Kansas City Walkway Tragedy

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For most practicing engineers, Friday July 17th, 1981 is a day in which changed the profession forever. On this particular day, a most horrific accident occurred in Kansas City. In just a split second, this senseless tragedy was the collapse of the Hyatt Regency hotel atrium walkway which claimed the lives of 114 people and injured more than 200 people. The collapse of the walkway would lead to public and professional outcry which would be a steppingstone in the betterment of engineering. The collapse of the walkway happened as a result of mismanaged errors from all spectrums which proved to be unfortunately fatal.

The grand design and the exhilarating architecture were the Hyatt hotels key features. Balconies, glass elevators, huge atriums, and huge skywalks were the extravagating parts which stood out most, which made the Hyatt one of the best social centers in Kansas City and the place to be. There were three 120 foot long suspended skywalks which were suspended from the ceiling. There were two separate skywalks on one side which connect the two buildings on the 2nd and 4th – floors respectively. On the other side was the skywalk which connects at the 3rd story level of building (see Figure 1).

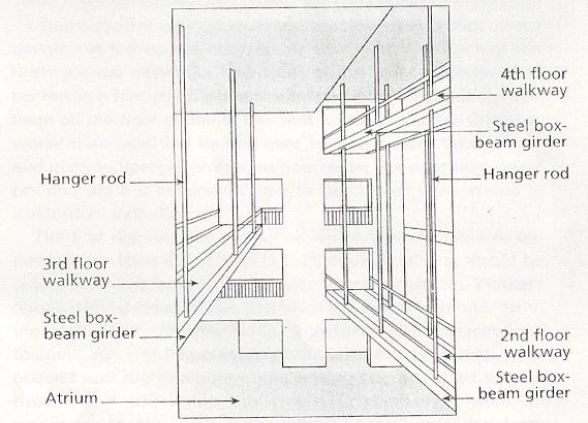

Figure 1

Each bridge was supported at the ends by equidistant intervals by three pairs of hangers suspended from the roof trusses. The walkway decks were formed of lightweight concrete placed over a corrugated metal deck which was supported by two I-beam stringers. These I-beams stringers, W16 X 26, would transfer the weight of the skywalk and superimpose the load to three transverse box beams per bridge. The box beams were

two welded flange-to-flange channel sections of MC8 X 8.5. The 1 ¼ diameter hanger rods passed throughout the center of the weld of the channel flanges and carried the weight transferred by them through a nut and washer installed on the treaded hanger (see Figure 2).

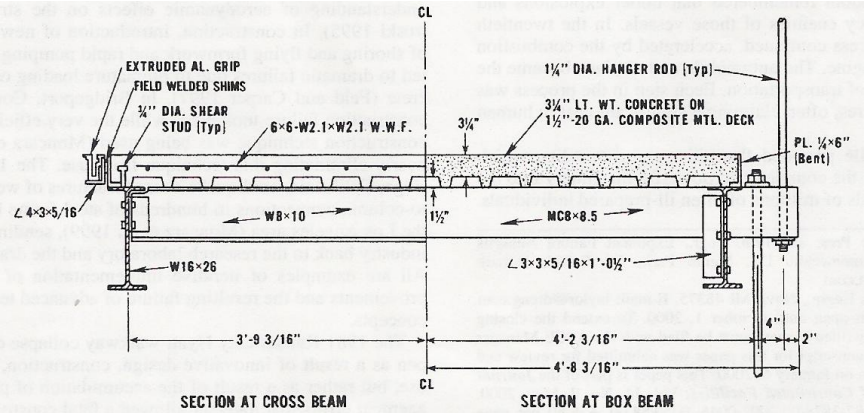

Figure 2

On Friday, July 17th, 1981, there were well over 1500 people at the Hyatt enjoying the music either on the floor atrium or looking from above on the skywalks. Within a split second there was a loud crack, followed by sharper cracking and screeching noises. With no time to scream, the 4th floor had plummeted downward with dozens of spectators falling with it. The 2nd and 4th walkways came crushing down onto the crowded floor below which proved deadly for most who were unfortunately under the skywalks at that particular moment.

The daunting task of evaluating the wreckage and determining what caused the failure was the next outcome. The hanger rods from which the collapsed skywalks came from were still hanging from suspended from the ceiling with only about six to eight inches looking raw and exposed (see Figure 3). With the nuts and washer still visible on the rods and no evidence of "necking" or in which the diameter of the rods become smaller and smaller to form a neck, it became quite clear that the failure was in the connection rather than the rods themselves. The next questions investigators had to ask was "What caused the collapse?"

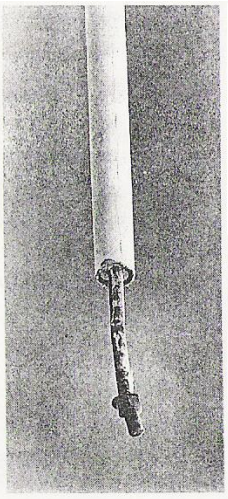
Figure 3

Some went as far as to do calculations on the natural frequencies of the skywalks caused by the music and people dancing on the skywalks. It was concluded that very high cycles per second would have to been generated in order for the skywalks to come crushing down. Therefore the resonance theory was rejected out of hand.

The next step was to look at the design of the skywalk itself. The original plan filled at City Hall required that the 2nd and 4th-floor walkways each hanging on six continuous rods being hung from the ceiling. In this design, the load of each walkway was supported by nuts and washers under each deck on the continuous rod. The as built design had two upper hanger rods, thus suspending the 4th-floor skywalk. It went through the transverse beam box and was supported only by nuts and washers underneath. The two separate, lower hanger rods went through the inner side of the beam box of the 4th-floor skywalk and suspended the 2nd-floor skywalk, again connected with nuts and washers (see Figure 4).

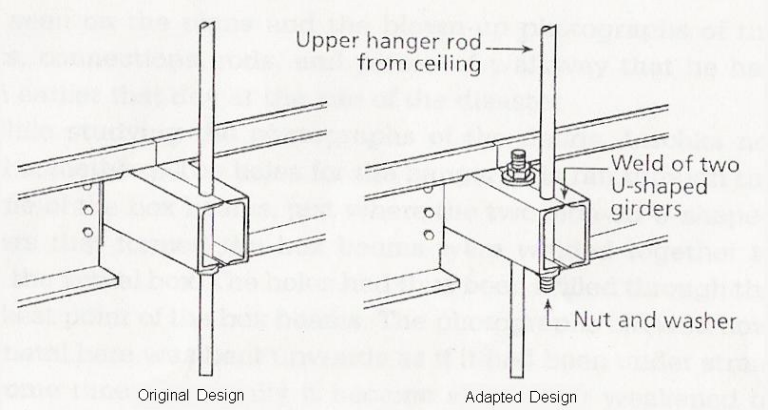

Figure 4

It is quite clear to see why the change was eminent. The original plan was impossible because one would have to raise the heavy decks up the hanger rods without stripping the threads. The original design was adapted to a double rod instead. This design change was a crucial mistake because now the 4th-floor skywalk was carrying the load of itself as well as the 2nd story skywalk load. This is like holding two people up on the same rope with only one set of hands enduring all the strain. On the other hand, if each person was hanging separately on the rope, there would be considerable less strain on your hands. Also the holes for the hanger rods were drilled directly in the middle of the welded beam box, which is already the weakest point. Photographs have shown that

metal was bent upwards as if it were already under considerable strain. Eventually the hanger rod with the nut and washer created a large enough hole to creep through the welded flange-to flange channel beam box to cause this tragedy (see Figure 5).

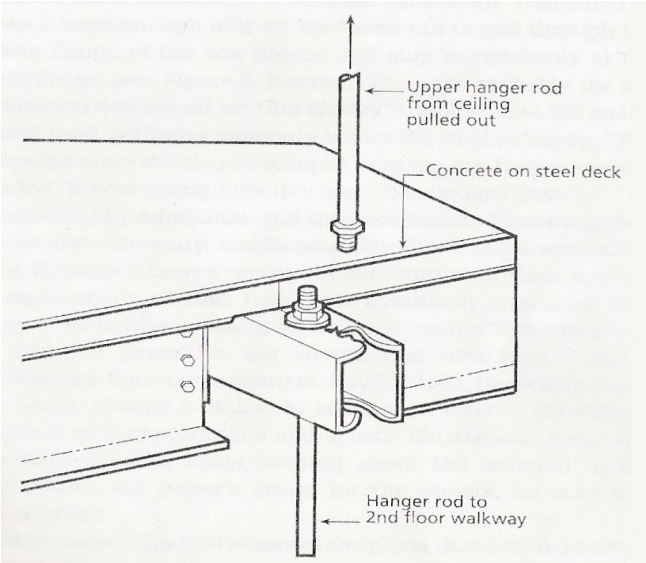

Figure 5

In the succeeding months, investigators took even a closer look at the debris and rubbles. The National Bureau Standards (NBS) concluded that the design was very close to failure margin and was unsafe. In the redesign plan, even without any alterations to the connections, box beams, or the rods, the dead load of the walkway was greater than what was specified. The actual dead load was 1300 lbs or about 8% more than the computed dead load. The corrugated steel deck and concrete made up the difference not shown on the original drawings. The extra weight took the walkway even closer to the edge as cameras have shown that there were about 63 people on the walkways or an approximate of 9,450 lbs of live load. The Kansas City Building Code required that at least 72,000 lbs per walkway or a total of 144,000 lbs. Therefore the walkway collapsed with a live load of about 1/15 the safe applicable load. From a finite-element study, the dead load level, the plastic deformation of the channel flanges was about 0.1 to 0.15 inches. This magnitude couldn't obviously be noticed by the naked eye since steel construction was covered by a finish and fireproofing. Experimental and analytical studies have shown minimal impact on the ultimate capacity of the connection by the weld. The finite element analysis showed the importance of the channel flange stiffness to the stress in which cause the failure (see Figure 6).

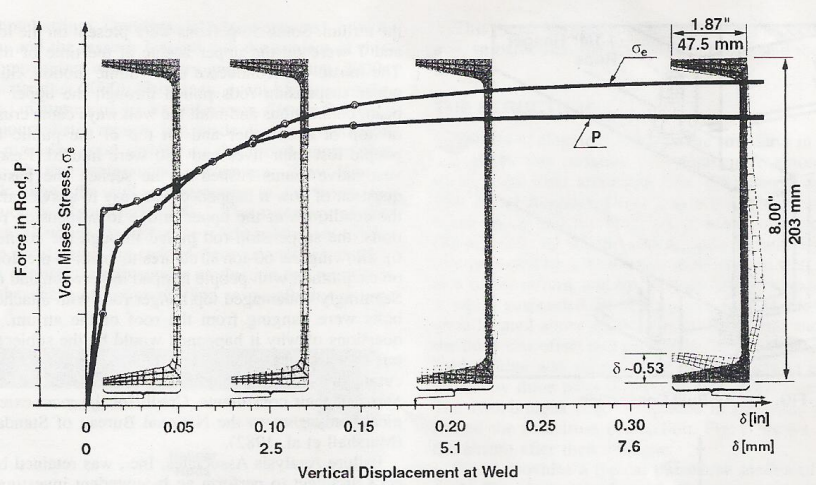

Figure 6

Records have proven that the systems basic design flaws slipped through the safe net procedures several times. The walkway was a failure of people involved, the construction, and the inspection team which allowed this to happen. The structural drawings were appointed by GCE International Inc. and the drawings included the continuous rod connection and these drawings were personally sealed by Jack Gillum. Havens Steel Company was to fabricate and erect the atrium steel and on a particular day called the structural engineer in charge at GCE, Dan Duncan, to explain that the continuous rod idea probably couldn't hold the decks and recommended the two rod system. Dan Duncan admits that he had no problems of the new changes. There was no further evidence of any calculations to check the new appropriate loading as well as the structural integrity. During another standard shop meeting at GCE, a technician noticed the discrepancy between the two drawings and Duncan declared that the two rod system was basically the same as the single rod system. Duncan also failed to review the box weld connection with the new setup as well and approved the design concept. The hotels architect and the general contractor all approved the designs before construction begun. Finally, a judge later proved that the structural engineers claimed that they done a special inspection of every detail but never checked the 4th-floor walkway.

Between 1984 -1985, a judge found Dan Duncan, Jack Gillum, and GCE International Inc. guilty of gross negligence, misconduct, and unprofessional conduct in practice of engineering. As a consequence, the State revoked their licenses and was

subsequently suspended from the American Society of Civil Engineers for violating the code of ethics.

As for any project, there come great responsibilities. As an up coming engineer, I've learned that if there are any questions in doubt; don't hesitate to talk about any potential problems. The Kansas City walkway is an inexcusable mistake which caused the unwanted injuries and death to many families. This tragedy could have been avoided by making the changes which were confronted along the project such as putting a face plate on the bottom of the welded flange-to-flange channel section to distribute the weight of the decks. Finally, some basic calculations could have given more concise answers in determining if the safety factor will be met or not.

Appendix, References

Wearne, Phillip (2000). *Collapse: when buildings fall down.* 79-97

Moncarz, P. D., Taylor, R. K. (2000). "Engineering Process Failure – Hyatt Walkway Collapse." ASCE, 14(2), 46-51