Orange Grove Library, Gulfport, Mississippi

Building Overview

Prescriptive Analysis

Performance-Based Analysis

Conclusion

Building Retrofit Suggestion

Operational Analysis and Fire Code Violations
Building Overview

Headquarters for county library system:
1. Branch library (Orange Grove), 2. Administration, 3. Technical Processing and 4. Information Technology

Attached Community Meeting Room

Construction began in 2011
32,000 square feet on two floors

First floor 17,000 sf
Second floor 15,000 sf

Stairs: two protected plus accessory
Automatic sprinklers throughout
Occupancy Classification – First Floor
Occupancy Classification – Second Floor
Reflected Ceiling Plan
Cross Section of Suspended Ceiling
Atrium – Facing East, Chairs Visible
Second Floor – Facing West
Second Floor – Facing North, Column
Floor Opening Classification

Types Considered:

- Atrium

- Mezzanine

- Communicating Space
Smoke Control

- Passive smoke control only

- Smoke sensors in the air handling system

- System shuts down when smoke is detected

- Detectors in air handling system may be the first to detect smoke
Alarm Analysis

- System consists of control panels, remote annunciators, addressable alarm initiating devices, visual and audio/visual alarm devices and supervised wiring system

- Manual Pull Stations at all exterior exit doors and where required to limit spacing between devices to 200 feet
Egress – First Floor
Egress – Second Floor, Bold Line = 1-hr Fire
Egress Introduction

- Five exterior exit doors

- Relatively tall shelves (7.5 feet) block source of a fire

- Lack of fire or smoke barriers around atrium communicating space
Egress Analysis & Equivalency

IBC (2009) Section 404.9 Travel distance allows 200 feet for an atrium

Concept of Equivalency
Equal level of protection to the original code

Some measures required to make two-story as safe as one-story

NFPA 101 (2009) Section 8.6.6, Communicating Space
often referred to as the “mini-atrium” requirements
Egress Analysis – “mini-atrium”

NFPA 101 Section 8.6.6, Communicating Space
often referred to as the “mini-atrium” requirements

There are a total of 8 requirements but the following three are violated:

(3) The entire floor area of the communicating space is open and unobstructed
(4) The communicating space is separated from the remainder of the building
(8) Each occupant not in the communicating space has access to not less than one exit without having to enter the communicating space
IBC Section 1018.6 Corridor continuity
NFPA 101 Section 1006.1 Illumination
Second floor egress close-up
Second floor – outside executive suite
Second Floor – Exit Sign and Smoke Detector
Structural Analysis

- Building structure is cast-in-place concrete, including slab, second floor and lower roof
  - Exterior is also non-combustible
  - Surrounded by public way around the building perimeter
  - Maximum building height is 38 feet

Building first floor area exceeds 15,500 square feet, however, increases allowed for frontage and the sprinkler system
Structural Analysis

- Plans and specifications say only generically state that the building shall comply with the IBC.

- Plans do not list any fire protection ratings for the structural members to be used or their expected performance.
Suppression Analysis

NFPA 13, Section 5.2 Light Hazard Occupancies
Wet-pipe sprinkler system
Dry pendant on the loading dock to protect against freezing

Flow test at nearby hydrant (from drawings):
- Static 50 psi and residual 47 psi at flow 1,190 gpm
Available water supply meets the required water supply

Building appears to be in compliance with codes (for design)
International Fire Code, Fire Department Connections  
Section 912.2.1 Visible location  
Section 912.3 Access

![Diagram of a fire hydrant location and access requirements.]

- **Move These 5'-0" East**
- **Fire Department Connection, See Detail P3.1.1**
- **Fire Hydrant, See Detail P3.1.1**
- **Post Indicator Valve with Tamper Switch, See Detail P3.1.1**
- **Below Grade**
FDC, Hydrant and Post Indicator Valve
Performance Based Design – Design Brief

Design Brief: Goals, Objectives and Performance Criteria

Primary goal is life safety

Objective is to evacuate all occupants

Available Safe Egress Time (ASET) greater than Required Safe Egress Time (RSET)

Achieved by maintaining tenability at 6 ft above walking surface

Performance Criteria for Life Safety: Tenability Requirements
# Tenability Requirements

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visibility</td>
<td>10m (30ft)</td>
<td>SFPE HB, Table 63.5</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>1706 ppm for 4 minutes for Fractional Effective Dose (FED) of 0.3</td>
<td>NFPA 130, Table B.2.1.2</td>
</tr>
<tr>
<td>Temperature</td>
<td>60 C (140 F)</td>
<td>SFPE HB, p, 2382</td>
</tr>
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Performance – 2nd Goal is Property Preservation

Secure administrative storage

Performance Criteria: protection of records

1-hour rated fire barrier & rated door assembly
Design Fire - Upholstered Chairs
Upholstered chairs – close-up
Fire Dynamic Simulator (FDS)

- Assume design fire starts in the group of 4 chairs in the mini-atrium
- Assume polyurethane foam with Heat Release Rate Per Unit Area 88.0551 Btu/(s*ft^2) [metric 1,000 kW/(m^2)]
- Furniture compliant with California Technical Bulletin 133 would be better than what is assumed here
- FDS User Guide Table 15.1: Smoke Detector activation obscuration 3.24%/m (1%/ft)
  - Assume fire sprinkler activation at 165 F (74 C)
- Boundary for FDS model is the all upper atrium space and the most of the lower atrium space
Mesh Boundary in Green
FDS Perspective View
Device Activation, Sensitivity Analysis

[Bar chart showing time (s) for different device activations, with '300 sec+' indicating a time above 300 seconds.]
Tenability Requirements

![Bar chart showing time (s) for different conditions: Visibility, four x four; Visibility, two x two; Temperature, four x four; Temperature, two x two; Carbon Monoxide, four x four; Carbon Monoxide two x two. The bars indicate time beyond 300 seconds for Temperature and Carbon Monoxide conditions.](image-url)
4’x4’ fire, minor tenability loss, temperature at 157 seconds
4'x4' fire vent, minor tenability loss, visibility at 30s
2'x2' fire vent, minor tenability loss, visibility at 48s
Safe Egress Time

Pre-movement time: 2 minutes
Travel time: 0.5 minute
Flow through doors: 2.2 minutes
Total Evacuation Time: 4.7 minutes

Required Safe Egress Time (RSET) for second floor occupants is 4.7 minutes.

Available Safe Egress Time (ASET) based on tenability requirements is 30 seconds (4’x4’) or 48 seconds (2’x2’) for visibility.
Conclusion

Because of the fire plume height and large volume of space in the atrium communicating space:

1. Smoke is less dangerous to humans  
   (lower temp & lower CO concentration)
2. Smoke is less likely to activate detection devices

There is a good chance this building will lose tenability due to smoke obscuration before the detection devices activate.
Operational Analysis and Fire Code Violations
First floor children’s area – plan
IBC Section 1015.2  Exit or exit access doorway
NFPA 101 Section 1006.1 Illumination
NFPA 101 Section 7.1.3.2.3 An exit enclosure 1
NFPA 101 Section 7.1.3.2.3 An exit enclosure 2
NFPA 101 Section 7.1.3.2.3 An exit enclosure 3
IFC Section 315.3.3.3 Equipment rooms 1
IFC Section 315.3.3 Equipment rooms 2
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