






Architecture

Burj Khalifa

Dubai, United Arab Emirates



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Burj Khalifa

Described as both a 'Vertical City' and 'A Living Wonder,' Burj Khalifa, at the heart of downtown Dubai, is also the world's tallest building.

Developed by Dubai-based Emaar Properties PJSC, Burj Khalifa rises gracefully from the desert and honors the city with its extraordinary union of art, engineering and meticulous craftsmanship.

At 828 meters (2,716.5 feet), the equivalent of a 200 story building, Burj Khalifa has 160 habitable levels, the most of any building in the world. The tower was inaugurated on January 4, 2010, to coincide with the fourth anniversary of the Accession Day of His Highness Sheikh Mohammed Bin Rashid Al Maktoum Vice President and Prime Minister of the UAE and Ruler of Dubai.

Arguably the world's most interesting construction project, Burj Khalifa is responsible for a number of world-firsts. The tower became the world's tallest man-made structure just 1,325 days after excavation work started in January 2004.

Burj Khalifa utilized a record-breaking 330,000 cubic meters (430,000 cubic yards) of concrete;



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39,000 tons of steel reinforcement; 103,000 square meters (1.1 million square feet) of glass; and 15,500 square meters (167,000 square feet) of embossed stainless steel. The tower took 22 million man-hours to build.

With a total built-up area of 526,000 square meters (5.67 million square feet), Burj Khalifa features 170,000 square meters (1.85 million square feet) of residential space, over 28,000 square meters



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(300,000 square feet) of office space, with remaining area occupied by a luxury hotel.

In 2003, as a result of an international design competition, Skidmore, Owings & Merrill LLP (SOM) was selected from a group of five international competitors to carry out the architecture and engineering of the Burj Khalifa.

With famous architecture in the Haj Terminal at Jeddah Airport and National Commercial Bank, SOM is no stranger to Middle Eastern design. SOM incorporated patterns and



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elements from traditional Islamic architecture, but the most inspiring muse was a regional desert flower, the Hymenocallis, whose harmonious structure is one of the organizing principles of the tower's design. Three 'petals' are arranged in a triangular shape and unified at the center, and instead of repeated identical patterns, the architectural plan appoints successively receding and rotated stories.

The Y-shaped plan is ideal for residential and hotel usage, with the wings allowing maximum outward views and inward natural light. Viewed from above or from the base, the tips of the Y-shaped plan evokes the onion domes of Islamic architecture. During the design process, engineers rotated the building 120 degrees from its original layout to reduce stress from prevailing winds.



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Architecturally, the building transforms itself from a solid base expression to a vertically expressed middle section of polished stainless steel projected metal fins and glass. Only vertical elements were used here, as the fine dust in Dubai's air would build up on any horizontal projecting elements.



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The structural system

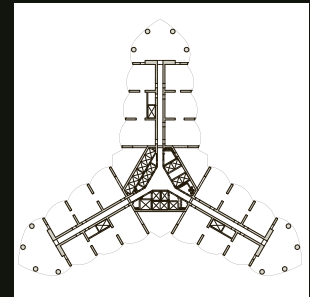
To support the unprecedented height of the building, the engineers developed a new structural system called the buttressed core, which consists of a hexagonal core reinforced by three buttresses that form the 'Y' shape. Each wing, with its own high performance concrete corridor walls and perimeter columns, buttresses the other wings through a connection to the six-sided central core, or hexagonal hub. The result is a tower that is extremely stiff laterally and torsionally.

Each tier of the building sets back in a spiral stepping pattern up the building. The setbacks are organized with the tower's grid, such that the building stepping is accomplished by aligning columns above with walls below to provide a smooth load path. This allows the construction to proceed without the normal difficulties associated with column transfers.

The setbacks are organized such that the tower's width changes at each setback. The advantage of the stepping and shaping is to 'confuse the wind'. The wind vortices are never allowed to build up because at each new tier the wind



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Burj Khalifa structural plan.pdf – © SOM

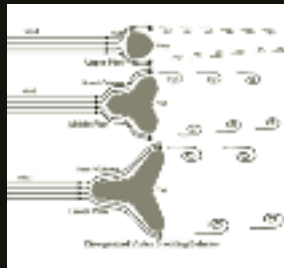


Rebar construction © Emaar Properties PJSC

encounters a different building shape. This structural system enables the building to support itself laterally and keeps it from twisting.

At the top, the central core emerges and transitions to a special steel framed structure which is sculpted to form a finished spire. The spire of Burj Khalifa is composed of more than 4,000 tons of structural steel.

The building utilizes high-speed, non-stop shuttle elevators to sky lobby floors where passengers transfer to local elevators serving the floors in between.



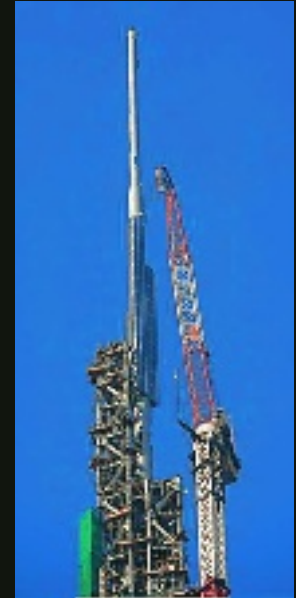
Burj Khalifa wind.jpg – © SOM



Inside the high-speed elevator
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Burj Khalifa has 57 elevators and 8 escalators. Travelling at 10 meters/sec (33 feet/sec) per second, they have the world's longest travel distance from lowest to highest stop. The building service/fireman's elevator will have a capacity of 5,500 kilograms (12,000 pounds) and is the world's tallest service elevator.

To achieve the greatest efficiencies, the mechanical, electrical and plumbing services for Burj Khalifa were developed all together during the design phase of the tower in cooperation with the architect, structural



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engineers and other consultants. The tower's water system supplies an average of 946,000 liters (250,000 gallons) of water daily. At peak cooling, Burj Khalifa will require about 10,000 tons of cooling, equal to the cooling capacity provided by about 10,000 tons of melting ice. Dubai's hot, humid climate combined with the building's cooling requirements creates a significant amount of condensation. This water is collected and drained in a separate piping system to a holding tank in the basement car park. The condensate collection system provides about 57 million liters (15 million gallons) of supplement water per year, equal to about 20 Olympic-sized swimming pools. The tower's peak electrical demand is 50 MVA, equivalent to roughly 500,000 100-watt light bulbs all operating at the same time.



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Facts about Burj Khalifa

Location: Downtown Dubai,
Dubai, United Arab Emirates

Architect: Skidmore, Owings & Merrill
LLP (SOM)

Building type: Supertall skyscraper

Materials: Reflective glazing, aluminum
and textured stainless steel

Construction: Reinforced concrete and steel

Date: From 2004 to 2010

Floor area: 464,511 m²
(5.67 million square feet)

Height: 828 meters (2,716.5 ft.)

Stories: 160+ stories



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The architects

With the design and engineering of Burj Khalifa, Skidmore, Owings & Merrill LLP (SOM), joined forces with Dubai based developers, Emaar Properties PJSC, to redefine what was possible with supertall buildings.

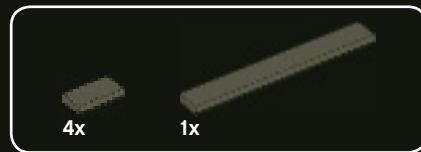
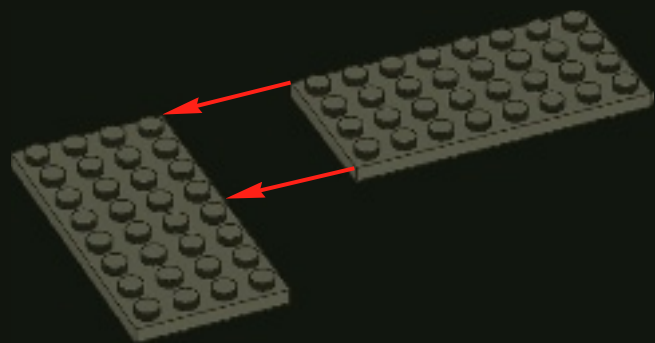
With a portfolio that includes some of the most important architectural accomplishments of the 20th and 21st centuries, including the John Hancock Center and Willis (formerly Sears) Tower, SOM was perfectly placed to carry out this challenging task.

To create Burj Khalifa — a building that shatters all previous height records at 828 meters (2,716.5 feet) — a team of more than 90 designers and engineers combined cutting edge technology and culturally-influenced design to create a global icon that will serve as a model for future urban centers.

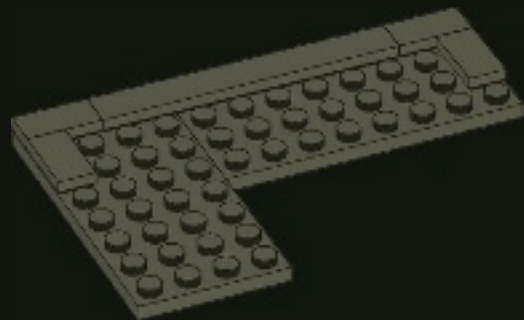


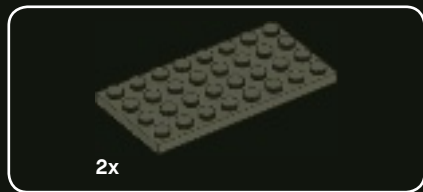


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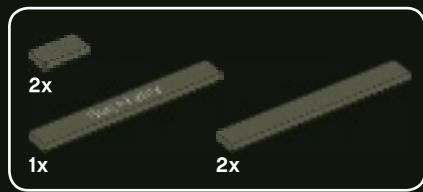
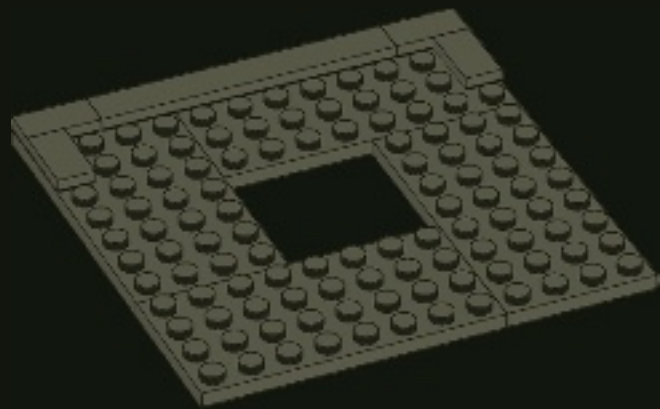


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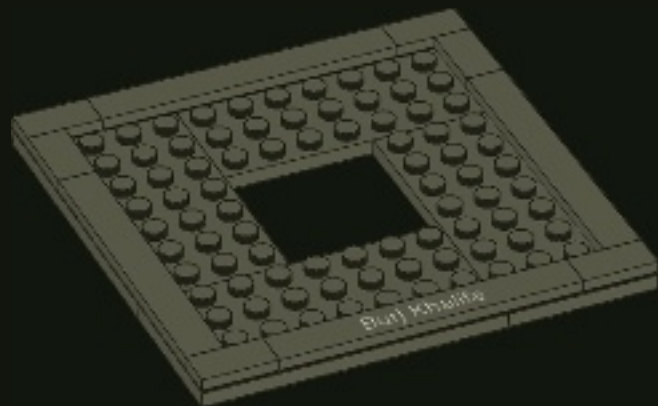




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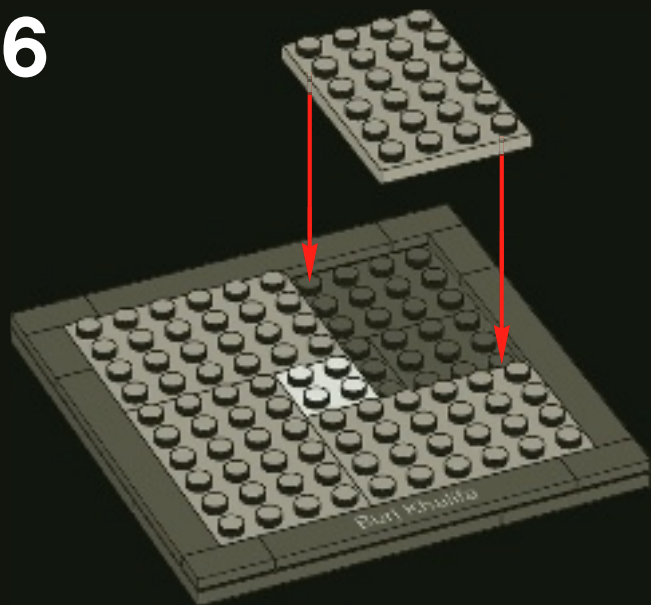




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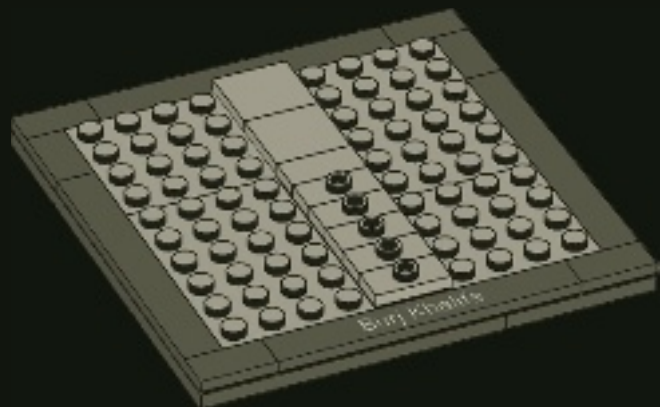


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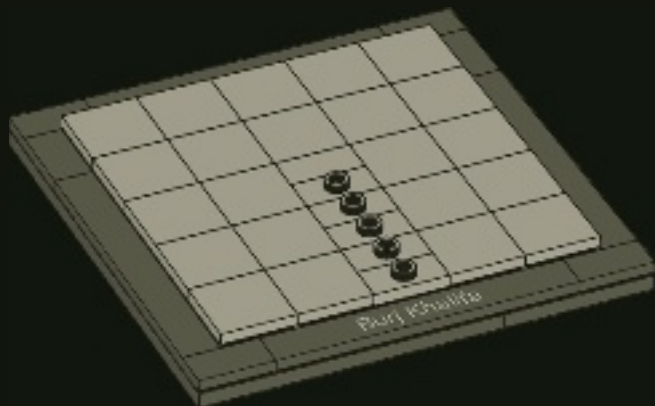
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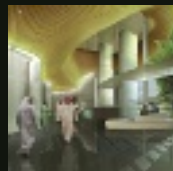


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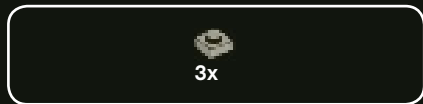
The interior is inspired by local culture while staying mindful of the building's status as a global icon and residence. The design features glass, stainless steel and polished dark stones, together with silver travertine flooring, Venetian stucco walls, handmade rugs and stone flooring.





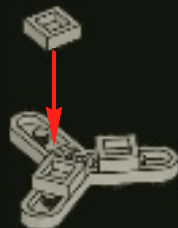
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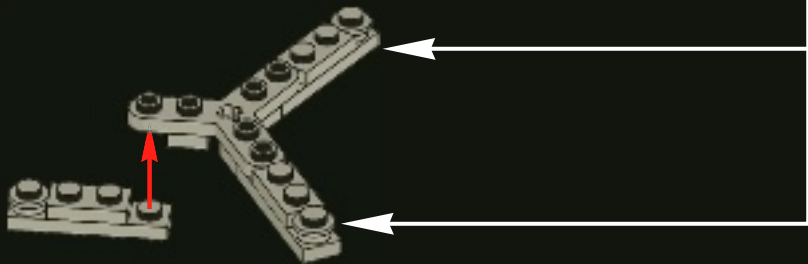
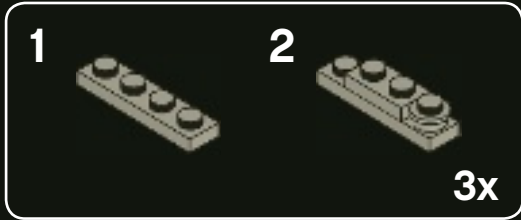
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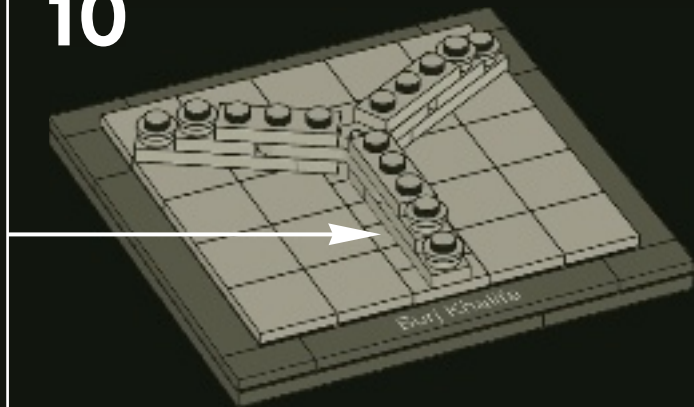


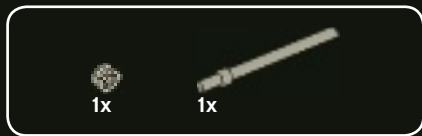
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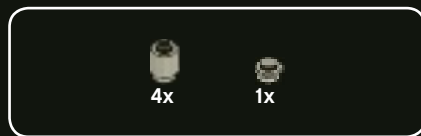
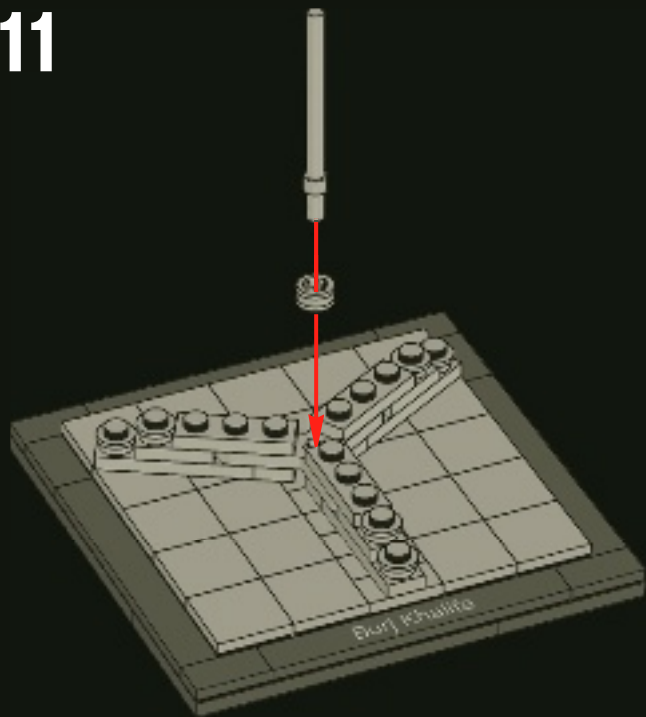


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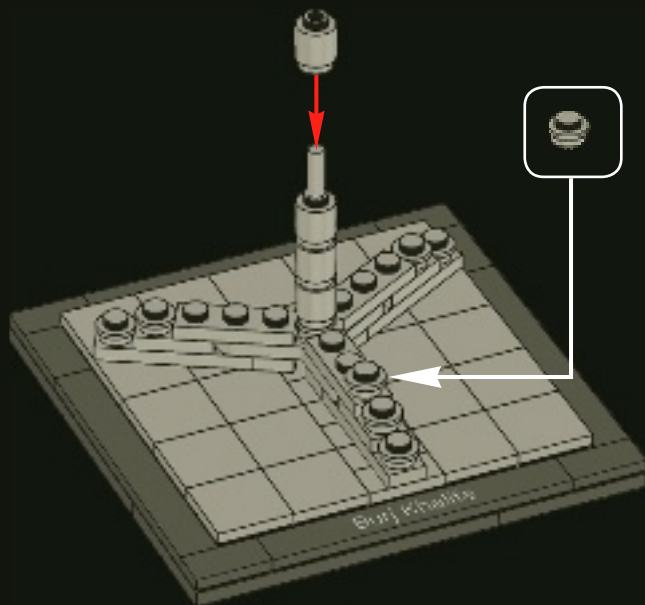




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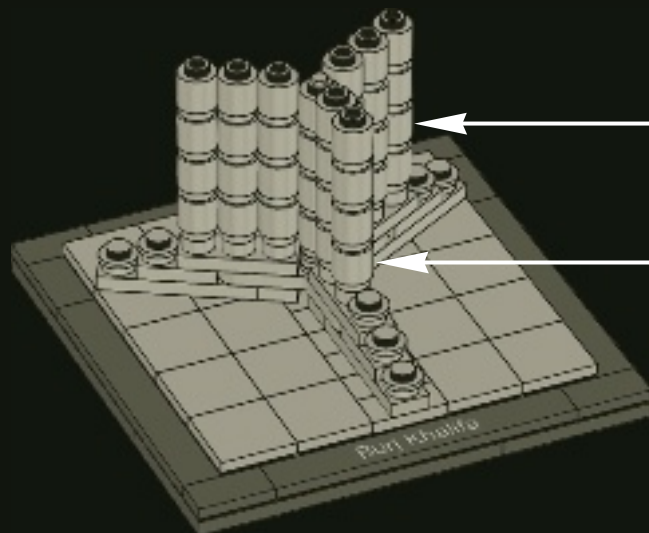


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8x

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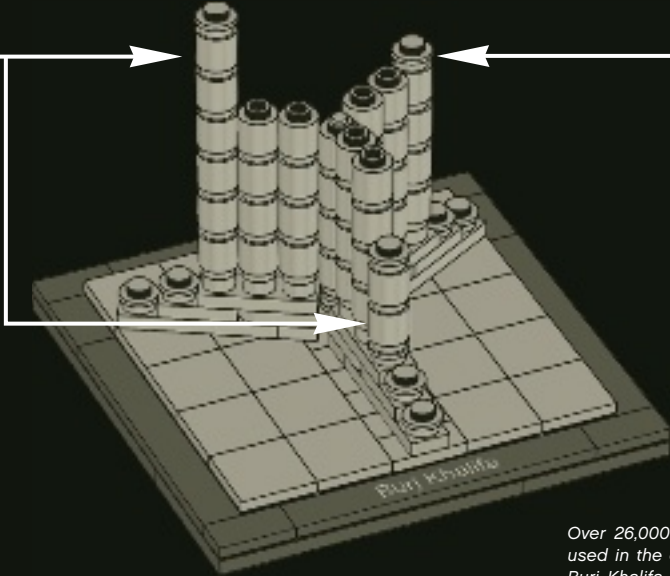
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8x



14



Over 26,000 glass panels were used in the exterior cladding of Burj Khalifa. Over 300 cladding specialists from China were brought in for the cladding work on the tower.



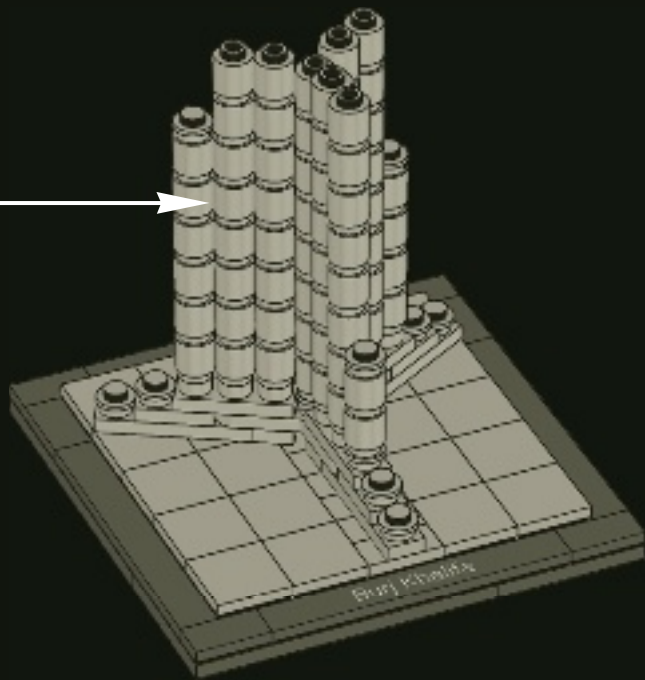


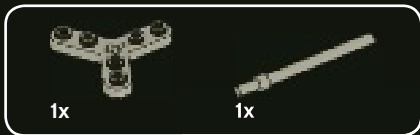
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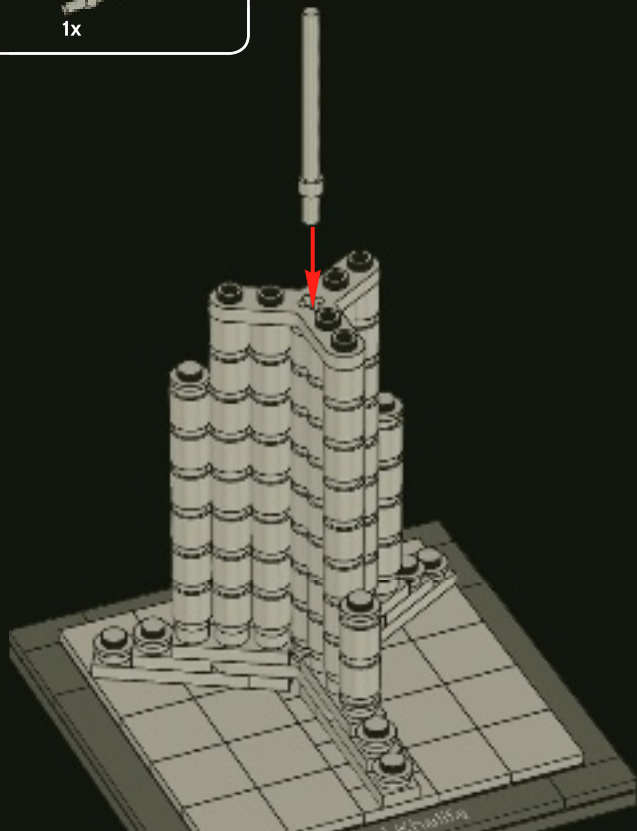


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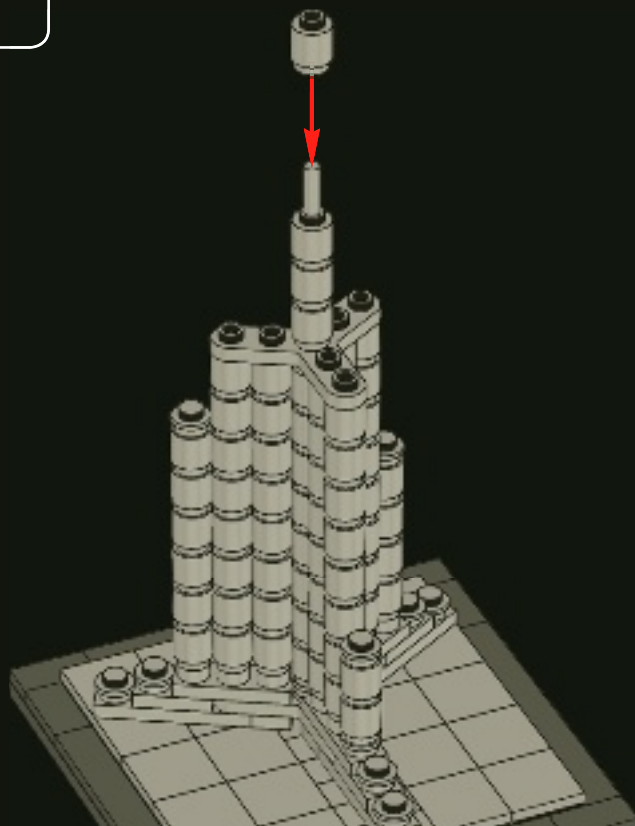
The opening ceremony of Burj Khalifa featured a display of 10,000 fireworks, light beams and further sound, light and water effects. Using 868 powerful stroboscope lights that are integrated into the façade and spire, different lighting sequences were choreographed, together with more than 50 different combinations of the other effects.





4x

17



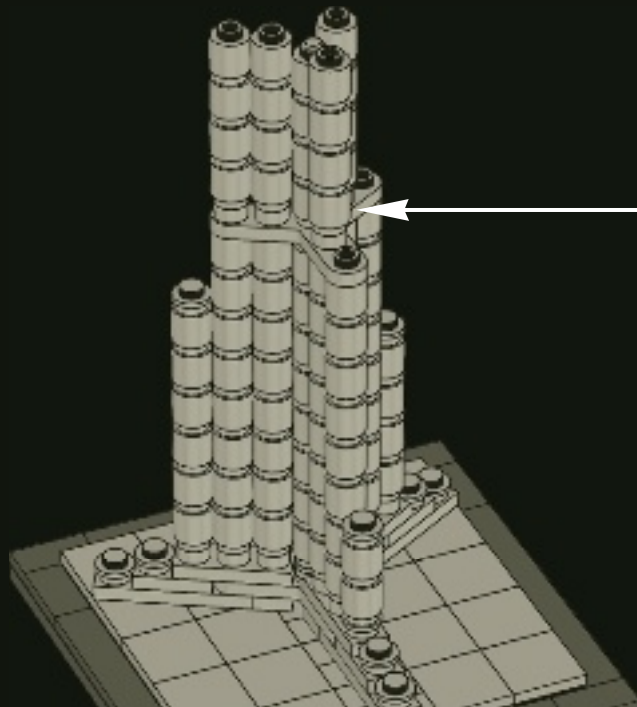


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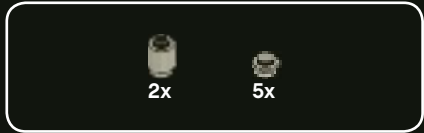
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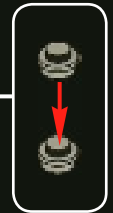
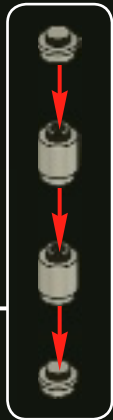
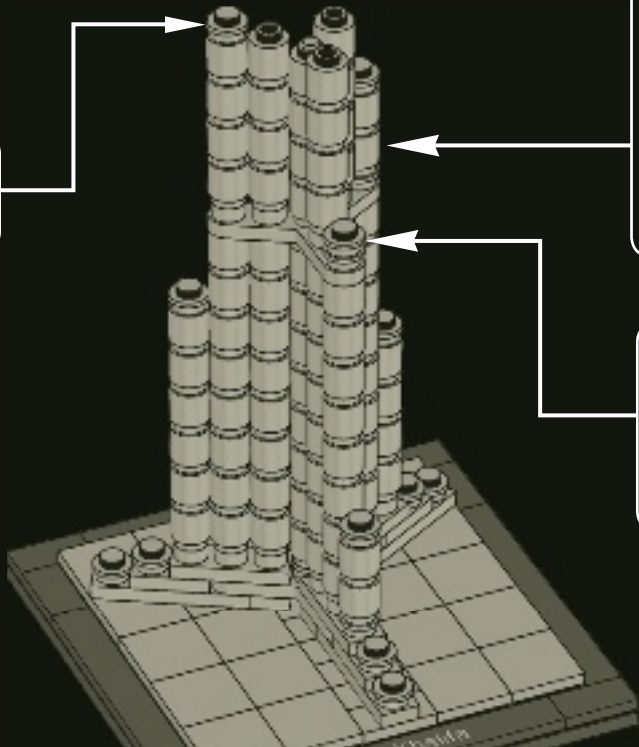
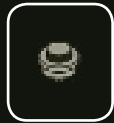
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It will take 36 workers three to four months to clean the entire exterior façade using all building maintenance units.





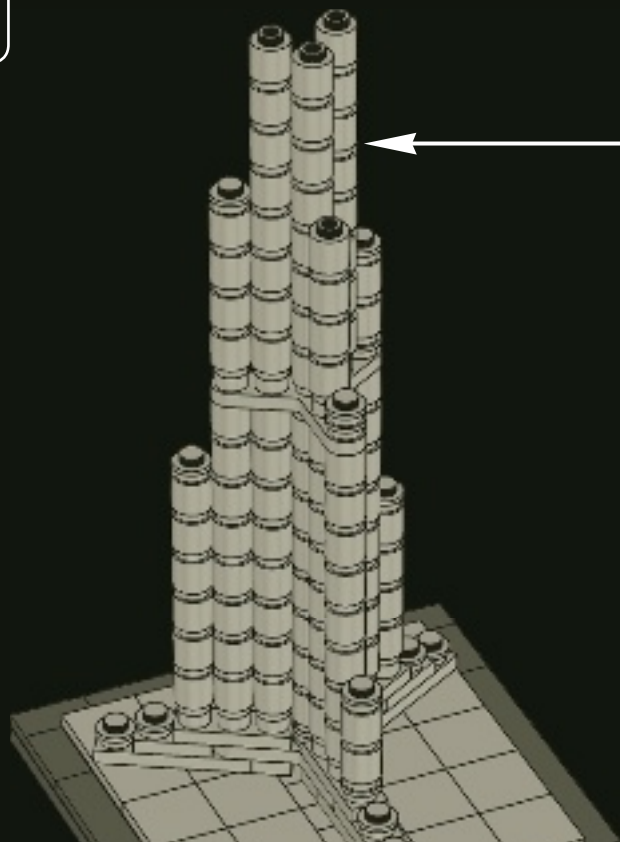
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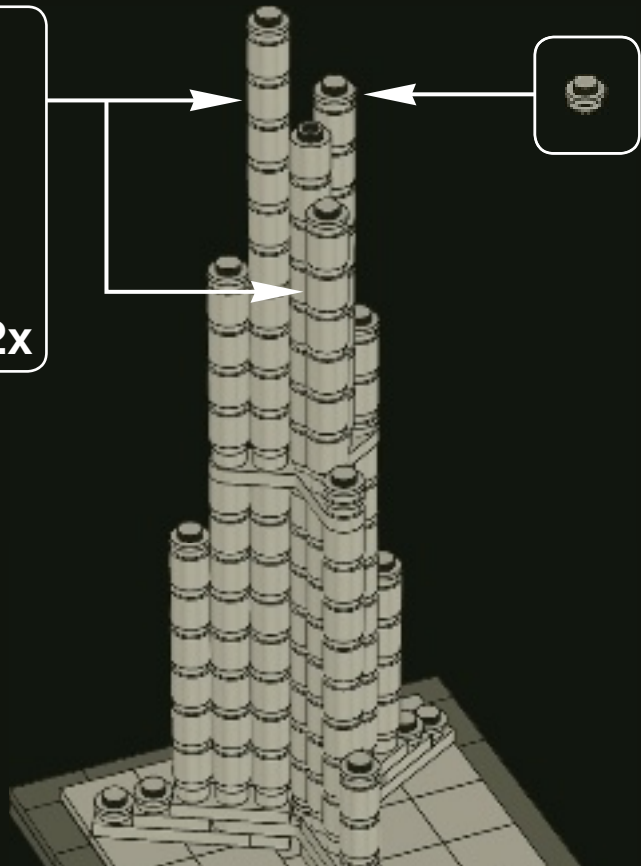


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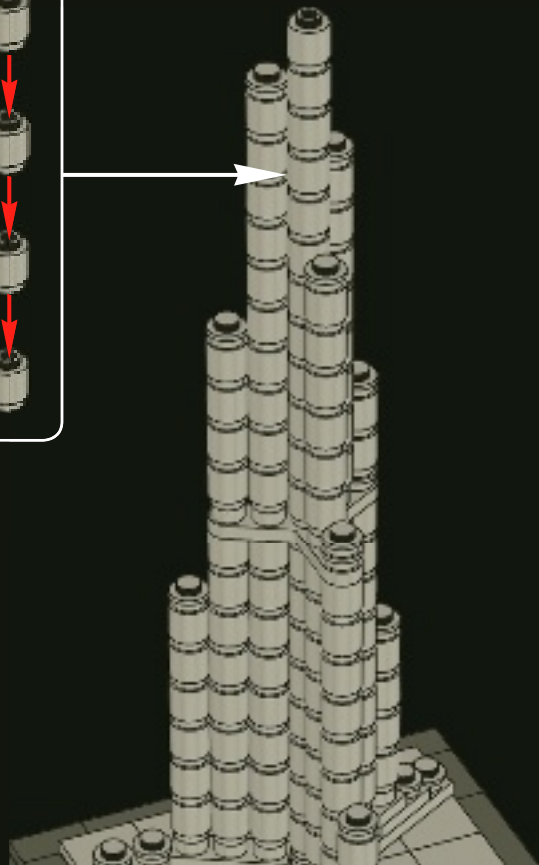
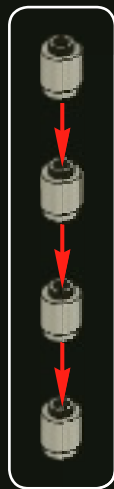
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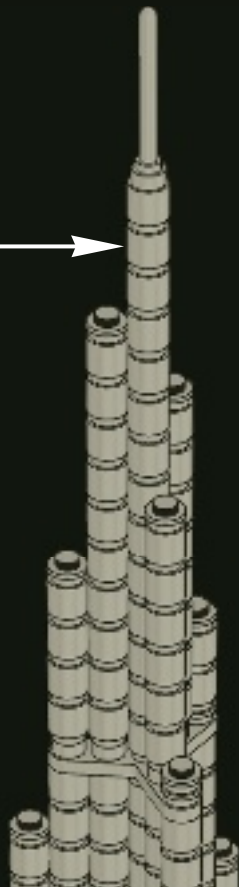
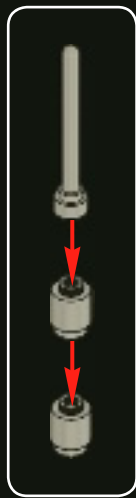


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23



Construction Highlights

Burj Khalifa is truly the product of international collaboration; over 60 consultants including 30 on-site contracting companies from around the world were involved in the project.

At the peak of construction, over 12,000 professionals and skilled workers from more than 100 countries were on site every day. The world's fastest high-capacity construction hoists, with a speed of up to 2 meters/sec (6.5 feet/sec) (120 meters/min), were used to move men and materials.

Over 45,000 cubic meters (1.59 million cubic feet) of concrete, weighing more than 110,000 tons, were used to construct the concrete and steel foundations, which feature 192 piles, buried more than 50 meters (164 feet) deep. Burj Khalifa employs a record-breaking 330,000 cubic meters (11.6 million cubic feet) of concrete; 39,000 m³ of reinforced steel; 103,000 square meters (1.1 million square feet) of glass; 15,500 square meters (166,800 square feet) of embossed stainless steel; and the tower took 22 million man-hours to build.

The amount of reinforced steel used at the tower, would if laid end to end extend over a quarter of the way around the world. The concrete used is equivalent to a sidewalk 1,900 kilometers (1,200 miles) in length, and the weight of 110,000 elephants. The weight of the empty building is 500,000 tons.

The tower accomplished a world record for the highest installation of an aluminum and glass facade, at a height of 512 meters (1,679.8 feet). The total weight of aluminum used on Burj Khalifa is equivalent to that of five A380 aircraft, and the total length of stainless steel 'bull nose' fins is 293 times the height of the Eiffel Tower in Paris.



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A Word from the Artist

As an Architectural Artist my desire is to capture the essence of a particular architectural landmark into its pure sculptural form. I first and foremost do not view my models as literal replicas, but rather my own artistic interpretations through the use of LEGO® bricks as a medium. The LEGO brick is not initially thought of as a material typically used in creating art or used as an artist's medium. I quickly discovered the LEGO brick was lending itself as naturally to my applications as paint to a painter or metal to a blacksmith. As I explore how to capture these buildings with the basic shapes of the bricks and plates, I find the possibilities and challenges they offer almost magical.

Burj Khalifa

This model has two unique details surrounding its launch. It is the first International model to be showcased in the LEGO Architecture line and it is also the latest skyscraper since the Seattle Space Needle in continuing the Landmark theme. In terms of design challenges this model really only had a few. As impressive as the real structure is, when captured in its

smaller LEGO form the only discernable form is its 3-spoke geometry. Y-shapes & triangular shapes can be tricky to construct using square bricks. However, in this case the use of a single Technic 3-bladed rotor propeller establishes the basis of the entire model. From there I was able to have 9 points and 1 in the central core totaling 10 nodes from which to build upward vertically, while expanding the propeller to add 2 downward vertical points from each blade totaling an additional 6 nodes. So, that single propeller piece anchors all 16 radial nodes and thus capturing the essence of the entire design.



– Adam Reed Tucker



“Architecture — a wonderful game”

This was the title, or rather a paraphrase of the French title ('L'architecture est un jeu ... magnifique') of a 1985 exhibition hosted by the Pompidou Centre in Paris, where 30 young European architects were given the opportunity to play with the famous Danish LEGO® bricks. The original idea was actually Dutch, Rotterdam's Kunststichting arranging a small event the previous year where ten local architects were let loose on a large number of LEGO bricks. Such was the success of this first initiative that the Pompidou Centre decided to expand the idea to include 30 young aspiring architects from across Europe—their goal: to each draw an imaginary villa which would then, brick by brick, be built at LEGO HQ in Billund.

During the event, many a quotation was used from the history of architecture. For example, the Italian Renaissance architect Palladio was quoted alongside modernists such as Mies van der Rohe and Gerit Rietveld, the quotes relating to architectural projects from oil platforms to romantic ruins. It was a case of 'no holds



barred' and even though some of the projects produced by the 30 talents ended in weird and wonderful pseudo-philosophical comments on opportunities, or rather the lack of same in the Eighties, it was all, nevertheless, a wonderful game.

References

Text credits:

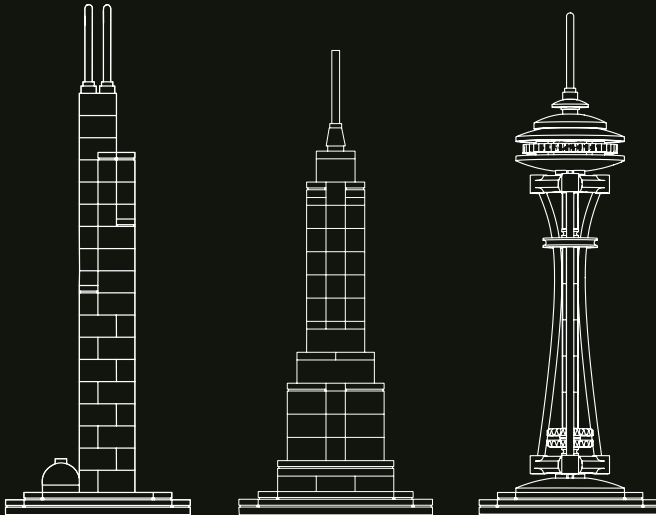
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