The economic boom of India in the past decade has brought with it a surge in the construction industry. To further boost development and increase export, the central government set up export processing zones, known as Special Economic Zones (SEZs). The city of Hyderabad is on the forefront of development and a maximum number of SEZs have been established in Andhra Pradesh, most of which are IT based.

The Hill County SEZ (HC SEZ) is one such development under the SEZ program on the outskirts of Hyderabad. The proposed design is nestled within a larger Hill County MP developed by SOM which promotes walk to work ideas. The current design of two buildings connected through bridges constitutes a total of approximately 1.2 million square feet of office space with amenities on the lower floors. The spaces are designed to be occupied by IT and IT Enabled Services companies.

India has only recently introduced the Energy Conservation Building Code (ECBC) and so many buildings built in the past decade lack energy efficient measures. Furthermore, many IT buildings with large floor plates and high occupancy density have poor indoor environment. In light of this background, HC SEZ design has driven the idea of an energy efficient building with increased indoor environmental quality from the onset.

Since the building only experiences cooling loads, it is essential to minimize insulation on its fenestration whilst allowing for daylight penetration. The design optimizes orientation and provides maximum fenestration for work spaces to the north and south. Relatively narrower floor plates of 22m are accommodated in a courtyard type building, where the north and south wings are office spaces and east and west, where radiation levels are high, are occupied by cores. In the next series of massing studies, the building form steps out upwardly on its south facing facades to create self-shading effects.

The facade design is carefully analyzed to minimize solar heat gains. The window wall ratio (WWR) is roughly 30% while maintaining views and daylighting levels. Vertical shading fins on the facade run the full length of the building. The angle of fins for each orientation is optimized through an extensive shading coefficient analysis. Informed by the traditional jali, the fins incorporate lattice patterns which are part of local traditional arts.

All the passive design measures applied to HC SEZ building design helped reduce the size of the proposed mechanical system. In addition, the active systems design complies by not only ECBC codes but also ASHRAE. Overall, at current stage of design, the energy consumption of HC SEZ buildings is 35-40% lower than an average office building in India and roughly 15% lower than an ASHRAE compliant building while maintaining a high level of indoor environmental quality.

The project is aiming and currently in the process of achieving LEED Gold rating under IGBC’s Core and Shell program.

Quantum change and transferability:

The building breaks free from the perceived generic image of an international standard office building. Shallow base-spans, unique to developer building typology in India, have been incorporated and justified through energy savings. Reduced chillers are in response to a well shaded facade. In essence, a courtyard shaped building has been made efficient and visible in the developer market.
Design:

At a primary level, the building complex takes advantage of its unusual Landscape Environment, carving itself into and out of the dramatically contoured and rocky site of Hyderabad.

Beginning as a series of programmed ribbons and surfaces, the built forms negotiate between the contours and strata's of the site, creating an activated 3-D ground plane that houses all the shared amenity spaces. This strategy enables programmatic movement, connectivity and exchange at the building level and the larger campus level.

As these ribbons elevate out of the landscape to define the individual office buildings, they carve vertical voids within themselves creating courtyard spaces. The courtyard spaces, a vernacular type extensively used in India, are used both as an architectural device to bring in daylight and enhance the sustainability of the work spaces as also to define a social place. A place of gathering, exchange and flow that connects the people, the place and the built form both visually and physically.

As a whole, we seek to evolve an architectural type that uses new technology and expertise in tandem with existing vernacular architectural and climatic solutions. Abstracted vernacular forms and patterns are used to help set the building within its cultural space.

Contextual and aesthetic impact:

The building forms and site walls take advantage of the unique site by carving itself into and out of the dramatically contoured and rocky site. The building elevates as extensions of the contours themselves. As these contours rise, the ribbon forms wrap around to form courtyards which have been integral to the local vernacular. The shading devices take cue from local traditional ‘kolam’ pattern and ‘jali’ used throughout India to achieve an abstract design.

Driven by daylight:

Daylighting studies comparing a typical box building with a courtyard building helped inform the client of its advantages in both occupant comfort and energy savings. Narrow lease spans were implemented by the use of courtyard shaped building.
Embedding environmental analysis into the design process:

To achieve sustainable design goals, a process was established by which all analysis may be streamlined in the best possible manner and implemented into the design and development process. This becomes critical in a project of this magnitude that involves large teams of designers and consultants.

Starting with the climate analysis and establishing design criteria and goals, initial studies deal with passive strategies that can be incorporated into the design of the building(s). These include daylighting, shading, building envelope and thermal analysis. Once the building design is optimized for its performance, efficient active systems which work in tandem with the architecture are incorporated and tested for. Restorative design analysis further optimizes the building to achieve minimal energy consumption and enhanced occupant comfort.

Analysing the climate:

- Available radiation (Wh/m²)
- DB Air temperature (°C)
- Precipitation (mm)
- Relative humidity (%)
- Wind directions
- Wind speed (m/s)
- Psychrometric chart

Ecological quality and energy conservation:

Solar response has been central to the design of the project to mitigate heat gains. Since lighting load is another large contributor to energy bills, careful attention has also been given to naturally lighting interior spaces. Water is a relatively more valuable resource in this part of the world. The project is designed to harvest rainwater to be used for irrigation and replenishing the aquifer. An on-site STP processes grey water to be used for non-potable use including the chilled water for the AHUs and no potable water supplied by the municipality is used for flushing. Whilst being sensitive to its exterior environment, the design has been mindful of the indoor environment directly impacting occupant comfort. Almost every occupied space achieves a daylight factor of ≥3% and ventilation rates have been increased to 30% over what is prescribed as per ASHRAE codes.

Orientation:

Orientation of the building can be key in allowing for passive design strategies to succeed. In the climate of Hyderabad, it was determined that solar gains would be a significant contributor to internal gains. If not mitigated effectively, it can also adversely impact occupant comfort.

As the design developed, the cores were placed facing east and west facades thereby reducing the need for windows on those orientations. Daylighting is achieved through north and south fenestrations.

Responding to the sun:

Solar analysis and response becomes central in all further environmental analysis due to the fact the Hyderabad experiences primarily cooling season and solar gains are the largest contributor to heat gains. This explains the emphasis given to solar mitigation in all phases of the analysis including orientation, massing and facade articulation.

Solar insolation for various facades

Orientation strategy responding to the environment

Energy-Efficient Office Complex
Stepped Massing:

Initial studies during the concept design phase were done to understand the impact of solar radiation on a courtyard shaped building and also potential design options in response to it.

Insolation analysis for the courtyard facing facades show higher levels of radiation on the south and east facing surfaces. A design option considered was to tilt the building inwards to self-shade its surfaces.

The analysis with stepped surfaces show that although the south facing surface is quite successful in reducing insolation levels, the east facing surfaces have limited success. This is due to higher solar altitude angles in the south direction and lower in the east direction.

Two options for massing were studied to understand the effects of self-shading. The first option extrudes the courtyard straight up in a linear fashion creating clean vertical surfaces.

The second option starts to slide the floor plates outwards as it moves up in the southward direction. This form starts to create patterns of self-shading.
Facade articulation:

The orientation of a facade and the corresponding program space behind create guiding parameters for the facade. Four basic panel types are defined based on 1.2m module with varying WWRs which can then be applied to facade types. A combination of panel types is then applied to each facade responding to its guiding parameter. For example, the north facade of an office space will have maximum WWR (B+B) whereas the west facade of a core will have minimum WWR (C+C).

Once the WWR is established for each facade, a shading analysis is performed to optimize fin angles. Fin angles and material as well as glazing specifications are further tweaked in response to daylighting, glare and energy analysis.

With the glazing size and the vertical shading fin width constant, a preliminary study was done to evaluate optimum fin rotation angle.

Further detailed analysis for each facade type, taking into account the effect of fins on floors above, were also done to obtain more precise shading percentage data. The data (below) showed that the fenestration was shaded on an average, 88% annually.

Daylighting & Glare:

Detailed illuminance and luminance studies were done to understand the effect of interior finishes, light shelves, etc. on enhancing daylighting and prevent glare in the office spaces. Although designed as a core and shell building, these studies can be used as a resource potential tenants to inform their interior design strategies.

Energy-Efficient Office Complex
Fin “Jail”:
The design of the fins is informed by the “jail”, a shading device of perforated ornamental screens that are used in vernacular Indian Architecture. The “jail” patterns are an intricate play of opacity, transparency and scale. In our design, the fins are an abstracted “jail” that through an enhanced play of light and shade on the façade further animate the tectonic quality of the building. The pattern on the fins take one from traditional kolam patterns prevalent in southern India. It has been abstracted to fit the Jail gradient. The techniques proposed for the pattern is a combination of lanced perforations and stamping in lieu of punched openings for minimal solar penetration.

Subject of research:
SOM collaborated with Steven’s Institute of Technology where graduate students joined the team to assist in research and design of various facade elements.

Amongst other tasks, the students studied shading effects of lanced perforation. It further became a subject of research to compare the empirical results using a physical model with results from various simulation tools to understand the tolerances for such computer simulations.

SOM has a history of such collaborations to promote research that benefits both academics and practitioners.

Economic performance and compatibility:
The use of local materials and techniques allowed for the unique structure and an intricate façade within margins of the proposed budget. The emphasis on passive design strategies has allowed the buildings to be energy efficient with no capital cost increment on active mechanical systems. Whilst maintaining a level of quality in building services and indoor environment, the building efficiency hovers around 80%. With tax incentives in place by the government as part of the SEZ, the project has and will attract national and international entities to the Hill County project.
Water Efficiency Strategies:

The project is designed to collect, store and distribute rainwater for non-potable purposes like landscape irrigation and flushing. Porous pavements reduce surface runoff while aiding groundwater recharge. Grey water is collected and transported to an on-site sewage treatment plant and the treated water is used for cooling in absorption chillers. The volume of grey water produced on site is reduced with the use of water efficient fixtures.

Planning Strategies:

The typical office floor has narrow floor plates with the cores on the East and West orientations. All open workstations are laid out on the perimeter to take advantage of daylight and views while conference and ancillary spaces are located in the middle. The central courtyard is shaded and encourages occupant usage all year round.

Ethical standards and social equity:

Programs such as this Information Technology (IT) SEZs are designed to promote economic growth for the burgeoning middle class in India. This project has strived to provide a physical work environment that promotes well being for these IT workers. In addition to providing employment to the IT workers, a project of this magnitude employs thousands of unskilled laborers who come from rural India in search of financial betterment. In the absence of any occupational hazard standards in India (such as OSHA in the US), IGBC requires minimum safety standards for construction to qualify for LEED certification. By adhering to LEED requirements, this project by default enforces safety requirements for its construction workers.