Energy-Efficient Elevator Solutions for High-Rise Buildings

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ThyssenKrupp Elevator Technology
Elevating R&D!
Shanghai CTBUH
Patrick Bass
September 16th to 19th, 2014
Elevator Technology is one Growth Pillar of ThyssenKrupp

Urbanization

Globalization

Demography

Developing the future.
Technology is our Engine
## Urbanization

By 2050 urban populations will account for 70%.

### Development of city population

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1975</td>
<td>4.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>6.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td>8.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2050</td>
<td>9.2</td>
<td></td>
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</table>

By 2050 urban populations will account for 70%.
The 21st century is the first metropolitan century

- By 2025 existing floor space will almost double
- The equivalent of a 1-million people city is being built every day
- Since 2000 the number of high-rise buildings (650 feet and above) has tripled
- Over 180 buildings currently under construction are above 820 feet
Clear Trend Towards Tall Mixed-Use Buildings

High-rise products are a lever for additional business

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CTBUH | ThyssenKrupp Elevator Technology
Patrick Bass | Shanghai | 2014/09/16-19
Efficient use of space?

Elevator footprint

Increasing loss of usable space

Building core [m²]

Building height

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Innovation is What Drives Us

β 17 TWINS
β 11 Double-Decker

CMA Tower Riyadh, Saudi Arabia
A very old idea of elevator engineers

1907
Upper car traction drive elevator, lower car drum drive elevator

1931
One counter weight for two traction elevator
TWIN - A Revolution in Elevator Technology

**Significant advantages**

- Up to 30% reduction in space requirements
- Up to 30% lower energy consumption

**Without TWIN**

**With TWIN**

Up to 50% increased transport capacity
TWIN - A Revolution in Elevator Technology

- TWIN provides best traffic results, if there are two main access landings (lobby/reception, parking areas, subway, 2nd street level).

- TWIN is also satisfying, if pit depth allows diving down of the lower car during loading the upper car.

- Use of TWIN allows to switch off one of the cabins in time periods of low traffic demand. (The other cabin can for example parked at basement floors).

- The TWIN system should combined with at least one conventional elevator as a recommendation. This makes sure, that travel from the lowest to the top floor is possible at any times (e.g. handicapped persons, VIP, ...)

- Call assignment will operate automatically.
TWIN - A Revolution in Elevator Technology

Characteristics

- Two cars are arranged on top of each other in one shaft using the same guide rails.
- Both cars can move independently in the shaft and approach each other up to the distance of one landing (depending on the distance between floors).
- The cars can also travel in opposite directions, which means that the cars can travel towards each other!
- Each elevator has its own traction drive and counterweight.
- Each elevator has its own over speed governor.
- The suspension is installed 1:1 or 2:1, depending on speed and travel height.
- The call assignment is generally performed by the Destination Selection Control DSC, which assigns each call intelligently.
More demand for energy - better solutions required

Elevators consume up to 10% of buildings total energy wage

<table>
<thead>
<tr>
<th>Life cycle cost of a building</th>
</tr>
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<tbody>
<tr>
<td>Cost 20%</td>
</tr>
<tr>
<td>Operation cost buildings 60%</td>
</tr>
<tr>
<td>Design &amp; build</td>
</tr>
<tr>
<td>Demo lition</td>
</tr>
<tr>
<td>Cost 80%</td>
</tr>
<tr>
<td>Energy cost buildings 40%</td>
</tr>
</tbody>
</table>

Elevators consume up to 10% of buildings total energy wage.

- Buildings: 41%
- Transport: 28%
- Industry: 31%

Elevators consume up to 10% of buildings total energy wage.
# Modernization: How much energy can you save? Where?

<table>
<thead>
<tr>
<th>Category</th>
<th>Energy Savings</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabs</td>
<td>90%</td>
<td>Lighting upgrades, light shutdown, LED lighting,…</td>
</tr>
<tr>
<td>Traction</td>
<td>65%</td>
<td>Motor controller, regenerative drives, roping configuration</td>
</tr>
<tr>
<td>Hydraulic</td>
<td>30%</td>
<td>Motor efficiency controllers, high performing fluids,…</td>
</tr>
<tr>
<td>Escalators</td>
<td>25%</td>
<td>Auto slow down, LED lighting,…</td>
</tr>
</tbody>
</table>

In Germany: ~60% energy consumption on standby
Comparison between TWIN versus Doubledeck with identical transportation demands and nearly the same “quality of service”. VDI 4707 ‡ both Systems „Energy Efficiency Classe A“
## Market Drivers – LEED and LEED for Elevators

### LEED
- Leadership in Energy and Environmental Design
- Developed by the USGBC in 2000
- Provides independent third-party verification that a building was designed and built using strategies aimed at achieving high performance in key areas
  - Sustainable Site Development
  - Water Savings
  - Energy Efficiency
  - Materials Selection
  - Indoor Environmental Quality

### LEED for Elevators
- Energy Efficiency - allow projects to count our energy efficient products by providing an energy calculation they can include in their energy model
- Low Emitting Interiors
  - Provide documentation of our materials
  - Use low-emitting on-site wet applied products (Machine room paint, cab adhesives)
- Construction Waste Management – appropriate recycling of construction waste on site
- Innovation in Design
LCA and the TKE SiLCA Tool

- To identify alternatives for improvement
- To compare the potential environmental impact of different design alternatives, during the design process
- To measure the potential environmental impact of new developments
- To track the environmental performance of our products
- To communicate the environmental performance of our products

TKE experience in LCA

- Time and resource consuming
- Developed by external companies
- Non-comparable results
- To support LEED, energy reduction, sustainable and safe products

Our tool for LCA

- Fast and easy-to-use
- Adapted to non LCA experts
- Global

SiLCA Tool

Simplified LCA Tool for TKE elevators
### TWIN Safety Concept

#### Comparisons to conventional elevator

Note: Measures avoiding collision - comparison between TWIN and conventional elevators

<table>
<thead>
<tr>
<th></th>
<th>Conventional Elevator</th>
<th>TWIN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal Speed</strong></td>
<td>1. Emergency Stop</td>
<td>1. Emergency Stop</td>
</tr>
<tr>
<td></td>
<td>2. Buffer (often designed with reduced buffer stroke and speed monitoring)</td>
<td>2. Safety Gear (actively activated via rope brake, which will be tested each 24h – controlled by SIL3 controller acc. IEC 61508)</td>
</tr>
<tr>
<td><strong>Over Speed</strong></td>
<td>1. Speed Governor</td>
<td>1. Speed Governor</td>
</tr>
<tr>
<td></td>
<td>2. Safety Gear</td>
<td>2. Safety Gear</td>
</tr>
</tbody>
</table>
## The 4-level Safety Chain

**Level 1:** Clearance relevant assignment of calls

Destination calls are assigned in a manner that the cars do not hinder each other and a minimum clearance is maintained at all times (by DSC).

**Level 2:** Monitoring of minimum clearances

While the cars approach each other less than a defined clearance, the speed is reduced so that an operational stop at next landing is possible at any time.

**Level 3:** Emergency stop

Electrical safety circuit is interrupted and the traction machines are stopped by activating the operating brakes.

**Level 4:** Triggering of safety gear operation

If there is no slowing down of the cars, the safety gears are engaged at both cars.

Cars will never touch!
## Collision Prevention Safety Level 2

- Each elevator control receives signals of actual position, direction of travel, and speed of both cars. The remaining clearance is calculated with these data.

- If minimum clearance falls short, the speed for both cars will be decelerated and stop at the next landing.

- The minimum clearance depends on speed, which means that the minimum clearance increases with higher speeds.
TWIN - Our Security

Collision Prevention Safety Level 3 + 4

Level 3

- If level 2 does not result in a sufficient deceleration of the cars, activation of the operating brakes for the machines initiates an emergency stop.

- The initiation is effected by the electronic logic control system according to IEC/EN61508, which interrupts the electrical safety circuits of both elevators.

- The logic control systems work independently from the elevator controls Level 3 + 4

Safety level 3 + 4 will be monitored by an independing control system according to (IEC EN 61 508) the heighest safety classification of Safety Integrity Level 3 (SIL3)

- Relevant Systems will be used in case of safety functions for e.g. „fly by wire“ (Airbus, Boeing), automatic train systems and the chemical industry

- Certifications have been effected with Notified Body (TÜV Germany) successfully. The system has been approved and certificated.
TWIN – Our Security

Common Shaft Doors

- For TWIN we need to guarantee, one car being able to open the doors, without any influence to the other car.

- Under normal operating conditions the opening of one car/shaft door, should not interrupt the safety circuit of the other car.

- In case of TWIN the monitoring of the shaft doors, if closed or locked, is performed by an additional PES according to IEC/EN 61508 SIL3.

- Two safe potential free contacts are connected independently to the safety circuits of both elevator controls. These contacts indicate the status of the shaft doors and comply to a shaft door safety circuit like it is the case for usual elevators.
Test Towers to foster innovations

- High capacity - 15 test shafts
- High speed - test elevators at 18 m/s
- Test elevators out of the construction sites
- Located close to manufacturing site, R&D center and engineering universities

Rottweil, Germany
ZhongShan, China
Elevator Technology
Elevating R&D!

Thank you

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Developing the future.