Property Risk Consulting Guidelines

XL Risk Consulting

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PRC.17.6.2

HIGH-RISE BUILDING CONSTRUCTION

INTRODUCTION

For the purposes of this document a high-rise building is one in which fires must be fought internally because of height, i.e. the upper stories are beyond the effective reach of fire department aerial equipment, commonly considered to be 75 ft (22.9 m). However, the conditions covered in this document also could be applicable to buildings with a height less than 75 ft (22.9 m). The general occupancies of high-rise buildings are offices, with attendant support areas, and/or residential areas, such as apartments, hotels, and condominiums. Lower floors may be occupied by casinos, shops, meeting rooms, restaurants, or a parking garage, while the top floors may house clubs or restaurants.

Fire protection philosophy for high-rise buildings must recognize and reflect the impediments and difficulties these structures inherently impose upon fire department operations. The logistics of gaining access to the building and placing personnel and equipment on the upper floors emphasize the importance of internal protection features and the resultant need for a coordinated and conservative approach in their design. Firefighting has increased reliance on internal protection features, such as effective smoke control through the use of the air conditioning systems, elevators to gain access to below the fire floor and the dependence upon automatic sprinklers, booster pumps and standpipes to help extinguish a fire. PRC.17.6.1 covers the fire protection aspects of high-rise buildings.

The guidelines offered are for the protection of property. No attempt has been made to cover the detailed aspects of life safety, although it is generally recognized that comprehensive protection of property has a significant, positive influence upon the security of the building occupants.

As a result, of recent fires in high-rise buildings, concerns for the building construction, including the attachment of the curtain walls (exterior walls) to the structure, openings in the floor/ceiling system and the layout of the HVAC system, have surfaced. In these cases, improper installation could cause a fire to spread unchallenged vertically until the fire passes through the roof.

In one major fire, the fire spread vertically because the space between the curtain wall (exterior wall) and floor system was not filled in with fire resistant material. The heat and smoke from the fire breached the ceiling system and passed through the space between the floor system and curtain walls, igniting the combustibles on the floor above. During the same fire, fire fighters discovered fire damaged a closet, 15 floors above the top fire floor. The closet contained paper products and the HVAC duct. The duct started on the ground floor, passed through the fire floors and through this closet. The paper products that were adjacent to the duct ignited due to hot exterior duct surface.

POSITION

Building Structure

Fireproof all structural steel in the high-rise using a material with a 3-hr fire-resistance rating by ASTM E119. Take precautions during construction that the fire-proofing material is not removed from the columns, beams, or girders to allow clamps or other material to be attached. Replace any fire-proofing material that has been removed.

Provide fire resistance rating of major structural components for a high-rise building as follows:

- 3-hr for columns
- 2-hr for floor slabs & beams
- 2-hr for shafts and chases
- 2-hr for stairwell and elevator enclosures

Protect all openings between floors found in shafts, chases and stairwells, or openings in partitions between floor areas by fire doors. Provide normally closed or automatic closing fire doors having a fire rating of at least 1½-hr. Protect all openings into the tower with 2-hr rated, fire dampers.

Protect all openings in floor slabs used for utilities (poke-through) with either UL listed or FM approved floor penetration fire stop with a minimum 2-hr fire resistance rating. Minimize the number of openings in each floor and arranged so that water cannot pass through.

Use non-combustible panels used for exterior walls. Examples include concrete, masonry, or glass fiber insulated steel sandwich panels. Secure the panels and frames tightly at each floor to prevent outward buckling under fire exposure.

Curtain Walls

Fire stop the space between the floor and the back part of the curtain wall. Spandrel areas must have non-combustible insulation at the interior face of the curtain wall. Curtain walls need to be securely attached to each floor to help minimize buckling and failure during a fire. Figures 1 through 4 show typical curtain wall construction.

Major Horizontal Penetrations

Separate atriums, open stairwell, and other open areas that extend between multiple floors from adjacent occupied areas by a smoke-tight fire partition having a fire-resistance rating of at least 2-h. Protect openings with fire doors with a minimum 1½-h fire rating. Protect any windows in the fire partition with a minimum 1½-h fire rating glazing.

Exterior Insulation and Finish System (EIFS)

If an EIFS is used as the curtain wall, use only EIFS that are tested and listed by a nationally recognized testing laboratory. The listing must be based on a large scale fire test. For a further description of EIFS, see PRC.2.0.2.

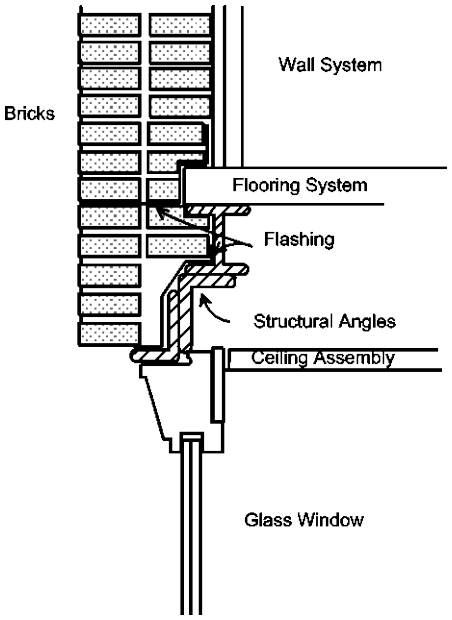

Figure 1. Brick Curtain Wall.

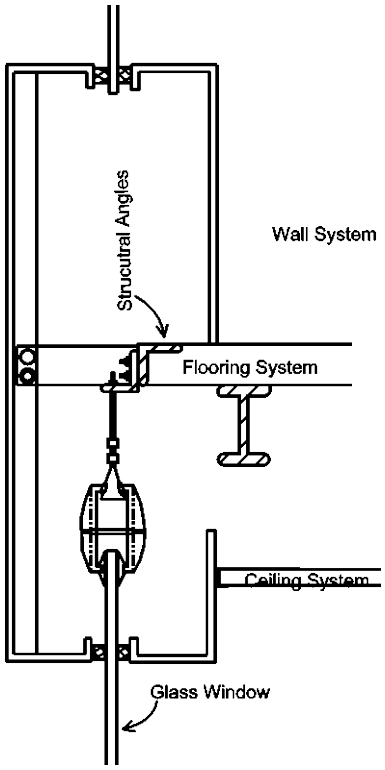

Figure 2. Hanging Glass Curtain Wall.

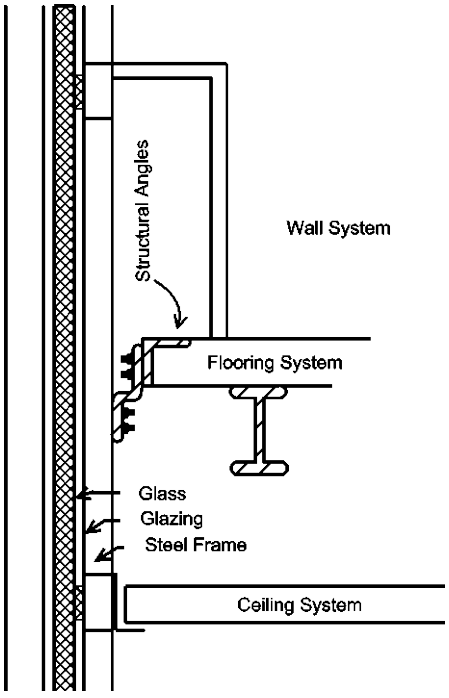

Figure 3. Glass In Metal Frame Curtain Wall.

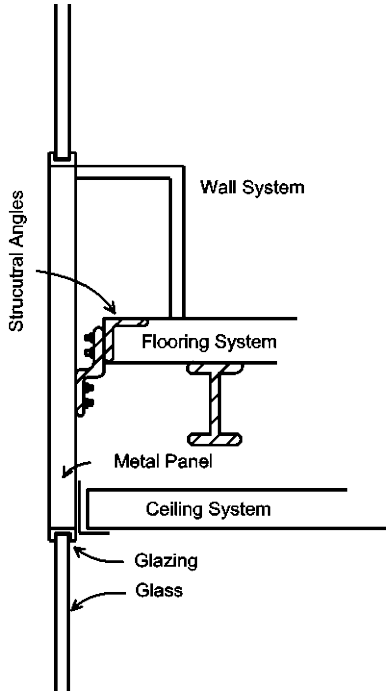

Figure 4. Glass And Metal Panel Curtain Wall.

Smoke Control

Depending on floor areas (which may vary considerably in some high-rises), the HVAC system should be zoned for the building vertically with a maximum of 20 floors per zone. Arrange the HVAC system so that fire dampers for the air supply would shut down upon detection of smoke on the fire

floor. Keep the supply dampers on the remaining floors open and continue to operate the air supply fans.

Keep the fire damper on the return (exhaust) side of the fire floor open and shutdown the fire dampers on all other floors. This arrangement would allow the floors above and below the fire floor to over-pressurize and retard the smoke migration, and allow the heat and smoke to vent to the outside through the return (exhaust) side of the HVAC system. Locate the exhaust outlet for the system in such a manner that the smoke would not re-enter the building through the fresh air inlet. Design the duct work to withstand the maximum possible overpressure stress. (Refer to Figure 5 for a typical HVAC system layout.)

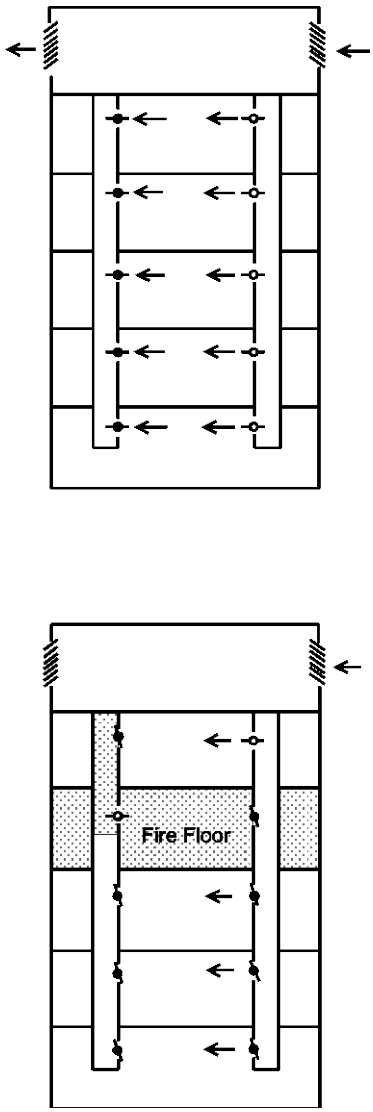

Figure 5. Heat And Smoke Venting Using The HVAC System.

Fire dampers installed between fire rated walls should be provided with break away connections. The break away connection is a joint connecting a fire damper sleeve and attached ductwork that will allow collapse of the ductwork during a fire without disturbing the integrity of the fire damper. (See NFPA 80)

If smoke towers are present, utilize the HVAC system to vent heat and smoke. Open the damper on the fire floor and shut the remaining dampers. Pressurize stair towers to allow fire fighters clear

access to the fire floors. Design the smoke removal and control system in accordance with PRC.2.1.4, NFPA 90A and NFPA 92.

DISCUSSION

Curtain Walls

Firestopping at the perimeter slab edge, which is the gap between the floor and the backpan of the curtain wall, is essential to slow the passage of fire and combustion gases between floors. It is important to note that the fire stop at the perimeter slab edge is considered a continuation of the fire-resistance rating of the floor slab. The curtain wall itself, however, is not ordinarily required to have a rating. If a curtain wall is non-rated, the area or room is not considered a fire compartment and a fire could spread vertically. The use of sprinklers has been shown to mitigate this matter. As such, unless the building is sprinklered, fire may still travel up the curtain wall, if the glass on the exposed floor is shattered due to fire influence, causing flames to lick up the outside of the building.

Exterior Insulation and Finish System

Many modern high-rise buildings, especially Casino Hotels have exterior walls covered with EIFS. EIFS is a system that uses an insulating material on the outside of the building that is then covered with either a stucco or an acrylic material. The insulation material can be either mineral wool, expanded polystyrene (EPS) foam plastic, or polyisocyanurate foam. Most EIFS use EPS as the insulation. The use of EPS provides both a continuity of combustibles and a high heat release of fuel (18,000 Btu/lb or 41.9 MJ/kg). It can contribute substantially to the growth and spread of a fire in both exterior fire propagation (vertical & horizontal) and in internal fire propagation.

External fire propagation can occur over the face of the EIFS, within the core insulation, or over the outer face of a combustible substrate. Internal fire propagation is within a stud cavity or on the building interior. If EIFS is installed improperly or without an approved fire coating, or the coating is not thick enough, the coating and insulation sheets can delaminate from the structure creating a serious fire exposure. Increased damage by fire and smoke is expected in a fire involving EIFS construction. With walls of combustible EIFS plastic materials several hundred feet in elevation, the potential for a devastating high-rise tower fire is substantial. EIFS systems over 4 in. (100 mm) thick in particular are a major fire concern, with anticipated extensive vertical fire spread.