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A Vertical Transportation Breakthrough

An elevator car is a transportation vehicle that travels up and down between floors in a vertical shaft. Elevators are so common and safe that they are often overlooked when people compare the safety records of different modes of transportation.

This often-overlooked mode of transportation is ubiquitous; elevators in buildings throughout the world lift 2 billion people a day. (See Photo 1.) According to Answers.com,"You are 10 times more likely to die by being struck by lightning (on average 60 U.S. deaths caused by lightning strikes annually) than from riding inside an elevator." (See http://wiki.answers.com/Q/What_is_the_safest_form_of_travel for more details.)

The modern elevator story began in 1852 with Elisha Otis's invention of a safety mechanism that stopped elevators from falling when their lift rope broke. The modern skyscraper story has always been tied to the elevator. Can you imagine walking up staircases to get to the top floor of any skyscraper? Actually the first tall buildings with the moniker "skyscraper," were only 10 to 20 stories tall.

This YouTube video, www.youtube.com/watch?v=WldqHQbrjUU, provides an excellent visual understanding of how modern elevators work. The video also shows why elevators, using current technology, have height limitations. It was filmed in the world's tallest building while the building was under construction.

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Photo 1—Can you imagine living or working in a building with 10 floors or more that didn't have an elevator?

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Photo 2 (left)—The Burj Khalifa is the tallest building in the world, likely to remain so for the forseeable future.

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Photo 3 (above)—Elevators that travel in very tall skyscrapers slowly accelerate and slowly decelerate to keep their occupants comfortable and safe during the ride.

The Burj Khalifa in Dubai, United Arab Emirates (Photo 2) is 2,717' tall (828.146 meters), which means that it rises a just a bit (77') over a half a mile into the sky. It has 163 floors and an elevator system that can send you up 1,654 feet (504 meters) on the world's fastest elevator ride. The elevators in this building need to accelerate and decelerate at speeds that keep occupants comfortable during the climb or descent. (See Photo 3.)

At peak speed, a Burj Khalifa elevator travels at 10 meters per second, which works out to 1,969' per minute. Still, the ride from the ground to the 124th-floor observation deck takes one minute and four seconds.

How fast an elevator can go straight up and down is limited by the need to keep its occupants safe and comfortable. The elevator ride in a skyscraper should not feel like an amusement park ride. The car needs to slowly come up to speed and also slowly decelerate to keep the oc-

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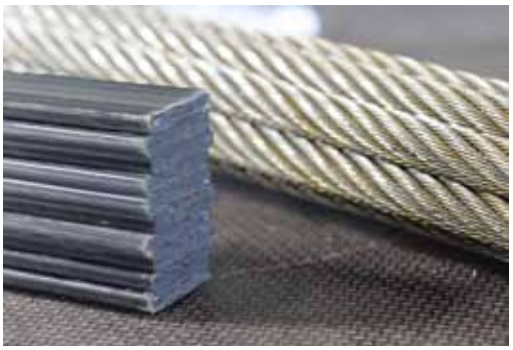

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Photo 3—Carbon fiber UltraRope is not round like conventional steel cables. It has flat sides and a friction- and abrasion-resistant outer coating.

cupants standing. The ears of the riders also need time to adjust to the change in air pressure as the elevator moves from the ground to a half mile into the sky.

To take passengers on a half-mile-high elevator ride in the Burj Khalifa skyscraper, the Otis Elevator Company had to build a lift system with a 100-ton capacity. To reach the clouds, each elevator has 6.5 miles of cables that weigh 30 tons. The YouTube video cited above graphically shows that, without a major breakthrough, elevators have reached their height limits. Longer cables will break under their own weight. Also, the longer the round cables get, the more they are affected by a swaying building in heavy winds.

At this time, the construction industry is evaluating KONE UltraRope™ as a carbon fiber replacement for the steel cables currently used in skyscraper elevator systems. Carbon fiber has already proven itself to be stronger and lighter than steel in other industries.

To make UltraRope the perfect replacement for elevator cables, KONE encases each cable with a high friction- and abrasion-resistant surface layer. UltraRope is flat like a belt—not round like a steel cable. (See Photo 3.) This change in shape should reduce the effect that building sway caused by wind will have on future skyscraper elevator systems.

For buildings to grow taller, elevator cables must become stronger and lighter. UltraRope is extremely lightweight when compared with the weight of steel cables it would replace. According to KONE, this change in weight, shape, reduced maintenance, and strength will allow future buildings to rise to twice the height of the Burj Khalifa skyscraper. A KONE graphic at the company's website (http://download.kone.com/ultrarope/index.htm) lets you see how the height of a building beyond Burj Khalifa affects the weight of steel vs UltraRope cables.

Recalling the Facts

1. How many stories tall were the first skyscrapers? Why do you think they were called "skyscrapers"?
2. Why can't the Burj Khalifa elevators instantly jump to full speed at the start of their trip to the building's observation deck?

