THE STUDY OF SERVICE CORE IN A TALL HOTEL BUILDING

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I. Introduction

A. *Tall buildings*

Tall buildings, as they are today, are the product of need, mostly to address the growth of urban population by supplying residential and commercial space. Tall buildings also act as landmarks, symbols of power, often becoming the city's identity.

B. *Service core*

The service core provides the skyscraper with structural solidity, room for elevators, toilets, and other amenities and constitutes the main network for utility, power and data.
The different types of service cores are -
Central core, peripheral core, and multi cores

II. Tall Building Design

(Toronto tall building design guidelines)

Regardless of stylistic approach, the design and placement of all tall buildings should make a positive contribution to the public realm, fit harmoniously within the surrounding context and skyline, and be consistent with the following:

- slender point towers, rising above well-proportioned and well-articulated base, with a strong relationship to the existing context and adjacent public realm, are preferred
- Avoid free standing towers without direct relationship to the street.
- avoid big, boxy, dominant massing, and large, elongated, or slab like floor plates
- Minimize shadowing and wind impacts and protects sunlight and sky view, for streets, parks, public and private open space, and neighboring properties;
- Respond appropriately to prominent sites, important views from the public realm, and the shape of the skyline to reinforce the structure and image of the city; and
- Ensure high- quality living and working conditions including access to public and private open space, interior day lighting, natural ventilation, and privacy for building occupants

III. Building Services

A. *Elevator Design*

The building should be examined to establish the following criteria, which should then be incorporated correctly into traffic flow models:
• Height of the building and its individual storeys
• Distribution of the population throughout the building
• Main entrance level(s) (points of entry and exit)
• Distribution of population over elevator groups (if the same destination can be reached using more than one group)
• Stair usage
The following parameters need to be determined in sequence for the anticipated traffic flow, given the building's envisaged function:
• Population (number of employees and/ or residents)
• Occupancy (presence/ simultaneousness)
• Peak demand (indicative traffic flow peak) where, required capacity = population x occupancy x peak demand (expressed as a % of the occupancy per 5 minutes).

Optimizing traffic performance in tall buildings: Traffic handling is more efficient when the number of destinations per elevator is reduced. There are 3 basic methods for reducing the number of destinations:

Method 1:
High-rise buildings (>150-200 m high) are split up in separate stacked towers (zones) to minimize continuous shafts over the tower's total height. To reach the sky lobby of the higher zone(s) shuttle elevators are required

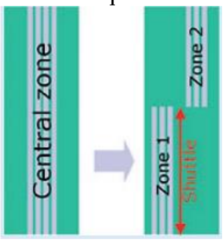

Fig.1 method 1

Method 2:
Elevators in local tower zones are split up in groups, serving local low-rise and high-rise floors. Low-rise and high-rise elevators in the same zone serve the same home floor (ground floor or sky lobby).

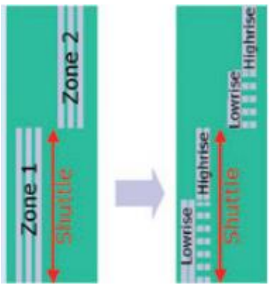

Fig. 2 method 2

Method 3:
Destination control reduces the number of destinations per car and thus the number of stops per cycle. This decreases the average travel height and the cycle time. When elevators are equipped with destination control, this can even reduce the number of elevators per group.

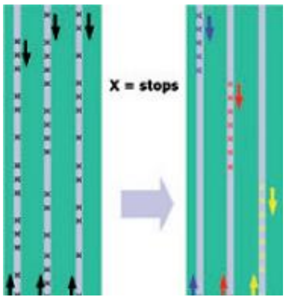

Fig. 3 method 3

B. Electrical and mechanical system

- The primary mechanical concerns are heating, ventilation and air-conditioning, and other services. Electrical generators, chiller plants, water pumps, and so on.
- Communication and control systems that service the building and sometimes outbound communications, such as through a large rooftop antenna (which is also physically held in place inside the top-floor mechanical levels).
- Modern computerized HVAC control systems minimize the problem of equipment distribution among floors, by enabling central remote control
- A mechanical floor or service floor is a story of a high-rise building that is dedicated to mechanical and electronics equipment.

C. Plumbing

Plumbing engineers learn early that as you lift water above a datum, you lose 1 pound per square inch for every 2.3 feet of elevation.
Vertical piping systems are generally more economic and need less maintenance than horizontal piping systems in multilevel projects. Vertical piping uses fewer supports, hangers, and inserts and requires less horizontal space in ceiling plenums for sloping to achieve drainage (Connelly, 2007). However, the drawback of vertical piping is the multiple penetrations through structural slabs. Each of these penetrations must be sealed or protected to fulfil the requirements of building codes, in term of protecting the building pressurization and also to prevent vertical migration of fire and smoke.

Zoning:
To avoid excessive pressure, several schemes have been developed over years to achieve an economical, efficient and conserving installation. Usually building over 100 feet in height require multiple water distribution zones.

D. fire and life safety
Although fire hazards in very tall buildings are essentially the same as in low-rise buildings of similar uses (e.g., business, residential, mixed-use), the consequences of a fire have a potential to be more severe given the large numbers of occupants, the inherent limitations in egress and access, and the physical aspects of the structure which can affect the hazard (e.g., stack effect).

As a minimum, all tall buildings should have sprinkler systems on each floor and standpipe systems in each stairwell. All tall buildings containing fire protection systems have large, dedicated fire pumps to provide the flows and pressures required for the individual system.

For hotels wet-riser cum down comer both the systems shall be provided. Diameter of riser will be 150mm for all the buildings. For each 1000m**2** floor area or its part one riser shall be provided.
Every building more than 15m in height shall provide both I.e. M.O.E.F.A & A.F.A.

Section: As per D 10(Appendix D) of part IV of N.B.C. For High rise buildings above 60 m in height provision for Helipad should be made.

Table 22 Travel Distance for Occupancy and Type of Construction
(*Clauses* 4.4.1, 4.5.1 *and* 4.5.2)

Sl No.	Group of Occupancy	Maximum Travel Distance Construction	
		Types 1 & 2 m	Types 3 & 4 m
(1)	(2)	(3)	(4)
i)	Residential (A)	30.0	22.5
ii)	Educational (B)	30.0	22.5
iii)	Institutional (C)	30.0	22.5
iv)	Assembly (D)	30.0	30.0
v)	Business (E)	30.0	30.0
vi)	Mercantile (F)	30.0	30.0
vii)	Industrial (G)	45.0	[1]
viii)	Storage (H)	30.0	[1]
ix)	Hazardous (J)	22.5	[1]

NOTES
1 For fully sprinklered building, the travel distance may be increased by 50 percent of the values specified.
2 Ramps shall be protected with automatic sprinkler system and shall be counted as one of the means of escape.
[1] Construction of type 3 or 4 is not permitted.

Table 1.travel distances from NBC

IV. CASE STUDY 1- BURJ KHALIFA

Facts
Official Name - Bur Halifax
Former / Other Name - Bur Dubai
Type- building
Status - completed
Country - United Arab Emirates
City - Dubai
Street Address -emaar Boulevard
Building Function - office / residential / hotel
Structural Material - steel / concrete
Global Ranking #1 tallest building in the world
Height: Architectural 828.00 meter / 2716.54 feet
Floors Above Ground :163
Floors Below Ground : 1
# of Apartments 900
# of Hotel Rooms 304
# of Parking Spaces 2957

A. *ELECTRICAL SYSTEMS*

- burj Dubai as one of the first super-tall buildings in Dubai and was also one of the first projects to distribute 11 kv voltage.
- the provided 11 kv services enter via underground concrete encased duct banks into the building by the dubai electricity and water authority (dewa).
- multiple 11 kv risers will provide power to the transformers to produce 400y/230v power.
- due to the extreme heat and humidity, the transformer rooms are air conditioned and have ventilation fans as back-up in case of emergencies.
- the emergency standby power generation system is diesel fueled engine generator set
- five 11 kv emergency generators; one 400 v emergency generator will provide power to the fire, life safety and critical systems.

B. *PLUMBING SYSTEMS*

- The water available at the site is desalinated sea water from the Persian Gulf.
- 250,000 Gallons of fresh water is required on peak.
- This incoming water can reach as high as 104 F degree in the summer and a minimum of 68 F in the winter.
- Therefore, pre-cooling of the water is required in the summer before serving the domestic cold water needs of the building.
- The hot water system includes liquid petroleum gas (LPG) hot water heaters placed in the podium, to heat the incoming water before transferring to multiple tanks within the tower.
- Local electric heaters are designed to heat the returning water from the riser prior to reaching the tanks. Transfer pumps will pump the cold and hot water to the water storage tanks located at multiple levels in the building.
- The domestic cold and hot water systems will consist of a gravity-feed system from the elevated water storage tanks and will provide water to all plumbing fixtures and equipment requiring cold and hot water.
- Express water line carries the water to the 40th floor and distributed to the other tanks above.
- A complete soil, waste and vent system from plumbing fixtures, floor drains and mechanical equipment arranged for gravity flow and, ejector discharge to a point of connection with the city municipal sewer is provided.
- A complete storm drainage system from roofs, decks, terraces and plazas arranged for gravity flow to a point of connection with the city municipal sewer system is provided.
- A complete low pressure propane gas distribution system is provided including independent incoming service pressure regulator and meter rooms located on the building

C. *HVAC SYSTEMS*

- Cooling water for the complex, as well as a nearby mall, is provided by central plants located off site.
- The district chilled water is routed to heat exchanger stations located on the Concourse Level.
- On the Concourse Level, separate heat exchanger stations will be provided for the office building, residential low zone, residential high zone express, hotel low zone, hotel high zone and cooling of the incoming domestic cold water.
- Given the height of the building, conventional design will require a minimum of 3 heat exchangers and pumping loops to move the chilled water up the tower.
- By selecting the maximum equipment pressure available and placing them at strategic locations, 2 heat exchanger loops, one runs express from the Concourse Level to the 75th floor, are designed for the chilled water to reach the top of building without the use of custom equipment.
- In the tower, six mechanical zones equipped with centrally treated outside air handling units provide fresh air to the fan coil units located at each floor. Exhaust fans, pressurization fans, chilled water pumps and electrical substations are located in the mechanical zones.

D. *FIRE AND LIFE SAFETY*

- Given the environment and the height of the building, a “defend in place” approach to fire protection in high rise buildings was adopted as the design approach.
- Areas of refuge are provided for throughout the building, respective to occupancy zones.
- Stairwell pressurization and fire lift vestibule pressurization systems with fire rated enclosure are provided for the tower.
- Smoke removal systems for different spaces are provided in the public hotel areas.

- A central smoke removal system for typical tower corridor is sized for 1 floor.
- The building is full-sprinklered.
- Similar to the domestic water system, a gravity feed system is designed to provide fire water for the tower. Tanks are located on multiple mechanical floors similar to the plumbing system.
- A total of 31050 Cubic Feet of water storage is available for the tower, or, up to 90 minutes protection for the lower portion of the tower and 30 minutes for the top portion.

E. ANALYSIS

ADVANTAGES

- Peak electricity demand – 50MVA – meets requirement the transformer rooms are air conditioned and have ventilation fans as back-up in case of emergencies
- Emergency generator will provide power to the fire, life safety and critical systems.
- A central battery system with capacity for three hour operation will provide continuous power for egress lighting.
- Well worked out plumbing system
- ‘The defend in place’ concept for fire safety
- Service core- central core - Equidistant from all three ends
- Top Elevator Speed 10 m/s

DISADVANTAGES

- Not very sustainable
- High usage of power and energy.

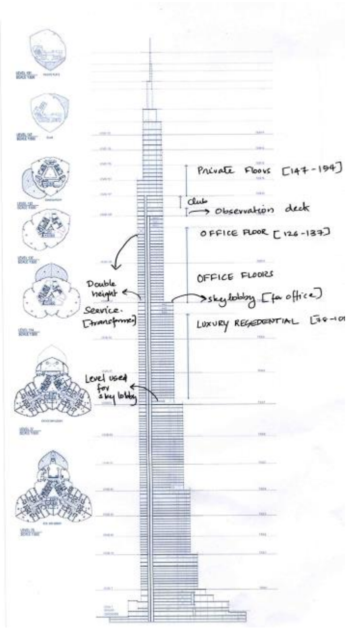

Fig.4 elevation

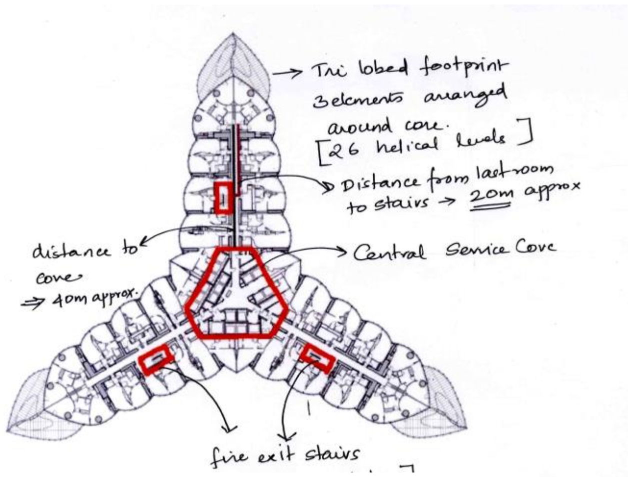

Fig.5 typical floor plan- burj khalifa

V. CASE STUDY 2- MARRIOTT MARQUIS

FACTS

- 1535 Broadway, times square
- New york city, new york
- Status: built
- Construction date: 1985
- Building use: hotel, office, restaurant, theatre
- Structural type: high rise , atrium
- Architectural style: brutalist
- Materials: glass, concrete
- No. of elevators – 12no.s
- Looking into atrium.
- Waiting time – earlier 30 min, now 5 min.
- Use destination dispatch control

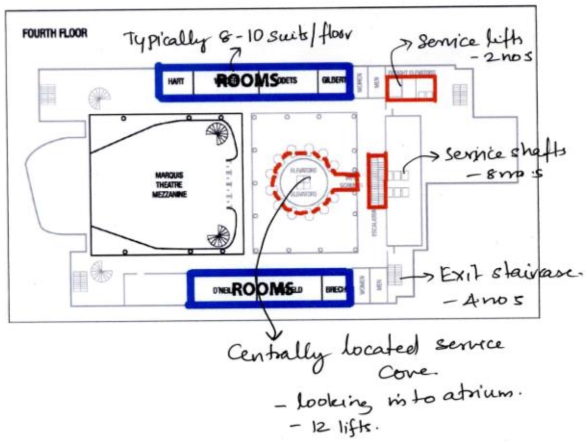

Fig.6. typical floor plan-- marriott hotel

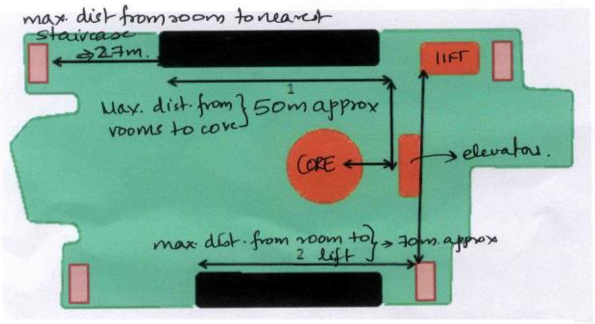

Fig.6. typical floor plan-- zoning

ADVANTAGES

- Central core- Opening up the perimeter for light and views.
- Mechanical services located on the centre of the floor
- Ease of construction
- Flexible arrangement for hotels (multi-tenant)
- The core is accessible through straight passageways. Avoiding confusion especially during peak times. (considering theatre and restaurant)
- Elevators view into atrium- aesthetics
- 4 external staircase- adequate for fire exit
- public bathrooms
- Visual connection of fire exit from every point of the hotel.

DISADVANTAGES

- Overcrowding near the lifts and escalators, especially during peak times
- Service shafts are in plain view – aesthetically bad.
- 45 story building- no evacuation lifts, refuge areas.
- 2 service lifts- inadequate for rooms and theatre.
- No ancillary rooms- such as pantry, cleaning store etc

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