Tall Residential Buildings Present Special Problems

In large cities a trend towards tall and luxurious residential buildings in central locations is noticeable. The problems of commuting between a faraway home and a city center are fuelling this trend.

The essential difference between tall office and residential buildings is their population. A tall office building will have a dense population of several thousand people, while an apartment building of the same height is likely to have a population of only several hundred persons. For this reason, multiple building zones, each served by a group of elevators, are not a viable solution for tall residential buildings. These groups are too costly in terms of capital, space and energy requirements. Groups in office buildings must be able to deliver high transport capacities and short time-dependent service qualities. Transport capacities are not the major problem of high-rise residential buildings; their greatest challenge is providing short wait- and travel times.

Although high transport capacities may not be essential for high-rise residential buildings, building planners should take into consideration evacuation capacity. Also in the future a building owner may want to convert a residential building into a hotel, office building or a combination of both. To protect the future market value of a building, the elevator plan should enable a different future usage. Consequently, elevator configurations for high-rise residential buildings should deliver:

- Short wait and travel times
- Adequate transport capacities
- Configurations that enable alternative future usage.

Multi-Deck Cars

For tall residential buildings, elevators with multi-deck cars enable economical configurations that solve their special problems. Cars that simultaneously serve two or more floors during one stop substantially reduce the number of destinations. This implies stops are minimized under all traffic conditions improving both time-dependent service qualities and transport capacities.

The decks of a triple-deck car can be identified with characters “A”, “B”, and “C”, and each deck serves a fixed range of floors. For example, upper floors one to three could be one destination for a triple-deck car group. Deck “A” serves floor one, deck “B” serves floor two and deck B floor three. The assignment of each car deck to specific floors is permanent. The next destination could be floors four to six, and so on. This concept can be applied to any group with any group control system.

A group with two triple-deck cars can serve an apartment building with 36 floors. This group would have only 12 destinations and could be a very economical configuration for a 36 floor apartment building. Floor zero could be three car-park levels assigned to residents of the “A”, “B” and “C” floors. The main pedestrian entrance could be level “B” of the car park, with stairs leading to the next lower and higher elevator lobbies for decks “A” and “C”. An elevator between the parking floors could assure wheelchair access to all floors.

Assuming each floor has two or three apartments, traffic to and from the six or nine apartments of each destination will be defined by the traffic these apartments generate. The maximum number of stops of each car during each round trip is defined by this low number of destinations. The contract speed of the triple-deck elevators could be 4 or 5 mps. This configuration will deliver fairly good service qualities for 36 a floor apartment building; however, if one elevator is out of order, service will be poor. It is obvious that for a 36-floor apartment building, a three car triple-deck group would be a better configuration. Â 3-car group will provide a high evacuation capacity and facilitate conversion for office usage. An office tenant requiring offices on two or more floors could be accommodated on floors “A”, or floors “B” or “C”. If the building plans include an empty hoist way, the three-car group could even be extended to four cars and provide 36 office floors, in three zones, with very good elevator service qualities.

What is true for office buildings also applies to apartment buildings: elevator service qualities depend entirely on building planning.

Planning Considerations

The distances between the levels of “A”, “B”, and “C” floors should be identical to match distances between the “A”, “B”, and “C” levels of triple-deck cars. The distances between floors “C” and “A” may vary. The contract load per deck could be 600 KG or even less. If cars should facilitate the occasional transport of large objects, one or two cars might have extra space behind a re-movable rear wall for special transports.

The Avighna Park apartment complex in Mumbai, India.

A news item in ELEVATOR WORLD’s December 2011 issue has been the spark that initiated the writing of this paper. This apartment complex will have 54 floors of apartments above nine parking floors. Apartment floors one to 24 are served by two single-deck elevators with a contract speed of 4 mps. The apartment floors 24 to 54 are served by three single-deck elevators with a contract speed of 6 mps. Two single-deck service elevators provide access to a total of 60 floors. The distance from the lobby at floor zero to apartment floor 54 is 240 m. The main structure of this complex consists of two apartment sections, each served by seven elevators as outlined.

The building’s website shows many details about interior designs, a two-level sports club above the car park and other amenities. The author could not find any reference to the quality of elevator services or elevator control systems. Also floor plans or numbers of apartments are not provided. Despite the lack of detailed information, it is of interest to study this project and to speculate on its elevator service qualities after completion.

Traffic Conditions

This building with 54 floors of apartments will at most times generate a light or medium level of demand for elevator services. Please note that even a light demand for service cannot be immediately satisfied due to long travel distances. If we envisage the cars serving the high apartments as a string of three rotating cars that are equally distributed over the total up and down travel distance of approximately 480 meters, we will note that the ideal average distance between cars is 160 meters! The two- and three-car groups will have service quality problems on account of the long distances between cars and the large number of floors served. During periods of light or medium traffic this may not cause great problems but during periods of heavy traffic service qualities will be poor.

The club and sport facilities on two levels are likely generate extra traffic that may coincide with heavier traffic to and from apartments. Both groups have doors at apartment level 24, which may indicate the building has shared amenities at its top floor that may cause additional traffic. If not the doors of the low-rise group at level 24 could be omitted. A unique problem for this building will be the two service elevators serving 60 levels. These elevators will be dysfunctional and probably require attendant operation to enable service by appointment. This implies a large share of the services normally provided by the service elevators will have to be provided by the passenger elevators.

Performance Evaluation

Direct trips from floor zero to 54, a distance of 240 m, will take approximately 52 seconds if the contract speed is 6 mps. This includes 4.5 s. for door operation and 7.5 s for acceleration and deceleration. For each intermediate stop we will assume an additional average time cost of 10 seconds for door operation, acceleration, and deceleration, because average trip distances between intermediate stops will be shorter. For each passenger we can assume a time cost of 2 seconds for car entry and exit. These data enable simple performance evaluations.

If we assume the three cars of the single-deck group serving floors 24 to 54 make five intermediate stops during an up trip to the top floor and five more stops during the down trip and transport a total of 11 passengers, the minimum round-trip time will be: 52 + 52 + 10 X 10 + 22 = 226 s. The theoretical minimum for the average interval between car departures will be 226 divided by 3 = 75 s. The theoretical minimum average waiting time is 75 divided by 2 = 38 s. The average travel time in the car will be approximately 70 seconds. If one elevator transports an average of 5.5 passengers UP and DOWN in 226 seconds the 3-car group can transport about 22 passengers UP <u>and</u> DOWN in a 5 minute period. If we assume the population of the 30 floors served is 400 persons a transport capacity of 5 % of the population per 5 minutes <u>in both directions</u> may give the impression that the elevators as planned may be able to provide acceptable service qualities.

This impression is misleading because the real challenge for the elevators are periods of heavy UP and DOWN traffic, for example during the early evening hours when guests arrive for cocktail or dinner parties and other residents are leaving for activities elsewhere. Under these circumstances a relatively short period of high traffic densities will cause long waiting times and may create a backlog of waiting passengers that will take a much longer period to clear when demand for transportation declines. The inability of the single deck elevators to satisfy traffic peaks is the real problem of this building. The large numbers of floors served, the long travel distances caused by their positioning above 9 car park floors, is unusual and will be the cause of unsatisfactory service qualities during periods of heavy traffic.

Intelligent group controls can deal with the problems of the single-deck cars outlined above and assure equitable service qualities for all passengers. These controls reply to each service call of a passenger with an assignment to a specific car. This implies that during periods of heavy traffic long waiting times will be equitably distributed over all passengers. Intelligent group controls will have full control of car operations under all traffic conditions and optimal group efficiency can be contractually guaranteed. However, readers should be aware that a group control system cannot compensate planning shortcomings. It will equitably distribute the discomforts of poor planning.

Alternative Configurations

Building construction appears to be well underway. To increase the number of hoist ways for other solutions with single-deck elevators is probably impossible. However, with **multi-deck elevators** it will be possible to substantially improve elevator service qualities.

Configuration One
A group of triple-deck cars serving all 54 apartment floors, i.e. a group with 18 destinations. Each destination consists of three apartment floors. The lowest floor of each destination is always served by deck “A,” the next higher floor by deck “B” and so on. With the five hoist ways as planned the triple-deck group might consist of three to five elevators. A group of three triple-deck cars serving all 54 apartment levels will deliver better service qualities than the five single-deck elevators of the present plans. A four car triple-deck group would greatly improve service qualities. A five car group will deliver service qualities that probably can be qualified as very good.

Configuration Two
Two groups, each with two double-deck cars, could serve all 54 apartment levels. Level zero of both groups could be a split-level lobby floor. Double-deck group “X” would serve 14 destinations and double-deck group “Y” would serve 13 destinations. Each destination consists of two apartment levels.
Deck “A” of the “X” group serves 14 levels: 1-5-9-13-17....49-53
Deck “B” of the “X” group serves 14 levels: 2-6-10-14-18...50-54
Deck “A” of the “Y” group serves 13 levels: 3-7-11-15-19...47-51
Deck “B” of the “Y” group serves 13 levels: 4-8-12-16-20 ...48-52
This possibly less costly configuration has low numbers of destinations, reducing the number of stops under all traffic conditions. If an “X” or “Y” elevator is out of service the full building height is still served by three elevators. Residents can use another group by walking one floor up or down. This configuration is less

flexible than triple-deck configurations and less suitable for later use of the building as a hotel or offices. The hoist way not required for groups “X” and “Y” could be used as an additional service elevator.

Configuration Three
A low-rise group with two double-deck cars could serve 12 destinations, i.e., apartment floors one to 24. A high-rise group with three double-deck cars could serve 15 destinations, i.e., apartment floors 25 to 54.

Performance and Configuration of the Service Elevators

The number of destinations served must be reduced because TWO single-deck elevators cannot serve 60 floors. A service call can be placed at any time but a car may never arrive because both cars are likely to be under the control of passengers at all times. If normal car operations are not possible the service elevators could be operated by attendants who provide service by appointment. Mobile phones can enable passengers and attendants to get in touch! Alternatively service to specific floors could be subject to specific service periods.

Cars with three or four decks could substantially reduce the number of destinations and might be an alternative solution.

Group Control Systems

The author has developed intelligent destination group controls on the basis of his discovery of the inherent relativity of the characteristics of groups of elevators. These controls minimize and equalize Round Trip Times relative to momentary up and down traffic densities. This implies that transport capacities and time-dependent service qualities can be optimized under all traffic conditions. The apartment building mentioned in this article can substantially benefit from multi-deck cars and even more if intelligent destination group controls are used.

For more information about intelligent destination group controls please refer to the author’s website: www.elevatorgroupcontrols.

(Author bio)
Biography
Pieter J. de Groot, has many years of elevator contracting experience in Hong Kong and other cities in the Far East and Australia. In 1972 he was appointed Schindler Area Manager for Asia-Pacific. In this capacity he initiated and managed the formation of Jardine Schindler (Far East) Holdings SA (1974) and Schindler Lifts (Australia) Pty Ltd (1980). His involvement in the planning of many tall buildings caused a profound interest in the theoretical performance potential of groups. In 1975 de Groot met Mr. Leo Weiser Port the person who invented destination group controls and realized the first such group in Sydney, Australia during the late 1960’s. De Groot noticed that this type of control should enable the optimal group performance. Afterwards he promoted the re-incarnation of this type of control and several years later the Schindler group successfully re-introduced destination controls on the basis of modern technology. At that time the artificial intelligence required for optimal group performance was not yet available. After retirement from Schindler de Groot decided to do his own research concerning the theoretical performance potential of groups and discovered the inherent relativity of group characteristics. This discovery enabled him to design intelligent destination group controls. He is the author of the book ’’The planning and performance of groups of elevators’’ that is published on his website: elevatorgroupcontrols.com.

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