



Ropeless Technology Moves Elevators in New Directions

MODERN ELEVATORS have been dependent on rope- or cable-based systems since their development more than 150 years ago, according to thyssenkrupp Elevator, a leading elevator company based in Essen, Germany. But a new future for elevators may be here with the company's creation of a safe, ropeless elevator system known as MULTI that not only moves vertically, but can also make a 90-degree direction change to travel horizontally. Multiple cars can travel along the same track, rather than traveling individually through a shaft. Because of this, cars can simultaneously move in, around, and even between buildings, depending on the design of the buildings and the wishes of each car's passengers. The system, which was verified this summer in thyssenkrupp's 246 m tall test tower in Rottweil, Germany, has the potential to completely redefine how architects and structural engineers approach the design of buildings.

"This is perhaps the biggest development in the elevator industry since the invention of the safety elevator some 165 years ago," said Antony Wood in a statement released by thyssenkrupp. Wood is the executive director of the Chicago-based Council on Tall Buildings and Urban Habitat (CTBUH) and a research professor in the College of Architec-

ture at the Illinois Institute of Technology, also in Chicago. "The 'holy grail' for elevators has been to move beyond being pulled vertically by a rope under tension, toward a system that allows movement in inclined or horizontal directions," Wood said. "This [development] has the capacity to transform the industry at large, changing the way tall buildings are designed, and allowing for much more efficient core designs, as well as better connectivity in buildings."

The MULTI system operates on the basic premise of a paternoster circular system, in which a single loop, or track, can incorporate numerous cars that travel along a guide rail system propelled by linear motors, according to Markus Jetter, the head of product development for thyssenkrupp Elevator, who

The development of a reliable, safe, ropeless elevator system by thyssenkrupp Elevator has the potential to completely redefine how towers are designed, both architecturally and structurally.

works in the company's research and development center in Neuhausen, Germany. Jetter provided written answers to questions posed by *Civil Engineering*. He says that the system expands upon the company's developments in linear motor technology, which it has used to develop a rapid-transit system called ACCEL as well as Germany's Transrapid magnetic

levitation (maglev) train system, which it created in conjunction with the global firm Siemens.

The system also makes use of the company's decade-old TWIN elevator technology, which enables two cars to travel along the same elevator shaft without coming too close to each other. Specifically, the MULTI uses TWIN's safety systems and multilevel braking and propulsion technology. "MULTI applies the concept of the TWIN's control system and safety features, but includes new elements such as new and lightweight carbon composite materials for cars and doors," Jetter explained. These lightweight materials reduce the weight of the cars by 50 percent compared with traditional cars, according to Jetter. "A new linear drive also enables [a] single motor to be sufficient to perform horizontal and vertical movements, and an exchanger moves cars from one shaft to the other," he said.

The system targets a speed of 5 m/s and near-constant passenger access to elevator cars, which are expected to arrive every 15 to 30 seconds, Jetter explained. Transfer stops every 50 m will give elevator cars the capacity to shift from vertical to horizontal movement. The MULTI ropeless elevator system can increase passenger capacity by 50 percent over traditional elevator systems, according to material distributed by thyssenkrupp.

The costs of such systems are also competitive with traditional systems, according to Jetter. "The benefit for the investors by [increasing] floor space over the building height of 100 and more stories (or above approximately 300 m) is much higher than the initial investment cost for the elevator system," Jetter said. "So the system amortizes very fast."

While the high-speed elevators typically used in supertall buildings are limited by the effects of pressure on the human body—because many people experience discomfort while traveling in elevators at speeds higher than 10 m/s—the flexibility of the MULTI system will enable it to offer higher capacities and faster and more comfortable movement in a building without the need for such high speeds, Jetter noted.

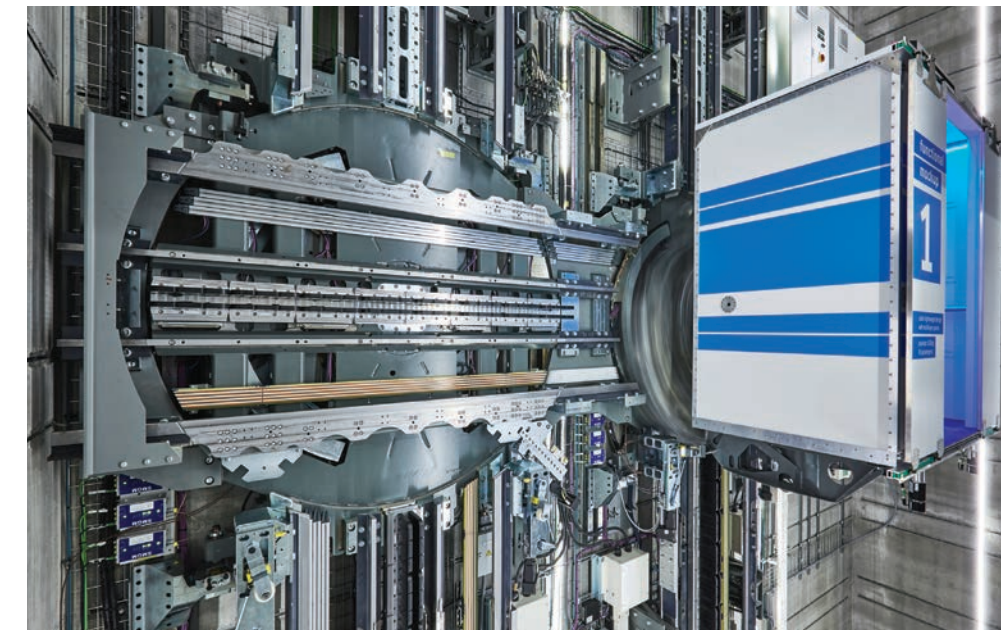
The system also reduces peak power demand by 60 percent compared with conventional elevator systems, according to thyssenkrupp. "This technology allows us to activate only those sections where the cars are located," Jetter explained. "The active part is on the shaft side and the passive on the car side, so energy consumption is only active when cars are accelerated, moved, and decelerated."

In addition to increased passenger capacity and energy savings, the system also has a smaller footprint than conventional elevator systems, decreasing the space required for an elevator by up to 50 percent. This is because the system uses narrower elevator shafts, and because there is no building-

length steel elevator cable that would need to be stored and supported within the building. Because traditional elevator and escalator footprints can occupy up to 40 percent of a high-rise's floor space depending on its height, thyssenkrupp estimates there would be a 25 percent increase in usable floor area in a high-rise building that uses a MULTI system instead of a traditional elevator.

But increased usable floor area is not the only benefit of the elevator system, according to Dennis C. K. Poon, P.E., M.ASCE, the vice chairman of Thornton Tomasetti's New York office and a steering committee member of the CTBUH's study on the design possibilities enabled by ropeless, nonvertical elevators. Ropeless elevator systems "will give us more flexibility to work with the architects so we don't have to limit our structural system to a rigid tower core," Poon says. "It gives us [the potential for] more creativity in our structural engineering."

"Good engineers love this creativity," Poon continues. "We could push structural systems [from the core] to



The ropeless elevator system can move cars both vertically and horizontally along tracks within a building, using multiple elevator cars along the same circular loop system to deliver passengers to their selected destination.

around the building perimeter, between partition walls, or between the walls in an office," he explains. "Even within the ropeless elevator concentrated area, we could express our bracing system in a more expressive way within the architecture. It frees up the space for us to do anything we see appropriate."

Thornton Tomasetti is already seeing a great deal of interest in the elevator systems, and the company is in discussions with architects and building owners about how the system might be incorporated into upcoming high-rise designs, according to Poon.

By the end of the decade, MULTI will be installed in its first building: the new flagship building, in Berlin, of the leading European real estate business OVG Real Estate.

—CATHERINE A. CARDNO, PH.D.