The National Institute of Standards and Technology was tasked with the investigation to determine how the WTC 7 building collapsed to the ground on Sept. 11, 2001 in New York City. Their final report on this issue was released in November 2008. At that time the structural, erection, and shop fabrication drawings for the steel frame of the building were not publicly released, and thus those interested in the structural details of the building were not able to review them and determine the plausibility of the fire induced progressive collapse explanation given in NIST report.

The NIST WTC 7 report claims the initiating event was that a critical girder (girder A2001) in the northeast corner of the building under the 13th floor was either pushed or rocked off its seats at exterior column 44 and corner core column 79 by thermally expanding beams framing into it from the east as shown in Figure 1.

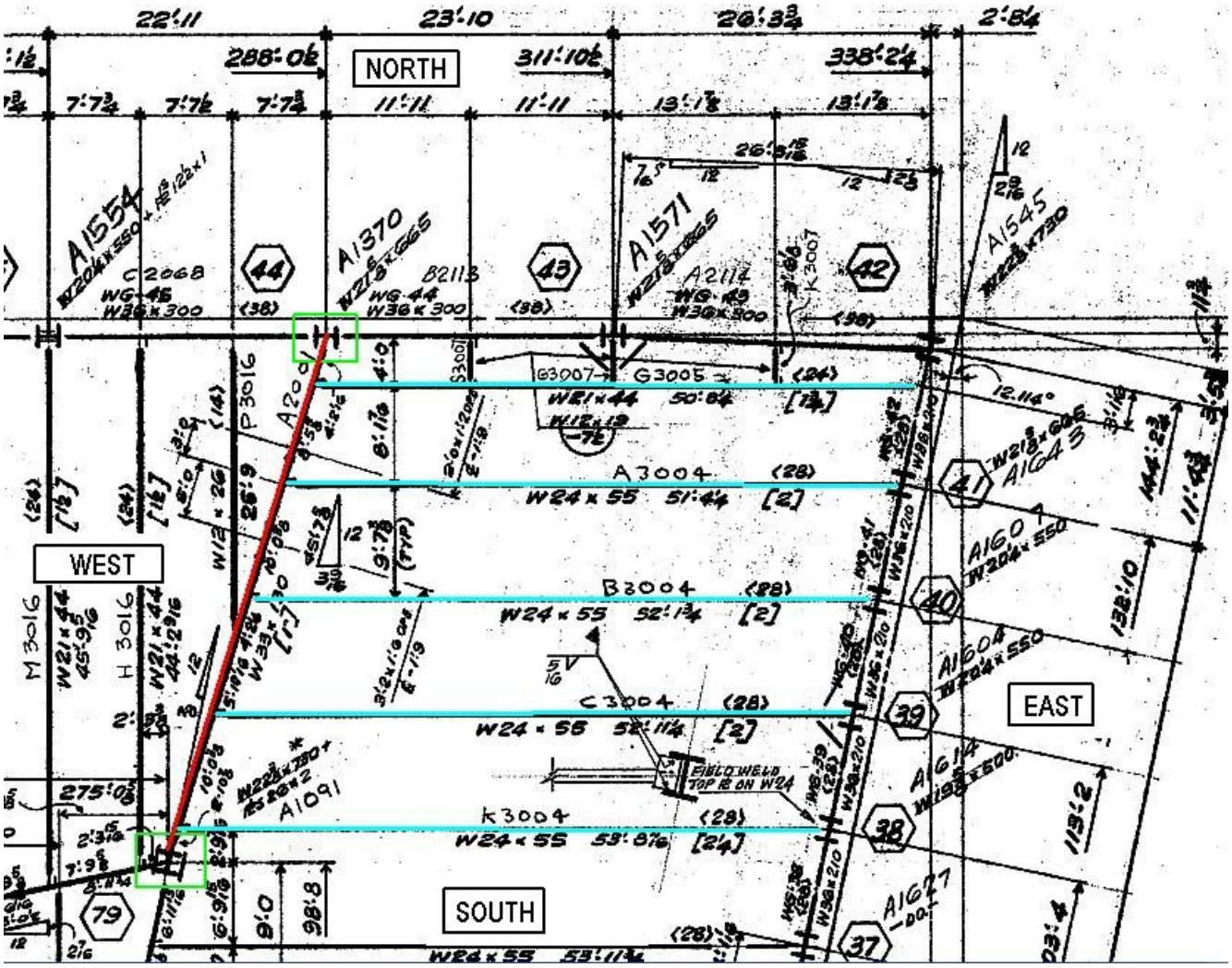


**Figure 1: Framing of the northeast corner of the 13th floor of WTC 7 as shown on Frankel drawing #E12/13 with the critical girder (A2001) highlighted in red and the five beams framing into it from the east (K3004, C3004, B3004, A3004, and G3005) highlighted in blue. Columns 44 and 79, which support the girder, are outlined in green.**

They then say this caused an eight floor cascade down to the 5th floor of the area supported by the girder, leaving column 79 laterally unsupported for nine stories and causing it to buckle. The column 79 collapse was

then claimed to have precipitated a north to south collapse of the east side interior which then had an east to west progression with the entire interior collapsing first and a subsequent buckling of the then laterally unsupported exterior columns.

A large number of the WTC 7 drawings were publicly released in late 2011. During review of these drawings it was ascertained that the NIST analyses of the structural performance under fire conditions in the northeast corner under the 13th floor had erred with the seat length dimension for girder A2001 at column 79 and also omitted two very pertinent structural features. Analyses by private citizen engineers show that with the correct seat length used, and the omitted features included, the failure of this critical girder as claimed in the NIST WTC 7 report would have been impossible.

The seat for girder A2001 at column 79 under the 13th floor had initially been described in Chapter 11, page 527 of NIST NCSTAR 1-9 as being 11 inches long. Review of the attached Frankel drawing #1091 showed this plate, labeled as "pf", to be 1.0 feet or 12 inches long. This issue was brought to the attention of NIST officials in a FOIA letter from a structural engineer dated March 19, 2012 and an erratum shown in Figure 2 was issued on June 27, 2012 correcting the seat length to 12 inches and giving a new lateral walk-off travel distance of 6.25 inches.

June 2012 Text Changes to the NIST Reports of the
Federal Building and Fire Investigation of the World Trade Center Disaster,
NIST NCSTAR 1-9

NIST has made the following changes to the report on the collapse of World Trade Center Building 7:

1. In Chapter 11, **page 482**, Analytical Model for Seated Connection at Columns 79 and 81

The fourth sentence in the 3rd paragraph should be modified as follows:

The travel distance for walk off was ~~6.25~~ 5.5 in. along the axis of the beam and ~~5.5~~ 6.25 in. lateral to the beam.

*The 5.5 in. dimension was the length of the girder bearing on the seat connection that had to slide off the seat axially to the girder. The 6.25 in. dimension accounted for the length from the flange tip to the far side of the web, so that the web was no longer supported on the bearing plate. This change corrects a typographical error which showed a lateral displacement of 5.5 in. instead of the correct value of 6.25 in., which was used in the analyses.*

2. In Chapter 11, **page 527**, Thermal Effects on Connections for Floor Beams and Girders

The third and fourth sentences in the 3rd paragraph should be modified as follows:

The bearing seat at Column 79 was ~~11~~ 12 in. wide. Thus, when the girder end at Column 79 had been pushed laterally at least ~~5.5~~ 6.25 in., it was no longer supported by the bearing seat.

*The 16-story model of WTC 7 used a 12 in. bearing plate on the north side of Column 79, consistent with Frankel drawing 1091. The 5.5 in. dimension was incorrectly cited, as the 6.25 in. dimension accounted for the lateral walk-off distance. These changes correct typographical errors. The dimensions and lateral displacements used in the analyses were correct.*

http://www.nist.gov/el/disasterstudies/wtc/wtc_finalreports.cfm last update 6/27/12

**Figure 2: Erratum issued June 27, 2012.**

Prior to this, the report claimed that with the beams to the east of the girder heated to 600 °C they would expand by 5.5 inches and push the girder web beyond the 11 inch long seat, with the gravity load on the girder then applied only to the girder flange, which was not sufficient to sustain it and would fold upward, causing the girder to fall off of the seat. The erratum states that the axial and lateral travel distances, required for the girder to walk-off its seat at column 79, had been transposed and that the lateral travel distance was actually 6.25 inches and the axial travel distance 5.5 inches.

However, when calculated from the provided geometry and details of the girder and seat shown in Frankel drawings #1091 and 9114 the axial bearing length of the girder on the seat is seen to be 6.25 inches as shown in Figure 3 below.

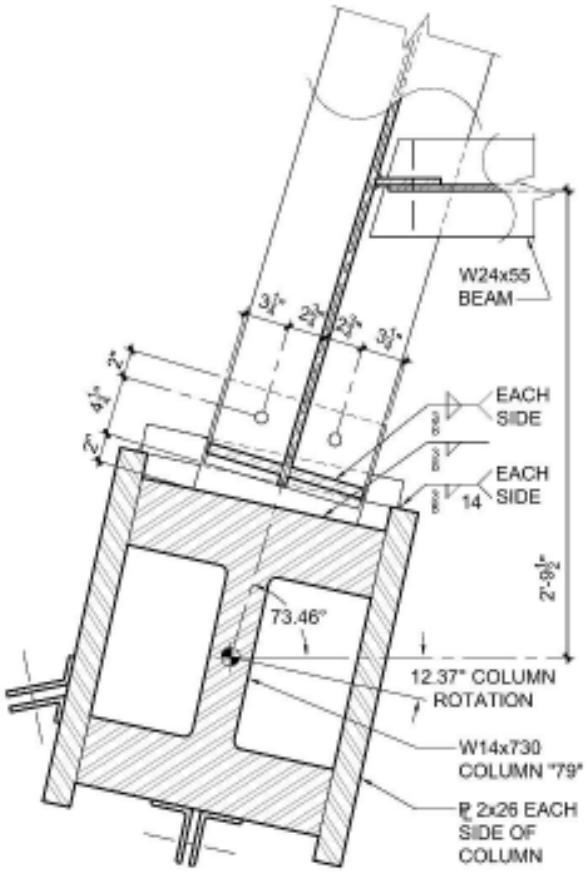


**Figure 3: Plan View at Floor 13, Column 79 Seated Connection of Girder A2001.**
**(Data from Frankel Steel Limited, 1985b)**

So it is unclear how the 5.5 inch axial travel distance for walk-off was determined as it is not related to bearing length. If it is due to when the seat would fail it needs to be stated.

However, the most serious issue that the erratum does not explain is how the additional beam expansion for a 6.25 inch lateral walk-off travel distance would occur. This is confounding as the 5.5 inches, previously given for lateral walk-off distance, is the maximum axial thermal expansion of the 53 foot long beams at the 600 °C temperature they were claimed to be heated to in the report. The NIST needs to explain why this greater expansion seems to have simply been assumed to occur. Otherwise, they need to update their thermal analysis to show significantly higher beam temperatures could have existed. They also need to provide beam

deflection calculations using the modulus of elasticity of the steel beams at those higher temperatures and the actual beam loading conditions, which would involve some sagging and actual shortening of the beams, while still showing the 6.25 inch lateral travel distance, required for walk-off with a 12 inch long seat, was possible.

The above also assumes that all of the expansion was directed westwards, and that the four bolts of the beam connections to the columns at the east side exterior would withstand the breaking of the 28 shear studs on the beams. The beam to exterior column connections also contained clearance between the beam and the columns as shown in Figure 4, so if the bolts broke there would be at least an inch of movement to the east. This is not discussed in the NIST WTC 7 report.

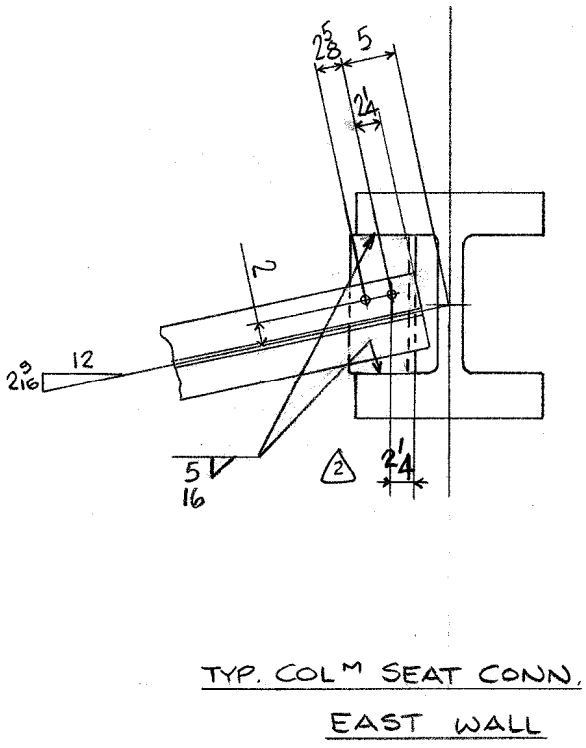


**Figure 4: Plan View of east side exterior beam to column connections from Frankel drawing #9101.**

As mentioned earlier, review of the released WTC 7 drawings also showed there were two serious structural feature omissions from the NIST analyses. They were:

1. Stiffeners were omitted from the column 79 end of girder A2001.

2. Lateral support beams S3007, G3007, and K3007 from the north exterior frame to beam G3005 were omitted.

Although the shop fabrication drawing for girder A2001 has not yet been released, the stiffeners at the column 79 end of the girder are clearly shown on Frankel drawing #9114 as seen in Figure 5 below.

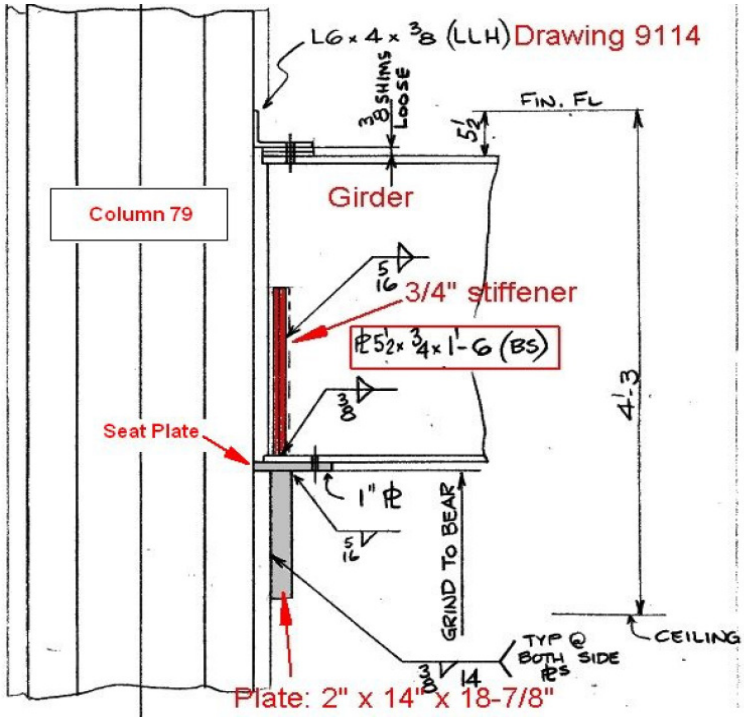


**Figure 5: Side View of Column 79 Seated Connection of Girder A2001 on Frankel Drawing #9114.**

Another WTC 7 girder is shown in Figure 6 to give an illustration of a typical stiffener configuration at the end of many of the girders, which review of the drawings shows was apparently used on girders where the connection design used a narrow support plate under the seat, such as that used under the column 79 girder seat and labeled as plate “pg” on Frankel drawing #1091.

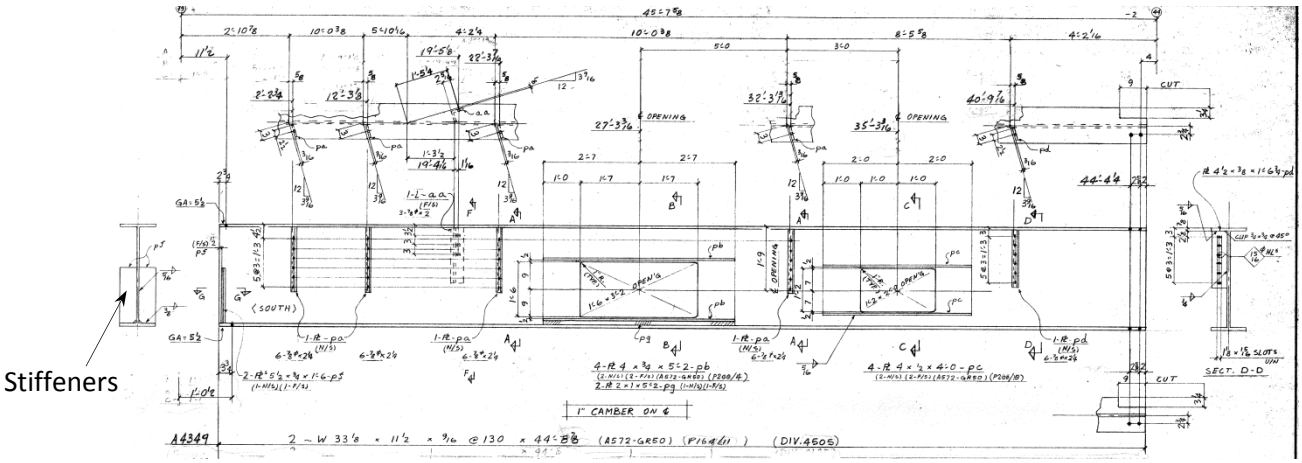


**Figure 6: Typical stiffeners used on girder ends with narrow support plates under girder seat.**

Figures 7 and 8 show how the girder was depicted without stiffeners in the NIST WTC 7 report and that the stiffeners were not included in the analysis model of the connection used to support the conclusions of the report.

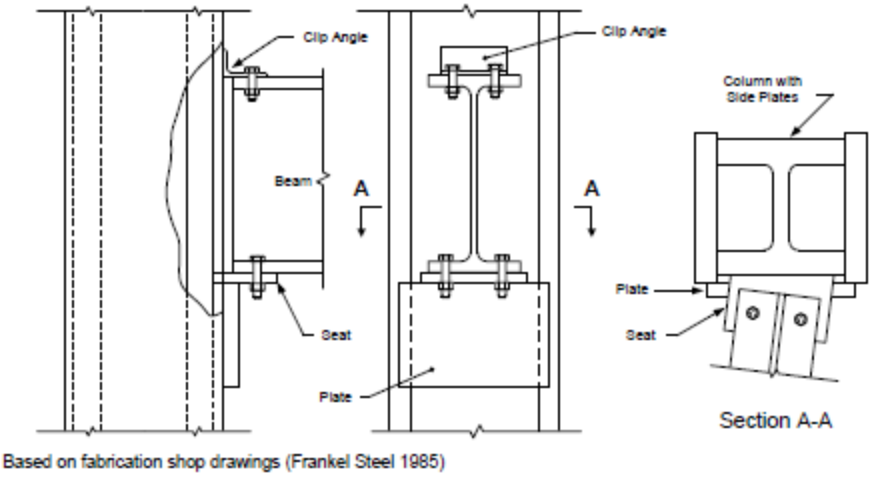


Figure 8–21. Seat connection at Column 79.

**Figure 7: Typical depiction of the girder end at column 79 in the NIST WTC 7 report.**

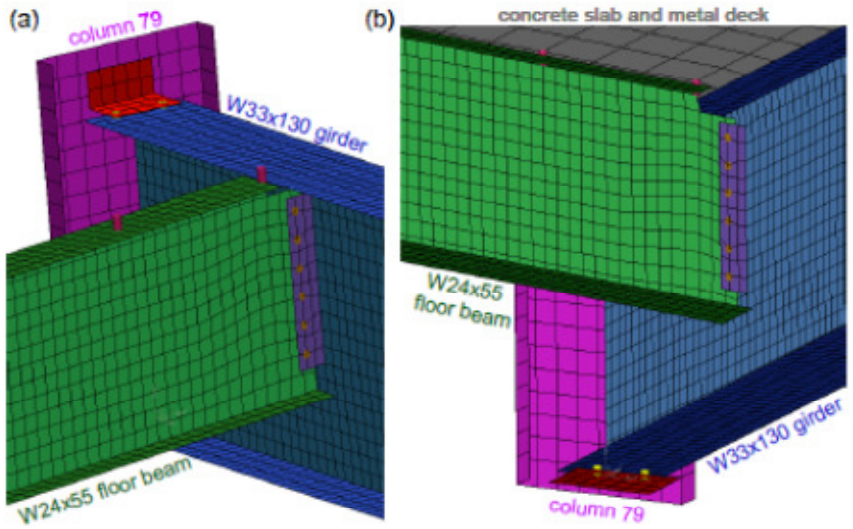


Figure 8–23. Views from northeast showing seat connection at column 79 and bolted shear plate connection of floor beam to girder

**Figure 8: Analysis model provided in the NIST WTC 7 report showing the girder connection at column 79.**

Structural analyses are generally not permitted to leave out structural features which would degrade the strength of the structure without admitting to having done so. These omissions were not divulged in the NIST WTC 7 report released in November 2008, and were only discerned three years later when the drawings became publicly available. Even then the NIST did not initially respond to inquiries asking why they were omitted, and in fact, only recently acknowledged that the stiffeners on the girder were omitted in correspondence dated October 25, 2013 as shown in the indented and italicized text below. The questions asked of the NIST are bolded and the answers from the NIST are not.

> *Following your e-mail of September 24 (see below), a set of responses to your questions were prepared. Unfortunately, the partial shutdown of the federal government delayed our getting these responses to you. With our apologies for tardiness, here are those responses:*

***A) In NCSTAR 1-9, which design drawing was used to create:***

***Figure 8-21?*** *1091, 9114*
***Figure 8-23?*** *1091, 3004, 9114*
***Figure 8-26?*** *1091, 3004, 9114*
***Figure 8-27?*** *E12-13*
***Figure 11-16?*** *E12-13, E120*
***Figure 11-19?*** *None*
***Figure 12-24?*** *1091, 9114*
***Figure 12-25?*** *1091, 9114, E12-13*

***B) Given that Frankel drawing #9114 shows 3/4" web/flange stiffeners installed on the girder at the 13th floor column 79 connection, why weren't the stiffeners reported in NCSTAR 1-9 and shown in the figures listed above? Was Frankel Drawing #9114 used? If not, why not?***

*The web stiffeners shown at the end of the girder in Frankel drawing #9114 prevent web crippling. The structural analyses of WTC 7 did not show any web crippling failures. Therefore, the web crippling plates did not need to be included in the models/analyses. Again, we apologize for the length of time it took to get this information back to you. Thank you for your interest in the NIST World Trade Center investigation.*

*Sincerely,*
*Michael Newman*
*NIST Public Affairs Office*

Figure 9 is an accurate to scale depiction of girder A2001's connection to column 79 showing the girder stiffeners based on Frankel drawing #9114. Figure 10 is an accurate to scale 3-D rendering of the connection.

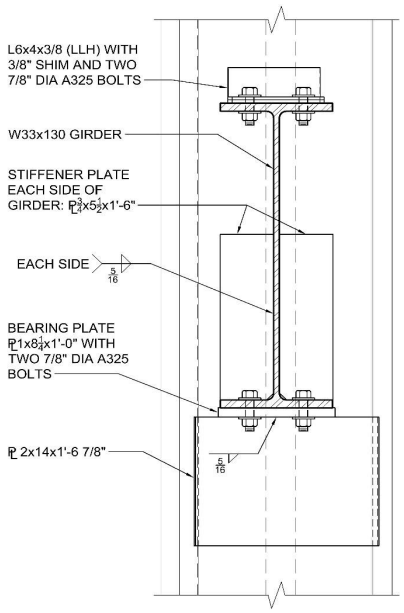


**Figure 9: The A2001 girder connection at column 79 with the girder stiffeners depicted as they should have been in the NIST WTC 7 report per Frankel drawing #9114.**

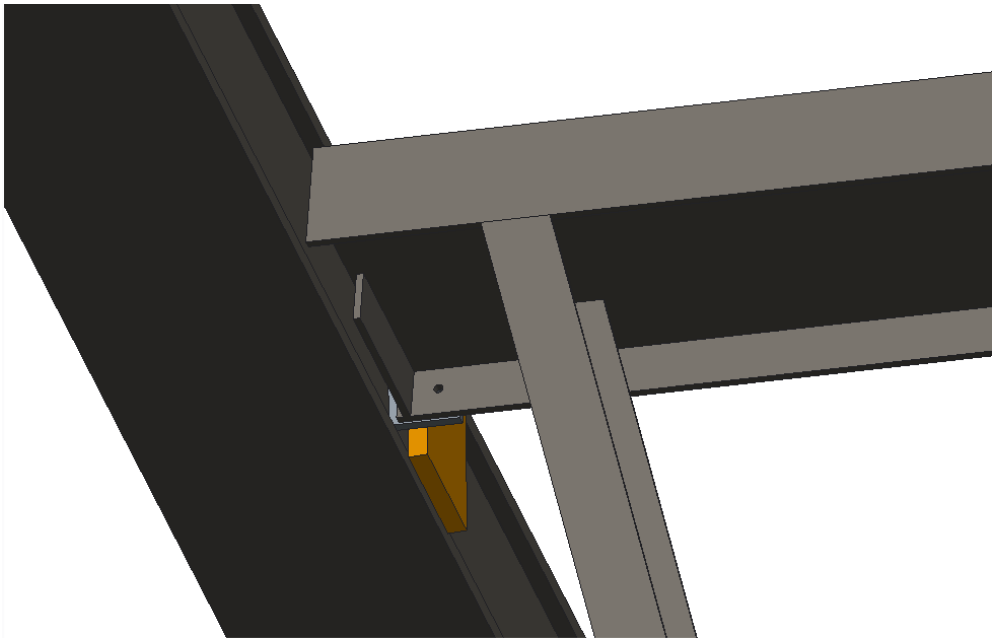

**Figure 10: Model showing how the Column 79 seated connection of girder A2001, as shown on Frankel drawing #9114, would actually appear.**

The stiffeners would have done more than simply prevent web crippling as they also strengthen and stiffen the flange. Figure 11 shows the results of an analysis with the girder web beyond the seat with stiffeners included. The stress on the flange and stiffeners is well below yield strength showing the stiffeners would prevent failure of the flange of the girder even if the web was pushed beyond the 12 inch wide seat. In reality, the centered girder web could not move beyond the edge of the 12 inch long seat due to the 5.5 inch beam expansion maximum.

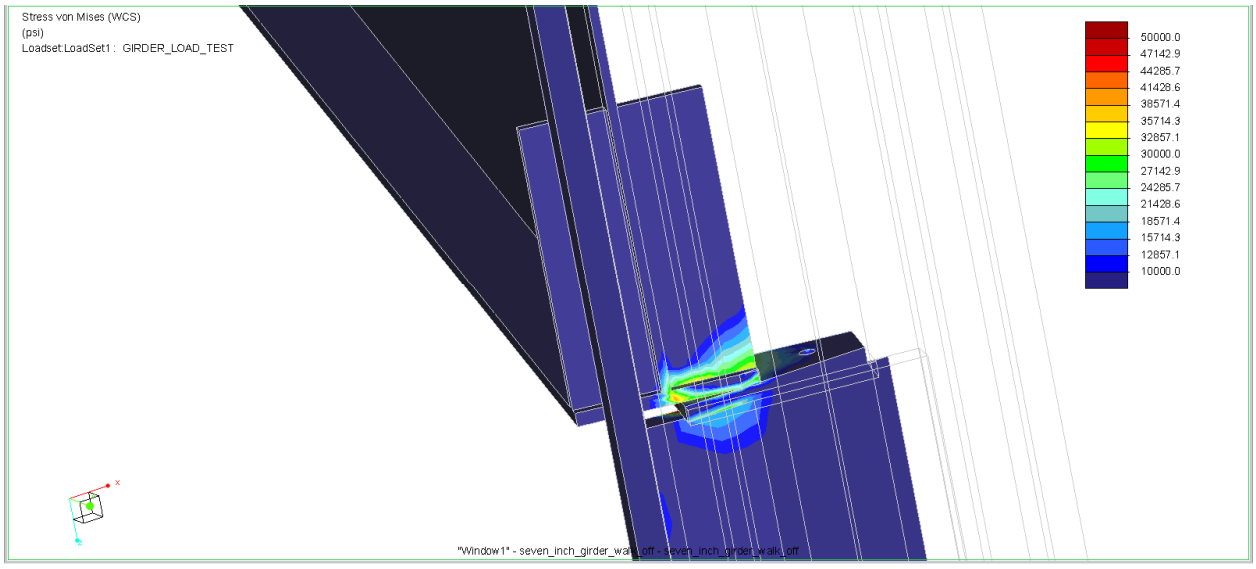


**Figure 11: Analysis showing the girder flange does not fail when the girder web is beyond the seat with stiffeners installed. The above is with 6.75 inches of beam expansion.**

The omission of the lateral support beams from the exterior frame to beam G3005 has not yet been acknowledged, although the question concerning them was also asked in the FOIA letter to the NIST dated March 19, 2012. They can be seen in Frankel drawing #E12/13 as shown in a blow up from that drawing of the northeast corner at floor 13 in Figure 12 below.


**Figure 12: Three W12 x 19 lateral support beams labeled S3007, G3007, and K3007 framing into beam G3005 are shown on Frankel drawing #E12/13 (the three beams are highlighted in green here).**

Figures 13 and 14 show the elements used in a second NIST analysis of the five floor beams and girder where beam G3005 is said to buckle due to its thermal expansion being restrained by girder A2001, to then lose its load carrying capacity, and subsequently cause the other four beams to buckle which then rocked the girder off its seats. While buckling of this beam, due to restraint from thermal expansion, is possible without the three lateral support beams framing into it, it is not possible when they are included. The lateral support beams drastically reduce the beam's slenderness and cause the required buckling force to be approximately 16 times greater than it is without them. The models from the NIST analyses do not include the lateral support beams.

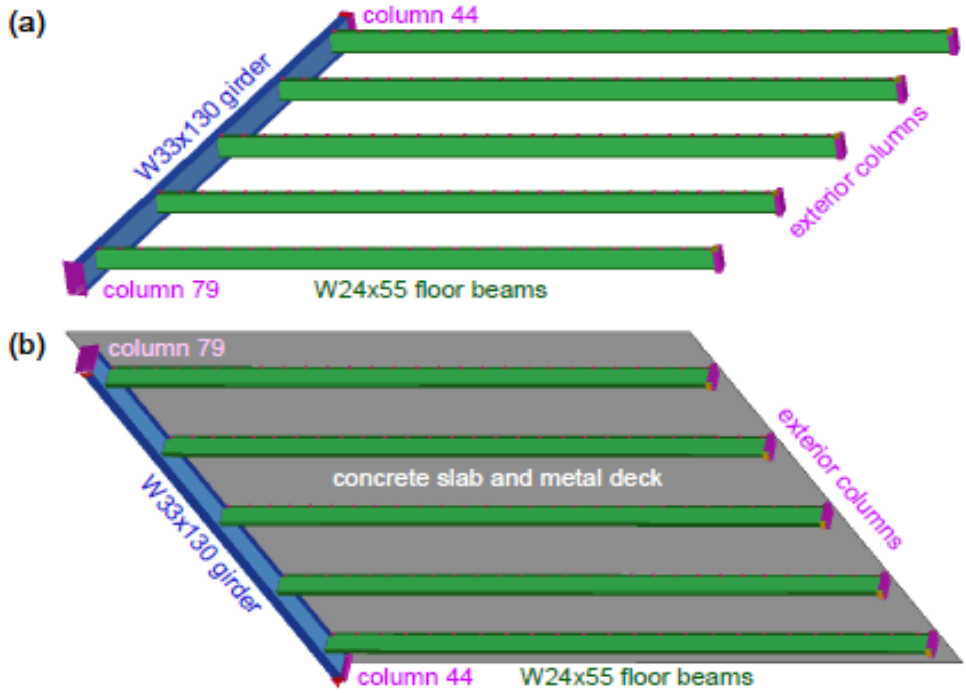


**Figure 8–22. Finite element model of northeast corner as viewed from the southeast**
(a) Top view, with deck removed; (b) bottom view.

**Figure 13: Figure from the NIST WTC 7 report does not include the lateral support beams framing into beam G3005 from the exterior as shown on Frankel drawing #E12/13.**

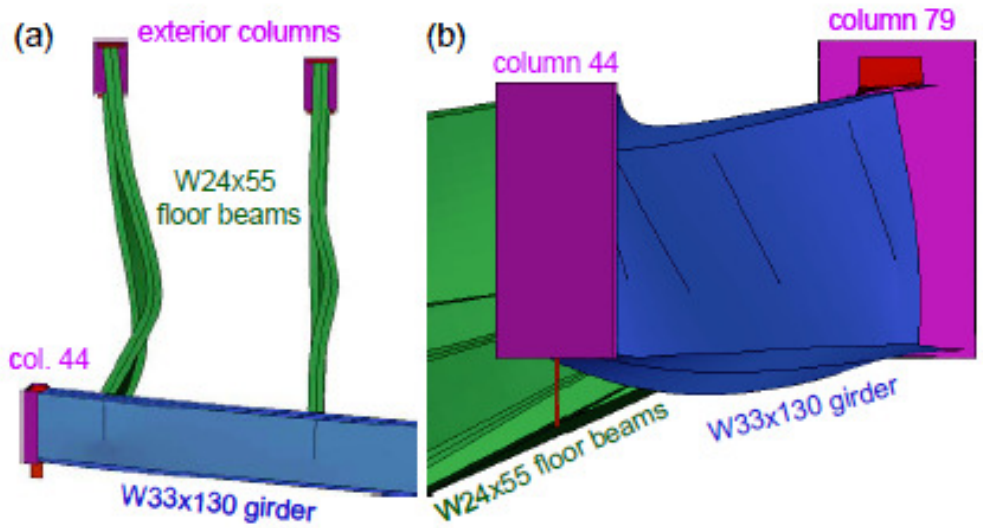


**Figure 8–27. Buckled floor beams shown from above (a) and along girder (b).**

**Figure 14: Figure from the NIST WTC 7 report showing buckling of beam G3005 does not include the lateral support beams framing into it from the exterior as shown on Frankel drawing #E12/13.**

Figure 15 shows the floor framing under the 13th floor in the northeast corner with the omitted lateral support beams included.

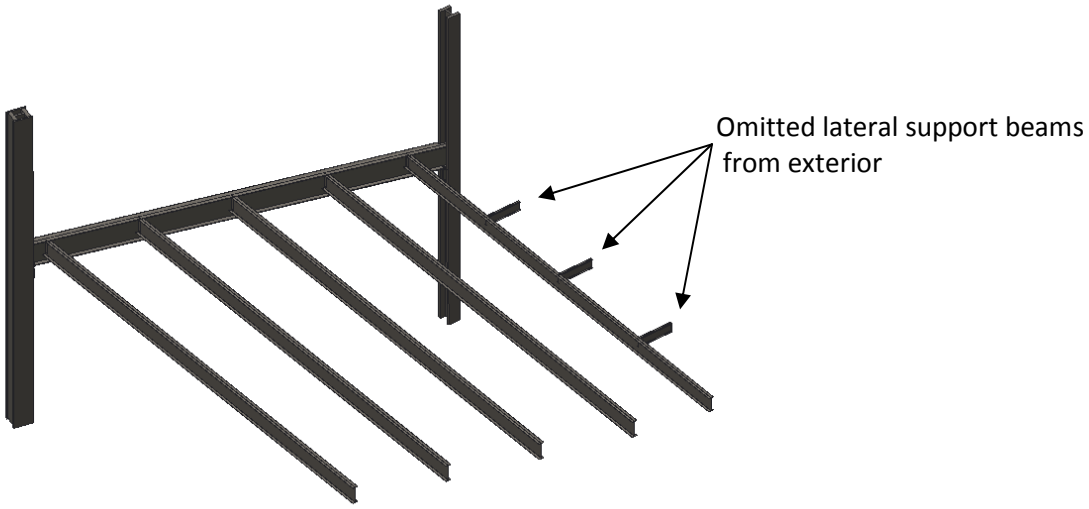


**Figure 15: Model showing the omitted lateral support beams framing into beam G3005 from the exterior as shown on Frankel drawing #E12/13.**

Figure 16 shows the results of an analysis performed with the lateral support beams included. They show beam G3005 does not buckle when the three lateral support beams are included. This is due to the beam's slenderness being drastically reduced by having the lateral support and requiring approximately 16 times more axial compression to cause buckling. With the lateral support beams included the axial stiffness of beam G3005 is significantly greater than the girder's lateral stiffness and thus when the beam was thermally expanded it would have simply deflected the girder.

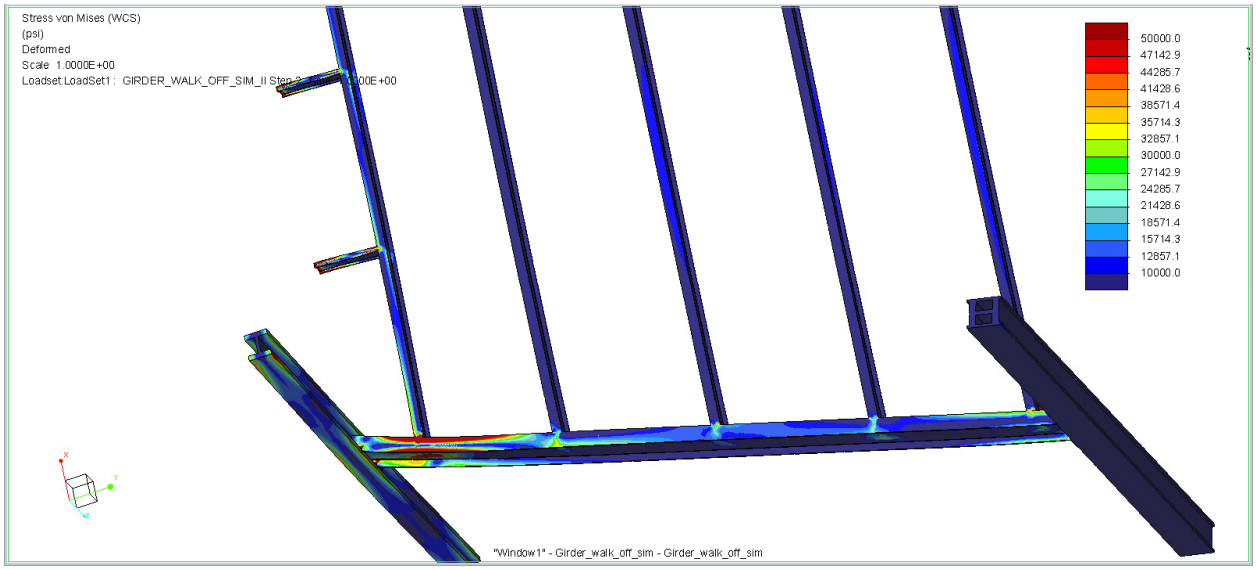


**Figure 16: Analysis results showing beam G3005 when it is thermally expanded at 600 °C temperatures and girder A2001 heated to 500 °C temperatures per the NIST WTC 7 report.**