Planning for Vertical Transportation

Elevators

Habib Srour  22-Sep-14
Do we need elevators?

- Are the lifts now days a luxury requirement?
- Of course it is not in a high rise Building!!!
Vertical Transportation Planning

- Traffic Analysis
- Applicable codes and Standards
- Coordination with other trades
- Actual Technologies and next generation
Traffic Analysis

- Questions:
  - How do we plan our elevator
  - What are the Performance Criteria

- Answer:
  - Traffic analysis
Passenger Traffic

- Incoming Traffic: Commercial Buildings (Offices)
- Two-Way Traffic: Institutional Buildings (Schools, Hospitals)
- Outgoing Traffic: Residential Building (Apartments)
Performance Factors

- Quality Factor => Waiting Time
- Quantity Factor => Handling Capacity
Based on incoming traffic known as Up Peak

CALCULATION BASIS
Waiting Time Definition

● Round Trip Time:
  - *Time from the moment car starts up to the next time it starts up*

● Interval: (Time between elevators)
  - *Up-Peak round trip time divided by number of lifts in the group*

● Average Waiting Time:
  - *Is the average of the interval i.e. interval divided by two (theoretically)*
Round Trip Time: Up Travel Cycle

- Worst Case: Arrival upon lift leaving
- Starting/Acceleration
- Running on rated speed
- Deceleration/stopping
- Door Opening
- Exit of the Passengers
- Door Closing
- Starting/Acceleration
- Similar Process
- Exit of the last passenger
Round Trip Time: Down Travel Direct Return

- Door Closing
- Start / Acceleration
- Rated speed
- Deceleration / stopping
- Opening of the doors
Estimated Travel Time ($T_1$)

- $T_1 = \frac{2H}{V}$

- Where
  - $T_1$: Total Return Travel Time (s)
  - $H$: Travel Height (m)
  - $V$: Rated Speed (m/s)
Estimated Waste Time ($T_2$)

- $T_2 = (A_p + 1) \times V / \gamma$
- Where:
  - $T_2 (s)$: Acceleration and Deceleration time
  - $A_p$: Probable stoppage of the car
    - it is a function of the population and rated load
  - $V (m/s)$: Rated Speed
  - $\gamma (m/s^2)$: Acceleration = deceleration
  - Jerk ($m/s^3$) is excluded in the manual calculation
Estimated Door Time \( (T_3) \)

- \( T_3 = K_1 \times (A_P + 1) \)
- **Where**
  - \( T_3 \) (s): Total Door closing and opening time
  - \( K_1 \) (s): is the time of door opening and closing including waiting time.
    It is a function of the door type and size
  - \( A_P \): Probable stoppage of the car
    it is a function of the population and rated load
Estimated Passenger Time \((T_4)\)

- \(T_4 = K_2 \times P_c \times CLF\)
- Where
  - \(T_4 (s)\): Total time needed by the passengers to enter and exit the car
  - \(K_2 (s)\): Transfer time in + out
  - \(P_c \) (persons): Car Rated Load
  - CLF: Car Load Factor (normally 0.8)
Estimated WT

- **Round Trip Time:**
  - \( RTT = T1 + T2 + T3 + T4 \)
- **Interval** = \( RTT / N \)
  - \( N = \) number of elevators in the same group
- **Average Waiting Time**
  \( AWT = Interval / 2 \)
- **More Complicated formula for speed exceeding 2m/s**
Handling Capacity Definition

- **HC (Handling Capacity)**: The percentage of population an elevator group can transport in five minutes.

- **CLF (Car Load Factor)**: Max load during the round trip of elevator (0.8).
Handling Capacity

- Handling Capacity is:
  \[ HC = N \times CLF \times P_C \times \frac{300}{RRT} \]

- Where:
  - \( N \): number of lifts in the same group
  - \( CLF \): Car Loading Factor
  - \( P_C \) (passengers): Rated Load
  - \( RRT \) (s): Round Trip Time per lift
  - 300 s (5 minutes)
Calculation Main Characteristics

- Number of lifts
- Car Capacity
- Stops
- Speed

- Example
Additional Considerations

- Highest Reversal Floor
- Up-Peak with down traffic
- Restaurants on the top floor (noon traffic)
- Parking areas in Basements
Suggested results for Commercial Buildings

- **Diversified office**
  - Peak arrival HC: 10 to 11%; Interval: 25 to 30 sec
  - Up-Peak with 10% down HC: 11 to 12%; 30 to 35 sec
  - Noon time HC: 10 to 12%; 35 to 45 sec

- **Single office**:
  - Peak Arrival HC: 12 to 18%; Interval: 20 to 25 sec
  - Up-Peak with 10% down HC: 13 to 20%; 25 to 30 sec
  - Noon Time HC: 13 to 17%; 30 to 40 sec
Suggested results for Residential Building

- **Hotel (Guest Lifts: Two-way)**
  - HC: 12 to 15%;
  - Interval: 40 to 60 sec
  - Inefficiency: 10%
  - Special attention for meeting rooms
  - Need for service lifts

- **Apartments:**
  - HC: 5 to 7%;
  - Interval: 50 to 70 sec
  - Inefficiency: 15%
Suggested results for Institutional Building

- **Hospital (Two-way)**
  - HC: 12%;
  - Interval: 30 to 50 sec
  - Inefficiency: 5%

- **Classrooms:**
  - HC: 25 to 40%;
  - Interval: 40 to 50 sec
  - Inefficiency: 0%
Imposed Building parameters

- Building Type (office, Hotel, Hospital, ...)
- Building population (per floor)
- Floor to floor distance
- Number of entrances
- Basement: Parking
Verified Lift Characteristics

- **Main Characteristics:**
  - Lift Capacity (Number of persons)
  - Speed (m/s)
  - Door dimension

- **Additional characteristics**
  - Door speed
  - Door response time
  - Acceleration
  - Deceleration
  - Jirk
# Recommended Lift Car Characteristics

<table>
<thead>
<tr>
<th>Type of Building</th>
<th>Capacity (Kg)</th>
<th>Door width (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Office Building</td>
<td>1600</td>
<td>120 (CO)</td>
</tr>
<tr>
<td>Large Prestigious Office Building</td>
<td>1800</td>
<td>120 (CO)</td>
</tr>
<tr>
<td>Hotel Building (5*)</td>
<td>1600</td>
<td>120</td>
</tr>
<tr>
<td>Prestigious Large Apartment Building</td>
<td>1150</td>
<td>100</td>
</tr>
<tr>
<td>Hospitals</td>
<td>2200</td>
<td>140</td>
</tr>
<tr>
<td>Schools/Universities</td>
<td>2750</td>
<td>150</td>
</tr>
</tbody>
</table>
Simulation

- In the basic formula, we considered that the passengers are all available in the same time.

- With modern software:
  - Passengers are arriving following Poisson distribution
  - Descending passengers during up-peak
Destination Control

- What is Destination Control?
- Is there any difference in the calculation?
- Introducing TTD: Time To Destination
APPLICABLE CODES AND STANDARDS IN LEBANON
Lebanese Applicable Standards

- NL EN 81-1 (+A3)2010: Safety rules for the construction and installation of lifts - Part 1: Electric lifts

- NL EN 81-2 (+A3)2010: Safety rules for the construction and installation of lifts - Part 2: Hydraulic lifts
Applicable Standards

- NL EN 81-80 (+A3)2010: Safety rules for the construction and installation of lifts - Existing lifts Part 80: Rules for the improvement of safety of existing lifts
Other Applicable Codes

- Decree related to the accessibility for people with limited mobility
- Life safety Code:
  - French (AS clauses)
  - NFPA 101 (clause 9.4)
  - NFPA 5000
Other helpful standards

- ISO4190 series
- EN81: Safety rules for the construction and installation of lifts-
  - 58: Examination and tests – Landing doors fire resistance test
  - 72: Particular applications - Firefighters lifts
  - 73: Particular applications - Behaviour of lifts in the event of fire
COORDINATION WITH OTHER TRADES

Construction
Mechanical
Electrical
Well Construction requirements

- Imposed loads on the walls
- Required strength of the wall (300N/5cm$^2$)
- Reaction loads on pit
  - Under rails
  - Under buffers (car and counterweight)
- Accessible area below the well (5000N/m$^2$)
- Pit > 2.5m => inspection door to the pit
- Ventilation openings
Machine Room Constructional Requirements

- Imposed loads on the floor
- Machine room door (height and Opening)
- In case of different levels in Machine room steps and handrails
- Hook
- Non-slippery floor
Machine Room and well
Mechanical requirements

- Keep temperature between +5 and 40deg
- Heat emission to be provided by lift supplier
- Special attention to glass well exposed to external sun
Machine Room Electrical requirements

- Control of Main switch(s) from the access
- Main switch (Pad lockable)
- Car light switch (ELCB 30mA)
- Socket outlet
- Lighting 200 lux
- Well lighting switch
- In case of MRL???
Well Electrical requirements

- Well lighting points at 0.5 m from ceiling and pit floor + needed points
- 50 lux
- Socket in the pit
- Light switch in the pit accessible before entering in the pit + light switch in Machine room or Emergency panel
NEW TECHNOLOGIES
Last Technologies

- Machine room less
- Destination control system
- Double deck system
- Twins
- Belts instead of ropes
Next Generation: Linear Synchronous Motor

Synchronous Rotating Machine

- Excitation
- Stator
Rotating Synchronous Machine

Synchronous Machine

Excitation
Stator
Linear Synchronous Machine
Linear Synchronous Machine

- Elevator World (May 2012)
  - James G. Wieler is vice, president of Strategic Planning and New Business Development at Magne-Motion, Inc.
  - Dr. Richard D. Thornton, is co-founder, chairman, and chief technology officer at MagneMotion, Inc.
The U.S. Navy has been progressing toward the concept of an “all-electric” ship.

MagneMotion’s development of the Advanced Weapons Elevator (AWE) aircraft-carrier elevator began in 2003 with the design and construction of a proof-of-concept system.
MagneMotion Statement

- LSM eliminates the need for hydraulics, counterweights, cables and pulley.
- Faster, safer?, environmentally friendly and more efficient, and has a higher lift capacity than existing Navy munitions elevators.
- Ability to transport loads over 20 T., it could provide a solution for many commercial elevators.
Test facility
Car Power Supply

- Car Light:
  Inductive power transfer is used to charge onboard energy-storage components that power the cab’s lighting and communication facilities.
Brake

- When a platform stops, electrically operated wedge brakes on the platform act on the guide rails.
- Springs cause the brakes to engage when power is not applied and solenoids hold the springs back when the brakes disengage.
- Multi-redundancy apply
Advantage

- No ropes: no height limits => space elevator
- Speed and capacity: speeds >20m/s and load 20T with little or no increase in cost.
- Multiple elevator cabs can travel within a single shaft and return in the other.
- Lower maintenance costs due to less rotating parts
Disadvantage

- The force produced by an LSM depends on the size of the stators and magnets, and duty cycle. Unlike rotary elevator motors, each stator operates with a low duty cycle, allowing higher force without overheating.

- Specially in case of multiple lifts in the same hoistway.
The End

- Thank you for your attention
  And for specially for your patience!!!!!!!!!!!!

- Any Questions?