To figure out what was happening, I reentered Tower 2 through a revolving door and went into the shopping mall, which was still lighted and open. About five minutes later, smoke came into the mall. On the way to the mall, I must have
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Kojima

The building shook like a rolling ship. Smoke seemed to come from a freight elevator lobby and local elevator lobbies.

In the stairway, there was no smoke, but it was crowded with many evacuees.

As I descended the stairway, smoke came in. I got out at the 78th floor, but I had to go back because the sky lobby was also filled with thick smoke.

Port Authority personnel led us out of the stairway. I went into a tenant area, but it was also crowded there, so I went back to the stairway immediately.

The lights were turned off.

Fresh air came up, and then, people who had behaved well all that while dashed down the stairway. It was like a panic.

Misakil

I heard a loud sound and vibration, like an earthquake or a thunderbolt. After about 5 minutes, white foggy smoke came rapidly into offices. Almost all the people, about 250-300 on the 79th-82nd floor, stayed in the office. After a few minutes, people from upper floors began to enter corridors. At 14:30, primary egress was started after ensuring safety in the exit routes. At about 15:30, the secondary egress was started. At 16:30, all remaining employees, including myself, started the last egress and arrived on the ground level within 30 minutes.

Murakoshi

I felt as if an earthquake hit just below us. Two or three minutes later, smoke came into the office along the corridor ceiling. I took an escalator down to the sky lobby. It was filled with smoke and people. In Stair A, it was not dark and hot, but it was very crowded and smoky.

I was led out of the stairway to a tenant area and guided into a dining room on the 48th floor. I was in the dining room for about one hour.

Yoshikawa

A shock like an earthquake pushed up. At 12:20, smoke infiltrated from the freight elevator lobby on the 49th floor. At 12:25, we started primary egress. At 12:50, people from upper floors came into corridors on the 48th and 49th floor. At 13:00, Port Authority personnel said that stairways were filled with smoke. Smoke kept getting increasingly thick and reached a maximum at about 14:00. At 14:25, we started secondary egress. I started egress at 16:10 p.m., and arrived at an office in the World Financial Center at 16:30.

Nagata

At the time of the explosion, I was sitting in my car. Suddenly, the car was shaken, as if it was hit from behind. I saw floor slabs shaking furiously, and all the other cars were shaking, too.

Figure 1. Outline of testimonies from five witnesses.