Chapter 12: Express elevators to Sky Lobbies

Summary: Express elevators are the ultimate destination elevators. With Double- or Triple-Deck cars express elevators can transport large numbers of passengers through one set of hoistways. Sky lobbies contribute to the economic value of a building in two ways: the value of the additional floors enabled by express elevators and the value of the Sky Lobby itself. Planning concepts for buildings with one and two Sky Lobbies are reviewed.

Sky Lobbies

A Sky Lobby is the “ground” floor of a “separate” building standing on top of another building. Express elevators connect the “ground” floors of both buildings.

The diagram in **Appendix 1** shows a planning option that is probably the most economical solution for positioning a Sky Lobby. The lowest building zone served from the Sky Lobby is formed by the floors **below** the Sky Lobby. At first sight this appears to be an odd solution, however, this arrangement has several advantages:

- If the Sky Lobby would be positioned on floors 26 and 27 both groups that start from the Sky Lobby would serve zones **above** the Sky Lobby. In this case the hoistway of group 4 cannot be a continuation of the hoistway of group 2 because the machine room (MR) of group 2 collides with the pit of group 4. The planning concept of Appendix 1 avoids this planning problem very elegantly.
- The additional travel time in the car to reach the higher Sky Lobby is very short because the additional travel distance is traveled at contract speed. For example if the express group of Appendix 1 has a contract speed of 7 m/s and the typical floor distance is 4 meters the additional travel distance of 52 meters adds only 7.4 seconds to the travel time (DDFT) of the cars.
- Groups 3 and 4 starting from the Sky Lobby are both Low Rise Groups identical to Group 1, i.e. all 3 groups serve 13 floors with a low speed drive system. These local groups will all have the same relatively low cost in view of their low contract speed. Please note that group 2 must have a higher speed, costs more but serves 12 upper floors only.
- When a Sky Lobby is positioned at a higher level it is usually more valuable because it will afford better views of the surroundings.

Buildings that require groups of express elevators are rare. When required the configuration shown in Appendix 1 deserves consideration.

Express elevators

Sky Lobbies generate high traffic densities and express elevators should have large cars or Double Deck- or Multi Deck cars to satisfy demand.

The transport capacity of express elevators must match the <u>maximum</u> traffic densities of the building zones that are served from the Sky Lobby PLUS the <u>maximum</u> traffic density generated by the Sky Lobby itself.

In case the transport capacities of the express elevators do not match the maxima of the local groups that operate from a sky lobby undesirable accumulations of waiting passengers may occur in the Sky Lobby.
The diagram of Appendix 1 shows DD express elevators with the UPPER deck loading and unloading at floor 1. This is a simplification because the ground floor of a very tall building is usually higher than the standard height of 4 meters assumed in this book. The UPPER deck lobby is usually located at an intermediate level between floors zero and one. A pair of escalators facilitates traffic between the LOWER- and UPPER deck lobbies. At the Sky Lobby the UPPER deck will serve the lobby level of group 4 and the LOWER deck the lobby level of group 3.

To enhance transport capacities express elevators usually have **two sets of doors opposite each other**. Car loading always happens from one side and unloading through the opposite set of doors. On arrival the unloading doors open immediately and the loading doors open when the car is about half empty. The number of passengers in an arriving car can be used to influence door timing. The calculations of this chapter are based on an assumed time allowance for loading and unloading of **1.5 seconds per passenger** instead of the 2 seconds assumed for local elevators with only one set of doors.

Transport capacities

It is very easy to calculate the transport capacity of express elevators. The Door to Door Flight Time (DDFT) and the assumed time allowance for a passenger entering and leaving the car enables calculation of all data. The travel distance of the express elevators in Appendix 1 is 156 meters (39 X 4m). In case the contract speed is 7 m/s the **DDFT is 34.8 seconds**. Please refer to chapter 3 for data that enable DDFT calculations.

The **maximum transport capacity per deck per 5 minutes in <u>one direction</u>** is calculated as follows:

Round trip UP and DOWN without passengers, 2 X 34.8	69.6 seconds
If <u>each deck</u> holds **16 passengers** the time for entering and leaving the car is: 16 X 1.5 =	24.0 seconds
RTT if car is full in **ONE direction** only	93.6 seconds
Transport capacity **per deck** in 5 minutes: 300/93.6 X 16	51.3 persons/deck
Total population of floors 26 to 53 (28 X75)	2100 persons
Transport capacity per deck in % of population	2.44 %
Total capacity in % of population when express group consists of 4 Double Deck cars (4X2X2.44)	19.5 %

The Average Travel Time in the Car (ATTC) is the DDFT for a direct trip UP or DOWN plus half of the time for disembarkation. The Average Time To Destination (ATTD) is the theoretical minimum Average Waiting Time (AWT) plus the ATTC. The AWT includes the boarding time of passengers.

During heavy **simultaneous UP and DOWN PEAK traffic**, i.e. when the car reaches full load for both the UP- and the DOWN trip, the RTT increases by 24 seconds in view of the additional car loading and unloading time for 16 passengers. The RTT in

this case is 117.6 seconds and the **maximum transport capacity in <u>each direction</u> is 15.6 %**.

In case the transport capacities of 19.5 and 15.6 % calculated above are considered insufficient we have the following options to increase transport capacities:

- increase the speed of the express elevators
- increase the contract load per deck
- increase the number of cars from 4 to 5
- increase the number of decks from 2 to 3, i.e. use of Triple-Deck cars

The first CPT of **Appendix 2** shows that the maximum DC5 (= TC5) increases from 19.5 % to 20.3 % for contract speed 8 m/s and to 21.2 % for contract speed 10 m/s. These increases are relatively small and the higher speeds are not cheap.

The second CPT of Appendix 2 indicates that an increase of the contract load per deck to 2200 KG increases the DC5 to 24.5 %, i.e. for a contract load increase of 37.5 % the DC5 increases by 25.6 %. The efficiency of the group is reduced by the longer time required for loading and unloading the additional 6 passengers. The group's footprint increases by approximately 25 % as well. Time-dependent service qualities are reduced.

If we increase the number of cars from 4 to 5 the DC5 increases by 25 %. The footprint of the group increases accordingly. Time-dependent service qualities are improved.

If we **increase the number of decks of the cars to 3** the maximum DC5 is increased by 50 % and the transport capacity in this case is probably excessive. The third CPT of Appendix 2 shows that **Triple-Deck cars** can deliver a **DC5 of 23.5 % with a contract load per deck of 1200 KG**.

In this case the **total contract load** for the drive system increases from 3200 KG for DD cars to 3600 KG for TrD-cars an increase of 12.5 %. The maximum DC5 increases from 19.5 to 23.5 % an increase of 20.5 %. **The efficiency of the group is improved** because the loading and unloading time is decreased in line with the reduced number of passengers per deck. **The footprint is reduced**.

Adding a third deck to each car **is the most economical solution**. In this case the <u>MID deck</u> of the Triple-Deck cars stops and starts at/from <u>level zero</u>. The LOWER and UPPER decks stop and start from lobbies below and above floor zero. TWO pairs of escalators facilitate traffic between the lobbies. In the Sky Lobby the HIGH deck passengers will disembark on the level of the group 4 lobby and the LOW deck passengers on the lobby level of group 3. The MID deck passengers disembark on an intermediate level and two sets of 2 escalators facilitate traffic to the lobbies of groups 3 and 4.

Please note that in case the building is served by DD express elevators only the passengers going to group 4 must use escalators to go from level zero to the upper deck lobby. With triple deck cars **all passengers to groups 3 and 4 must use escalators <u>once</u> on their way to the Sky Lobby** of a specific group.

Core area for elevators

The above shows that the express elevators too can have the footprint of 1200 KG elevators. Chapter 8 proved that THREE 4-car groups of "intelligent elevators" with a contract load of 1200 KG will deliver best-possible service qualities and reduce the required core space for each group by 5 m^2. The total reduction of the core area enabled by "Intelligent destination" group controls is 15 m^2 and the rentable area per floor is increased accordingly. For the 53 storey building of the planning example in this chapter the core area savings **increase the rentable area of the building by 795 m^2**.

The application of express elevators to a Sky Lobby will enable a building of 53 floors instead of 36 floors with the planning concept of chapters 8 and 5. The core areas of these two buildings are identical because both are based on the **footprints for 3 sets of hoistways for groups of 1200 KG elevators.**

Buildings with two Sky Lobbies

When a building requires two Sky Lobbies it is recommended to plan the building on the basis of **two completely separate groups of express elevators.** When satisfactory solutions for both groups are defined the two groups **can be combined into ONE group with an intelligent destination group control**.

Groups of express elevators with UP DOWN buttons in the lobbies, i.e. non-intelligent controls, **cannot be combined in one group** because the cars are not under control. At all times, i.e. during heavy traffic as well, passengers can enter and take control of any car and **the efficiency of direct trips required for periods of PEAK traffic is lost**.

Express elevators with "Intelligent destination" controls can be combined into a single group and deliver **substantial advantages** in comparison with separate groups:

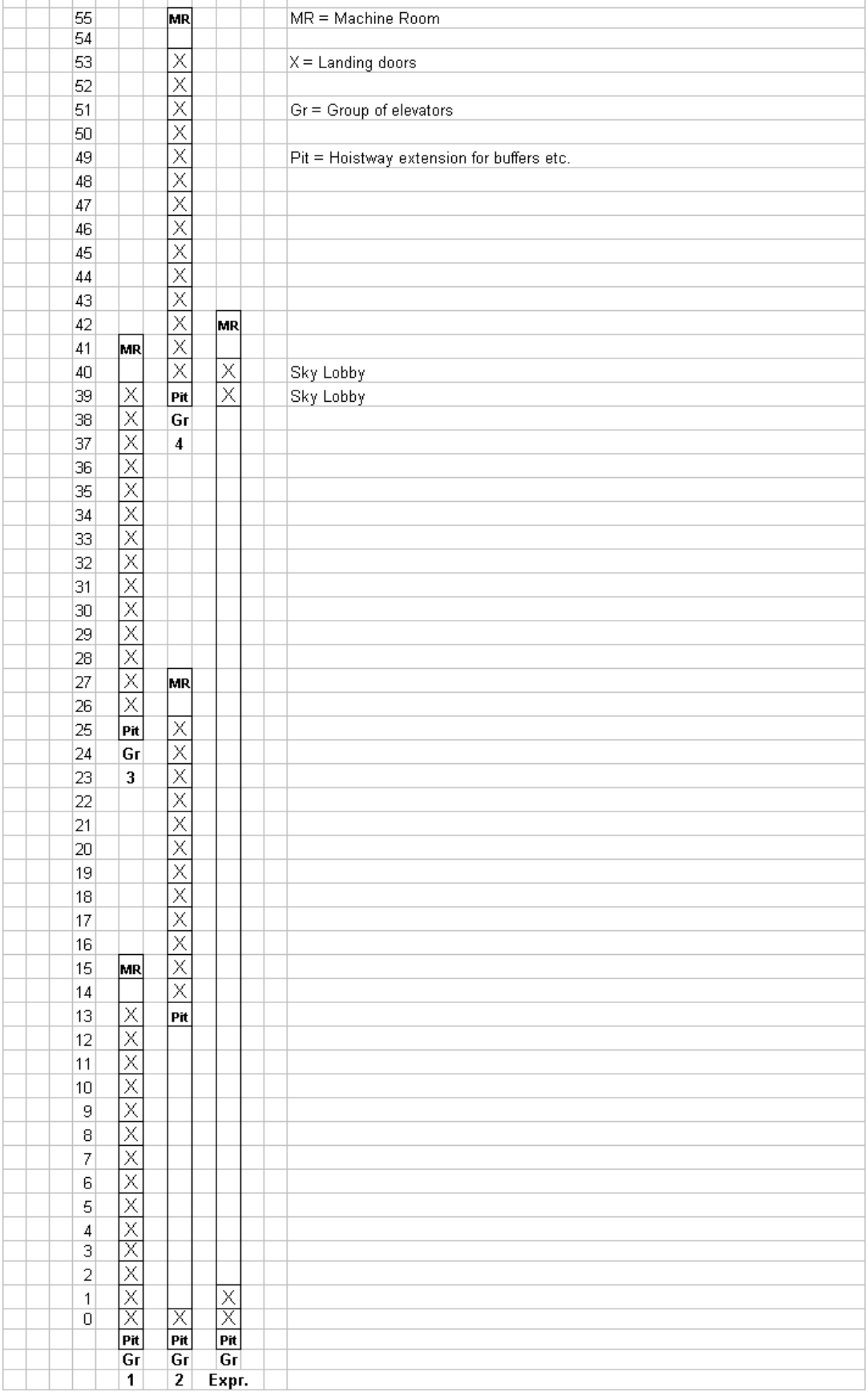
- During NON-PEAK traffic, i.e. probably more than 80 % of all operating hours, all cars can serve both Sky Lobbies. Although the average RTT increases the Departure INTERVALS and AWT's will be substantially shorter.
- When traffic density increases the group may assign individual cars to direct trip service to increase transport capacity but continues to serve both Sky Lobbies with the remaining cars to maintain best-possible service qualities.
- In a well planned building traffic densities that require each sub-group to make direct trips only may never occur.
- Traffic PEAKS to and from both Sky Lobbies will most probably not be entirely simultaneous. This means extra capacity is available when only one Sky Lobby generates PEAK traffic. It could be that the combined group can be one car less than the sum of the cars of the two sub-groups. In this case the footprint (space), capital, maintenance and energy costs will be substantially reduced.

Combining all express elevators in ONE group is more expensive because the group to the lower Sky Lobby must be extended to the upper Sky Lobby and both groups will require an additional set of doors in the other Sky Lobby, however, the

advantages are obvious. The advantages of using more and smaller cars for local groups are the same but less obvious.

Appendix 1: Concept for express elevators to Sky Lobbies
Appendix 2: CPT's showing how the RTT and DC5 change when the contract speed is increased.

Appendix 1 to Chapter 12: Express elevators to Sky Lobbies



Appendix 2

Transport capacities of Express elevators **in one direction**. Each CPT below shows the performance data for identical groups with different speeds.

Comparative Performance Table (CPT) for a group of Express elevators with Double Deck cars and contract speeds 7, 8 and 10 m/s.

Number of upper floors served	Floor designation highest floor	Total zone population	Total travel in meters	Contract speed in m/sec.	Average car load of each deck in persons	Number of "selected floors"	Number of "probable stops"	Average RTT Low & High trips	Average Travel Time in the car	Average time for group to serve all floors once	% of population distributed into building by 4 elevators in 5 min.	Average Time To Destination in seconds (= AWT + ATTC)	Average departure INTERVAL from floor zero	Cycle INTERVAL: INTERVAL for AWT calculation	Theoretical minimum Average Waiting Time (AWT) in seconds
Nr flrs served	Top floor	Pop.	Trav.	Contr. speed	Car load	Sel. floors	Prob. stops	Av. RTT L & H	ATTC	Cycle RTT	DC5 **4-cars**	ATTD	INT	Cycle INT	AWT
Contract load: 1600 KG (20 persons) per deck, total 3200 KG											DD				
1	1	2100	156	7	16	1	1	93.6	40.8	93.6	19.5	52.5	23.4	23.4	11.7
1	1	2100	156	8	16	1	1	90.0	39.0	90.0	20.3	50.3	22.5	22.5	11.3
1	1	2100	156	10	16	1	1	86.2	37.1	86.2	21.2	47.9	21.6	21.6	10.8

Comparative Performance Table (CPT) for a group of Express elevators with Double Deck cars and contract speed 7, 8 or 10 m/s.

Nr flrs served	Top floor	Pop.	Trav.	Contr. speed	Car load	Sel. floors	Prob. stops	Av. RTT L & H	ATTC	Cycle RTT	DC5 **4-cars**	ATTD	INT	Cycle INT	AWT
Contract load: 2200 KG (28 persons) per deck, total 4400 KG											DD				
1	1	2100	156	7	22	1	1	102.6	43.0	102.6	24.5	55.9	25.7	25.7	12.8
1	1	2100	156	8	22	1	1	99.0	41.3	99.0	25.4	53.6	24.8	24.8	12.4
1	1	2100	156	10	22	1	1	95.2	39.4	95.2	26.4	51.3	23.8	23.8	11.9

Comparative Performance Table (CPT) for a group of Express elevators with Triple Deck cars and contract speed 7, 8 or 10 m/s.

Nr flrs served	Top floor	Pop.	Trav.	Contr. speed	Car load	Sel. floors	Prob. stops	Av. RTT L & H	ATTC	Cycle RTT	DC5 **4-cars**	ATTD	INT	Cycle INT	AWT
Contract load: 1200 KG (15 persons) per deck, total 3600 KG											Tr.D				
1	1	2100	156	7	12	1	1	87.6	39.3	87.6	23.5	50.2	21.9	21.9	10.9
1	1	2100	156	8	12	1	1	84.0	37.5	84.0	24.5	48.0	21.0	21.0	10.5
1	1	2100	156	10	12	1	1	80.2	35.6	80.2	25.7	45.6	20.1	20.1	10.0

Characteristics of elevators and building

Speed	>	see table	Distance 0 to 1	4		meters	
Acceleration and deceleration rates	1	m/s^2	Typical floor distance	4		meters	
Jerk rate	1	m/s^3	Population	75		pers./floor	
Door closing time	2.5	seconds	Car load in persons	>		see table	
Door opening time	2	seconds	Traffic	>		UP PEAK	
Time gain advanced door opening	0	seconds					
Time allowance car IN/OUT each pass.	1.5	seconds				Chap12dia1	