Fire Endurance Testing of Floor Truss Assemblies

Prepared by:

Joe Treadway
Fred Hervey

ASTM E119 prescribes a standard fire exposure of controlled extent and severity.

Performance is defined as the period of resistance to standard exposure before the first critical point in behavior (conditions of acceptance) is observed.

Conditions of acceptance for floor systems include:

- Sustained applied load during classification period
- No passage of flame or hot gasses
- Maximum and average temperatures of the unexposed side of the specimen
- Maximum and average temperatures of the steel joists
Testing Summary

• Two tests conducted in Toronto at ULC
  August 7, 2004 - 35 ft. Restrained Assembly
  August 11, 2004 - 35 ft. Unrestrained Assembly

• Two tests conducted in Northbrook at ULI
  August 19, 2004 - 18 ft. Restrained Assembly
  August 25, 2004 - 18 ft. Restrained Assembly
  (1/2 in. fireproofing)
WTC Floor Assembly

- Concrete
- Metal Deck
- Bridging Truss
- Main Truss
Test Restraint Conditions

Restrained Test Condition

Unrestrained Test Condition
Effect of Restraint Against Thermal Expansion

A heated floor assembly wants to expand. If thermal expansion is restrained, forces will develop. The floor assembly is subjected to fire conditions.
Design and Fabrication of Test Assemblies
Preparation of Test Assemblies
Instrumentation

Each Assembly Contained:

• 159 Thermocouples
  • 44 on Each Main Truss
  • ~6 miles of thermocouple wire

• 2 Plate TC’s, 2 Radiometers, 2 Asp. TC’s

• 15 Deflection Measurements
  • 9 on Unexposed Surface
  • 6 on Bottom Chords
UL - Northbrook Furnace with Test Specimen
Loading of Test Assembly - Northbrook

- Water-filled Containers
- Hydraulic Actuators
- Concrete Block
Post Test Observations Test No. 3
Post-Test Observations – Steel Truss Behavior
Post Test Observations - Slab Deflections

Test 1 - before

Test 1 - after
## Fire Resistance Ratings

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
<th>Temperature on Unexposed Surface</th>
<th>Steel Temperatures</th>
<th>Failure to Support Load</th>
<th>Test Terminated (min)</th>
<th>Standard Fire Test Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average (Ambient +250°F)</td>
<td>Maximum (Ambient +325°F)</td>
<td>Average (1100°F)</td>
<td>Maximum (1300°F)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>35 ft, restrained, ¾ in fireproofing</td>
<td>---</td>
<td>111</td>
<td>66</td>
<td>62</td>
<td>(3)</td>
</tr>
<tr>
<td>2</td>
<td>35 ft, unrestrained, ¾ in fireproofing</td>
<td>---</td>
<td>---</td>
<td>76</td>
<td>62</td>
<td>(3)</td>
</tr>
<tr>
<td>3</td>
<td>17 ft, restrained, ¼ in fireproofing</td>
<td>180</td>
<td>157</td>
<td>86</td>
<td>76</td>
<td>(3)</td>
</tr>
<tr>
<td>4</td>
<td>17 ft, restrained, ½ in fireproofing</td>
<td>---</td>
<td>58</td>
<td>66</td>
<td>58</td>
<td>(3)</td>
</tr>
</tbody>
</table>

(1) Imminent collapse  
(2) Vertical displacement exceeded capability to measure accurately  
(3) Did not occur