Engineering Ethics: Kansas City Hyatt Walkway Collapse

An Online Continuing Education Course for Engineers

Course Number: ET-1018

Credit: 1 Hour / 1 PDH / 1 CPD

Engineering Ethics: Kansas City Hyatt Walkway Collapse

Edward P. Brunet, Jr., P.E.

Prologue

The mood was festive in the huge atrium of the Kansas City Hyatt Regency hotel on a warm summer night in July, 1981. More than 1,500 people were enjoying a weekly dance contest called the "Tea Party" hosted by a local radio station.

Sally Firestone was all dressed up, standing on a catwalk above the atrium floor, watching the dancers below. Suddenly, she heard a loud "crack." Then, her world came crashing down around her. As the band played Duke Ellington's "Satin Doll," catwalks lined with people on the second and fourth floor above the atrium fell onto the dance floor below.

The deadliest structural failure in U.S. history killed 114 people and injured nearly 200 others. Ms. Firestone lay unconscious and trapped for hours under the debris. She was eventually rescued, but was left a quadriplegic.

"I'm not really bitter. I'm just amazed that no one discovered the problems with the building," said Firestone many years later. "So many things happened along the way that should have been caught."

Introduction

As Kansas City Mayor Richard Berkley stood in front of the Hyatt Regency shortly after the accident, he called it a "very serious tragedy." But, what made this disaster even more tragic was that it should never have happened.

The collapse of the skywalks resulted from a simple design error. In 1981, there was nothing particularly complex about designing skywalks that hang from the ceiling, supported by rods. At the time, the engineer of record for the Kansas City Hyatt Regency hotel project had many previous years of experience designing structures. Yet, the design error was so simple that a junior or senior undergraduate engineering student could have recognized it.

And there were numerous opportunities for the design error to be caught during design and construction.

This course will examine the events that led up to and caused the Kansas City Hyatt disaster. We'll see how negligence and lack of design responsibility by the engineer of record was the direct cause of the accident. We'll see how constructability issues led to an ill-fated design

change by the fabricator. And we'll learn how the lack of a change management process for shop drawings contributed to the tragedy.

Finally, we'll discuss lessons learned from this accident that you can take forward with you in your professional practice.

Project History

In 1976, Crown Center Redevelopment Corporation initiated a project to design and build a Hyatt Regency Hotel in Kansas City, MO. Gillum-Colaco, Inc. was selected as the consulting structural engineer for the project. Gillum-Colaco subcontracted the structural engineering work for the project to their subsidiary firm, Jack D. Gillum & Associates (G.C.E.).

PBNDML Architects, Planners, Inc. was selected as the architect for the project. Eldridge Construction Company was selected as the general contractor; and they in turn subcontracted the fabrication and erection of the hotel's atrium steel to Havens Steel Company.

The project employed three distinct "teams," each with different roles. The "design team," consisting of PBNDML and G.C.E., was authorized to control the entire project on behalf of the owner. Eldridge Construction Co., acting in the role of the "construction team" was responsible for general contracting. And the "inspection team" was made up of two inspection agencies, H&R Inspection and General Testing, as well as a quality control manager, a construction manager and an investigating engineer.

The proposed Kansas City Hyatt Regency Hotel consisted of three sections: a 40-story tower section, a function block, and a connecting atrium. The atrium, where the accident occurred, is a large open area approximately 117 feet wide x 145 feet long x 50 feet high. Three suspended "skywalks" spanned the atrium at the 2nd, 3rd and 4th floor levels. The 3rd and 4th floor walkways were each suspended from the atrium roof trusses, while the 2nd floor walkway was located directly underneath the 4th floor walkway and was suspended from the 4th floor walkway (see Figure 1 after the collapse showing the dangling 4th floor walkway rods to the right in the picture).

Figure 1. Third Floor Walkway (left)

As is fairly typical for these types of projects, the architect, PBNDML, prepared the project specifications and G.C.E., the structural engineer, was responsible for producing structural engineering drawings. Havens, the atrium fabrication contractor, used G.C.E.'s structural engineering drawings as the basis to create shop fabrication drawings.

G.C.E.'s Original Design

The Kansas City Hyatt atrium catwalk design prepared by G.C.E. intended for the 2nd floor and 4th floor walkways to be suspended one under the other from six single continuous 1 ¼"

diameter round steel rods anchored in the ceiling. The 3rd floor walkway was to be located east of the 2nd and 4th floor walkways and was to be suspended from the atrium ceiling in the same manner.

The box beam members that formed the lateral structural support for each walkway were comprised of two (2) 8 x 8.5 MC channels welded toe-to-toe (see Figure 2a).

On the 2nd and 4th floor walkways, the rods were intended to run from the ceiling down to and through the 4th floor box beams and were then to continue down to and through the 2nd floor box beams, where the rods would terminate with a nut and washer. The ends of the rods were depicted as threaded so that the walkways could be leveled by adjusting the nuts on the threaded rods.

A total of 60 structural design drawings were prepared by G.C.E. and were transmitted to Havens through the normal document transmittal process. The project engineer for G.C.E. had prepared preliminary sketches for the atrium walkways showing design criteria, including calculated preliminary loads and information on the box beam hanger rod connection; however, these preliminary sketches were not transmitted to the fabricator along with the structural drawings.

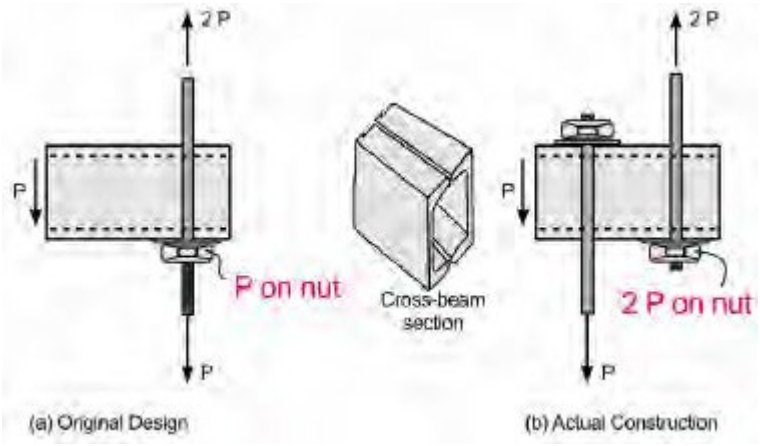

Figure 2 – 4th Floor Atrium Walkway Box Beam Connection Detail

Design Change

From Havens' perspective, there were two problems with G.C.E.'s design. First, the long rods required to hang the 2nd floor catwalk from the atrium ceiling were not readily available. Building the walkways per the G.C.E. design would have resulted in material delays that could have potentially impacted the overall project schedule.

Secondly, the original design would have required threading the entire length of the long rod in order to install a nut under the 4th floor catwalk box beam. The nut for the 4th floor catwalk box

beam would have to be installed after inserting the rod through the 2nd floor catwalk box beam, and would likely have required extensive scaffolding to complete the connection. This would have resulted in significantly higher erection costs. Further, Havens was concerned that the threads on the rod might be damaged during the erection process.

Therefore, Havens changed from a single to a double hanger rod box beam connection at the 4th floor catwalk (see Figure 2b). A rod was hung from the ceiling down to the 4th floor walkway. And a second rod was hung from the 4th floor walkway down to support the 2nd floor walkway. This allowed the use of shorter rods, which were readily available. It also simplified the erection process and eliminated the need for the entire rod to be threaded.

Havens claims to have called G.C.E. to "red flag" the connection design change. G.C.E. claims that the call was never made. Regardless of the disputed phone call, the change was reflected on Havens' shop drawings and erection drawings, which were forwarded to G.C.E. On February 26, 1979, G.C.E. returned the drawings to Havens, stamped with the project engineer's engineering review seal, authorizing construction.

Roof Collapse

On October 14, 1979, while the hotel was still under construction, part of the atrium roof collapsed. Fortunately, it was a Sunday, and there was no construction activity occurring at the time, so there were no injuries.

The owner used resources from the project's "inspection team" to investigate the roof collapse. Additionally, the owner hired an independent engineering firm, Seiden-Page, to determine the cause. The investigation determined that the roof collapse occurred due to faulty roof connections. The problem was fixed. However, the owner did not direct or ask Seiden-Page to check the walkway connections or any other structural details on the project.

As a result of the roof collapse, G.C.E. wrote the owner stating that G.C.E. would begin a thorough design check of all steel connections in the design. Construction on the project continued, and the hotel opened for business in July, 1980.

The Accident

On July 17, 1981, just one year after the hotel opened, the load resulting from people standing on the walkways caused one of the connections at the 4th floor walkway to fail. Due to a lack of redundancy in the design, the connection failure resulted in the collapse of the 4th floor walkway onto the 2nd floor walkway, which then collapsed onto the floor below.

The collapse of the walkways fractured water pipes in the atrium, which flooded the hotel's main entrance. Nonetheless, rescue efforts were swift and well coordinated. More than 40 rescue vehicles quickly converged on the scene from all over the Kansas City metropolitan area and helicopters were used to take the injured to area hospitals. Aiding the rescue efforts were scores

of doctors in town for a Radiology convention who happened to be dining in the hotel at the time of the accident.

The accident killed 114 people and injured nearly 200 others, making it the deadliest structural failure in U.S. history.*

> * Note: This claim is debatable since the collapse of the World Trade Center Towers on September 11, 2001 resulted in a much higher death toll. However, most experts do not categorize the WTC collapse as a structural "failure" because the buildings were never intended to be designed for such a terrorist attack. By contrast, the Kansas City building code mandated that the Hyatt walkways be designed for the live load conditions that existed on the night of the collapse.

The Investigation

Speculation about th… …onse workers had even finished rescuing … …ly theory was that that the walkways colla… …ing on the catwalks, … anyone on the …eory speculated that …ashers along with the

Figure 3 - Fourth Floo… Box Beam Connectior…

…r, Richard Berkley, …S) – now the …chnology – … City Hyatt …etermined that the …g from the 4th …ed the C- …eld joint between the …channels then split and the washer, nut and …od slipped through the box beam, resulting in the collapse of the walkway (see Figure 3).

Because of the double rod design change initiated by Havens, the load at the nut on the 4th floor upper rod section was twice the load of the original single rod design. The investigation discovered that the original design could only support 60% of the load required by the building code. The shop drawing change to a two rod design doubled the load at the 4th floor connection, meaning that the as-constructed connection could only bear 30% of the mandated load.

Responsibility for Designing Connections

The steel-to-steel connection is what ultimately failed and resulted in the accident. Therefore, a historical perspective of design responsibility for steel-to-steel connections is in order. Prior to