Pic courtesy of RJA Group

Challenges to the designer:

Exiting from high-rise & large mixed-use buildings

High-rise and large mixed-use buildings are located throughout the world. These facilities have the potential to contain a tremendous amount of occupants, especially gaming resorts. Finding a way to egress building occupants in an emergency can be a challenge depending on the complexity of the facility and the uses within the complex. When multiple uses come together in one of these facilities, the exiting challenges can grow exponentially. These facilities are sometimes referred to as "Mega Resorts".

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Typically designed around a casino and hotel premise, Mega Resorts have developed to include all the amenities a consumer could imagine within one facility. Obviously, this is intended to keep occupants at the same place to maximize revenue (e.g., gaming, entertainment, retail, restaurants, etc.).

Las Vegas, Nevada and Macau, China are two such destinations that have taken the concept of the Mega Resort to new levels. Although Las Vegas has been a part of the resort industry for over fifty years, ideas for larger and more encompassing resorts to replace those previously in operation has been the norm over the past twenty years. These facilities are attracting tourists by the millions each year. Macau is relatively new to the resort industry, but has not suffered for lost time and is predicted to be just as glamorous and stimulating as Las Vegas.

Dubai, located in the United Arab Emirates, has also recently entered the construction of extremely tall and large facilities. Although not associated with gaming, the facilities in Dubai do not lack in size or substance. However, these facilities also present significant challenges to the designer to determine how to address a satisfactory means of egress.

The layout of the Mega Resort typically includes a parking structure, podium levels, and residential high rise towers. The podium levels are typically arranged to house the amenities for the public. Whether it be theaters to attend Broadway style

Pic courtesy of RJA Group

productions, a retail complex that would rival any local mall, an expansive pool, multiple restaurants and nightclubs, or a wedding chapel; these uses, that by themselves could pose unique egress concerns, have been incorporated within these mega facilities to push the limits of the egress system. The number of podium levels varies from resort to resort and is generally between one to five levels. The hotel tower provides thousands of rooms and suites for overnight guests.

Challenges

Typically, the larger the resort, the greater the challenges presented for life safety related systems within the facility. Each facility competes with its predecessors to have a more elaborate theater, a larger convention center, a more expansive casino floor, taller residential tower accommodations, unique shopping opportunities, varied dining experiences, and amenities to better a patron's overall experience and entice future visitors. Tower heights, large occupant loads, multiple uses, proximity to property lines, paths for exit discharge, common path of travel, and travel distances are common challenges for these resorts.

Within every large facility there are multiple high-rise stairs serving the hotel tower, levels of the podium, and the parking garage.

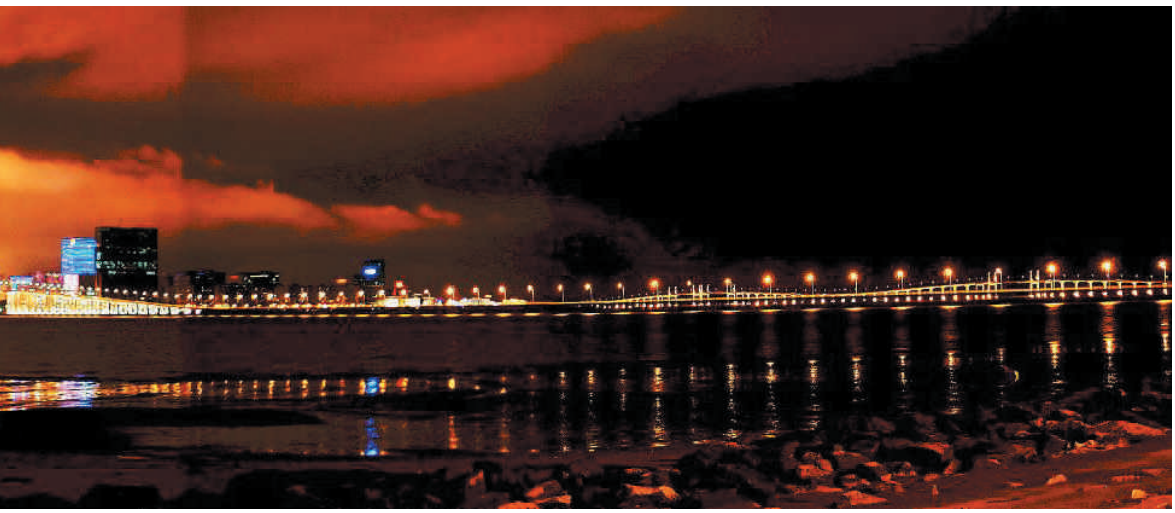
These resorts contain just about everything a city does. Almost all the major occupancies called out in the International Building Code (IBC) are in these facilities. In addition to the amenities provided to patrons (gaming, shopping, dining, etc.), there are just as many back-of-house support areas. Many times these areas are even located on intermediate levels that patrons do not even know exist. These support areas often include offices, mechanical and electrical rooms, storage, kitchens, and loading docks. On occasion, these back-of-house areas can also include hazardous occupancies, such as fuel for emergency generators and fire pumps, bulk pool chemical storage, etc. Because of the multiple occupancies located within the resorts, additional challenges come with these mini-cities. Occupancy separations, high security areas, the desire to keep the public out of unoccupied spaces, or employee only areas also add complexity to the egress design. Additionally, these massive properties are all contained within sites that can range from 20 to 70 acres. Compare this to a city whose high density could be spread over 10-square miles. Each resort is jammed packed into these sites and the building or buildings can also approach adjacent property lines. Space within these facilities is at a premium and exiting is not always the initial focus of the designers.

Sometimes coinciding with these mega resorts and other times standing alone, it is common practice to have residential or office high rise towers in excess of 500 feet. Sometimes these facilities reach more than 1,000 feet above grade. These heights lead to new challenges in exiting.

Within every large facility there are multiple high-rise stairs serving the hotel tower, levels of the podium, and the parking garage. Many of these stairs face the challenge of exit discharge due to their location within the facility. Many of these stairs are not located on the exterior portion of the facility. As such, these stair terminations reside in the middle of the resort. Once occupants achieve a level of protection (i.e. a two hour exit enclosure), that level of protection or greater must be provided to the exterior of the building. Through the use of intermediate levels, horizontal stair transfers may be added to avoid having a two hour enclosure running through the main podium levels.

With facilities of this magnitude, exits need to be distributed evenly. The IBC limits the maximum distance an occupant is allowed to travel before reaching an exit, as well as the maximum common path of travel. Typically the main podium levels of large resorts stretch well over 1,000 feet in one dimension. Now, not only is capacity an issue with exits, additional exits need to be provided and placed to address maximum travel distances. Maximum travel distances are quantified within the IBC based upon the occupancy group, and whether automatic sprinkler protection is provided. For most occupancies within these fully sprinkler facilities, the maximum travel distance from any point to the closest exit is 250-feet.

Another component of the means of egress



system is the limitation of the maximum common path of travel. Common path of travel is defined in the IBC to be "that portion of exit access which the occupants are required to traverse before two separate and distinct paths of egress travel to two exits are available." Common path of travel challenges within these facilities typically occur in back-of-house areas and large residential units. Rooms or spaces that may require only a single exit due to a limited occupant load would require a second exit if the common path of travel was exceeded.

The maximum occupancy for these facilities rivals the total population of many cities. For example, the average new gaming facilities must accommodate anywhere between 70,000 to 100,000 occupants worth of egress capacity, with some of the larger facilities approaching over 250,000. This is due to not only these facilities being very large, but also the IBC requirement that all portions of the building be considered to be occupied simultaneously. Large occupant loads are a major concern for the egress systems within these Mega Resorts, since available floor space needs to include exits. Space within these resorts is at a premium and the location of these exits is a critical balance. Additionally, the largest of these occupant loads are not always located at grade level. As a result, there could be 20,000 to 40,000 occupants on each of the podium levels. These loads could account for up to 750 feet of exit width. This is a considerable amount of space when trying to maximize revenue generating space within a building. It has also become common practice to put large assembly uses at the top of residential towers, such as night clubs, restaurants, pool decks, etc. This issue results in larger exit stairs that potentially take away from guest rooms, condominium units, or even leased areas on lower tower and podium levels.

Solutions

There are several solutions that can be used to alleviate the impact on exit width for these facilities. These solutions may all need to be used depending on the level or sometimes only one will resolve the exiting issues. Two examples of pre-scriptive code compliance that may address exiting challenges include scissor stairs and horizontal exits. A third solution to improve the impact on exit capacity, when allowed by the local authority, is separate evacuation zones. There are two additional solutions for high rise buildings to aid in the evacuation occupants. These solutions include the use of area of refuge floors or the use of elevators in full building evacuations. Some facilities may require both.

Scissor stairs are a great way to add to the capacity of an exit without significantly increasing the width. Each scissor stair will have two separate entrances with two separate sets of treads that criss-cross each other. However, it is important to remember, that scissor stairs can only add to the capacity of an exit. Even though there are two separate entrances into this stair, it can only be considered as one exit since they are essentially within one stair shaft. It should be noted that some international codes recognize double helix stairs as separate exits. These are similar to scissor stairs in that the two sets of treads criss-cross each other. The difference is that each set of stair treads, landings and stair entrances are separated from each other by two-hour construction. Although explicitly not permitted by the IBC, this means of stair construction has been utilized successfully in several areas of the world to

Jin Mao building in Shanghai, PR China. Picture courtesy of Rolf Jensen & Associates

Pic courtesy of Jalite plc

address required additional exits.

Horizontal exits are another solution that can be utilized to approximately double the number of exits and the amount of exit capacity without a need for additional stairs. Since up to 50 percent of the number of exits and capacity can be configured with horizontal exits, this can help reduce stair widths within the building. Horizontal exit walls are required to be continuous from the exterior wall to the exterior wall of a building creating a two hour fire resistive constructed separation between the two areas. Once occupants have crossed the two hour barrier, they are considered to have exited the area being evacuated. However, on the opposite side of the horizontal exit wall, a refuge area providing sufficient room for the exiting occupants, as well as the occupants already anticipated in that area. From the refuge area, occupants are required to be provided with a clear path either directly to the exterior or to a rated stair enclosure to take them to the exterior of the building. Horizontal exits are an effective means of egress for convention centers, ballrooms and theaters, as well as dividing casinos from other areas of the resort. These inherent architectural boundaries for these uses can then be effectively are utilized for horizontal exit purposes. For podium levels located at grade, the use of horizontal exits and multiple exterior exits is usually sufficient to meet the exiting needs.

When allowed by the local authority, a third solution that is typically used on high density podium levels is separate evacuation zones. Evacuation zones coincide with the fire alarm, sprinkler, and smoke control system boundaries and naturally utilize the horizontal exit walls as some of the boundaries. When using separate evacuation zones, the entire floor no longer exits at the same time. Occupants within one zone would exit, while the other zones would remain in normal mode. This way both exit stairs and horizontal exits can be used by multiple zones and in a sense utilizing the same exit capacity many times. Evacuation zones are a viable option because with these mega resorts the type of construction (Type IA or IB) is the most restrictive and in a sense each zone is enclosed by two hour rated construction. Using separate evacuation zones is an extension of the provisions allowed for a horizontal exiting scheme, since not all areas of the floor will be evacuated.

Due to the significant height of high rise towers, additional protective methods may be

considered and utilized for the overall exiting system. Although not a requirement within the IBC area of refuge floors are a means to allow occupants to gather and rest during an event within exceedingly tall high rise structures. Typically located every ten to thirty levels depending on the project and jurisdiction, refuge floors are either open to the atmosphere or completely enclosed. Refuge floors are of the same construction of the stair shaft that it serves and sized to allow for three square feet per person of the floor of alarm, floor above, and floor below since those would be the floors evacuated. Occupants can enter these levels only from the exit stair. These levels are used to have occupants gather for further instruction by trained personnel (either building management or fire rescue). These levels can also be used as a resting place for occupants because should they want to continue, occupants would re-enter the stair and continue down to the next refuge floor or to the building exterior.

Though it is not a new practice and not recognized by the IBC, the use of elevators for ambulatory evacuation is still being defined through different projects in the world depending upon the height and complexity of the facility. The most effective use of elevators for this type of evacuation is typically when the building as a whole needs to be evacuated. Should this be the case, through the use of the voice evacuation system, occupants would be instructed to meet on designated floors (by means of an exit stair) where elevators would pick occupants up and take them to the ground level. The elevators are on both normal and emergency power and are only used once the building and building systems affecting the elevators are deemed safe.

As an alternative to the prescriptive requirements of the building code, performance based solutions may also be utilized for numerous aspects of the required means of egress, including extended travel distances, and increased exit capacities. These solutions may include tenability analyses to determine the maximum amount of time occupants are provided with a tenable environment to exit the area under consideration. Timed egress analyses can then be computed to determine the maximum travel distances that occupants are permitted given this tenability analysis. Further, computer based models can also be utilized to determine if exit components can accommodate greater numbers of occupants, also based upon this tenability analysis. Of course, these solutions are also dependent upon the authority having jurisdiction being comfortable with the conclusions of these analyses.

Summary and conclusion

These Mega Resorts or high rise buildings can be overwhelming from a life safety aspect, especially the required means of egress systems. Breaking the facility down by levels and areas helps alleviate the prospect of having to exit an entire facility simultaneously, which can rival the size of small cities. It can be broken down into the same categories as above; high rise levels, garage, and podium. From there, each level may need to be further broken down and evaluated. Parking garages are usually the lesser challenging aspect of the facility followed by typical residential levels. However, the more challenging residential levels with larger guest suites or the upper levels containing high density occupancies (night clubs, pool decks, restaurants) as well as the podium levels will need to apply several of the solutions listed above.

Mega Resorts and high rises are the norm as desired destinations throughout the United States and the world. Exiting from these facilities is extremely challenging when dealing with so many factors, while trying to keep the design intent of the owner and architects in mind. Since floor space is at a premium, cost on the high density floors, creative solutions to exiting are almost always required. Through the use of multiple stairs/exits, scissor stairs, horizontal exits, separate evacuation zones, interior stair transfers, area of refuge floors, and elevator evacuation, these buildings can be designed efficiently to provide both entertainment and safe evacuation for those patrons. The ultimate design is to make the required exits augment the architectural design. IFP