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BURZ KHALIFA: THE TALLEST SKYSCRAPER IN WORLD: THE HALLMARK OF EXCELLENCE

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ABSTRACT

The Burj Khalifa, known as the Burj Dubai prior to its inauguration in 2010, is a skyscraper in Dubai, United Arab Emirates. It is located in: Burj Park by Emaar. Address: 1 Sheikh Mohammed bin Rashid Blvd - Downtown Dubai - Dubai - United Arab Emirates. Departments: Burj Khalifa Pool Annex. Hours: Open 24 hours. Phone: +971 4 888 8888. Appointments: atthetop.ae. Height: 828 m, 830 m to tip CTBUH. Floors: 163. Owner: Emaar Properties. Architects: Adrian Smith, George J. Efstathiou, Marshall Strabala. Construction started: 6 January 2004. Contractors: Samsung C&T Corporation, Turner Construction, Laing O'Rourke, Besix, Arabtec Holding PJSC. Opened: 4 January 2010.

KEYWORDS: Burj Khalifa, Burj Dubai, UAE, Emaar properties.

INTRODUCTION

Burj Dubai renamed Burj Khalifa in honour of the President of the UAE and ruler of Abu Dhabi, Sheikh Khalifa bin Zayed al Nahyan. 10 March 2010: Council on Tall Buildings and Urban Habitat certifies Burj Khalifa as world's tallest building. The Burj Khalifa, known as the Burj Dubai prior to its inauguration in 2010, is a skyscraper in Dubai, United Arab Emirates. With a total height of 829.8 m (2,722 ft, just over half a mile) and a roof height (excluding antenna, but including a 244 m spire) of 828 m (2,717 ft), the Burj Khalifa has been the tallest structure and building in the world since its topping out in 2009, supplanting Taipei 101, the previous holder of that status.

Construction of the Burj Khalifa began in 2004, with the exterior completed five years later in 2009. The primary structure is reinforced concrete and some of the structural steel for the building originated from the Palace of the Republic in East Berlin, the former East German parliament. The building was opened in 2010 as part of a new development called Downtown Dubai. It is designed to be the centrepiece of large-scale, mixed-use development. The decision to construct the building is based on the government's decision to diversify from an oil-based economy, and for Dubai to gain international recognition. The building was originally named Burj Dubai but was renamed in honour of the ruler of Abu Dhabi and president of the United Arab Emirates, Khalifa bin Zayed Al Nahyan; Abu Dhabi and the UAE government lent Dubai money to pay its debts. The building broke numerous height records, including its designation as the tallest building in the world.

Burj Khalifa was designed by Adrian Smith, of Skidmore, Owings & Merrill, whose firm designed the Willis Tower and One World Trade Center. Hyder Consulting was chosen to be the supervising engineer with NORR Group Consultants International Limited chosen to supervise the architecture of the project. The design is derived from the Islamic architecture of the region, such as in the Great Mosque of Samarra. The Y-shaped tripartite floor geometry is designed to optimize

residential and hotel space. A buttressed central core and wings are used to support the height of the building. Although this design was derived from Tower Palace III, the Burj Khalifa's central core houses all vertical transportation with the exception of egress stairs within each of the wings. The structure also features a cladding system which is designed to withstand Dubai's hot summer temperatures. It contains a total of 57 elevators and 8 escalators.

Adrian D. Smith **George J. Efstathiou** **Marshall Strabala**

Figure 1: Burj Khalifa construction companies & Constructors.

At a certain point in the architectural and engineering process, the original Emaar developers experienced financial problems, and required more money and economic funding. Sheikh Khalifa, the ruler of the United Arab Emirates, granted monetary aid and funding, hence the changing of the name to "Burj Khalifa". The concept of profitability derived from building high density developments and malls around the landmark has proven successful. Its surrounding malls, hotels and condominiums in Downtown Dubai have generated the most revenue from the project as a whole, while the Burj Khalifa itself made little or no profit.

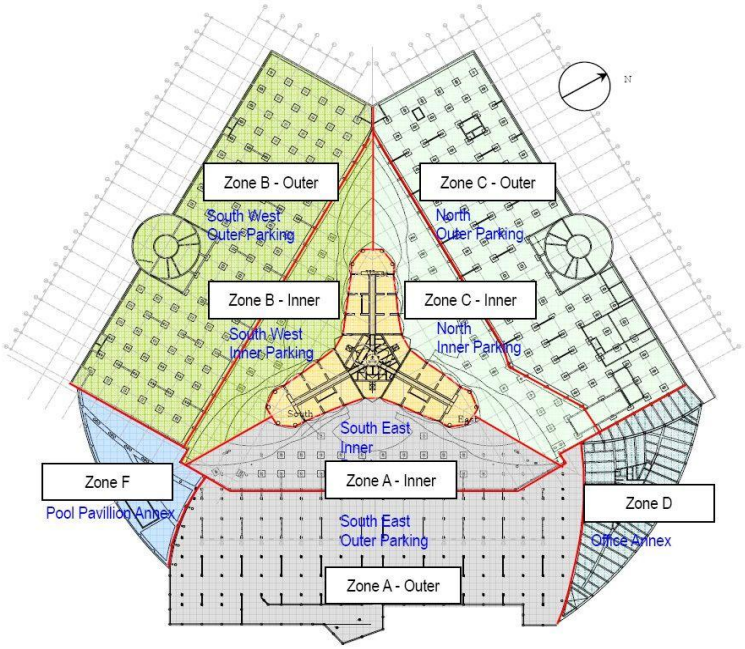


Figure 2: Burj Khalifa basement.

Critical reception to Burj Khalifa has been generally positive, and the building has received many awards. However, there were numerous complaints concerning migrant workers from South Asia who were the primary building labour force. These centered on low wages and the practice of confiscating passports until duties were complete. Frequent suicides committed by expatriate employees who worked at the structure were reported in 2011.

Development: Construction began in January 2004, with the exterior of the structure completed on 1 October 2009. The building officially opened on 4 January 2010 and is part of the 2 km^2 (490-acre) Downtown Dubai development at the 'First Interchange' along Sheikh Zayed Road, near Dubai's main business district. The tower's architecture and engineering were performed by Skidmore, Owings & Merrill of Chicago, with Adrian Smith as chief architect, and Bill Baker as chief structural engineer. The primary contractor was Samsung C&T of South Korea.

Conception: Burj Khalifa was designed to be the centerpiece of a large-scale, mixed-use development to include 30,000 homes, nine hotels (including The Address Downtown Dubai), 3 hectares (7.4 acres) of parkland, at least 19 residential skyscrapers, the Dubai Mall, and the 12-hectare (30-acre) artificial Burj Khalifa Lake. The decision to build Burj Khalifa was reportedly based on the government's decision to diversify from an oil-based economy to one that is service and tourism based. According to officials, it was necessary for projects like Burj Khalifa to be built in order to garner more international recognition, and hence investment. "He (Sheikh Mohammed bin Rashid Al Maktoum) wanted to put Dubai on the map with something really sensational," said Jacqui Josephson, a tourism and VIP delegations executive at Nakheel Properties. The tower was known as Burj Dubai ("Dubai Tower") until its official opening in January 2010. It was renamed in honour of the ruler of Abu Dhabi, Khalifa bin Zayed Al Nahyan; Abu Dhabi and the federal government of UAE lent Dubai tens of billions of US dollars so that Dubai could pay its debts – Dubai borrowed at least $80 billion for construction projects. In the 2000s, Dubai started diversifying its economy but it suffered from an economic crisis in 2007–2010, leaving large-scale projects already in construction abandoned.

Records: The Burj Khalifa set several world records, including:
Tallest existing structure: 829.8 m (2,722 ft) (previously KVLY-TV mast – 628.8 m or 2,063 ft)
Tallest structure ever built: 829.8 m (2,722 ft) (previously Warsaw radio mast – 646.38 m or 2,121 ft)
Tallest freestanding structure: 829.8 m (2,722 ft) (previously CN Tower – 553.3 m or 1,815 ft)
Tallest skyscraper (to top of spire): 828 m (2,717 ft) (previously Taipei 101 – 509.2 m or 1,671 ft)
Tallest skyscraper to top of antenna: 829.8 m (2,722 ft) (previously the Willis (formerly Sears) Tower – 527 m or 1,729 ft)
Building with most floors: 163 (previously World Trade Center – 110)
World's highest elevator installation (situated inside a rod at the very top of the building)
World's longest travel distance elevators: 504 m (1,654 ft)
Highest vertical concrete pumping (for a building): 606 m (1,988 ft)
World's tallest structure that includes residential space
World's highest installation of an aluminium and glass façade: 512 m (1,680 ft)
World's highest nightclub: 144th floor
World's highest restaurant (Atmosphere): 122nd floor at 442 m (1,450 ft) (previously 360, at a height of 350 m (1,148 ft) in CN Tower)
World's highest New Year display of fireworks.
World's largest light and sound show staged on a single building.

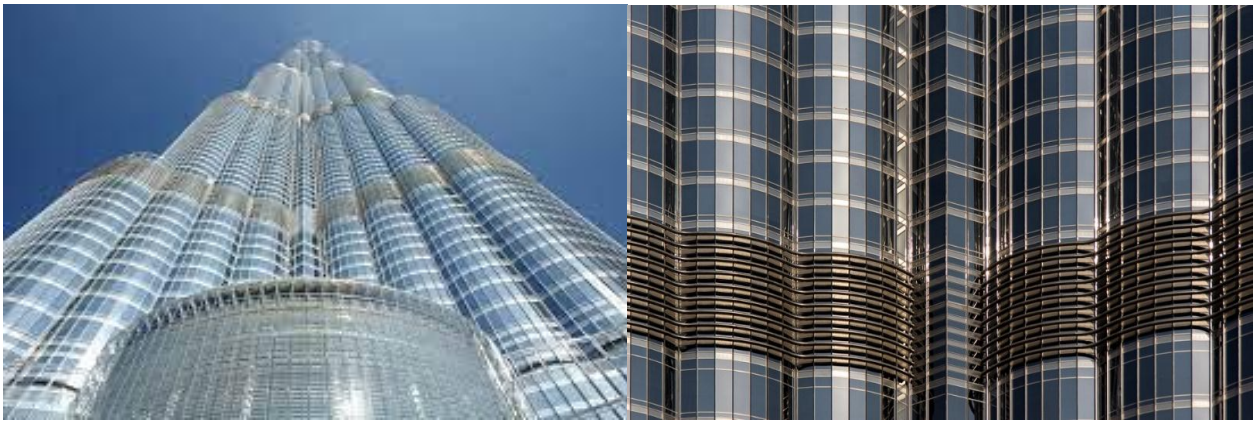


Figure 3: Burj Khalifa guardian glass coverings.

History of height increases: Burj Khalifa compared with some other well-known tall structures. There are unconfirmed reports of several planned height increases since its inception. Originally proposed as a virtual clone of the 560 m (1,837 ft) Grollo Tower proposal for Melbourne, Australia's Docklands waterfront development, the tower was redesigned by Skidmore, Owings and Merrill. Marshall Strabala, a Skidmore,

Owings and Merrill architect who worked on the project until 2006, said in late 2008 that Burj Khalifa was designed to be 808 m (2,651 ft) tall. The architect who designed it, Adrian Smith, felt that the uppermost section of the building did not culminate elegantly with the rest of the structure, so he sought and received approval to increase its height. It was stated that this change did not add any floors, which fit with Smith's attempts to make the crown slenderer. The building opened on 4 January 2010.[1]

Architecture and design: Cross-section comparisons of various towers, from ground level to top: Burj Khalifa, Taipei 101, Willis Tower, and World Trade Center. The tower was designed by Skidmore, Owings and Merrill (SOM), which also designed the Willis Tower (formerly the Sears Tower) in Chicago and the One World Trade Center in New York City. Burj Khalifa uses the bundled tube design of the Willis Tower, invented by Fazlur Rahman Khan. Due to its tubular system, proportionally only half the amount of steel was used in the construction, compared to the Empire State Building. Khan's contributions to the design of tall buildings have had a profound impact on architecture and engineering. It would be difficult to find any worldwide practices in the design of tall buildings that have not been directly or indirectly influenced by his work. The design is reminiscent of Frank Lloyd Wright's vision for The Illinois, a mile-high skyscraper designed for Chicago, as well as Chicago's Lake Point Tower. When Adrian Smith was conceiving the project at SOM, he looked out his office window toward Lake Point Tower's curved three wing layout and thought, "There's the prototype". According to Strabala, Burj Khalifa was designed based on the 73 floor Tower Palace Three, an all-residential building in Seoul. In its early planning, Burj Khalifa was intended to be entirely residential. Subsequent to the original design by Skidmore, Owings and Merrill, Emaar Properties chose Hyder Consulting to be the supervising engineer and NORR Group Consultants International Ltd to supervise the architecture of the project. Hyder was selected for their expertise in structural and MEP (mechanical, electrical and plumbing) engineering. Hyder Consulting's role was to supervise construction, certify the architect's design, and be the engineer and architect of record to the UAE authorities. NORR's role was the supervision of all architectural components including on-site supervision during construction and design of a 6-story addition to the office annex building for architectural documentation. NORR was also responsible for the architectural integration drawings for the Armani Hotel included in the Tower. Emaar Properties also engaged GHD, an international multidisciplinary consulting firm, to act as an independent verification and testing authority for concrete and steelwork.

The design is derived from Islamic architecture. As the tower rises from the flat desert base, there are 27 setbacks in a spiral pattern, decreasing the cross section of the tower as it rises and creating convenient outdoor terraces. These setbacks are arranged and aligned in a way that minimizes vibration wind loading from eddy currents and vortices. At the top, the central core emerges and is sculpted to form a finishing spire. At its tallest point, the tower sways a total of 1.5 m (4.9 ft). The spire of Burj Khalifa is composed of more than 4,000 tonnes (4,400 short tons; 3,900 long tons) of structural steel. The central pinnacle pipe weighs 350 tonnes (390 short tons; 340 long tons) and has a height of 200 m (660 ft). The spire also houses communications equipment. This 244-metre spire is widely considered vanity height, since very little of its space is usable. Without the spire, Burj Khalifa would be 585 meters tall. This was reported in a Council on Tall Buildings and Urban Habitat study, which notes that the empty spire "could be a skyscraper on its own". Such a skyscraper, if located in Europe, would be the 11th tallest building on that continent. In 2009 architects announced that more than 1,000 pieces of art would adorn the interiors of Burj Khalifa, while the residential lobby of Burj Khalifa would display the work of Jaume Plensa.

Figure 4: Burj Khalifa parking zone & dining hall.

The cladding system consists of 142,000 m^2 (1,528,000 sq ft) of more than 26,000 reflective glass panels and aluminium and textured stainless steel spandrel panels with vertical tubular fins. The architectural glass provides solar and thermal performance as well as an anti-glare shield for the intense desert sun, extreme desert temperatures and strong winds. The glass covers more than 174,000 m^2 (1,870,000 sq ft) in area. The Burj's typical curtain wall panels measure 4'6" wide by 10'8" high and weigh about 800 pounds each, with wider panels near the building's edges and taller ones near the top. The exterior temperature at the top of the building is thought to be 6°C (11°F) cooler than at its base. A 304-room Armani Hotel, the first of four by Armani, occupies 15 of the lower 39 floors. The hotel was supposed to open on 18 March 2010, but after several delays, it finally opened to the public on 27 April 2010. The corporate suites and offices were also supposed to open from March onwards, yet the hotel and observation deck remained the only parts of the building which were open in April 2010. The sky lobbies on the 43rd and 76th floors house swimming pools. Floors 20 through 108 have 900 private residential apartments (which, according to the developer, sold out within eight hours of being on the market). An outdoor zero-entry swimming pool is located on the 76th floor of the tower. Corporate offices and suites fill most of the remaining floors, except for the 122nd, 123rd and 124th, where the Atmosphere restaurant, sky lobby and an indoor and outdoor observation deck are located respectively. In January 2010, it was planned that Burj Khalifa would receive its first residents from February 2010. The elevators have a capacity of 12 to 14 people per cabin, the fastest rising and descending at up to 10 m/s (33 ft/s) for double-deck elevators. However, the world's fastest single-deck elevator still belongs to Taipei 101 at 16.83 m/s (55.2 ft/s). Engineers had considered installing the world's first triple-deck elevators, but the final design called for double-deck elevators. The double-deck elevators are equipped with entertainment features such as LCD displays to serve visitors during their travel to the observation deck. The building has 2,909 stairs from the ground floor to the 160th floor.

Plumbing systems: The Burj Khalifa's water system supplies an average of 946,000 L (250,000 U.S. gal) of water per day through 100 km (62 mi) of pipes. An additional 213 km (132 mi) of piping serves the fire emergency system, and 34 km (21 mi) supplies chilled water for the air conditioning system. [mi=malleable iron].

Air conditioning: The air conditioning system draws air from the upper floors where the air is cooler and cleaner than on the ground. At peak cooling times, the tower's cooling is 46 MW (62,000 hp), equivalent to that provided by 13,000 short tons (26,000,000 lb; 12,000,000 kg) of melting ice in one day. Water is collected via a condensate collection system and is used to irrigate the nearby park.

Window cleaning: To wash the 24,348 windows, totalling 120,000 m^2 (1,290,000 sq ft) of glass, the building has three horizontal tracks which each holding a 1,500 kg (3,300 lb) bucket machine. Above level 109, and up to tier 27, traditional cradles from davits are used. The top of the building is cleaned by a crew that uses ropes to descend from the top to gain access. Under normal conditions, when all building maintenance units are operational, it takes 36 workers three to four months to clean the entire exterior. Unmanned machines clean the top 27 additional tiers and the glass spire. The cleaning system was developed in Melbourne, Australia, by CoxGomyl, a manufacturer of building maintenance units, at a cost of A$8 million.

Outside, WET Enterprises designed a fountain system at a cost of Dh 800 million (US$217 million). Illuminated by 6,600 lights and 50 coloured projectors, it is 270 m (900 ft) long and shoots water 150 m (500 ft) into the air, accompanied by a range of classical to contemporary Arabic and other music. It is the world's largest choreographed fountain. On 26 October 2008, Emaar announced that based on results of a naming contest the fountain would be called the Dubai Fountain.

An outdoor observation deck, named At the Top, opened on 5 January 2010 on the 124th floor. At 452 m (1,483 ft), it was the highest outdoor observation deck in the world when it opened. Although it was surpassed in December 2011 by Cloud Top 488 on the Canton Tower, Guangzhou at 488 m (1,601 ft), Burj Khalifa opened the 148th floor SKY level at 555 m (1,821 ft), once again giving it the highest observation deck in the world on 15 October 2014, until the Shanghai Tower opened in June 2016 with an observation deck at a height of 561 metres. The 124th floor observation deck also features the electronic telescope, an augmented reality device developed by Gsmprjct° of Montréal, which allows visitors to view the surrounding landscape in real-time, and to view previously saved images such as those taken at different times of day or under different weather conditions. To reduce the daily rush of sightseers, management allows visitors to purchase tickets in advance for a specific date and time, at a 75% discount on tickets purchased on the spot. On 8 February 2010, the observation deck was closed to the public for two months after power-supply problems caused an elevator to become stuck between floors, trapping a group of tourists for 45 minutes. When the tide is low and visibility is high, people can see the shores of Iran from the top of the skyscraper.

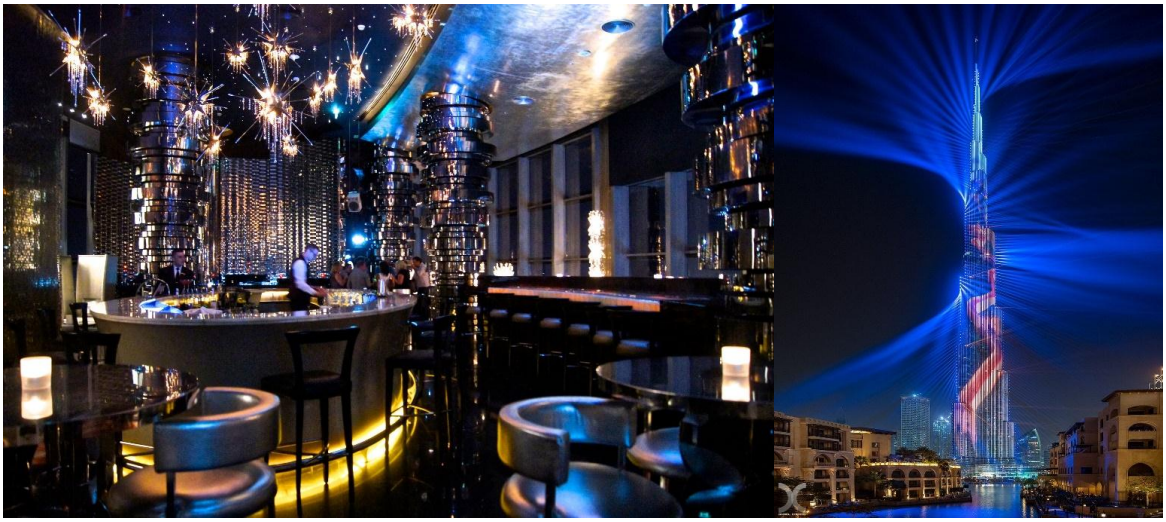


Figure 5: Burj Khalifa Bar & Laser display.

Burj Khalifa park: Burj Khalifa is surrounded by an 11 ha (27-acre) park designed by landscape architects SWA Group. Like the tower, the park's design was based on the flower of the Hymenocallis, a desert plant. At the centre of the park is the water room, which is a series of pools and water jet fountains. Benches and signs incorporate images of Burj Khalifa and the Hymenocallis flower. The plants are watered by water collected from the building's cooling system. The system provides 68,000,000 L (15,000,000 imp gal) annually. WET Enterprises, who also developed the Dubai Fountain, developed the park's six water features.

Ramadan observance: On the higher floors, the sun can still be seen for several minutes after it has set at ground level. This has led Dubai clerics to rule that those living above the 80th floor should wait 2 additional minutes to break their Ramadan fast, and those living above the 150th floor, 3 minutes.

Structure construction: The tower was constructed by Samsung C&T from South Korea, which also did work on the Petronas Twin Towers and Taipei 101. Samsung C&T built the tower in a joint venture with BESIX from Belgium and Arabtec from the UAE. Turner was the project manager on the main construction contract. Hong Kong-based Far East Aluminum combined to provide the exterior cladding for Burj Khalifa. The contractor and the engineer of record was Hyder Consulting. Under UAE law, the contractor and the engineer of record is jointly and severally liable for the performance of Burj Khalifa. The primary structure is reinforced concrete. Putzmeister created a new, super high-pressure trailer concrete pump, the BSA 14000 SHP-D, for this project. Burj Khalifa's construction used 330,000 m^3 (431,600 cu yd) of concrete and 55,000 tonnes (61,000 short tons; 54,000 long tons) of steel rebar, and construction took 22 million man-hours. In May 2008 Putzmeister pumped concrete with more than 21 MPA ultimate compressive strength of gravel to surpass the 600 meters weight of the effective area of each column from the foundation to the next fourth level, and the rest was by metal columns jacketed or covered with concrete to a then world record delivery height of 606 m (1,988 ft), the 156th floor. Three tower cranes were used during construction of the uppermost levels, each capable of lifting a 25-tonne load. The remaining structure above was constructed of lighter steel.[2]

Figure 6: Burj Khalifa entrance.

Floor plans

Table 1: Burj Khalifa Flooring plans.

Floors	Purpose	Floors	Purpose	Floors	Purpose	Floors	Purpose
1–8	Armani Hotel	43	Sky lobby	111–121	Corporate suites	139–147	Corporate suites
9–16	Armani Residences	44–72	Residential	122	Atmosphere restaurant	148	Sky observatory
17–18	Mechanical	73–75	Mechanical	123	Sky lobby	149–154	Corporate suites
19–37	Residential	76	Sky lobby	124	At the Top observatory	155	Mechanical
38–39	Armani Hotel suites	77–108	Residential	125–135	Corporate suites	156–159	Broadcasting
40–42	Mechanical	109–110	Mechanical	136–138	Mechanical	160–163	Mechanical
Lobby	Armani Hotel	Concourse	Armani Hotel	B1–B2	Parking		

In 2003, 33 test holes were drilled to study the strength of the bedrock underlying the structure. "Weak to very weak sandstone and siltstone" was found, just metres below the surface. Samples were taken from test holes drilled to a depth of 140 metres, finding weak to very weak rock all the way. The study described the site as part of a "seismically active area". Another challenging element was the shamal which often creates sandstorms. Over 45,000 m^3 (58,900 cu yd) of concrete, weighing more than 110,000 tonnes (120,000 short tons; 110,000 long tons) were used to construct the concrete and steel foundation, which features 192 piles; each pile is 1.5 metre in diameter by 43 m in length, buried more than 50 m (164 ft) deep. The foundation was designed to support the total building weight of approximately 450,000 tonnes (500,000 short tons; 440,000 long tons). This weight was then divided by the compressive strength of concrete of which is 30 MPa which yielded a 450 sq.meters of vertical normal effective area, which then yielded to a 12 meters by 12 meters dimensions. A cathodic protection system is under the concrete to neutralize the sulphate and chloride-rich groundwater and prevent corrosion. During construction of the Burj Khalifa, over 35,000 tonnes of structural steel which held the Palace of the Republic, the former parliament building of the German Democratic Republic, the Volkskammer, in East Berlin together were shipped to Dubai in 2008. The Burj Khalifa is highly compartmentalised. Pressurized, air-conditioned refuge floors are located every 13 floors (in floors G, 13, 26, 39, 52 etc.) where people can shelter on their long walk down to safety in case of an emergency or fire. Special mixes of concrete were made to withstand the extreme pressures of the massive building weight; as is typical with reinforced concrete construction, each batch of concrete was tested to ensure it could withstand certain pressures. CTL Group, working for Skidmore, Owings and Merrill, conducted the creep and shrinkage testing critical for the structural analysis of the building. The consistency of the concrete used in the project was essential. It was difficult to create a concrete that could withstand both the thousands of tonnes bearing down on it and Persian Gulf temperatures that can reach 50°C (122°F). To combat this problem, the concrete was not poured during the day. Instead, during the summer months, ice was added to the mixture and it was poured at night when the air was cooler and the humidity was higher. Cooler concrete cures more evenly and is therefore less likely to set too quickly and crack. Any significant cracks could have put the entire project in jeopardy.

Milestones

Table 2: Milestones of Burj Khalifa.

Date	Event
January 2004	Excavation commences
February 2004	Piling starts
21 September 2004	Emaar contractors begin construction
March 2005	Structure of Burj Khalifa starts rising
June 2006	Level 50 is reached
February 2007	Surpasses the Sears Tower as the building with the most floors
13 May 2007	Sets record for vertical concrete pumping on any building at 452 m (1,483 ft), surpassing the 449.2 m (1,474 ft) to which concrete was pumped during the construction of Taipei 101, while Burj Khalifa reached the 130th floor.
21 July 2007	Surpasses Taipei 101, whose height of 509.2 m (1,671 ft) made it the world's tallest building, and level 141 reached.
12 August 2007	Surpasses the Sears Tower antenna, which stands 527 m (1,729 ft).
12 September 2007	At 555.3 m (1,822 ft), becomes the world's tallest freestanding structure, surpassing the CN Tower in Toronto, and level 150 reached.
7 April 2008	At 629 m (2,064 ft), surpasses the KVLY-TV Mast to become the tallest man-made structure,

	level 160 reached.
17 June 2008	Emaar announces that Burj Khalifa's height is over 636 m (2,087 ft) and that its final height will not be given until it is completed in September 2009.
1 September 2008	Height tops 688 m (2,257 ft), making it the tallest man-made structure ever built, surpassing the previous record-holder, the Warsaw Radio Mast in Konstantynów, Poland.
17 January 2009	Topped out at 829.8 m (2,722 ft).
1 October 2009	Emaar announces that the exterior of the building is completed.
4 January 2010	Burj Khalifa's official launch ceremony is held and Burj Khalifa is opened. Burj Dubai renamed Burj Khalifa in honour of the President of the UAE and ruler of Abu Dhabi, Sheikh Khalifa bin Zayed al Nahyan.
10 March 2010	Council on Tall Buildings and Urban Habitat certifies Burj Khalifa as world's tallest building.

Real estate values: In March 2009, Mohamed Ali Alabbar, chairman of the project's developer, Emaar Properties, said office space pricing at Burj Khalifa reached US$4,000 per sq ft (over US$43,000 per m²) and the Armani Residences, also in Burj Khalifa, sold for US$3,500 per sq ft (over US$37,500 per m²). He estimated the total cost for the project to be about US$1.5 billion. The project's completion coincided with the financial crisis of 2007–2008, and with vast overbuilding in the country, leading to high vacancies and foreclosures. With Dubai mired in debt from its huge ambitions, the government was forced to seek multibillion dollar bailouts from its oil-rich neighbour Abu Dhabi. Subsequently, in a surprise move at its opening ceremony, the tower was renamed Burj Khalifa, said to honour the UAE President Khalifa bin Zayed Al Nahyan for his crucial support.

Because of the slumping demand in Dubai's property market, the rents in the Burj Khalifa plummeted 40% some ten months after its opening. Out of 900 apartments in the tower, 825 were still empty at that time. However, over the next two and a half years, overseas investors steadily began to purchase the available apartments and office space. By October 2012, Emaar reported that around 80% of the apartments were occupied.

Official launch ceremony: The ceremony was broadcast live on a giant screen on Burj Park Island and on smaller screens elsewhere. Hundreds of media outlets from around the world reported live from the scene. In addition to the media presence, 6,000 guests were expected. The opening was held on 4 January 2010. The ceremony featured a display of 10,000 fireworks, light beams projected on and around the tower, and further sound, light and water effects. The celebratory lighting was designed by UK lighting designers Speirs and Major Associates. Using the 868 powerful stroboscope lights that are integrated into the façade and spire of the tower, different lighting sequences were choreographed, together with more than 50 different combinations of other effects.

Incidents

Fatalities: Within 17 months of the building's official opening, a man described as "an Asian in his mid-30s", who worked at one of the companies in the tower, died by suicide on 10 May 2011 by jumping from the 147th floor. He fell 39 floors, landing on a deck on the 108th floor. Dubai police confirmed the act as a suicide, reporting that "[they] also came to know that the man decided to commit suicide as his company refused to grant leave." On 18 May 2015, Dubai police disputed a report that a Portuguese national who was in Dubai on a tourist visa fell to her death from Burj Khalifa's "At the Top SKY" observation deck on the 148th floor, and said that this incident took place in Jumeirah Lakes Towers. A Dubai coroner's report stated her body was found on the third floor of the Burj Khalifa. Emails obtained under the Freedom of Information act from Portugal's embassy in the UAE also confirmed that she had committed suicide from the 148th floor of the Burj Khalifa.

Figure 7: Burj Khalifa sky diving.

Labour controversy: The Burj Khalifa was built primarily by workers from South Asia and East Asia. This is generally because the current generation of UAE locals prefer governmental jobs and do not have an attitude favouring private sector employment. On 17 June 2008, there were about 7,500 skilled workers employed at the construction site. Press reports indicated in 2006 that skilled carpenters at the site earned £4.34 a day, and labourers earned £2.84. According to a BBC investigation and a Human Rights Watch report, the workers were housed in abysmal conditions, and worked long hours for low pay. During construction, only one construction-related death was reported. However, workplace injuries and fatalities in the UAE are "poorly documented", according to Human Rights Watch. In March 2006 about 2,500 workers, upset over buses that were delayed for the end of their shifts, protested and triggered a riot, damaging cars, offices, computers and construction equipment. A Dubai Interior Ministry official said the rioters caused almost £500,000 in damage. Most of the workers involved in the riot returned the following day but refused to work.

Other uses

BASE jumping: The building has been used by several experienced BASE jumpers for authorised and unauthorised BASE jumping. In May 2008, Hervé Le Gallou and David McDonnell, dressed as engineers, entered Burj Khalifa (around 650 metres (2,130 ft) at the time), and jumped off a balcony situated several floors below the 160th floor.

On 8 January 2010, with permission of the authorities, Nasr Al Niyadi and Omar Al Hegelan, from the Emirates Aviation Society, broke the world record for the highest BASE jump from a building after they leapt from a crane-suspended platform attached to the 160th floor at 672 m (2,205 ft). The two men descended the vertical drop at a speed of up to 220 km/h (140 mph), with enough time to open their parachutes 10 seconds into the 90-second jump.

On 21 April 2014, with permission of the authorities and support from several sponsors, highly experienced French BASE jumpers Vince Reffet and Fred Fugen broke the Guinness world record for the highest BASE jump from a building after they leapt from a specially designed platform, built at the very top of the pinnacle, at 828 metres (2,717 feet).

Climbing: On 28 March 2011, Alain "Spiderman" Robert scaled the outside of Burj Khalifa. The climb to the top of the spire took six hours. To comply with UAE safety laws, Robert, who usually climbs in free solo style, used a rope and harness.[3]

Awards: In June 2010, Burj Khalifa was the recipient of the 2010 "Best Tall Building Middle East & Africa" award by the Council on Tall Buildings and Urban Habitat. On 28 September 2010 Burj Khalifa won the award for best project of the year at the Middle East Architect Awards 2010. Awards Chair Gordon Gill, of Adrian Smith + Gordon Gill Architecture, said: We are talking about a building here that has changed the landscape of what is possible in architecture – a building that became internationally recognized as an icon long before it was even completed. 'Building of the Century' was thought a more apt title for it.

Figure 8: Burj Khalifa opening ceremony by Sheikh Mohammed bin Rashid Al Maktoum [Prime Minister of UAE] and Khalifa bin Zayed Al Nahyan [President of UAE].

Burj Khalifa was also the recipient of the following awards

Table 3: Burj Khalifa Awards.

Year	Award
2012	Award of Merit for World Voices Sculpture, Burj Khalifa Lobby from Structural Engineers Association of Illinois (SEAOI), Chicago.
2011	Interior Architecture Award, Certificate of Merit from AIA – Chicago Chapter.
	Distinguished Building Award, Citation of Merit from AIA – Chicago Chapter.
	Interior Architecture Award: Special Recognition from AIA – Chicago Chapter.
	Design Excellence Award: Special Function Room.
	Excellence in Engineering from ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) – Illinois Chapter.
	Outstanding Structure Award from International Association for Bridge and Structural Engineering.
	Decade of Design, Presidential Commendation in Corporate Space Small from International Interior Design Association (IIDA).
	Decade of Design: Best of Category/Mixed Use Buildings from International Interior Design Association (IIDA).

	GCC Technical Building Project of the Year from MEED (formerly Middle East Economic Digest). Project of the Year from MEED.
2010	International Architecture Award.
	Arab Achievement Award 2010: Best Architecture Project from Arab Investment Summit.
	Architecture Award (Mixed Use) Dubai from Arabian Property Awards.
	Architecture Award (Mixed Use) Arabian Region from Arabian Property Awards.
	International Architecture Award from Chicago Athenaeum.
	American Architecture Award from Chicago Athenaeum.
	Commercial / Mixed Use Built from Cityscape.
	Best Mixed Use Built Development in Cityscape Abu Dhabi.
	Skyscraper Award: Silver Medal from Emporis.
	Award for Commercial or Retail Structure from Institution of Structural Engineers.
	International Architecture Award (Mixed Use) from International Commercial Property Awards.
	Special Recognition for Technological Advancement from International Highrise Awards.
	Best Structural Design of the Year from LEAF Award.
	International Projects Category: Outstanding Project from National Council of Structural Engineers Associations.
	Best of What's New from Popular Science Magazine.
	Spark Awards, Silver Award.
	Excellence in Structural Engineering: Most Innovative Structure from SEAOI.

Burj Khalifa hidden truths

How big is the base of the Burj Khalifa? The foundation of the building is 15 metres (49 feet) deep. It was built with 192 columns being put into the ground. Each column was 1.5 metres (4 feet 11 inches) in diameter and 43 metres (141 feet) long. 55,000 tonnes (121,000,000 pounds) of steel rebar was used in the construction of the tower.

Which foundation is used in Burj Khalifa? The grade of concrete raft is C50 which was self-consolidating concrete. The concrete volume used in the raft is 12,500-meter cube. The number of piles used were 194.

How deep are the Burj Khalifa foundations? Over 45,000 m^3 (58,900 cu yd) of concrete, weighing more than 110,000 tonnes were used to construct the concrete and steel foundation, which features 192 piles buried more than 50 m (164 ft) deep

How is the floor in Burj Khalifa? Towering over the city, at 2,717 feet tall with 160 floors, the Burj Khalifa is the tallest tower in the world. It has an observation deck on the 124th floor.

Owner of Burj Khalifa: Emaar Properties PJSC is the Master Developer of Burj Khalifa and is also one of the largest real estate companies in the world. Mr. Mohamed Alabbar, Chairman of Emaar Properties, said: "Burj Khalifa goes beyond its imposing physical specifications. At 2717 feet, this 160 floor building is HUGE. ... Well, according to Wolfram|Alpha, Mount Everest is 29,035 feet high...which is about 5.5 miles (or 8.85 kilometers)! As we discovered yesterday, at 2717 feet the Burj Khalifa is just over 0.5 miles high.

How expensive is Burj Khalifa? Burj Khalifa Cost: US$1.5 billion

How many died building the Burj Khalifa? Four people died during the construction of the Burj Khalifa, which opened in 2010.

What is the cost of one flat in Burj Khalifa in rupees? The Burj Khalifa one day room price in Indian Rupees it will be ₹ 22,410 for a Deluxe Room excluding taxes and charges. This is truly a five-star Hotel with private swimming pool, free WIFI, direct entry to Dubai Mall, Spa and with the most beautiful view of Dubai fountain.

Who lives at the top of Burj Khalifa? In India, BR Shetty is famous as the man who owns all the apartments on the 100th and 140th floors of Dubai's iconic Burj Khalifa, which he is said to have acquired for a whopping $25 million.

Does Burj Khalifa have a hotel? First things first: yes, there is a hotel operating at Burj Khalifa - Armani Hotel Dubai. Secondly, Burj Khalifa, formerly known as Burj Dubai, a building soaring up to 829.8 m (2,722 ft), includes a hotel, residences and offices.

How safe is Burj Khalifa? Sprinkler systems, fire alarms, smoke evacuation systems, and stairwell pressurization are the primary fire safety systems installed in Burj Khalifa building. ... This building is also equipped with 38 smoke and fire-resistant evacuation lifts.

How tall is the Burj Khalifa in feet? 828 m, 830 m to tip

When was the Burj Khalifa finished? 4 January 2010

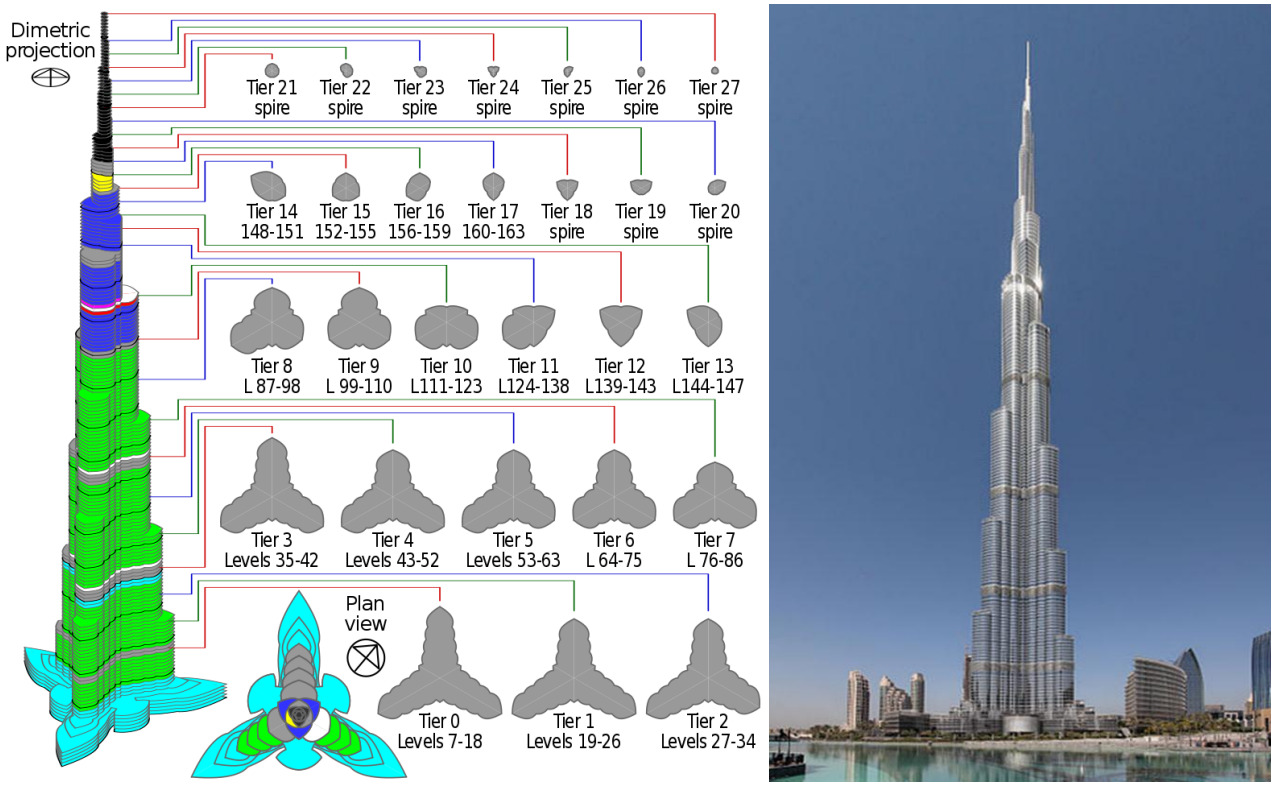


Figure 9: Burj Khalifa Foundation to Coronation.

What is inside in Burj Khalifa? Burj Khalifa has a rich array of amenities and services that provide residents and their guests an unparalleled lifestyle experience. Exclusive Sky Lobbies on Levels 43, 76 and 123 include state-of-the-art fitness facilities, indoor/outdoor swimming pools, Jacuzzis and a recreation room for gatherings and events.

Is the Burj Khalifa concrete? Burj Khalifa employs a record-breaking 330,000 cubic m (11.6 million cubic ft) of concrete; 39,000 m/t of reinforced steel; 103,000 sq m (1.1 million sq ft) of glass; 15,500 sq m (166,800 sq ft) of embossed stainless steel; and the tower took 22-million-man hours to build.

What are the types of foundation? As the shallow foundation depth is low and it is economical, it is the most popular type of foundation for lightweight structures. Shallow Foundations, Isolated Spread Footing, Wall Footing or Strip footing, Combined Footing, Cantilever or Strap Footing, Raft or Mat Foundation.

Indian businessman George V. Nereaparambil is the very man who owns more than his fair share of the 900 apartments in the Burj Khalifa. Do you have a good success story happening in the UAE to share?

How much does a night cost in Burj Khalifa? The Burj is famous for its striking sail-shape design, and the lavish suite, which is one of the most expensive hotel rooms in the world, has an average price tag of $24,000 a night.

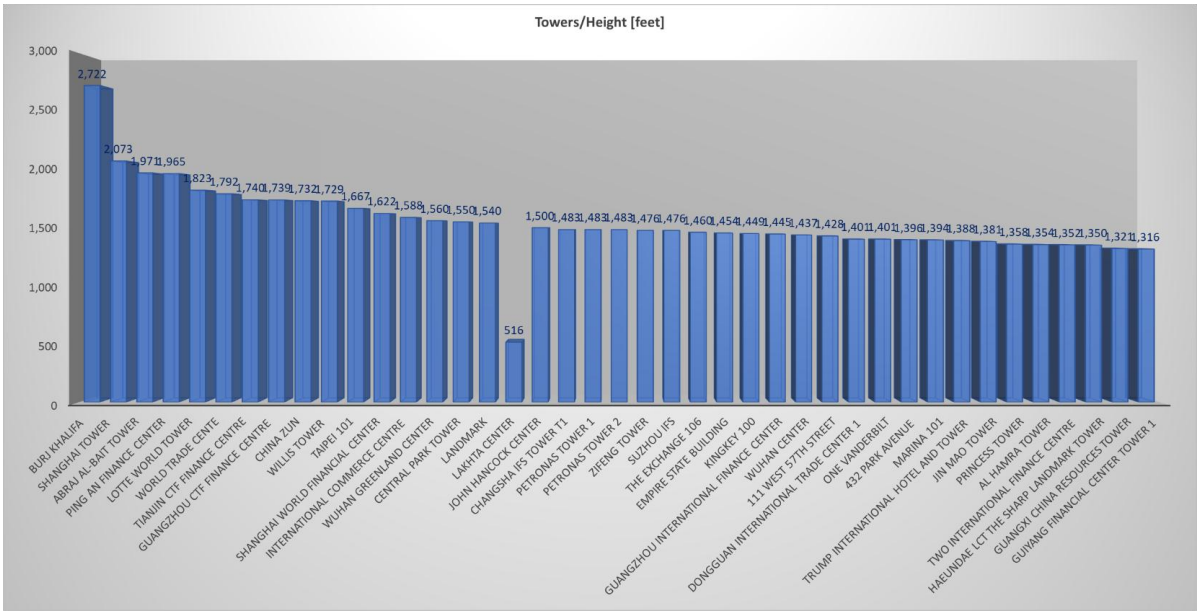
Is Burj Khalifa empty? The Burj Khalifa - the world's tallest building - is the most famous address in the Gulf. Today, about 80% of the luxury flats have tenants but two-thirds of the office space still lies empty - and one owner has even tried selling an entire floor of the tower on an auction site.

Who is the CEO of Burj Khalifa? Mohamed Ali Alabbar
How much does it cost to eat in Burj Khalifa? The costs for a dinner in the Burj Club including a visit to At the Top costs 83 dollar per person from 12 years, children between 4 and 12 years pay 76 dollars. The price for a normal At the Top ticket is between 35 and 40 dollars so a dinner at the Burj Club is for Dubai standards and the location very well priced.

Can you go up the Burj Khalifa for free? The very top of the Burj Khalifa is the 163rd floor, however it is not accessible to the public. To get to the top of the Burj Khalifa, you need to purchase a ticket. The Burj Khalifa is now the highest tower in the world. According to its website, there are about 330,000 cubic meters of cement in the tower - one fourth of it comprises sand. How easy for the Burj and other Dubai skyscrapers to have all that sand in their backyard, right? The desert that has run out of sand![4]

How does the Burj Khalifa not fall? Depending on the identified polarity the panels create a potential charge at the top of the tower which is very, very strong. Therefore, when there is a strike of lightning coming down on the tower, the panels throw up a lightning

strike, which is stronger. This prevents the tower from having to go through any damage.



Histogram of skyscrapers

CONCLUSION

Burj Khalifa ("Khalifa Tower"), known during construction as Burj Dubai, was officially named to honour the leader of the neighbouring emirate of Abu Dhabi, Sheikh Khalifa ibn Zayed Al Nahyan. Although the tower was formally opened on January 4, 2010, the entirety of the interior was not complete at that time. Tallest skyscrapers are present in this world and out of that the enlisted atchitects are here:

Burj Khalifa [Place: Dubai, Country: United Arab Emirates, Height: 829.8 m, 2,722 ft, Floor: 163, Opening: 2010]; Shanghai Tower [Place: Shanghai, Country: China, Height: 632 m, 2,073 ft, Floor: 128, Opening: 2015]; Abraj Al-Bait Towers [Place: Mecca, Country: Saudi Arabia, Height: 601 m, 1,971 ft, Floor: 120, Opening: 2012]; Ping An Finance Center [Place: Shenzhen, Country: China, Height: 599 m, 1,965 ft, Floor: 115, Opening: 2016]; Lotte World Tower [Place: Seoul, Country: South Korea, Height: 555.7 m, 1,823 ft, Floor: 123, Opening: 2016]; World Trade Center [Place: New York City, Country: United States, Height: 546.2 m, 1,792 ft, Floor: 104, Opening: 2014]; Tianjin CTF Finance Centre [Place: Tianjin, Country: China, Floor: 530.4 m, 1,740 ft, Floor: 98, Opening: 2019]; Guangzhou CTF Finance Centre [Place: Guangzhou, Country: China, Floor: 530 m, 1,739 ft, Floor: 111, Opening: 2016]; China Zun [Place: Beijing, Country: China, Height: 528 m, 1,732 ft, Floor: 108, Opening: 2018]; Willis Tower [Place: Chicago, Country: United States, Height: 527 m, 1,729 ft, Floor: 108, Opening: 1974]; Taipei 101 [Place: Taipei, Country: Taiwan, Floor: 508 m, 1,667 ft, Floor: 101, Opening: 2004]; Shanghai World Financial Center [Place: Shanghai, Country: China, Height: 494.3 m, 1,622 ft, Floor: 101, Opening: 2008]; International Commerce Centre [Place: Hong Kong, Country: China, Height: 484 m, 1,588 ft, Floo: 118, Opening: 2010]; Wuhan Greenland Center [Place: Wuhan, Country: China, Height: 475.6 m, 1,560 ft, Floor: 97, Opening: 2021]; Central Park Tower [Place: New York City, Country: United States, Height: 472.4 m, 1,550 ft, Floor: 98. Opening: 2020]; Landmark [Place: Ho Chi Minh City, Country: Vietnam, Height: 469.5 m, 1,540 ft, Floor: 81, Opening: 2018]; Lakhta Center [Place: St. Petersburg, Country: Russia, Floor: 462 m, 516 ft, Floor: 86, Opening: 2019]; John Hancock Center [Place: Chicago, Country: United States, Height: 457.2 m, 1,500 ft, Floor: 100, Opening: 1969]; Changsha IFS Tower T1 [Place: Changsha, Country: China, Height: 452 m, 1,483 ft, Floor: 94, Opening: 2018]; Petronas Tower 1 [Place: Kuala Lumpur, Country: Malaysia, Height: 451.9 m, 1,483 ft, Floor: 88, Opening: 1998]; Petronas Tower 2 [Place: Kuala Lumpur, Country: Malaysia, Height: 451.9 m, 1,483 ft, Floor: 88, Opening: 1998]; Zifeng Tower [Place: Nanjing, Country: China, Height: 450 m, 1,476 ft, Floor: 89, Opening: 2010]; Suzhou IFS [Place: Suzhou, Country: China, Height: 450 m, 1,476 ft, Floor: 98, Opening: 2019]; The Exchange 106 [Place: Kuala Lumpur, Country: Malaysia, Height: 445.1 m,1,460 ft, Floor: 95, Opening: 2019]; Empire State Building [Place: New York City, Country: United States, Height: 443.2 m, 1,454 ft, Floor: 102, Opening: 1931]; Kingkey 100 [Place: Shenzhen, Country: China, Height: 441.8 m, 1,449 ft, Floor: 100, Opening: 2011]; Guangzhou International Finance Center [Place: Guangzhou, Country: China, Height: 438.6 m, 1,445 ft, Floor: 103, Opening: 2009]; Wuhan Center [Place: Wuhan, Country: China, Height: 438 m, 1,437 ft, Floor: 88, Opening: 2019]; 111 West 57th Street [Place: New York City, Country: United States, Height: 435.3 m, 1,428 ft, Floor: 82, Opening: 2020]; Dongguan International Trade

Center 1 [Place: Dongguan, Country: China, Height: 426.9 m, 1,401 ft, Floor: 88, Opening: 2020]; One Vanderbilt [Place: New York City, Country: United States, Height: 427 m, 1,401 ft, Floor: 58, Opening: 2020]; 432 Park Avenue [Place: New York City, Country: United States, Height: 425.5 m, 1,396 ft, Floor: 85, Opening: 2015]; Marina 101 [Place: Dubai, Country: United Arab Emirates, Height: 425 m, 1,394 ft, Floor: 101, Opening: 2017]; Trump International Hotel and Tower [Place: Chicago, Country: United States, Height: 423.2 m, 1,388 ft, Floor: 96, Opening: 2009]; Jin Mao Tower [Place: Shanghai, Country: China, Height: 421 m, 1,381 ft, Floor: 88, Opening: 1998]; Princess Tower [Place: Dubai, Country: United Arab Emirates, Height: 414 m, 1,358 ft, Floor: 101, Opening: 2012]; Al Hamra Tower [Place: Kuwait City, Country: Kuwait, Height: 412.6 m, 1,354 ft, Floor: 80, Opening: 2010]; Two International Finance Centre [Place: Hong Kong, Country: China, Height: 412 m, 1,352 ft, Floor: 88, Opening: 2003]; Haeundae LCT The Sharp Landmark Tower [Place: Busan, Country: South Korea, Height: 411.6 m, 1,350 ft, Floor: 101, Opening: 2019]; Guangxi China Resources Tower [Place: Nanning, Country: China, Height: 402.7 m, 1,321 ft, Floor: 85, Opening: 2019]; Guiyang Financial Center Tower 1 [Place: Guiyang, Country: China, Height: 401 m, 1,316 ft. Floor: 79, Opening: 2021.

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