

Marina Bay Sands and Sustainability in Tall Buildings – Singapore

Tall buildings represent the most advanced technologies and innovative materials in building construction. However, they also bring problems such as high energy consumption, fire accidents, and high operational costs. This paper analyzes the Marina Bay Sands and how tall buildings can also be sustainable.



What is the rated green system building in Singapore?

The goal for this building was to achieve the platinum level of BCA Green Mark, which is the local equivalent of U.S. Green Building Council's LEED certification. The Building and Construction Authority (BCA) is an agency under the Ministry of National Development, championing the development of an excellent built environment for Singapore. "Built environment" refers to buildings, structures and infrastructure in our surroundings that provide the setting for the community's activities.

The Green Mark is a green building rating system to evaluate a building for its environmental impact and performance based on five key criteria:

- ✓ Energy Efficiency
- ✓ Water Efficiency
- ✓ Environmental Protection
- ✓ Indoor Environmental Quality
- ✓ Other Green Features

Under the Green Mark assessment system, buildings are awarded the Platinum, Gold Plus, Gold or Certified rating depending on the points scored.

<http://www.lohas-asia.org/2010/03/03/green-mark-for-green-buildings-in-singapore/>
http://www.bca.gov.sg/AboutUs/about_bca.html

What type of building is the Marina Bay Sands?

MBS is a three 55-storey hotel towers that are connected at the top by the one hectare SkyPark. Over 2,500 suite hotel rooms are contained within the three distinctive towers which are 200m-tall structures. In addition, there is a 340m-long Skypark which is considered the largest cantilevered public observation deck in the world; furthermore, a grand ballroom seating more than 6,000 diners, 100,000m² of casino, retail, and restaurant space, two theaters with total capacity of 4,000, and two crystal pavilions that appear to float on the sea like icebergs are also important items of the main design. At night the roof of the museum will become an amphitheatre with seating for 3000 people, playing host to a light and water show.

<http://cempaka-tourist.blogspot.com/2010/01/marina-bay-sands-attraction-and-threat.html>



What are the project details?

Design Architect: Moshe Safdie,

Design Engineers: Arup Singapore

Location: Singapore

Client: Marina Bay Sands Pte. Ltd. (A subsidiary of the Las Vegas Sands Corporation)

Public Openings: June 23, 2010 (Sky Park, hotel, retail, convention center and entertainment venues) and Fall 2010 (Museum of Art Science, performing arts theatres)

Site Area: 154,938 square meters / 15.4 hectare (1,668,000 square feet / 38 acres)

Gross Floor Area: 581,400 square meters (6,258,000 square feet)

Total Area: 845,000 square meters (9,096,000 square feet)

Height: 57 stories / 195 meters (640 feet)

Total Cost: US \$5.7 billion, including land cost

The SkyPark is longer than the Eiffel Tower and is large enough to park four-and-a-half A380 jumbo jets.

It is also home to the Infinity Pool, one of the world's largest outdoor pools at three times the length of an Olympic pool. It gives the illusion of the water extending to the horizon but the water actually spills over the edge into a catchment below.



[Pile caps under construction within the Tower One.](#)

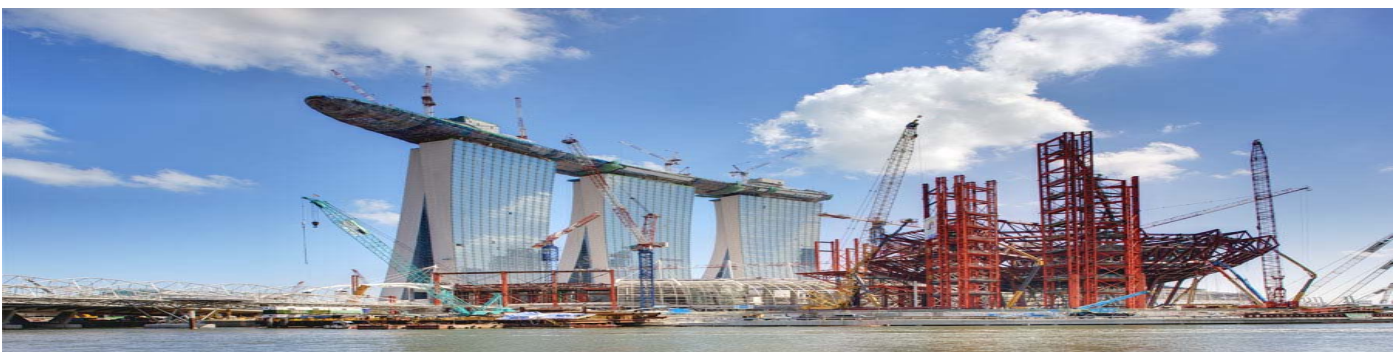
[Deep Basement & Foundations Diaphragm Wall, Jet Grouting, Barrette & Bored Piles. MARINA BAY SANDS, SINGAPORE Bulletin A496.](#)

<http://www.news.com.au/travel/travel-advice/first-review-of-singapores>

What were the main challenges during construction?

- ✓ The coastal sites' geology: Marina Bay Sands sits on sand infill, which rests in soft clay marine deposits. This soft clay makes excavations more than a few meters deep very difficult. The scheme required a large basement car park, with deep excavations across most of the site. In addition, the engineering team had to design a 35m-deep "cut and cover" tunnel next to an existing bridge. In addition, the retaining walls and the foundations were required to penetrate into the hard underlying old alluvium with many of the foundations reaching nearly 80m depth.
- ✓ Constructing and lifting the Skypark into place on top of the three towers: Arup's structural and bridge engineers devised the heavy lifting operation that is at, 200m, one of the highest strand-jacking operations ever undertaken. In addition, Arup used dynamic studies to investigate and model how the Skypark's cantilever would behave in the face of Singapore's coastal winds, as well as the structure's response to human activity such as dancing crowds.

Arup Design Yearbook 2010



Why is the Marina Bay Sands a Green Building?

1. Energy Conservation:

- ✓ At the core of Marina Bay Sands' green initiatives is an S\$25 million Intelligent Building Management System which allows automated control of lighting, heating and water supplies for the entire integrated resort to constantly provide optimal indoor conditions while utilizing energy efficiently.
- ✓ Marina Bay Sands makes use of a District Cooling System to use energy more efficiently. The air conditioning is supplied by water-cooled chillers, which are more efficient than air-cooled models.
- ✓ The District Cooling System uses ice storage whereby ice is generated at night during off-peak power periods to reduce peak loading on electric distribution grids and then used during the day to help cool the buildings.
- ✓ Some of the heat emitted from the chillers is reclaimed by heat pumps to provide hot water to the hotel and some restaurants.
- ✓ A computerized control system automatically dims or brightens lighting depending on the time of the day and the weather conditions.
- ✓ The hotel rooms are equipped with an advanced eco-mode system so that guests can play their part in protecting the environment. An "Eco" button on the remote control gives guests the option of bringing up the room temperature by a few degrees when the room is empty to save electricity.
- ✓ The curtains are programmed to close in unoccupied rooms to keep them cooler.
- ✓ Double glazed windows in the hotel and most of the retail area reduces noise and halve the heat that normally comes through the windows.
- ✓ "Green roofs" with landscaping on roof decks are located throughout the development. The Sands SkyPark crowning the three hotel towers has 250 trees and 650 plants, some up to 8 meters tall.

- ✓ In the casino, enthalpy wheels recover cool air in the building exhaust to help pre-cool the incoming fresh air and cut down on energy use.
- ✓ The hotel atrium is cooled to an ambient temperature of 25 degrees Celsius (77 degrees Fahrenheit), which is a little warmer than in a typical lobby environment. The air is dispersed at lower levels closer to guests, creating comfortable conditions and improved energy efficiency.

2. Water Conservation

- ✓ Engineers installed automatic faucets and constant flow regulators in the toilets within the public areas to minimize water usage.
- ✓ Guestrooms feature water efficient fixtures.
- ✓ Rainwater will be collected on the roof of the Museum in a rain harvesting system and cascade into a pool below. The water collected can be recycled in the museum's restroom flushing system.

3. Waste Management

- ✓ Building one of the largest properties in Singapore could create a lot of waste; the Marina Bay Sands have taken steps to cut waste to a minimum, for instance:
 - ✓ Segmenting waste into organic and non-organic waste for proper disposal.
 - ✓ Minimizing waste by recycling and reusing wood, metal and excavated earth.
 - ✓ Treating water on the site to remove silt and sediment, and then recycling the water to wash floors and truck tires.

4. Other Green Features

- ✓ The MBS's designers identified areas where the building can help to protect the environment, including partnerships with eco-friendly suppliers and contractors, for instance:
 - ✓ Eco-paints frequently incorporate recycled or leftover paints which would normally go to the landfill.
 - ✓ Engineers reduced the use of diesel machinery to lower carbon monoxide emissions at the site.

- ✓ Shielded from the winds and lavishly planted with 250 trees and 650 types of plants. The landscape network reinforces urban connections with the resorts surroundings and every level of the district has green space. The SkyPark celebrates the notion of the "City in a Garden" that has been the underpinning of Singapore's urban design strategy.
 - ✓ Half of the roofs of the hotel, convention center, shopping mall, and casino complex are planted with trees and gardens.
5. Ensuring Quality Air
- ✓ The basement parking facility is equipped with carbon monoxide monitoring and nitrous oxide to ensure appropriate ventilation.
 - ✓ Carbon dioxide monitoring controls are deployed in casino and meeting rooms, to regulate the amount of fresh air to meet the needs of the building.
 - ✓ Non-toxic eco-paints are used wherever possible, reducing the amount of toxic fumes released into the air.
 - ✓ The property provides complimentary shuttle services to guests to encourage the use of alternative transportation, and is within walking distance of various bus stops and a subway station.
- <http://www.architecturezine.com/marina-bay-sands-building-in-singapore-by-safdie-architects/>
- http://www.arup.com/Homepage_Archive/Homepage_Shaping_Singapore.aspx



“Marina Bay Sands is really more than a building project, it is a microcosm of a city rooted in Singapore’s culture, climate, and contemporary life,” says architect Moshe Safdie. “Our challenge was to create a vital public place at the district-urban scale, in other words, to address the issue of megascale and invent an urban landscape that would work at the human scale.” As quoted by Moshe Safdie.

Conclusions

Marina Bay Sands is the realization of a long-term development vision for Singapore and one of the fastest-growing business hubs in Asia; furthermore, Singapore needed to assure that the demand for new developments could be met within the cities limits without causing sprawl. In this perspective, tall buildings such as MBS are becoming increasingly necessary as a result of the efficient use that they make of the limited land available; however, a sustainable design needs to be incorporated into building design for two major reasons: to create a better environment and protect the earth’s resources, as well as legislative reasons. In general, new tall buildings have to fit within this context. The main concern for the construction of tall buildings like MBS is their operational efficiency rather than their environmental impact. The most

intensive use of energy usually results from the heating or cooling of spaces. Vertical transportation uses about 10 per cent of a tall building's energy while lighting can make up about 20 per cent.

The goods and the bads:

- ✓ A series of layered gardens provide ample green space throughout Marina Bay Sands extending the tropical garden landscape from Marina City Park towards the Bayfront. The landscape network reinforces urban connections with the resort's surroundings and every level of the district has green space that is accessible to the public.
- ✓ The MBS played an important role in the city of Singapore; for instance, the MBS building can maintain high and stable levels of economic growth and employment while producing a social progress that recognizes the needs for everyone.
- ✓ Sustainable tall buildings need to be effectively designed and constructed from the outset. This is the answer to these key issues; ensuring durability and longevity, as well as energy savings is the goal of every stakeholder involved in tall building projects.
- ✓ Advantages of tall building construction:
 - Economies of scale Refinements of design eg. repetitive floor plans can offer major savings in materials
 - Standardization Procurement of large quantities can lead to more efficient production and cheaper unit costs
 - Selection of Materials Choosing environmentally friendly materials in facades can reduce impact
 - Land use Tall buildings may occupy part of a plot allowing more public space at ground level.
- ✓ Disadvantages of Tall Building Construction:
 - Safety working at height in construction.
 - Surface area Greater area of façade per m2 floor area
 - Floor area efficiency Lower net-gross floor area ratio
 - Heavier structural frame Lower columns must support floors above.
 - Deeper foundations
 - Wind effects
 - Shading Shadows on other buildings - rights to light
- ✓ There are good commercial and practical reasons for developing these three mega-towers in Singapore; however, it appears that there is a race in the new building development around the world in order to be the "tallest". This factor is defining power and highly social standards without taking in consideration the environmental impact that is producing these powerful buildings in major metropolitan cities

<http://blog.malaysia-asia.my/2010/04/marina-bay-sands-opening-singapore.html>

Faber Maunsel, Tall Buildings and Sustainability Corporation of London, March 2002.