of the Year 2007

Project

Category 5

Inclined Elevators

Dockland Hamburg

by Achim Hütter

The Project

The Dockland is one of the most interesting properties in Hamburg, Germany, from an architectural perspective. The glass building, with a total floor space of approximately 6,500 square meters, tilts from east to west and cuts 40 meters into the Elbe River like the bow of a ship. The unusual office building, designed by architectural firm Bothe Richter Teherani, is located on the north bank of the Elbe opposite the Hamburg container terminal. The site itself is a protruding spit of land that was used as a dock for the ferry terminal to England until 2004. The site offers a breathtaking view of the Elbe from a public viewing area on the roof of the graduated building, accessible by an outside staircase. There will also be access to a wharf belonging to the HADAG harbor ferry, which will be integrated into regular ferry service. The Dockland office building received the Leading European Architects Forum for Intelligent Design and Build Innovations (LEAF) Award 2005 for Best Structural Design in a ceremony in Barcelona.

Figure 1

Construction Details

The Dockland is part of the Pearl Chain – a concept for the redevelopment of the riverbank in the center of the city. For container ships and passenger liners, this position marks the entrance to the Hamburg Harbor. Dockland's dynamic form is created by a rhomboid constructed from steel and glass cantilevers with a fully glazed front façade 47 meters over the river, using an inclination of 66° and evoking strong association with a ship's form. This shape allows an open series of steps to landside, allowing visitors to walk up the building's 140 steps to a public viewing platform on the rooftop. The attic floor houses a roof terrace. Entrance to the offices on the first to fifth floors can be assessed by

Figure 2

these stairs and two glass-walled, inclined elevators following the angle of the stairs. The building width is 21 meters, and the length of each floor is 86 meters. The construction is made from a lattice-beam system of four steel frames, welded in a shipyard opposite the site, transported in one piece over the Elbe by a huge floating crane and attached to the main reinforced-concrete structure of the building.

Figure 3

Horizontal loadings in the long direction are combated with compression and tension elements from steel, which are visible in the north and south double façades that protect from the sun and extreme wind conditions while also providing favorable acoustic properties. The horizontal loads in the short section are concrete cores and floor plates. The dock walls were extended into the river with 30,000 cubed meters of earth surrounding the concrete pile foundations. Planning regulations also applied to the cantilever over the Elbe, requiring special approvals from federal shipping and harbor authorities. Large posts had to be positioned within the Elbe to avoid any rudderless maritime vessels coming into contact with the building. The ground floor is an open car park with mechanical and electrical rooms. This level is situated over the normal high tide, but in extreme cases it can become flooded and thus not accessible for fire brigades. Therefore, the building is fitted with sprinklers with a one-hour, 20-minute duration.

Special Requirements and Highlights

The installed inclined elevators had to run over the heads of office renters, which made noise reduction a high priority. A 24°-inclined elevator running on its tracks rather than hanging between them tends to transmit more vibration than a vertical lift. Furthermore, even in the latest cable-chain designs, the traveling cable is a transmitter. Consequently, the following measures were taken.

- Isolate the minimized connections to the building
- Abandon the cable chain and traveling cable.

Continued

- Figure 1: Evening view of the Dockland building
- Figure 2: Elbe River view, highlighting the building's 40-meter cantilever over the water
- Figure 3: The east side of the Dockland includes stairways on the outside edges of the building (horizontal lights) and elevator shafts to the inside of the stairways (vertical lights).

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Continued

- Installing a contactless power-transmission system.
- Use radio control for transferring controller information from car to machine room.
- Use two-wire bus technology.

Isolation

The required isolation to the building was calculated in close collaboration with acoustic engineering company Taubert & Ruhe. The drive unit and its frame were mounted on a block of concrete with a mass of 3,750 kilograms. The concrete block was completely isolated from the building by a one-inch-thick sylomer mat. The guide brackets were isolated from the walls and the floor. The supporting rollers for the ropes with rubber buffers were calculated according to the weight and frequency of the given materials.

Power Transmission

The customer requested the operation of a 3-kilowatt air conditioner in the car, another major task for the transmission of the power to the car due to the missing traveling cable. It was decided to use the latest inductive power-transmission rather than a conductor rail system. This contactless power-transfer system allows electrical energy to be supplied to mobile consumers without any electrical or mechanical contact. Power may be transferred across large air gaps up to several centimeters. The only other elevator with this system is in the Ostankino TV Tower in Moscow, which was refurbished in 2003-2004 after a major fire (ELEVATOR WORLD, January 2001 and July 2006).

Handling Capacity (HC)

The 21.9-meter vertical travel had to be extended to 55 meters due to a 24° incline with floor-to-floor distances of over 9 meters. The impact of horizontal acceleration and deceleration required an interaction of drive, frequency converter, controller and shaft information. For an optimal configuration, a 1600-kilogram capacity with an SM 850 gearless drive with a speed of 2.5 mps and corresponding frequency converter from Ziehl-Abegg was selected together with Lisa control from Schneider in connection with a two–wire bus system for the shaft information. The HC was calculated using ELEVATE® software. The five-minute HC was calculated with 18.2% of the building population. This value was rated okay since an increase in speed to 3.5 mps only brought the five-minute HC to 18.8%: a minor increase with a substantial budget rise. A three-elevator solution with a capacity of 1000 kilograms wasn't feasible due to the small building structure.

Continued

Figure 4

Figure 5

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Figure 6

Figure 7

- Figure 4: View from the top of the elevator shaft
- Figure 5: Elevator car traveling on tracks
- Figure 6: Window-side interior of the elevator car
- Figure 7: Control side of the elevator car
- Figure 8: Scheme of inductive power transmission

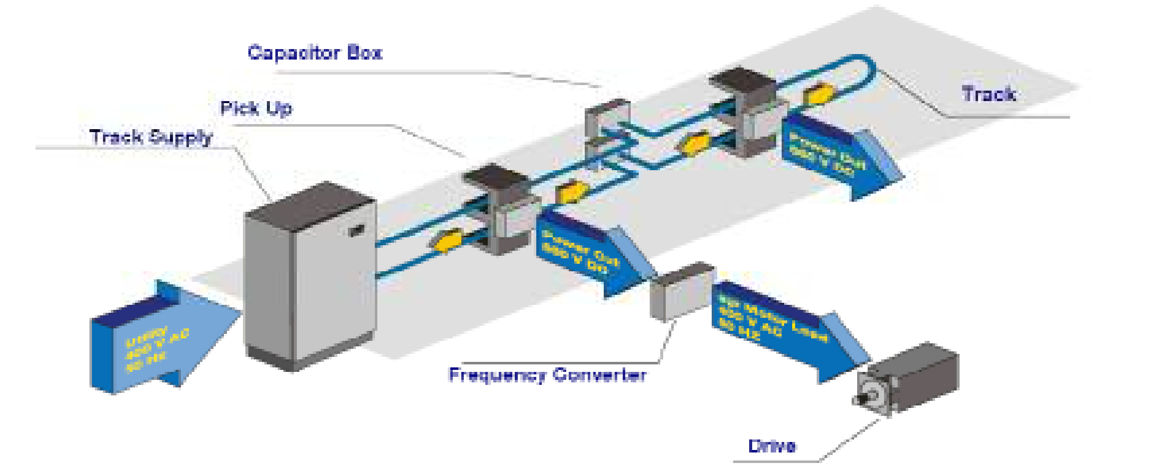

Figure 8

Techanical Specifications

Type: Inclined
Number of Lifts: Two
Drive system: Gearless traction
Controller: Microprocessor
Location of machine: Above
Stops: Seven
Entrances: Seven
Capacity: 1600 kilograms

Speed: 2.5 mps
Inclination: 24°
Code: European Lift Directive
Travel: 55,000 millimeters (inclined)
Car width: 2,450 millimeters
Car depth: 1,400 millimeters
Car height: 3,800 millimeters

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Door System

For inclined elevators with side-mounted doors, the door and the interlocking system are of outstanding importance to maintain reliable function of the elevator. Therefore, precise leveling is a prerequisite. A system available on the market was disassembled, reinforced and reassembled to fulfill the high demands of this project. The locking device of the shaft is adjustable to the inclination.

Buffers

European Norm EN 81 defines a deviation of 15° out of the vertical within its scope. The main differences for inclined elevators are 1) the risk of the oil buffers getting air in their system after being compressed, 2) the inclined elevators' unacceptably high value of retardation and 3) the extended wear and tear of oil buffers used in inclined elevators with front-mounted doors where oil buffers are compressed at every trip. Therefore, Hütter developed a completely new line of reinforced oil buffers with an external compensating tank from 0.5-2.5 mps and a maximum retardation of 0.4 mps^2. All oil buffers received a European Type Certificate and carry a CE sign.

Radio Control

The radio control allows the controller to "talk" to the car without an electrical cable as well as transfer and monitor the safety circuit. The control incorporates a category-4 stop circuit (according to EN 954-1). A radio-antenna cable installed along the travel of the car avoids interference with nearby harbor and Airbus airfield radio operations.

Car Design

The car's surface is made from sandblasted stainless steel. Three sides have laminated safety glass, coated on the back side with white enamel. The fourth side is a clear laminated safety glass 1.4 meters wide and 2.5 meters high. The floor is made from two sections of satin-finished three-layer laminated safety glass with a thickness of 2.5 inches. The car lighting is below the glass floor.

Achim Hütter is part of the family-owned and -run Hütter-Aufzüge GmbH, located in Hamburg.

Figure 9

▪ Figure 9: Reinforced oil buffer

Credits

Builder:
Robert Vogel GmbH & Co. Kg.
Architect:
BRT Bothe Richter Teherani
General Constructor:
Richard Ditting GmbH & Co. KG
Elevator Consultant:
LÜSEBRINK Ingenieure VBI
Elevator Company:
Hütter-Aufzüge GmbH

Quotes from Those Who Worked on the Project

Christian Feck from building firm Robert Vogel Gmbh noted:

It was a challenge to convey the architectural quality to otherwise often simple technical components and to view the technical building equipment not merely as functional resources of a building, but rather as decisive and important parts of the whole. This, for instance, is evident in the deliberately produced level of suspense generated by a ride in the inclined elevators.

The user enters the ground floor in darkness, rises to the light with a fantastic view over the harbor (including piers), and completes his ride once more in darkness on the 6th floor. This exciting ride is characterized by unobtrusive lighting, which is created by the glass floor with underneath illumination. The formulation of the cabin has been deliberately adjusted to the integral architecture with the design concept of an 'ice crystal.'

Genuine materials were used. The chute is illuminated, but the glass floor eliminates any glare. Thus, the view over the harbor remains undisturbed. The user feels [like the] captain of the elevator cage. Due to the remarkable operator panel with an upward window, the ride becomes a special experience and makes the building part of this event. The chute is anything but boring. There are interesting details to observe. For instance: exposed concrete, illuminated parts of the technically required enclosure, like ropes and rail guides.

Ilga Nelles of BRT Architects commented:

The power of the concept is evident in the constancy of form. A building, situated at the river frontage, enters into a dialogue with the water by extending 50 meters over the water surface. The path to the floors and the roof leads over a 24° flatly inclined façade. The form of Dockland corresponds to a lattice girder. Structure and concept form a unit. The tenants are proud of their open and bright office concepts. The Elbe is omnipresent. The feeling of floating on water is one of exceptional conciseness.

Wide stairs and integrated panoramic elevators with 24° inclines, make the entire building an adventure for everyone who comes here. The ultimate experience is arriving at the public terrace with its impressive panoramic view over harbor, bridges, church towers and rooftops.

Klaus-Peter Lüsebrink of elevator consultant Lüsebrink Ingenieure said:

The Dockland project, in particular the inclined elevators, [placed] great demands on planning. The challenge faced during the execution and implementation of planning applies not only to architectural and technical requirements, but also to planning itself. Due to the detailed specifications provided by BRT architects, the architectural concept was firmly defined; thus, even common detailed planning in elevator engineering was very demanding on implementation. Particularly, the cabin equipment, the position of the car-operating panel, the special glazing of the glass sections, the position of the air-conditioning unit [and] the cabin lighting must be mentioned here, and in the exterior area the creation of maintenance platforms and their accessibility . . . To ensure good ride quality, a car trolley had to be developed that could accommodate the components necessary for the control system and power current transmission. Furthermore, a good accessibility for service technicians at optimal paneling design had to be realized.

To be able to realize the remarkably high speed for inclined elevators of 2.5 mps, different simulations were performed. In doing so, special emphasis was placed on acceleration and deceleration. The gathered guidelines were implemented by the manufacturer and optimized in the construction documentation to the extent that the developing cross acceleration is almost unnoticeable during acceleration and deceleration. On the one hand, this can be attributed to the assiduous layout design, and on the other to the installation adjustment and pre selection of the driving cycles, which were carried out with great expertise. After realization, the project represents a unique undertaking in Germany due to the close collaboration and coordination between planning and implementation.