

construction details were identified as being important. A finite element analysis of the northeast corner of the building, representing the framing of a lower tenant floor, verified that the following fire-induced failures were possible:

- Significant lateral deflections (movement) of the girder produced by thermal elongation of the floor beams,
- Failure of shear studs on the floor beams,
- Shear failure of the erection bolts fastening the girder to the seated connections,
- Failure of single shear plate (fin) connections attaching the floor beams to the girder,
- Buckling of floor beams, and
- Girder sliding off its seat connection.

Analysis of the northeast floor system showed that the fire-induced failure modes predicted by simple analyses were, indeed, realized for the case of uniformly increased temperatures. These results helped to guide the development of special connection elements that used a combination of break elements, rigid links, contact elements and elastic elements, that captured the salient features and failure modes of the various types of connections used in the floor system of WTC 7. These features and failure modes included individual bolt failure, weld failure, shear stud failure, contact between floor slab and girder (without shear studs), gap closing and contact, slip-off of seated connections, etc. In Chapter 11, the structural models that capture these features of the floor framing and connections, and their failure modes, are described in detail.

It was also concluded in this chapter, that neither a fuel oil fire, a hypothetical blast, nor fires in the Con Edison substation was a valid hypothesis for initiating collapse.

## 8.11 REFERENCES

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