

**CAYAN TOWER | PROJECT FACTS**

**Official Name :** Cayan Tower  
(previously known as *Infinity Tower*)<sup>1</sup>  
**Location :** Dubai | United Arab Emirates<sup>1</sup>  
**Function :** Residential<sup>1</sup>  
**Architect :** Skidmore, Owings & Merrill<sup>1</sup>  
**Structural Engineer :** Skidmore, Owings & Merrill - William F. Baker<sup>1</sup>  
**Construction :** 2006 - 2013<sup>1</sup>  
**Architectural Height :** 306,4 m<sup>1</sup>  
**Occupied Height :** 263,1 m<sup>1</sup>  
**Global | Regional | National Rankings :** 67 | 22 | 19<sup>1</sup>  
**Floors Above Ground :** 73<sup>1</sup>  
**Floors Below Ground :** 5<sup>1</sup>  
**Number of Apartments :** 495<sup>1</sup>  
**Number of Parking Spaces :** 623<sup>1</sup>  
**Number of Elevators :** 7<sup>1</sup>  
**Top Speed of Elevators :** 28.8 km/h (8m/s)<sup>1</sup>  
**Gross Floor Area :** 111 000 m<sup>2</sup><sup>1</sup>  
**Construction Cost :** US \$ 207 million<sup>2</sup>

Figure 2: Retrieved from <http://cayan.tdimg/gallery/infinity/es/infinity-ex-2.jpg> on 13<sup>th</sup> January, 2015

Figure 3 (Front page): Retrieved from <http://cayan.tdimg/fullscreen/infinity-yano-2.jpg> on 13<sup>th</sup> January, 2015  
Figure 3 (Caption): Retrieved from <http://skyscrapercenter.com/building/cayan-tower/464> on 13<sup>th</sup> January, 2015  
1: Cayan Tower Facts | TheSkyscraperCenter. Retrieved from <http://skyscrapercenter.com/building/cayan-tower/464> on 13<sup>th</sup> January, 2015  
2: Smith, S., & Coul, A. (1991). Tall Building Structures: Analysis and Design. New York: McGraw-Hill Book Company.  
3: Smith, S., & Coul, A. (1991). Tall Building Structures: Analysis and Design. New York: McGraw-Hill Book Company.  
4: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.

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Figure 3: Retrieved from <https://gulfphoto.com/photos/taiz-ai/2013/4/Cayan-Tower-on-13th-January-2015>

**Material :** Reinforced Concrete<sup>3</sup>  
**Structural System :**  
- According to Günel;  
**Framed-tube System**<sup>3</sup>  
- According to Tarahati;  
**Framed-tube System**<sup>4</sup>  
- According to Smith;  
**Framed-tube System**<sup>5</sup>  
- According to Buyukozturk;  
**Framed-tube System**<sup>6</sup>



Figure 4: Structural Model, drawn by Fatih Topak

1: Cayan Tower Facts | TheSkyscraperCenter. Retrieved from <http://skyscrapercenter.com/building/cayan-tower/464> on 13<sup>th</sup> January, 2015  
2: Smith, S., & Coul, A. (1991). Tall Building Structures: Analysis and Design. New York: McGraw-Hill Book Company.  
3: Smith, S., & Coul, A. (1991). Tall Building Structures: Analysis and Design. New York: McGraw-Hill Book Company.  
4: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.  
5: Buyukozturk, O. (2004). High Rise Buildings - Evolution and Innovations. Cambridge: MIT.

**CAYAN TOWER | DESIGN IDEA & GOALS**

• Cayan Tower is the tallest twisted tower in the world.<sup>7</sup>

• Each floor of Cayan Tower has exactly same contours and is rotated by 1.2 degrees to achieve the full 90° spiral, creating the shape of a helix.<sup>7</sup>

• Unique spiral shape of Cayan Tower reflects the ever-changing shapes of the deserts, winds, and seas that surround it.<sup>7</sup>

• The shape of the tower is a variation on Turning Torso in Malmö, Sweden, which also twists exactly 90°.<sup>7</sup>



Figure 5: Screenshot Retrieved from <https://www.youtube.com/watch?vH1v9v1AgdUk> on 13<sup>th</sup> January, 2015

7: Cayan Tower | Emporis, Retrieved from <http://www.emporis.com/building/cayan-tower-dubai-United-Arab-Emirates> on 13<sup>th</sup> January, 2015

**CAYAN TOWER | DESIGN IDEA & GOALS**



Figure 7: In final design, glazing is pushed 20 cm from exterior face of the columns, drawn by Fatih Topak.

• The design team presents 3 options; a) 60 degree rotation; b) 90 degree rotation; c) 90 degree rotation with glazing pushed 20 cm from exterior face of the columns from original 12 cm for maximizing sellable area to the client. Based on the clients comments, last one was picked.<sup>8</sup>

8: Ganev, & Haymaker, J. (2007). Conceptual design of high rises with parametric methods. Frankfurt: eCAADe Conference Proceedings.

**CAYAN TOWER | TOP VIEW & ELEVATIONS**



Figure 8: Top View of Cayan Tower, drawn by Fatih Topak



Figure 9: Elevations of Cayan Tower, drawn by Fatih Topak

9: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.

**CAYAN TOWER | SITE PLAN & FUNCTIONS**

• It is located near the north inlet of the Dubai Marina and this positioning, halfway between the new city and the water, became the design's driving force.<sup>9</sup>

• At its base, the project addresses the marina's Riverwalk, a twelve meter wide ribbon of pedestrian walkways, outdoor cafes, seating and green space that provides a continuous communal amenity for the Marina. Residents living lower in the tower benefit most from views back into the marina.<sup>9</sup>

• As the building ascends, the more desirable views become those of the Gulf. By incorporating incremental plan rotations at each level to generate the building's distinctive twist, the designers were able to capitalize on the changing prevailing views as the building ascends.<sup>9</sup>

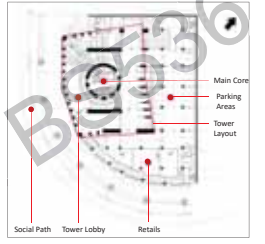


Figure 10: Site Plan & Functions, Retrieved from <http://www.architectmagazine.com/multimedia/cayan-tower-designed-by-skidmore-owings-merrill.aspx> on 13<sup>th</sup> January, 2015

9: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.

**CAYAN TOWER | BUILDING FUNCTIONS**

• Cayan Tower has six podium floors in which there are tower lobby, car parks, retail and public cafes.<sup>9</sup>

• There are two mechanical floors in Cayan Tower and they are located on 28th and 72nd floors. Both mechanical floors are in two story-height.<sup>9</sup>



Figure 11: Residential Plan Layouts, Retrieved from <http://www.architectmagazine.com/multimedia/cayan-tower-designed-by-skidmore-owings-merrill.aspx> on 13<sup>th</sup> January, 2015



Figure 12: Functional Diagram, drawn by Fatih Topak

9: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.

**CAYAN TOWER | STRUCTURAL SYSTEM**

• The design philosophy for the Tower is based upon the exterior form of the building as a direct expression of the structural framework.<sup>9</sup>

• The lateral load resisting system for the Tower consists of a combination of a reinforced concrete moment-resisting perimeter tube frame and a circular central core wall, connected at each level by the two-way spanning reinforced concrete flat plate slabs acting as diaphragms. Perimeter columns are also connected to each other with spandrel beams.<sup>9</sup>

• Floor to floor height of each identical structural floor is 3.7 meters.<sup>9</sup>

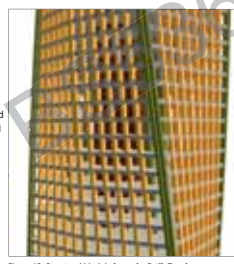


Figure 13: Structural Model, drawn by Fatih Topak

8: Ganev, & Haymaker, J. (2007). Conceptual design of high rises with parametric methods. Frankfurt: eCAADe Conference Proceedings.  
9: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.

**CAYAN TOWER | STRUCTURAL SYSTEM**

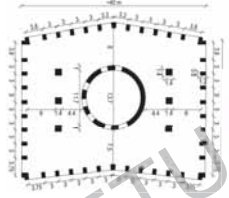


Figure 14: Structural Plan of Cayan Tower, drawn by Fatih Topak



Figure 15: Cayan Tower, drawn by Fatih Topak

9: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.

**CAYAN TOWER | STRUCTURAL SYSTEM**

• A series of options are studied for the perimeter frame in order to create the unique twisting geometry of the Tower. For its distinct advantages, from the standpoint of architectural efficiency, structural performance and ease of construction, stacking the columns in a step-wise manner at each level, where each column slopes in one direction, and is offset over the column below is applied as the perimeter columns system.<sup>9</sup>



Figure 16: Retrieved from <http://www.constructionweekonline.com/pics-16663-pictures-infinity-tower/5> on 13<sup>th</sup> January, 2015



Figure 17: Retrieved from <http://dubai.constructionupdate.blogspot.com/2009/06/infinity-tower-dubai-marina-26june2009.html> on 13<sup>th</sup> January, 2015

9: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.

**CAYAN TOWER | STRUCTURAL SYSTEM**

• As the perimeter columns ascend from story to story, they lean in or out, in a direction perpendicular to the slab edge. At every level, the columns make a small step to the side, shifting in position along the spandrel beams so that as the building twists, each column maintains a consistent position at each floor relative to the tower envelope. The corner columns and the six (6) interior columns follow a different rule, twisting as they ascend.<sup>9</sup>

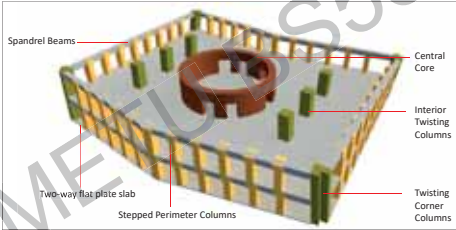


Figure 18: Structural Orthogonal Drawing of Cayan Tower, drawn by Fatih Topak

9: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.

**CAYAN TOWER | STRUCTURAL SYSTEM**

• The structural system offers significant construction simplification by permitting a high level of repetition in the formwork, which directly impacts the construction cycle time. Also, this system leads to residential floor layouts which are repetitive at each level despite the twisting nature of the building form.<sup>9</sup>

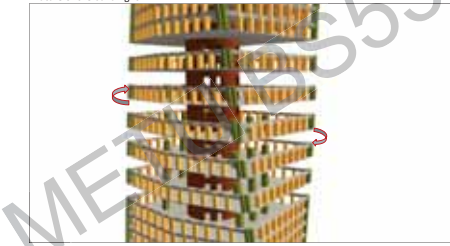


Figure 19: Floor twist of Cayan Towers, drawn by Fatih Topak

9: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.

**CAYAN TOWER | WIND ENGINEERING**

• Due to the Tower's significant height and unique shape, detailed wind tunnel testing was performed in order to understand the wind forces acting on the building.<sup>9</sup>

• A series of 1:400 scale model tests were performed in order to determine the design wind loads for the structure as well as peak pressures for the design of the cladding.<sup>9</sup>

• Pedestrian wind studies were also performed to ensure a comfortable wind environment for those spaces designated for outdoor use, and for adjacent public thoroughfares, respecting air, and sun rights of the surrounding.<sup>9</sup>



Figure 20: Retrieved from <https://architizer.com/projects/cayan-tower/> on 13<sup>th</sup> January, 2015

9: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.

**CAYAN TOWER | WIND ENGINEERING**

• For the twisting Cayan Tower, the variation in the building silhouette over its height creates a constantly changing frontal wind sail dimension as the building ascends, acting to disorganize the wind forces which are generated.<sup>9</sup>

• This disorganization of the wind forces, and therefore a reduced correlation of the Tower's wind response over its height, results in reduced lateral motion and thus reduced effective wind forces acting upon the building. Moreover, corners are also designated as notched to contribute buildings performance against the wind forces.<sup>9</sup>

• When compared to a similar building taken as a straight extrusion with height (no twist), it is estimated that the twisting form of the Cayan Tower reduced the structure's across-wind excitation by some 25% or more.<sup>9</sup>

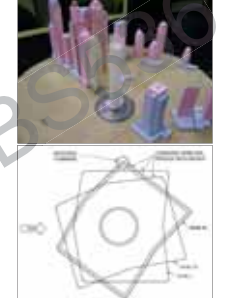


Figure 21:22: Wind Engineering | Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE.

9: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010; pp. 3078-3087.

## CAYAN TOWER | MEP SYSTEMS

In Cayan Tower, major mechanical risers are located in the circular central core, which allows a straight vertical path through the Tower. The balance of the building's mechanical, electrical and plumbing systems is located within a deep demising wall between the central circulation corridor and the residential units. This zone is specifically located and designed to create a minimally obtrusive vertical path for the building services to access all residential units as they rotate about the central core as the building ascends.

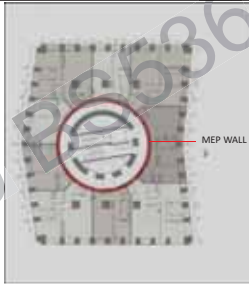


Figure 23: Retrieved from <http://www.outdoor-design.com.au/landscape-design/new-record-breaking-building-with-a-twist/1616.html> on 13<sup>th</sup> January, 2015

9: Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010. pp. 3078-3087.

## CAYAN TOWER | FACADE DESIGN

- The winding shape of Cayan Tower reveals a structure that helps protect its interior from the sun.<sup>10</sup>
- Yet, in order to protect the building from the intense desert heat and to provide additional shade, reinforced concrete structure on the exterior is fully clad in metal (titanium) panels and screens.<sup>10</sup>
- Balconies of the residents are covered with sun blinds which are again made out of titanium panels in order to control the sunlight.

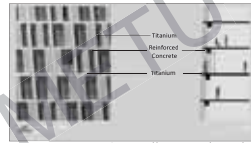


Figure 24, 25, 26: Retrieved from <https://architizer.com/projects/cayan-tower/> on 13<sup>th</sup> January, 2015

10: In progress: Cayan Tower | Archdaily, Retrieved from <http://www.archdaily.com/331128/in-progress-infinity-tower-som/> on 13<sup>th</sup> January, 2015



## CAYAN TOWER | REFERENCES

- Cayan Tower Facts | TheSkyscraperCenter, Retrieved from <http://skyscrapercenter.com/building/cayan-tower/464> on 13<sup>th</sup> January, 2015
- Infinity Tower | Khatip Alami, Retrieved from <http://www.khatibalami.com/projects.htm> on 13<sup>th</sup> January, 2015
- Gunel, H. & Ilgin, E. (2014), *Tall Buildings: Structural Systems and Aerodynamic Form*, Routledge – Taylor and Francis Book Company.
- Taranath, B. (1998). *Steel, Concrete & Composite Design of Tall Buildings*, New York: McGraw – Hill Book Company.
- Smith, B.S. & Coull, A. (1991). *Tall Building Structures: Analysis and Design* New York: Wiley.
- Buyukozturk, O. (2004). *High Rise Buildings – Evolution and Innovations*, Cambridge: MIT.
- Cayan Tower | Emporis, Retrieved from <http://www.emporis.com/building/cayan-tower-dubai-united-arab-emirates> on 13<sup>th</sup> January, 2015.
- Gane, V. & Haymaker, J. (2007). *Conceptual design of high rises with parametric methods*. Frankfurt: eCAADe Conference Proceedings.
- Baker, W., Brown, C., Young, B., and Zachrisson, E. (2010) Infinity Tower, Dubai, UAE. Structures Congress 2010. pp. 3078-3087.
- In progress: Cayan Tower | Archdaily, Retrieved from <http://www.archdaily.com/331128/in-progress-infinity-tower-som/> on 13<sup>th</sup> January, 2015